आपो हि ष्ठा मयोभुवः

ANNUAL REPORT 2023-24



NATIONAL INSTITUTE OF HYDROLOGY

Department of Water Resources, River Development & Ganga Rejuvenation,
Ministry of Jal Shakti
Jalvigyan Bhawan, Roorkee - 247667(Uttarakhand)

National Institute of Hydrology
राष्ट्रीय जल विज्ञान संस्थान

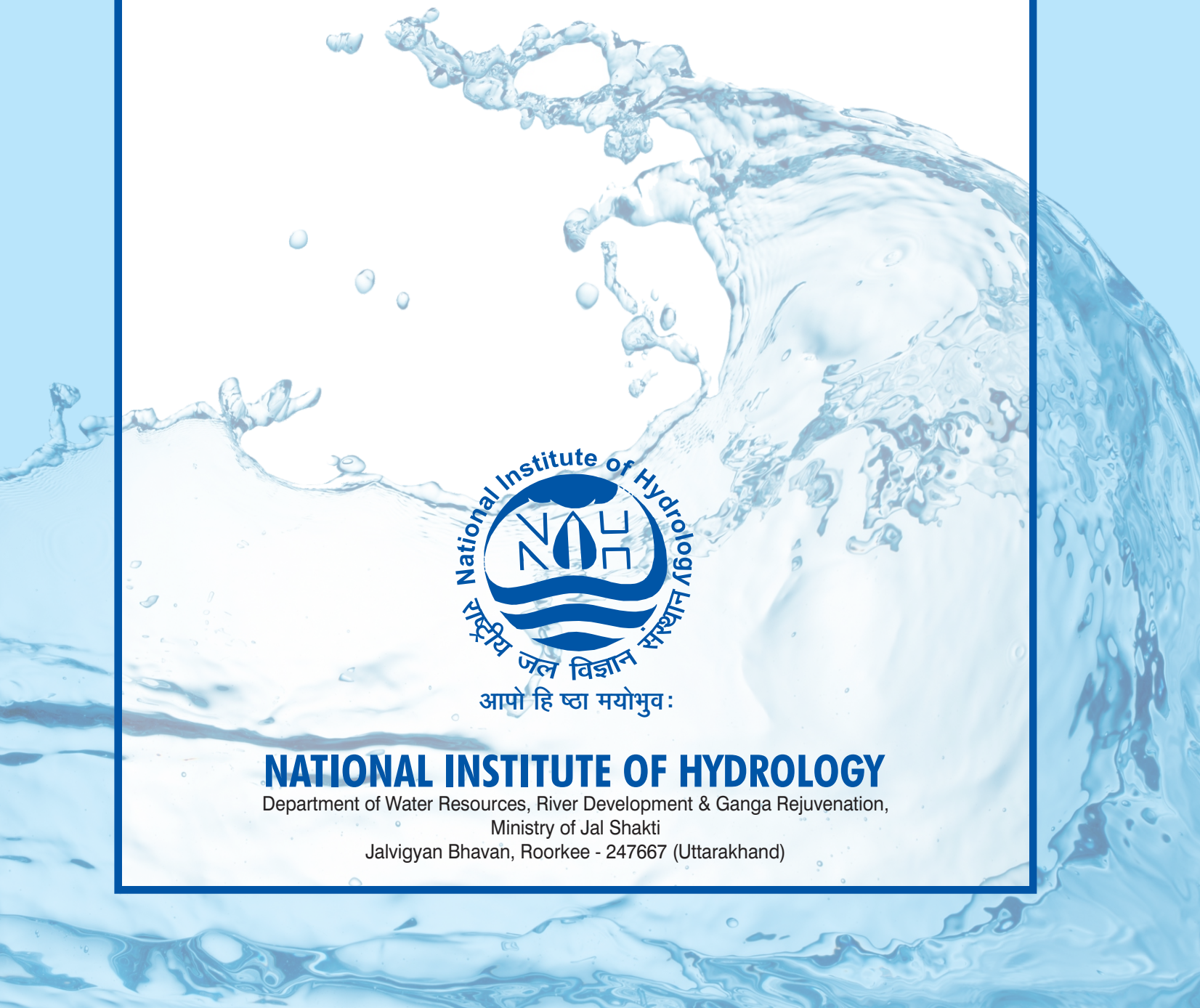
आपो हिष्ठा मयोभुवः

आपो हिष्ठा मयोभुवः स्थान ऊर्जे दधातन ।
महे रणाय चक्षसे ।।

O water, because of your presence,
the atmospherer is so refreshing,
and
impart us with vigour and strength.
We revere you
who gladdens us by your pure essence.



ANNUAL REPORT
2023-24



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Director's Note



I feel immensely proud to present the Annual Report of the National Institute of Hydrology, Roorkee for the year 2023-24. The Annual Report provides glimpses of the activities and achievements of the Institute during the year 2023-24.

Its more than four decades since the NIH was established in the year 1978 and I feel greatly privileged to be associated with the Institute for more than three decades. It gives me immense satisfaction to witness how the Institute has grown up in recent years and established itself as a centre of excellence, contributing significantly to research in the area of hydrology and water resources, not only through organizational growth and infrastructure, but also in its activities and achievements. The Institute is carrying out its R&D activities under six scientific divisions at its HQ Roorkee and seven regional centres located across the country.

The Institute is well equipped to carry out hydrologic modelling, laboratory & field oriented studies in the emerging areas of hydrology & water resources. Besides the basic and applied research undertaken through various in-house/sponsored/consultancy research projects and collaborative studies with relevant national/international organizations, the Institute vigorously pursues capacity development and technology transfer activities by organizing a number of training programs for field engineers, scientists, researchers and NGOs in the areas of hydrology and water resources. In addition, the Institute also performs various outreach activities viz., exhibitions, mass awareness in schools/villages/general public, etc. The Institute has now established itself not only as a premier research institute of the Government of India but also as Institute of International repute.

The achievements of the Institute have been possible due to the dedicated efforts of the scientists with due support from the scientific, technical and administrative staff and the project staff. My sincere gratitude to all of them for their sincerity, hard work and dedication. I also express my sincere gratitude towards N.I.H. Society, Governing Body, Standing Committee, Technical Advisory Committee, Working group and Regional Coordination Committees of the regional centres for their constant support and guidance. I also thank Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti, Government of India for their continuing support and encouragement, without which the achievements of the Institute would not have been possible I also take this opportunity to express my appreciation towards all our national and international collaborators and sponsors for their support in our scientific and technical endeavours.

Considering the overall growth and progress being made by the Institute every year, I believe firmly that the Institute shall attain further higher levels of achievements in the years to come to fulfil the aspirations of the nation.

(Dr. M.K. Goel)
Director

Achievements *at a glance*

- ✓ The R&D work in the Institute has been carried out at the headquarters, Roorkee and seven regional centres located at Bhopal, Belagavi, Guwahati, Jammu, Kakinada, Jodhpur and Patna. At the headquarters, significant emphasis has been given on basic, applied and demand driven research while at the Regional Centres, more emphasis has been given to field oriented research problems related to the respective jurisdiction of the centre.
- ✓ During the year 2023-24, the Institute has worked on 60 R&D studies and 39 International/National sponsored projects to fulfil its objectives. With the changing scenario in water sector, the Institute has focused more on advanced and demand driven research.
- ✓ The Institute has also taken up 67 consultancy projects and successfully completed 28 consultancy projects funded by various Central/State Governments, PSUs and Private Organizations during the year.
- ✓ The studies and research carried out by the Institute have received national and international recognition and have resulted in the publication of 7 books, 32 chapters in books, and 292 research papers in reputed international and national journals and proceedings of various international and national conferences, seminars and symposia, during the year.
- ✓ As part of the Technology Transfer Programme of the Institute, a total 60 training courses/ workshops/brainstorming sessions symposia/seminar/conferences. The Institute also organized the World Water day 2024 on 22 March, 2023.
- ✓ A total 53 Mass Awareness Programme were organized by the Institute during the year in different parts of the country. Of these, 20 activities under Swachh Bharat Mission.
- ✓ The Institute has been participating in majoractivities under the National Hydrology Project (NHP) funded by MoJS (GoI) through World bank. NIH has been involved in various activities of NHP viz., Purpose Driven Studies, training and capacity building, development of hydrological model and Decision Support System Planning& Management (DSS-PM).
- ✓ The Institute was awarded the ISO 9001:2008 Certificate on December 13, 2012. It was upgraded to ISO 9001:2015 on December 13, 2015. During the year 2023-24, on the basis of internal and external audits, the Institute continued as ISO 9001:2015 certified organization.

1 About the Institute

The National Institute of Hydrology is a premier research organization in India working in the areas of hydrology and water resources. It was founded on 16th December 1978 as an autonomous body registered under the Registration of Societies Act of 1860 under the then Ministry of Irrigation (Now under the Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti), Government of India, at Roorkee. The Institute is funded by the Ministry of Jal Shakti. The main objectives of the Institute are:

1. To undertake, aid, promote and coordinate systematic and scientific work in all aspects of hydrology
2. To cooperate and collaborate with other national, foreign and international organizations in the field of hydrology
3. To establish and maintain a research and reference library in pursuance of the objectives of the Society and equip the same with books, reviews, magazines and other relevant publications
4. To do all other such things as the Society may consider necessary, incidental or conducive to the attainment of the objectives for which the Institute has been established.

Since 1978, the Institute has expanded with addition of seven Regional Centres in different hydrological regions of India.

The organisational structure of the Institute consists of NIH Society, Governing Body, Standing Committee, Technical Advisory Committee, Working Group for Scientific Divisions at the Headquarters, and Regional Coordination Committees for the six Regional Centres. Details of each component of the structure are presented in Chapter - 2.

The Director of the Institute is the Principal Executive Officer of the Society and is appointed by the Government of India. As on 31.3.2024, the Institute has a team of 92 Group 'A' officers (including the Director, well qualified/trained Scientists, Senior Administrative Officer and a Finance Officer) and 81 other supporting scientific, technical and administrative staff.

The research activities of the Institute are being carried out under six Scientific Divisions at the Headquarters at Roorkee and Seven Regional Centres at Belagavi, Jammu, Kakinada, Guwahati, Patna, Jodhpur and Bhopal. The Institute's research and other technical activities are monitored and guided by the Technical Advisory Committee, Working Group (for headquarters) and Regional Coordination Committees. As per the directions of the Technical Advisory Committee, significant efforts have been made to include basic and applied research as part of regular work program of the Scientific Divisions at Headquarters, while at the Regional Centres and the Centre for Flood Management Studies, more emphasis is being given to applied research and field-oriented research problems.

During the year 2023-24, the Institute has contributed significantly to the water sector in the country through basic and applied research in various frontier areas of hydrology. During the year, the Scientists of the Institute have published books, chapters in books, book reviews, research papers in peer-reviewed International/National Journals and proceedings of the various National and International Conferences/Symposia. A large number of R&D studies have also been undertaken under various thrust areas in hydrology. The Institute has also assisted several Central and State

Government organizations, public sector undertakings and private institutions in the country in solving various hydrological problems through sponsored and consultancy projects. A number of technology transfer activities have also been organised. Brief details in respect of the above are given in 'Achievements at a Glance' and complete details are given in the ensuing chapters.

The progress made during the year 2023-24 in various scientific and technical activities along with the statement of accounts is presented in this report.



Figure - 1.1 : NIH Head Quarter Office Complex, Roorkee (Uttarakhand)

2 Organizational Structure

The organizational structure of the Institute is given below:

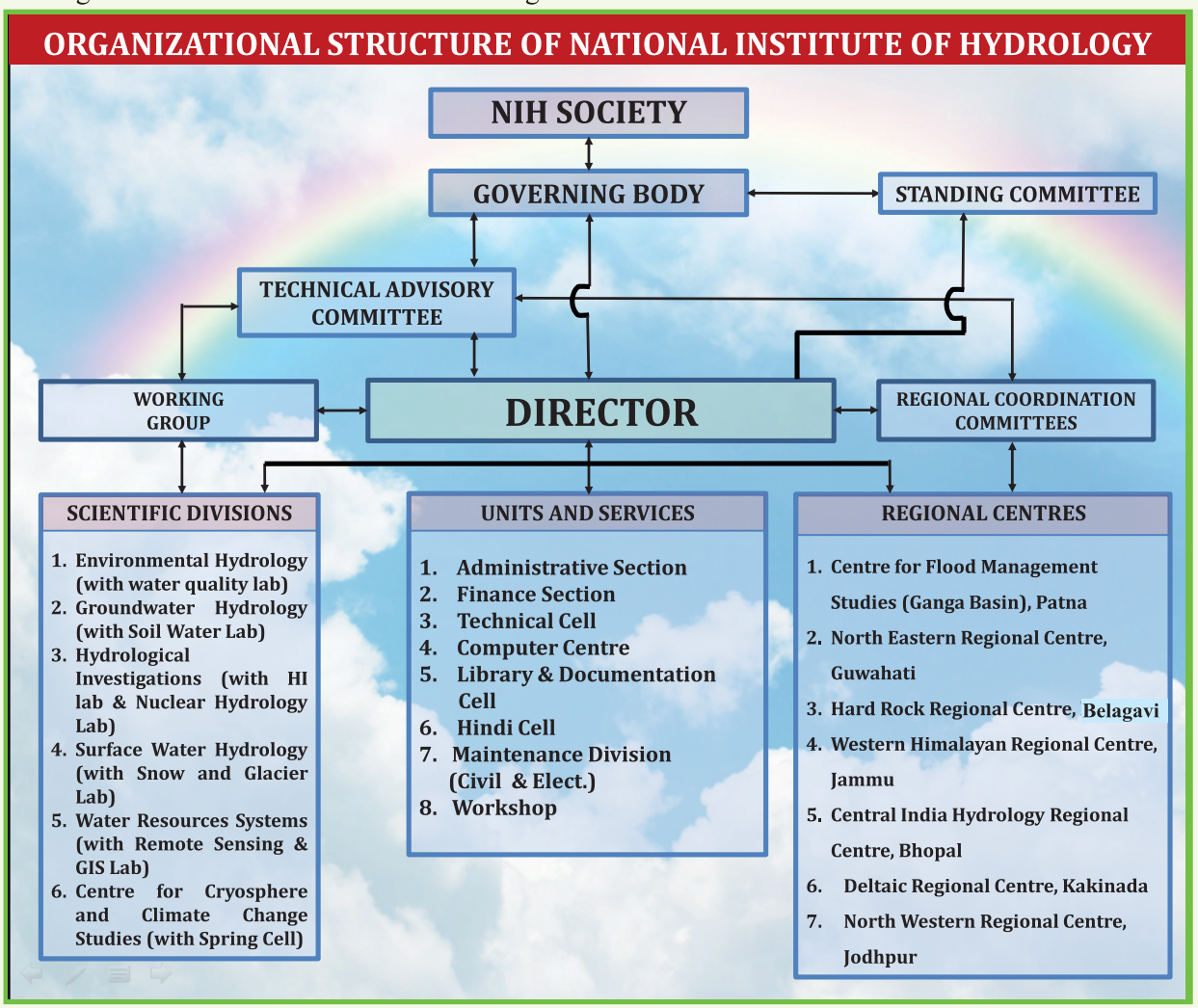


Figure - 2.1: Organizational Structure of NIH

2.1 Society

The National Institute of Hydrology Society is the apex body of the Institute. It reviews the progress and performance of the Institute and gives such directions as it may deem fit, to the Governing Body and the Institute towards attainment of the objectives enunciated in the Memorandum of Association of the Society. The Society has 48 members out of which 10 Ministers-in-Charge of Irrigation and Water Resources from the States and 10 eminent engineers and water resources experts are nominated by the President of the Society for a 3 years' term. The membership of the Society as on March 31, 2024, is given in Appendix-I.

2.2 Governing Body

The Governing Body (GB), under the Chairmanship

of the Secretary, DoWR, RD & GR, Ministry of Jal Shakti, Government of India, is the executive body of the Institute and is responsible to pursue and carry out the activities as per objectives laid down by the Society. GB exercises all executive and financial powers of the Society. The constitution of the GB as on March 31, 2024, is given in Appendix-II.

2.3 Standing Committee

The GB has constituted a Standing Committee under the Chairmanship of the Additional Secretary, DoWR, RD & GR, Ministry of Jal Shakti, Government of India, to consider the financial and administrative matters pertaining to the Institute. The Standing Committee reviews the matters referred to it by the GB. Decisions of the Standing Committee are reported to the GB for its approval. The constitution of the Standing Committee as on March 31, 2024 is given in Appendix-III.

2.4 Technical Advisory Committee

The Technical Advisory Committee (TAC) under the Chairmanship of the Chairman, Central Water Commission (CWC), New Delhi, carries out technical scrutiny of the research program of the Institute and recommends priority areas for studies and research. It also scrutinizes the individual schemes submitted for external assistance and expansion of the Institute. The constitution of TAC as on March 31, 2024 is given in Appendix-IV.

2.5 Working Group

The GB has constituted a Working Group to consider and recommend to TAC the program of studies to be taken up by various Scientific Divisions of the Institute and review the progress of work. The Working Group, under the Chairmanship of Director NIH, has members from various Central and State Government organizations, Universities and individual experts working in the field of hydrology and water resources. The constitution of the Working Group as on March 31, 2024 is given in Appendix-V.

2.6 Regional Coordination Committees

Regional Coordination Committees (RCCs) have been constituted to ensure effective coordination between the respective Regional Centre and the various academic and field organizations engaged in water resources research and development in the Region. RCCs advise the Regional Centres in all technical and scientific matters and also examine the proposals for diversification of activities of the Centres. Experts from field organizations and academic institutes of the region covered by the Regional Centre are members of the RCCs with Director, NIH as the Chairman. Duly approved constitution of RCC for each Regional Centre is given in Appendix-VI.

2.7 Scientific Divisions

Studies and research activities at the headquarters are carried out under the following six scientific Divisions:

1. Environmental Hydrology Division
2. Ground Water Hydrology Division
3. Hydrological Investigations Division
4. Surface Water Hydrology Division
5. Water Resources Systems Division
6. Centre for Cryosphere and Climate Change Studies

The Divisions also undertake various consultancy and sponsored research projects and technology transfer activities.

2.8 Regional Centres

In order to deal with the specific hydrological problems in various regions of the country and for providing effective interaction with the States, the Institute has one Centre for Flood Management Studies (CFMS) and six Regional Centres (RCs) as given below:

1. Centre for Flood Management Studies (Ganga Basin), Patna
2. Hard Rock Regional Centre, Belagavi
3. Western Himalayan Regional Centre, Jammu
4. Deltaic Regional Centre, Kakinada
5. Central India Hydrology Regional Centre, Bhopal
6. North Eastern Regional Centre, Guwahati
7. North Western Regional Centre, Jodhpur

The detailed activities of Scientific Divisions and Regional Centres are given in Chapter - 3.





Figure – 2.2: 77th Meeting of TAC of NIH on 19 Feb., 2024



Figure – 2.3: 54th Working Group Meeting of NIH during 22-23 Feb, 2024



Figure – 2.4: 19th RCC Meeting of NIH-NERC, Guwahati on 19 March, 2024

3 Scientific Divisions and Regional Centres

Scientific activities of the Institute are carried out under the scientific divisions and regional centres. The details are given below:

3.1 SCIENTIFIC DIVISIONS

3.1.1 Environmental Hydrology Division (EHD)

The EH Division undertakes coordinates and conducts basic and applied research studies and organizes technology transfer activities in the area of environmental hydrology contributing to the sustainable water resources development and management. The thrust areas of research for the Division cover environmental monitoring including natural contaminants/pollutants, point and non-point source pollution, contaminant transport modelling, metal speciation/fractionation, wastewater and solid waste treatment/remediation technologies, river rejuvenation, water quality and human health, environmental impact assessment, environmental flow requirement for aquatic ecosystems and area drainage studies.

Research activities are conducted at varied scale from site, problem and demand specific issues to understanding the basic relationships and dynamics between processes and their impacts in terms of quality and quantity of water resources. This includes investigations of the fate and transport of hazardous substances, investigations of chemical, biological and microbiological processes that affect quality of water and exploration of the complex hydrologic phenomena of water bodies. All research activities are aimed at improving the understanding of how the quality and quantity of water is affected by the natural environment and the anthropogenic activities.

The complex hydrological problems related to chemical-soil-water interactions are studied adopting multidisciplinary approach for drinking water, irrigation water, wastewater, hazardous wastes, and microbial pollution. To carry out basic and applied R & D studies, the Division has a well-equipped NABL Accredited Water Quality Laboratory with state-of-the-art monitoring and analytical instruments powered by a qualified team of scientists and technical personnel. The laboratory has facilities and capabilities to determine various water quality constituents including major and minor ions, trace elements, pesticides, hydrocarbons and other organic compounds and bacteriological parameters.

Current R & D Activities: The Division is engaged in conducting field and laboratory based R & D activities related to water quality monitoring, assessment and modeling, contaminant mobilization, environmental flow requirement, and pollutants remediation. During 2023-24, the division has undertaken seventeen externally funded projects; nine sponsored R&D and eight Consultancy Projects in the area of hydrology and water resources besides the five in-house research studies. Moreover, six training programmes/ workshops were organized under technology transfer and knowledge dissemination activities.

Interactions with other Organizations: In pursuits of the various R & D activities, the Division has made interactions with various organizations like Central Water Commission, Central Ground Water Board, Central and State Pollution Control Boards, State Water Resources Departments, NTPC, BIS, FRI, THDC, State Wetland Authorities, and premier academic institutions like IITs, NITs & Central Universities, etc.



Figure – 3.1: Teams Conducting Field Investigations for Ongoing Studies of the Environmental Hydrology Division as well as Mass Awareness

3.1.2 Groundwater Hydrology Division (GWHD)

The vision of the Division is the development and application of efficient and effective methodologies and technologies for sustainable groundwater resources development and management. The thrust areas of research in the field of groundwater hydrology include groundwater storage and resource estimation; groundwater modelling and management; coastal aquifer management; surface water and groundwater interaction; hard-rock and karst hydrology; strategies to sustainably manage groundwater supply and demand; river bank filtration; contaminants mobilization in groundwater systems; threat of emerging contaminants in groundwater; groundwater protection measures against contaminants; and impact of environmental changes on groundwater resources. Keeping in view these thrust areas, the Ground Water Hydrology Division is pursuing basic and applied research pertaining to various aspects of groundwater hydrology such as aquifer parameter estimation; aquifer response to untoward stresses; groundwater assessment, modelling and management; coastal groundwater dynamics; contaminant transport modelling; managed aquifer recharge; bank filtration; impact of climate change on groundwater resources, etc. The division has two technical

services facilities (i) Soil Water Laboratory, and (ii) Centre of Excellence for Advanced Groundwater Research which includes 'Numerical Groundwater Modelling Unit' and 'Indo-German Competence Centre for Riverbank Filtration'. All these facilities are well equipped with advanced tools and instrumentation required for estimation of soil physical, hydraulic and chemical parameters, groundwater monitoring and assessment, characterization of aquifer hydraulic parameters, groundwater quality detection, modelling and management of groundwater.

Current R & D Activities: During the year 2023-24, the Ground Water Hydrology Division was engaged in conducting field, laboratory and computer based research studies and projects related to Integrated management of water resources for quantity and quality in Upper Yamuna basin up to Delhi; Leachate transport modeling for Gazipur landfill site for suggesting ameliorative measures; Enhancing food and water security in arid region through improved understanding of quantity, quality and management of blue, green and grey water Studying arsenic genesis and developing alternate water supply management strategies in Ganga basin; Conjunctive management of water resources in IGNP command; Development of archive of soil hydraulic characteristics; and Enhancement and application of NIH_WISDOM.

Apart from conducting regular R&D studies, the Division has also undertaken various sponsored and consultancy projects. In addition, the division organized one Training of Trainers course on 'Usage and Applications of Decision Support System' during 2023-24.

Interaction with other Organizations: From time to time, the Ground Water Hydrology Division has been receiving demands for undertaking R & D and specific studies from different State Government departments and National organizations in areas related to groundwater. The Division has interacted with various organizations like MoES, MoEF&CC, Central Water Commission, Central Ground Water Board, Central and State Pollution Control Boards, NMCG, CAZRI, BIS, GWRDC, UP Irrigation and Water Resources Department and other R&D and academic institutions like IITs, NITs & Central Universities.



Figure – 3.2: Training on "System Modelling for Proposed M-G Link"



Figure – 3.3: Training on G-MCDA Tool for Site Suitability Mapping for MAR

3.1.3 Hydrological Investigations Division (HID)

The Hydrological Investigations Division works on field and laboratory based hydrological studies using advanced isotope techniques, geophysical and hydrological techniques. The Division's main areas of research include

(i) Groundwater Management
(ii) Surface water-ground water interaction studies
(iii) Dynamics of Deeper Aquifers
(iv) Lake, Wetland & Reservoir studies
(v) Snow & Glacier Studies
(vi) Riverbank filtration studies
(vii) Spring Hydrology & Spring Management
(viii) Rain Water Harvesting studies
(ix) Atmospheric air moisture studies
(x) Isotopic fingerprinting of different water sources
(xi) Developmen/implementation of modern technologies for measurement of various data.

The Division has two laboratories attached to it, namely

(i) Nuclear Hydrology laboratory
(ii) Hydrological Instrumentation laboratory

The Nuclear Hydrology laboratory has facilities to measure different types of radioactive and stable isotopes while the Hydrological Instrumentation laboratory has state of art instruments for measurement of various hydro-meteorological parameters.

Current R & D Activities: During the year 2023-24, the Division has carried out 05 Institute funded R & D Studies and 03 Sponsored Projects. The important components studied under these studies include (i) assessment of dissolved radon concentration in groundwater (ii) spring mapping and sustainability of springs (iii) ground water dynamics in coastal aquifers (iv) conservation and management plans for lakes (v) inventorization of springs (vi) leachate transport modelling (vii) rain water harvesting studies (viii) assessment of impact of agriculture on water balance etc. Apart from the R&D studies and sponsored projects, the Division was also engaged in consultancy projects related to hydro-geological aspects of thermal power plants, assessment of impacts of thermal power plants on water quality and rain water harvesting studies etc. The Division also organised a number of training course.

Interaction with other Organizations: Currently, the division is consistently working with International Atomic Energy Agency (IAEA), Austria; BGS, UK: British High Commission, HTWD, Dresden, Germany; NWO, IHE Delft Netherlands. The division is also working closely with CGWB, IITs, SKUST (Kashmir), SRM University (Chennai), BHU (Varanasi), NTPC, NEERI, and Irrigation Departments, UP and Uttarakhand.





Figure – 3.5: Scientists and Staff of HI Division Working in Field

3.1.4 Surface Water Hydrology Division (SWHD)

The thrust areas of research of SWHD include: (i) water availability analysis, flow duration curve analysis and environmental flow requirement, (ii) flood estimation, (iii) flood routing, (iv) hydrological modeling, (v) structural and non-structural measures of flood management, (vi) snow and glacier melt monitoring and modeling, (vii) urban hydrology, (viii) watershed management studies, (ix) socio-economic aspects of flood disasters, (x) drought mitigation and management and (xi) impact of climate change on water resources.

Current R & D Activities: SWHD is actively pursuing research on hydrology of extremes, i.e., floods and droughts, hydrological modeling, prediction in ungauged basins, dam break analysis & preparation of emergency action plan, flood inundation modeling and flood hazard assessment, area drainage study, project hydrology, flood forecasting using deep learning techniques, development and applications of DSS(PM) for integrated water resources development and management, modeling of snow and glacier melt, Glacier Lake Outburst Flood (GLOF) modelling, water availability analysis, environmental flow requirement assessment, impact of climate change

on water resources, applications of soft computing techniques in hydrology, etc. The division is maintaining a meteorological observatory at Roorkee. The division is also engaged in sponsored and consultancy projects and has organized seminars/symposia/training courses/ workshops in the area of Surface Water Hydrology.

Interactions with other Organizations: The Scientists of the division are in constant interactions with various organizations like Central Water Commission, State Water Resources Departments, NTPC, NPCIL, BIS, FRI and other R&D and academic institutions like IITs, NITs & Central Universities, etc.



Figure – 3.6: Capacity Building Programme on "Application of Space Technology for Flood related Disaster Management Support" during October 09-14, 2023 at NIH, Roorkee

3.1.5 Water Resources Systems Division (WRSD)

With the diverse climatic and geographic setup, India has a variety of concerns in managing its water resources, such as (a) huge spatial and temporal variation in the water availability and disparity with water demands which results in intersectoral and interstate deficits and water-related natural disasters such as floods, droughts, soil erosion and reservoir sedimentation, etc.; (b) rising water stress in large parts of the country, triggered mainly by rapidly growing population, irrigation needs, industrialization, urbanization and climate change; and (c) lack of accessible databases on hydrology and related sectors. Water resources projects are frequently planned in an isolated manner without giving due consideration to optimum utilization and environmental sustainability. WRS division is working towards finding solutions to these issues. The division is determined to provide feasible solutions to water problems by developing and applying methodologies for integrated and optimum management of water resources at the basin scale.

Current R&D Activities: The Division is currently carrying out experimental hydrology studies in Henval Catchment, Himalayan region involving establishment of a state-of-art hydrological field observatory with advanced automated instrumentation such as automatic weather station, automatic water level recorder, etc. The Division has carried out extensive works in the field of water availability, water accounting plus (WA+), snow & glacier studies, hydrological assessment in ungauged basins, etc. Application of various models for river basin planning involving the use of remote sensing data and GIS tools is in progress. The Division is actively participating in National Hydrology Project

(NHP), ISRO-DoS, and National Mission on Himalayan Studies (NMHS) projects. The Division is also actively involved in developing a few software, such as NIH_ReSyP (NIH_Reservoir Systems Package) and web-based information software, which is under constant refinement and improvement. The division has organised 08 numbers of technology transfer/capacity building/mass awareness activities during the year 2023-24.

Interaction with other Organizations: The scientists of the Division are coordinating with Water Resources Departments of various States for the database development for DSS applications. Research collaborations with UK Centre for Ecology and Hydrology (UKCEH) and Cranfield University, U.K. have been developed by the scientists of the division. The division is involved in one national project funded by MoS-ISRO. Some of the national research collaborations have been developed by the division with IIT Roorkee, NIT Raipur, IGKV, Raipur, Jawaharlal Nehru University (JNU), Delhi, GB Pant Institute of Himalayan Environment and Development (GBPNIHESD), Rajiv Gandhi National Ground Water Training & Research Institute, Raipur, Indian Institute of Remote Sensing (IIRS), Dehradun etc. Scientists are interacting with officials of public sector units, viz. THDC, UJVNL, SJVNL, NTPC, ICFRE, etc., for solving their specific project problems. Scientists of the division are also interacting with Central Govt. Organizations like MoES, CWC and CGWB for various studies being carried out in the Division.



Figure – 3.7: National Workshop at Geology Department, Alagappa Government Arts College, Karaikudi (19&20, Jan, 2024)



Figure – 3.8: Location of AWLR on a Bridge of Henval River under ISRO Sponsored Project



Figure – 3.9: Inaugural Session of Training Course on "Hydrological Modeling using SWAT+" during May 22-27, 2023.

3.1.6 Centre for Cryosphere and Climate Change Studies (C4S)

Snow and glaciers are important components of Himalayan hydrology. Scientific studies on Himalayan glaciers and glacial lakes are of foremost importance. Regular monitoring of glaciers and their melt characteristics in current environment of climate change is very much required in order to meet the water security in the downstream areas. Due to the global warming and climate change, many

glaciers and glacial lakes are being vulnerable. In the Himalayas, many glaciers and snowpacks are receding due to the warming trends of the lower atmosphere, which could be a significant cause of decreasing snow depth, snowpack duration and snowmelt runoff over the snow-glacier induced Himalayan watersheds. Climate change has a wide range of impacts on water resources, affecting water availability, quality, and reliability. Climate change is causing rising temperatures, severe spatio-temporal shifts in precipitation, and unpredictable weather which are likely to affect precipitation and its distribution, as well as river flows, groundwater, and impaired water quality. To handle and manage these issues of climate change and cryosphere, a Centre for Cryosphere and Climate Change Studies (C4S) has been created in the Institute. The purpose of creation of this Centre is to have a branch of scientific research that focuses on the study of the interactions between climate and cryosphere and impact on water availability in the Himalayan rivers. The focus of the Centre is to study the impact of climate change on water resources of the Indian Himalayan Region (IHR). The Centre is determined to provide best practices by proper mapping of snow, glaciers and glacial lakes in the IHR under the changing climatic conditions and assess water availability by developing knowledgebase on the Himalayan cryosphere in coordination with various national institutions and organizations. The Centre is also equipped with a Cryosphere Lab.

Current R&D Activities: The Centre is carrying out climate change as well as experimental studies in the Himalayan region (Gangotri glacier, Milem glacier, Khatling glacier and Triloki glacier) involving establishment of state-of-art hydrological field observatories with advanced automated instrumentation such as automatic weather station, automatic water level recorder, etc. Though the Centre is in nascent stage but is carrying out extensive works in the field of snow and glacier contribution and impact of climate change on snow and glacier, glacial lake outburst flood and mass balance. Application of various models, viz. SNOWMOD, SPHY and VIC, is being done for various hydrologic analysis using remote sensing data and GIS tools. The Centre is also participating in the National Hydrology Project (NHP), DST, IIRS, National Mission for Sustaining the Himalayan Eco-system (NMSHE) and National Mission on Himalayan Studies (NMHS) projects. The Centre is actively involved in developing web-based portals for water resource information.

Vision & Mission: To address the challenges posed by climate change to water resources requires multi-facet approaches. The vision of the Centre for Cryosphere and Climate Change Studies (C4S) is to develop advance scientific knowledge and understanding of the complex interactions between climate and the hydrological cycle. The Centre aims to contribute to the development of sustainable water resource management practices, adaptation strategies, and policies in the face of climate change. The vision of the Centre is:

Investigating the impacts of climate change on water availability, water quality, and water management. This involves studying changes in precipitation patterns, temperature, evaporation rates and river flows in response to climate variability and long-term climate change.

Developing and improving hydrological models, data analysis techniques, and decision support tools to simulate and predict hydrological processes under changing climate conditions.

In Himalayan region, rising temperatures lead to reduced snow accumulation, earlier snowmelt, and accelerated glacial melting. Simulation of the behaviour of snow and glaciers under different climate scenarios and aid in predicting the impacts on water resources, river flows, and water availability.

Collaborating with national and international organizations, research institutions, and stakeholders to foster interdisciplinary collaboration and knowledge sharing in the field of climate hydrology.

Contributing to capacity building efforts by providing training, education, and knowledge transfer to researchers, professionals, and decision-makers in the field of climate hydrology and water resource management.

Providing climate information and predictions to support water resource management, decision-making, and adaptation strategies. This includes developingtools and methods for communicating climate information effectively to policymakers, water managers, and other stakeholders.

By conducting advanced research, developing models, and providing climate services, the Centre is firm to contribute towards a more resilient and adaptive research for water resource management under the changing climatic conditions.

Interaction with other Organizations: The scientists of the Centre are interacting and coordinating with State Water Resources Departments, Central Govt. Departments like, CWC, CGWB, DST, MoES, DGRE, NESAC, MoEFCC, GBPNIHESD, etc. for advance research and database development in the domain of cryosphere and climate change. The Centre is also in process of establishing collaborative research with some international organizations in the related domain. Scientists are interacting with officials of public sector units, viz. THDC, UJVNL, SJVNL, NHPC, etc., for solving their specific project problems.



Figure – 3.10: Training Course on the "Tools and Techniques for Springshed Management" Jointly Organized by NIH and CGWB during 22-27 January, 2024 at Roorkee

3.2 CENTRE FOR FLOOD MANAGEMENT STUDIES AND REGIONAL CENTRES

In order to deal with the specific hydrological problems in various regions of the country and for providing effective interaction with the States, the Institute has established following one Centre for Flood Management Studies (CFMS) and five Regional Centres (RCs).

3.2.1 Centre for Flood Management Studies (CFMS), Patna

Centre for Flood Management Studies (CFMS), formerly known as the Ganga Plains North Regional Centre (GPNRC) was established in May, 1991. Important rivers in the region originate mainly from different mountain ranges of the Himalayas. These Himalayan rivers carry enormous amount of silts which get deposited in the river courses and over the

plains. Shifting of river courses are reported to be a common phenomenon in most of the rivers of Himalayan origin. Apart from floods, formation of chaurs, waterlogging and drainage congestion in most of the river basins are also of grave concern. Based on the hydrological problems of the Gangetic plains covering eastern Uttar Pradesh, Bihar, Jharkhand and West Bengal, the Centre is currently focusing on the studies related to design flood estimation, flood routing, structural and non-structural measures of flood management, application of remote sensing and GIS, waterlogging and drainage congestion problems, evaluation of geomorphologic characteristics of rivers, river flow modelling, erosion and sedimentation modelling, preparation of flood plain zoning maps, rainwater harvesting potential assessment and design of rainwater harvesting structures/facilities/ systems and urban hydrology. In addition to field and laboratory-based studies the centre also focuses on rain-fed rivers of Vindhyan basin and Chotanagpur plateau. Vindhyan basin rivers causes erosion in the upper hilly region and heavy siltation in the constructed structural sites whereas flash flood prone rivers of Chotanagpur plateau origin causes waterlogging and drainage congestion in lower regions and water scarcity in upper regions are observed. The Centre is also involved in technology transfer activities and collaboration with various local Goverment. organizations and reputed institutes. The Centre is also involved in mass awareness campaigns by organizing activities for students and villagers/farmers/women's on the topics of water conservation and sanitation.

Objectives of the Centre: (i) to undertake strategic and adaptive research activities related to flood management for the Ganga basin (ii) to advice different Government organizations dealing with hydrology and water resources about the technological advancement in flood management and (iii) to make aware different Government organizations through technology transfer activities about the advancement in flood management.

Current R & D Activities: The centre is actively involved in basic and applied research pertaining to various aspects of the hydrological problems of the Gangetic plains with six active studies. Total five number of institute funded R & D studies and one sponsored study are ongoing at the moment. The centre is presently focusing on the Gandak River Basin in comprehension program of the year 2023-2024. The studies are hydrologic, hydro-dynamic and sediments analysis related in nature. One sponsored project funded by the by NHP-PDS is focuses on morphodynamic modeling for 45 km stretch of Gandak River from Rewaghat to Hajipur bridge. The institute funded studies include (i) Evaluation of hydrologic models for Gandak river basin, (ii) Macro-scale modelling of Gandak River basin and (iii) Sediment yield modelling for Gandak River Basin using SWAT model. Also, one study is addressing the waterlogging in local urban area (PhuulwariSharif) and focuses on drainage design aspects of the area. Another study focuses on selection of suitable site for Kichha barrage, Uttarakhand using morphological analysis of Kichha River.

Interaction with other Organizations: The Centre has established close interaction with various central and state government organizations of water resources sector of the region. In pursuance of various R & D activities, the Centre is interacting with NWDA; CWC; CGWB; GFCC; IMD; Water Resources Departments, Governments of Bihar, Jharkhand and Uttar Pradesh. The Centre is also in close contact with public sector undertakings like NTPC,NHPC, and NPCIL etc. Interactions has also been established with technical institutes like IIT Roorkee, IIT Patna, NIT Patna, Central University of South Bihar, Central university of Jharkhand and other training and research institute like WALMI, FMISC, MMC, ICAR regional centre. Interactions with NGOs of Bihar, Jharkhand and West Bengal dealing with disaster management and rehabilitation works have also been established.

Technology Transfer Activities: The centre is actively involved in technology transfer activities by organizing trainings on state-of-art hydrological modeling tools, study specific workshops and awareness programme for the user agencies as well as students. The centre organized two training



23rd Meeting of RCC, CFMS, Patna



Figure – 3.11: Plantation in Office Campus, CFMS NIH, Patna

program this year. "River Flow Modelling" during January 2024, and "Hydrological Modelling using HEC-HMS" during in March, 2024 has been organized at the centre in which students from different universities and working professionals from WRDs participated. The Scientists of the Center deliver lectures in other organizations like ICAR, WALMI, NERIWALM, Engineering colleges and also provide guidance to Ph.D, M. Tech and B. Tech students.

3.2.2 Hard Rock Regional Centre (HRRC), Belagavi

About 67% area of India is occupied by hard rock

terrain. This region frequently experiences drought and at times flood also. Groundwater is one of the most dependable water resources in the region. Over the last decade, the usage of groundwater has increased exponentially causing lowering of groundwater levels. On the other hand, increased anthropogenic activities in region have resulted in dramatic changes in the land use and land cover. This has strongly affected the water availability of the region. These problems are further complicated by the changes observed in the rainfall and meteorological parameters over the region. Keeping these problems of the peninsular India in view, the Hard Rock Regional Centre (HRRC) is carrying out studies related to water availability of the hard rock region, forest hydrology, groundwater, and water logging and salinity studies. However, looking at the present and future needs of the region, drought studies, urban hydrology and impacts of climate change on water resources sector have also been added.

Current R & D Activities: The Regional Centre is actively involved in conducting field-based studies for many years. Presently the centre is engaged in many research studies, such as, Monitoring and Evaluation of Ground Water Quality of Belagavi City, Karnataka, India, impact of Sand Mining on Ground Water regime in parts of Manjira River Basin, Telangana State, Comprehensive Assessment of Water availability, Use and Issues for Goa State, Climate change impact assessment studies, groundwater model development in a micro basin of hard rock in Krishna and Godavari River basins of Telangana, Flood review in Kali and Sharavathy river basin, Dam Break analysis, inundation mapping and preparation of Emergency Action Plan for Dams in Kali, Sharavathy and Varahi river basin, Comprehensive Hydrological analysis of Harangi Catchment, Karnataka, India.

Interaction with other organizations: The HRRC has taken up collaborative studies with Maharashtra Irrigation and Ground Water departments, Karnataka Water Resources Department and Ground Water Department of Telangana. The Regional centre is regularly interacting with Karnataka Irrigation Department; WALMI, Dharwad, Institute of Water studies, Taramani, Chennai; Central Ground Water Board; Dept. of Mines and Geology, Karnataka; Gogte Institute of Technology, Belagavi; KLE Society's College of Engineering and Technology, Belagavi; S G Balekundri Institute of Technology, Belagavi, Karnataka Power Corporation Ltd; Rani Chennamma University, Belagavi; Visvesvaraya Technological University, Belagavi etc. Further, the centre is recognized under Visvesvaraya Technological University, Belagavi for guidance of students pursuing M. Tech and PhD in the field of Hydrology and Water Resources. Also, Internship training are being organized for the UG & PG students of various Engineering and Science colleges in Karnataka.



Figure – 3.12: Office Building of Hard Rock Regional Centre, Belagavi

3.2.3 Central India Hydrology Regional Centre (CIHRC), Bhopal

The Central India Hydrology Regional Centre (CIHRC), Bhopal, formerly known as Ganga Plains South Regional Centre, was established at Sagar on 1st December 1995. The Centre was relocated to MP-WALMI Campus, Bhopal on November 1, 2012 and renamed as the "Central India Hydrology Regional Centre (CIHRC)" in the year 2015. The jurisdiction of CIHRC Bhopal covers Madhya Pradesh, Chhattisgarh, southern part of Uttar Pradesh, southeast part of Rajasthan, western part of Jharkhand and Vidarbha region of Maharashtra. This Centre has been set up to carry out research studies to solve hydrological problems of basins and sub-basins of north-flowing tributaries of the Ganges namely Banas, Chambal, Kalisindh, Betwa, Dhasan, Ken, Tons, Son, etc. It also covers part of west flowing Narmada and south-east flowing Mahanadi and Wainganga, etc.

The area under the jurisdiction of the Centre is primarily dependent on rain-fed agriculture. Lack of appropriate water resource management, degraded watersheds, recurrent droughts, excessive soil erosion, groundwater depletion, deterioration of water quality and reduction of forest cover has given rise to water scarcity, reduced crop yields which has resulted in the exacerbated poverty in this region. Under these circumstances, sustainable management of water resources including its quality is one of the key challenges in the R & D activities. The major focus of the Centre is towards sustainable management of water resources in Central India region based on scientific research including Hydrological modelling, Climate change impact assessments, Development of regional hydrological indices, Drought management, DSS development, River basin planning and management, Reservoir operation, Reservoir sedimentation, Command area management, Watershed management, Groundwater assessment, Artificial recharge of groundwater, Rainwater harvesting and Water quality assessment.

Current R & D Activities: The Regional Centre is presently involved in conducting various sponsored as well as in-house research studies and projects. During 2023-24, the centre has carried out three Purpose Driven Studies (PDS) under NHP and three in-house projects. These PDS studies are being carried out in collaboration with Water Resources Department, Govt. of Madhya Pradesh and Chhattisgarh. PDS studies are mainly focused on prominent hydrological issues such as assessment of



Figure – 3.13: 20th RCC meeting of CIHRC, Bhopal at NCA Indore

the impacts of climate change and land use change on the hydrology of the Narmada basin, evaluation of return flow and irrigation planning for optimal utilization of water resources in the command of Sanjay Sagar project in Madhya Pradesh, Integrated reservoir operation studies for Mahanadi reservoir project complex in Chhattisgarh. The in-house projects include re-assessment of evapotranspiration (ETo) estimation for irrigation planning in Madhya Pradesh, water availability assessment in sub-basins of Ganga river in MP, development of reservoir operation plan under climate change scenarios for Kolar reservoir in Madhya Pradesh.

Interaction with other Organizations: The Centre has been involved in many national and international sponsored R&D projects in collaboration with other states and central government departments in Madhya Pradesh, Gujarat, Rajasthan, and Chhattisgarh including CWC, CGWB, WALMI, WRD, PHED, CPCB. The Centre has organized six mass awareness programs during the current year on water conservation, protection of water bodies and cleanlinesds. The Centre activities also follow interaction with institutions viz., MANIT & IIFM, Bhopal, BHU Varanasi, IGKVV Raipur, JNKV Jabalpur, and MPU Udaipur.

3.2.4 North Eastern Regional Centre (NERC), NIH, Guwahati

The North Eastern Regional Centre (NERC), NIH Guwahati, formerly known as Centre for Flood Management Studies, catering for the seven North-East states, Sikkim, and parts of West Bengal (Teestha basin) was established in August 1988 at Guwahati and is working for solving various water resources problems of the region. The centre works towards addressing the specific hydrological challenges and requirements of the North-Eastern region of India. It extends its reach and resources to cater to the unique hydrological dynamics of the region, contributing to the development and sustainability of water resources management in the North-Eastern states.

The Centre is working on the following thrust areas: (i) Flood estimation and routing; (ii) Structural/non-structural measures for flood management; (iii) Integrated watershed management for flood control; (iv) Hydrological data base management system; (v) Drainage congestion and erosion problems; (vi) Water quality problems; (vii) Socio-economic aspect of flood disaster; (viii) Springshed management; and (ix) Technology transfer through trainings and awareness programs etc. The Centre has got long-term ongoing program of representative basin studies and has procured advanced software for flood studies and packages for GIS.

Current R&D Activities: The Centre's current research and development (R&D) activities emphasize applied and field-based studies that address critical issues in hydrology and environmental management. Presently, the Centre is engaged in six institute-funded R&D studies, focusing on areas like flood inundation mapping, flood forecasting, riverbank erosion analysis, drought characterization, and climate as well as land use/land cover change impact studies. In addition to these studies, the Centre has completed a significant



Figure – 3.14: Office building of NERC

project funded by the Department of Science and Technology - Science and Engineering Research Board (DST-SERB). The project titled "A Coupled Hydrodynamic and Bank Dynamic Modeling Approach for Forensic Analysis of Bankline Erosion Process Along Majuli Island – the Largest Inhabited River Island in the World" was completed in March 2024. Majuli Island, being the largest inhabited river island in the world, faces significant challenges due to bank erosion. This project aimed to provide a comprehensive understanding of the erosion processes affecting the island, contributing to the development of effective erosion control and management strategies. The final report of the project has been submitted to DST for review.

Interaction with other Organizations: Since its inception, the Centre has been actively interacting with various state/central government agencies and academic institutions like Brahmaputra Board, CWC, CGWB, IMD, NESAC, NERIWALM, Soil Conservation Service, Water Resources Departments, State Pollution Control Boards, IIT Guwahati, Guwahati University, and Assam Engineering College for carrying out its studies and research within the framework of recommendations of the Regional Coordination Committee.



Figure – 3.15: Photographs of various activities carried out at NIH-NERC during 2023-24

3.2.5 Western Himalayan Regional Centre (WHRC), Jammu

The major objective of Western Himalayan Regional Centre (WHRC), located at Jammu, is to carry out hydrological research for the Western Himalayan Region of the country. Jammu & Kashmir, Ladakh, Himachal Pradesh and the hilly portion of Uttarakhand constitute the jurisdiction of WHRC. This region is marked by elevated and snow-clad mountain ranges that influence the climatic conditions of north-west India and is the main source of water supply for Indo-Gangetic plains.

The hydrological problems of the Himalayan region differ from those of the plains due to variable topography, geology, climate, soil, land use, land cover, etc. The Western Himalayan region faces a variety of hydrological problems aggravated by the increasing impact of climate change and LULC changes, depleting cryosphere resources, drying up springs, decreasing water availability, floods associated with high intensity rainfall events, cloudbursts and glacial lake outbursts, water quality problems as well as soil erosion & sedimentation. Deficient scientific planning for optimum use of water at various scales constrained by inadequately trained manpower and insufficient monitoring network as well as low public awareness regarding water security, results in poor water management and wastage. Keeping these in view, the thrust areas for research at WHRC are focussed on the impact of climate change on weather patterns, dynamics of Western Himalayan cryosphere including snow, glacier and permafrost with special emphasis on climate feedbacks and their impact on downstream water availability using field methods, remote sensing applications and hydrological modelling, inventorying springs for their rejuvenation, hydrology of floods, representative basins, water availability and quality, effects of afforestation/ deforestation on hydrological regime, lake hydrology, hydrological network improvement & instrumentation.



Figure – 3.16: Training programme on "Cryosphere, Climate Change and Hazards (CCCH): theory and practice" organized by WHRC NIH, Jammu during 19-23 February, 2024

Current R & D Activities: In view of the hydrological problems in the Western Himalayan Region, WHRC is striving hard to develop methodologies for providing solutions to some of these. Cryosphere Field Station in Leh, Ladakh is at the centre of collecting primary hydrometeorological and glaciological data sets to gain increasing process understanding of the variability of climate-cryosphere feedbacks and its impact on water availability in cold-arid ecosystems. In addition, WHRC envisions contributing in the following areas: assessment of impact of climate change on hydrological variables, preparation of synthetic data sets suited for WHR using statistical methods, strengthening hydrological network in the region using state-of-the-art instrumentation, hydrological characteristics of cryosphere in the region with dual emphasis on monitoring and modelling, integrated



Figure – 3.17: Field visit to Khardung Glacier, Ladakh as part of the study on glacier climate interactions and impact on downstream water resources during September 08 - 16, 2023

water resources management studies for Tawi river basin aiming at flood disaster risk reduction and water availability, soil erosion assessment as well as hot spot analysis of springs and their rejuvenation plan. Moreover, scientific personnel posted at WHRC are actively involved in sponsored and internal studies carried out by NIH-HQ. Water Quality and RS/GIS laboratories have been equipped to cater to the immediate needs of the region.

Interaction with other Organizations: The Regional Centre has been involved in supporting the State Specific Action Plan under National Water Mission, as well as assisting National Disaster Management Authority, National Green Tribunal, Jal Jeevan Mission – Jammu & Kashmir, Jammu and Kashmir Water Resources Regulatory Authority, Jammu and Kashmir Wetland Authority, Department of Jal Shakti, J&K, including Irrigation & Flood Control Department, Jammu, Public Health Engineering Department, Jammu, Soil and Water Conservation Department, J&K, Central Ground Water Board, North-West Himalayan Regional Centre, Jammu, Jal Shakti Abhiyaan, etc., by providing technical inputs. It also has been interacting with academic institutions in the region such as University of Jammu, Central University of Jammu, SKUAST, Jammu, IIT Jammu, IIT Mandi, Central University of Himachal Pradesh, etc., in issues related to the water sector. The Regional Centre also has been at the forefront of spreading awareness regarding water conservation and water security among the budding youngsters especially in Jammu and nearby areas through various IEC activities.



Figure – 3.18: Technical discussion on "Managing the Water Scarcity in Kandi Belt" under Swachhata Pakwada organised by WHRC On 22nd March 2024 (World Water Day)

3.2.6 Deltaic Regional Centre (DRC), Kakinada

The east coast of India is rich in utilizable water resources as most of the central and peninsular rivers (i.e., Ganges, Mahanadi, Godavari, Krishna and Cauvery) drain towards the Bay of Bengal through important river deltas. Approximately 25 km width of the east coast of India is vulnerable to the cyclone hazard and the risk is particularly severe at the mouths of rivers and estuaries. Due to cyclones and floods, the coastal areas are frequently inundated. Groundwater problems are also significant in coastal areas apart from surface water problems. The backwater through the streams and rivers, aquaculture practices, excessive pumping of groundwater and increasing temperatures are the main sources of salinity contamination in the shallow aquifers. Other than the salinity, the groundwater and surface water are also deteriorating due to industrial effluents, poorly treated sewage, irrigation return flows, and unsatisfactory household

and community sanitary conditions. Further, the east coast of India, with its high population density and significant economic activities, is one of the regions that are highly vulnerable to the adverse effects of climate change. This region has also faced droughts, heat waves, andcoast al floods frequent in recent decades. Therefore, the thrust area shave been identified after interacting with various water resources agencies in the region. The main thrust areas are Urban hydrology, real-time flood forecasting, climate change impacts on river flows, drought monitoring, flash floods in ungauged basins, reservoir sedimentation, point and non-point groundwater source contamination, submarine groundwater discharge (SGD) studies, saltwater intrusion modelling, time series analyses, and rainfall-runoff modeling. The Centre is also equipped with a water quality laboratory, RS & GIS, and advanced hydrological software.

Current R&D Activities: The Deltaic Regional Centre is presently working on demand driven R&D studies referred by various state Govt. departments. Further, sponsored projects on High Performance Advanced SepticSystem (HPAS) for villages and roadside restaurants, Institute funded R&D Studieson, 'Impact assessment of backwater through drains, creeks and river mouths on groundwater salinity in the Godavari Delta, Andhra Pradesh', Storm water flood management in the coastal city - A case study', 'Climate Change Impact Assessment under Future Scenarios over the East Coast of India: A focus on the Hydroclimatic Extremes', 'Evaluation and post-processing of multi-model short-to medium-range precipitation forecasts: Towards developing a flood early warning system over Subarnarekha Basin' are being carried out in the Centre. Apart from these studies, institute funded R&D Study on'Identification of Recharge and Discharge areas of Palar river basin in Tamil Nadu has been completed during 2023-24. Additionally, studies pertaining to seawater intrusion modelling, water accounting using Water Accounting+ (WA+) frame work, climate change impacts on regional hydrology and natural hazard risk assessments are under progress.

Interaction with other Organizations: The Centre is actively participating in various review meetings of all State Water Resources Departments of Odisha,



Figure - 3.19: Office Building of Deltaic Regional Centre, Kakinada

Tamilnadu and Andhra Pradesh and also contributing to the NGT cases. Further, the Centre is imparting training on various facets of Hydrology and extending guidance for M. Tech thesis work and conducting public awareness programs.



Figure 3.20 : Water Quality Laboratory at Deltaic Regional Centre (NIH), Kakinada

3.2.7 North Western Regional Centre (NWRC), Jodhpur

The North Western Regional Centre (NWRC), the 7th Regional Centre of NIH, was established in year 2023 at Jodhpur, popularly known as the Sun City/Blue City, located in the Thar Desert region of Rajasthan. NWRC has jurisdiction of north western states of India namely Rajasthan, Gujarat, Haryana, and Punjab. These states largely fall within arid and semi-arid zones, facing challenges such as low and erratic rainfall, recurrent droughts, flash floods, water scarcity, and contamination of water resources. Additionally, overexploitation of groundwater resources leads to the depletion of aquifers, reducing water availability for agriculture, industrial, and domestic use. The region also struggles with inefficient water management and climate change vulnerability.

The vision of NWRC encompasses various aspects of water resources management in arid and semi-arid regions. This includes the efficient utilization of surface and groundwater resources, enhancing groundwater recharge through water harvesting structures, utilizing Palaeochannels as groundwater repositories, and water quality monitoring and assessment. Additionally, NWRC aims to combat desertification, mitigate and adapt to climate change, explore alternative water harvesting methods, reduce disaster risks, rejuvenate rivers and degraded water bodies, conduct reservoir sedimentation and river modeling & coastal studies along with implementation of integrated water resource management planning.

Current R & D Activities: The current R&D activities are integral to developing sustainable water management practices and mitigating the

impacts of climate change and water scarcity in the north western region of India. To address the diversified challenges of arid and semi-arid regions, the center has taken up multiple studies including addressing the long-persisting critical issue of groundwater level rise in Jodhpur City; to identify heterogeneity of crops at the farm scale using remote sensing data in the IGNP canal command area. A couple of gauging sites have been planned to be established for regular monitoring of Jojari River, a tributary of Luni River. Moreover, NWRC has taken up multiple studies in Luni Basin i.e., analyzing flash flood events and devising remedial measures to store excess water, assessment of water productivity, land productivity, agricultural drought, and evaluation of diversified crops using geospatial data. Also, the centre is involved in a sponsored research project from GWRDC, Gandhinagar, Gujarat to prepare a detailed status reports on salinity ingress in the coastal areas of Saurashtra and Kachchh Regions of Gujarat State. In addition, scientists and technical personnel posted at NWRC are also involved in sponsored and internal studies carried out by NIH-HQ on different aspects.

Interaction with other Organizations: The Regional Centre has been involved in supporting the State Specific Action Plan under National Water Mission. Also, NWRC, Jodhpur, has proactively taken the initiative to collaborate with various esteemed institutions, aiming to augment its research



2nd Regional Coordination Committee Meeting (15th March 2024)



Mass Awareness Programme on "Water Conservation and Security" on the occasion of World Earth Day-2024



Training /Workshop on "Applications of RS& GIS in Natural Resources Management" at Jodhpur (26th Feb to 1st March, 2024)



Monitoring & Water Sample Collection of Jojari River, Jodhpur, Rajasthan

Figure – 3.19: Various activities at NWRC, Jodhpur

and development endeavors. Notable organizations such as Indian Institute of Technology Jodhpur (IITJ), Central Arid Zone Research Institute (CAZRI), Central Water Commission (CWC), Central Ground Water Board (CGWB), India Meteorological Department (IMD), MBM University, Agriculture university, State Surface Water and Ground Water Departments of Rajasthan, Gujarat, Punjab, and Haryana, and several other government and non-government organizations, have been engaged in interactions and collaborative efforts.

Water Resources of India

4

Water resources of a country constitute one of its vital assets. India receives annual precipitation of about 4000 km3. The total average annual flow per year for the Indian rivers is estimated as 1953 km3. The total annual replenish able groundwater resources are assessed as 432 km3. The annual utilizable surface water and groundwater resources of India are estimated as 690 km3 and 396 km3 per year, respectively. With rapid growing population and improving living standards the pressure on our water resources is increasing and per capita availability of water resources is reducing day by day. Due to spatial and temporal variability in precipitation the country faces the problem of flood and drought syndrome. Over-exploitation of groundwater is leading to reduction of low flows in the rivers, declining of the groundwater resources, and salt water intrusion in aquifers of the coastal areas. Over canal-irrigation in some of the command areas has resulted in waterlogging and salinity. The quality of surface and groundwater resources is also deteriorating because of increasing pollutant loads from point and non-point sources.

Water requirement for various sectors has been assessed by the National Commission for Integrated Water Resources Development Plan (NCIWRD) as tabulated below:

Table-4.1:Projected Water requirements of India

Sector	Water Requirement (BCM)	
	Year 2025	Year 2050
Irrigation	611	807
Drinking Water	62	111
Industry	67	81
Energy	33	70
Others	70	111
Total	843	1180

Climate of India

Temperature and rainfall are two important variables that characterize climate. Most of the rainfall takes place under the influence of South-West monsoon between June and September, except in Tamil Nadu where it occurs under the influence of North-East monsoon during October-November. Rainfall in India shows great variations, unequal seasonal distribution, unequal geographical distribution, and frequent departure from the normal. The long-term average annual rainfall for the country is 1160 mm, which is the highest anywhere in the world for a country of comparable size. The annual rainfall in India however fluctuates widely. The highest rainfall in India of about 11,690 mm is recorded at Mousinrarn near Cherra punji in Meghalaya in the northeast. In this region rainfall as much as 1040 mm is recorded in a day. At the other extreme are places like Jaisalmer, in the west, which receives barely 150 mm of rain. Though the average rainfall is adequate, nearly three-quarters of the rain pours down in less than 120 days, from June to September. As much as 21% of the area of the country receives less than 750 mm of rain annually while 15% receives rainfall in excess of 1500 mm. Precipitation generally exceeds 1000 mm in areas to the east of Longitude 78°E. It reaches nearly to 2500 mm along almost the entire west coast and over most of Assam and sub-Himalayan West Bengal. Large areas of peninsular India receive rain fall less than 600 mm. Annual rainfall of less than 500 mm is experienced in western Rajasthan and adjoining parts of Gujarat, Haryana and Punjab. Rainfall is equally low in the interior of the Deccan plateau, east of the Sahyadris. A third area of low precipitation is around Leh in Kashmir. The average rainfall over India is shown in Figure below. Annual rainfall for major rivers basins is given in Table below.

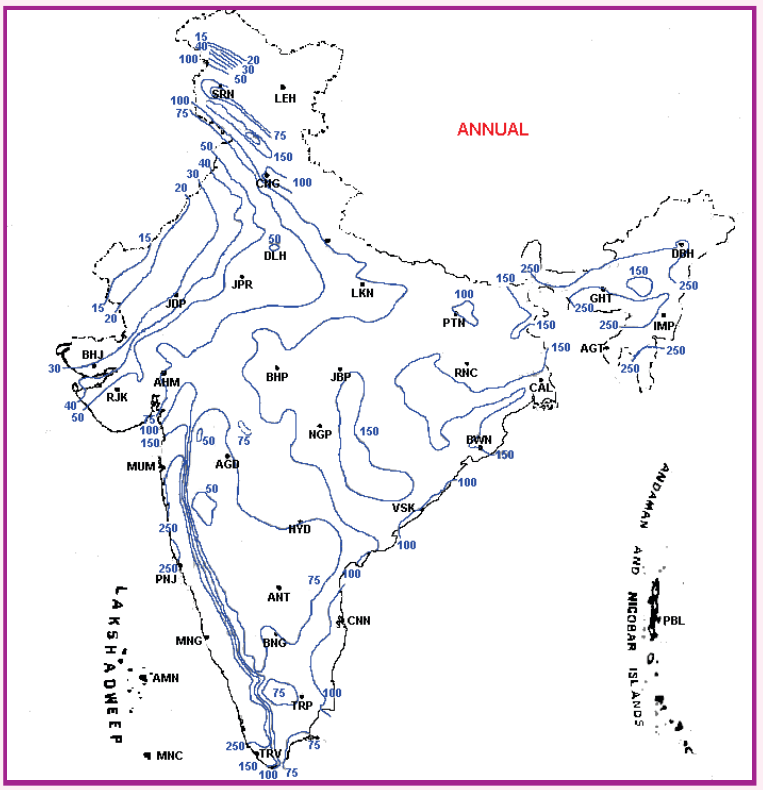


Figure-4.1: Average annual rainfall over India

Table-4.2: Annual rainfall for major river basins in India

River basin	Annual normal	
	Rainfall (cm)	No. of rainy days
Brahmaputra	268.7	112
Cauvery	119.8	65
Ganga	115.8	52
Godavari	116.1	59
Indus	88.7	46
Luni	40.6	20
Mahanadi	142.2	69
Mahi & Sabarmati	84.0	37
Narmada	123.1	50
Tapi	79.7	46

In the parlance of the India Meteorological Department (IMD), a day with a rainfall of 2.5mm or more is known as a rainy day. The mean annual number of rainy days over India varies from less than 20 over the northwestern parts (West Rajasthan and Kutchh region of Gujarat), to more than 180 in the north-east parts. In the southern parts of the West Coast also, the annual number of rainy days is quite high, about 140 days. The annual number of rainy days is around 40–60 over central parts of India. From the observed spatial pattern, the mean intensity of rainfall is found to vary between 10 and 40mm per rainy day. In the extreme northern parts, the lowest value is below 10 mm/day. The intensity is near about 10 mm/rainy days over north-western India. Along the West Coast as well as in some parts of north-eastern India, the highest value is about 40 mm/day.

With the onset of monsoons, the maximum temperature drops significantly, although the weather can be quite humid at times. Temperatures start falling from October onwards and are at the lowest during December-January. With the passage of vernal equinox in March, cool weather gives way to hot summer. Eastern parts of Andhra Pradesh, Tamil Nadu and some parts of Gujarat and Orissa are the warmest parts of the country. Jammu & Kashmir, Himachal Pradesh, Uttaranchal, and Arunachal Pradesh are the coolest states. Over the central parts of India, the maximum recorded temperatures often exceed 45^0cwhile along the west coast, the maximum temperatures fall in the range between 35–40^0C. Smaller values of maximum temperatures of around 25^0C are recorded in parts of Himachal Pradesh and Jammu & Kashmir. Low temperature dropping to the vicinity of −40^0C have been recorded in the northern most parts of India at Kargil.

Based on the temperature and precipitation variations, there are four distinct seasons in India.

(i) The Cold Weather Season

The cold weather season starts in early December and is over by the end of February. January and February are the coldest months. In these months the temperature remains cool and dry. The temperature varies between 100 C–150C in the northern India as well as about 250 C in the southern India. Due to the western disturbances, heavy rainfall on the coast of Tamil Nadu occurs in this period. The north-west part of India also receives some rainfall or snowfall in this season. In other parts of the country, the months of January and February are cloudless and rainless and the weather remains pleasant.

(ii) The Hot Weather Season

The hot season starts in the month of March and lasts till mid-June. Weather is very hot during this season due to vertical sunshine over India. The highest day temperature reaches close to 50_ C in some places. Pre-monsoon showers are found to occur in Chottanagpur, Kerala, and Western Ghats due to low-pressure moist winds from Arabian Sea. The northern plains remain dry and hot winds called loo blow during the day. Sometimes dust storms occur in Punjab, Haryana and Uttar Pradesh followed by light rain and cool breeze, thereby lowering the temperature to a great extent.

(iii) The Advancing Monsoon Season

As already described above, this season runs from mid-June to September. Heavy rainfall in the whole of India occurs due to monsoon winds starting from Bay of Bengal and Arabian Sea.

(iv) The Retreating Monsoon Season

This season runs from October to November. In this season sky is usually clear and humidity is low. Monsoon starts retreating in late September to early October. The months of October and early November form a period of transition from hot rainy season to dry winter season.

Snow and Glaciers

Precipitation occurring in the Himalayas at heights of 2,450 m and above usually gets solidified as snow. The mountainous area covered by snow is about 80% of the total area of Himalayas. In Himalayas, the western part gets more snow than the eastern and gets it earlier. The snowline, the lowest line on a mountain at which snow exists throughout the year, is about 5,490 m at the equator and 610 m in Greenland. In temperate zones, it is about 3,050 m. In winters, the snow line can descend to altitudes as low as 2,500 m. As successive snowfalls occur, pressure on the lower layers increases and the snow becomes a granular ice. When the weight of ice increases, the depth of ice being more than 76 m, it begins to move and is known as a glacier. The rate of movement varies from 0.3 m to several meters a year.

Indian Himalayan Glaciers

Glaciers can be conceived as natural reservoirs which store precipitation in the winter season and gradually release it as melt water in summers, thereby augmenting flows into the rivers. Himalayas are the home to a multitude of glaciers and are the largest reservoir of snow and ice outside the polar regions. In the rivers originating from Himalayas, significant snow and glacier melt runoff contribution begins in April when seasonal snow cover starts

ablating. This contribution continues till October/ November depending upon the climate conditions.

The principal glaciers in Himalayas can be divided in four groups:

a) Punjab Himalaya Group,

b) Garhwal Himalaya Group,

c) Nepal Himalaya Group, and

d) Assam Himalaya Group.

Punjab Himalaya Group of Glaciers: Under the Punjab Himalaya Group, the major glaciers are: Rakhiot Glacier, Kolhai Glacier, Neh-Nar Glacier, Sarbal Glacier, Kangriz Glacier, Brahma Glacier, Drung Drung Glacier, Mulkila Group Glaciers, Barashigri Glacier, Dibi Bokri Glacier, Gara Glacier and Gorgarang Glacier.

Garhwal Himalaya Group of Glaciers: Garhwal Himalaya Group of Glacier includes Gangotri Glacier, Santopath Glacier, Kedarnath Glacier, Milam Glacier, Pindari Glacier, Shankulapa Glacier, and Poting Glacier.

Nepal Himalaya Group of Glaciers: Yaling Glacier, Chong Kumadan Glacier, Rundun Glacier, Glaciers adjoining to Dhaulagiri and Annapurna Peaks, Kang Shung Glacier, Rupal Glacier, Khumbu Glacier, Glaciers adjoining to Makalu Peak, and Zemu Glaciers fall under this group.

Assam Himalaya Group of Glaciers: Glaciers adjoining Kanchenjunga peak, Sanlung Glacier and Glaciers adjoining Gyara Pari peak falls under the Assam Himalaya Group of glaciers.

Major River Groups of India

Based on the topography, the river systems of India can be classified into four groups. These are: (i) Himalayan rivers, (ii) Deccan rivers, (iii) Coastal rivers, and (iv) Rivers of the inland drainage basin.

The Himalayan Rivers receive input from rain as well as snowmelt and glacier melt and, therefore, have continuous flow throughout the year. During the monsoon months of June to September, Himalayas receive very heavy rainfall and experience maximum snow melt and these are the periods when the rivers carry about 80% or more of the annual flows. This is also the time when these rivers are prone to flooding. The main river systems in Himalayas are those of the Indus and the Ganga-Brahmaputra-Meghna. The Indus rises near Mansarovar in Tibet. Flowing through Kashmir, it enters Pakistan and finally falls in the Arabian Sea near Karachi. A number of important tributaries of Indus flow through India, namely, the Sutlej, the Beas, the Ravi, the Chenab and the Jhelum.

The Deccan rivers are rainfed and therefore have very little flow during non-monsoon season; many of these are non-perennial. The rivers of Deccan can be further classified in two groups: west flowing rivers and east flowing rivers. The Narmada and the Tapi rivers flow westwards into Arabian Sea. The important east flowing rivers are the Brahmani, the Mahanadi, the Godavari, the Krishna, the Pennar, and the Cauvery. These rivers fall into the Bay of Bengal.

The coastal streams, especially on the west coast, have small catchment areas and are short in length. Most of them are non-perennial. There are numerous coastal rivers which are comparatively small. While only handful of such rivers drain into the sea near the deltas of east coast, there are as many as 600 such rivers on the west coast. The West Coast rivers are important as they contain as much as 14% of the country's water resources while draining only 3% of the land.

The rivers of the inland system, centered in western Rajasthan state, are few and frequently disappear in years of scant rainfall. They flow for some time during monsoon only. A few rivers in Rajasthan do not drain into the sea. They drain into salt lakes or get lost in sands with no outlet to sea. Basins of India are shown in the figure given below which is taken from WRIS (Water Resources Information System).



Figure 4.2 : River basins of India

Physical Characteristics of India

India occupies the south-central peninsula of the Asian continent. Besides the mainland, there are two groups of islands, namely Lakshadweep in the Arabian Sea and Andaman & Nicobar Islands in the Bay of Bengal. The mainland of India lies between 8^0 4' N and $37^0$6' N latitude and $68^0$7' E and $97^0$25' E longitude. The Andaman and Nicobar Islands lie to the south east of the mainland and Lakshadweep to the southwest.

India is endowed with almost all the important topographical features, such as high mountains, extensive plateaus, and wide plains traversed by mighty rivers. The country is bounded by Himalayas in the North and has a large peninsular region tapering towards the Indian Ocean. The Himalayas in the north are the major mountain ranges of the world. The other prominent mountains of India include the Aravallis, the Vindhyachals, the Satpuras, the Eastern Ghats, and the Western Ghats. The mountains are the primary source of rivers

which derive their flow from rainfall and snow and glacier melt. The plateaus are another striking feature of topography in India and they range in elevation from 300 to 900 m.

With a geographical area of 3,287,263 sq. km, India is the seventh largest country in the world. India occupies about nearly 2.42% of the land area of the earth. The latitudinal and longitudinal extent of India is almost of the same magnitude in degrees, about 30_. The distance between the extreme north to south tip is about 3,200 km while the east-west extent is 3,000 km.

In India, about 51.09% of the land is under cultivation, 21.81% under forest and 3.92% under pasture. Built up areas and uncultivated land occupy about 12.34%. About 5.17% of the total land is uncultivated waste, which can be converted into agricultural land. The other types of land comprise upto 4.67%.

Indian soils are generally classified into four major types: (i) the Indo-Gangetic alluvium soils; (ii) the black cotton or regur soils; (iii) the red soils lying on metamorphic rocks; and (iv) the laterite soils.

India is rich in bio-diversity – the country is one of the 12 mega-diversity nations. The country has 7% of the world's biodiversity and supports 16 major vegetation types. About 200 million people in India depend on forests for their livelihoods –directly or indirectly. Forests are important in environmental and economic sustainability, provide numerous goods and services, and maintain life-support systems.

The Indian forests ranges from evergreen tropical rain forests in the Andaman and Nicobar Islands, the Western Ghats, and the north-eastern states, to dry alpine scrub that are found in the Himalayas. Interspersed between these two extremes are semi-evergreen rain forests, deciduous monsoon forest, thorn forests, subtropical pine forests, and montane zone forests.

The Forest Survey of India (FSI) assesses the forest cover of the country using satellite imageries and ground verification. India has 51,285 sq. km of very dense forest, 339,279 sq. km of moderately dense forest, 287,769 sq. km of open forest, and 99,896 sq. km of tree cover. This implies that forest cover occupied 20.64 % of country's geographic area, tree cover occupied 3.04% area, yielding total 23.68 % of the covered area. Madhya Pradesh accounts for the largest forest cover of the country at 76,429 sq. km followed by Arunachal Pradesh (68,019 sq. km), and Orissa (48,366 sq. km).

Plants of a particular region, which have several species, are referred to as flora. About 49,000 species of plants have already been found in India, which represents the widest range for any country of the world. Out of 49,000 species of flora, about 5,000 species are found exclusively in India including flowering and non-flowering.

Agriculture Seasons in India

India has mainly two agricultural seasons, namely, the Kharif and the Rabi. In Kharif season crops are sown in June-July and harvested in September-October. The Kharif crops include rice, millets, maize, groundnuts, jute and cotton. Pulses are also grown during this season. Rabi Season Crops are sown in November and are harvested in April-May. The Rabi season production largely depends upon subsoil moisture. The major crops are wheat, gram, oil seeds like mustard and rapeseed.

Besides these two main seasons, farmers in irrigated areas are able to reap a third harvest during May to July. This season is known as hot weather or Zaid. Moong and Urad are popular crops of this season. Watermelon and Cucumber are also grown in this season. In addition to food crops, India also produces a large number of non-food or cash crops like, Sugarcane, Tea, Coffee, Cotton, Tobacco, Rubber, and Spices, etc. Sugarcane is a perennial crop that occupies land year around. India is famous all over the world for high quality tea, such as the Darjeeling tea. Tea plants thrive in hot and humid climate. Tea is mainly grown in West Bengal, Assam, Tamil Nadu, and Kerala. Coffee is a related crop that also requires similar climatic conditions albeit lesser rainfall. It is

grown mainly in Karnataka, Kerala, and Tamil Nadu and large production of the crop has made India a leading coffee exporter.

Water Resources Requirement

Water use efficiency in India is presently estimated to be around 40% for canal irrigation and about 60% for ground water irrigation schemes. India's per capita water availability per year (1991 census) was estimated at 2,209 m^3 against the global average of 9,231 m^3. Surface water is either used in-stream for hydropower, recreation, navigation etc. or is diverted for off-stream use. Ground water is mostly used for irrigation or for domestic requirements. The consumptive uses of water are: (a) Irrigation for agriculture, (b) rural and municipal water supply, and (c) industrial water supply. The Indian economy has traditionally been agriculture based and the principal consumptive use of water is for irrigation. On the total water use in 1990, the share of agriculture was 83%, followed by domestic use (4.5%), energy (3.5%) and industrial use (2.7%). The remaining 6% were for other uses including environmental requirements. At the time of independence, it was of crucial importance to develop irrigation to increase agricultural production for making the country self-sustained and for poverty alleviation. Accordingly, irrigation sector was assigned a very high priority in the 5-year plans. Giant schemes like the Bhakra Nangal, Hirakud, Damodar Valley, Nagajunasagar, Rajasthan Canal project etc. were taken up to increase irrigation potential and maximize agricultural production.

The annual potential natural groundwater recharge from rainfall in India is about 342.43 km^3, which is 8.56% of total annual rainfall of the country. The annual potential groundwater recharge augmentation from canal irrigation system is about 89.46 km^3. Thus, total replenishable ground water resource of the country is assessed as 431.89%. After allotting 15% of this quantity for drinking, and 6 km^3 for industrial purposes, the remaining can be utilized for irrigation purposes. Thus, the available groundwater resource for irrigation is 361 km^3, of which utilizable quantity (90%) is 325 km^3.

Dams and Lakes in India

Dams in India are constructed mainly for irrigation, hydroelectric generation, flood control, and water supply; a few are constructed for other purposes. At the turn of twentieth century (1900), there were 42 dams in India. During 1901 to 1950, about 250 dams were added. That is, at the time of the beginning of first five-year plan period (1950-51), there were a total of about 300 dams. During the next twenty years, there was a spurt in dam construction activity in which 695 dams were added, bringing the total number of dams to nearly 1,000 up to the year 1970. The dam building activity intensified during the next two decades and at the end of 1990, the total number of Indian dams stood at 3,244 (not accounting for 236 dams for which the year of construction is not available). Due to slow down in economy, opposition on socio-economic grounds, and other reasons, only 116 dams could be added between 1990 and 2000. India had 4,291 large dams and about 250 large barrages by 2003, including 695 dams under construction. Distribution of large dams in India according to their age is presented below.

Table-4.3: Distribution of large dams according to age

Year of completion	Number of dams
Up to 1900	42
1901-1950	251
1951-1960	234
1961-1970	461
1971-1980	1,190
1981-1990	1,066
1991 – 2000	116
Year of construction not available	236
Under construction	695
Total	4,291

Depending upon the depth of water and uses, the lakes are known by different names in different parts of the country like, Jheels, Bheels, Marshes, Talab and Tank. In India, the lakes have been extensively utilized, often resulting in overexploitation. A national inventory of lakes entitled "The All-India Wetland Survey" was completed in the mid-1980s.

Some lakes in India have significance from religious point-of-view. The city of Amritsar in Punjab which is famous for the Golden Temple got this name (Amritsar means the lake of nectar, the drink of Gods. He who drinks nectar becomes immortal) because of the holy lake. A bath in the lake water is considered to be a privilege. The main important lakes in India are Dal lake, Nagin lake, Surinsar Lake, Mansar Lake, upper Lake, Bhopal, Wular Lake Nainital lake, Harike lake, Loktak lake, Chilka lake, Pushkar Lake etc.

Concluding Remarks

Water is one of the most essential natural resources for sustaining life and it is likely to become critically scarce in the coming decades, due to continuous increase in its demands, rapid increase in population and expanding economy of the country. Variations in climatic characteristics both in space and time are responsible for uneven distribution of precipitation in India. This uneven distribution of the precipitation results in highly uneven distribution of available water resources both in space and time, which leads to floods and drought affecting the vast areas of the country. Better and scientific structural and non-structural measures are required for mitigating the floods and droughts. Mathematical models are needed for forecasting the monsoon rainfall accurately, which may be utilized by the decision makers and farmers for adopting appropriate strategies for management of droughts and floods. There is a need for increasing the availability of water and reducing its demand. For increasing the availability of water resources, there is a need for better management of existing storages and creation of additional storages by constructing small, medium and large sized dams considering the economical, environmental and social aspects. The availability of water resources may be further enhanced by rejuvenation of dying lakes, ponds and tanks and increasing the artificial means of ground water recharge.

Impact of Climate Change in India

5

Introduction

India's water resources are already under pressure due to population growth, economic development, industrialization, urbanization, over exploitation of groundwater and most importantly the inefficient usages of water. It has been further exacerbated by adverse impacts of climate change due to number of reasons. Climate change is causing, rising temperatures, and spatio-temporal shifts of precipitation more severe, unpredictable weather are likely to affect rainfall and its distribution, as well as river flows and groundwater, and impaired water quality. The climate change has also resulted in an increase in frequency and intensity of extreme precipitation, droughts and tropical cyclones. Floods account for almost 47% of natural disasters in India in the last 100 years and nearly 20% of the total flood-prone area is affected every year. Climate change is also expected to increase the frequency of droughts in future. India has to ensure water, food, and energy security to its growing population and also need to protect its people from water-related disasters which are likely to become more frequent, intense, and widespread with time. Recently published Sixth Assessment Report (AR6): Working Group (WG) 1 (The Physical Science Basis) in August, 2021 by the Intergovernmental Panel on Climate Change (IPCC) is quite similar but larger than its predecessor AR5 and differs from it on one main account i.e. the scientists are now more confident that one of the major cause of climate change are Anthropogenic activities. Therefore, it would be necessary to initiate actions in time so that the adverse impacts are mitigated and the damage to infrastructure and population is minimized.

Likely Impacts of Climate Change

The regional climate over the Indian subcontinent involves complex interactions of the atmosphere–ocean– land–cryosphere system on different space and time scales. In addition, there is evidence that anthropogenic activities have influenced the regional climate in recent decades.

(i) Rainfall

The summer monsoon precipitation (June to September) over India has declined by around 6% from 1951 to 2015, with notable decreases over the Indo-Gangetic Plains and the Western Ghats. There is an emerging consensus, based on multiple datasets and climate model simulations, that the radiative effects of anthropogenic aerosol forcing over the Northern Hemisphere have considerably offset the expected precipitation increase from GHG warming and contributed to the observed decline in summer monsoon precipitation. In order to study the impact of Climate Change on rainfall quantity and pattern, a detailed analysis was carried out to determine the trends in rainfall amount and number of rainy days in Indian river basins by using daily gridded rainfall data at $1^{o}\times1^{o}$ resolution.

(ii) Temperature

Temperature is another critical variable showing changes over the years. There is a rapid rise in surface temperatures over India, particularly since 1980 and may increase 2.5^{0}C to 5.5 ^{0}C at the end of 21st century under GHG scenarios. The maximum susceptibility over Himalayas, north, central and western parts of India with a lower influence on the southern part of India and will have more warm days and nights as compared to the cold days and night.

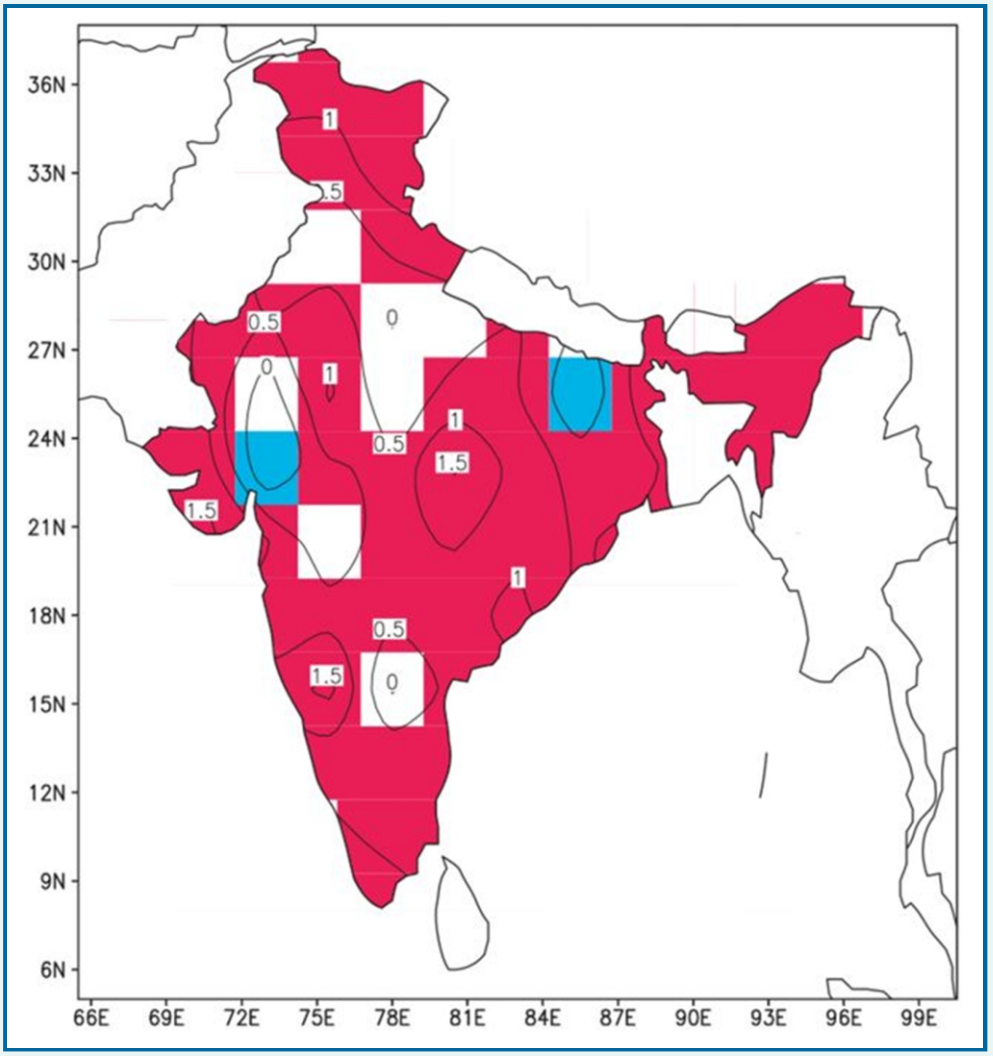


Figure – 5.1: Trends in annual mean temperature significant at the 95% level over India during 1901–2016(after Ross et al., 2018) (red colour indicates increasing trends while blue colour indicates decreasing trend)

The temperature anomalies based on the data for the period 1901-2019 suggest significant positive (increasing) trend over most parts of the country except in parts of some States that include Rajasthan, Gujarat, Uttar Pradesh and Bihar, where significant decreasing trend was observed.

(iii) Water availability

Water availability is a major factor for human society's ability to meet the future food and energy needs of a growing population. Climate change is likely to cause significant changes in the availability of surface and groundwater in river basin. It is projected to affect the water balance, and particularly the amount of runoff and recharge, which in turn determines the water resources available for human and ecosystem. Due to likely reduction in stream flow and ground water recharge along with increase in irrigation demands, the water stress in the region would aggravate.

Climate change is also expected to affect groundwater due to changes in temperature, precipitation and evapo-transpiration which in turn affect soil water balance and ground water recharge. The direct effect of climate change on groundwater resources depends upon the change in the volume and distribution of groundwater recharge.

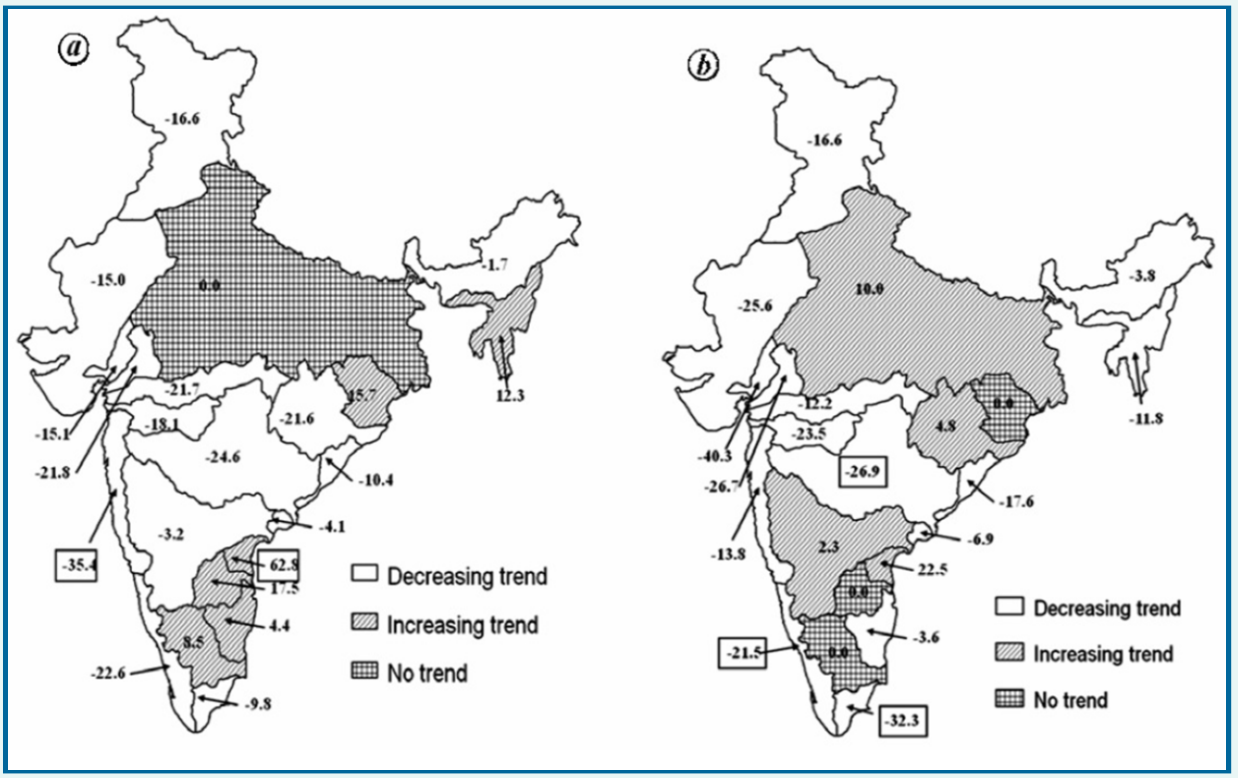


Figure - 5.2 : Trends and Magnitude Pertaining to Rainfall Changes for Different River Basins in India. Significant Trends are Displayed in Boxes. (a) Annual Rainfall (% of mean/100 years); (b) Annual Rainy Days (% of mean/100 years)

Increase of temperature and changes in precipitation patterns over the Himalayan region is a major concern for the health of the Himalayan snow cover and glaciers. This region has experienced significant melting of snow and retreat of glaciers during the past five decades. Long-term trends in the maximum, minimum and mean temperatures over the north western Himalaya during the 20thcentury suggest a significant rise in air temperature in the north western Himalaya, with winter warming occurring at a faster rate. The continuous glacier loss and corresponding development and progressive growth of glacial lakes has been attributed to warming temperatures particularly minimum temperature.

(iv) Water Demands

Rising temperatures and altered meteorological variables will also alter demand for most water uses leading to imbalance between user demand and supply and may be worsened under climate change.

Water use in Agriculture

The Indian agriculture is heavily climate dependent with notable regional and climatic variabilities. The agriculture sector is already facing multi-dimensional pressure from many stressors such as climate change, socio-economic, i.e., population growth, unbounded urbanization and industrialization. The changes in climate (mainly) in the form of precipitation, temperature, and radiation will affect the water availability and water demands for both irrigated and rainfed crops, crop growth and productivity. The crop water demands differ among cropping systems and could be significantly impacted by climate change.

Domestic and Industrial Water use

India's urban population as per the 2011 census was 377 million, accounting for nearly 31% of the country's total population. Currently, around four billion people live under conditions of severe

freshwater scarcity for at least one month of the year, with half a billion people in the world facing severe water scarcity all year round. India is in the midst of a severe and chronic water shortage due to climate change, supply/demand imbalance, and poor water resource management. By 2050, India is expected to have significant water shortages due to population growth and other factors.

Water use in Energy Production

India is the 7th largest hydroelectric power producer in the world and has a high potential for hydropower generation. Climate change is likely to have an impact on hydropower generation by altering the timing and amount of streamflow, increasing inter-annual variability of flows, changing the type and variation of demands, and altering evaporation from reservoirs and sediment fluxes. Changes in seasonal snow, as well as glacier mass, will also have the potential to change the magnitude and seasonality of streamflow. All of these changes can directly affect hydropower operations.

Water for Environment

Climate change induced changes will also likely freshwater environments and ecosystem services (e.g. fisheries, water purification, tourism). It has many possible impacts on the biogeochemical processes that occur in different types of water environments. The major impacts may be (i) enhanced eutrophication, salinization, and nutrients release, (ii) reduced pH and dissolved oxygen in the water bodies, (iii) increase in the influx of pollutants into the water bodies due to more frequent extreme storm events, (iv) increase in waterborne diseases due to upsurge of pathogens, and (iv) alteration in the aquatic biodiversity composition. Rising water temperature will also lead to the deterioration of the drinking water quality due to impact of climate change.

Challenges in Assessment and Mitigation/ Reducing the impacts of Climate Change

(i) Uncertainties in Projections

The questions in hydrological studies is how to develop more reliable and regional scale projections so that they can be applied in hydrological modelling effectively. Uncertainty in future climate change presents a key challenge for adaptation planning. Customization of climate models for Indian conditions is also a challenge.

(ii) Human Migration due to climate change

The Intergovernmental Panel on Climate Change (IPCC) noted that the greatest single impact of climate change could be on human migration with millions of people displaced by shoreline erosion, coastal flooding and agricultural disruption.

The climate change is likely to be the primary driver of biodiversity loss in the future. Climate change imposes additional stress on ecosystems that are already stressed due to overuse, degradation, fragmentation, and loss of total area. When these factors interact, they reduce not only ecosystem resilience but also human options for dealing with a changing environment.

In India, a very large populations live in the areas that are likely to get more floods and water stress. It may also lead to lower agriculture productivity therefore migration of people from these places is expected. In coastal areas also, the dependence on agriculture for daily subsistence and livelihoods, more floods, landslides, droughts, and cyclones will increase vulnerability leading to migration related challenges.

(iii) Understanding Hydrological Extremes

Hydro climatic extremes such as droughts and floods are inherent aspects of the monsoonal landscape. The quantification of extreme events (floods or droughts) due to Climate Change poses a major challenge because of accuracy related issues in downscaling of global climate models at smaller catchment scales. Increased frequency of localized heavy rainfall on sub-daily and daily timescales has enhanced flood risk over India. Increased frequency and impacts of floods are also on the rise in urban areas. The overall decrease of seasonal summer monsoon rainfall during the last 6–7 decades has led to an increased propensity for droughts over India. Both the frequency and spatial extent of droughts have

increased significantly during 1951–2016. In particular, areas over central India southwest coast, southern peninsula and north-eastern India have experienced more than 2 droughts per decade, on average, during this period.

(iv) Crop growth and food production

Climate change may have a number of negative consequences on crops in various locations, and detrimental consequences are already being felt. The majority of model predictions indicate that without adaptation major agricultural yields (wheat, rice, and maize) will suffer in tropical areas. There is a need for intensive, innovative, and location-specific adaptations to ensure food security in the future.

(v) Ensuring Water, Food and Energy Security

India is one of the countries most affected by climate change and occupies sixth place in the Global Climate Risk Index 2018. According to India's Composite Water Management Index (2018), 600 million people in the country are suffering from an acute shortage of water.

Energy is the primary cause of climate change since it produces the majority of greenhouse gases. The world's reliance on fossil fuels, as well as their increasing usage, has contributed to the current situation. The climate change problem will not be solved unless the energy issue, in all of its aspects, is addressed.

Climate change, on the other hand, is limiting the amount and quality of water available for drinking and agriculture. Country's food security may be placed under progressively greater pressure due to rising temperatures, heat extremes, floods, droughts and increasing year-to-year rainfall variability that can disrupt rain-fed agricultural food production and adversely impact crop yield. In Himalayan region, receding of glaciers and reduction of snowmelt coupled with rising population and altered land use/land cover have serious implications for water security.

Energy security and climate change are interrelated issues, and India will need to adopt strategies that would meet its energy needs and cause minimal disruption to the economic growth, at the same time, reducing carbon emissions. The challenge is managing the integration and trade-offs of energy security and climate change.

(vi) Infrastructure and Governance Needs

Effective climate change adaptation requires an understanding of the various ways in which social processes and development pathways shape reduction in disaster risk. India must adopt mainstream climate action, accelerate adaptation efforts across sectors, and build resilience capacity, while also maintaining efforts toward sustainable development and embracing innovative solutions to reduce GHG emissions. This will necessitate the use of governance frameworks that include key components as well as feedback between the various components. Appropriate institutional arrangements to achieve the goals to coordinate between different institution/departments having expertise in the related interdisciplinary field as we know that the climate change impact studies are multi-disciplinary.

Opportunities and Way forward

(i) Mitigation and Adaptation

A detailed scientific understanding of the causes behind climate change, trends in data and possible impacts is essentially required. For this, impact of climate must be assessed at regional and national level. Hydrologists need to generate what-if scenarios based on the probability of occurrence of extreme events in order to develop adaptation measures. Such scenarios can reveal the performance and resilience of hydro-infrastructure, as well as any critical design and operation gaps.

Probabilistic flood inundation maps for each basin should be created and updated on a regular basis to account for changes in land use, construction, climate, demography, and so on.

The adaptation measures such as rainwater harvesting, afforestation in soil erosion-prone areas, water recycling and reuse, desalination, efficient crop water management, and pond and wetland restoration need to be promoted.

(ii) Management of Hydrological Extremes

As the extreme events are going to be more frequent and intense, it will be necessary to develop and strengthen infrastructure (structural as well as non-structural for both, surface water and groundwater resources) to deal with increasing variability. We need to develop ways and means to store water made available during high flows to minimise adverse impacts and use stored water beneficially in dry periods. In this regard, there is strong need to conserve water at suitable places in natural/artificial surface water storages (through dams/ponds/ wetlands or interlinking schemes) as well as in aquifers (through water harvesting and artificial GW recharge). The creation of adequately sized surface water storage provides resilience against temporal variability of inflows whereas the interlinking of rivers (ILR) takes care of the spatial variability of water resources availability across river basins. The ILR alone, if implemented as per the National Perspective Plan, can increase the utilisable water resources to the tune of about 200-250 BCM.

There should be active collaboration within the institutes and departments engaged in the applications of new methodologies and techniques such as hydrological modelling, soft computing, GIS and remote sensing, downscaling of GCM and RCM data and assessment of impact of climate change etc. for estimation of design floods for various types of hydraulic structures and flood inundation for the present situation and future considering impact of climate change.

Regulation of urban development in flood-prone areas and flood plains needs to be brought along with Preparation of Emergency Evacuation Plans (EAP) for the flood prone areas and design of appropriate drainage systems in urban centres, to quickly drain off the accumulated flood waters in the city.

(iii) Aspects of Research & Development

More research is needed towards understanding the behaviour of climate system, especially in four areas: a) regional climate prediction, b) precipitation forecasts, c) aerosols, and d) paleoclimate data.

Improved Understanding of Climatic phenomena

The climate research and development programs strive to advance the understanding of the physical, chemical, and biological components of the Earth system, the causes and consequences of climate and land use change, and the vulnerability and resilience of the earth system to such changes. A thorough scientific understanding of the causes and historical trends underlying climate change and its consequences is a must for dealing with the problem. This will aid in initiating the necessary actions to mitigate the negative consequences. Future climate projections at the local and regional levels are full of uncertainty. These projections serve as the foundation for corrective actions such as adaptation projects. As a number of modelling groups around the world work to improve their models, it is hoped that the regional projections made by the next generation of models will be less uncertain and useful to planners and policymakers. These efforts will be aided by the availability of better data and more powerful computers.

Improved Hydrological and Allied Data Collection

Climate data are essential in an array of climate research and applications that include analyses of climate variability and trends and modelling the impact of climate variability and change on different socioeconomic activities. But, there is considerable uncertainty in the country's future climate projections due to a lack of data on hydrologic, economic, and other sectors. Uncertainty may arise as a result of the use of GCMs for climate projections, downscaling techniques, and hydrologic models. There are numerous critical data gaps in India's water sector. To predict the changes, reliable baseline data are required. It would be beneficial to establish a network of reference climate data stations capable of providing high-quality long-term data for a better understanding of changes in meteorological and hydrological variables across the country and we need to develop future projections of maximum temperature, minimum temperature, mean temperature, and precipitation at fine spatial and temporal resolutions for various greenhouse gas

concentrations.

Alongside this, a society which is knowledgeable and aware is more resilient and can better be prepared to manage the risks. Hence, the society should be made aware and their understanding about climate change risks need to be enhanced. Water quality data in India are scanty; limited variables are measured and at sub-optimal frequency. Hydrogeological maps are needed for improved assessment of ground water resources, impact of climate change on them, and groundwater contamination. Utilization of water in its various uses is rarely measured. Hence, there is considerable uncertainty in the estimates of water utilization which needs to be resolved.

Improved Water Management Practices

With the changing water demands and water availability distributions, the design and operation protocols of water resources projects (say, rule curves for deficit water management and flood operation policies for excess water management) need to be revised at regular time intervals. IWRM (integrated water resources management) is increasingly seen as the holistic way to manage water resources in a changing environment while managing competing or conflicting demands. IWRM consists primarily of three major components: explicit consideration of all potential supply-side and demand-side actions, inclusion of all stakeholders in the decision-making process, and ongoing monitoring and review of the water resources situation. In the absence of climate change, IWRM is an effective approach with numerous justifications for implementation. Adopting integrated water resource management will go a long way toward improving water managers' ability to adapt to climate change.

Concluding Remarks

India is among the countries that are highly vulnerable to climate change, due to geographical location as well as topography, economy and population. Reports of IPCC and discussions on international forums have been urging the nations to initiate actions tackle challenges arising due to climate change. In response, the Indian government developed a National Action Plan on Climate Change (NAPCC) in 2008 as well as asked all states to prepare State Action Plans on Climate Change (SAPCC). The NAPCC has eight missions that deal with different facets of climate change adaptation and mitigation. Among these, the missions relevant to water sector are: National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for Sustainable Agriculture, and National Mission for Strategic Knowledge on Climate Change.

6 Research and Development

The National Institute of Hydrology is engaged in hydrological research for more than forty years. At present, research and development activities at the Institute are carried out under six scientific divisions at headquarters and seven regional centres at Belagavi (Karnataka), Jammu (J&K), Kakinada (Andhra Pradesh), Bhopal (Madhya Pradesh) and Guwahati (Assam) and one Centre for Flood Management Studies (CFMS) at Patna (Bihar). The program of studies and research for the year 2023-24 of the Institute is given in Appendix-VII. Brief description of some of the important studies completed and ongoing during the year 2023-24 is given below.

6.1 R & D STUDIES COMPLETED DURING 2023-24

Impacts of Glacier and Climate Change on Runoff for Selected Basins of Himalayan Region

This study carried out a research analysis over Himalayas to assess the impact of glacier and climate change in the long-term time frame (e.g. 21st century). For glacier change analysis, a novel approach based on snow-glacier hydrological model such as SPHY has been incorporated. SPHY model is a grid-based model and uses multiple thematic and meteorological datasets. In this study, we have used a temperature index model utilizing variable degree-day factors (uses separate factor for snow, clean ice glacier and debris glacier) in SPHY at each grid scale for analyzing snow and glacier melt runoff, especially designed for the Himalayan conditions. This has improved the assessment of snow and glacier melt contributions. No such variable degree-days factors have been applied for each grid. For climate change analysis, latest CMIP5/CMIP6 GCMs coupled with SWAT model have been utilized. Remote sensing-based snow-cover and glacier change dynamics have been carried out at selected Himalayan river basins such as Baspa, Upper Ganga and Teesta River basins. Snow cover

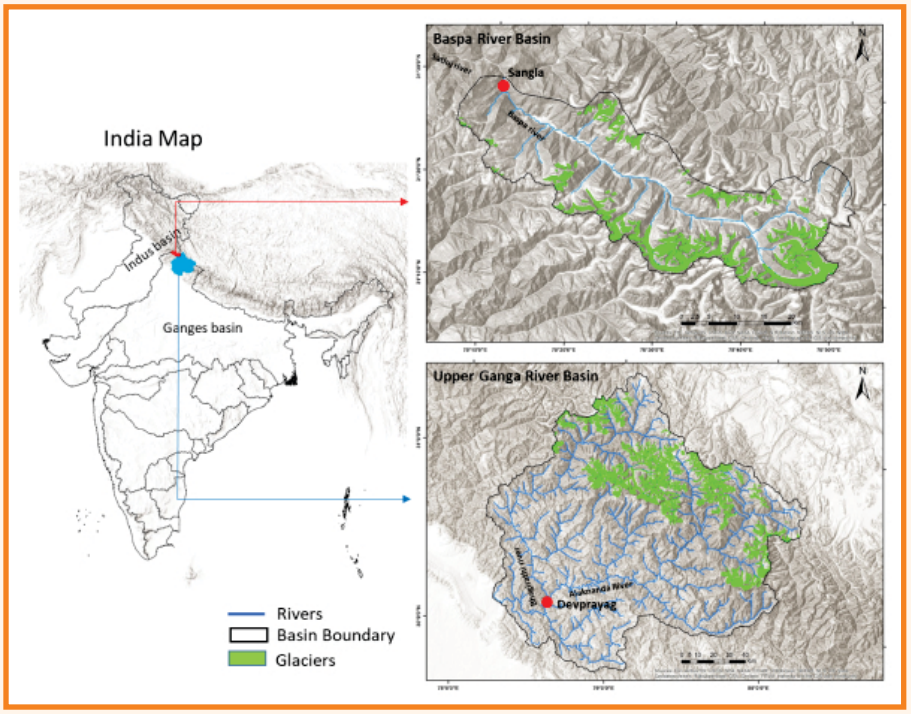


Figure – 6.1: Study Area Map

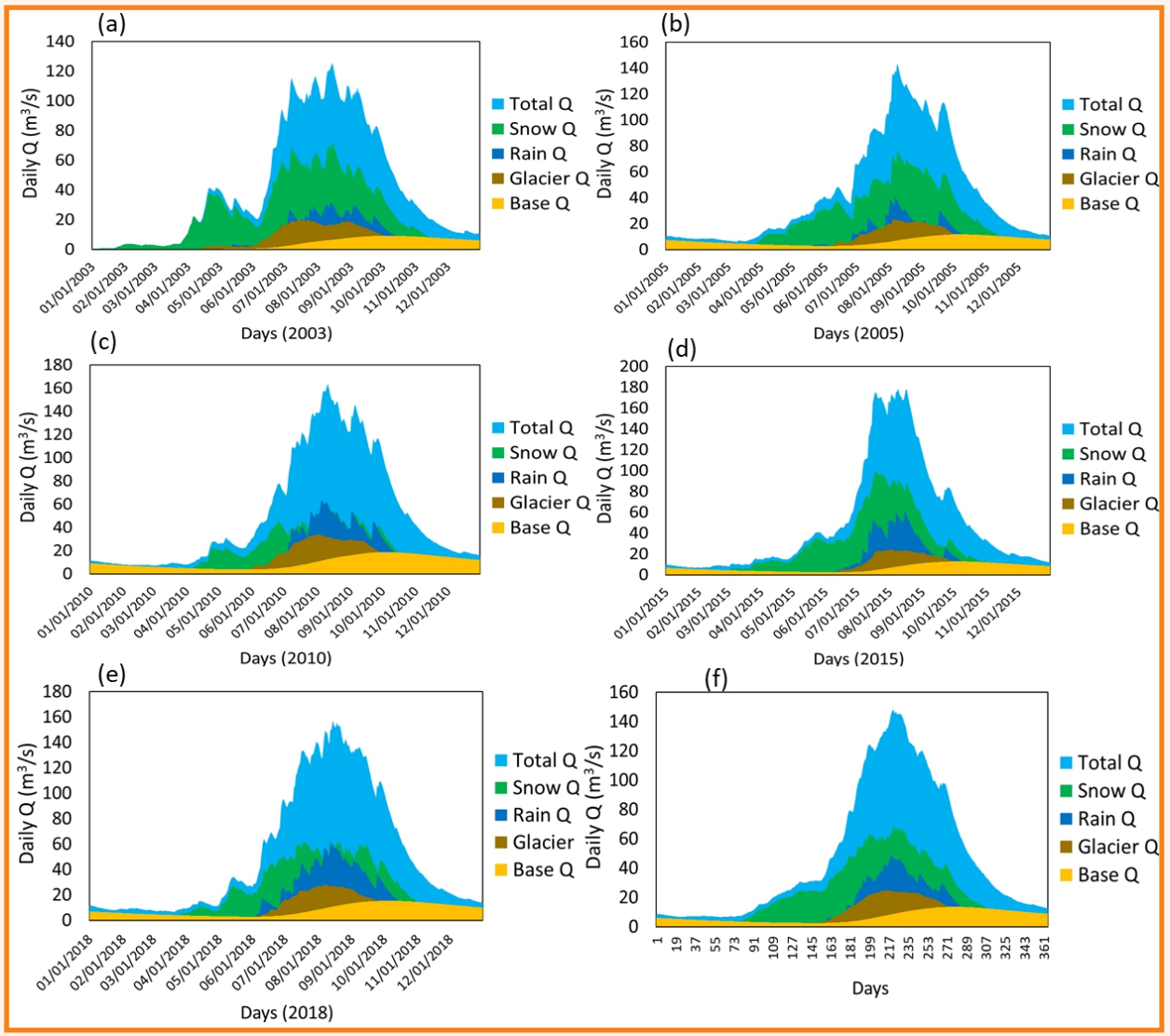


Figure – 6.2: Separation and Annual Variations in Runoff at Sangla, Baspa River Basin

and glacier change have been analyzed by performing statistical and mathematical functions. Model calibration and validation have been done utilizing real time remote sensing data products and observed hydro-observational datasets. The effect of global warming in terms of climate change and their impacts on snow and glacier melting have been analyzed. The snow and glacier melt induced runoff changes have been assessed by applying fractional elevation band approach. The elevation dependent warming and their impacts on snow-glacier changes have been carried out the different regions of the Himalayas. The snow and glacier melt runoff contribution in total discharge have been accounted and their fluctuations have been analyzed across all the selected Himalayan basins. The comparative seasonal and monthly snow cover and glacier change (area/volume) have been computed to highlight the variability across all selected.

SPHY performs well in the separation and quantification of all runoff components viz. snow Q, glacier Q, base Q, rain Q and total Q, evaluated at Baspa and Upper Ganga basins. SPHY derived snow cover area (tested on a monthly scale) found comparable to MODIS derived snow cover areas. Based on the glacier change analysis, the smaller area size glaciers have more significantly reduced

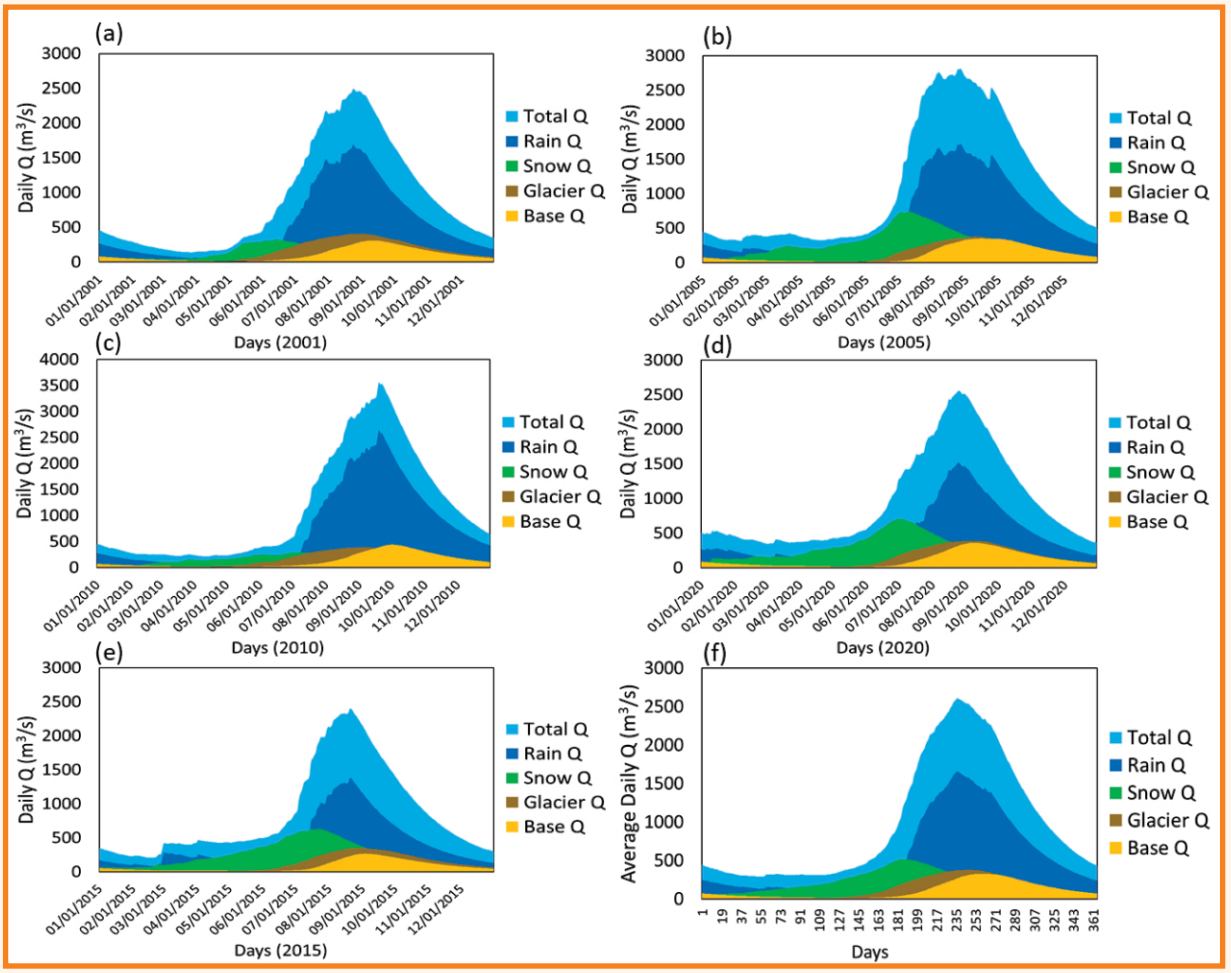


Figure – 6.3: Separation and Annual Variations in Runoff at Rishikesh

than large size glaciers and high elevated glaciers found less reduction in mass than low elevated glaciers. Observations show that in case of large size glaciers, the melt runoff has increased, while in case of small size glaciers, the melt runoff has decreased due to reduced glacier cover. Baspa basin shows more frequent loss in glacier mass than Ganga and therefore, the glacier melt runoff is decreased, while in case of Ganga, it is slightly increased.

In case of Baspa, most of the months and subbasins show an increase in snow Q, except Sub 2, and the April month found more critical for increase in snow Q. The glacier Q is significantly enhanced at Sub 2 and Sub 3, especially during winters, while it shows slight decrease in glacier Q during April to July in Sub 1 and Sub 5. In case of Upper Ganga, April to June shows a clear increase in snow Q across all subbasins. The total flow is also increased during April-July across all subbasins, while Sub40, Sub 79 and Sub 146 have shown slightly higher increase than other subbasins.

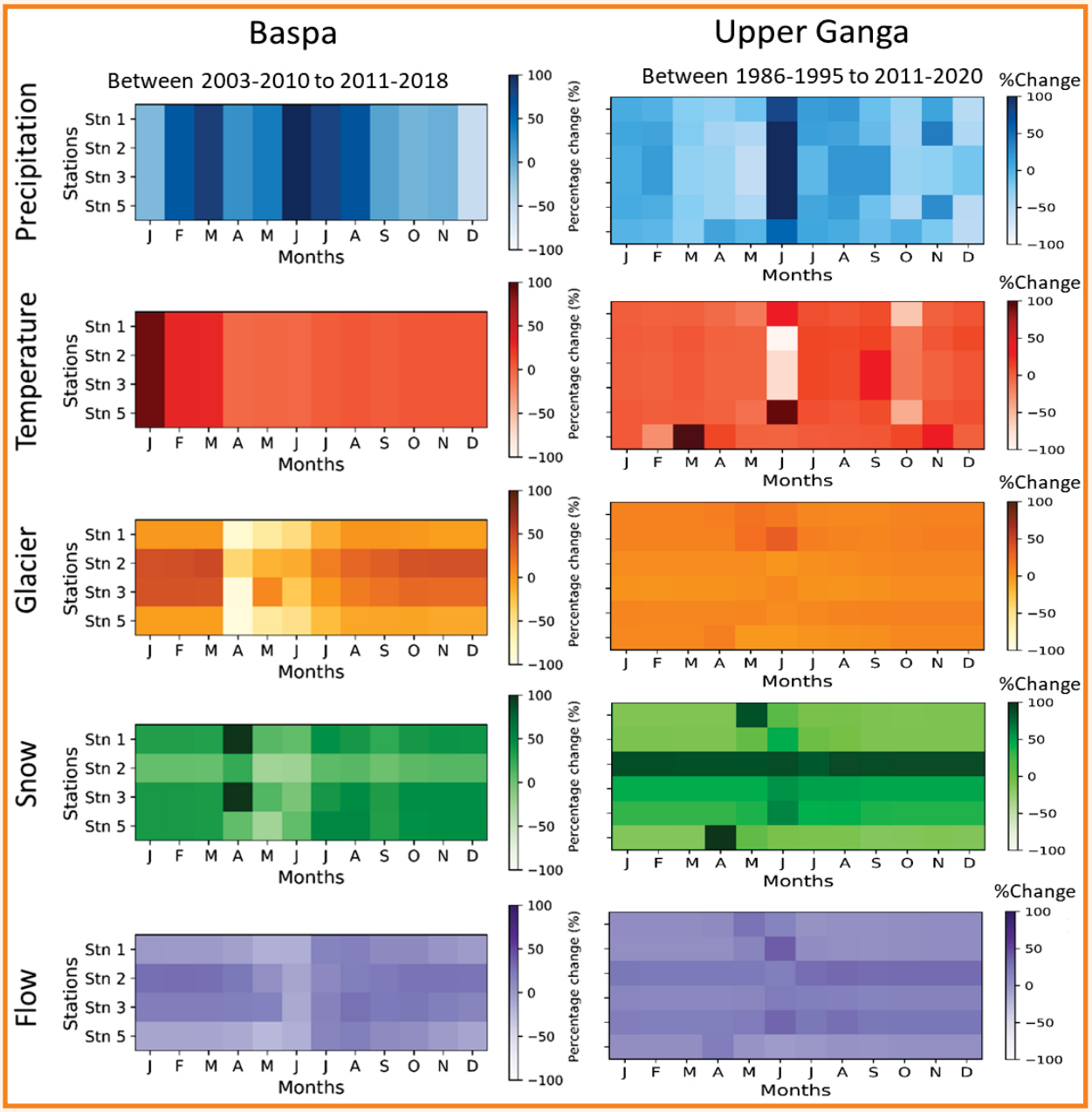


Figure – 6.4: Comparative Assessment of Monthly Variations in Runoff Components

Identification of Recharge and Discharge Areas of Palar River Basin, Tamil Nadu

The Palar basin has a total catchment area of 10,273 km2 within Tamil Nadu. The Weighed Index Overlay Analysis (WIOA) technique has been implemented in this study to identify the recharge zones of Palar basin using drainage density, soil, slope, geomorphology, geology, land use/cover (LULC), lineament density and ground water level fluctuations data. Each parameter in the thematic map was assigned ranks from 1 to 5 based on the values obtained from analytical hierarchy process. The study area contains geomorphologic units predominantly such as alluvial plain, bajada, buried pediments, flood plain, inselberg, etc. The units, which are having high infiltration characteristics, are assigned rank 5. The moderate units are assigned the rank 2 to 4 and the units which have less infiltration

characteristics are assigned the rank 1. The slope of the study area has been classified into five classes. The less to moderate slope (1% to 20%) has high recharge capabilities, hence these units have been assigned ranks 5 and 4. The higher slopes (> 20%) are assigned ranks 1 to 3. The LULC of the Palar basin consists of crop land (46.27%), fallow land (8.05%), deciduous forest (21.60%), forest blank (1.62%), forest plantation (1.98%), built-up area (4.64%), wasteland (9.56%) and water body (6.28%). The LULC units were assigned ranks according to their recharge characteristics. In the study area, the lineament density, ranges from 0 to 120 km/km2. The lineament density was classified into five categories, viz., 0-10.8, 10.9-26.3, 26.4-42.3, 42.4-62.0, and 62.1–120.0 km/km2. The lineament density was relatively high in the central portion of the study area, which lies between the altitude 100 to 200 m amsl. The high lineament density shows high recharge characteristics and provided high rank (5) value. Likewise, the parameters in the drainage density, soil and geology have also been ranked. Based on the above said analysis the recharge/discharge zones of the Palar basin have been classified as low, moderate, moderate to good, good and excellent. Further, stable isotope analysis has been carried out for which samples were collected from groundwater, stream water, pond/lake water. The stable isotope analysis of δ18O and δ2H has been carried out at NIH, Roorkee laboratory. The stable isotope values of these samples reveal that the groundwater recharge takes place in the central portion of the Palar basin and discharges at the downstream of the basin. This is also supported by WIOA results in the Palar River basin. Hence, recharge structures such as check dam, Nalla bund, and recharge shaft can be constructed in the identified zones to increase the water availability of the Palar basin.

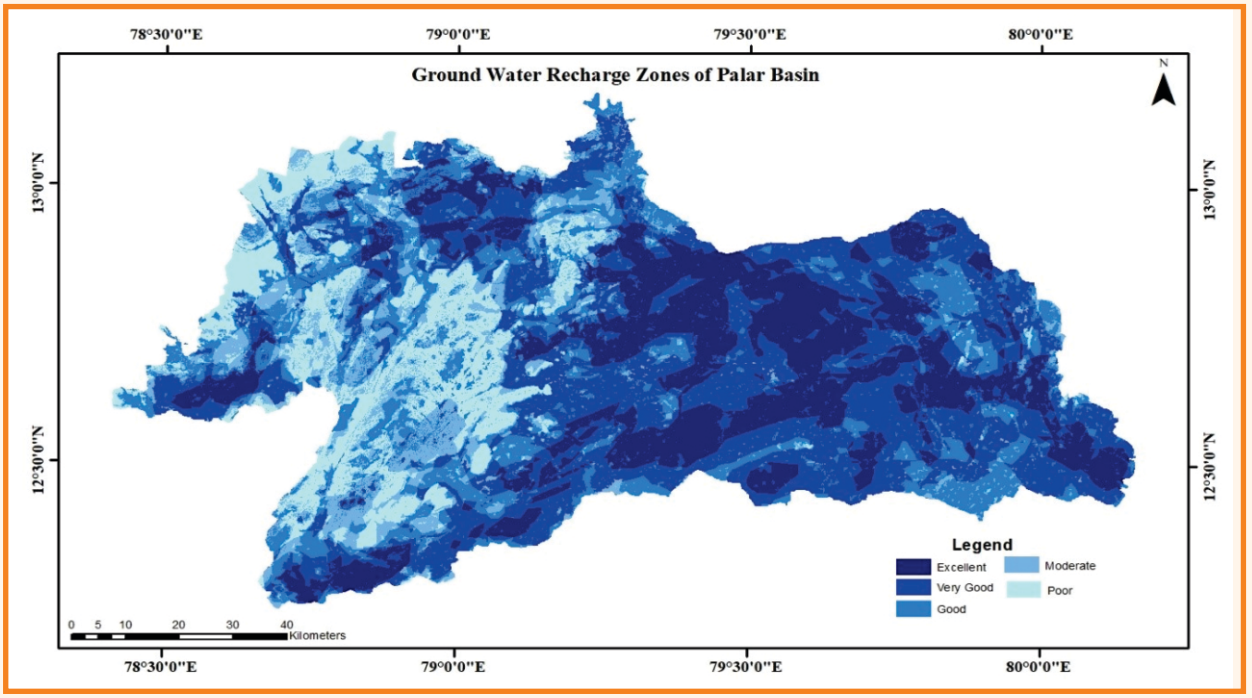


Figure – 6.5: Identified groundwater Recharge Zones of Palar basin

Characterization of Groundwater Dynamics in Krishna-Godavari Delta Interims using Groundwater Levels, Hydrochemistry, Isotopes and Emerging Contaminants

The term Emerging contaminants (ECs) is generally used to refer to the compounds previously not considered or known to be significant in groundwater in terms of distribution and/or concentration, which are now being more widely detected and which have the potential to cause

known or suspected adverse ecological or human health effects. ECs include perfluorinated compounds (PFCs), nanomaterials, pesticides, pharmaceuticals, industrial compounds, personal care products, fragrances, water treatment by-products, flame retardants and surfactants, UV-filters as well as caffeine and nicotine. In view of the above, characterization of groundwater dynamics in Krishna-Godavari (KG) Deltas interims had been proposed using geochemical, Isotopes and emerging contamination analysis and contaminant sources and its adverse impacts on human health have been identified.

Total 137 ground water samples during pre-monsoon (June 2022) and post-monsoon seasons (December 2022) were collected and analyzed for physico-chemical parameters, metal concentrations, pesticides, polynuclear aromatic hydrocarbons (PAHs), Polychlorinated biphenyls (PCBs) and volatile organic compounds (VOCs). Hydro-chemical data for pre- and post-monsoon seasons was processed as per BIS and WHO standards to examine the suitability of ground water for drinking purpose. Spatial distribution maps were prepared in the form of contour diagrams to identify degraded water quality zones, possible sources of pollution and specific parameters not conforming to drinking/irrigation water quality standards. Very high values of TDS and hardness were observed specially in Krishna basin delta. The high sodium values may be attributed to base-exchange phenomena causing sodium hazards. Hydro-chemical data was also processed to understand the geochemical processes controlling the chemical composition of groundwater using Scatter Plots and Gibbs Plot which reveals that hydrochemistry of groundwater is controlled by evaporation crystallization process and dissolution of rock forming mineral in Godavari basin delta while dissolution of rock forming minerals in Krishna basin delta. Carbonate weathering is a major source of dissolved ions in the groundwater. Cation exchange process and halite dissolution control the chemistry of groundwater. Groundwater is more saline in Krishna Delta than Godavari delta. The sources of groundwater salinity Krishna delta are more due to sea water intrusion. The comparison between LMWL and groundwater level indicates there is no direct rainfall recharge into shallow groundwater due to alluvial formations. The stable isotopes indicated that there is more evaporation in Krishna delta than in Godavari delta thus supports EC variations. The Tritium values (TU) of groundwater in KG deltas indicated that the Krishna delta groundwater is older than Godavari delta. The d-excess vs well depth indicated that there are significant evaporation and mixing processes found in the KG Deltas. The presence of heavy metals has been recorded in many samples and the water quality standards have been violated for iron, aluminum, boron, manganese, nickel, lead, mercury and arsenic in few of the samples in Godavari basin delta during the pre-monsoon period while the concentrations of iron, aluminum, boron, mercury, manganese, lead, uranium and arsenic in few samples have been violated in Krishna basin delta. Presence of pesticides were observed in many samples and BHC-Alfa has exceeded the maximum prescribed limit in few samples of the study area. Polychlorinated Biphenyls have also been detected in the samples but within the permissible limit of Total PCB. Total PAHs exceeded the maximum prescribed limit in more than 60% of the samples collected from Godavari basin delta. The presence of volatile organic compounds (Benzene) was also observed in few samples of KG delta. It may be inferred from the above findings that there is the alarming situation of the groundwater quality in the study area with special reference to emerging contaminants and needs regular monitoring as well as control measures.

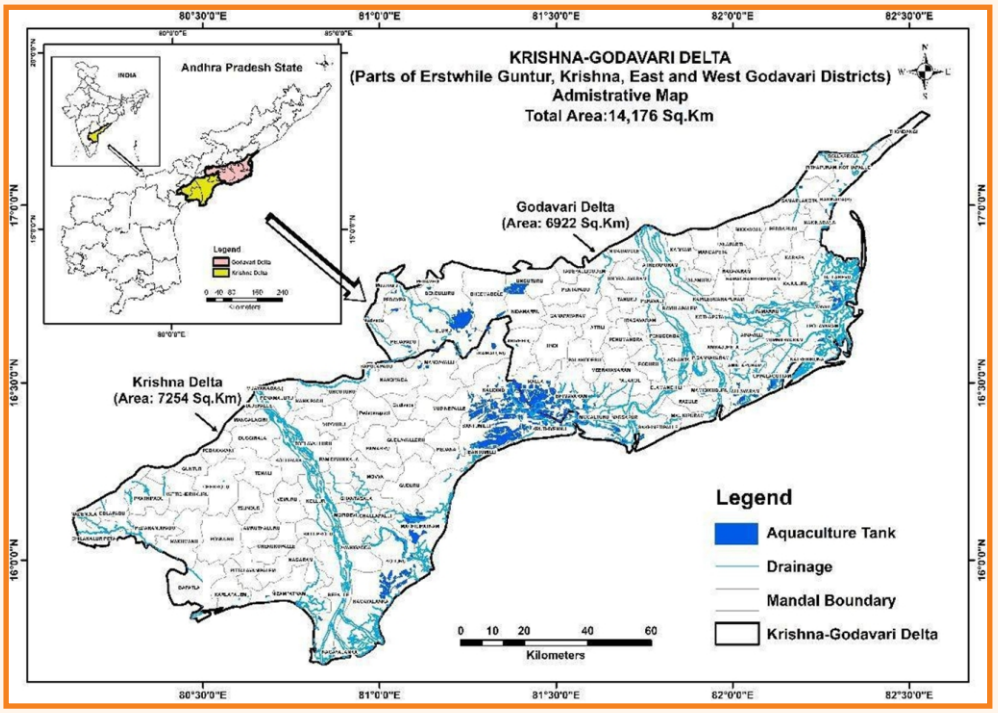


Figure – 6.6: Map of the Study Area of Krishna Godavari Delta

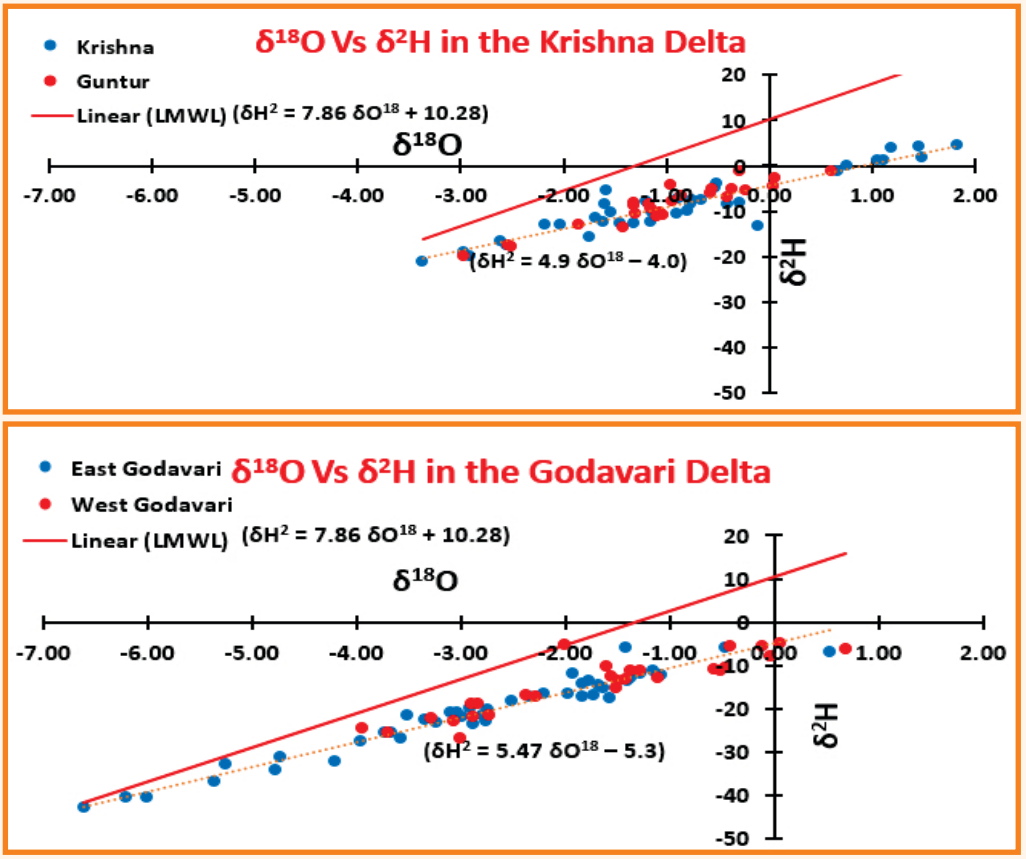


Figure – 6.7: $\delta^{18}O$ Vs $\delta^{2}H$ in Krishna Godavari Delta

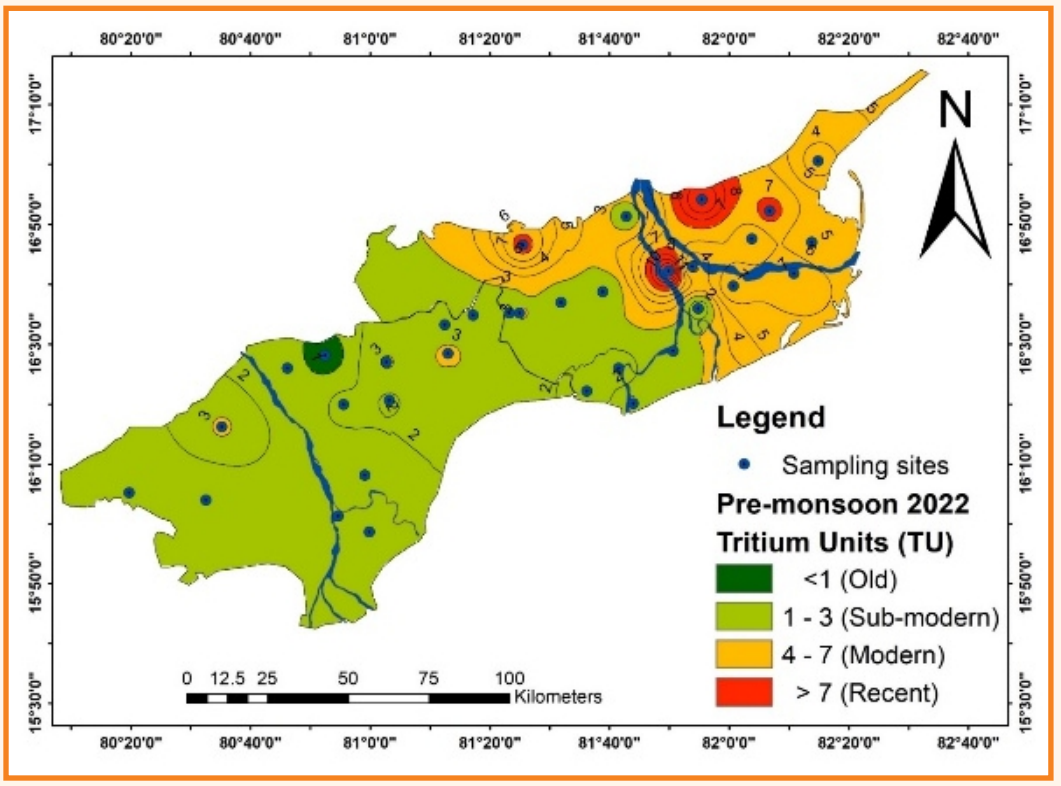


Figure – 6.8: Spatial Distribution of Tritium (TU)

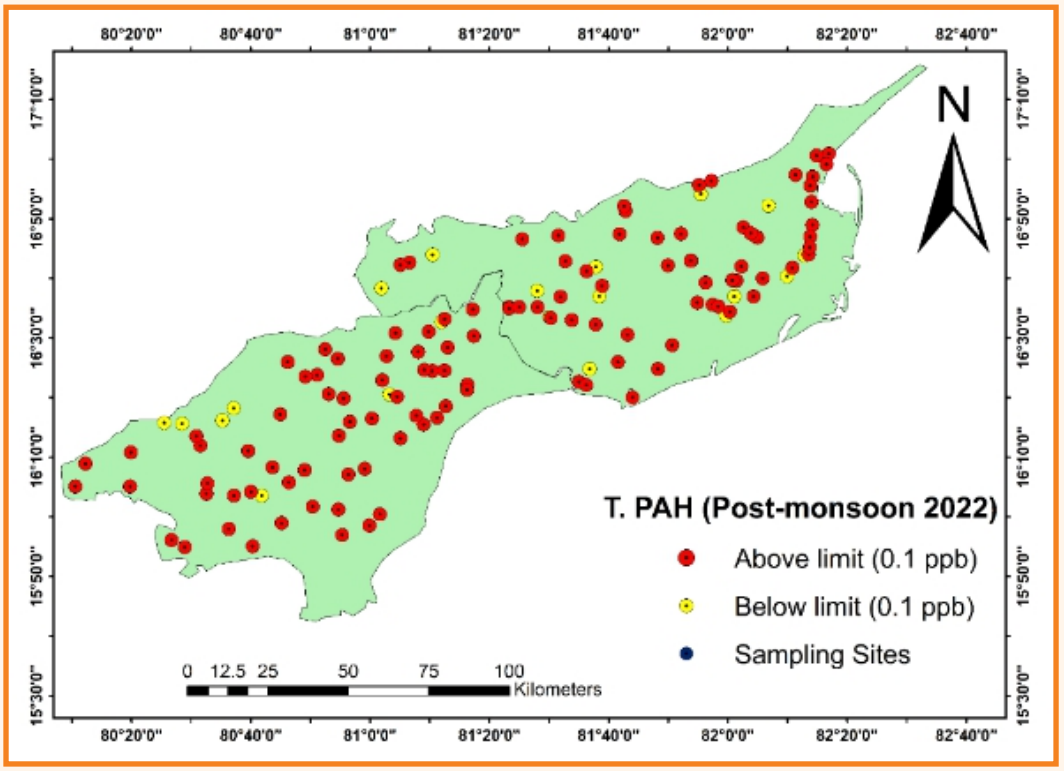


Figure – 6.9: Distribution of PAHs in Shallow Groundwater

Monitoring and Evaluation of GW Quality of Belagavi City, Karnataka, India

The study was proposed to monitor the ground water quality of Belagavi city, which is one of the fast-growing cities of Northern part of Karnataka. Since last 2-3 decades, the city has seen a large migration of people due to industrialization, enhanced commercial activities and improved education system. This leads to stress on the natural resources and degradation of natural resources. The objectives of the study are; to evaluate the groundwater quality of Belagavi city, to identify the groundwater quality problems in the city, to classify the groundwater based on the water quality index, and application of DRASTIC model for assessing the vulnerability to groundwater pollution. The study aims to assess the sources of ground water pollution and suggests the guidelines for proper management of waste disposal systems and adequate drainage facilities to safeguard the ground water for future uses.

The analysis shows that higher TDS values are reported in many samples which is attributed to sewage water contamination and fertilizer application in the area. The open well data of Kanabargi area shows TDS value of 1656 mg/l, making it unsuitable for irrigation. Almost all the samples show high to very high values of total hardness. Total Hardness of 1200 mg/l (Kanabargi) is unsuitable for drinking purpose. Most of the unused wells have higher concentration of contaminants. Chloride Concentration goes up to unreasonable level of 1242 mg/L (Kanabargi) making it unsuitable for drinking purpose. Water samples collected from the solid waste disposal site at Khasbhag wells besides the Bellary Nala show increasing concentrations of Hardness, Calcium, Magnesium and as we go away from the drain the concentration decreases. This is attributed to the use of sewage water for irrigation. However, in majority of the open well's concentration is well within the limits. Some of the samples are highly polluted/contaminated like Khasbhag, Shahapur and main market areas (Khade bazaar, Old Belagavi, etc). As per the piper trilinear classification, it is found that the most dominating class is $CaHCO_3$ Mixed $CaNaHCO_3$ and Mixed CaMgCl (about 85%) followed by NaCl, CaCl and $NaHCO_3$ (about 15%). As per U.S. salinity classification, the groundwater samples, belongs to low to high salinity and low sodium category. On the basis of EC values, the groundwater samples fall under low to very high salinity zone. The SAR values indicate that the water of the area belong to excellent category and are free from sodium hazards. Based on the water quality index values, water samples fall under excellent to very poor class during pre-monsoon and poor to very poor class during post monsoon. The DRASTIC indices vary significantly in 2001, 2009 and 2023 due to rapid urbanization and improper waste management. Similar changes were observed in water quality which shows higher concentrations of EC, TDS, Chlorides and Sodium. Organizing awareness programs and regular monitoring of water quality is necessary to understand the impact of waste management. Sewage treatment plants need to be installed at various parts of the city.

Hydrogeological and Isotopic Investigations of Groundwater in a Himalayan Watershed of Kashmir, India

Stable water isotopes - hydrogen (δ^2H) and oxygen ($\delta^{18}O$) in conjunction with conventional hydrogeology and hydrogeochemistry have been shown to be effective tools for solving many critical hydrological problems. This study was undertaken to investigate the effect of altitude on hydrogen and oxygen isotopes and the interaction between surface and groundwater in the mountainous watershed of the Doodhganga River. The specific objectives of the study are to (i) assess surface and groundwater quality using hydro-geochemical analysis, (ii) characterize isotopic signatures in groundwater and surface water to delineate the sources of groundwater recharge using isotopic signatures, and (iii) delineation of the groundwater recharge zones and groundwater contamination sites / or assessment of groundwater contamination risk mapping.

The study has been carried out for the mountain watershed of the Doodhganga River located in the Kashmir Valley between 33° 42′ to 34°50′ N latitude and 74°24′to 74°54′ E longitude, which covers an area of 655 km². It is one of the left bank tributaries of

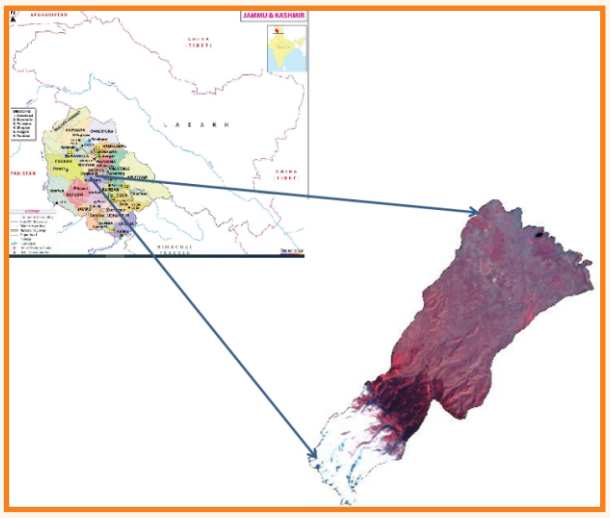


Figure – 6.10: Map of the study area Doodhganga Watershed

the river Jhelum, originating on the eastern slopes of the Pir-Panjal Mountain range below the Tatakuti peak. The topography of the watershed is varied and exhibits altitudinal extremes of 1,548–4,634 m amsl. The upper reaches of the catchment are usually snow covered and have extremely steep slopes of more than 70 %, followed by comparatively lesser steep slopes of 60–70 % which reflect the different aspects of mainly the Karewa formations in the middle parts of the watershed. The downstream watershed area has very gentle slope.

The values of $\delta^{18}O$ and $\delta^{2}H$ of precipitation and groundwater were assessed to identify the recharge areas of groundwater and were correlated to the altitude at which precipitation could have infiltrated into the ground. Groundwater contamination sources were assessed. The spatial variability of hydro-geochemical and isotopic characteristics was assessed using GIS and the hotspots of aquifer contamination were identified. The isotopic (^{18}O) composition of rain exhibits significant monthly variations. December rains are the most depleted (< -20‰). In other months, it fluctuates between -4‰ and -9‰. During the pre-monsoon period (April), a highly enriched composition ranging from 0‰ to -3‰ was observed. The isotopic data reveals a stable isotopic characteristic line with the equation $D=7.92\ ^{18}O +14$. The isotopic composition of groundwater generally maintains an average value of -8±1.3 ‰ throughout the year, with occasional exceptions of enriched values, reaching up to -5‰ at certain locations. The ^{18}O of groundwater ranges from -6.7‰ to -9.3‰. With a few exceptions, the GW isotopic data aligns with the Local Meteoric Water Line (LMWL), indicating its origin from local rainwater and good surface recharge characteristic of soils Rainwater samples collected from various altitudes (ranging from 1600 m to 2100 m amsl) show no significant dependence on altitude. This suggests that the stable isotopic composition of rainfall at a specific location is more influenced by the amount of rainfall and the evaporation effect of falling raindrops than the altitude of the sampling locations.

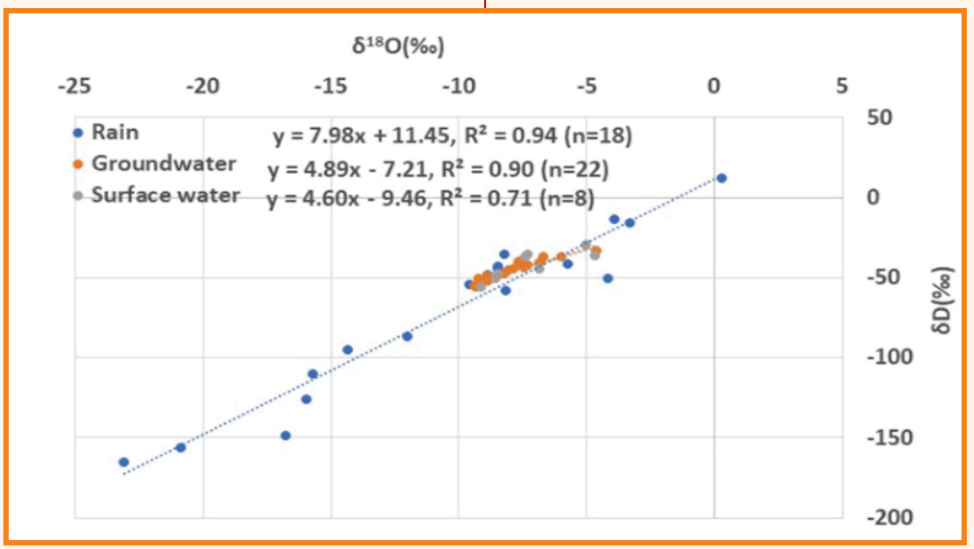


Figure – 6.11: Isotope Characterization of waters of Doodhganga Watershed

Investigating gap areas, current trends and future directions of research in climate change impact on hydrology and water resources in India through Scientometrics

Scientometrics is considered a powerful tool of tracing the development of a given scientific field, thereby revealing the gap areas and emerging research problems, and evaluation of scientific contributions and research productivity of, institutions, regions, countries, etc. With technological advancements it is recommended to look for emerging trends. Bibilometric analysis and scientometric mapping can show the change in mindset of researchers by studying the research outcomes. There is a strong need to reconnect climate science and policy development to support future climate change adaptation and disaster risk reduction strategies. For scientometric analysis, Scopus cited research database (1992-2021) by Indian authors for the 'Hydrology' and 'Climate Change' keywords was collected from Library of IIT, Roorkee. The database includes research papers, book chapters, conference papers, review articles, books, editorials, short surveys, and conference proceedings. The collected data were processed and analyzed in R-biblioshiny package to extract preliminary results related to hydrology- climate change research in India. The extracted information includes the author's contribution to the research articles (single authored, multi- authored, authors per document, co-authors per documents etc.). The average citations per documents and collaboration index of the research was also highlighted in the information. Other results include most cited documents, relevant documents, word cloud and thematic evolution. The Word Cloud result showed that research is focused on climate models, water supply, hydrological modelling, water resources, environmental monitoring, rainfall, runoff, rivers, evapotranspiration etc. Thematic evolution shows that impact of climate change on humans and environment were also evolved in research. Important findings are shown below.

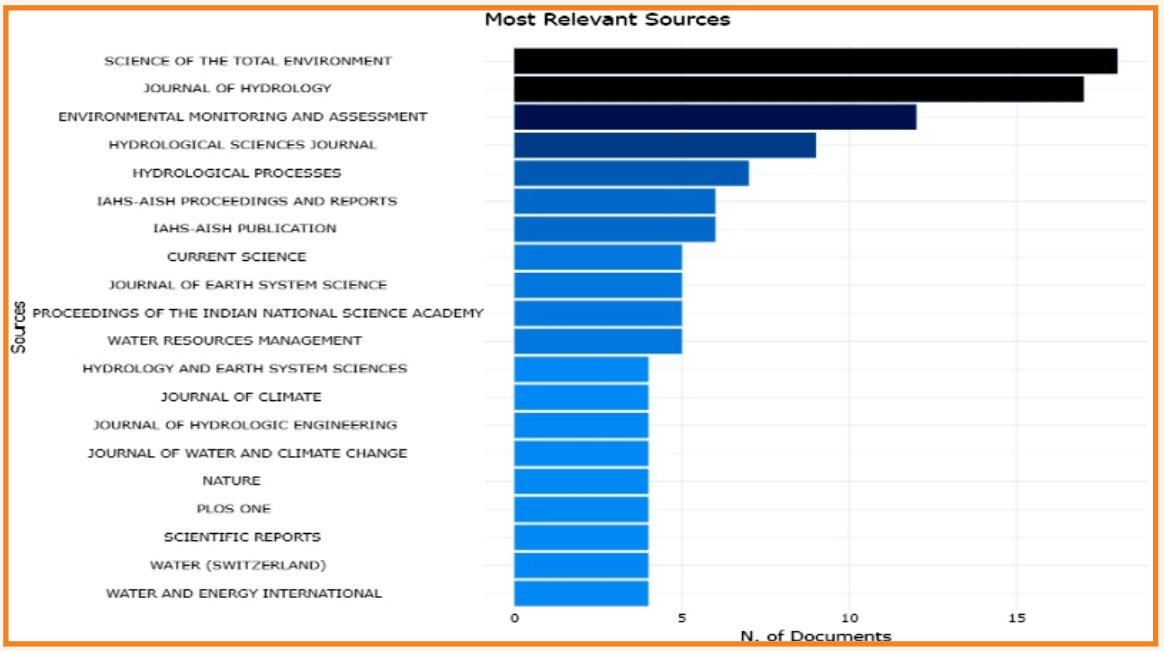


Figure – 6.12: Most Relevant Sources

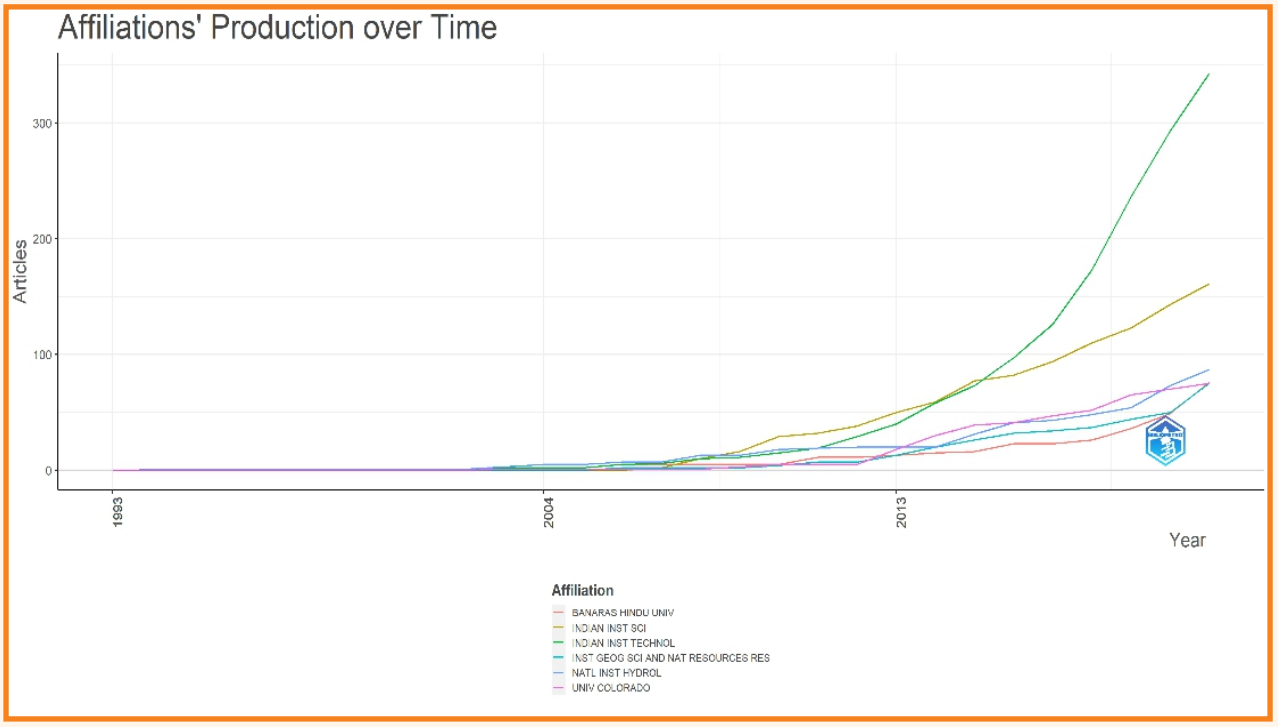


Figure – 6.13: Productivity of Institutions in India

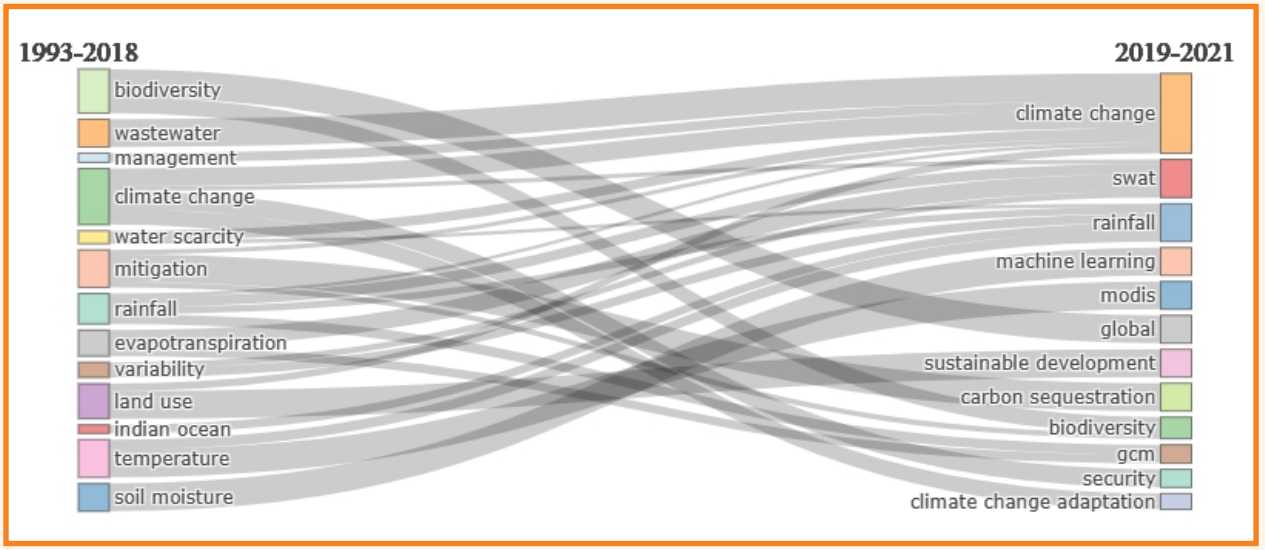


Figure – 6.14: Thematic Evaluation

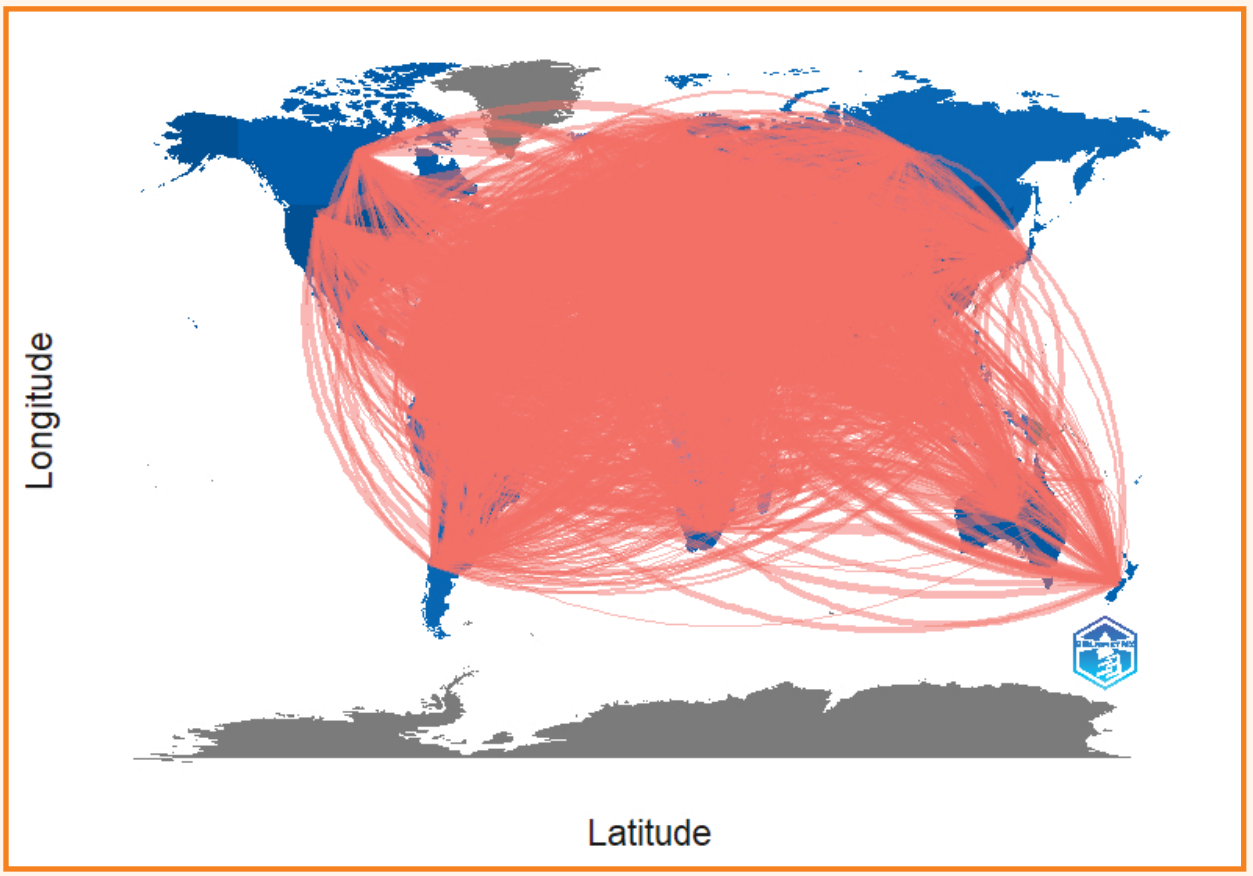


Figure – 6.15: World Collaboration

6.2 R & D STUDIES ON-GOING DURING 2023-24

Early Signatures of 21st Century on Snow Cover Dynamics in Zanskar River Basin, Ladakh

Glaciers and transient snow extensively cover the Himalayan landscape, influencing global water resources. Nonetheless, their specific impacts remain poorly understood, particularly in the region of Ladakh. Snow cover is integral to the global water and energy cycle, influencing radiation feedback mechanisms as well as the storage and release of freshwater. The North West Himalaya receives substantial snowfall, with the resulting meltwater from snow and glaciers contributing significantly to river discharge. Traditional methods for mapping snow cover are challenging due to various factors; however, space-based remote sensing satellites, such as Terra and Aqua equipped with the MODIS sensor, have provided high-resolution data for monitoring snow cover, glacier extents, and high-altitude lakes since 2000. Global warming has exacerbated glacier melting in this region, thereby affecting snow cover and river discharge patterns. Reanalysis products like ERA-5 are instrumental in studying the climate-cryosphere interaction. To advance current understanding, a thorough investigation of snow cover extent in relation to regional climatology is essential. Previous research has predominantly focused on large-scale analyses, often neglecting regional complexities. Utilizing satellite imagery and finer scale reanalysis products can yield valuable insights into the impacts of climate change. In this study, the Zanskar River basin in Ladakh was selected for analysis with the objectives to (a) analyze the spatial distribution of snow cover extent in Zanskar River basin with respect to elevation, slope, and aspect; (b) analyze the seasonal variability in snow cover extent in Zanskar River basin; and (c) investigate the impact of climate change on snow cover extent during 2001-2020.

The mean temperature of the basin is found to be -9.9 °C as revealed by the ERA5 reanalysis data during 1950-2021, and only few months were found to show positive temperature during monsoon season. While analyzing the first 20 years of data from 21st century, it was found that mean temperature of the basin has increased by 0.4 °C, from -9.9 °C (1950-2021) to -9.5 °C (2000-2020). However, only monsoon months showed the positive temperature which is mostly during July and August. Statistical analysis of regional and grid-based temperature data revealed a significant warming trend in the basin. This rise in temperature has the potential to substantially alter the distribution of snow cover, thereby affecting the availability of water resources and energy feedbacks.

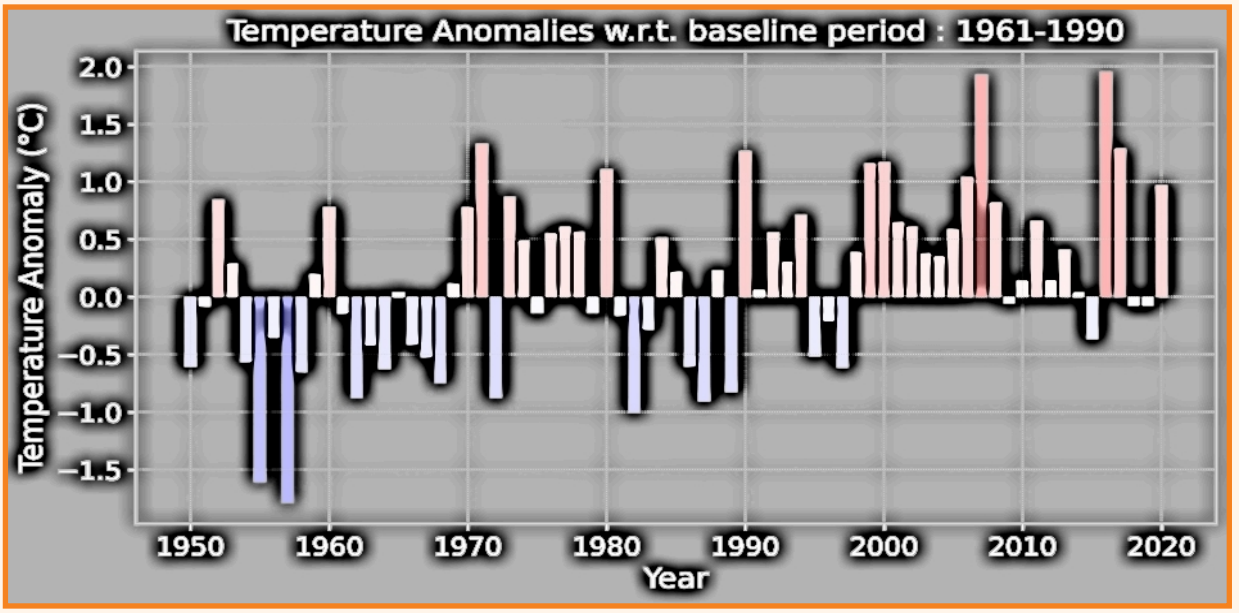


Figure – 6.16: Temperature Anomaly in the Zanskar Region

Ascertaining the Efficacy of Use of State of the Art Technologies for Spring Mapping and Sustainability of Springs through Suitable Interventions

The present study is being conducted for the Bhilangana valley of Tehri Garhwal District, Uttarakhand. The study area lies in the watershed of the Bhilangana River which originates from the Khatling Glacier (N 30.83°, E 78.90°) at an elevation of about 3750 m amsl. From its origin at the mouth of the Khatling Glacier, Bhilangana travels for about 95 km and meets the Bhagirathi River at Tehri. The major tributaries of Bhilangana are Balganga and Dharamganga. The climate of the catchment is tropical monsoon type. The area experiences summer season from April to June, monsoon months of June to September and cold winter from December to March. The average air temperature in the region varies from 4.6°C to 36.5°C. The annual rainfall ranges from 1409 mm to 2000 mm with the mean of 1600 mm and the relative humidity in the region fluctuates between 36% and 75%. The objective of the study is to check the adequacy of the state of art technology for mapping of springs. Various thematic maps i.e., drainage, drainage density, geological, LULC etc. were prepared using SRTM DEM (spatial resolution of 30 m), published data of CGWB and ESRI Sentinal-2 data (spatial resolution of 10 m).

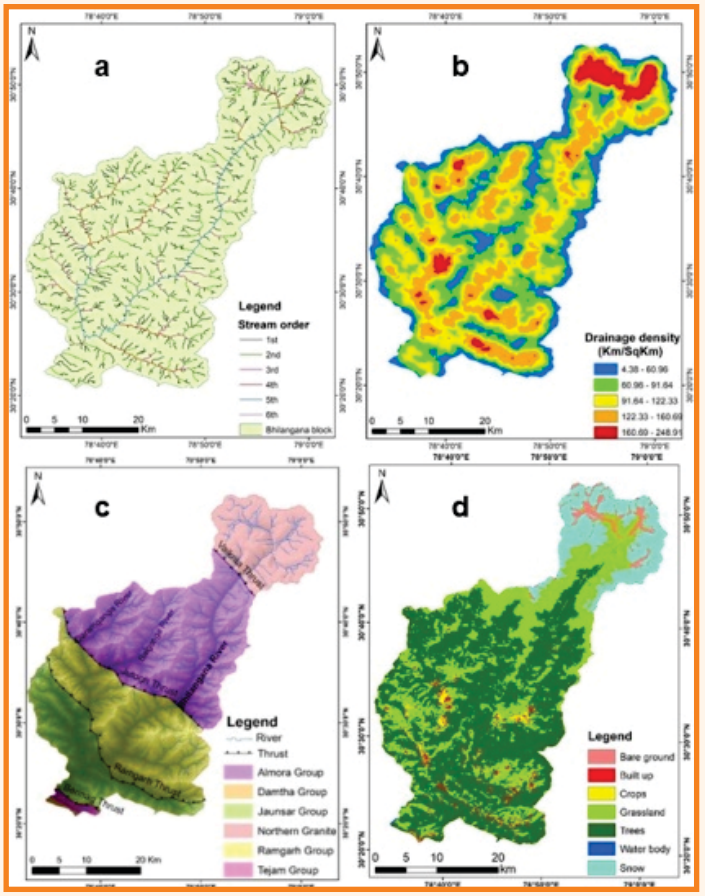


Figure – 6.17: Thematic Maps viz. (a) Drainage, (b) Drainage Density, (c) Geology, and (d) LULC of Bhilangana Block, Tehri Garhwal, Uttarakhand

Field excursions have been carried out by the project team during February to November, 2023 for verification of the spring locations given by SoI and mapping of other springs which could not be mapped by the SoI. A total of 134 springs have been geotagged using KoBo Toolbox and 123 spring samples for detailed water quality and isotopic analysis were collected during the field visits. The physiochemical parameters (i.e., pH, temperature, DO, ORP and EC) were measured onsite. Details of the spring surveyed are given in Table below.

Table – 6.1: Details of Spring Data as per Field Investigations

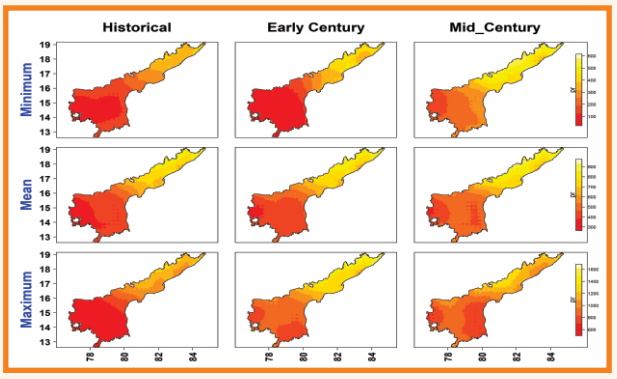
S. No.	Dataset	No. of Springs
1	Spring locations given by SOI	76
2	Spring locations geotagged by NIH	134
3	New springs identified	66
4	Springs found on SoI location	30 (±100m)
6	Springs in inaccessible regions	28
7	Springs not found at locations of SOI	12

Out of total surveyed springs of Bhilangana block, 26.4% springs are safe, 31% springs are at low risk, 29% springs at moderate risk and 14% springs are at high risk as per WHO drinking water standards. Therefore, springs of the Bhilangana block are need to be monitored regularly for various geochemical and pathogens related aspects. The qualitative status of the springs is proposed to be analyzed in detail. The collected data and analyzed hydro-geo-chemical and isotopic data is expected to be useful to understand the sources of the springs in the area. This work is exposed to be extended for Pratapnagar CD block of Tehri Garhwal district and Ukhimath CD block of Rudraprayag district.

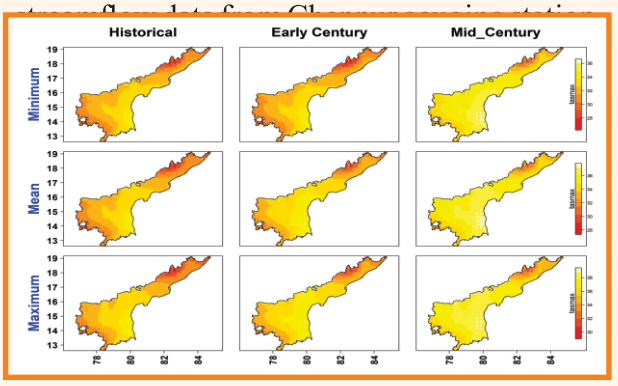
Climate Change Scenarios for Andhra Pradesh and its Impact on Streamflow and Groundwater Levels in Pennar River basin

It has been globally accepted that the changing climate is imposing significant alterations in the hydrological systems, which eventually is leading to the changes in the characteristics of hydrological extremes. In a most recent special issue on the impacts of climate on hydrological extremes, the focus was on the historically observed hydrological extremes and how these extremes are linked to the changing climate across the globe. Therefore, to evaluate the impacts of changing climate on the basin hydrology and/or hydrological extremes, the knowledge of complex interactions between climate and hydrological systems is vital. This study aims to analyse the projected rainfall and temperature data from CMIP6 GCMs and generate multi-model climate change scenarios for the state of Andhra Pradesh. Other objectives of the study is to generate hydrological scenarios using a calibrated and validated hydrological model and evaluate the impacts of climate change on the hydrology of Pennar River basin (PNB). In this study, global climate scenarios derived from GCM runs conducted under CMIP6 were used. These scenarios were downscaled to a common grid of 0.25 x 0.25 degrees by NASA and is made available through NASA Earth Exchange Global Daily Downscaled Projections, NEX-GDDP-CMIP6.

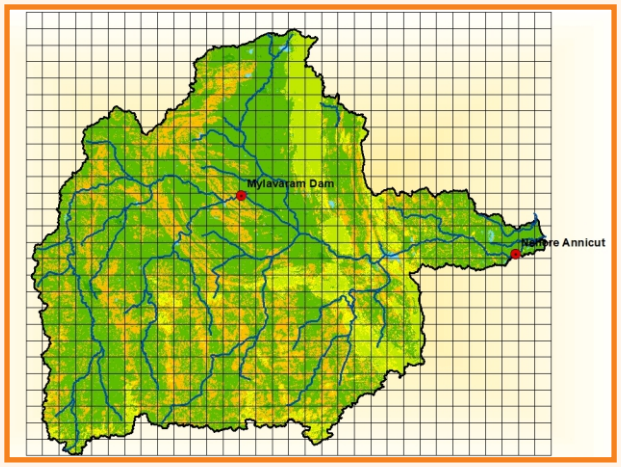
Ten out of 35 existing GCMs were selected based on the recommendations from recently published literature and for 2 SSP scenarios, viz. SSP2-4.5 and SSP3-7.0. These datasets are first bias corrected using delta-change approach with the gridded datasets of precipitation and temperature from IMD. The bias-corrected projections are later used to generate various change scenarios of precipitation and temperature for the state of Andhra Pradesh. In addition, a VIC model was developed for the PNB with a resolution of 5 km, which was calibrated and validated with the historical



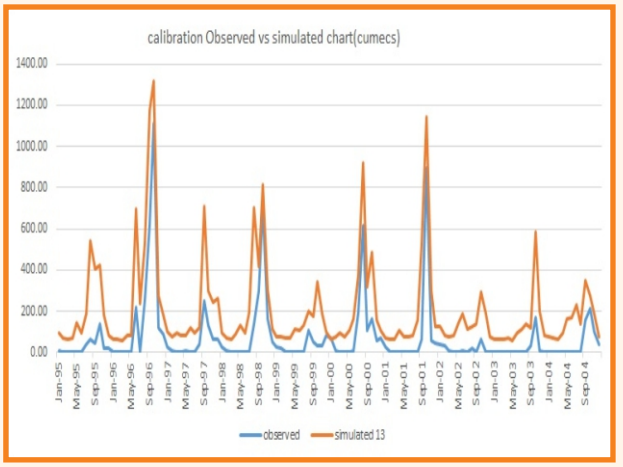
Multi-model (10 GCMs) Maximum, Mean and Minimum of Precipitation (pr) Scenarios for the State of Andhra Pradesh



Multi-model (10 GCMs) Maximum, Mean and Minimum of Maximum Temperature (tmax) Scenarios for the State of AP



VIC Model Grid for the Pennar River Basin



Calibration Plot of VIC Model at Chennur

Figure – 6.18: Impact analysis of climate change in Pennar River basin

The model will further be calibrated with observed data from Nellore anicut. Bias-corrected projected climate of 21st century will be used to generate hydrological scenarios. In addition, a random-forest-based model will be developed to simulate the groundwater levels in the basin. The results from this study is likely to benefit water managers, irrigation and hydro-electric engineers, to plan and allocate water appropriately for its effective use and reduce adverse impacts of floods and droughts.

Investigations on Occurrences of Seasonal Extremes across Northwest Himalaya in Relation to Global Atmospheric Thermal and Circulation Changes

Heavy rain events over the northwest Himalayas (NWH) under the influence of highly complex terrain and tropical-extratropical interactive atmosphere are becoming ferocious in recent years. The large-scale long-period extreme rain events (EREs) intended to quantify the severity of persisting intense rains causing severe flood and spatio-temporal (ST) isolated EREs indicating unprecedented regional local rainfall are calculated during 1951-2021 using IMD's 0.25° gridded rainfall data over NWH comprising three states (Himachal Pradesh, Uttarakhand, Jammu and Kashmir). No significant trend is observed in annual and monsoonal rainfall of NWH during 1951-2021 tested using the Mann-Kendall test. However, in recent 20 years, OND rainfall has decreased significantly by 25% compared to preceding 51 years. No significant long-term trend is observed in annual and monsoonal rainfall series of Uttarakhand state (UK), however OND rainfall shows significant decreasing long-term trend during 1951-2021. In recent 20 years, it has decreased significantly by 35% compare to preceding 51 years record. Significant decreasing long-term trend is observed in annual rainfall of Himachal Pradesh (HP) during 1951-2021, however other seasonal rainfall series are homogeneous and random. In recent 20 years, annual rainfall of HP decreased by ~13%, monsoon by ~8.5%, OND by ~33%, JF by 17% and MAM by ~17%, respectively. Significant increasing long-term trend is observed in JF rainfall of Jammu and Kashmir (JK) during 1951-2021, however annual and other seasonal rainfall series are homogeneous and random. In recent 20 years, monsoon rainfall of JK increased by ~18% compare to preceding period. During 1951-2021, over JK, AE of 1- to 7-days ERE-RA and RW of 1- to 2-day ERE-RW of shows significant increasing trend.

Normally rainfall amount of large-scale extreme rain events concerning rainfall amount (ERE-RA) of 1- to 10-day duration increases from 58 mm to 203.36 mm, over NWH. No significant change is seen in RA of ERE-RA, but the areal extent (AE) of 1-3 day duration EREs significantly increased by 28-43%

and rainwater (RW) of 1-day extremes concerning rainwater (ERE-RW) by 16% in recent 20 years. Over HP, RA of 3- to 10-days ERE-RA and RW of 4-10 day ERE-RW shows significant decrease. Over UK state, rainfall amount of large-scale EREs of different durations increased by 10-23% and rainwater by 14-34% in recent 20 years. Over J&K state, rainfall amount of 1-day large-scale ERE-RA increased by 16% and rainwater of ERE-RW by 23%, while areal extent of different durations by 19-23% in recent 20 years. Over HP state, rainfall amount of large-scale ERE-RA of different durations decreased by -10 to -20% and rainwater by -14 to -19% in recent 20 years. Most of the severe ST-EREs of the length up to 3-days are observed to occur below 3000 m amsl mostly in the states of HP

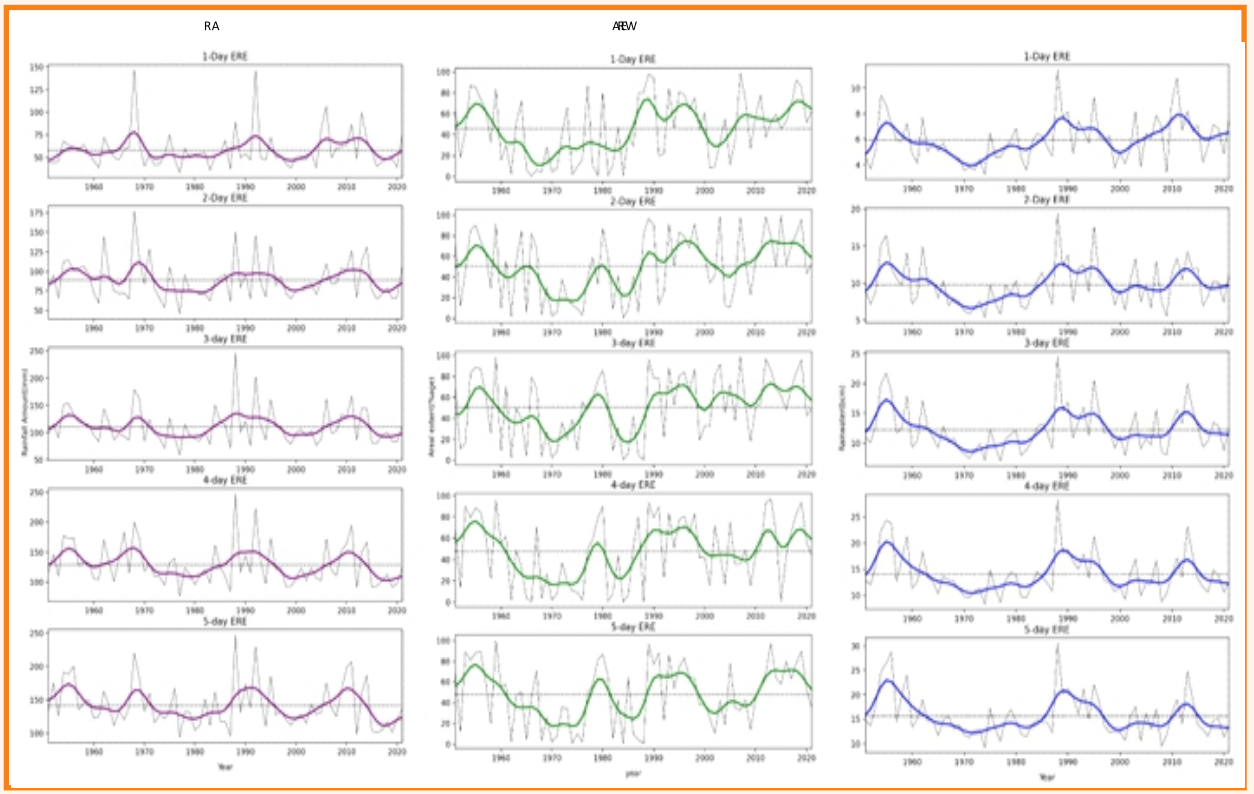


Figure – 6.19: Inter-Annual Variations in Rainfall Amount, Areal Extent and Rainwater of LS-EREs of 1-to 5-day Duration over NWH

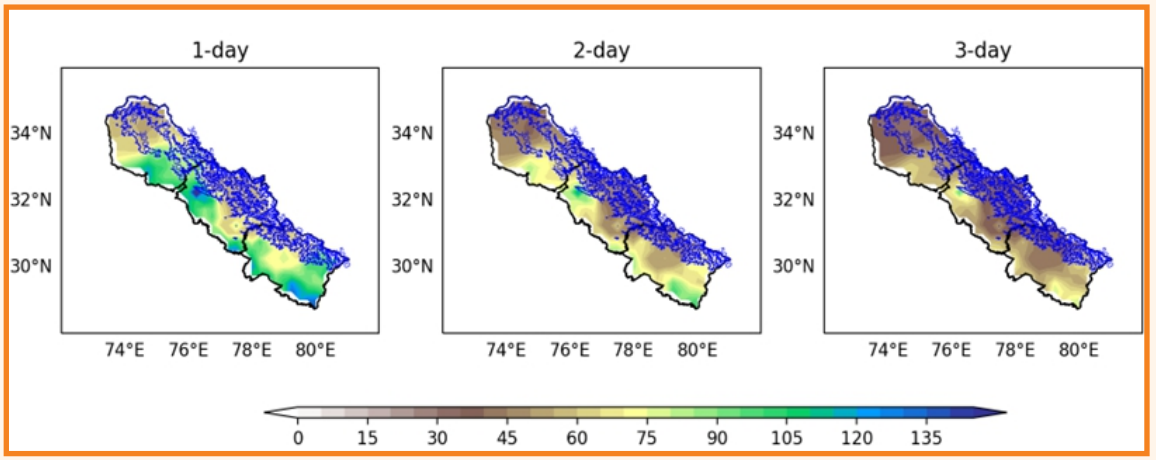


Figure – 6.20: Mean Rainfall Intensity of 1- to 3-day EREs and Elevation (>3000 m amsl) across NW Himalaya

Comparative Analysis of Fine Scale Satellite and Reanalysis Precipitation Products in Upper Ganga Basin using Multi-criterion Decision-Making

The study utilized data from a rain gauge network managed by the IMD and CWC, comprising 47 and 11 stations, respectively in the upper Ganga basin (UGB). After data processing, 37 stations (19 IMD and 11 CWC) were selected for analysis. Despite this effort, a considerable portion of the basin lacked coverage, necessitating the exploration of additional resources to achieve comprehensive spatial data for hydrological modeling. In recent years, various high-resolution precipitation products, such as IMERG, ERA5 land hourly data, and IMDAA, have been made available by different organizations. These products, with spatial resolutions ranging from 0.05° to 0.12°, have gained traction among researchers. However, their suitability for application in the Upper Ganga Basin, based on station records, has not been thoroughly evaluated. Moreover, there is a dearth of studies that rank these products performance relative to observed station data. A prior study utilized a MCDM approach to assess various gridded precipitation products in the Satluj River Basin. This statistical methodology proved effective for evaluating the accuracy of gridded products in a specific region. Building on this approach, the current study aims to evaluate the suitability of high-resolution gridded products, using station records to accurately represent local precipitation patterns in the Upper Ganga Basin. The study has two main objectives: first, to statistically evaluate fine-scale satellite and reanalysis precipitation products in the Upper Ganga Basin in comparison with station records; second, to rank the performance of these products using MCDM and Group Decision-Making techniques. Statistical analysis of precipitation estimates from IMERG, ERA5, and IMDAA indicates that IMERG is the most suitable product for studying the precipitation regime of the UGB. Notably, IMDAA exhibited the highest degree of overestimation in capturing the regions precipitation cycle.

Real Time Monitoring of Snow-Glacier Related Parameters and Ensemble Hydrological Modeling (EHM) to Study the Triloki Group of Glaciers and Khatling Glaciers Part of Western Himalaya, India under Climate Change Scenarios

Under this study a glacier survey in a physical model is being conducted to identify the most suitable glaciers for the analysis of glacier changes and its impact on river runoff and other watershed components. The objectives of this study are (i) Field based measurement on snow-glacier dynamics and preparation of snow cover and glacier maps, (ii) Long-term change assessment in snow covers and glaciers (depth & area) using Satellite remote sensing and field based observations, (iii) Development of an improved modelling framework (temperature index model & energy balance methods) to address glacier changes and its impact on river runoff under varying topographical & climatic conditions, (iv) Snow-glacier runoff under extreme conditions and GLOF hazard assessment in the downstream sections, (v) Projecting 21st century scenarios of snow covers w.r.t. elevation and temperature gradient changes using CMIP6 climate models and (vi) Projection of glacier areas and thickness in 21st century using CMIP6 climate models.

In the present study, meteorological variables, soil and runoff monitoring shall be done within the established experimental watershed. Modelling of runoff, soil moisture monitoring and modelling and comparison and validation of satellite soil moisture product with in-situ sensors are proposed. For meteorological datasets, a high resolution gridded daily precipitation dataset ($0.05^{o}\times0.05^{o}$) will be constructed for the historical time by assimilating IMD precipitation, TRMM based precipitation, GPM based precipitation and CHIRP precipitation datasets as per their availability. The bias correction will be done using advanced bias correction methods (such as Quantile mapping, Linear scaling etc.). For the ensemble modeling, the SWAT, Spatial Process in Hydrology (SPHY) and Variable Infiltration Capacity (VIC) model, will be used for the

estimation of snowmelt and glacier runoff over the selected Himalayan River basins. For snow-covered areas (SCAs) and glacier mapping, MODIS, LISS 3, LISS 4, and Sentinel satellite sensors data will be utilized. For snow cover extraction Normalized Difference Snow Index (NDSI) based on cloud removal technique will be utilized as previously used by various researchers. For the computation of snow and glacier melt a variable degree day factors-based temperature index model will be applied.

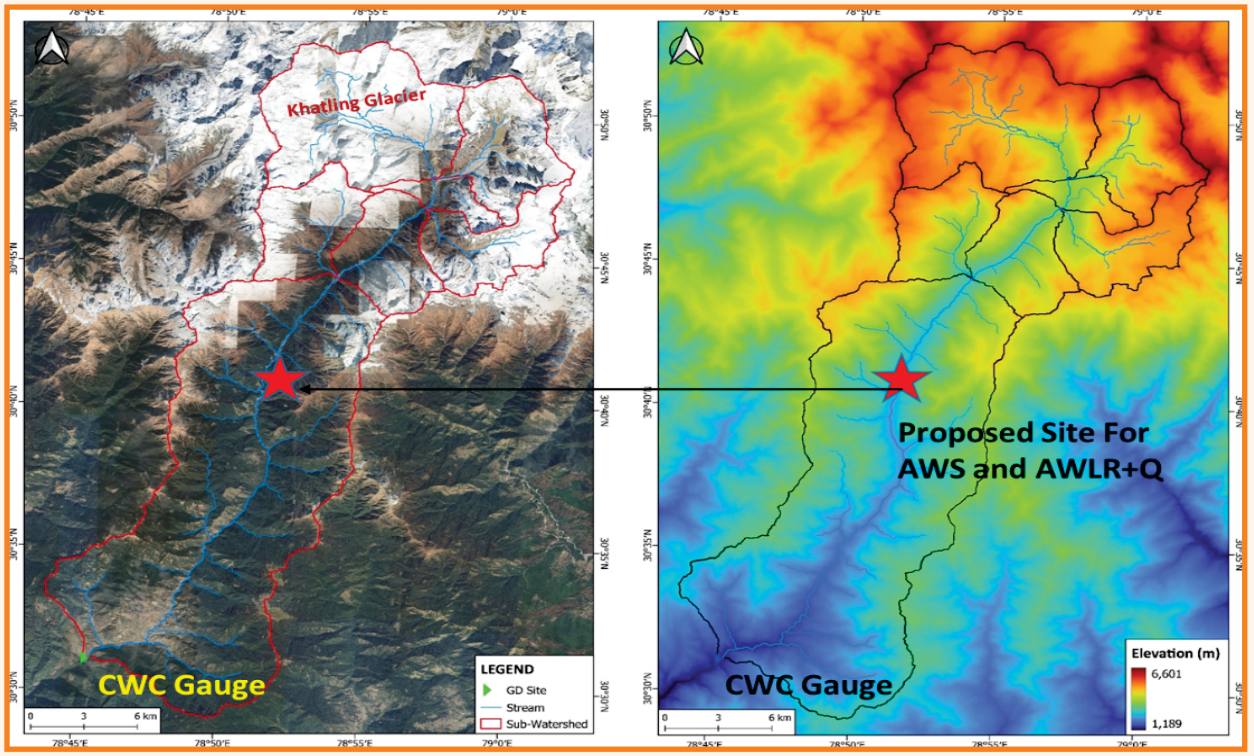


Figure – 6.21: Upper Bhilangana River Basin (Highlighting Khatling Glacier)

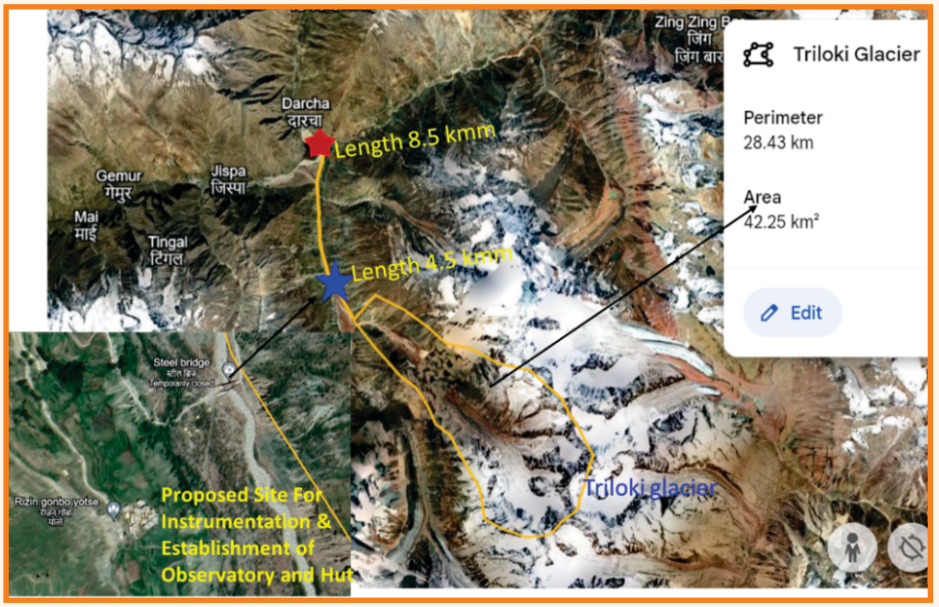


Figure – 6.22: Location of Triloki Glacier (Chandrabhaga basin)

Geo-hydro-chemical and Isotopic Aspects of Occurrence of Springs: A Case Study from the Major Settlement Areas of Bhagirathi Basin, Uttarakhand, India

In Indian Himalayan region, springs form the major sources of potable and irrigation water for rural households. Majority of the Himalayan Rivers have their origin in form of springs which maintain base flow of the rivers in lean season. Several studies that have been carried out on spring water are mostly focused on qualitative analysis. However, the occurrence of springs in any region is controlled by the regional geology and topography, presence of lineaments such as faults, fractures, joints, etc. Additionally, the presence of lineaments also plays an important role in the development of secondary porosity and permeability in hard rock terrain. The dip direction of rocks, faults and fractures determine the flow direction of water in springsheds. Such studies focusing the genesis of springs in relation to regional geology and structural features are lacking in Himalayan region. Therefore, the present study is focused on the genesis of springs and their variability along the major structural features in addition to identification the ionic sources and quality assessment of spring water.

The present study will be carried out from New Tehri to Harshil, Uttarakhand along the River Bhagirathi, a tributary of mighty River Ganga. The study will be focused in an area of about 2 km on both sides of the river, considering the major settlements region. Geologically, the area consists of rocks of lesser Himalaya and central crystallines, separated by the main central thrust near Sainj (20 kms from Uttarkashi town along Uttarkashi-Gangotri Road). Lesser Himalayan part comprises of Quartzite, limestone, Slates, Schistosh-Quartzites and Epidiorites and the central Crystallines constituted by Gneisses, Schists, amphibolites and Migmatites. The area encompasses several major tectonic lineaments such as North Almora Thrust, Vaikrita thrust, Munsiari thrust.

A comprehensive field survey was conducted, resulting in the identification and geotagging of 111

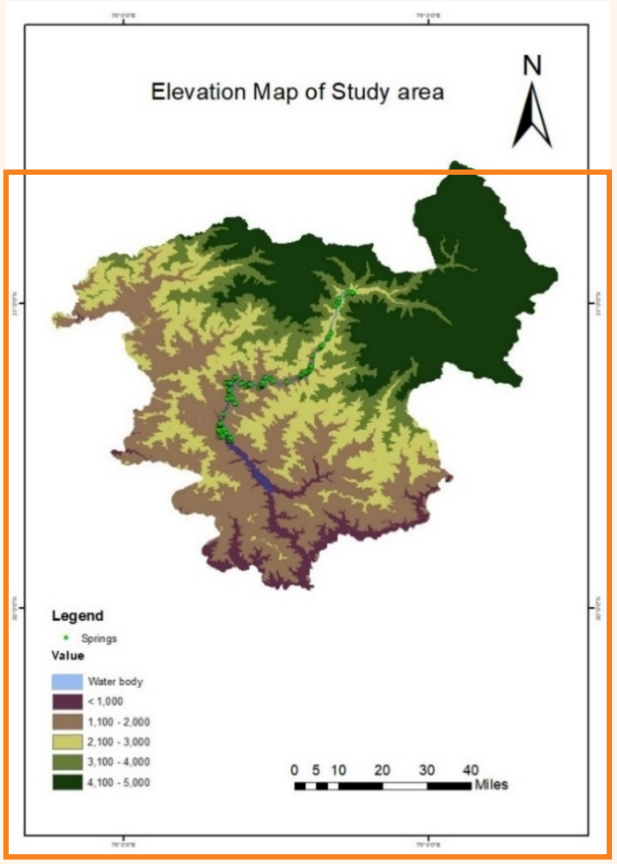


Figure – 6.23: Study Area and Geotagged Springs Locations

springs. During the survey, meticulous records of on-site physiochemical parameters were maintained, and water samples were systematically collected. These samples undergo thorough laboratory analysis to delve into water quality and isotopic characteristics. As part of the study, various base maps, including a geological map and a LULC map have been prepared. These maps serve as essential tools to better understand the geological context and land utilization patterns within the study area. An extensive classification of springs was undertaken, based on the characteristics of pH levels, electrical conductivity, discharge, Geology and LULC characteristics.

Long-term Glacio-Hydrological Investigations and Modelling of the Gangotri Glacier System

The Gangotri Glacier (source of Bhagirathi River), one of the largest glaciers of Himalaya, located in the Uttarakhand state (Central Himalaya, India) has

immensely contributed to billions of people through irrigation, tourism, hydropower purposes. Because of these reasons, hydrological studies in the Cryosphere regime of Himalaya has gained a massive momentum in recent times. Climate change and global warming has added more concern to the health of the Gangotri Glacier and the River Ganga as well. It is, therefore, essential to study the hydrological system of the Gangotri Glacier System in a comprehensive way using observational methods, remote sensing based geospatial techniques and modelling so that prediction of future water supplies from these glacierized catchments in the downstream area can be performed precisely.

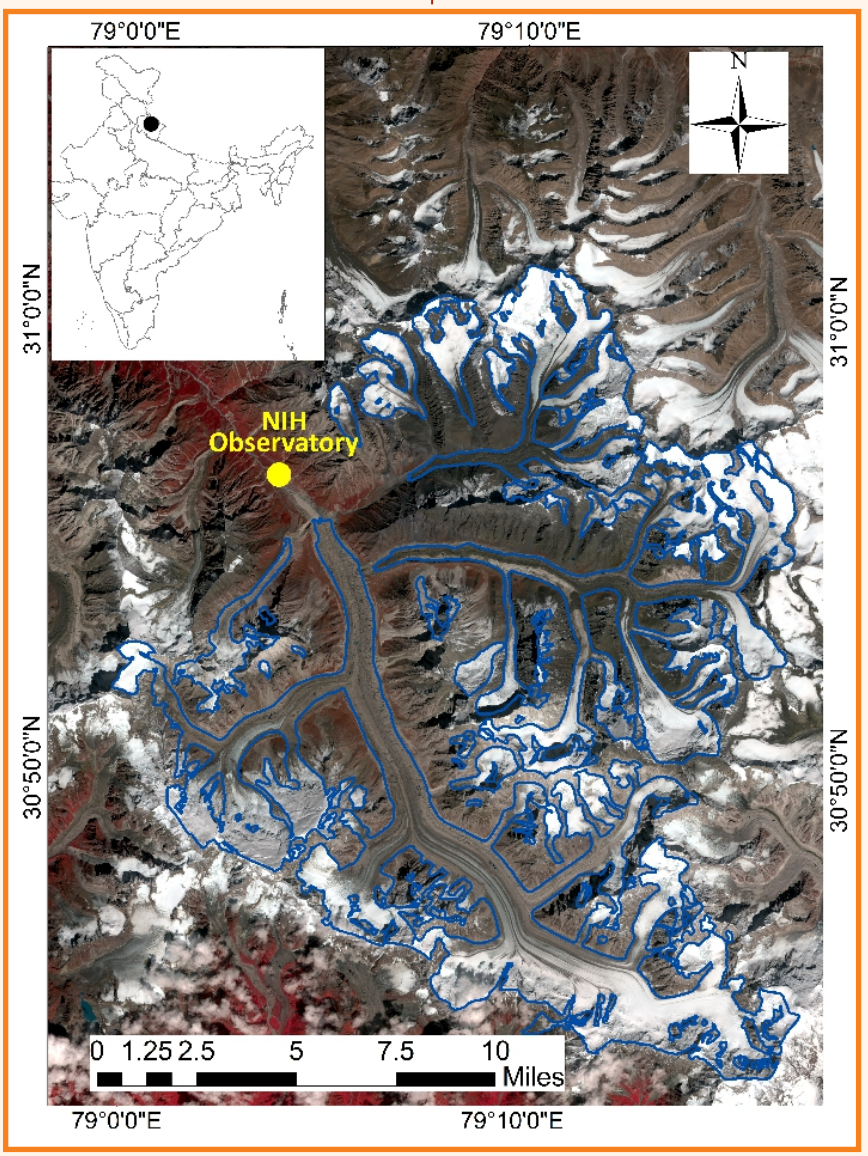


Figure – 6.24: Gangotri Glacier System and NIH, Observatory at Bhojwasa

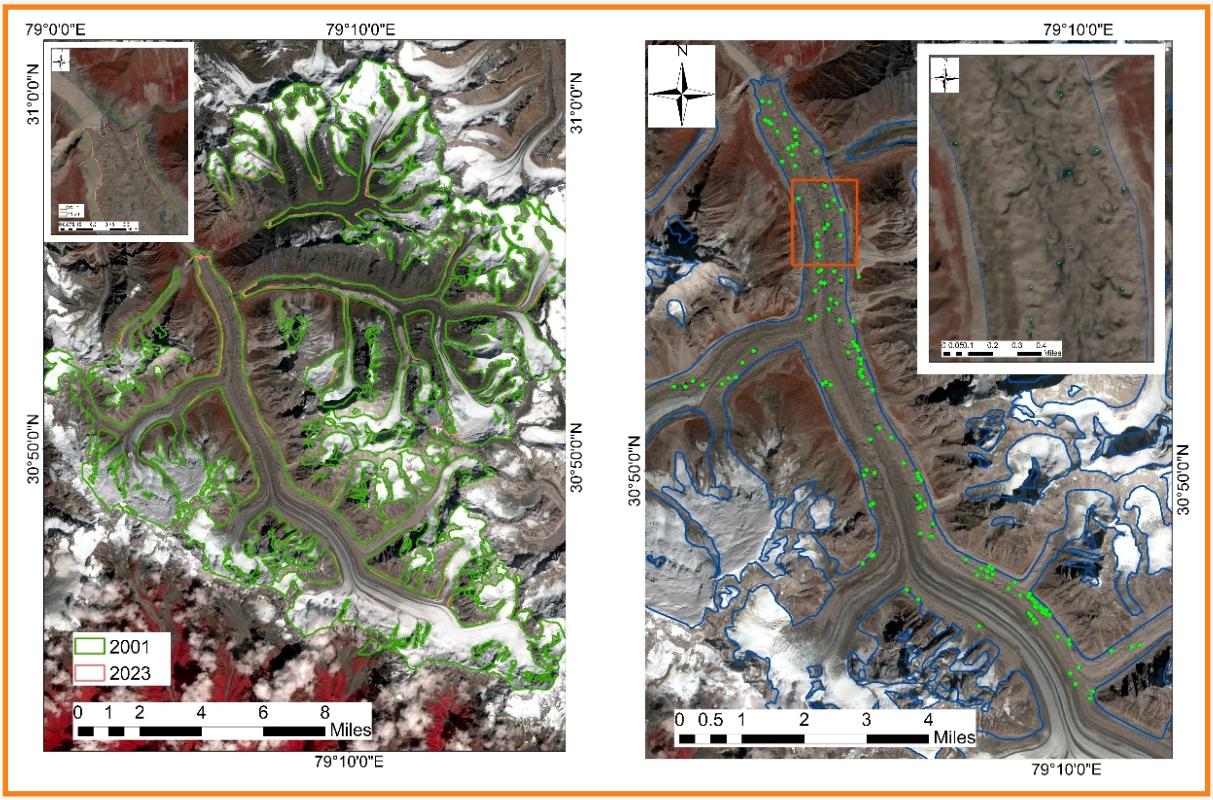


Figure – 6.25: The Glacier Retreat and Distribution of Supraglacial Lakes over the Main Trunk of Gangotri (Source: Sentinel 2B, MSS, 2023)

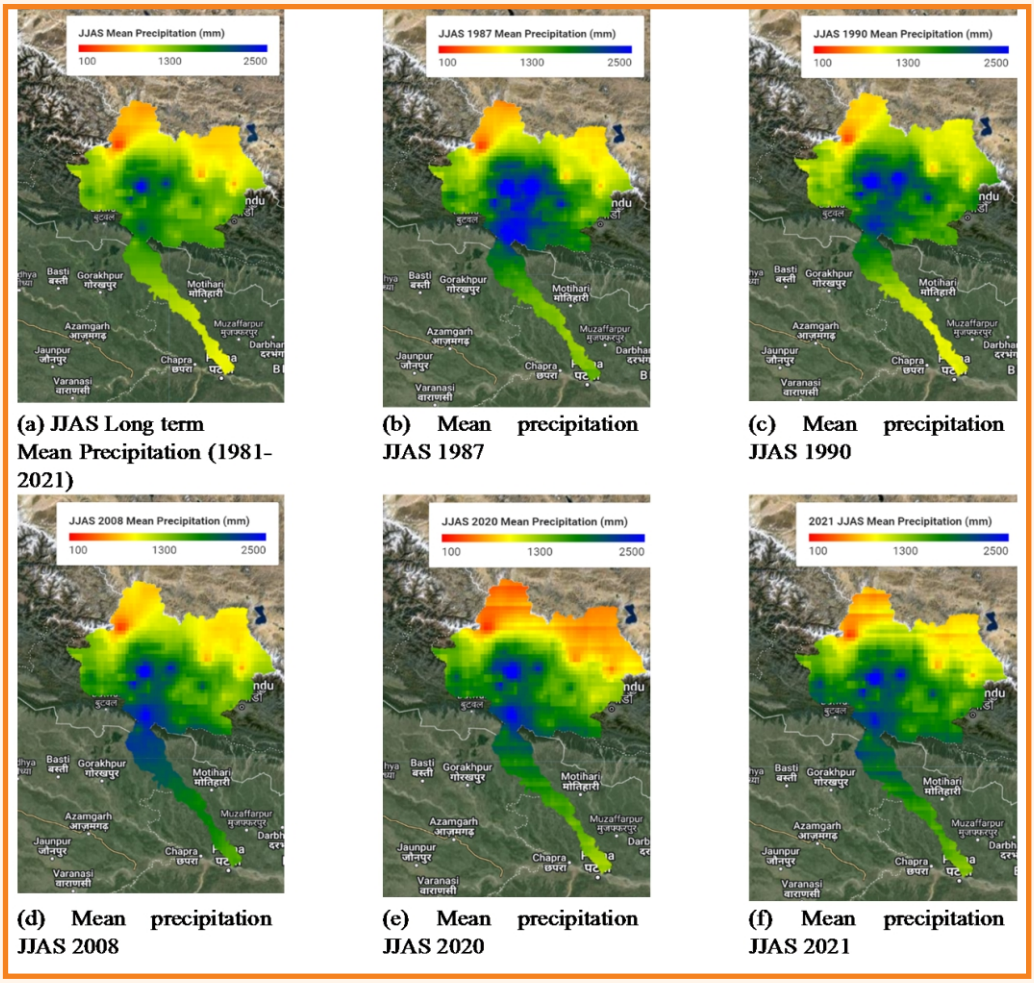
The long-term hydro-meteorological date sets, sediment samples were collected during the ablation season of the year 2023. During the ablation season, the average temperature was ranging from 2.1 – 15.7 °C. The total precipitation was 269 mm. Higher temperature and precipitation were observed during July and August. The average monthly discharge was varying from 26.1 to 51.9 m^3/s, and higher discharge was observed during July and August. The total suspended sediment from the Gangotri Glacier was estimated to be 1.50 $\times 10^6$ tons for 2022, while during melt season, 1.36 $\times 10^6$ tons was estimated. The satellite observations for the period 2001 – 2023 indicated an aerial loss: 4.41 km^2 (0.18 km^2/a) and terminus retreat: 358 m (16.4 m/a). Additionally, the supraglacial lakes over the main channel have also been increased from 121 to 169 in numbers.

Evaluation of Hydrological Models for Gandak River Basin

With the advancements of computing facilities there are many hydrologic models present for decision makers. Hence, comparison of these models becomes a necessity for better planning of the water resource and for providing efficient flood forecast. The study aims to evaluate performance of three widely used hydrologic models. The objective of the study are (i) to develop multiple hydrologic models using HEC-HMS, SWAT and MIKE Hydro Basin for inter-comparison of flows for Gandak river basin and (ii) evaluation of model performance with respect to observed discharge and water level data for Gandak river at their respective CWC GD sites. The methodology has been finalized and multi-satellite remote sensing dataset is being used for the study. Study incorporates analysis of CHIPRS, TRMM and

APHRODITE precipitation dataset for Gandak river basin and utilizes these for modelling purpose. Precipitation trend has been analyzed using MK test. The CHIRPS dataset monthly mean precipitation values from 1981-2021 have also been analyzed.

The MK test for this dataset shows no significance trend (Sen's Slope: -0.00066, Intercept: 21.197). The maximum precipitation trend results for MK test with CHIRPS data are showing decreasing trend. However, the trend for number of rainy days is showing an increasing trend in the. Spatial precipitation distribution maps have been finalized for CHIRPS dataset. TRMM precipitations rates (mm/day) monthly averaged values (1998-2019) are showing a declining trend specially in the months of June, July and August. The GRACE dataset has also been analyzed for the GRB. All three sub-dataset of GRACE viz. CSR, GFZ and JPL shows a declining trend. The global soil moisture active passive dataset commonly known as SMAP (2016-2021) has been analyzed for GRB. The main constraint of this dataset is the temporal range availability which is only from March 2015 to present at 9 km spatial resolution. For the analysis, the dataset from 2016 to 2021 is selected. MK test has been performed for this dataset, but no significant trend has been found.



(a) JJAS Long term Mean Precipitation (1981-2021)

(b) Mean precipitation JJAS 1987

(c) Mean precipitation JJAS 1990

(d) Mean precipitation JJAS 2008

(e) Mean precipitation JJAS 2020

(f) Mean precipitation JJAS 2021

Figure – 6.26: Spatial Precipitation Distribution over Gandak Basin during Monsoon

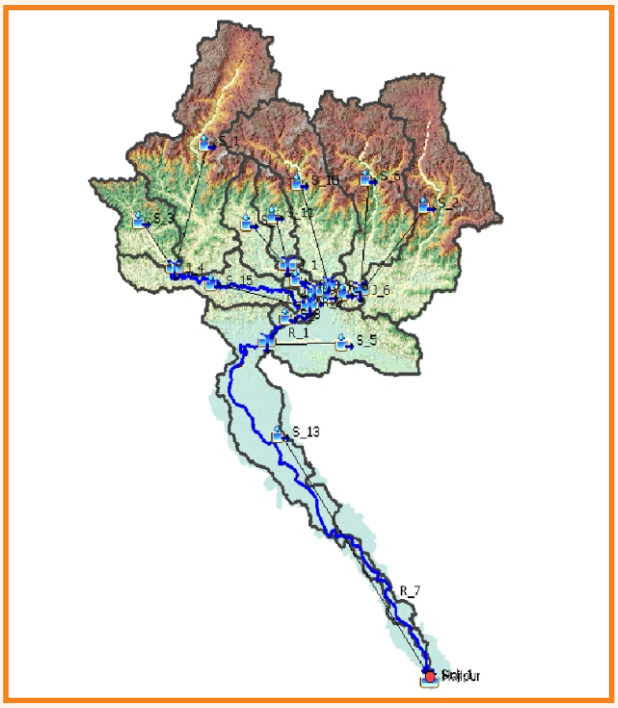


Figure – 6.27: HEC-HMS Model Setup for Gandak River Basin

The model setup has been created for HEC-HMS model using ALOS PALSAR Radiometric Terrain Corrected (RTC) product with 12.5 m x 12.5 m spatial resolution and the calibration process is in progress. Semi-distributed modelling approach is adopted. Soil Moisture Accounting (SMA) method is being used in HMS for capturing long term catchment responses accurately. The model setup for SWAT model is also in progress. These hydrologic models can be used further for setting up the boundary conditions in sophisticated hydraulic models which can help in accurate flood plain mapping.

Influence of Non-Stationarity on Flood Frequency Analysis of South-Bihar Region

Traditional flood frequency analysis (FFA) assumes independence and stationarity of extremes, disregarding spatio-temporal variability of rainfall and catchment characteristics. Incorporating climatic and anthropogenic non-stationarity into FFA is crucial for accurate design flood. This study aims to (i) detect trends and breakpoints indicating non-stationarity in maximum annual flow (MAF) series; (ii) evaluate the impact of covariates (time, annual precipitation, LULC) in non-stationary (NS) models of MAF series; (iii) determine the best fit non-stationary model for efficient FFA and compare it with the stationary model; and (iv) compare flood quantiles and return periods derived from stationary and non-stationary models. It includes major catchments of the South-Bihar region viz. Punpun, Falugu, Kiul-Harohar, except Sone. The study will conduct NS-FFA using RStudio, by determining location and scale parameters as linear functions of covariates in different combination estimated via MLE or Bayesian-MCMC methods. Flood quantiles for specific return periods, utilizing robust distributions from EV1, GEV, LOG, GLOG, NOR, GNOR, UNF, PE-III, EXP, GPA, Kappa, and Wakeby will be compared. The best-fitting model will be selected using Zi–statistic, log-likelihood estimates, Akaike and Bayesian information criteria (AIC, BIC), L-moments ratio diagram, and diagnostic plots (Quantile:Q-Q, Probability:P-P). MAF series from multiple GD sites, sourced from WRD, Bihar, and CWC were combined. Out of 35 gauged stations, 12 were selected based on having MAF data ranging from 15 to 61 years. Autocorrelation plots assess randomness of data whereas, trend tests detect trends or breakpoints. Stationery and NS distributions (GEV and GLO) were fitted to MAF series of 12 stations. One stationary (MLE-based) and three NS models, varying in location, scale, or both parameters, were fitted, with the scale parameter log-transformed for positivity across covariate values. To summarize, the first objective has been achieved. Additionally, as per 2nd objective, incorporating time as a covariate, its impact on NS-GEV and -GLO based design flood was analyzed. The best-fitting model (whether stationary or NS) was selected using statistical indices and *Q-Q* plots, and flood quantiles derived for various return periods were compared. Further analysis will incorporate other trend tests, PDFs, parameter estimation methods, goodness-of-fit criteria, and other covariates to enhance insights and reduce uncertainty. Both Pettitt's and PELT tests reveal a negative trend at the Lakhisarai gauge site, with a breakpoint observed in 2007. GEV-based *Q-*

Q plots indicate that, NS model with varying location and scale exhibit the best fit. Flood quantiles for a 50-year return period derived for Lakhisarai using the best fit model indicate a significant decrease from 3139 to 1013 m^3/s. Utilizing a NS approach to estimate design floods for different return periods would urge local flood managers to enhance existing flood management plans and

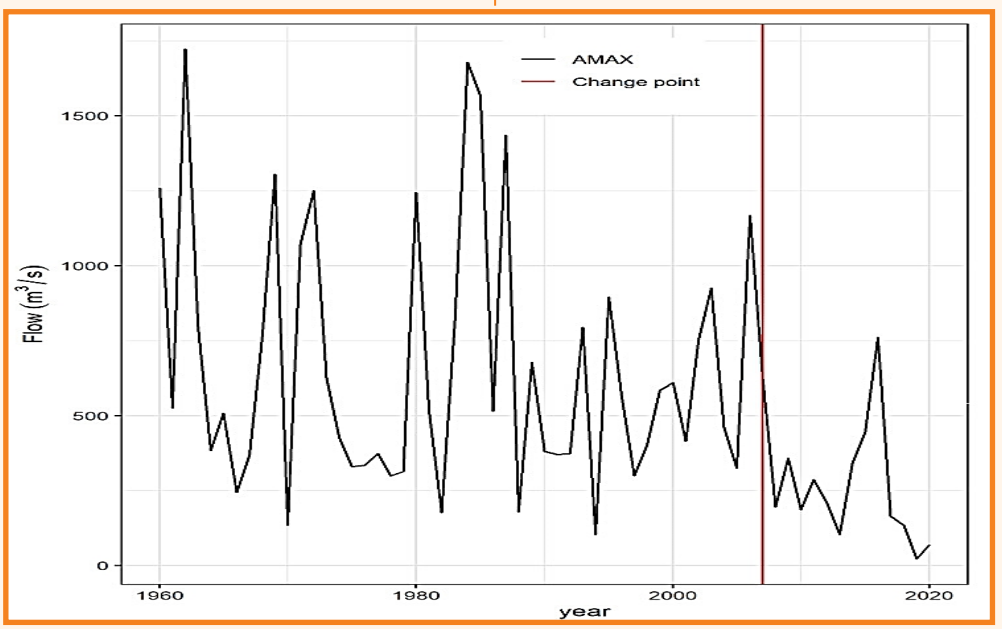


Figure – 6.28: Trend or Breakpoint Detection using PELT Test

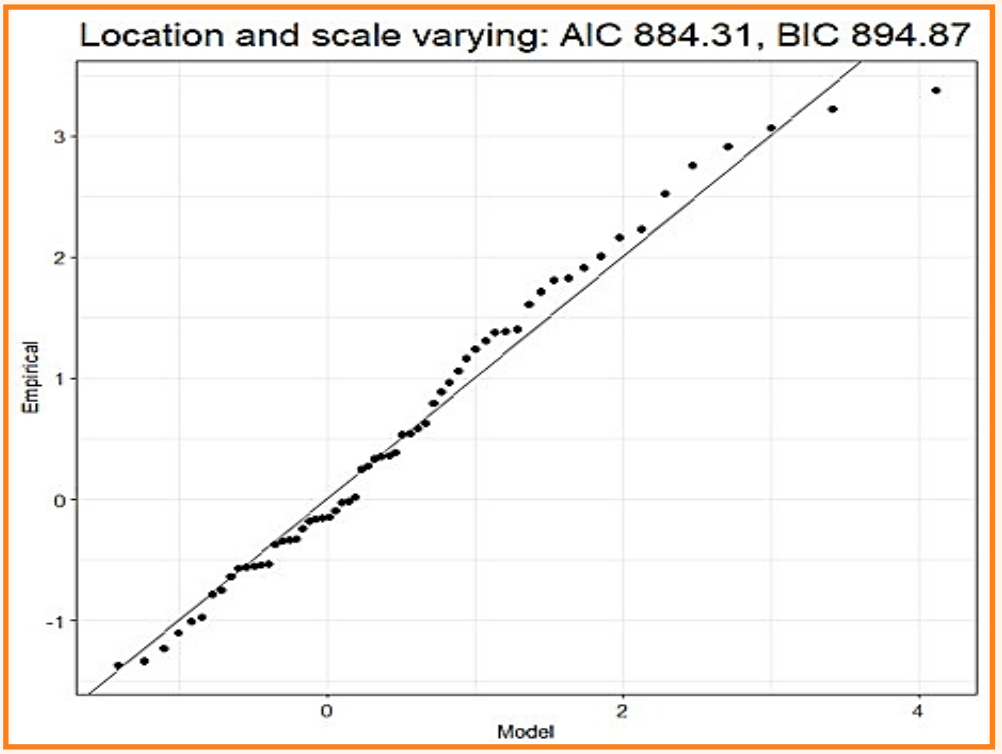


Figure – 6.29: GEV based Q-Q Plot for Best Fit NS Model

Re-assessment of Evapotranspiration (ET_o) Estimation for Irrigation Planning in Madhya Pradesh

In Madhya Pradesh (MP), the crop and irrigation water requirement is estimated as per the methodology suggested in Technical Circular (TC) – 25 of the Water Resources Department (WRD) of June, 1990. Due to climatic changes, biotic evaluation, changing agricultural practices, and anthropogenic interferences, the evapotranspiration (ETo) estimates seem to have been overestimated and need to be re-assessed for irrigation planning. The aim of the study is to verify method of estimation of ET_o and Irrigation Requirement (IR), suggest changes in TC-25 and develop accurate methods and software for estimation of ETo. The long-term climatic data of 52 district stations and 11 agroclimatic zones obtained from different sources like IMD station data, IMD grided data, NASAPOWER was used for estimation of ETo and IR. The software like CROPWAT, ET-Calculator and excel based dashboards were used for estimation of ETo. The excel based dashboard has been developed to estimate ETo using four methods, Penman-Monteith, Hargreaves, Blaney-Criddle, and Modified Penman. It was observed that the Modified Penman method which is used in the TC-25 overestimates the ETo, hence TC-25 need to be revised using Penman-Monteith method using recent climatic data. Hargreaves method shows adherence to the Penman-Monteith method. The table of recommended efficiencies for canal system for project planning TC-15 (1988) has been revised in the year 2002 and is recommended for irrigation planning. The crop water requirement (CWR) for Wheat estimated using Penman-Monteith method and TC-15 (2002) was seen to be considerably less as compared to the old estimates based on TC-25. No significant changes could be seen in soil characteristics and cropping pattern that may affect CWR and IR. The simple dashboard developed in Excel has been found to be reliable for the estimation ET_o. The analysis work is completed and report preparation is under progress.



Figure – 6.30: Infiltration Tests Conducted in the Kolar Command Area

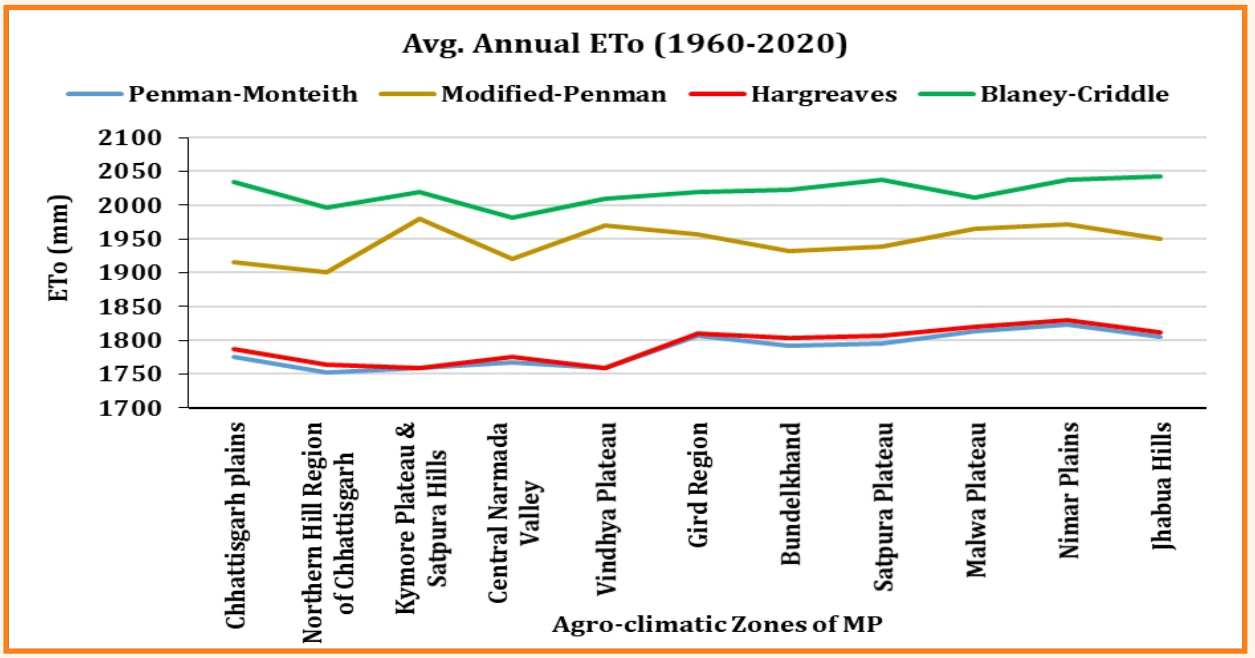


Figure – 6.31: ET_o Estimation in 11 Agroclimatic Zones of MP using IMD Grided data

Development of Reservoir Operation Plan under Climate Change Scenarios for Kolar Reservoir in Madhya Pradesh

Kolar reservoir is an important source of potable water for the Bhopal city and for irrigation. The project was proposed to irrigate 45,078 ha of area but, only 31,000 ha is being irrigated presently due to water shortage. Looking into the deficit in reservoir storages in the past years, this study is envisaged to assess scenarios-based demand-supply analysis and management option for optimal use of water in Kolar reservoir. The study has been undertaken with the objectives: (i) Development of Rainfall-Runoff Model for assessment of reservoir inflows, (ii) Assessment of present and future supply demand scenario of Kolar dam, (iii) Scenarios development under changing climate, demography and water resources management aspects, and (iv) Development of Reservoir Operation Policy under changed scenarios. The output of the study would be revised reservoir operation policy under changed scenarios for better water management practices. Collection of hydrological, meteorological parameters, soil, geology, etc. from diverse sources and a GIS database has been prepared consisting of drainage, canals, digital elevation model, soil, LULC map of Kolar catchment and Kolar command. Trend analysis of annual and seasonal precipitation and maximum temperature using MK test and Sen's Slope estimator has been done for the time period of 26 years (1996-2021). Sen's Slope estimator revealed significant rising trend in annual precipitation whereas; seasonally winter and post monsoon period is showing slight declining trend in rainfall. Temperature trend is not significant for Kolar basin. CWR of Rabi crops of the Kolar command has been estimated using CROPWAT 8.0 model during the baseline and present period which comes to be 110 MCM and 149.9 MCM, respectively. NAM model setup and detailed analysis is under progress.

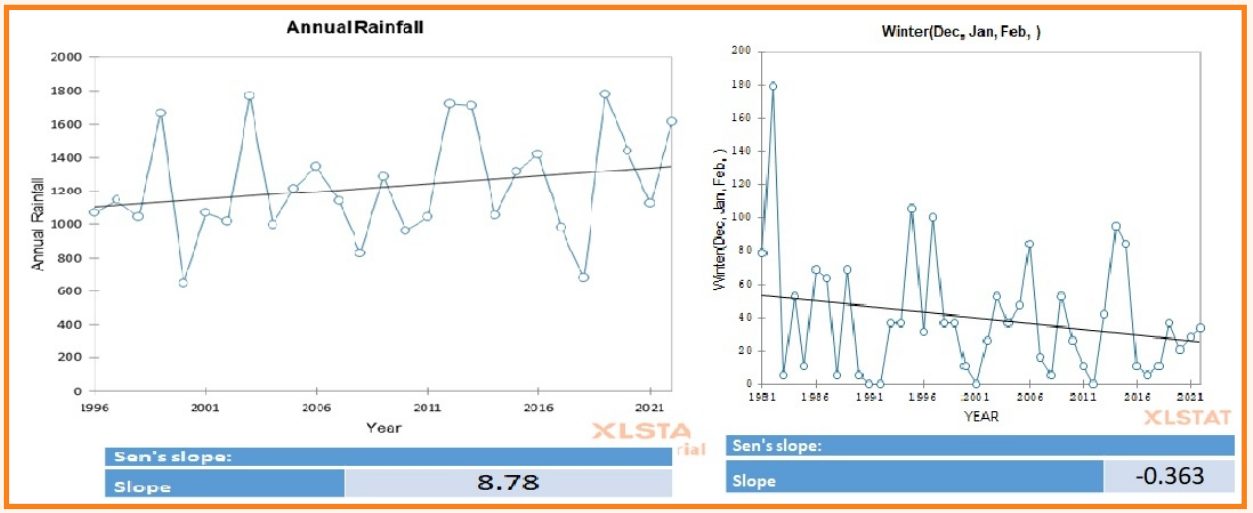


Figure – 6.32: Trend Analysis of Annual Precipitation (mm) and Seasonal Precipitation (mm) of Kolar Basin and its Command Area

Water Availability Assessment for Project Formulation in Sub-Basins of River Ganga in Madhya Pradesh

To assess the water availability, long-term runoff records (almost 30 years) are required at the site where the reservoir would be built. The streamflow data scarcity can be simplified by transferring data from a neighboring location. However, data collection and analysis concerns are still prone to planner bias in terms of donor catchment selection and record length. In the study, different models including GR2M, SCS-CN in GEE, MIKE 11 NAM, linear regression, and NAPI models were applied on a few G/D sites of Betwa, Chambal, Ken, Sindh, Son, and Tons basins.

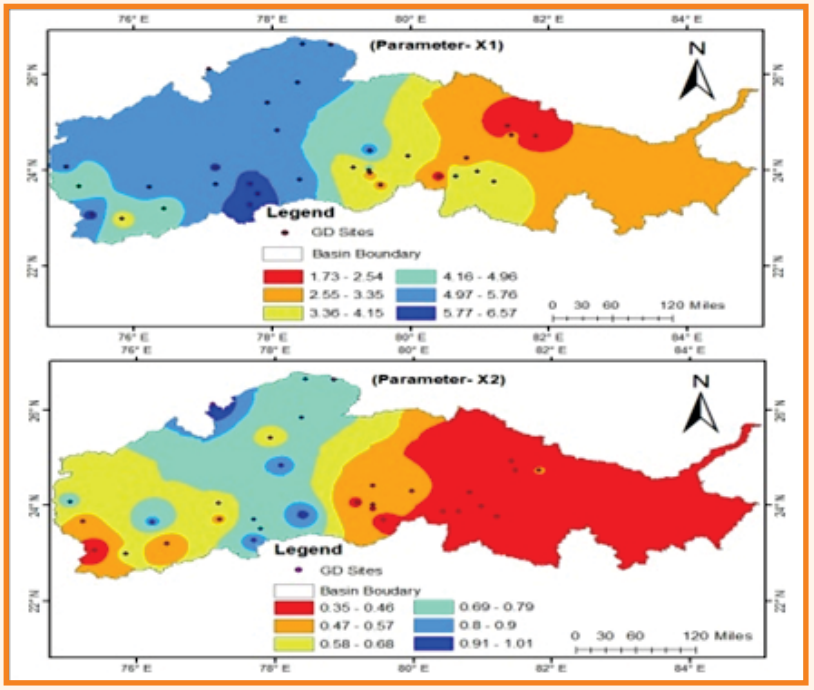


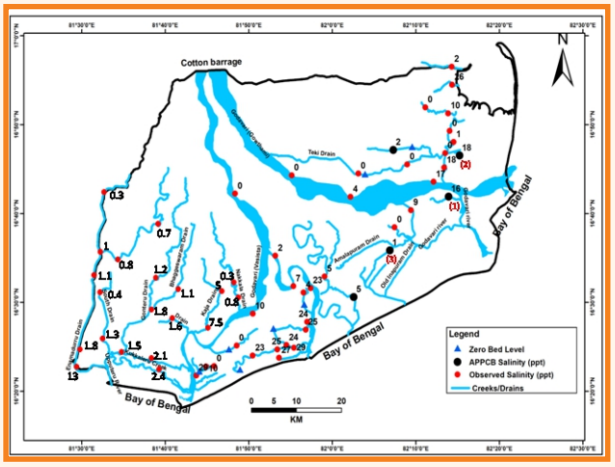
Figure – 6.33: Spatial Distribution of Parameters of GR2M Model in Ganga Sub-basins in MP

It was concluded that the GR2M model was found suitable for all the basins. Further, GR2M monthly rainfall-runoff model was applied on 33 sites in these basins where efficiencies ranged from 75.4% (Didi G/D site in Sindh basin) to 94.1% (Kuno G/S site in Chambal basin) during calibration and 61.2% (Neemkheda G/D site in Betwa basin) to 98% (Daboh G/D site on Sindh basin) in validation. The GR2M model that works on a monthly basis was applied and found most suitable to assess the monthly water yield required for the assessment of project water availability. The spatial distribution of parameters of GR2M model is shown below.

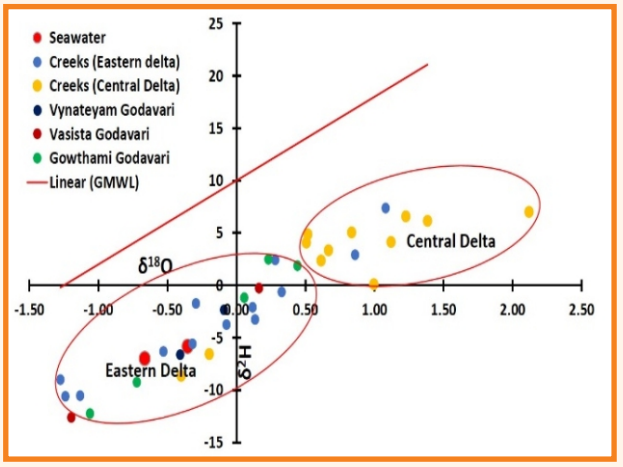
Impact Assessment of Backwater through Drains, Creeks and River Mouths on Groundwater Salinity in the Godavari Delta, Andhra Pradesh

The first set of intensive fieldwork was collected conducted in the Eastern and Central Godavari Delta and 35 samples were collected from the 3 branches of the Godavari River and creeks/drains in June 2023 and the in-situ pH, temperature, EC and salinity levels were determined . The water samples were collected for the trace metal assessment and stable isotope characterization. Historical water quality data at 13 drains have been collected from A.P. Pollution Control Board to understand the salinity levels of drains in the Eastern Godavari delta from the period April, 2018 to May 2023. The hydraulic particulars of the drains were collected from the A.P. Drainage Department and zero bed levels were marked which helped in further understanding of salinity. For collecting the second set of salinity data on drains, another intensive fieldwork was carried out in February 2024 which covered the Western Godavari delta, including the Eastern and Central delta. During this field visit, a total number of 55 water samples were collected from major/minor drains (24), backwater from rivers (2), sea (3), canals (17), groundwater (5) and aqua ponds (4) for estimation of trace elements, isotope and chemical analysis. The locations of water sampling points on all creeks/drains in the Godavari delta and their salinity values are shown in figure. The in-situ salinity, pH, temperature, and EC of the water samples were measured at sampling sites.

The analysis of trace elements and stable isotopes was carried out at NIH, Roorkee. It was found that except Boran (B) and Mercury (Hg), all the creek water samples are within the permissible limits. For The relationship trend between $\delta^{18}O$ and $\delta^{2}H$ has been compared for the creeks/drains in the Central and Eastern deltas with the equation of Global Meteoric Water Line (GMWL). It was found that the stable isotopic signatures of creeks and Godavari River (backwater) samples in the Eastern delta are close to seawater samples and those in the Central delta are away from the seawater samples. This may



Locations of Water Sampling Points on Creeks/Drains in Godavari Delta



δ18O–δ2H Relationship of Creeks/Drains in the Central and Eastern Deltas

Figure – 6.34: Water sampling locations on Creeks/Drains and isotopic relationships

be due to the higher flows (during high tide) of backwater through the long and large drainage system of creeks. However, salinity values in the creeks of the Eastern delta are comparatively low (1-18 ppt). This may be due to higher irrigation return flows which dilute the backwater. The high freshwater inflows in the Gowthami River (Godavari) can also lower the seawater salinity and consequently backwater salinity. Enriched isotopic signatures in the creeks of Central Delta indicate the high evaporation process due to the long residence time of the backwater. The creeks in the Central delta are not well connected to the inland delta and are mostly limited to near the coast. The irrigation return flows are less and hence high salinity values (10-24 ppt) are attributed to the creeks of Central Delta. The analysis of the water quality (Cl and HCO_3) with the stable isotopes of creeks is being studied. The salinity values in the creeks/drains of the Western Delta are ranging from 0.3-13 ppt which are much less when compared to the Eastern and Central Deltas. The trace metals and isotope analysis of creeks and other water samples in the Western delta are being carried out at NIH, Roorkee. The study is under progress.

Storm Water Flood Management in Coastal City-Case Study

Kakinada is part of a Special Economic Zone and a proposed 'Petroleum, Chemical and Petrochemical Investment Region (PCPIR)'. It is a hub for all the deep-sea exploratory activity in the region due to its deep-water seaport and its proximity to the gas fields. The Ministry of Housing and Urban Affairs, Government of India selected the Kakinada City as "Smart City" during the 1st phase of the Smart City. Drainage network details, 0.5 m contour interval and smart city basin map have been collected from Kakinada Municipal Corporation (KMC) and the field survey was conducted along with KMC officials. DEM of the smart city has been generated and sub-catchments have been delineated with field verification of existing drainage network. The existing storm water drainage network is observed to not follow the natural drainage system.

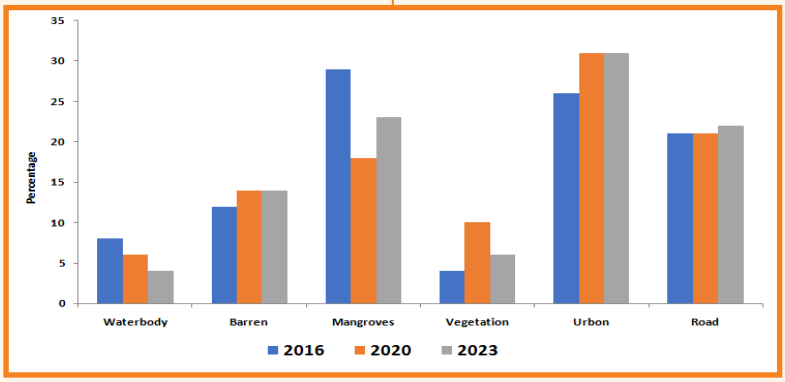


Figure – 6.35: Changes in LULC of Kakinada Smart City

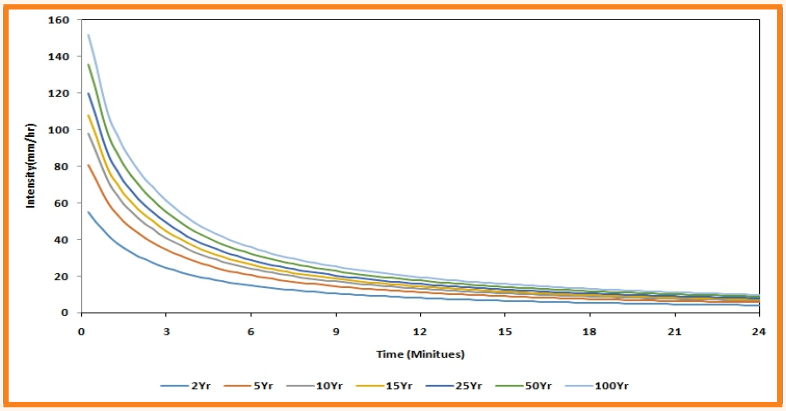


Figure – 6.36: IDF Curves of Kakinada Smart City

The major LULC details of the study area were estimated from Sentinel 2 (spatial resolution 10 m) (2016 to 2023). The major LULC found to be water body, barren land, mangroves, plantation, urban, and road. Impervious area has been increased from 54 to 58 % form the year 2016 to 2023. The thematic maps of percentage of slope and soil groups were prepared in GIS Rainfall data (15 minutes) for the period 2007 - 2023 were collected from DRC hydro-meteorological observatory and the IDF curves were developed for various return periods. The 5 minutes maximum peak intensity of 2, 5, 10, 15, 25, 50 and 100 years return periods are found to be 55, 81, 98, 108, 120, 136 and 152 mm/hr, respectively. SWMM model setup and evaluation is under progress.

Climate Change Impact Assessment under Future Scenarios over the East Coast of India: A Focus on the Hydro-climatic Extremes

The East Coast of India, with its high population density and significant economic activities, is one of the regions that are highly vulnerable to the adverse effects of climate change. The assessment of historical hydro climatology includes trend analysis of rainfall, maximum and minimum temperature using non-parametric (modified MK test, Sen's slope and Spearman's Rho) tests at different timescales, rainfall seasonality/concentration analysis using precipitation concentration index, and extreme characteristics. Using IMD gridded (0.25° × 0.25°, daily) rainfall dataset, the extreme rainfall indices, viz., maximum 1-day rainfall (rxa), maximum 5-day rainfall (rx5d), number of rainy days (dr), total rainfall in wet days (rtwd), number of heavy rainfall events (d64), maximum consecutive wet days (cwd), and simple daily intensity index (sdii) are computed for each year considering the IMD-based thresholds and their temporal patterns were analyzed. Similarly, the hottest day, coolest night, difference of temperature range, and heatwaves are assessed using the IMD gridded TMAX data (resolution: 1° × 1°, daily). A mix of significant/non-significant positive and negative trends are observed in different seasons across the east coastal states. Specifically, for the Godavari Delta, the frequency of extreme rainfall events has been significantly higher in recent years even though the trend line showed a declining pattern for rxa and rx5d; an increasing trend is observed for cwd and dr; rainfall has decreased significantly in post-monsoon and winter seasons. The heatwave frequency is found to increase over several parts of study area. For future projections, a total of 15 GCMs are selected from the NEX-GDDP-CMIP6 datasets corresponding to SSP2-4.5 and SSP5-8.5 scenarios. The data for the east coastal states have been downloaded. An improved mechanism of bias-correction accommodating multiple criteria is under process.

Evaluation and Post-Processing of Multi-Model Short-To-Medium-Range Precipitation Forecasts: Towards Developing a Flood Early Warning System Over Subarnarekha Basin

Accurate precipitation forecasting with sufficient lead time is a prerequisite for developing a robust flood warning system (FWS), which is particularly challenging in developing countries like India. Numerical weather prediction models like THORPEX Interactive Grand Global Ensemble (TIGGE) have shown potential for alleviating these challenges. The quantitative precipitation forecasts (QPF) from 7 TIGGE models is collected for 2010-2016 with lead times up to 7 days. The IMD gridded rainfall for the same period is used as the reference dataset. Three popular bias-correction techniques, viz. spatio-temporal bias correction (STB), power transformation (PT) and quantile mapping (QM), are investigated for their comparative performance in bias correction of the TIGGE precipitation forecasts for different lead times (1-day, 3-days, 5-days, and 7-days).

The proposed methodology for bias correction is shown below. The raw QPF estimates are found to possess low to moderate forecast skills with a high bias, which improved significantly after bias correction. Moreover, the quality of the forecasts deteriorated with increasing lead time. The QPF forecast in different countries at different resolutions are given in Table. The ECMWF and UKMO models performed better than the other TIGGE models in precipitation forecasting. At present, a LSTM-based bias correction scheme is under progress, which shall be compared with the three popular techniques for improving the accuracy of

Table – 6.2: QPF Models Forecast Available in Different Countries at Different Resolutions

Short Name	Country/region	Resolution
CMA	China	0.5° × 0.5°
CPTEC	Brazil	0.94° × 0.94°
ECCC	Canada	0.25° × 0.25°
ECMWF	Europe	0.3° × 0.3°
KMA	Korea	0.3° x 0.45°
NCEP	United States	0.5° × 0.5°
UKMO	United Kingdom	~0.19°x 0.28°

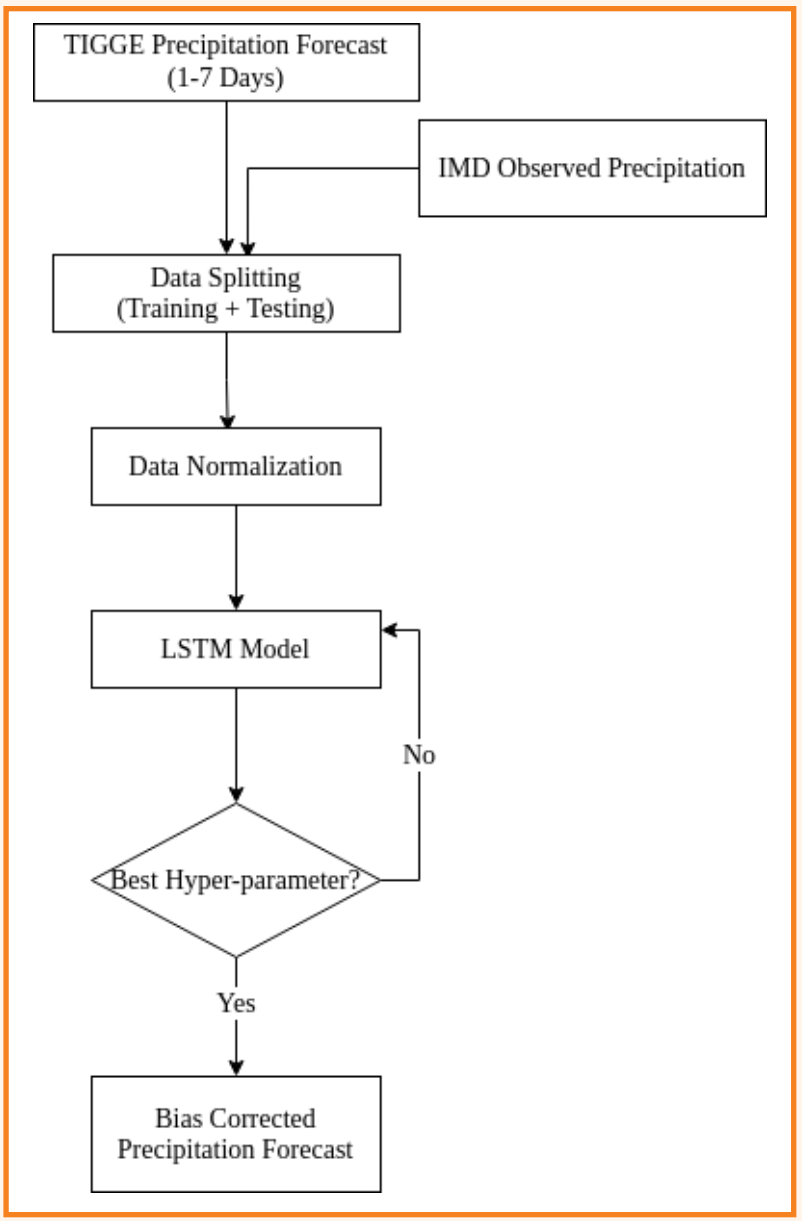


Figure – 6.37: Proposed Methodology for Bias Corrected Precipitation Forecast

Understanding Arsenic Mobilization in Groundwater of Haridwar and Formulating Remediation Measures

The study explores the biotic and abiotic geochemical mechanisms responsible for mobilization of As in the aquifers of Laksar and Roorkee tehsils of Haridwar. Monthly samples from the study area were analyzed for water quality parameters with emphasis on arsenic and the factor responsible for its occurrence in groundwater (GW). It was observed that the shallow wells (<80 ft) are significantly contaminated with As up to 267 ppb concentrations and around 68% samples exceeded the permissible limit of 10 ppb for drinking water. Similarly, As concentration in the groundwater upto 150 ft were observed to exceed the permissible limit in 59% samples. The maximum As concentrations in the deep wells (>150 ft) was 36.9 ppb and around 26% samples exceeded the acceptable limit of 10 ppb. Contrary to the general tendency of dilution of GW contaminants during monsoon and post-monsoon period, As concentration in the GW of the study area was highest in the monsoon period and lower concentrations were observed in the subsequent expeditions. Most of the research on As occurrence in the groundwater indicates that As concentration in GW is inversely proportional to ORP of GW, however, no such trend was observed in this study. It was also observed that groundwaters with nitrate concentration above 20 ppm were low in As except few exceptions. It was observed that the study area water samples contain As resistant bacteria, and out of 29 isolates, 14 isolates have the potential to transform As (III) to As(V). Several contradictory observations were observed in this study indicating different drivers playing a role in the mobilization of As from the aquifer sediments in the study area.

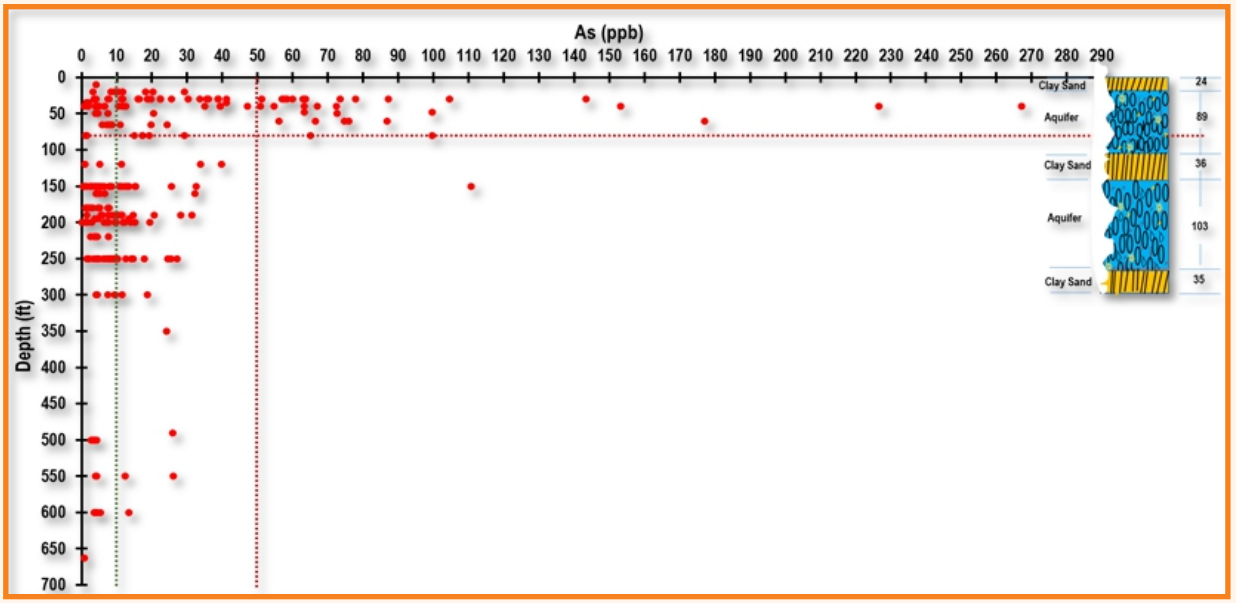


Figure – 6.38: Depthwise Variation in As Concentrations and Aquifer and Lithological C/S

Comprehensive Evaluation of Disinfection Units of STPs in Ganga Basin: Occurrence and Control the Formation of Emerging Oxidation Precursors

This work presents a comprehensive exploration of the generation of disinfection byproducts in chlorine disinfection units of STPs in the Ganga basin. The main focus of the study is to investigate the performance of disinfection units of various sewage treatment plants for physical-chemical and microbiological properties, tracer studies of chlorine disinfection units, DBPs formation and characterization and propose a technical solution to control and remove the DBPs. Chlroine disinfection unit at STP and Onsite testing and sample preservation for disinfection by-products analysis is shown below.



Chlorine Disinfection Unit at STP



Onsite Testing and Sample Preservation

Figure – 6.39: Activities for Evaluation of Disinfection Units of STPs in Ganga Basin

The organic pollutants (BOD, COD and TSS) of studied STPs were found under the discharged standards. Chlorine dosing of the plants was in the range of 2.1 to 5 mg/L. Residual chlorine in most of STPs were <0.2 mg/L. Low residual chlorine affect plant's disinfection efficiency. Among studied STPs, THM concentrations were less than the standard criteria except 5 MLD STP at Rishikesh.

Hydrological Studies for the Conservation of Rewalsar Lake

Rewalsar lake is presently facing problems related to water quality, frequent incidents of high fish mortality and siltation. Rewalsar wetland ecosystem is at the critical stage of deterioration mainly due to water pollution and siltation in the water body. Increasing tourism activity and human settlement around the lake create hydrological and ecological distresses. An increase in nutrient levels in lake from the various non-point sources also leads to eutrophic conditions. Keeping this in view and as suggested by the HPSWA, a systematic and comprehensive study on the hydrological investigation of Rewalsar Lake was taken. The objectives of the study are: (a) Identification of hydro-morphological features of the lake and water balancing study of lake for sustainable management of water resources; (b) To identify the causes of fish mortality and eutrophication status of lake and (c) To assess the rate of sedimentation. Based on the outcome of the study and remedial measures can be suggested for pollution abatement.

To assess the physico-chemical characteristics of the Rewalsar lake, a total of 03 samples from the lake water inlet sources, 02 samples from the lake, and 01 is from the lake outlet were collected and analysed. The pH regulates most of the biological processes in the aquatic system, and plays an important role for the growth of aquatic vegetation. In the present study, the pH value is found to be alkaline ranging from 7.90 to 8.31, however during the night time (8.00 pm) the pH value is observed to be acidic varied from 5.02 to 5.42. The range of pH in lake water showed significant diurnal variations, primarily driven by the photosynthetic and respiratory activities of aquatic vegetation. Average value of EC in the collected lake water samples

varied from 237 µS/cm to 256.2 µS/cm. The most abundant cation content in the lake water body is found to be $Ca^{2+} > Na^{+} > Mg^{2+} > K^{+} > NH_4^{+}$ (54.76 mg/L > 10.66 mg/L > 6.99 mg/L > 5.11 mg/L > 0.92 mg/L) followed by $Cl^{-} > SO_4^{3-} > NO_3^{-} > F^{-}$ (7.73 mg/L > 4.82 mg/L > 0.58 mg/L > 0.08 mg/L) as predominant anions. Similarly, the lake water inlet 1, inlet 2 and outlet follows the identical ionic trend as the lake water body. The DO and other on-site parameters were monitored 4 times (06:30 HR, 11:00 HR, 16:30 HR, and 20:00 HR). Diurnal variation in DO was observed ranging from 6.3 mg/l at 06:30 HR to 8.7 mg/l at 20:00 HR indicating significant decrease in DO levels from night time to early morning time and the situation may be worse during summer months. In the sample collected from inlet 2, the concentration of NH_4^{+} and COD are found to be under detection limit which can be the result of dilution factor associated with the buffer zone of the lake. The average concentration of chemical oxygen demand (COD) in the Rewalsar Lake is 22.7 mg/L, which may be due to input of domestic drains and religious practices along the shore of the lake. The overall alkalinity as $CaCO_3$ for the lake water is observed to be 158 mg/L, mainly originated from carbonate/calcareous minerals during monsoon, and silicate minerals during pre-monsoon. The dissolution of calcite and dolomite results in the SO_4^{3-}, Mg^{2+} and higher Ca^{2+} concentration in the lake water. The concentration of alkali metals such as Na^{+}, K^{+} and Cl^{-} in the lake water can be attributed to the silicate weathering as well as halite dissolution and anthropogenic activities occurred in the catchment area, while parameters like NO_3^{-}, NH_4^{+}, F^{-} are mainly a result of anthropogenic activities.

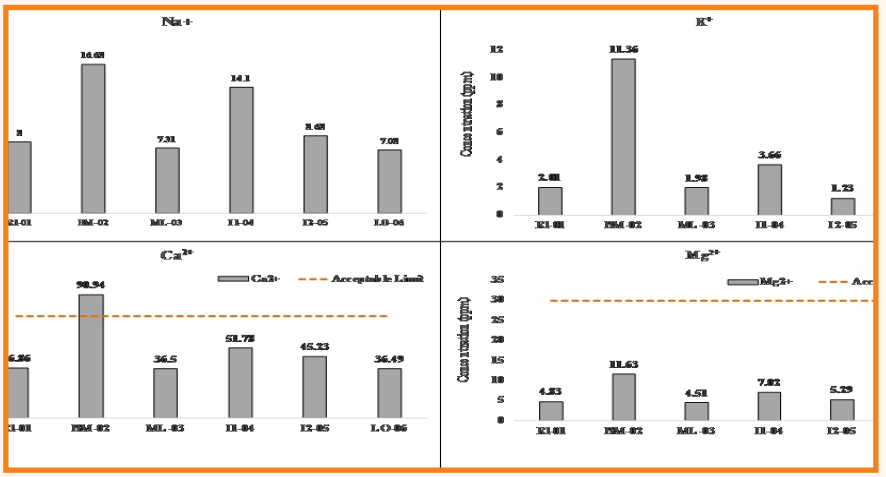


Figure – 6.40: Observed Cation Concentration in the Collected Water Samples

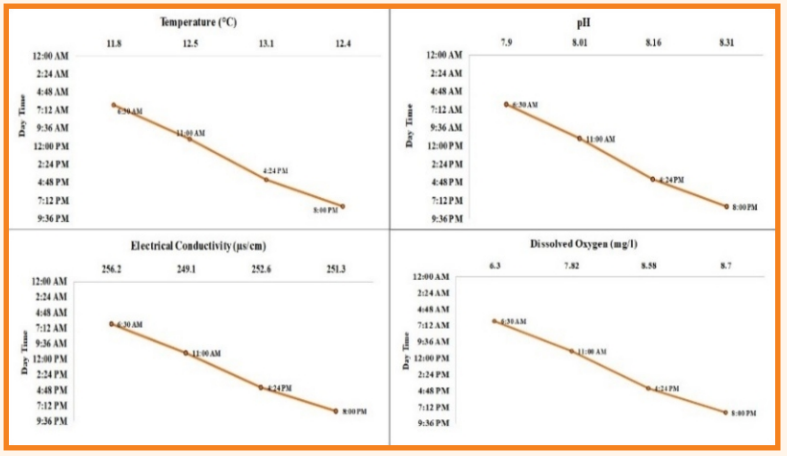


Figure – 6.41: Diurnal Profile of In-Situ Parameters in the Rewalsar Lake

There is a noticeable increase in the temperature profile, pH levels, electrical conductivity, and dissolved oxygen concentrations in the collected water samples. Similarly, an increasing diurnal variation has been observed for the inlet and outlet water samples. The catchment area was delineated using a DEM. The thematic map of various topographical aspects such as LULC, geology, geomorphology, lithology and drainage were created using the spatial analyst tool in the ArcGIS. The information obtained from thematic maps was verified through a field

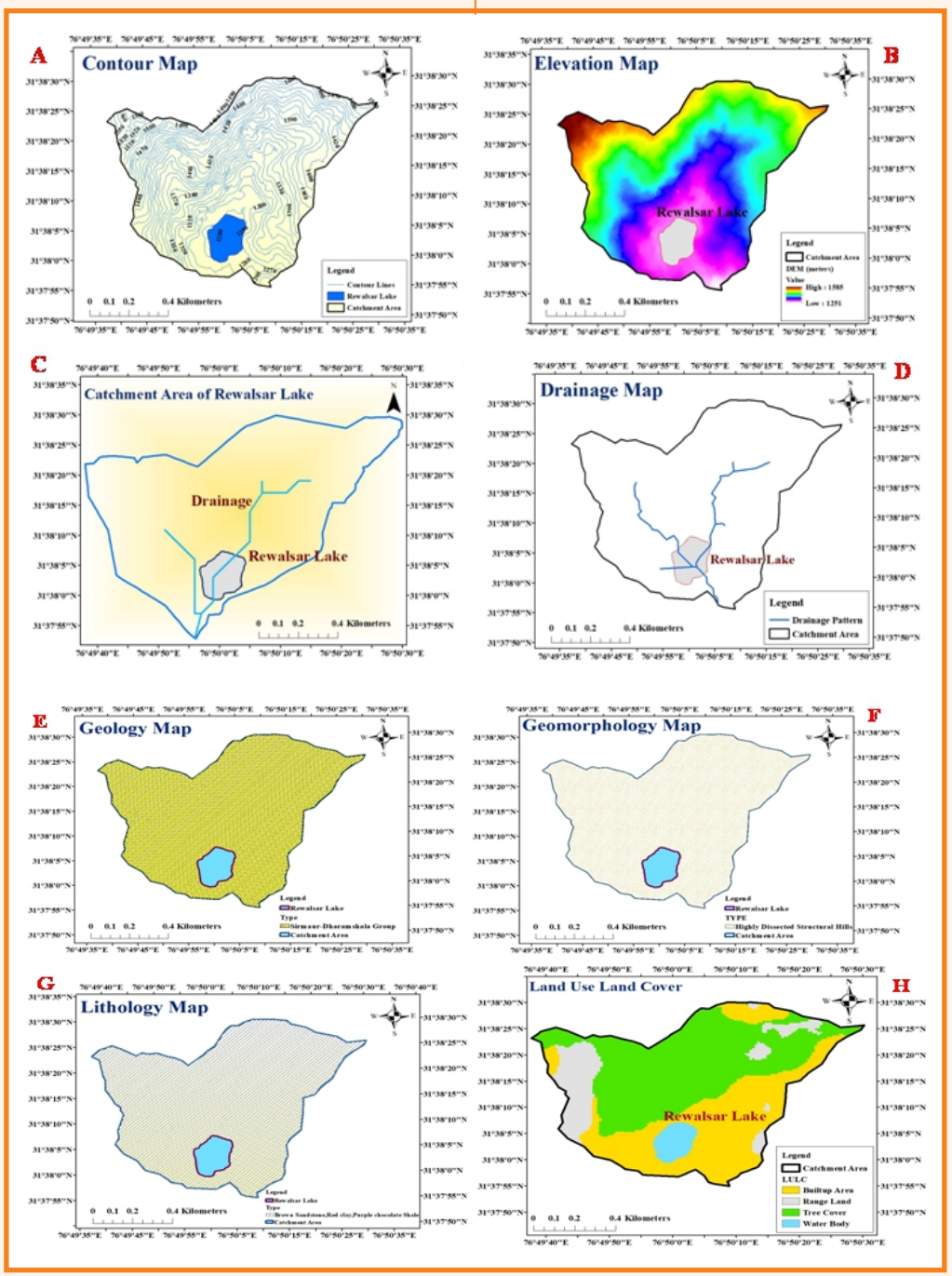


Figure – 6.42: Thematic Maps of Rewalsar Lake (A) Contour; (B) DEM; (C) Catchment Area; (D) Drainage; (E) Geology; (F) Geomorphology; (G) Lithology; (H) LULC

Studying Arsenic Genesis and Developing Alternate Water Supply Management Strategies in Ganga Basin

Arsenic (As) contamination of water is producing the greatest impact on livelihoods in terms of public health and thus arsenic calamity in the Ganga River basin put millions of lives in danger. The sediments in river Ganga and its tributaries determine the chemistry of water. The rivers originating from the Siwalik Hills are reported to release more arsenic and heavy metals from their sediments in comparison to those major rivers originating from the Higher Himalaya. In order to study the causes of arsenic occurrence in Ganga basin and its mobilization from solid to water phase, it is planned to carry out mineralogical, geochemical and mobilization study. The objectives of the present study are i) Mineralogical characteristic of sediments and water chemistry in the Indian Himalayan region to detect genesis of As, (ii) Demarcating safe aquifer for drinking water supply in As affected areas, (iii) Performance evaluation of existing treatment units and their comparison in terms of cost, efficiency and ease of operation etc. in the central Ganga basin. For achieving the objectives, a grid-wise sampling is being done in upper and middle Ganga basin to study the spatio-temporal variation of water quality parameters including As. The river bed sediment samples at different location are being collected and analyzed for sediment characterization using grain size characterization and elemental characterization. The mineralogical study are also being carried out to help in identifying the minerals of As present in the Ganga basin. Groundwater and surface water samples are collected during multiple field campaigns from both deep and shallow aquifers. The isotopic samples are also being collected for understanding recharge source and SW-GW interaction.

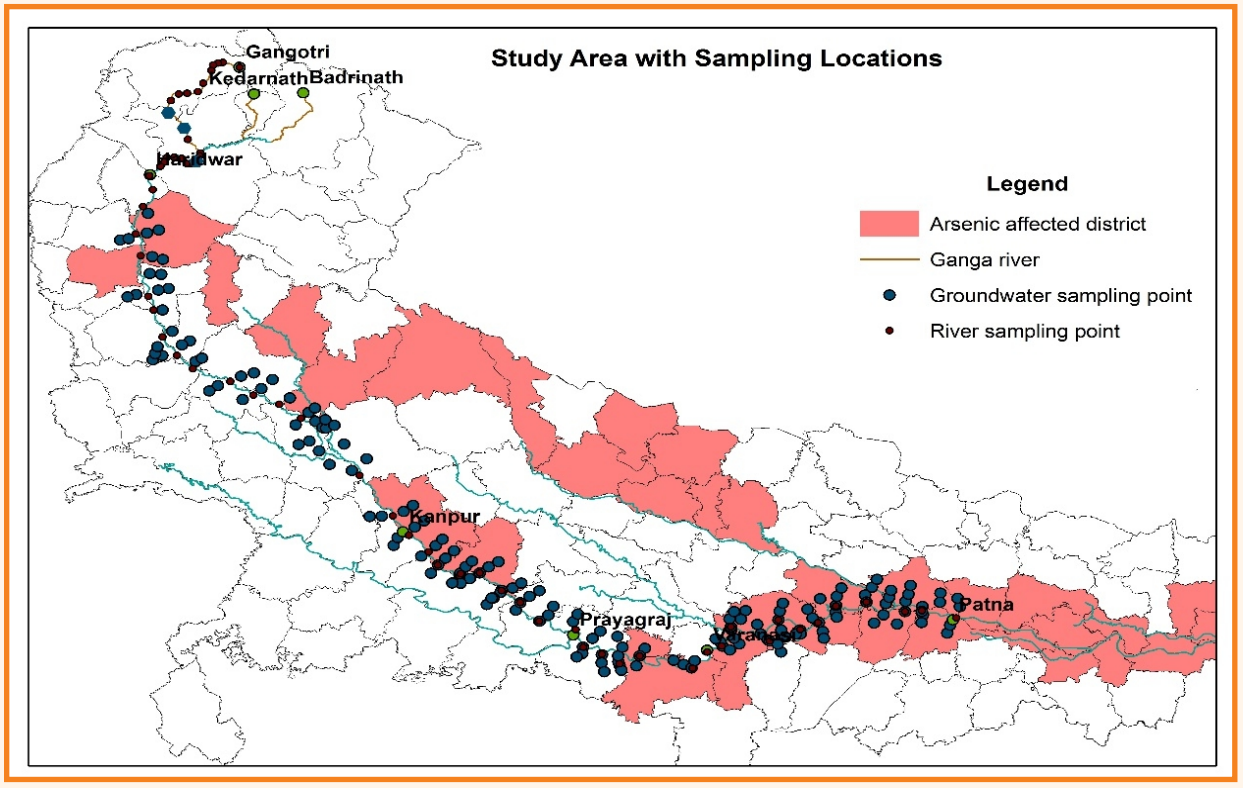


Figure – 6.43: Study area of Ganga basin with GW and River Water Sampling Location

The pH of the water samples varies from 6.8 to 9.3 (mean 8.1) for Ganga River. It was observed that the pH values are increasing as the sampling location descends from the Gangotri up to Devprayag, after that it remains constant around 8 and further down, the pH rises to 9 around Prayagraj and then again comes down to 7-8 after Varanasi. The pH was acidic and sulphate concentration was high at Gangotri and nearby areas, showing sulphide oxidation whereas bi-carbonate concentration was increasing while coming downstream and it may be interpreted that carbonate dissolution is taking place. The EC of the water samples varies from 107 to 604 µs/cm (mean: 218 µs/cm) for Ganga River. It has been observed that the EC values were following a declining trend in Bhagirathi River from Gangotri to Devprayag, thereafter, the EC values follow an increasing trend up to Haridwar and after that it remains in the range of 150 -200 µs/cm up to Kanpur. After Kanpur, EC spikes up very sharply and reaches above 250 µs/cm. The influence of river Yamuna can be observed as the EC values spikes up to 3 folds around Prayagraj and then further gets down to the range of 200-300 µs/cm. The DO values in the River varies between 5.4 to 12.4 mg/L with an average value of 8.2 mg/L. The river water samples were analyzed for trace metals (As, Fe, Mn, Zn, Cu, Cr, Cd, Ni, Pb) and the concentration of Al were found to be higher than permissible limit in bulk of the river water samples. In majority of the river samples As, Cr, Pb, Cd and Cu were below the permissible level except in few instances. The pH of the groundwater samples of study area varies from 6.4 to 7.9 (mean 7.2). Overall, the pH values of the samples are mildly alkaline and the variations in pH are not systematic. The EC of the water samples varies from 160 to 2910 µs/cm (mean: 704 µs/cm) for groundwater along Ganga River. It has been observed that the EC values were following an increasing trend. In majority of the groundwater samples As, Cr, Pb, Cd, Al, Ni, Cu and Mn were below the permissible level except in few instances. However, Fe observed to be higher in most of the samples. Occurrence of As in groundwater samples is rare in upper Ganga region but the frequency of getting higher As is more in groundwater samples after Varanasi. The As concentration in the water samples in the whole study area varies between ND to 393.19 µg/L with and average value of 12 µg/L. In the lower stretch of sampling points along the Ganga River the As occurrence was higher and the average value increases to 25.77 µg/L.

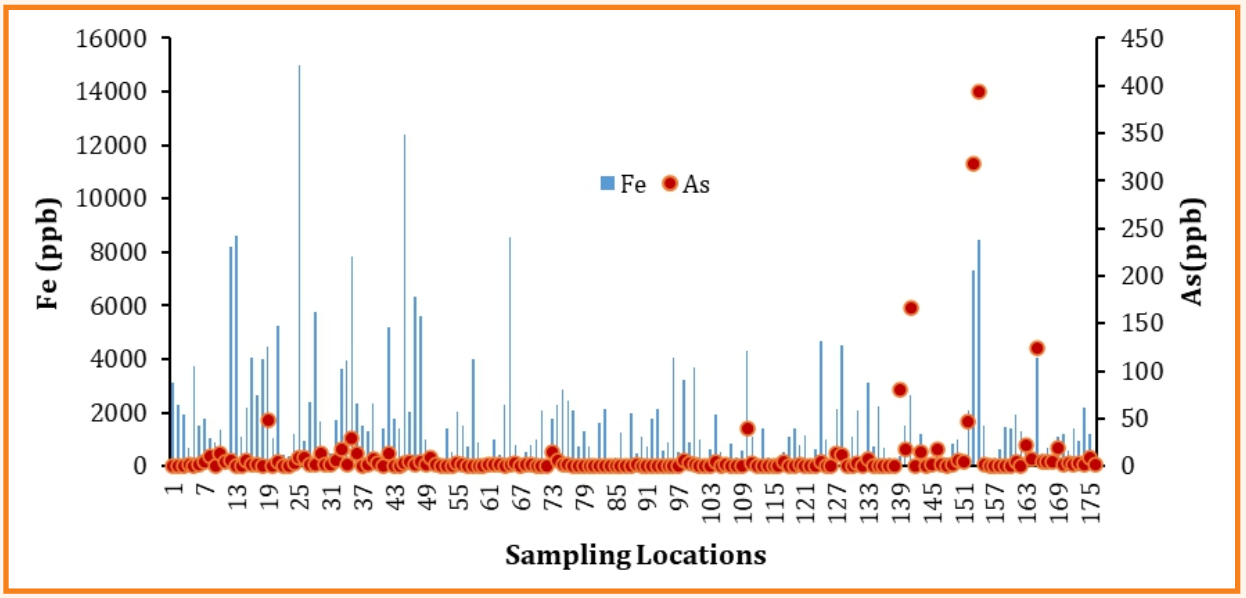


Figure – 6.44: Fe and As Concentration in Groundwater Samples

Conjunctive Management of Water Resources in IGNP Command

Conjunctive management of surface water and groundwater for irrigation is recognized as an effective solution to water logging and root zone salinity. The conjunctive utilization of water resources also ensures consistent water availability for irrigation and support sustainable water management. However, despite these advantages the conjunctive management of water resources is scant in canal commands. The Indira Gandhi Nahar Pariyojana (IGNP) provides irrigation to an area of 1.963 million hectare (CCA) in Rajasthan. The project also provides domestic water supply to most of thar dessert of Rajasthan and is therefore the most important water source in the arid Rajasthan. Since the inception of the project, there has been various issues related to rising water table and increasing soil salinity. The present scenario of groundwater and mapping of water-logged area is essential in the IGNP command for effective management of land and water resources. Such analysis would help in quantifying the current potential of groundwater in conjunction with canal water to maximize the irrigation potential in command and to contain salt mobilization in root zone. The objectives of the present study are : Analysis of present groundwater scenario in enroute command of IGNP, ii) Mapping of water-logged area in IGNP command using remote sensing, iii) Estimation of GW recharge from rainfall, canal and irrigation under present and future climatic scenarios, and, iv) Conjunctive management of water resources in enroute command area of IGNP canal.

The status of groundwater in the IGNP command was analyzed utilizing groundwater observations of CGWB. It is seen that the groundwater was deepest during 1994 which ranged between 20 to 50 m below ground level (bgl). During the years 2005-10, the groundwater was observed to be the shallowest which varied between 2 to 50 m bgl. During the recent years, groundwater declined again and varies in the range 10 to 35 m bgl. It is also observed that most of the wells show rising groundwater level (Blue color in the following figure indicate decreasing depth to groundwater level). Trend analysis revealed that 58% of the wells show rising groundwater, while the 16% wells show falling groundwater. Around 26% wells have no significant trend.

To monitor real-time area under water logging, a Google Earth Engine (GEE) application is developed which can be accessed through the web. The application estimates water occurrence for the specified period and also displays depth to groundwater in the IGNP command.

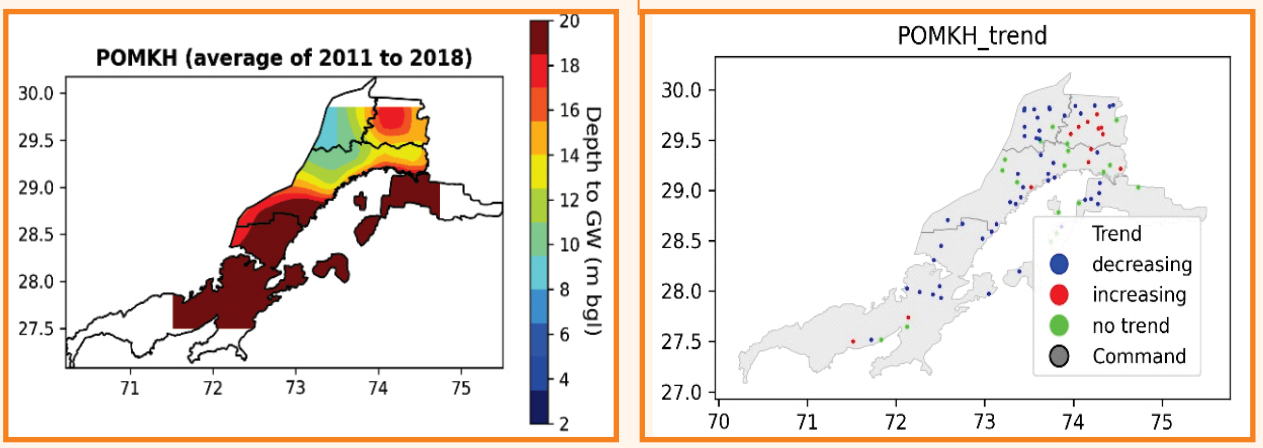


Figure – 6.45: Depth to GW during Post-monsoon season and trends in GW depth

Development of Archive of Soil Hydraulic Characteristics

Soil hydraulic properties viz. soil texture, hydraulic conductivity and soil moisture retention curve, etc. are important inputs to various hydrologic analysis and modelling and are rarely available. Soil Water (SW) Laboratory of NIH has been conducting such investigations in various parts of India under various R&D studies funded by NIH and external agencies. NIH Scientist and Staff of SW Lab make considerable efforts to collect soil samples from the field and conduct various investigations in the lab to derive soil hydraulic properties. Numerus soil samples have been tested since 2011 which provide abundant data for various hydrologic analysis. The analysis includes soil texture identification with measurement of sand, clay and silt fractions, analysis on pressure plate apparatus to derive soil moisture at different suction pressures for soil moisture characteristic curve, analysis of soil organic contents, estimation of soil hydraulic conductivity, etc. It is envisaged that such soil test results conducted in past historical period (with a buffer gap of 4 years for reporting/publication by the project team), if published through a GIS-portal on NIH website, could help researchers and planners in their analysis towards better water management. In this context, it is planned to develop an Archive of Soil Hydraulic Characteristics to store the soil-test results in digital format and disseminate them through a GIS portal. The objectives of the study are: i) Development of archive of soil hydraulic characteristics. The results of soil analyses performed during the past years (2011-2022) will be digitized in a standardized format to append in the archive, ii) Development of an automated system to store the results of soil hydraulic analysis to be performed in future in the archive and publish them on the portal, iii) Development of a web-based GIS-dashboard to publish the soil hydraulic characteristics.

The historic data are converted to digital format in order to process, store in the archive and publish on the portal. A standardized format for each soil hydraulic characteristic is decided and the same is followed while converting the data from hard copies to digital sheets. An automated system is being developed for processing and storing the results of soil analysis to be performed in the future. This will enable automated data insertion to the archive and allow automated publishing after the analysis completes the assigned lock-in period (say four years). A framework has been developed in Python-Django for automated system.

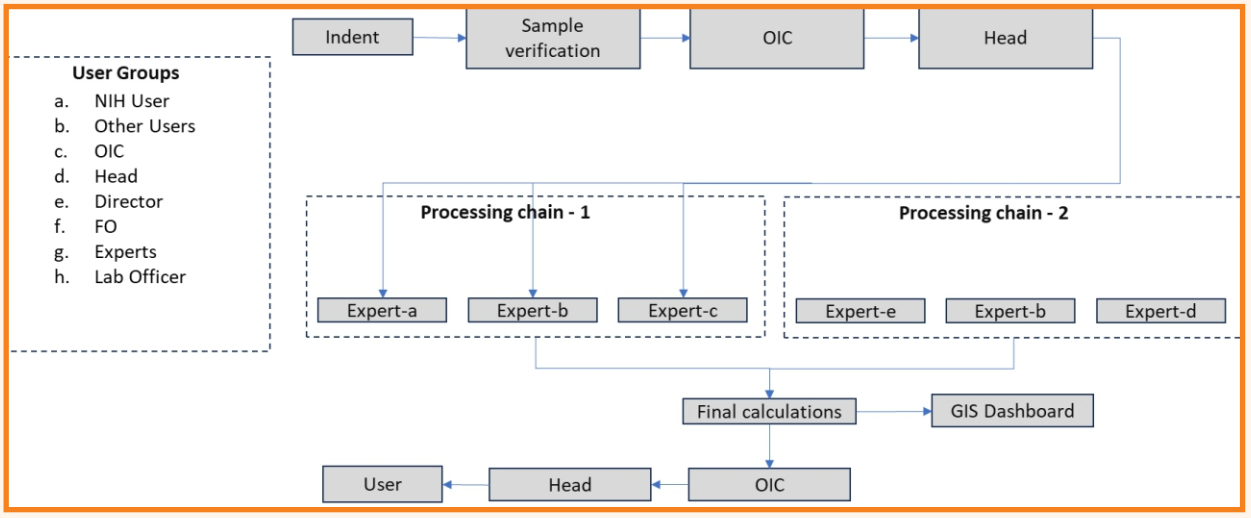


Figure – 6.46: Schematic of the Workflow of the Automated System

Enhancement and Application of NIH_WISDOM

The excessive groundwater withdrawal led by growing water demands has resulted in rapid and widespread groundwater declines in many parts of India. To manage water resources in a sustainable manner, comprehensive understanding of groundwater system is essential. Of particular importance are the understanding of recharge processes, quantification of recharge from various sources, such as rainfall and surface water bodies, assessment of the impacts of groundwater withdrawal, and understanding the exchange of fluxes between surface and subsurface hydrological systems. Web-based integrated catchment modelling System for Decision Making (WISDOM) is developed recently at NIH. For integrated hydrologic modelling a model, named "GEE-MODFLOW" is developed as a part of WISDOM for groundwater recharge estimation. Estimation of recharge requires simulation of both the surface and subsurface hydrological processes. The water that reaches to groundwater table, so called recharge, is an end result of various processes happening at surface/subsurface which are driven by various influxes, such as infiltration and irrigation, and outfluxes, such as root water uptake and soil evaporation. Therefore, in order to mimic all such processes, an integrated model is needed. The integrated GEE-MODFLOW model consists of various modules which simulate surface and sub-surface processes in unsaturated and saturated zones. The model has three simulation modules, namely Root Zone Flow (RZF), Unsaturated Zone Flow (UZF), and Groundwater Flow (GWF). During the development, the GEE-MODFLOW was tested in the Hindon river basin for groundwater recharge estimation. However, to ensure its applicability in other areas, a detailed testing and validation is required. Therefore, it is planned to test the GEE-MODFLOW model in other basins.

The current version of WISDOM has mainly two models, the RZF (developed at NIH) and MODFLOW (developed by USGS) which was developed to estimate groundwater recharge, although it estimates all other hydrological components, such as runoff, ET, soil moisture and streamflow. WISDOM have several advantages, such as easy-to-use and free access through web-browser. To extent its capability to model surface hydrology using state-of-the-art models, such Variable Infiltration Capacity (VIC) model, and integration of a surface hydrologic model with MODFLOW is proposed. Further, inclusion of tools, like map creator, trend analysis, etc., would further enhance the utility of NIH_WISDOM. The objectives of the study are i) Integration of surface hydrologic model in NIH_WISDOM, ii) Development of tools for hydrologic analysis such as, map creator, trend analysis, etc., and iii) Testing of developed models by comparing simulated groundwater recharge with CGWB's assessments in an alluvium aquifer, iv) Application of NIH_WISDOM in a hard-rock area by developing equivalent porous media model. Two basins/inter-basins, Gangatic plain and Upper Narmada basin, have been identified for testing the model. The VIC model is being integrated with the MODFLOW model for integrated modelling. An interface for the integrated VIC-MODFLOW model is being developed and will be included in the NIH_WISDOM. The tools, such as map creator and trend analysis, will also be integrated in WISDOM using Python programs.

Comprehensive Assessment of Hydrology of Large Rivers basins of Western Ghats of Karnataka

The Western Ghats runs for over 300 km from Kerala border to Goa border in the state of Karnataka. The area receives more than 80-90% of its rainfall during South-West monsoon season with the annual average rainfall of 4000 mm. There are more than 15 major and medium rivers which originate in the Western Ghats and some of them drain into Arabian Sea and many of them flows towards east coast. The River basin considered for study are Netravathi (1095 km^2), Malaprabha (540 km^2), Seetanadi (343 km^2), Bhadra (809 km^2), Disginala (502 km^2), Tattihalla (1062 km^2) and Aghanashini (1006 km^2). The objectives of the study are: (i) assessing the effects of LULC changes on water resources and (ii) assessing spatio-temporal distribution of the water

availability. The streamflow data upto 2013 have been collected for Aghanashini River whereas, data for other rivers will be collected from WRDO Banaglore. The LULC changes in Aghanashini basin have been analyzed for the years 2017 and 2022. The rainfall analysis has been completed for entire Western Ghats and further analysis is under progress.

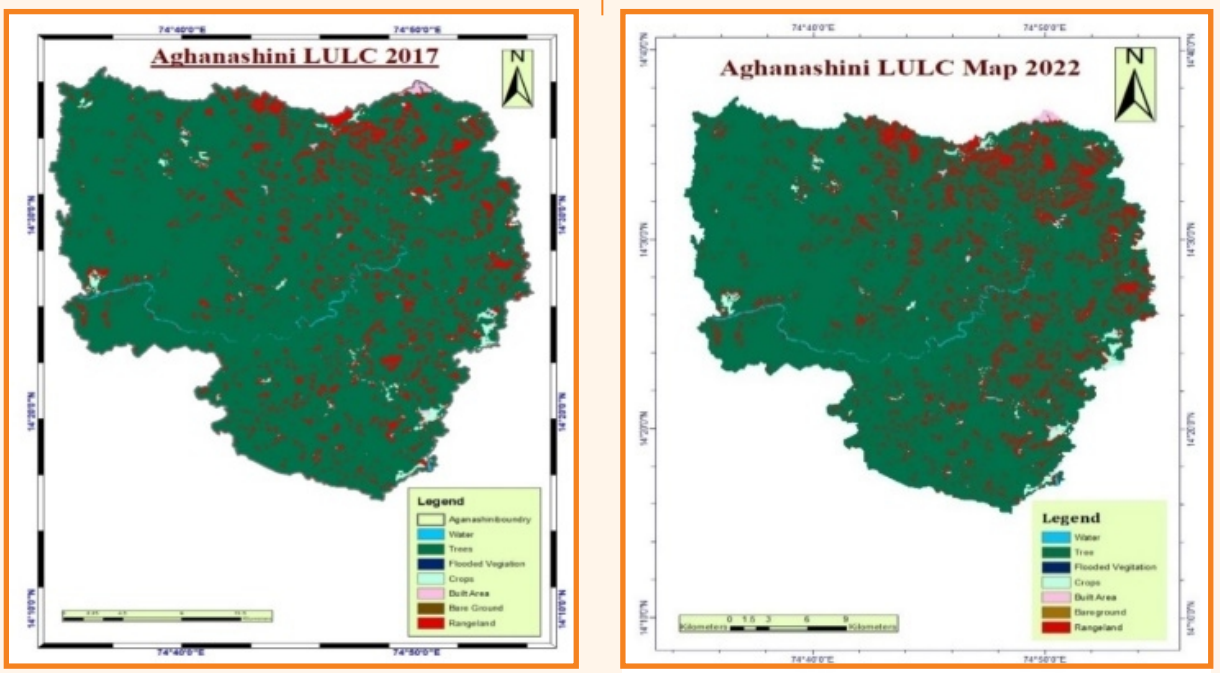


Figure – 6.47: LULC Changes in Aghanashini Basin

Studies on Occurrence, Distribution of Springs in Parts of Western Ghats, India

Springs are the primary source of water for fulfilling requirements related to drinking, household activities and irrigation in many households in the remote parts of Western Ghats. The profound dependence of hill communities on springs makes their conservation and rejuvenation a basic facet of water security. In addition, springs have always served as an integral part of the hill ecosystem. Factors like deforestation, erratic precipitation trends, marked decline in winter rains, changes in LULC and forest fires have severely affected the existence of springs. Springs have not received due attention and are today facing an existential threat in many parts of the Western ghats. It is therefore imperative that all the stake holders come together to develop new methods and planning tools to identify spring sheds using a trans disciplinary approach. Some of the basic components of spring shed management include springs inventory, data monitoring, hydrogeological assessments and recharge interventions and community participation for conserving the springs. This research will therefore prove to be a handy tool for future initiatives in springshed management. Further, this study will be of immense help for water managers, consumers, institutions and organization addressing the water crisis. It is proposed to evaluate the occurrences and distribution of springs based on physiography, geomorphology, topography, climate parameters such as rainfall, LULC in parts of Western Ghats in Karnataka. The objectives of the study are to (i) develop inventory of springs in Western Ghats (Karnataka Region), (ii) assess the status of springs, (iii) assess the water quality of springs, (iv) prepare springs information system. Springs inventory of Goa and parts of Karnataka is completed based on topo maps, secondary data received from state departments, NGOs, GSI and other sources.

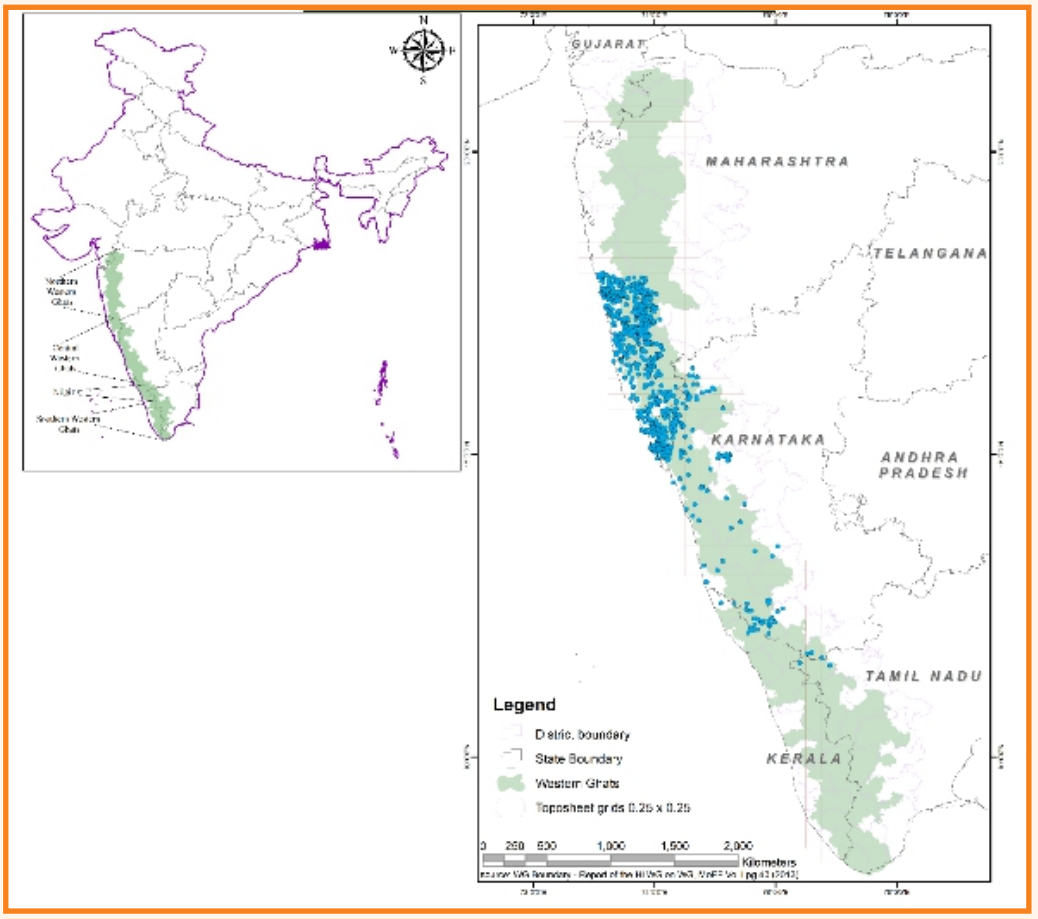


Figure – 6.48: Study Area of western ghat

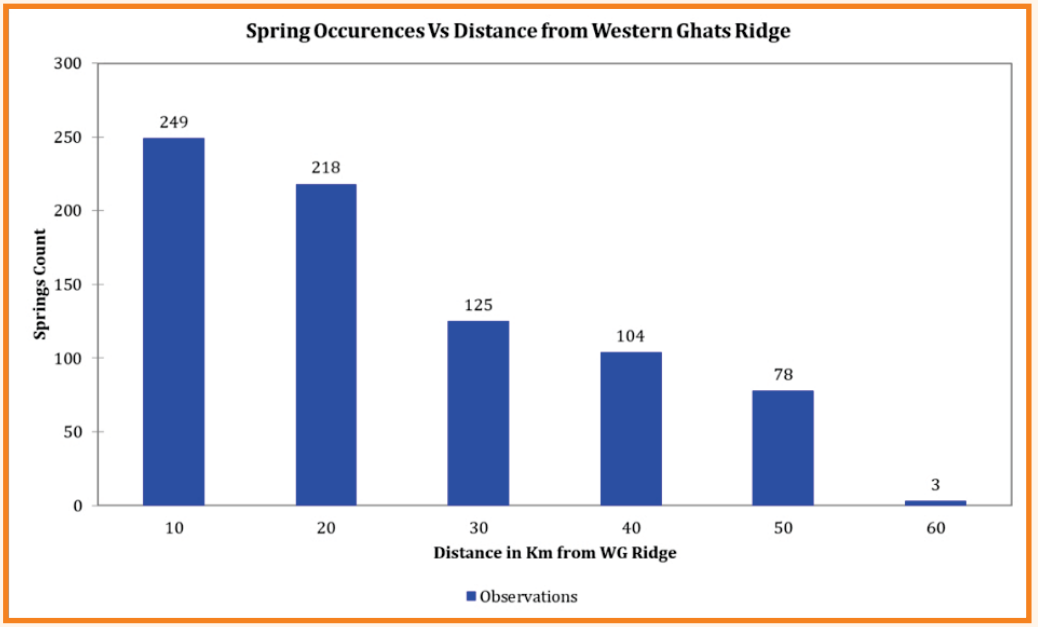


Figure – 6.49: Distribution of Springs from Western Ghats Ridge

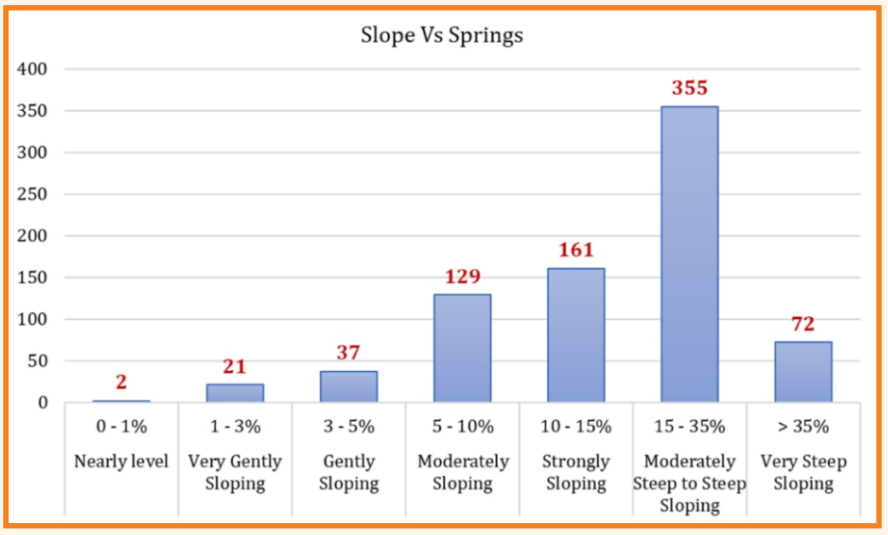


Figure – 6.50: Distribution of Springs along Different Slopes of Western Ghats

Water Productivity Assessment in Irrigation Projects by Geo-Spatial Optimization Techniques

In India, a comprehensive action plan is framed by NITI Aayog to implement four goals set under the Pradhan Mantri Krishi Sinchai Yojana (PMKSY). One of the goal "Per Drop More Crop" aims clearly at improving water-use efficiency using suitable water conveyance and promoting precision water application strategies to produce more output per unit of water. Under Jal Sanrakshan's (water conservation) task, the scheme promotes adoption of a suitable cropping pattern to obtain maximum benefits with the use of available water. The study area proposed is the Narayanapura Left Bank Canal Modernization Project which was recently inaugurated by Hon'ble Prime Minister of India on 19th January, 2023. To improve water use efficiency and canal water management, supervisory control and data acquisition (SCADA) canal automation and modernization under the AIBP scheme of PMKSY are implemented along with canal lining works. The automation system comprises SCADA-based real-time gate operations from dam to canal delivery outlets supported by a robust communication system and GIS based Irrigation Network Management Information System (INMIS).

The research is proposed to cover the gap of spatial optimization techniques in resolving command area management issues. The study envisages to identify the water stressed regions in the command by the use of geospatial techniques and assess the water use efficiency of the command and enhance the decision support system. The objectives of the study are to (i) assess water productivity in the command by use of various optimization techniques, (ii) identify water stressed regions in the command, (iii) provide optimized irrigation scheduling and (iv) study the impact of modernization on water productivity. The rainfall and weather data (1960 – 2023) is collected from state department and trend analysis of rainfall is completed. Mapping of canal network is also completed. Land parcels mapping for integrating farmers information has been done. Field visits are completed and sampling locations are finalized for continuous monitoring during cropping season.

Runoff and Water Storage Capacity Estimation for Deciding Rainwater Harvesting Strategies

The quantification and volumetric assessment of runoff is more important for accurately estimating the storage capacity of the rainwater harvesting structures (RWHs) in the catchment. Various sources of topographic data of different resolution may have varying order of uncertainty. This may lead to errors in the runoff estimation and subsequently in storage capacity estimation of RWHs in the catchments. Therefore, the aim of this study is to understand the complexity of the different

resolutions data on the estimation of surface runoff and storage capacity of RWHs. The study outcome may be useful for policy makers, engineers and management authorities for deciding effective RWHstrategies in the catchments. A catchment from hilly terrain of the Tehri Garhwal district in Uttarakhand has been selected for the study where RWH is already available Primary and secondary data from different sources have been collected and literature review has been completed. The topographic data of different resolutions have been downloaded for the study location from different sources (i.e., SRTM 90 m, ASTER DEM 30 m and ALOSPALSAR 12.5 m). The catchment area has been delineated and GIS database for the study area has been prepared. The surface runoff (peak rate and total volume) will be estimated by using Rational method and SCS Curve Number method. The water storage capacity of the RWHs will be estimated by using different resolutions of topographic data and hydrological modelling tool, while other datasets will be kept the same. The Intensity-Duration-Frequency (IDF) curves for different return periods of rainfall and flow duration curves for sustainability analysis of the streamflow will be developed for safe design of RWHs. Suitable recommendations regarding appropriate resolution of topographic data from different sources will be made for making RWH strategies to get optimal benefits at minimal cost in the catchment. The detailed analysis is in

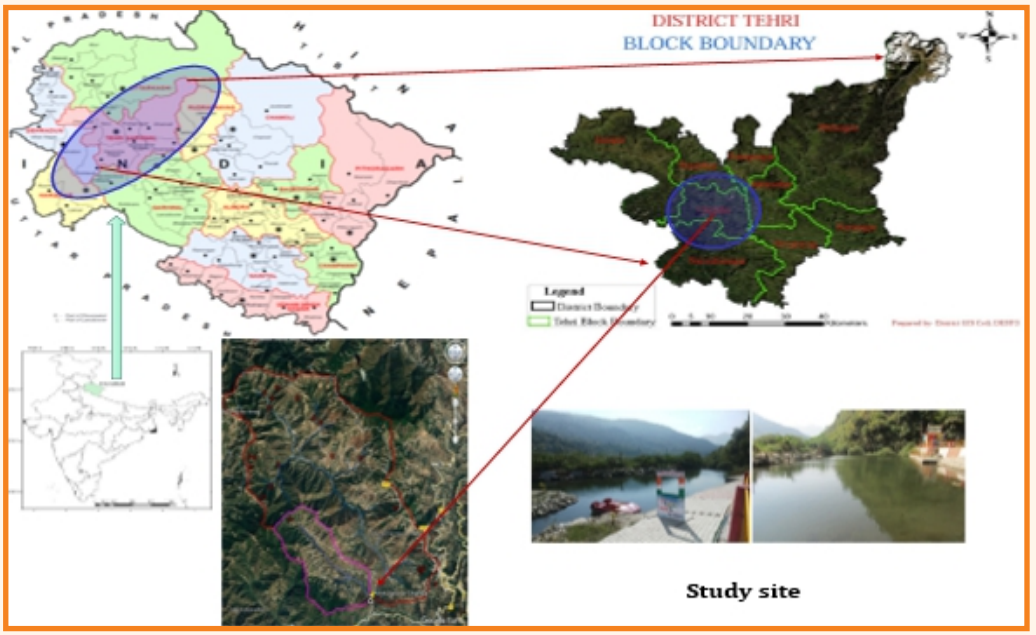


Figure – 6.51: Location Map of the Study Area of Tehri Garhwal

Sedimentation and Water Quality Study of Fulhar Lake, Pilibhit (U.P.)

The discharge in Gomati River has reduced significantly in recent years due to reduced outflow from Fulhar Lake. The Fulhar Lake is located 3 km east of the Pilibhit Town in U.P. at an elevation of 185m amsl. Around 26 different types of Tortoise species are present in the Lake. The state administration is developing a Tortoise Conservation and Research Centre near the Lake. Hence, the Uttar Pradesh State Govt. is interested in water quality study of the lake. The local administration has approached NIH for conducting the sedimentation and water quality study of the lake. Therefore, the present study was undertaken with the objectives to i) determine the bathymetry of the Lake; ii) estimate sedimentation rate in the Lake and iii) assess the environmental health of the Lake through assessment of its water quality. The study will be useful in conserving the Fulhar Lake, which is an important religious place of Pilibhit in U.P. Preliminary survey was conducted in April 2023 and sampling locations were identified. Two field visits were undertaken to collect pre and post monsoon

samples during May & October 2023, respectively. Groundwater levels were measured and groundwater samples were collected for stable isotope analysis ($\delta^{18}O$ and $\delta^{2}H$). Also, in-situ measurement of water quality parameters (e.g., Temp, EC, pH) was performed using multi-parameter water quality kit. In addition, various thematic GIS Maps have been prepared for the study area which includes Digital Elevation Model, Land Use\Land Cover, Drainage and Slope, etc. In future, Bathymetry survey of the lake and further sampling will be carried out. Isotopic data indicates that the isotopic values of both the river and ground water (Hand Pump and Bore Wells) lie on IMWL. The Lake and Pond water samples show the evaporation effect. From the preliminary investigations carried out so far, the recharge source of ground water in the study area is observed to be the local precipitation. Further, all the surface water bodies including the Fulhar Lake is mainly recharged by the groundwater in the study area. The detailed analysis is in progress.



Figure – 6.52: Location Map of the Study Area



Figure – 6.53: Field Sampling

Short Term Flood Forecasting using Bootstrap based Artificial Neural Networks within Beki River Basin, Assam

River flow forecasting deals with the estimation of future stages or flows at a single or multiple sites of a river system. Daily river flow forecasts are essential for water resources planning and management whereas hourly water level forecasts are essential for issuing flood warning to mitigate natural disaster. The purpose of the study was to demonstrate that

Neural Networks can be successfully applied to flood forecasting. The study area is Beki River Basin. The Beki (Manas) river originates in Tibet, runs through Bhutan and has wide floodplains in Assam's Barpeta district. Area of the total basin is 32,725.92 km^2. Objectives of the study are to explore the potential of flood forecasting using ANN in Beki Basin and to quantify the uncertainty in flood forecasts using bootstrap technique.

Neuropath software was used to develop ANN for Beki Basin. Neuraopath software uses bootstrap bagging (bootstrap aggregating) predictors. Performance of the neural networks was evaluated by coefficient of determination (R^2). The uncertainty in neural networks was quantified by bootstrap estimates using Root Mean Square Error (RMSE) and Mean Absolute Error (MAE). The BANN models were developed following a hierarchical approach. BANN model 1 corresponded to only rainfall as inputs. BANN model 2 was developed with daily rainfall and rainfall lagged by one day as input. Similarly, BANN model 3 was developed with inputs of daily rainfall, rainfall lagged by one day and by two days. The process was repeated until the performance of BANN model was found to increase. The performance of BANN models was assessed by using statistical performance indicators. These results show the applicability of BANN models in forecasting floods when limited data is available. Increasing the number of inputs in the BANN model does not necessarily signify increase in the performance. Best performance was observed for BANN2.

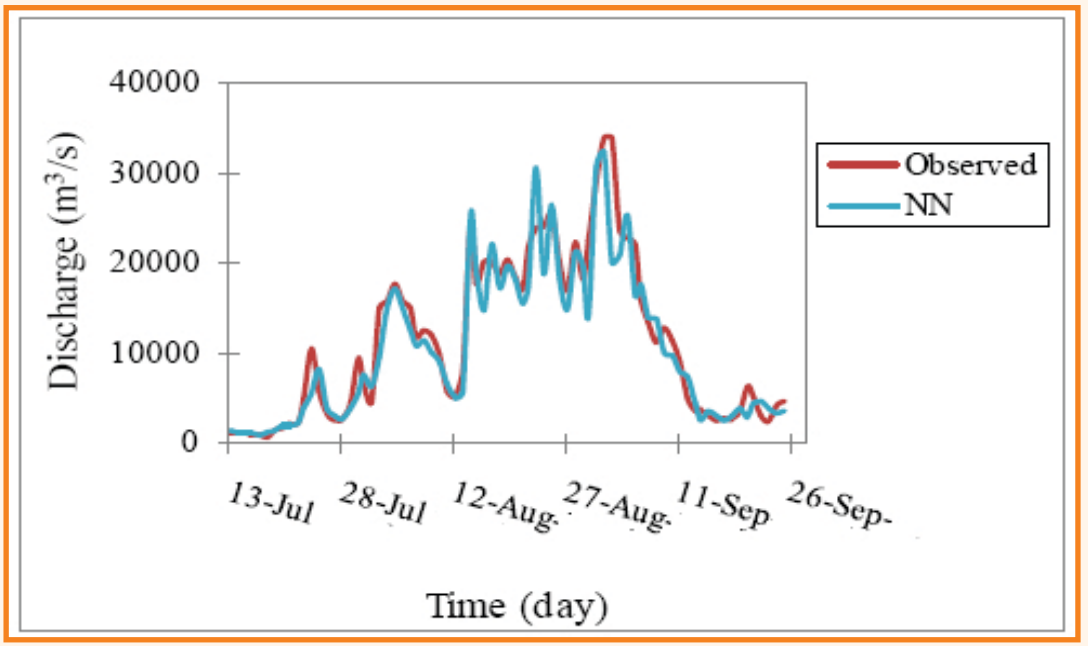


Figure – 6.54: Performance of BANN Model 1

Rainfall Induced Flood Hazard Risk Vulnerability Assessment in East Jaintia Hills, Meghalaya

The study area, East Jaintia Hills District is one of the 11 districts of the state of Meghalaya. It covers an area of 2040 km^2. It stands at an average altitude of 1200 m amsl. Development of intensity duration thresholds is under progress. Rainfall intensity duration thresholds will be matched with the flood inventories prepared. Analysis of Satellite precipitation products would be carried out for the monsoon season of 2018 to 2022. NASA's GPM – IMERG V06 and JAXA's GSMaP V06 based half hourly & hourly gridded rainfall rates with 0.1° x 0.1° spatial resolution will be analyzed for the assessment of precipitation and identification of rainfall intensity duration thresholds that trigger floods in vulnerable zones. Terrain properties will be used for flood propagation weights. LULC and

geomorphology maps will be prepared. Soil map will be collected from NBSS-LUP. The lithology map would be derived from GSI's District resources map. Further analysis is in progress.

Linear Hydrological Routing using Satellite Precipitation Datasets for Flood Forecasting in Parts of Brahmaputra Basin

The North Eastern Region (NER) of India experiences heavy rainfall and is prone to annual flooding in Brahmaputra and its tributaries. Due to vast extent of the NER, field-based demarcation of the flood vulnerable areas is tedious task. Thus, hydrological modelling shall be used as tool along with routing techniques to identify flood prone areas. The primary input for the modelling is DEM and precipitation data along with supplementary data such as LULC and soil characteristics. The precipitation data apart from station data is available from satellite derived rainfall in gridded format. As multiple sources of data are available, a suitable dataset need to be identified in terms of accuracy and reported bias, which forms the first objective of the study. The bias correction of the suitable dataset shall be undertaken to represent the actual rainfall in the catchment so as to accurately identify inundated areas in case of floods, which is the second objective. The development of IDF curves and flood frequency analysis shall be undertaken to correlate the flood scenario and precipitation rate. The hydrological modeling along with routing techniques then shall be employed to identify the extent and frequency of flooding in specific vulnerable areas, which is the third objective. The HEC-HMS and HEC-RAS models shall be used to undertake this task. The outcome will be the identification of flood prone zones and relation between flooding and excess precipitation. Further, this technique can be coupled with future meteorological data to undertake flood forecasting. The study is in progress.

Drought Characterization and Vulnerability Assessment in Assam

Assam is generally a flood prone state but due to declination of south-west monsoon in the region and over-exploitation of water resources results in reduction in availability of water. Assam has been observed to be affected by drought in the recent years. So, a study is carried out to observe and characterize the drought condition of Assam with the help of Standardized Precipitation Index (SPI). The objectives of this study are to (i) characterize historical drought occurrences for all the districts of Assam, (ii) project future drought occurrences at district level using projected precipitation, and (iii) generate drought vulnerability map of Assam at district level. A district wise (33 districts) characterization of drought is performed to understand the past drought condition of Assam from 1951 to 2020 with the observations of IMD. A focus is on predicting the future probability and condition of drought from 2026 to 2055 through the projected data generated by GCMs i.e. CMIP 6 models. Four future climate change scenarios (SSPs) are considered for assessment of drought. Major findings of the study are: (i) rainfall is projected to be decreased during 2026-2055 in majority of the districts in all four SSP scenarios, (ii) from1951 to 2020, on an average, 122 of the 838 months were fall under the drought, (iii) the average percentage of drought occurrences is about 15% of the total time, which is almost very similar to the share of wet conditions, (iv) between 2026 and 2055, the average percentage of drought under SSP126, SSP245, SSP370, and SSP585 were projected as approximately 16%, 17%, 18%, and 17%, respectively, (v) certain districts such as Tinsukia, Dibrugarh, Majuli, Nagaon, Morigaon, Hojai, Dima Hasao, Cachar, Hailakandi, and Karimganj would experience frequent drought under all climate scenarios, and (vi) out of the 33 districts, 10 districts were found to be extremely vulnerable to meteorological drought while 7, 8, and 8 districts were found to be in the category of highly, moderately and least vulnerable.

Hydrodynamic Modeling for Riverbank Protection-A Case Study

According to the officials from the WRD, Government of Assam, the Bagaribari area along the Puthimari River in the Tamulpur Division is particularly susceptible to frequent erosion. The project aims to analyze the processes of bank erosion in the designated area and assess the effectiveness of

various preventive measures in safeguarding the banks against erosion. Simulation of bank erosion requires a numerical model capable of coupling the in-channel vertical erosion process with the lateral bank erosion process. The Puthimari river has got the concern of many researchers due to its highly erosive nature on both banks. The adverse consequence of streambank erosion led to stream channel instability which produce higher sediment yields. Therefore, the study has been taken up with three objectives: (i) To study the bank erosion/deposition and bankline migration status of the Puthimari river and to estimate the rate of riverbank erosion during last three decades, (ii) To develop a process-based coupled model integrating HEC-RAS sediment transport capabilities and Bank Stability and Toe Erosion Model (BSTEM) model for prediction of streambank retreat, and (iii) To suggest mitigation measures for sustainable bank stability. Mitigation measures proposed in the study will be discussed with WRD for its feasibility of implementation in the field.

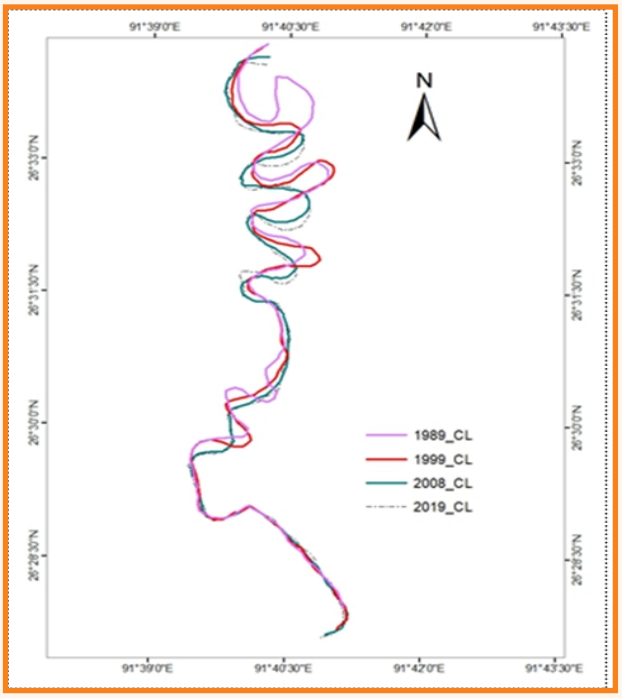


Figure – 6.55: Superimposed Banks of Puthimari near Bogaribari Area from 1989 to 2019

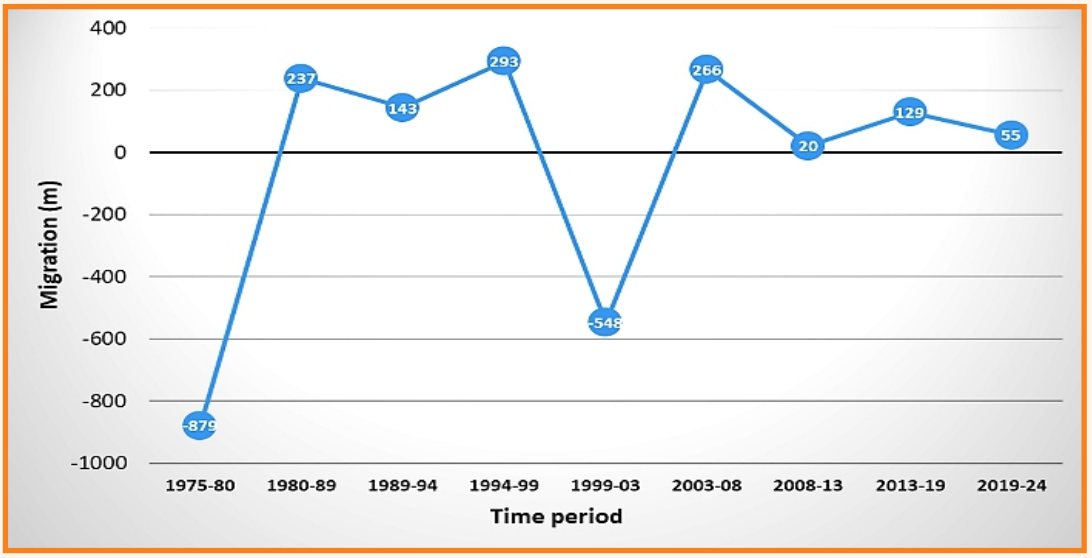


Figure – 6.56: Migration of River Puthimari near Bagaribari Area from 1989 to 2019

Assessment of the Water Level Rise Crisis in Jodhpur, Rajasthan: A Comprehensive Follow-up Study with Challenges and Remedial Approaches

This study is being conducted in Jodhpur, an arid city that is experiencing rising groundwater levels from the last two decades. The study is planned with objectives to identify the factors and sources contributing to this issue and assess its impacts on the environment, infrastructure, and society. The study will also explore potential mitigation strategies for the water level rise issue. Currently data collection is in progress where groundwater levels, groundwater extraction, soil data and open-

source rainfall have been collected from different agencies like CGWB, IMD, NBSS etc. and additional relevant data needed is to be procured. The development of thematic maps contour maps, land use/ land cover, soil map, and DEM have been done. The collected open source rainfall and GWL data have been used to analyze rainfall and groundwater trends and preparation of groundwater contour maps. A water balance study will be conducted once all the required data is obtained. Potential mitigation strategies will be explored using groundwater modeling to address the rising water table issue. The study will provide recommendations for sustainable water management in Jodhpur, including determining sustainable pumpage rates and suggesting the use of pumped water for nearby water-deficit regions.



Figure – 6.57: Ground Water Level Monitoring in Jodhpur City



Figure – 6.58: Water Quality Sample Collection in Jodhpur City

Identification of Different Crops at Farm Scale using Remote Sensing Data in IGNP Canal Command Area

This study aims to identify different crops sown in the IGNP canal command area using freely available satellite data and conduct water budgeting based on crop types. The Danntor distributary of the IGNP canal has been selected for the pilot study. A field survey was conducted in February 2024 in its command area and crop location samples were collected using GPS-enabled mobile devices. Discharge data from Danntor distributary has been obtained from the IGNP office, Bikaner. In the study, Sentinel-2 satellite data (spatial resolution of 10 m), is being utilized and time series analysis would be performed to identify the crops. After the identification of different crops, water budgeting plan will be prepared for optimal water utilization of the study area.



Figure – 6.59: On Field (IGNP Command) Wheat Crop Data Collection



Figure – 6.60: On Field (IGNP Command) Mustard Crop Data Collection

Hydrological Monitoring in Jojari River Basin

This study has been planned with specific objective to establish a gauging station at a suitable site in the Jojari River basin to monitor water levels, flow rates, groundwater levels, and other relevant hydrological and water quality parameters as currently it is ungauged. This will help to develop an understanding of hydrological processes occurring in the vicinity of the Jojari River. For this, a preliminary field survey along the Jojari River has been completed and suitable upstream/downstream locations have been identified to establish gauging sites at Jojari River. Water quality sampling has been initiated for monitoring river water quality. Also, the stilling well design has been finalized for gauging sites.



Figure – 6.61: Jojari River Cross-Section Measurement



Figure – 6.62: Jojari River Water Sample Collection

Investigation of Hydrodynamic Approach of Flood Inundation Mapping along with Assessment of Changes in River Planforms using a Cloud-Based Google Earth Engine (GEE) Computing Platform in Data-Scares Western Himalayan River Basin

There is a very high societal demand to cope with flood hazards and incurred damages. Usually, in conditions of scarce data availability, a preliminary and cost-effective floodplain delineation can be carried out using procedures that rely on the analysis of geomorphic features. As observed changes in geomorphic dynamics in rivers are strongly timescale-dependent, limiting a geomorphic study to a single timescale can cause biased observations in channel dynamics. With long-term measurements leading to underestimations of the total change occurring over shorter timescales. Based on the these issues the study objectives are to (a) use a cloud-based GEE computing platform to systematically identify inter-annual changes in river planform morphology, (b) interpret changes in channel conveyance that are relevant for flood risk assessment, (c) evaluate predictive capabilities of Rainfall-Runoff-Inundation (RRI) model in development of flood inundation map and, (d) carry out a comparison of the RRI model-based flood inundation maps with those obtained by using HEC-RAS and HEC-HMS models. The changes to river planform and geomorphic dynamics have caused, and continue to cause ecological, hydrological and environmental impacts. The changes in the Tawi planform from 1988 to 2022 based on the composite Landsat data is shown below.

The significant changes in the planform of the Tawi river have been observed in the lower reaches downstream of the Sidhara gauging site as shown in subsequent figure. Further, the required hydro-meteorological, river cross-section, gauge/discharge, rating curve data and satellite images and thematic maps have been collected. Using these annual active channel masks, various effective techniques were developed in the MATLAB environment to map and

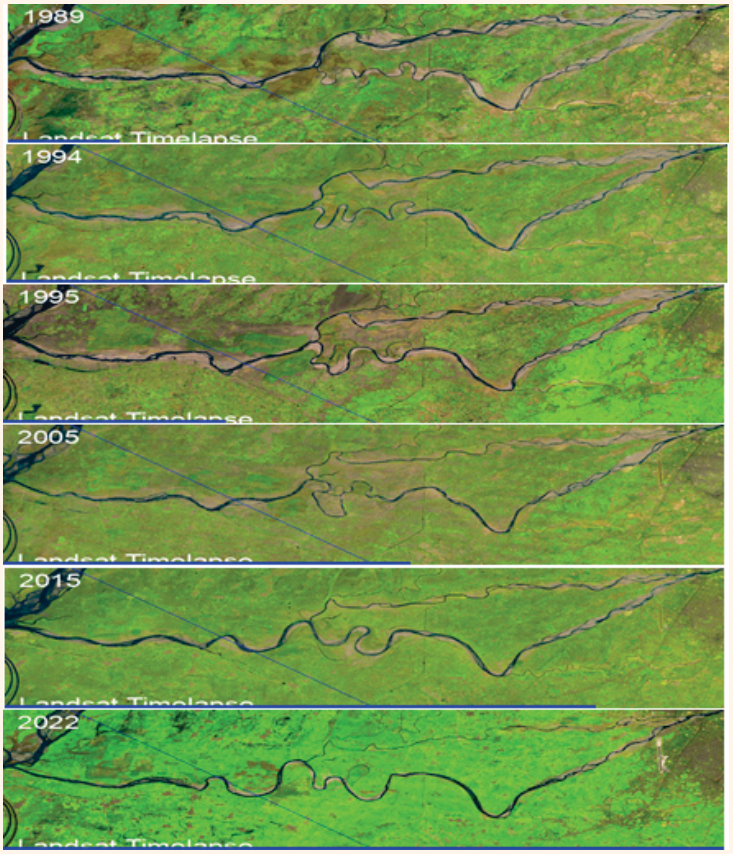


Figure – 6.63: Observed Changes in the Lower Tawi River Planform during 1988 to 2022

measure changes in channel widths, the locations and rates of migration, accretion, and erosion, as well as the space-time characteristics of cutoff dynamics have been analyzed for the Tawi River. The meandering dynamics and morphological transformations in the Tawi River during 1988–2021 is shown below.



Figure – 6.64: Meandering Dynamics and Morphological Transformations in the Tawi River (1988–2021)

During the study period two significant cutoff events were observed in the river channel. The first cutoff event occurred between 2001 and 2005, leading to the formation of an area approximately 2.7 km^2. The second event took place between 2015 and 2020, resulting in an area encompassing approximately 1.2 km^2. In 1988, the erosion rate was remarkably high at 3,554 m/year, indicating significant channel incision. In 2012, the accretion rate reached 4,100 m/year, indicating a notable period of sediment deposition. These findings provide essential insights into the Tawi River's behavior, emphasizing the need for adaptive management strategies to ensure the long-term sustainability of this crucial fluvial system and its surrounding environment. The setup of 2D rainfall runoff inundation model is almost completed. The required input parameter files and GIS layers were prepared. Presently, the calibration of model parameters is under-progress.

Estimation of Confidence Intervals of Index Flow Duration Curves

A flow duration curve (FDC) illustrates the relationship between magnitude and frequency of daily, weekly, monthly streamflow, providing an estimate of the percentage of time a given streamflow was equaled or exceeded. FDC provides a graphical view of overall historical variability associated with stream flow in a river and thus useful in hydropower planning, water quality management, flood control, river and reservoir sedimentation, etc. An FDC is the complement of the cumulative distribution function (cdf) of daily streamflow and their interpretation depends on the particular period of records on which they are based. However, if one considers N individual FDCs, each corresponding to one of the individual N years of record, then one may treat those N annual FDCs in the same way as one treats a series of annual maximum and annual minimum stream flows. This annual based interpretation enables confidence intervals and recurrence intervals to be associated with FDCs in a nonparametric framework. A nonparametric framework based on annual flow duration curve (AFDC) and index flow duration curve is being used for estimation of the confidence intervals (CIs) of AFDCs. To estimate index FDC and CIs, the FDC are developed on an annual basis by considering *N* annual FDCs, each corresponding to one of the *N* years of the data. Daily discharge (and water level) data for several gauging sites in the lower Godavari basin been collected from field organizations and related reports published by CWC. The discharge data for each gauging site have been analyzed as per the described methodology for developing AFDC and index FDC. The computation of the CI for the developed AFDCs is in progress.

Review of Design Flood and Dam Break Analysis of Khadakhai Dam in Odisha

The Khadakhai dam (Suleipat reservoir) is an earthen dam of 365.4 m length build across Khadakhai river in 1981, mainly for irrigation purpose. The maximum height of dam above foundation is 37 m. It has been constructed on two ends points of hills i.e., Bhitarmda hill and Karanjharan hill. In April 2012, DoWR, RD & GR through CWC with an objective to improve safety and operational performance of selected dams started the Dam Rehabilitation and Improvement Project (DRIP) with World Bank assistance. Design flood review and preparation of EAP are two important activities in DRIP. The older dams are designed with limited data and atmospheric realities of that period. Now, as those realities shift dramatically with the climate crisis, and need to be relooked. A dam operator has to manage the water release and storage cycle in such a manner that at the end of the monsoon period, the reservoir is at its full capacity. The storage and release schedule of a dam is governed by a rule curve. However, these rule curves are based on monsoon patterns of a time when such patterns were far more predictable, and less disrupted by climate change than they are today. Dam breach modelling is a key component to a well-rounded and robust dam safety program. Various researcher and guidelines recommended combination of breach parameters which are highly sensitive to peak flood and resulting flood inundation extent. This is further increased with uncertainty in design flood, reservoir operation policy, reservoir sedimentation etc. These needs to be addressed systematically while developing flood inundation map and EAP.

The salient features of Khadakhai dam have been obtained from the project authority and literatures. The physiographic parameters of the river catchment at dam site have been estimated by GIS through processing of STRM_DEM. The SUH is developed using these catchment characteristics and relationships provided in flood estimation report for Lower Ganga Plains Subzone-1g (CWC, 1994). The manual on estimation of design flood analyzed for time distribution pattern of storms in the area for which adequate self-recoding rain-gauge data are available. Using the manual, depth duration analyses of maximum rainfall depths for standard duration of 6, 12, 18, 24, 36, and 48 hrs, were obtained for each of the storms and expressed as percentage of the total storm depth. Enveloping percentages are then obtained and applied to adjust the design rainfall based on observational data. In absence of hourly rainfall data it is recommended to apply a factor of 1.15 to convert 1-day maximum rainfall to 24-hr maximum rainfall. The 24-hr rainfall is divided in to incremental hourly rainfall according to time distribution provided in the CWC report. To obtain the critical sequence of rainfall the largest of increments is placed against the peak of UH, then the next largest against the next UH ordinate and so on until all rainfall increments get arranged. Then the sequence is reversed to get the critical sequence for all spells. In case of 24-hr duration rainfall the first and second 12-hr blocks are interchanged to get critical situation. The design loss rate is subtracted from the hourly rainfall to obtain effective rainfall hyetograph and then direct runoff hydrograph is estimated by convoluting this effective rainfall with SUH. Finally, the base flow is added to obtain design flood hydrograph shown below. The HEC-HMS model has also been prepared with IMD gridded rainfall data as input. Sarkar and Maity (2020) suggested to consider temporal change of PMP in India for planning, designing and future risk assessment of any major high risk water resources infrastructure. Based on their findings, the PMP may decrease by 2.2% under RCP 4.5 and may increase by 12.75% under RCP 8.5 for the projected time period of 2071 to 2100. The corresponding design flood hydrographs are also developed. The HEC RAS model setup for dam break modelling is under progress.

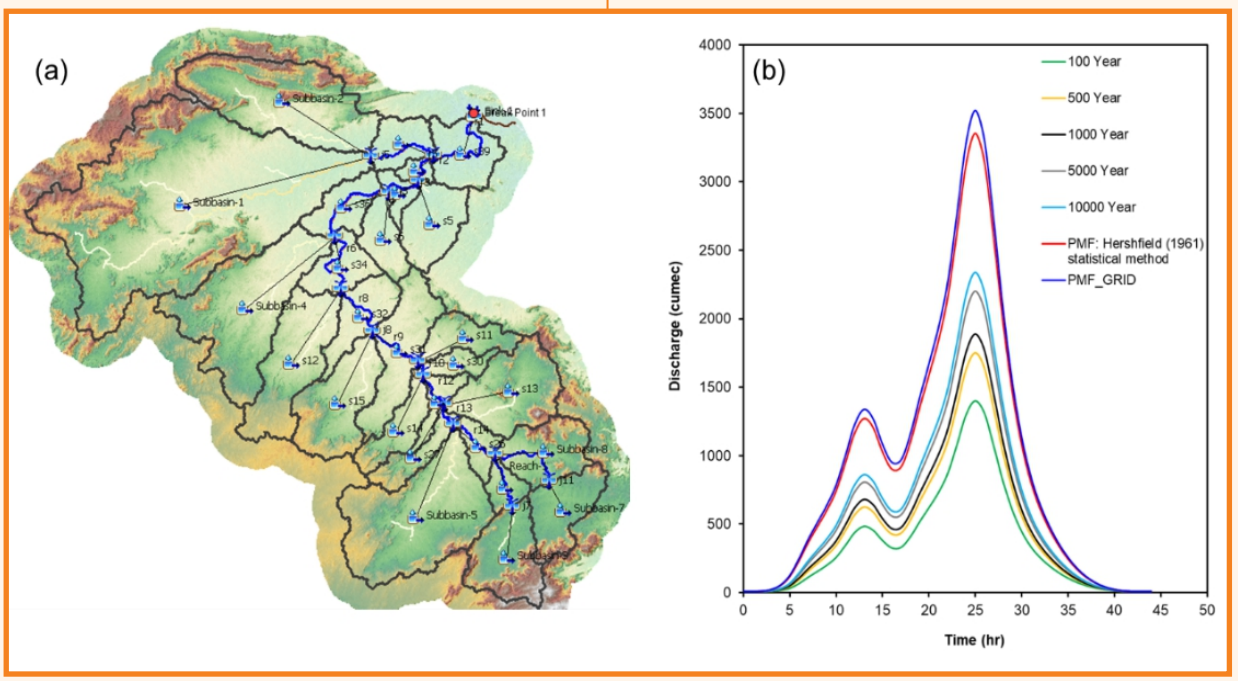


Figure – 6.65: (a) HEC-HMS Model Setup; (b) Design Flood Hydrographs at Dam Site

Hydrologic and Hydraulic Study for Jata Ganga River at Jageshwar Dham

The Jageshwar is a Hindu pilgrimage town near Almora in Almora district of Uttarakhand. The site is protected and managed by the Archaeological Survey of India (ASI). Jageshwar is about 36 km northeast of Almora, in the Jata Ganga river valley near a Deodar forest. The temple clusters begin starting near the confluence of two streams Nandini and Surabhi after they flow down the hills in the narrow valley. The Govt. of Uttarakhand is committed to develop Jageshwar Temple (part of Manas Khand) and its surrounding areas in a planned manner as per the vision of the Hon'ble Prime Minister to develop the Manas Khand circuit in the Kumaon region. For this purpose, the State Govt. have appointed INI Design Studio, Ahmedabad as a master planning consultant. The consultant has developed the master plan, which comprises different components like temple illumination, infrastructure facilities, parking facilities, streetscape development etc. Further, riverfront development for Jata Ganga (which flows behind the temple complex) is also one of the components of master plan. For this aspect, the Tourism department of Uttarakhand approached NIH, Roorkee to carry out hydrological and hydraulic studies to support the riverfront development plan developed by INI Design Studio.

The DEM of the study area has been developed from the CARTO DEM V3 data. Hydro Tool has been used for basin delineation in ArcGIS. It is to be noted that the catchment and sub catchment area are very small. Hence, SUH is not derived and rational formula is used for computation of peak discharge for various return periods. The time of concentration is estimated by Kirpich, Kerby and California formula and average value is considered. The nearest rain gauge station is at Almora. The observed 1-day highest rainfall is 223 mm in 29/09/1924 (CWC, 2015). The 1-day annual maximum return period rainfall for various return periods at Almora is used as design rainfall. Further the time distribution coefficients as per the CWC sub basin 401A has been adopted to compute hourly and smaller time steps. It is observed that the various bridges/culverts and tree canopy are not removed from the high resolution DEM provided by M/s INI Design Studio, which is essentially a Digital Surface Model (DSM). However, for river flood modelling a Digital Terrain Model (DTM) is essential. The INI is asked to provide river cross-section for pre and post project condition. As for hydraulic modelling with HEC-RAS, this DSM has been used for extraction of river cross-section. The computed runoff for various return period and for cloud burst condition (intensity = 10 cm/h) are given in Table. For hydraulic modelling in HEC-RAS the manning's n value of 0.04 and 0.06 have been used for main river channel and over banks considering it as a mountain stream. Steady flow simulation is carried out for design discharge of various return periods viz. 25, 50 and 100 year, respectively. The longitudinal water surface profile for different return period floods for the study reach and the simulated water surface profile for various return periods at RS 753 is as shown below. The simulated water level for pre-project scenario for 100 year return period flood has been provided. The details of proposed intervention are awaited and will be incorporated in the post project scenario.

Table – 6.3: Design Runoff (m^3/s) for Various Return Periods

Sub Catchment	Return Period (Year)				Intensity (10 cm/h)
	2.33	25	50	100	
A	17.23	33.78	38.26	42.73	104.55
B	18.71	36.69	41.55	46.41	91.55
C	1.48	2.90	3.28	3.66	7.13
D	6.21	12.19	13.80	15.41	29.10
E	5.73	11.23	12.72	14.21	27.80
F	0.94	1.85	2.09	2.33	4.65

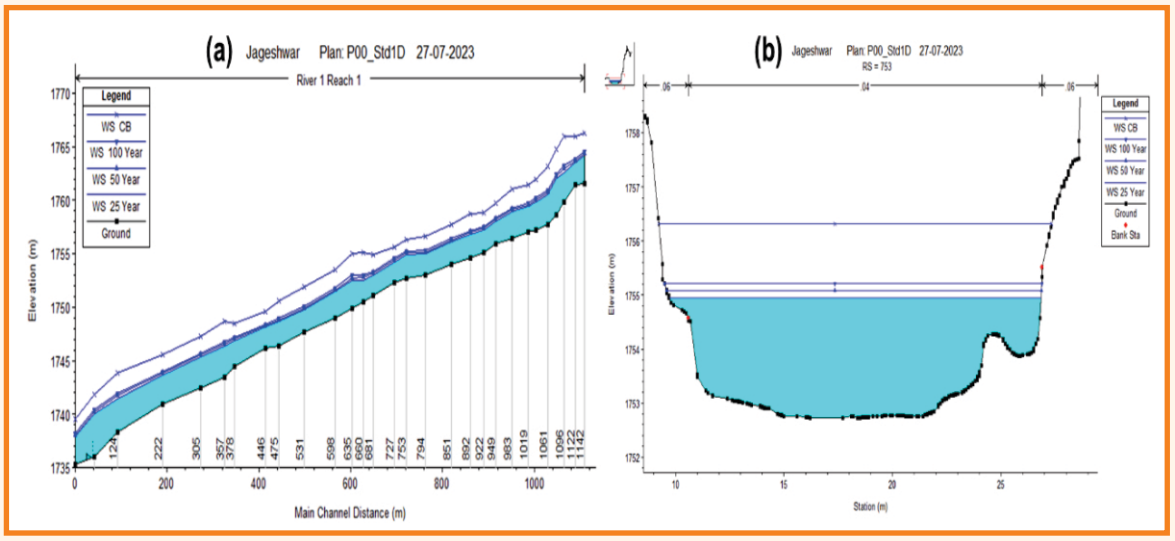


Figure – 6.66: Simulated Water Surface Profile for Different Return Period Floods (a) Longitudinal; (b) Cross-Section at RS 753

Hydrological Study for Revival and Restoration of the Waterbodies of Bikaner, Rajasthan

Bikaner city has a number of water bodies since ancient time, which has been disappeared due to ignorance and non-maintenance. Due to over-exploitation and increasing pressure these water bodies are deteriorating and declining. The objectives of the study are: (i) prepare inventory of water bodies in Bikaner, (ii) long-term spatio-temporal analysis of rainfall and temperature variables, (iii) decadal LULC change detection in the study area, (iv) trend analysis of groundwater levels and assessment of recharge to groundwater in Bikaner district, (v) surface water availability estimation in the pilot water bodies, (vi) assessment of various water quality parameters of pilot water bodies, (vii) soil loss assessment from the catchment, and (viii) suggesting ameliorative measures for rejuvenation of water bodies.

In the present study, 13 pilot waterbodies were identified. The catchment area of these waterbodies were delineated and LULC change was detected during three decades i.e. 2000s, 2010s, and 2020s using satellite imagery. Detection and quantification of trend in climatic variables i.e. rainfall, maximum temperature, minimum temperature was carried out on annual and seasonal basis for the duration 1951-2020 using MK test. Moreover, change in magnitude of these parameters were also detected using Sen's slope test. Soil samples were collected from 7 different locations and infiltration test was performed at 4 different locations. Trend in groundwater level was analysed utilizing groundwater level data acquired from CGWB. Total 17 surface water samples and 2 groundwater samples were collected for physico-chemical parameters (as per APHA 2017), demand parameters, and heavy metals analysis. Major cations, major anions, and minor ions were analysed using Ion chromatograph. A non-significant increasing trend in rainfall and maximum temperature, whereas a significant increasing trend in minimum temperature was observed. Soil sample analysis showed a sandy texture soil with the infiltration rate varying from 16 to 19 mm/hr, except in the lake near RD-507. Groundwater trend analysis showed a rising trend (in 43% wells) towards the IGNP canal, falling trend is found in the southern parts of district (in 21% wells), whereas, approximately 35% wells show no-trend in groundwater levels.

The SCS-CN method was employed to assess runoff from the catchment of different waterbodies. It is revealed that among all the waterbodies, Kodamdesar pond had a shortage of water availability during the period i.e. 2005-2020. Soil loss assessment from the catchment of waterbodies was conducted using the geospatial techniques by

utilising various thematic layers and climatic data. The minimum and maximum average annual soil loss has been found for Swarupdesar and Kolayat catchment respectively. Water quality assessment of different water bodies showed that majority of physico-chemical parameters except Dharnidhar (SW4) were observed within the permissible limit of BIS (2012) for drinking water (IS: 10500). Safe BOD level (>2.0 mg/L) was observed in almost all water bodies. Heavy metal concentrations analysis shows Al, Fe, Mn, Pb and B exceeded the prescribed permissible limit of BIS (2012) for drinking water (IS: 10500) in few of the samples.



Figure – 6.67: Field investigations under the study at Bikaner

Spatio-temporal Water Availability under Changing Climate and Land-Use Scenarios in the Wainganga River Basin

Presently, the total water availability of the Wainganga basin is 9225 MCM. The various sectorial demands have grown steadily over the years, leading to an intensification of competition and conflicts for the limited water resources. Therefore, the study aims to assess the basin's water resources availability and, further, to evaluate the impact of existing and other prospective water resources developmental initiatives on the overall water balance of WRB and to estimate the influence of current and future changes in climate and land use on the Wainganga River basin's water balance. To meet the various demands such as food, water, settlement, etc. of the ever-growing population, the LULC have changed drastically. The LULC change can alter land surface interactive processes, thus affecting the hydrological cycle. This research has examined the impacts of various scenarios of varying climate and land-use on the water availability of the Wainganga River basin, in India.

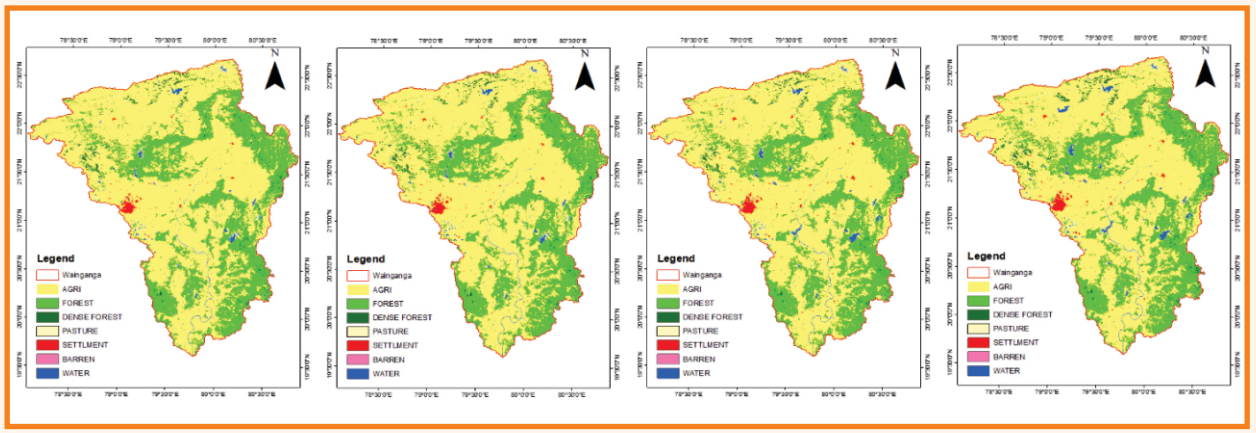


Figure – 6.68: LULC Change over years (2005, 2010, 2015 & 2020) in Wainganga Basin

As a first step, variation in the past LULC has been analysed and seen tremendous growth in the urban settlements at the cost of open forest and agriculture. An MLP-ANN-Markov process-based land-use change model was applied to predict the land-use conditions for the year 2030, 2060 and 2090 in future. For hydrological simulation, SWAT model with GIS-based GUI was calibrated for the period of 25 years of period (1980-2005) including 3 years of warm-up period and validated for 5 years of period (2000-2005). The study also includes a detailed uncertainty analysis to identify and quantify the various components for the assessment of hydrological response under changing climate and land-use of the basin. The study results in the assessments of water availability in the future periods with various percentages of dependability and can aid policymakers in effective planning and implementation of different water resources strategies.

Estimation of Changes in Snow Cover and Glacier Mass Balance for Upper Chenab River Basin

Snow and glaciers are important components of the Himalayan Cryosphere, critical to fulfilling water requirement in the Himalayan region. Upper Chenab basin (UCB) (~3,700 km^2) composed of Chandra and Bhaga sub-basins has reportedly 50-80% snow and glacier contributions, and climatologically falls under the monsoon-arid transition zone, being alternately influenced by mid-latitude Westerlies and Indian Summer Monsoon, although most of the accumulation happens in winter months. There is also a gradual increase in aridity as we go from SE to NW. Moreover, the basin is important from the point of hydropower generation, and several run-of-the-river HEPs, depend on snow and glacier melt contributions for their power generation in summer months. In view of this, the study aims to estimate changes in snow cover and glaciers investigate climate-cryosphere linkages in UCB. The snow cover dynamics in UCB was estimated for the period of 2000-2020 using 939 MOD10A2 images, dividing the entire basin into different zones based on elevation, slope, and aspect. While almost the entire basin was snow covered between February and April, through the first two decades of the 21st century, the minimum snow cover was mostly observed in August. Glacier mass balance of two selected glaciers (Chhota Shigri and Bara Shigri) in UCB was attempted using Area Accumulation Ratio (AAR) method.

Glacier areas obtained using glacier boundaries from Randolf Glacier Inventory and accumulation areas estimated using snow lines obtained for select glaciers at the end of ablation season from Normalized Difference Snow Index (NDSI) snow cover with different thresholds (0.4, 0.45 and 0.5). AAR estimated from NDSI and supervised classification was compared with that calculated from field glaciological method on Chhota Shigri Glacier between 2003 and 2019 and NDSI threshold of 0.4/0.45 gave comparable values for different years and sensors. An attempt has also been made to use DEM differencing and SNAP Tool to estimate elevation change and surface velocity of Chhota Shigri Glacier using Sentinel 1 SAR data, SRTM and ASTER DEMs to estimate geodetic mass balances.

Mass Balance of Phuche and Khardung Glaciers, Ladakh Range with Implications for Downstream Water Availability under Changing Climate

Long-term mass balance and meteorological measurements on representative glaciers are not only important to link the glacier dynamics with climate

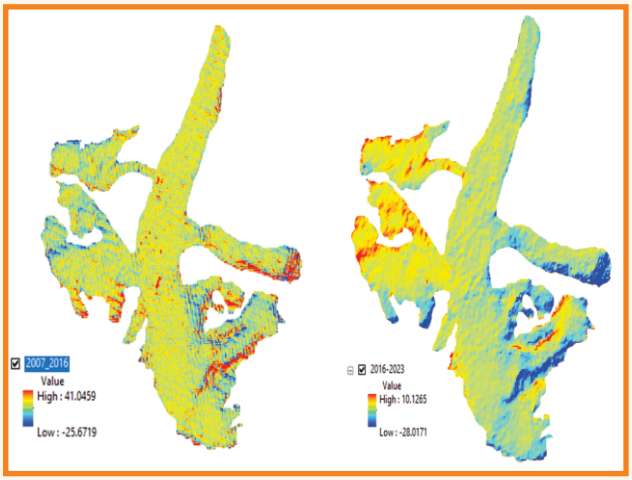


Figure – 6.69: DEM Differencing (2007-2016 and 2016-2023) for Estimating Geodetic Mass Balance of Chhota Shigri Glacier, Upper Chenab Basin

change forcing, but also for quantifying the impact of changing climate on glaciers and downstream water resources. Phuche glacier is not only the water tower for Leh town being the headwater of Ganglass catchment but also shows marked difference in mass turnovers with Khardung Glacier on the Nubra Valley side. Thus, the objectives of the study are to continue winter and summer mass balance studies of Phuche and Khardung glaciers for building a long-term mass balance data series, study of glacier –climate linkage and runoff modeling using improved understanding of temperature-precipitation gradients and permafrost thaw. Ablation and accumulation measurements on Phuche and Khardung glaciers as well as discharge and meteorological data collection is ongoing using automatic and manual instrumentation. During the September 2003 fieldwork, the stake network on both the glaciers were re-established for long-term data generation.



A B C

Figure – 6.70: a) Pluvio Precipitation Gauge at South Pullu Field Station, b) Newly Installed Accumulation and Ablation Stake Pair on Phuche Glacier, c) Floating AWS on Phuche Glacier, Leh, Ladakh

7 Sponsored and Consultancy Projects

For the past many years, the Institute is carrying out projects sponsored by International and National agencies. During 2023-24, work on 47 sponsored projects was carried out, in which 6 projects were internationally funded and 41 projects were funded by national agencies. The list of sponsored projects is given in Appendix-VIII.

NIH is also providing solutions to problems faced by industry and field organizations through consultancy projects. The consultancy projects are being referred by State Governments, Public Sector Undertakings, and also by private companies. During the year 2023-24, the scientists of NIH worked on 67 consultancy projects of which 28 projects were completed. The list of consultancy projects is given in Appendix-IX. The details of some of the sponsored projects are given below:

7.1 SPONSORED PROJECTS COMPLETED DURING 2023-24

Assessment of Seasonal Variations in Hydrology and Cryosphere of Upper Ganga

Seasonal snow water is the crucial source of water in the upper Ganga basin of NW Himalayan region and it is of great significance to be estimated. In this study, seasonal snow water equivalent (SWE) was estimated for the 16-snow seasons from the period 2001 to 2020 at 9 snow-glacier dominated sub-basins. For this purpose, the SPHY hydrological model in conjunction of GRACE satellite data has been utilized. This model separates the contribution of snowmelt, glacier melt, base flow, runoff induced with rainfall from the total runoff at different watersheds. The calibration and validation have been done using observed discharge and GRACE satellite derived total water storage anomalies (TWSA). The modeled snow covers and melt runoff have been evaluated with MODIS derived snow covers. For the assessment of glacier changes and corresponding melt runoff, different glacier maps (i.e. for the years 1990, 2000, 2010, 2020) have been prepared using LANDSAT imageries. The contributions of all these runoff components have been analyzed from upstream to downstream portions under different retreat conditions in different time scenarios (e.g. 1986-1995, 1996-2005, 2006-2015 and 2011-2020) by incorporating glacier maps of different times. This study relies more on the real time observations of glacier changes rather than incorporating climate model scenarios to explore the current situation of glacier melting in the Upper Ganga River basin. The model calibration and validation have been done utilizing the observed discharge and MODIS derived snow cover datasets. To capture the seasonality in snow and glacier melt runoff in a more effective manner, the MODIS derived snow cover area (SCA) is compared with the SPHY derived SCA.

At Rishikesh outlet, the coefficient of determination R^2 is recoded ~0.6 with respect to the observed discharge. The seasonal snow cover computed by SPHY is validated by snow cover derived from the MODIS 8-day snow cover maps with a coefficient of determination 0.73 (2015). For validation purpose, the GRACE data is downscaled from 1° × 1° to 0.25° × 0.25° for working at watershed scale by incorporating simple Multilinear Regression (MLR), Random Forest (RF) and Support Vector Regression (SVM) machine learning models. For predicting downscaled GRACE data, a statistical relationship is established with GLDAS soil

moisture, canopy water, root moisture, and snow water equivalent hydrological variables with GRACE data and results have shown a well match between GRACE and GLDAS variables (R^2 varies from ~0.4 to 0.7). It is observed that RF performed superior as compared to other methods in predicting the downscaled GRACE data in the upper Ganga River basin. The downscaled predictions at watershed scale combined with SPHY simulations for estimating the SWE. Results showed that the estimated SWE and TWSA is found comparable with GLDAS SWE and TWSA, which is almost 33% underestimated than our computation.

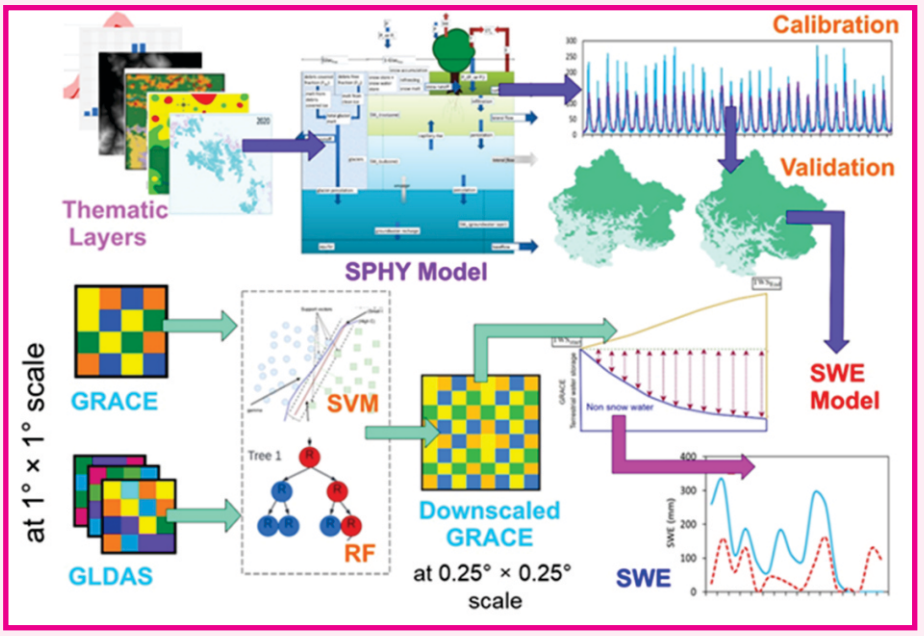


Figure – 7.1: Overall Methodology and Work Flow of the Study

Integrated Assessment of the Impacts of Climate Change on the Hydrology of the Narmada Basin through Hydrological Modelling Approaches

Climate change induced higher average temperature and changes in the precipitation and temperature extremes are projected to alter the water availability in river basins. The Narmada basin in Central India represents a highly complex hydrological system where water resources development is taking place at a rapid pace with many projects being executed. The objectives of the study include, (a) application of select hydrological models for simulation of surface water, and groundwater processes, (b) assessment of present and future water availability under alternate scenarios of climate change, (c) water allocation planning and management based on future scenarios of water availability, (d) flood plain mapping of the flood prone Hoshangabad district and (e) climate change adaptation measures. The comprehensive study carried out in Upper Narmada basin, focused mainly on investigation of climate change signals, application of semi-distributed and conceptual hydrological models for simulation of runoff and other hydrological processes using SWAT, VIC, WEAP, MIKE11-NAM and HEC-HMS models, application of distributed groundwater models for groundwater flow modelling using MODFLOW, MUSE and WetSpass models, and hydrodynamic modelling using HEC-RAS for flood plain mapping. Whereas; the SPI has been used to evaluate the drought characteristics. CMIP6 GCMs based climate change impact assessments on water availability, groundwater recharge and drought have been carried out using SSP245 and SSP585 scenarios, for 5 time zones viz., baseline (1961-1990), present (1991-2015), near-term (2021-2040), mid-term (2041-2070) and end-term (2071-2100).

The observed average annual maximum temperature is increasing at the rate of 0.75°C/100 years. In future, the maximum temperature is projected to increase at a rate of 1.58°C/100 year and 2.61°C/100 year under SSP245 and SSP585 scenarios, respectively, leading to higher water demands. Also, the minimum temperature is projected to increase at a rate of 2.14°C/100 year and 3.62°C/100 year under SSP245 and SSP585 scenarios, respectively. The annual average rainfall is projected to increase to 1280.7 mm during the near-term, 1364.5 mm during the mid-term and 1493 mm during the end-term under SSP245 scenario. However, a much higher increase is projected during end-term (1831.3 mm). The average daily runoff is projected to increase in all future time periods for all tributaries and in main River. Higher groundwater recharge is projected in future in Narsinghpur district, but the cropping pattern is changing fast with area under water intensive crops viz., sugarcane and paddy. Since, most of the major blocks of the district are dependent on groundwater for irrigation, its sustainable use is advocated. The high-flows represented by the 1-day maximum runoff and Q5 & Q10 flows are projected to increase substantially. This will generate floods in the river system and low-lying areas. Also, the projected marginal increase in the low flows (Q90 & Q95) in future will help to sustain the perennial nature of the river. The drought duration and magnitude are projected to increase considerably in all future time periods, the highest being during the end-term. As such, planning for additional water storage structures is necessary for providing supplemental irrigation during dry spells.

The scenario of future unmet demands can be addressed through judicious use of water by switching over to pressurized irrigation systems like drip and sprinkler irrigation, lining of canals to reduce the seepage losses, and reducing the sediment inflow into the reservoir to prevent reduction in their storage capacity by catchment area treatment works. The sensor-based operation of the reservoirs and irrigation systems will help in substantial water savings in the agriculture sector and can be considered to be a good adaptation measure to enhance climate resilience. Integrated operation of reservoirs based on real-time weather and flood forecasting is essential to minimize the floods at Hoshangabad. Various strategies for climate change adaptation have been suggested in detail based on future climate change impacts evaluated for the study area. Efforts should be initiated to implement the suggested measures, which will ensure sustainable development in future as well. The study will be beneficial to line departments including water resources department, agricultural department, public health engineering departments including the various decision makers and the researchers.

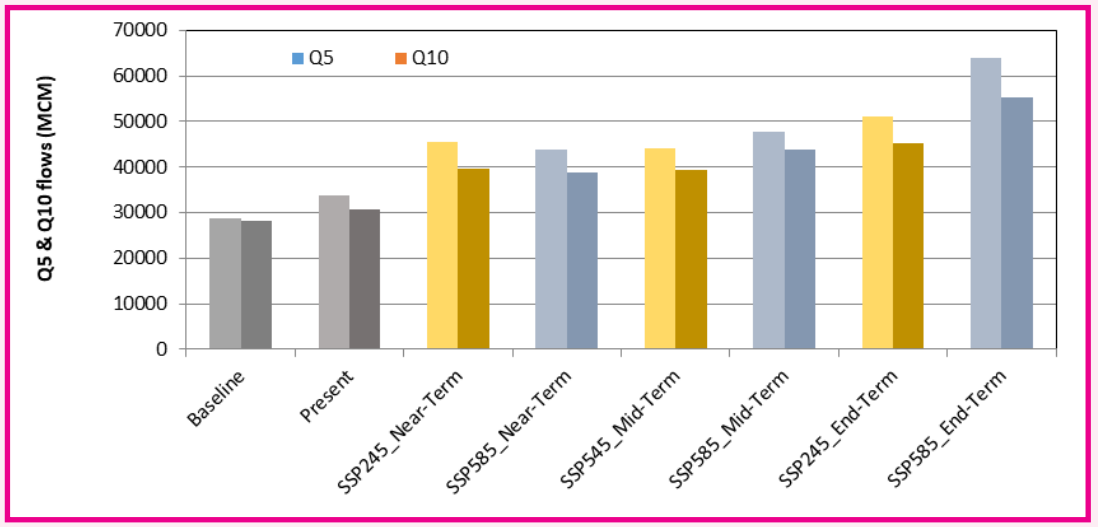


Figure – 7.2: Comparison of High Flows of Q5 & Q10 for River Narmada at Barmanghat

Hydrological Modeling for Evaluation of Return Flow and Irrigation Planning for Optimal Utilization of Water Resource in the Command of Sanjay Sagar Project in MP

Irrigation return flow refers to the portion of water that is not consumed by crops and eventually returns to the water system. It has two main components: regenerated flow and recharge. Regenerated flow involves the portion of water that runs off the fields and returns to surface water bodies, contributing to downstream water availability. Recharge, on the other hand, refers to the infiltration of excess irrigation water into the groundwater aquifers replenishing groundwater reserves. In MP, a fixed 10% of water storage is used as regenerated flow from the command which needs to be verified using scientifically for open canal system. This study was taken jointly by CIHRC, NIH, and WRD MP to address the issue of computation of irrigation return flow from the command of the Sanjay Sagar irrigation project (Vidisha, MP) for optimal irrigation water management. The return flow from a command is a complex phenomenon that depends on multiple factors like soil, geology, topography, type of crops, canal condition, application method, etc. The runoff analysis of G/D site D/S of the Sanjay Sagar dam suggested that the flow increased significantly during the Rabi season after the construction of the dam in the year 2014. Three different techniques were employed: the water balance, isotopic analysis, and hydrological modeling using the SWAT model. A detailed water balance of the different components of the hydrological cycle in the continuum of the river, canal, and command areas was either measured or computed. The error in the computation ranged between -0.7 and 3.5 MCM, which is less than 10% of the supplied water. The yearly regenerated water ratio was found in the range from 12.3 to 35.9%, with an average of 22.9%, which is considered reasonably high. The isotopic analysis suggested that the open wells have the maximum contribution (88%) from canal. In the hydrological modeling technique, the SWAT model was calibrated and validated using the virgin flow data from 1991 to 2013. The model was then reorganized by adding reservoir, crops in the selected sub-basins, and irrigation supplies. The regenerated flow was found as 18.8 to 30.7% of water reached the command from the dam. The baseflow increased from 3.98 to 6.54 MCM due to the application of irrigation during the rabi season, which was around 8.90% of supplied water.

The MIKE 11 NAM model was developed and used in the MIKE HYDRO Basin model for reservoir operation and irrigation planning. Four different scenarios were generated using enhanced efficiency and conjunctive use options. The developed model was exported in DSS-PM to explore the impact of climate change and other management options. An Excel-based irrigation management model was

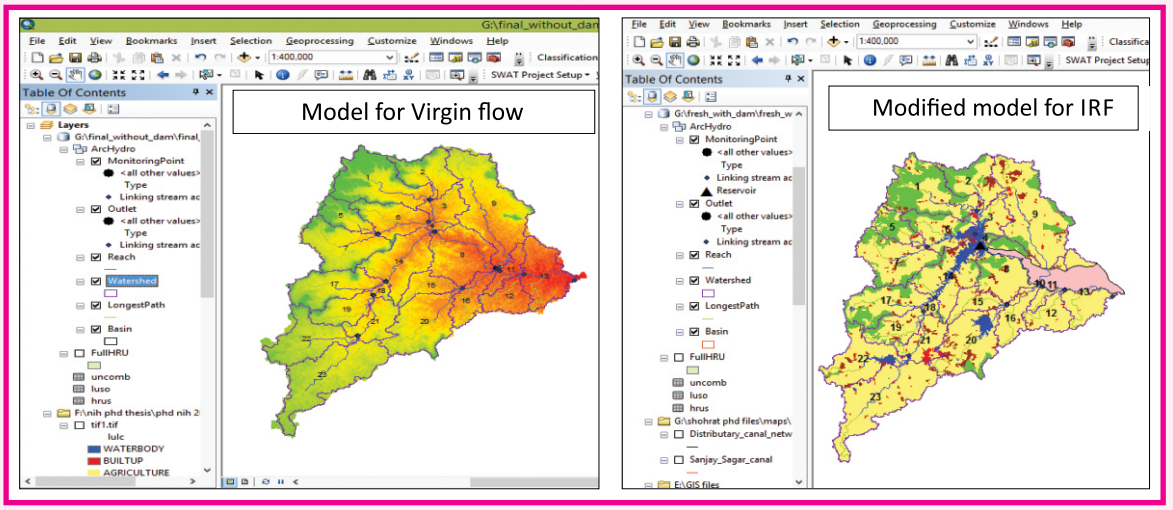


Figure – 7.3: Hydrological Modeling (SWAT) for Computation of Irrigation Return Flow

developed for the Sanjay Sagar project. This model provides information on crop areas, canal start times, and reservoir operation rules, and it can automatically compute the demand and deficit for different Water User Associations (WUAs) based on crop water requirements, reservoir water availability, future climate forecasts, and more. The developed Excel model is user-friendly for water resource managers and policymakers. A web/mobile application called "KISAN MAITRI" was created to facilitate communication between farmers and water resource managers. The farmers can get information on crop water demand, deficit, and water availability in the dam and optimized cropping patterns based on the availability of water and future climate conditions.



Figure – 7.4: Different Dashboard of "KISAN MAITRI" Mobile Application

Integrated Management of Water Resources for Quantity and Quality in Upper Yamuna Basin upto Delhi

River Yamuna constitutes a major source of irrigation water in rural north India and of drinking water supply for Delhi. In recent years, several reaches of Yamuna River have experienced dry conditions and the contamination levels have increased especially near Delhi. The unprecedented increase in groundwater pumpage has led to declining its levels in many areas despite the presence of the intensive canal network. In view of the above, hydrologic modeling studies have been conducted to investigate both surface water and groundwater resources in the upper Yamuna basin upto Delhi and also to assess suitability of selected hydrologic models for the region. The work carried out mainly pertains to the following: snowmelt runoff modeling for quantification of snowmelt contribution to surface water resources in the Himalayan region; flood frequency analysis for Upper Yamuna Basin upto Okhla barrage in Delhi; analyses of future precipitation and temperature patterns using climate indices under two climate scenarios SSP245 and SSP585 derived from CMIP6 global climate projections; impact of climate change on water availability and adaptation options to mitigate adverse impacts; integrated modeling to study the subsurface flow dynamics and analyse impact of climate variability on renewable groundwater resources, as well as assessment of changes in baseflow contribution to River Yamuna; assessment of water quality of surface water and groundwater resources in Upper Yamuna Basin including impact of anthropogenic activities on water quality and modeling of water quality of Yamuna river water; assessment of suitability of selected hydrologic models for the Upper Yamuna Basin; and, time series analysis of streamflow in Upper Yamuna Basin.

The hydrological modeling for Himalayan portion upto Hathnikund was performed using SWAT to simulate and quantify the snowmelt contribution to Yamuna River at the following river gauging sites: Tuini, Tuini Tons, Yashwant Nagar, Naugaon, Bausan and Hathnikund. The snowmelt variation is

found to vary month wise. The ablation time also varies with elevation. Snowmelt from lower elevations contributes low runoff over a smalltime span and vice-versa. WinSRM was also utilized to simulate snowmelt runoff. For identifying the most suitable method of probability distribution for flood prediction at selected gauging stations, a diverse array of statistical distributions, including Normal, Log Normal, Gumbel, GEV, Gamma, Log Pearson 3, Goodrich, and Weibull were utilized. The results highlight the superior performance of the Log Pearson 3, Weibull (2p), and GEV distributions in capturing the peak flood discharge. In addition, stochastic time series models were developed to simulate monthly streamflow at six locations. Characteristics of extreme temperature and precipitation in Upper Yamuna Basin were analysed under two scenarios SSP245 and SSP585. Both scenarios project a gradual rise in the frequency of rainy days across the basin. Higher-altitude regions are projected to experience a slower rate of temperature rise compared to the lower plains. The number of summer days is projected to increase across both hilly and plains regions, with a faster rise observed in the plains. Values of dependable flows and dependable water availability at Hathnikund site under baseline conditions and climate scenarios SSP245 and SSP585 for the near future (2021-2040); the mid future (2041-2060) and the far future (2081-2100) are estimated. Adaptation options to mitigate adverse impacts of climate change are discussed in respect of water sector, agricultural sector, and flood management.

The soil database utilized in the study was build up by collecting soil samples from selected locations and performing in situ measurements. The soil samples were analysed in the SW Lab of the Institute to determine their physical and hydraulic characteristics. To simulate the subsurface flow processes in both the unsaturated and saturated zones in upper Yamuna basin, the web-based integrated model NIH-WISDOM, developed at NIH, is utilized. The model simulates flows in the root zone, unsaturated zone, and saturated zone. In the saturated zone, flows are simulated using the MODFLOW software. Groundwater recharge is also estimated using WetSpass model. The water quality assessment of the Yamuna River from Paonta Sahib to Delhi was carried out to investigate its adequacy for irrigation and the effect of mixing of drain waters. In addition, groundwater samples were collected from different districts and analyzed for trace metals. The water samples collected from the field were analysed in the Water Quality Lab of the Institute. Hydrochemical analysis based on graphical analysis of IC, ICP-OES results were performed. Two models, namely SWAT and QUAL2K, were employed for modelling of water quality in selected stretches of Yamuna River. Suitability of various hydrological models for Upper Yamuna Basin was assessed for simulation of streamflow, simulation of snowmelt runoff, simulation of subsurface flows, and simulation of contaminant dynamics in river.

Leachate Transport Modeling for Gazipur Landfill Site for Suggesting Ameliorative Measures

The growth in population, urbanization and industrialization has led to the increase in the generation of solid waste all over the world. It is believed that the rate of waste generation is an index of socio-economic development and an economic prosperity of a country. This is evident from the fact that the rate of waste generation is more prominent in the developing countries, where there is an increased rate of unplanned urbanization of the cities. In India, the total Indian urban population amounts to approximately 377 million (Census of India 2011). The cities which have more than 100,000 populations contribute to more than 72 % of the total municipal solid waste. The growth rate of population in urban India is much higher than that in rural India. The Census figures also show Delhi to be the most urbanized State in India. Since waste generated by the city depends on its population and per capita income, it is estimated that the quantity of Municipal Solid Waste (MSW) would reach 17,000 – 25,000 MT/day by 2021. For solid waste management in Delhi, twenty landfill sites were identified and

developed since 1975, and of which 15 have already been closed and two were suspended. At present only three landfill sites are in operation. They are namely, Bhalaswa catering the needs of northern part of Delhi, Okhala in the southern part and Gazipur in the eastern part of Delhi.

The dumping of waste in these non-engineered landfill sites contributes to percolation of leachate in the groundwater. These percolating liquids have high concentration of hazardous chemicals. The harmful constituents of leachate then move along the groundwater in the surrounding region rendering it unfit for human consumption and pose various health risk. The various attempts made so far to model leachate movement suffer from a common problem that no surety can be established as to whether the pollution is result of leachate or any other source is contributing towards groundwater deterioration in that region. The current study focuses on modeling of leachate movement through groundwater and apportionment of leachate which has not been attempted so far. The objectives framed under the study are: (1) understanding of hydrodynamics of groundwater flow in the study area, (2) chemical characterization of Leachate, (3) isotopic characterization of leachate and its variation due to recharge and extraction of groundwater, (4) modelling of leachate migration pattern in groundwater in space and time, (5) assessment of Micro-plastic and metals (Hg, Ni, Co) and emerging contaminants in landfill leachate, (6) suggesting ameliorative measures for contaminant plume migration, (7) technology transfer to stakeholders through manuals, leaflets, booklets and workshops/training programs. The study identified the sources of groundwater pollution in the study area by employing groundwater modelling and isotopic results of the samples collected. The study also shed light on the presence of microplastics in the leachate and groundwater of the area. Two new technologies were developed to improve sampling and analysis. The study also brought out a new indexing methodology for leachate pollution and measures to deduce and manage landfill fires.

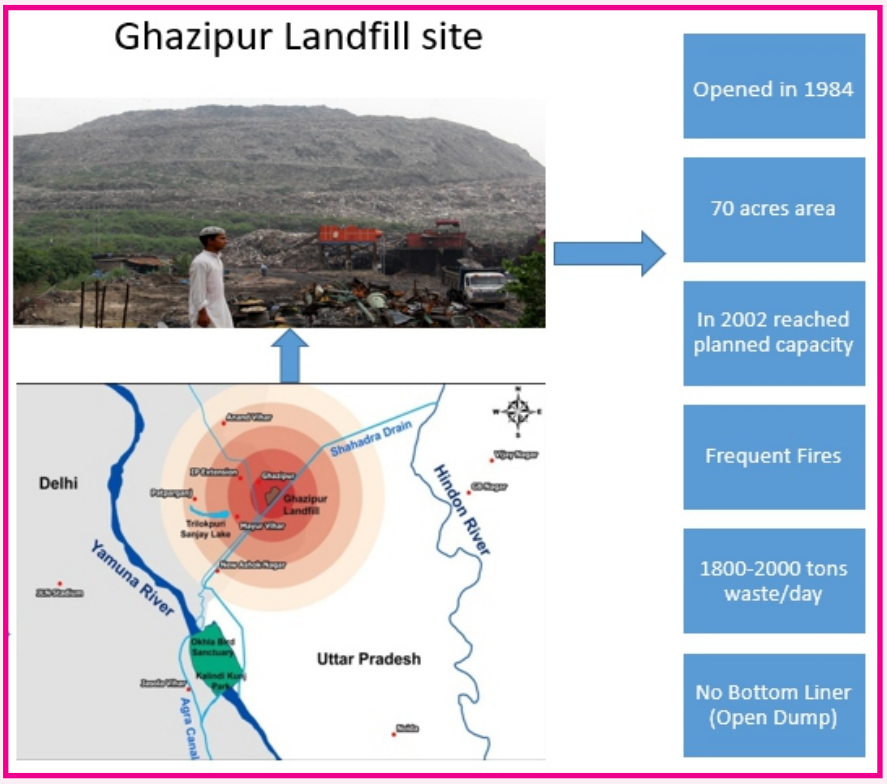


Figure – 7.5: Study Area Ghazipur Landfill Site, New Delhi

Expansion of the Indo-German Competence Centre for Riverbank Filtration – CCRBF

The floodplain of the Yamuna River between the NCR of Delhi and Agra is one of the most densely populated regions in India. Despite the Yamuna's poor water quality, the river is a major source of raw water for domestic purposes and for irrigation. Most of the conventional drinking water treatment plants are technically unable to remove the high concentrations of pollutants present in the river water. Field investigations have confirmed that there is a large potential to use river bank filtration (RBF) as an alternative to directly abstracted SW, which has high potential as a pre-treatment step for drinking water production as well as provide cost-savings for post-treatment. The RBF site in Agra was found feasible for the construction of a vertical exploratory well. The well was constructed in the premises of the Agra waterworks at Jeevani Mandi in February 2018. Due to the scheduled termination of PJS in 2018, it was not possible to evaluate the purification efficiency of the RBF system.

With the impending conclusion of project PJS in 2018, NIH and HTWD endeavored to exploit the infrastructure created in PJS (pumping well), in a new collaborative project. None of the following were possible to investigate in the predecessor project PJS (i) Validation of RBF process, (ii) Demonstration of RBF scheme, (iii) Execution of above through development of a masterplan for RBF water supply in India, revision of existing guidelines on RBF, and inclusion of RBF in the "Smart City" project. NIH has already established an abstraction well at Agra in PJS project (2015-2018) including vertical borewell with pump house. Samples will be collected from river, RBF well, adjoining drainages and groundwater to assess the removal of emerging pollutants and pathogens. So, the main focus of this project will cover validation, demonstration and execution aspects (discussed above) to (i) Determine the upper limit of removal of "emerging pollutants" by RBF (ii) Equip the site with water quality monitoring infrastructure, and (iii) equip site with promotional/information materials on research done at site. Due to the Covid-19, only the following tasks have been completed: (i) scientific-technical support to CCRBF German partners HTWD & TUD for field investigations in Agra, liaison with stakeholder UP Jal Nigam (Oct. 2021 – Nov. 2022), (ii) collection and analyses of water samples for Oxygen-18 and Deuterium isotope, (iii) field work comprising water sampling for ions, heavy metals, dissolved organic carbon and organic micropollutants, shallow drilling with auger/tripod

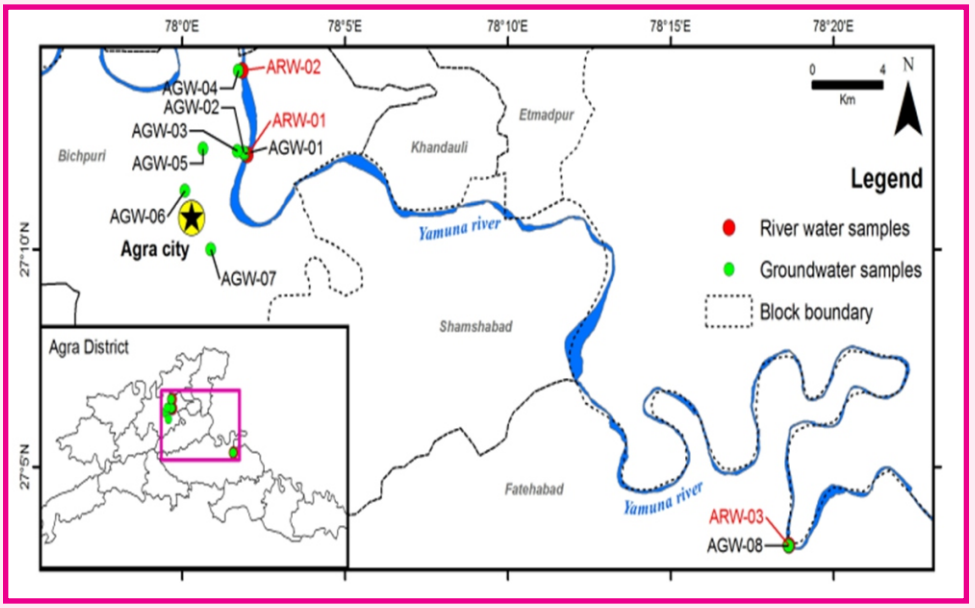


Figure – 7.6: Study site of the Project

to determine groundwater level at site, and (iv) review and synthesis of literature and preparation of project reports. After careful analysis of the data the EC values for river water, RBF Well and groundwater was found to be in the range of 595-1986 µS/cm, 1129-1556 µS/cm and 690-2940 µS/cm, respectively.

Additionally, after including a potential RBF site in Gagdhagara village, near Talwan town by the Sutlej river in Punjab, and with reference to the progress report of CCRBF for the year 2022-2023, a potential RBF site in Dera Bassi by the Ghaggar river in Punjab has also been included in the project. This is in tune with the World Bank report (2020) on "Managing Rural Drinking Water Quality in Punjab". Consequently, the quality of the Sutlej and Ghaggar rivers water and groundwater from a vertical well located 100-200 m from the riverbank in Gagdhagara and Dera Bassi were investigated within the CCRBF project in 2023-2024 with the following key results and conclusions: (a) current investigations in Gagdhagara and Dera Bassi by NIH & German partners HTWD and TUD reaffirm recommendations of World Bank report (2022, points i & ii above), (b) inorganic water quality of well within IS 10500 limits for drinking water, (c) little to no removal of atrazine and carbamazepine during subsurface passage indicates river-aquifer hydraulic connection, (d) potential for RBF at existing site exists, however further geohydraulic investigations and water quality monitoring are needed (e) good example of RBF as a sustainable source in Jal Jeevan Mission.

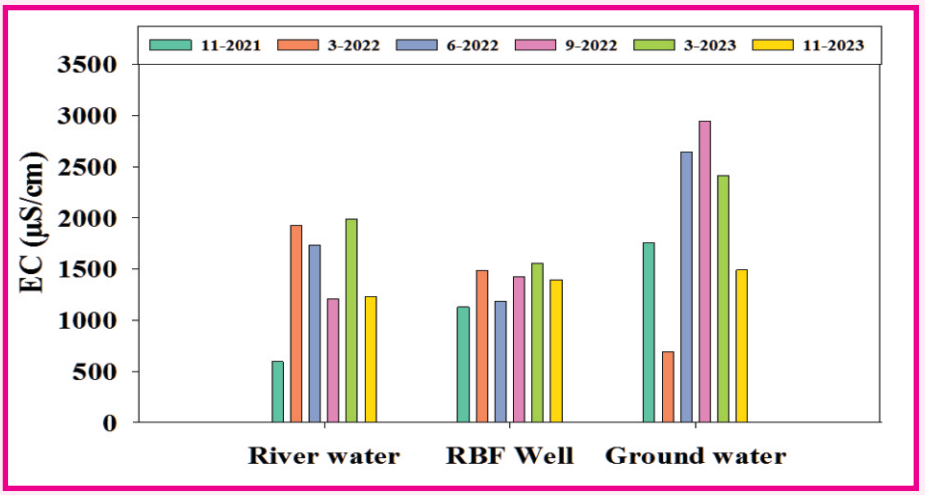


Figure – 7.7: Variation of EC at the Study Site

A Coupled Hydrodynamic and Bank Dynamic Modeling Approach for Forensic Analysis of Bankline Erosion Process Along Majuli Island-The Largest Inhabited River Island in the World

Majuli, the largest inhabited river island in the world is bounded by river Brahmaputra on its south and by river Subansiri on the north. Apart from its rich cultural value, the acute erosion problem, especially on its southern bank by the river Brahmaputra needs attention. The study was proposed with three objectives to (i) study the erosion/deposition and bankline migration process of the acute erosion-prone Bengena Ati reach of Brahmaputra along Majuli and to estimate rate of riverbank erosion since last five decades, (ii) develop historical flow scenario of the river using hydrological modeling to understand the change in flow pattern within the reach, and (iii) develop a coupled hydrodynamic and bank dynamic modeling approach to estimate the role of fluvial erosion and pore water pressure on the bank erosion process. Using hydrological model, the historical flow scenario of the river along the selected reach will be developed. Based on this, a coupled hydrodynamic and bank dynamic model was proposed to understand the interactive processes

responsible for bank retreat. The historical streamflow of Brahmaputra upstream of the study area was determined using the SWAT hydrological model. Required hydrological data were acquired from both CWC and WRD, Govt. of Assam. For the hydrodynamic simulations, an event-wise approach is considered. To select the events for analysis, annual erosion from 1971 to 2014 at the six points where soil samples were collected, was estimated from satellite imagery. 1D simulations are performed to estimate the optimal Manning's n value for each event. 2D simulations have been performed to estimate shear stresses at the six locations. The fluvial erosion model is used to estimate the extent of lateral erosion using the shear stresses acting at the bank. In this study, the fluvial erosion model was used to determine the methods that can be used at this bank. The best performing critical shear stress method was found to be Julien's method. The stability of the bank at the six points for all the events was then analyzed. The stability was analyzed in two stages: a seepage analysis was first conducted to determine the pore water pressures at the bank and the pore water pressures are then used to analyze slope stability. This study is beneficial particularly to the agencies working on flood and erosion management activities to take preventive measure against erosion of Majuli and other riverbanks as well with similar characteristics.

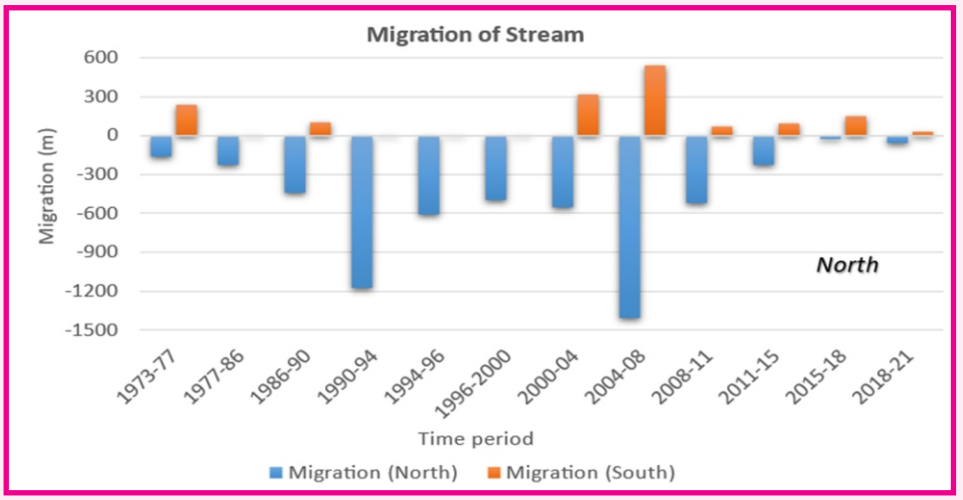


Figure – 7.8: Lateral Migration of the Study Reach from 1973–2021

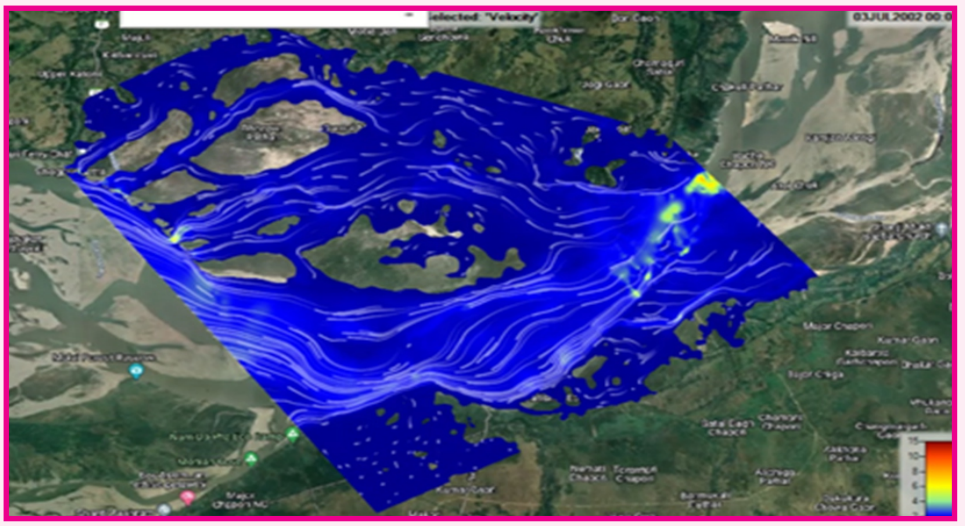


Figure – 7.9: High Flow Condition obtained from HEC-RAS

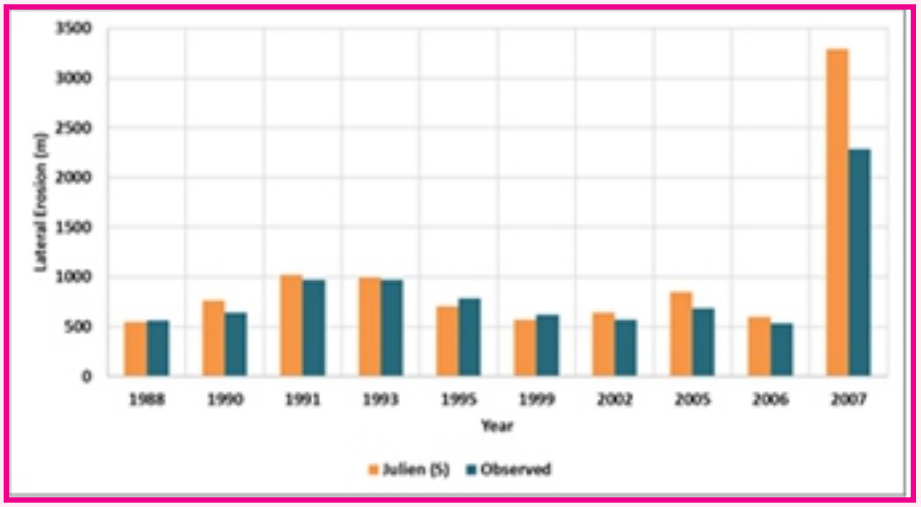


Figure – 7.10: Comparison of Lateral Erosion Estimated from GIS and Julien's Method

Development of Water Accounts for the Different Sub-Basins in the State of Nagaland using Water Accounting Plus (WA+) Framework

The study has been awarded as a Special Study under NHP. The major objective of this study is to apply the newly developed Water Accounting Plus (WA+) framework for the selected sub-basins of Brahmaputra, Barak and Irrawady-Chindwin basins in the state of Nagaland for estimating the status of the water resources. The specific objectives include: (i) to set-up WA+ Framework for the selected study basins/sub-basins; (ii) to estimate ET consumption patterns for the selected basins/sub-basins; (iii) to estimate land and water productivity for the selected basins/sub-basins; (iv) to develop Resource Base (Surface water & Groundwater) for the selected basins/sub-basins; and (v) to develop capacity on WA+ to the State Govt. officials from WRD, Nagaland through training programmes. WA+ Framework is quick, reliable, and provide unbiased measure of water resources using Open access data. It is useful for inaccessible data scare region. WA+ provides information on consumptive water use, land and water productivity, available water; utilizable flow; non-utilizable flow, etc. which is helpful in water resource sector.

From the CHIRPS rainfall data analysis (2001-02 to 2019-20), it was found that a considerable amount of rainfall is falling in the northern and north-eastern parts of Nagaland draining into the Brahmaputra basin. Sub-basins falling in the Brahmaputra basin generates maximum yield for the state of Nagaland. The water accounting-based land use (WALU) suggested that forest cover dominates in the state followed by shrub land, fallow land, agriculture, and built-up area. The area of four land use management classes viz. protected land use (PLU), utilized land use (ULU), Modified land use (MLU) and managed water use (MWU), were 134.42 Km^2, 12425.58 Km^2, 3651.25 Km^2 and 373.10 Km^2 respectively. WA+ tool was set-up for the period 2001-02 to 2019-20. Six factsheets viz. Sheet 2 (evapotranspiration), Sheet 3 (part 1: agricultural water consumption; part 2: land and water productivity), Sheet 4 (part 1: man-made utilization; part 2: natural utilization), Sheet 5 (surface water), Sheet 6 (groundwater) and Sheet 1 (Resource base) were generated. Sheet 2 revealed that an average water loss of 14.91 BCM (~ 900 mm) is occurring in the form of ET from different basins and sub-basins annually. 37% of the ET loss is beneficially contributing to the intended purpose. The remaining loss of 63% is non-beneficial, and can be suitably converted to beneficial component by adopting suitable agronomical and mechanical measures. Sheet 3 estimated a total agricultural water consumption of 2.50 BCM and 2.55 BCM, predominantly met from the rainfall, during a dry and wet year respectively. Overall, the average land

productivity was found to vary from 2564.2 to 4028.3 kg/ha/year and 6149.6 to 7818.9 kg/ha/year during the period 2001-02 to 2019-20, respectively for rainfed and irrigated cereals. The WP was found to vary from 0.66 to 1.02 kg/m^3 (with an overall average of 0.83 kg/m^3) and 1.90 to 2.56 kg/m^3 (with an overall average of 2.2 kg/m^3) for rainfed and irrigated cereals, respectively.

Spatial maps of land and water productivity provide the areas performing well (progressive farmers with high productivity) and poor (farmers with low productivity) in a large basin. These rich information enables the water managers to understand the interventions undertaken at local level by both progressive and less progressive farmers. This helps in planning different interventions for a particular area for higher productivity. The annual average gross withdrawal for man-made and natural land uses are 0.8 BCM and 1.94 BCM, respectively. It can be seen that water utilized for natural purposes is almost double than the man-made utilization. Out of the total man-made utilizations, almost 63% of withdrawal was from the surface water. Whereas, surface water utilization was 23% for the natural land uses. The total outflow from the seven sub-basins viz. Dhansiri, Chathe-Dzuza, Doyang, Dikhu,

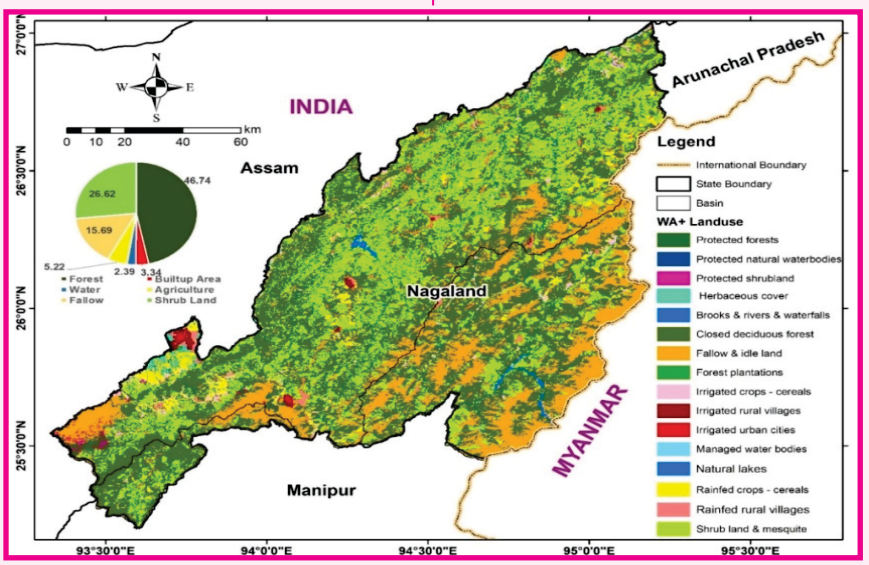


Figure – 7.11: Water Accounting-based Land Use categorization for water management

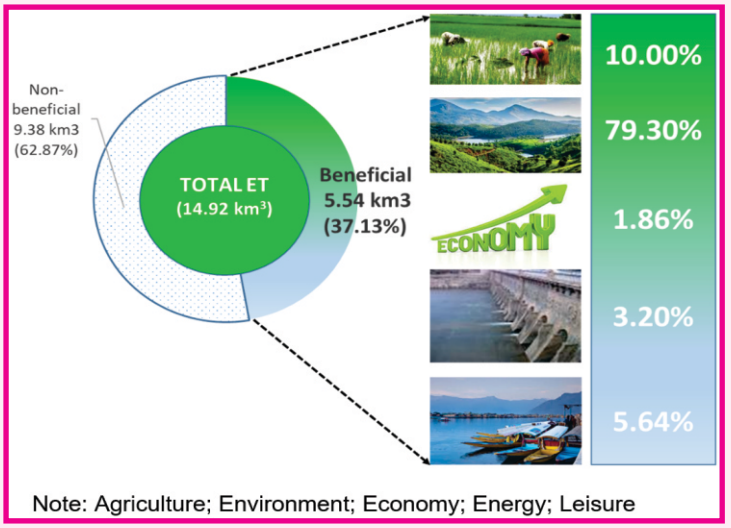


Figure – 7.12: Percentage of Beneficial Contribution of ET as per the Intended Purpose

Tizit, Tsurang and Milak to the river Brahmaputra were about 14051 MCM. The estimated outflow from the catchment within the Nagaland to the Barak and Tizu (Irrawady-Chindwin) basins were about 572 MCM and 4435 MCM, respectively (Sheet 5).

As per the estimates in Sheet 6, an annual vertical recharge of 15.68 BCM was estimated, out of which 87% was contributing to the baseflow. Groundwater withdrawal was about 1.77 BCM. An average annual gross inflow of 29 BCM of water was estimated in the study. A net inflow of 28.5 BCM was estimated with a net storage contribution of -0.5 BCM (a negative sign indicates net recharge). The committed flow, as provisioned in the WA+ framework, was estimated to the tune of 3.1 BCM. An annual average of 15.3 BCM of water is available for utilizations in the state, of which about 22% (3.4 BCM) is utilized, and the remaining 11.7 BCM of water was available for utilization (utilizable flow), but yet to be harnessed. Out of the total net inflow into the basin (28.5 BCM), 48% of water is consumed to meet mainly the ET requirements (ET green and ET blue). The study estimated an annual average outflow of 16.2 BCM (Sheet 1). Although all the estimates from WA+ was not validated, but the rich information available from the study provides a preliminary accounting of the water resources for the state of Nagaland entirely based on the satellite-based open access datasets. This will help the planners, policy makers and others associated in the water sector for undertaking appropriate actionable measures. A capacity building programme on "Application of Water Accounting Plus (WA+) Tool for Water Resources Management" was organized during 28 Nov.-02 Dec., 2022 at Kohima, Nagaland for the officials from WRD, Nagaland.

Snow and Glacier Contribution and Impact of Climate Change in Teesta River Basin, Eastern Himalaya

Recently, inter-governmental panel on climate change (IPCC, 2018) in its report 'Global Warming of 1.5^{0}C' has mentioned very specifically that climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5°C and increase further with 2°C. Sikkim being a Himalayan state is one of the glacier rich areas of the country. The state of Sikkim within the Indian Himalayan region (IHR) falls almost entirely in the catchment of River Teesta, which has the highest sediment yield among all the Himalayan Rivers. During the last few decades, there has been a rapid retreat of glaciers which has created many precarious glacial lakes. For proper water resources planning and management, it is therefore essential to study and monitor glaciers and glacial lakes including GLOF in the Himalayan region. The objectives of the study are: (a) assessment of recent changes in snow, glacier, rainfall and its impact on the hydrology of the Teesta basin through hydrologic modelling, (b) to understand the influence of glacier size, debris cover, topographic (i.e., altitude, aspect, and slope) and climatic variables on recent glacier changes, (c) Sediment transfer characteristics of Teesta River at selected sites and identification of major drivers, (d) assessing climate change in the basin and future scenarios and resultant hydrological responses, (e) to understand and simulate the magnitude of the GLOF hazard of glacial lakes formed due to glacier recession, (f) identification of key change indicators for water resources of the region and their impact on local communities, (g) to develop a comprehensive and interactive web-enabled database repository of the hydro-met database and modelling spatial outputs with basic GIS functionalities.

An innovative trend analysis (ITA), MK test and extreme precipitation indices (EPIs) has been used to assess the spatio-temporal variability of the 7 satellite and reanalysis precipitation datasets and their comparison with the IMD datasets has been carried out to identify the best precipitation dataset. Further, the zonal and altitudinal variability of the precipitation datasets is also assessed. The popular USLE and RUSLE models were used in GIS environment to estimate the soil erosion and identify the areas having higher and lower erosion rates. The latest CMIP6 model (EC-Earth3 BCC-CSM2-MR)

with SSP245 and SSP585 scenarios is used to assess the impacts of the climate change on soil erosion. The AT/RH sensors, raingauge and soil moisture sensors were installed at 07 locations selected to cover whole Teesta basin with altitudinal aspects, i.e. from 430 to 2623 m a.m.s.l as shown below. The Hydrological and cryospheric modelling was done using the SPHY and SWAT models. Wherein, separation and simulation of the different runoff components was done using SPHY model. Future projection were derived using CMIP6 climate models. The inventory of glacial lakes and vulnerable lakes was prepared using LANDSAT dataset and Google. The hydrodynamic modelling of GLOF was done using HEC-RAS model. Water quality sampling was also conducted t 21 locations.

It was found that, out of 7 global precipitation datasets, i.e., IMDAA, ERA, PRINCETON, APHRODITE, CHIRPS, TRMM, and SM2RAIN, the IMDAA outperformed the other datasets in comparison with IMD. Based on the EPIs, an increase in the number of 5-day wet spells and wet days in the southern and southwest parts of the basin, along with a decrease in other areas was observed. The maximum 1-day precipitation depth showed an overall increase across the basin. The parts of the northern and western regions of the basin covered by permanent snow show no erosion, However, some parts of these regions also contribute to the highest erosion. This may be attributed to the sparse

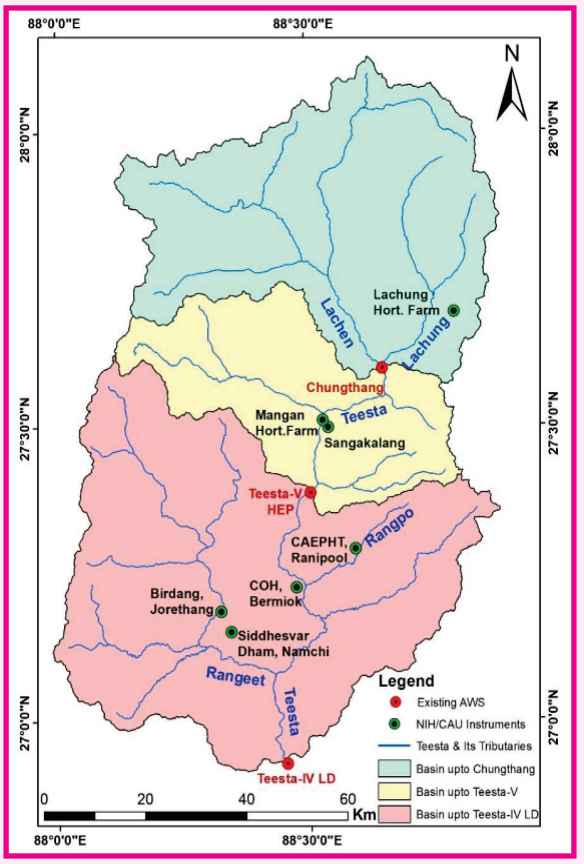


Figure – 7.13: Location of Seven Meteorological Stations in the Teesta Basin



Figure – 7.14: AT/RH, Rain and Soil moisture sensors at Birdang, Jorethang (Rangeet)

vegetation. It was observed that the maximum basin area falls under the classes of very to extremely severe erosion. As per USLE & RUSLE almost 35-40% area under high-risk erosion zone. The SPHY was used to compute and separate the different runoff components such as Snow Q, Glacier Q, Base Q, Rainfall Q and Total Q which helps us to understand the behavior of snow melt and glacier melt in the historical as well as long term domain as shown below.

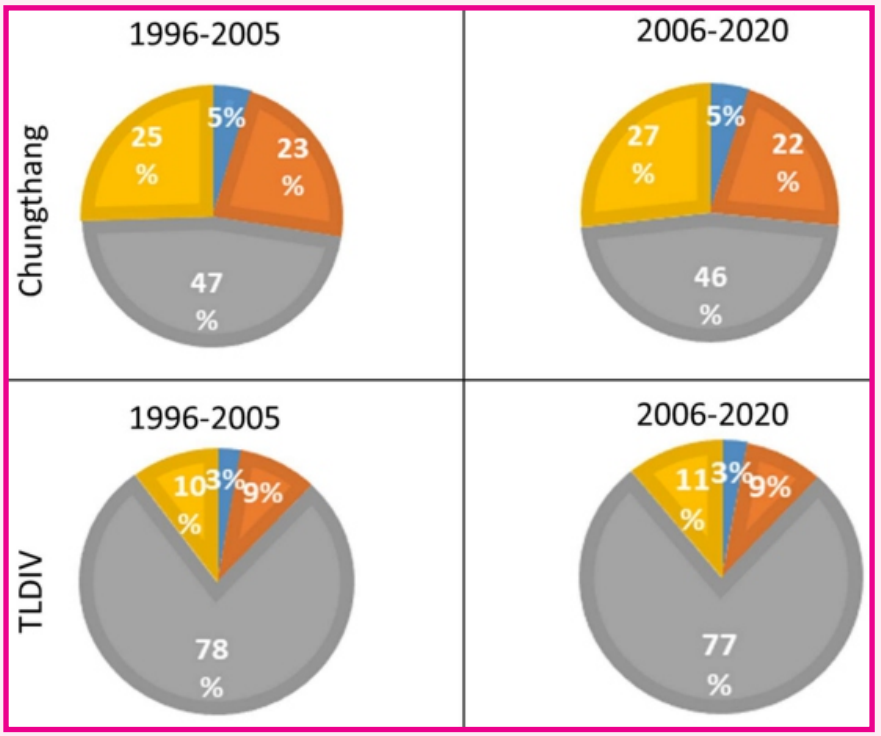


Figure – 7.15: Decadal Changes in Runoff Components at Chungthang (Station 124)

The rainfall has increased and the snow fall has decreased due to enhanced warming in moderate to higher elevation areas and therefore the precipitation vs rainfall ratio is enhanced and the precipitation versus snowfall ratio is decreased. As per the glacier change analysis, it was found that around 5-6% glacier mass have been reduced in the Teesta river basin in last two decades. The comprehensive inventory of glacial lakes in the Teesta basin has been completed, including data on 247 glacial lakes with area (>0.1 ha) for the year 2020. Finally, these lakes were examined to identify which ones are potentially dangerous. The 25 most vulnerable lakes were found using several weighted geometric and geomorphic characteristics, from which 10 lakes offering the highest GLOF threat were determined. These lakes, which are largely located near the major snowline and great Himalayan water divide in Sikkim's north-eastern region, should be monitored on a regular basis. The HEC RAS software was used for the generation of a flood hydrograph for a breach width of 80 m. The GLOF peak is 6683.02 cumec at the lakeside and the same gets mitigated to 4661.32 cumec, 2808.58 cumec and, 2825.53 cumec at Lachen Town, Chungthang Town and, Chungthang HEP, respectively. The time of travel of flood peak from the lake i.e., Lower Barun Lake site to the Lachen Town, Chungthang Town and, Chungthang HEP are 02:00 (hh:mm), 03:00 (hh: mm), 03:00 (hh: mm), respectively. A web portal has been developed under this project (http://nih-teesta.in/index.aspx). This web portal in-houses the datasets such as precipitation datasets (CHIRPS, IMDAAA, TRMM, ERA, SM2RAIN, PRINCETON, APHRODITE, IMD), other thematic layers such as DEM, LULC, Soil, LS factor, soil erodibility factor,

basin and subbasin shape files, district shape files, climate scenario datasets, erosion maps of USLE, RUSLE using CHIRPS, IMDAA and TRMM datasets. These maps can help identify the regions with higher and lower erosion rates. Many of the datasets can be easily downloaded for the area of interest in the Teesta basin. Overall, the results of this study have practical implications for effectively managing water resource and for developing mitigation strategies to address the consequences of climate change in the basin.



Figure – 7.16: Knowledge Dissemination Workshop for the Stakeholders of Teesta Basin

Development of Water Accounts for the Different Subbasins of Brahmaputra and Barak River Basins in the State of Meghalaya Using Water Accounting Plus (WA+) Framework

Agriculture sector is the largest user of water globally and more so in India. About 78% of the water resources available are diverted towards agriculture. However, till now only 48% of the gross cropped area is irrigated in India. This indicates that there is a need for efficient agricultural water management practices to bring more area under irrigation and diverting the excess water to domestic, industrial, and environmental needs. Hence, there is a growing emphasis for increasing water productivity (both irrigated and rainfed) in agriculture. The major objective of the study was to apply the newly developed WA+ framework for the Brahmaputra and Barak River basins of Meghalaya. The specific objectives of the study are to: (a) estimate ET consumption patterns and beneficial and non-beneficial water consumptions, (b) develop accounts for agricultural services (i.e., land productivity and water productivity), (c) prepare the detailed WA+ report for study basins/sub-basins, and (d) impart training on WA+ to the officials of State Water Resources, Agricultural and other allied departments.

WA+ Framework is developed by IHE-Delft in partnership with IWMI, FAO, and the World Water Assessment Program (WWAP). WA+ is based on a mass water balance approach (at the pixel level) and uses Budyko theory (Budyko, 1974) and WATERPIX model (IHE, 2016) for this purpose. The basis of this water balance approach is that outflow from a certain area of interest (e.g., river basin) are explicitly related to the net inflow and depletion through a measurable ET process. The methodological flow chart for developing the

accounts of water productivity and land productivity using WA+ framework is shown below. WA+ utilizes widely available remote sensing datasets to compensate for missing ground measurements of the water balance components (e.g., evapotranspiration) (Karimi et al., 2013). WA+ is particularly useful for water resource reporting in data-scarce regions and ungauged locations as it primarily relies on open-access remotely sensed data. WA+ framework is rather suitable for the scale of large river basins (larger than a few 1000 km^2) and regional studies due to the usually coarse spatial resolution of satellite data.

The performance of the 7 satellite-based, re-analysis and gridded precipitation products, i.e., IMDAA, ERA, Princeton, APHRODITE, CHIRPS, TRMM, and SM2RAIN was assessed with the IMD gridded dataset using goodness of fit statistics in terms of mean, STDEV, R^2, MAE and RMSE and were ranked on the basis of rank-grading (RG) system. The results show that the APHRODITE and CHIRPS perform better than the other datasets for the state of Meghalaya. For wet year, the non-beneficial consumptions in the basin are 19.5 BCM/year much greater than the beneficial consumptions, i.e., 9.6 BCM/year. Similarly, for dry year, the non-beneficial and beneficial consumptions are found to be 19.3 BCM/year and 9.9 BCM/year, respectively. These results show that there is a need of adopting the agronomical and mechanical measures along with the advanced micro-irrigation systems to reduce the non-beneficial consumption. This will make available more water for irrigation and other purposes.

The land productivity of Meghalaya is found to vary from 1959 to 2762 kg/ha/year and 2428 to 3275 kg/ha/year for rainfed and irrigated cereals with an average of 2349.6 and 2783.91 kg/ha/year, respectively during the period of 2003-2019. The water productivity is found to vary from 0.79 to 1.1 kg/m^3 and 2.18 to 3.29 kg/m^3 for rainfed and irrigated cereals with an average of 0.94 kg/m^3 and 2.72 kg/m^3, respectively during the period of 2003-2019. The land productivity of the irrigated cereals (paddy) and water productivity for rainfed cereals (paddy) for the different districts of the Meghalaya. The water productivity and the land productivity data can be coupled with the crop price to estimate the income of farmers. Such information will be helpful in preparing poverty alleviation programs and in improving village livelihoods. A follow up analysis to identify the factors behind large differences in WP will guide the government in taking steps to improve WP in areas where it is low.

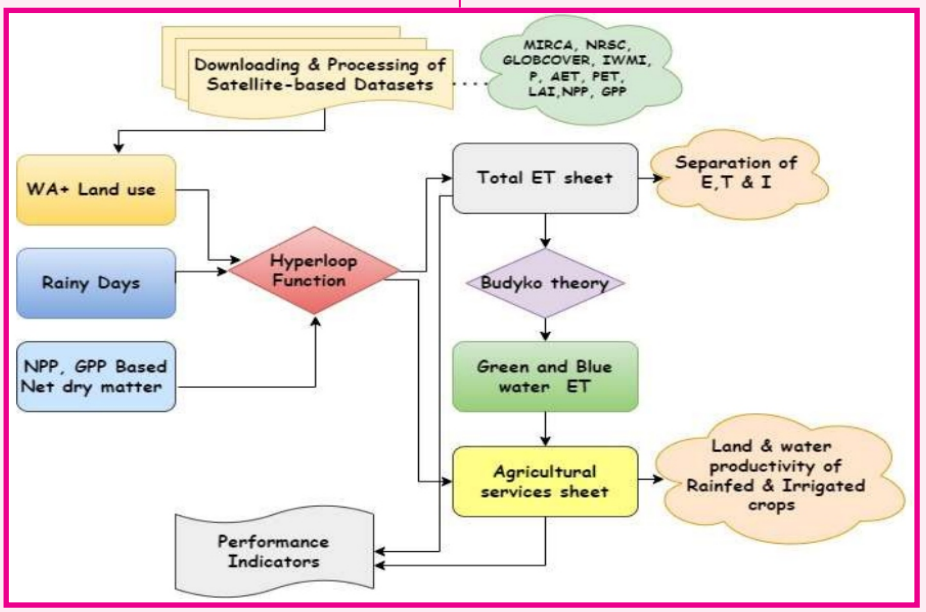


Figure – 7.17: Flow chart of WA+ Framework for Water and Land Productivity

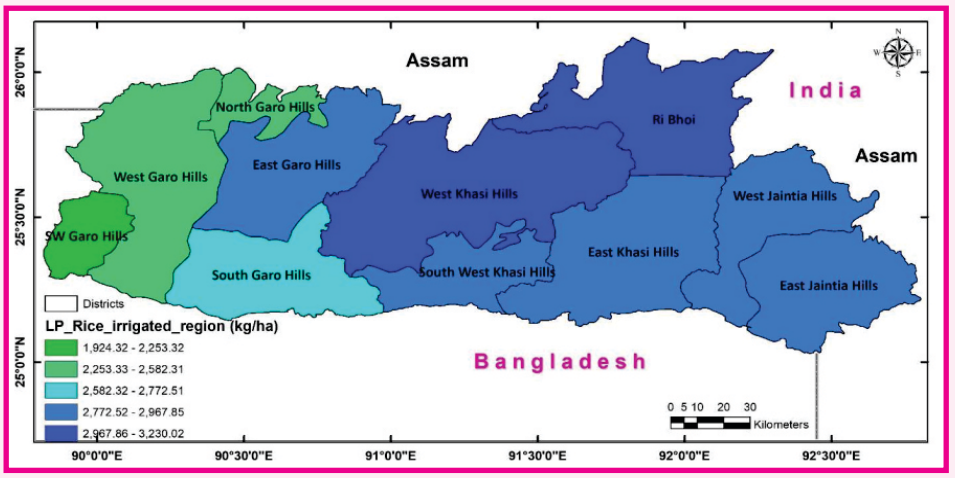


Figure – 7.18: District-wise Average Land Productivity for Irrigated Cereals (Paddy)

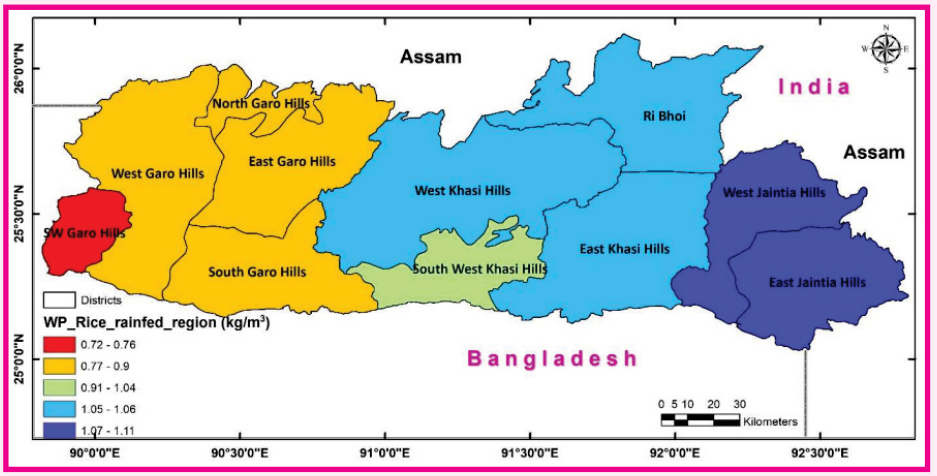


Figure – 7.19: District-wise Average Water Productivity for Rainfed Cereals (Paddy)



Figure – 7.20: Knowledge dissemination workshop for North-East WRD Officials, Shillong

7.2 SPONSORED PROJECTS ON-GOING DURING 2023-24

Long-term Hydrological Assessment for the Development of Water Security Plan in the Mizoram State, India

The study is envisaged to apply the advance modeling framework for Barak, Minor rivers draining into Bangladesh (MRD-BAN) and minor rivers draining into Myanmar (MRD-MYA) subbasins in the state of Mizoram for water security plan. This will generate useful base data to help development of proper water management strategies and decision processes. The major objectives are (a) to collect, prepare and evaluate various thematic maps such as DEM, LULC map, soil map, population data and hydro-meteorological data-such as precipitation, temperature, discharge etc., (b) Long-term rainfall trend analysis based on rainfall frequencies and intensities to analyze the effect of climate change, (c) hydrological modelling, calibration and parameterization over Barak, Minor rivers draining into Bangladesh and Minor rivers draining into Myanmar subbasins in the state of Mizoram for the assessment of watershed components and water availability using SWAT and SWATCUP models, (d) analyzing the effect of LULC changes on the hydrological scenarios such as water availability (or water yield) at sub-catchments scale and discharge at the outlets, (e) analyzing the effect of climate changes on the hydrological systems, with possible thresholds for resilience under different conditions and combinations anticipated, (f) To setup WEAP model for calculating water demand of Mizoram state subject to mid-term water availability (up to 2050) to increase water use efficiency and maintaining the adequate water supply sustainable development, (g) to prepare the detailed report for study basins/sub-basins in Mizoram state as per the mid-term hydrological assessment with the guidelines of water security plan with particular reference to demands identified by the WRD, Government of Mizoram, (h) to impart training on "hydrological modelling" to the officials of Water Resources, Agricultural and other Depts, as well as officers from NHP, (i) selection of dam sites with suggested capacity to meet the growing demand of water in the state. This study is under progress.

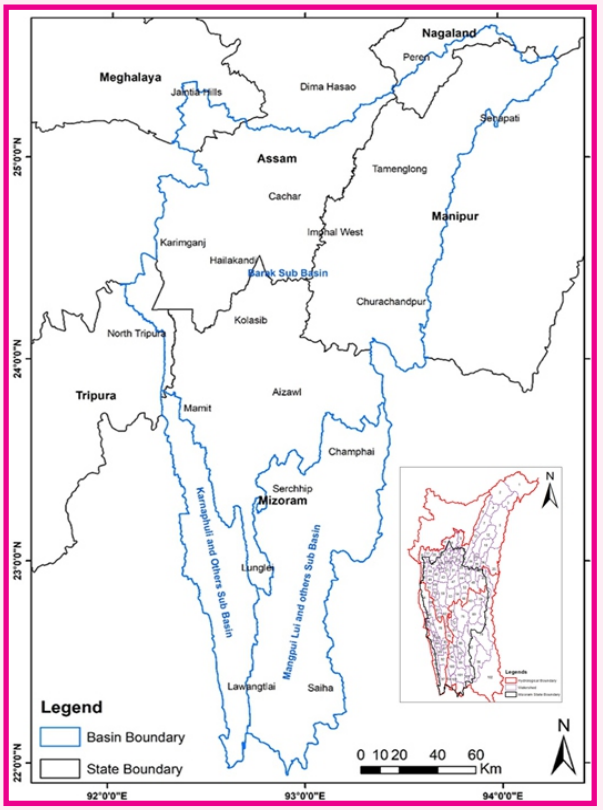


Figure – 7.21: Location Map of the Study Area

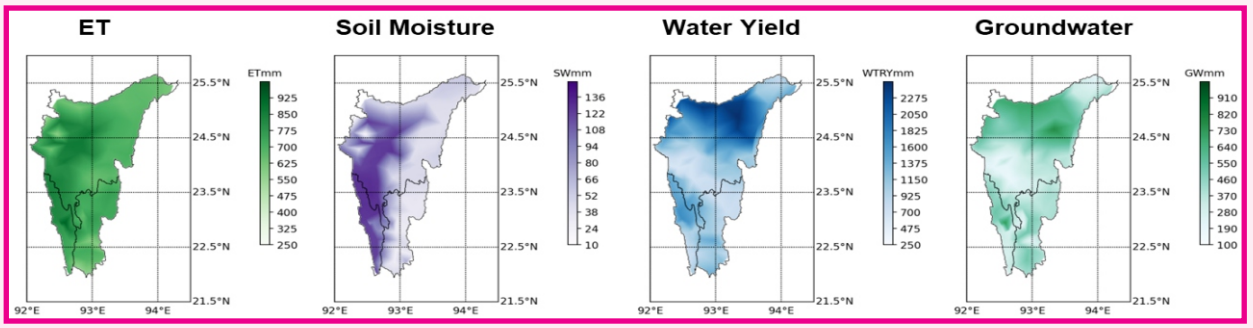


Figure – 7.22: Mean (2002-2020) scenarios of main hydrologic components in the area

Assessment of Glacier-Climate Functional Relationships across the Indian Himalayan Region through Long-Term Network Observations

Himalayan glaciers are remotely located and known for its extreme topography and harsh climatic conditions. Therefore, the scope of continuous physical observation and monitoring of glaciers is very limited. However, indigenous and foreign satellites in the polar orbits provided a variety of remote sensing data in optical, infrared and microwave bands that can be precisely used for larger spatial extent and better temporal observations. RS data acquisition techniques have been significantly improved and have been offering a better resolution of data as good as the sub-meter level that not only can be used to study the surface features but also the subsurface features present in the glacier regions. Assessment of glacial dynamics, changes in the glacial morphometry and mass balance will be carried out using space-based resources and field measurements. Identifying changes in the glacier hydrodynamics and glacier melt-water chemistry will be done using in-situ observations. Investigating glacial mass balance as a response to changing climatic parameters using functional relationships through real-time and memory-based networks for understanding the glacial-climate functional relationships is essential. The water balance, glacier discharge measurements and meltwater chemistry analysis will be carried out for selected glaciers of the Kali sub-basin.

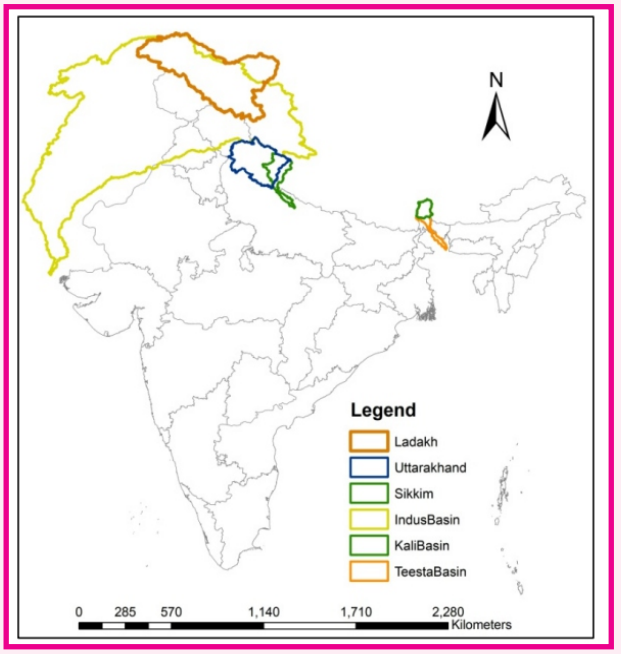


Figure – 7.23: Study Area (Indus, Kali and Teesta Basins)

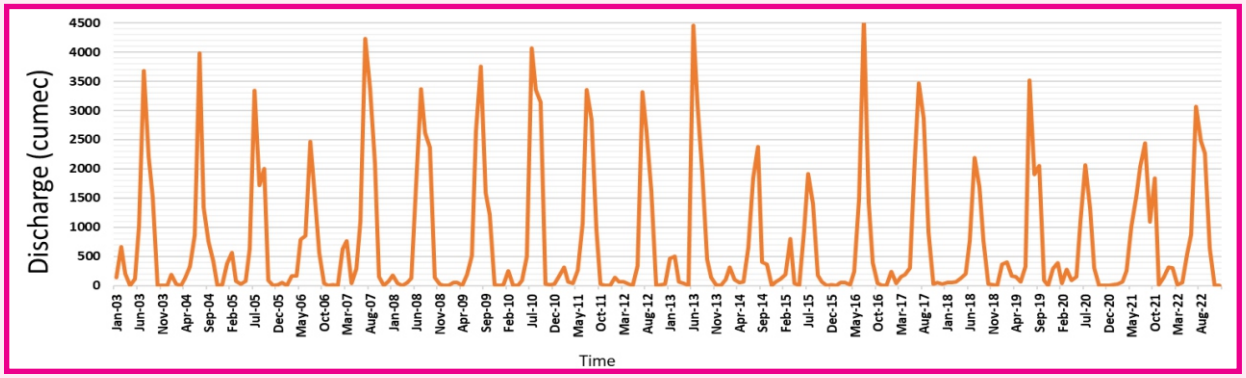


Figure – 7.24: SWAT Model based derived flow at Outlet of Kali River basin, Uttarakhand

Satellite based Mountain Hazard Assessment and Monitoring (MHAM) in Uttarakhand.

The study area of the project includes the Gangotri and adjoining areas in Bhagirathi valley (Gomukh to Harshil). The scope of work includes as per data availability, monitoring and mapping of potential hydro-meteorological hazard prone zones in the study area jointly with IIRS using satellite data products and DEM, Preparation/compilation of thematic layers like LULC maps, slope, drainage network, basin boundary, glacial lakes map, glacier map, Generation of hydrographs and flood inundation library for extreme rainfall events, and flood hazard assessment for extreme events of selected flood prone river reaches.

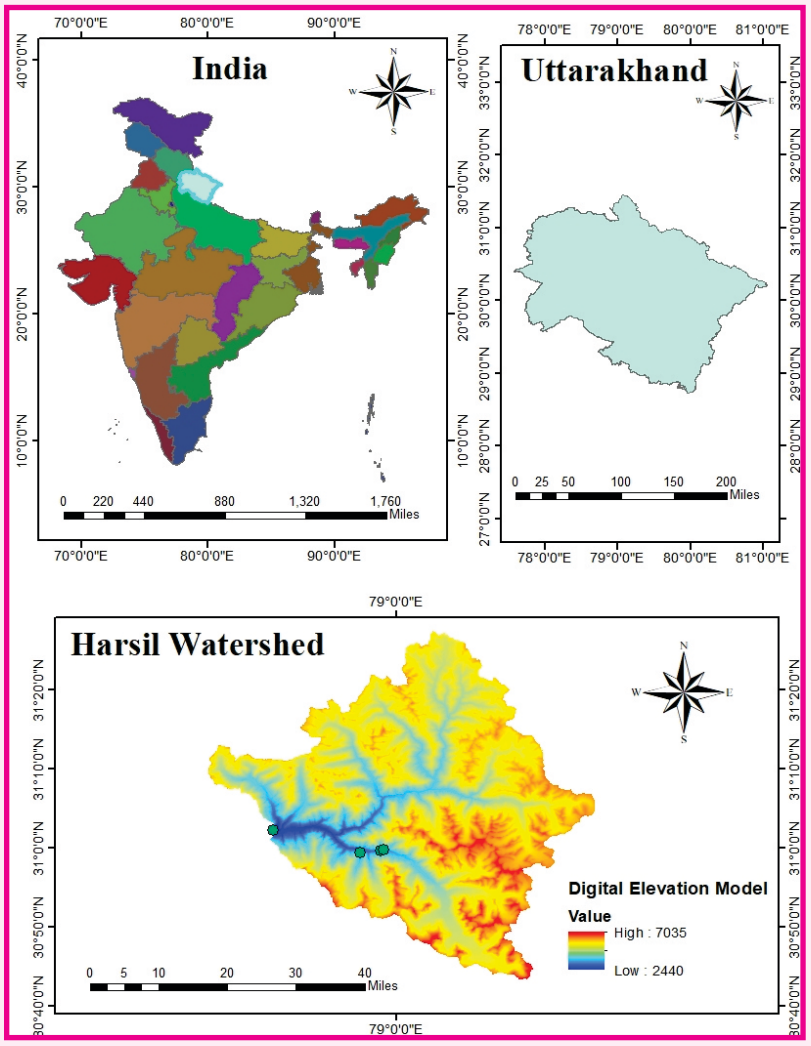


Figure – 7.25: Study Area Map of Bhagirathi River (up to Harshil)

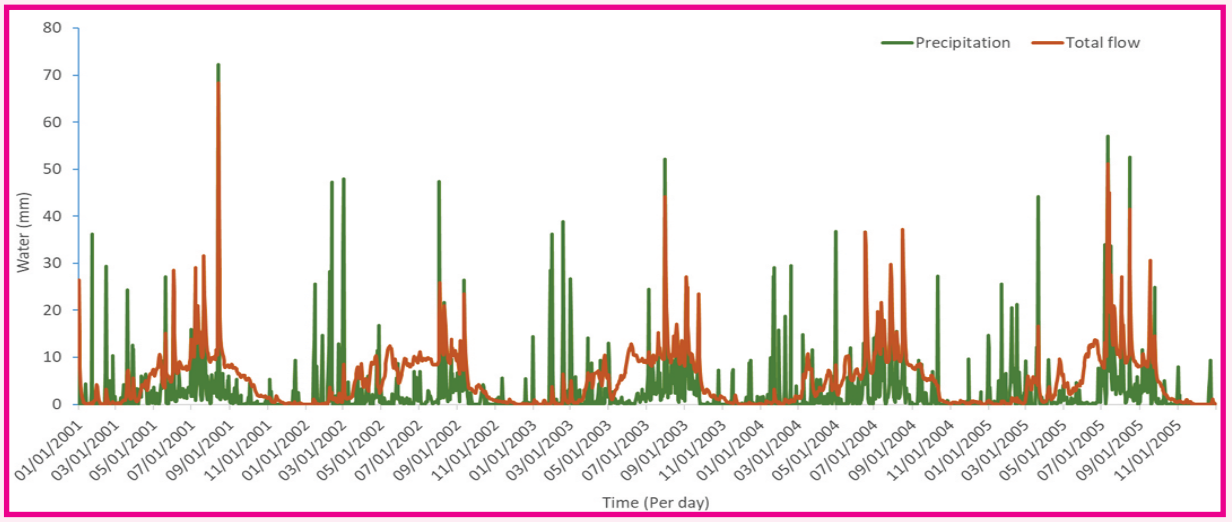


Figure – 7.26: Rainfall vs Runoff Computation using SWAT at Harshil in Bhagirathi River

Hydrological Assessment of Ungauged Basins (Aghanashini, Dasanakatte, Sita Nadi, Madisala Hole, Swarna Nadi and Gurupur River Basins) of the West Flowing Rivers in the Western Ghat Region of Karnataka

The Western Ghat region is the origin and primary catchment of many rivers in peninsular India. This ungauged (mostly) region falls within high rainfall region and the rivers yield large amount of water, most of which flows are unutilized and drained into the Arabian sea owing to the steep slope. In view of this, the Govt. of Karnataka has decided to assess the water yield of the ungauged river basins within the Western Ghat region. Since these large water resources are being unutilized, the State Government has formulated some plans to divert the water from water rich catchments to other parts of the State. Therefore, it is required to carry out a comprehensive study on water availability and environmental water requirement of the catchments of the west flowing rivers within this region.

The objectives of the study are (a) to collect, prepare and evaluate various thematic datasets such as DEM, LULC map, soil map, and hydro-meteorological data-sets such as precipitation, temperature, discharge (if available) etc., (b) to analyze long-term hydro-meteorological variables such as precipitation, ET, and water consumption patterns in the basin and assessment of their possible impacts on water management in the basins, (c) to assess water potential and demands of the west-flowing rivers, i.e., Aghanashini, Dasanakatte, Sita Nadi, Madisala Hole, Swarna Nadi and Gurupur River basins, (d) to assess the effects of climate and land use changes on the water yield and demands in these basins, (e) to analyze the hydrological sensitivity and resilience capacity of the basins under adverse climatic impacts, (f) to impart training on the hydrological models to the state officials of the WRD including IAs of NHP, (g) to prepare the detailed sub-basin wise project report for the state WRD for planning purposes.

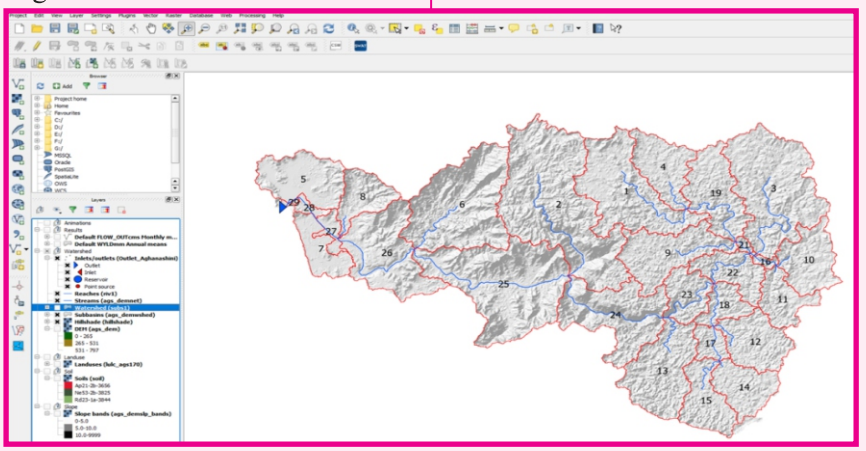


Figure – 7.27: Location of the Aghanashini Basin

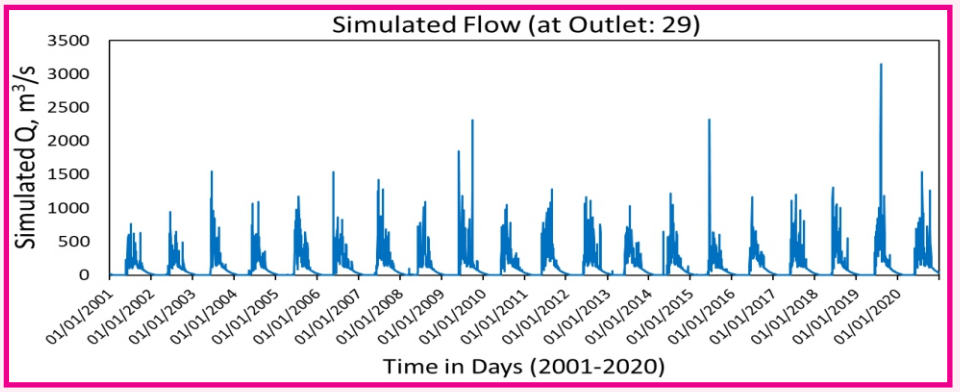


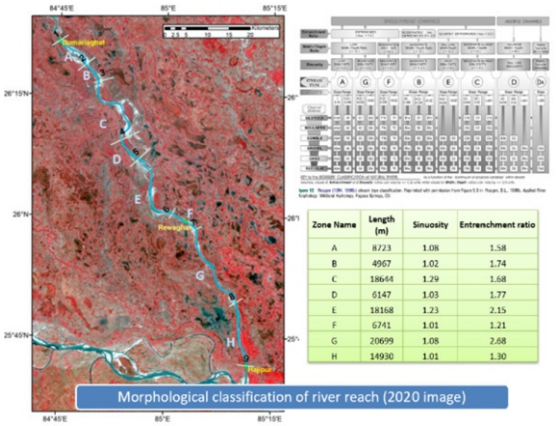
Figure – 7.28: Simulated Flow at the Outlet of River Agnashini

Modeling and Management of Erosion and Sedimentation Processes in Gandak River using Morphodynamic Modeling

The problem of erosion and siltation in a river reach is equally disastrous and need engineering interventions at critical locations. For providing dependable protection, scientific approach is required to understand the river morphodynamic and to estimate the suitable hydraulic design parameters for anti-erosion works and silt management measures. The 2D morphodynamic models are better replica of flow conditions and velocity distribution in alluvial river to understand the river regime and flow characteristics. The study is proposed with following objectives: (i) satellite image based river shifting/ meandering analysis, (ii) to develop the flow field and carry out flood studies of river channels and adjacent floodplains using a curvilinear grids that follow the bank lines to compute the flow characteristics like maximum flood level, flow velocity, flow direction, etc., (iii) to forecast of morphological changes over 2-3 years in the mobile braided river, (iv) to prepare design criteria for river training works in terms of flow velocities, flow depths, scour depths, bank line retreat rates, shoaling, etc., (v) to analyze sediment deposition (and erosion) in the study stretch, particularly at the meandering portion, bifurcations, confluences etc. and prediction of required annual volume of silt for dredging and sand mining, etc. The river stretch for the study has been finalized in consultation with WRD, Bihar. It is situated around Rewaghat on Gandak river, about 45 km stretch upstream of Hajipur Bridge on the Gandak River. The study reach for detailed analysis is from Fatehabad/ Kunwari village to Baligaon village in a stretch of 20 km.

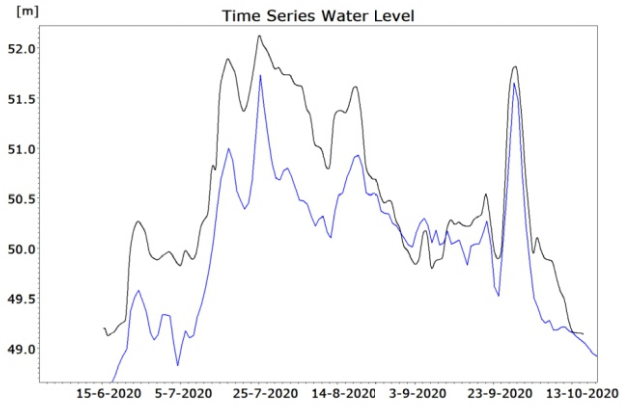
The numerical models for river flow simulation and sediment transport are divided into three main categories: one-dimensional (1D), two-dimensional (2D) and three-dimensional (3D). 1D models, although simple to use, fail to provide detailed information regarding the flow field while data requirement for 3D models are extensive and almost impracticable for field applications. However, 2D modelling has the advantage of simulation of flow propagation with greater accuracy. In the study, use of MIKE 21C model is proposed. The main advantage of MIKE 21C model is that it is based on a curvilinear (boundary-fitted) grid where the grid lines follow the bank lines. The curvilinear grid makes the MIKE 21C model a suitable tool for fast and detailed simulation of river hydraulics and sediment transport. The morphodynamic model is able to describe the variation in hydrodynamic characteristics i.e. water level, flow velocity and morphological characteristics such as helical flow, sediment transport, scour and deposition, bank erosion and plan form change of a river etc.

During the first year, river morphological studies in temporal satellite images for the study reach has been carried out from Dumariagath to Hajipur. The river is divided into eight stretches and bank line shifting trend and morphological parameters for each reach were computed. During the second year, the river bathymetry and on-site observation of hydrological data at Baligaon village were carried out for measurement of the flow velocity and discharge, eco-sounder and current metre were used. Further, radar based AWLR have been installed at two sites. The flood frequency analysis of flow data observed at Dumariaghat and Lalgunj site have been carried out. During the current year the 1D hydrodynamic and sediment transport flow models have been developed. The 1D hydrodynamic model is developed for Gandak river from Dumariaghat to Hajipur GD location. The model is calibrated with the observed water level at Lalganj. The model is simulated for the observed data of sediment for the year 2020 and the change in the bed level is computed. 2D HD flow model using curvilinear grid has also been developed for a part of Gandak River in a stretch of 20 km. The stretch is divided into 484x134 grids. The 2D curvilinear model is calibrated with the observed water level at Rewaghat site.



Zone Name	Length (m)	Sinuosity	Entrenchment ratio
A	8723	1.08	1.58
B	4967	1.02	1.74
C	18644	1.29	1.68
D	6147	1.03	1.77
E	18168	1.23	2.15
F	6741	1.01	1.21
G	20699	1.08	2.68
H	14930	1.01	1.30

Morphological Characteristic of Gandak River



Flow model (1D) Calibration for 2020 Flow Data

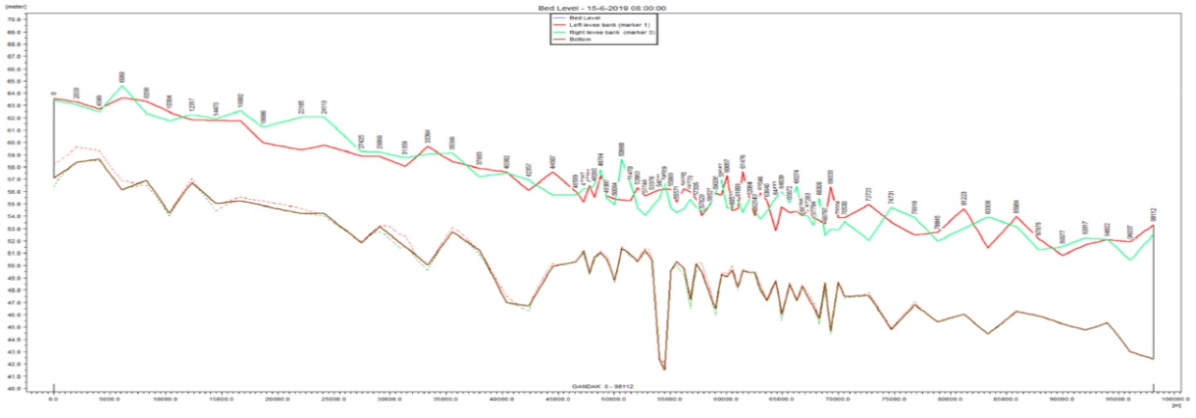
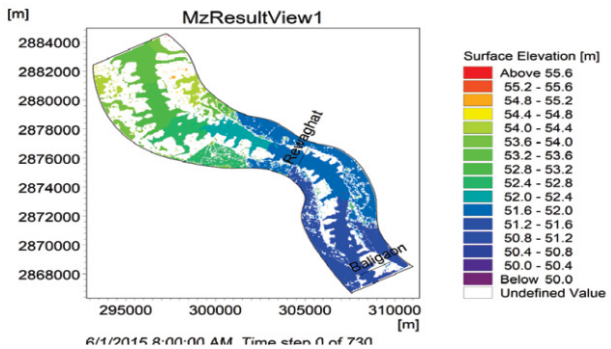
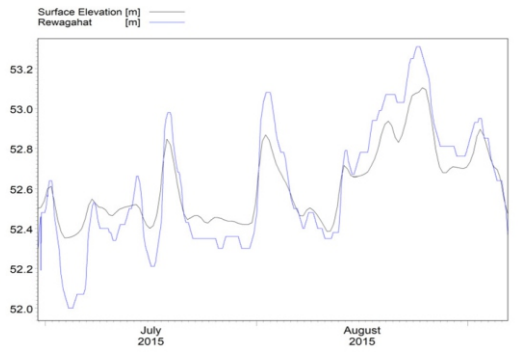


Figure – 7.29: Sediment transport model to estimate the change in river bed level



Study Stretch for Curvilinear Flow Model



2D Curvilinear Grid Model Calibration

Figure – 7.30: Sediment transport model and its calibration

Integrated Reservoir Operation Study for Mahanadi Reservoir Project Complex in Chhattisgarh

Chhattisgarh state is rich in water resources having several multiple complex projects. Most of the projects are very old and working on experience-based rules for operation. The study under PDS aims to develop a multi-reservoir operation rule using optimization techniques for the complex reservoir system in the Mahanadi Reservoir Project (MRP). The MRP complex consists of four reservoirs in the Mahanadi basin: Ravishankar

Sagar, Dudhawa, Maramsilli, and the Sondur reservoir in the Pairi basin. An inter-basin transfer of water occurs from the Pairi basin to the Mahanadi basin through a feeder canal. The major demands on this system include municipal, industrial, irrigation, and hydro-power needs, serviced by both the feeder canal and the Mahanadi main canal. During this period, data on reservoir levels, releases to canals and spillways, transfer of water, etc. were collected and applied in the water balance models to determine inflow to these reservoirs. The inflow, rainfall, and evapotranspiration were used to develop MIKE 11 NAM model for the catchments of all these reservoirs. The calibration was made from 2005 to 2015 with the coefficient of determination from 0.7 to 0.76, and validation from 2016 to 2020 with the coefficient of determination from 0.69 to 0.73. The developed NAM models were used to extend the runoff series for thirty years to develop rule curves. The demand and inflows were used in NIH_ReSyp software to develop rule curves for individual reservoirs. The integrated system operation of reservoirs is in progress.

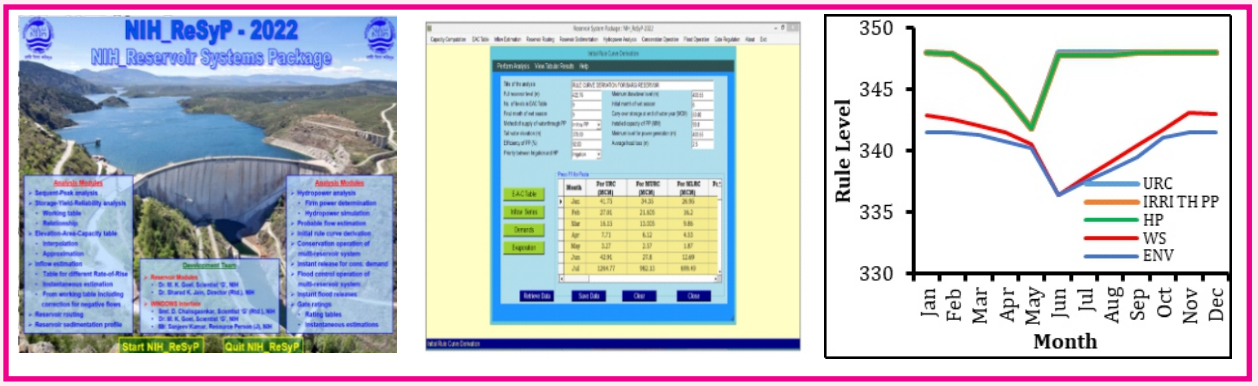


Figure – 7.31: NIH_ReSyp software application for development of rule curves of RS Sagar

High Performance Advanced Septic System for Villages and Roadside Restaurants

The water samples were collected from main pump house, septic tank, wet land and final tank, as per availability during the period of 2023-24. The evaluation of HPAS in terms of DO, BOD, various physical parameters and hydrochemistry is completed up to August 2023. In-situ measurements of Temperature, pH, EC, TDS, Turbidity and DO were carried out. The samples were analysed for BOD, Ammonia, Nitrates, Nitrites, Phosphates and Sulphates. The samples were also tested for Coliform Bacteria in the Lab. The HPAS performance of sewage water treatment evaluation is being continued. Results indicated that 85 to 95% contaminants were removed from the raw sewage water by using the HPAS system. The variation of DO and Nitrate in the HPAS system is as shown below.

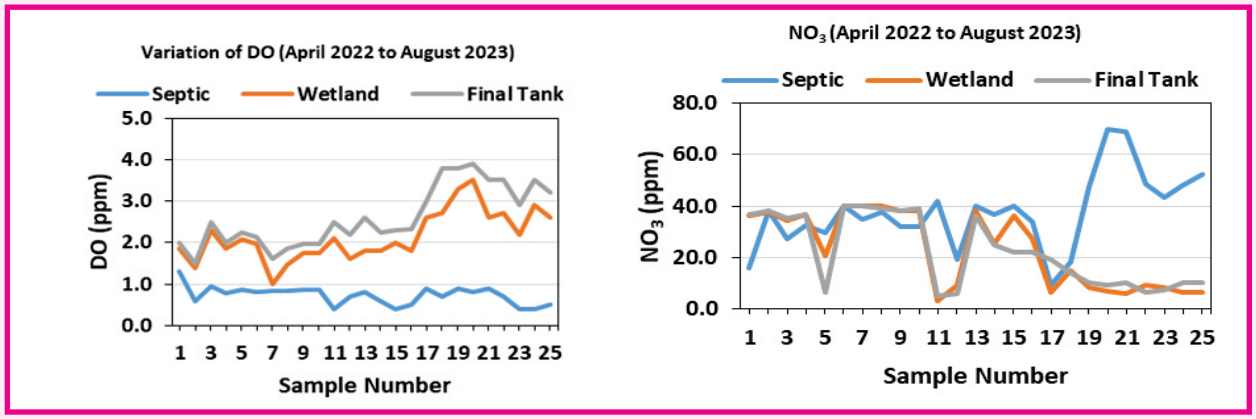


Figure – 7.32: Comparison of DO and Nitrate in SPAS system

Innovation Centre for Eco-Prudent Wastewater Solutions (IC-EcoWS)

This project has been funded by DST, Government of India. The NIH Roorkee is the leading institute for implementation of this project, in collaboration with the project partners from IIT, Bombay, MNIT, Jaipur, and IRMA, Anand. The objectives of the project are (i) establishment of a state-of-art Centre for Eco-Prudent Wastewater Solutions (IC-EcoWS) to harness the potential of Natural Treatment Systems (NTS) and other eco-prudent resource recovery technologies for water security and sustainability in India, (ii) development of a Decision Support Tool (DST) based on Life Cycle Assessment (LCA) and Multiple Criteria Decision Making (MCDM) approach for selection of appropriate "Technology Packages" for resource recovery oriented wastewater treatment infrastructure, (iii) establishment of few pilot study sites (Live Laboratories) for detailed assessment of selected NTS in urban, peri-urban and rural settings, for both secondary and tertiary treatment requirements as per new CPCB norms as well as for select emerging pollutants, (iv) to explore innovative ideas on the development (e.g. use of pre-fabricated structures, efficient structures for control of solid waste in sullage) and application (e.g. retrofitting of existing village ponds, drains, linkage to livelihood options) of NTS for wastewater treatment and (v) to organize capacity building, awareness creation, documentation and dissemination activities, and preparation of a TOT Module on NTS applications and an Indian handbook for promotion and propagation of NTS for resource recovery and wastewater treatment in India.

During 2023-24, innovative ideas for wastewater treatment using NTS have been explored, including the removal of heavy metals from water using macrophytes such as *Pistia stratiotes* and *Azolla pinnata*, and field experiments on pesticide removal from synthetic wastewater. The potential for biogas generation from *Canna indica* is also being evaluated as part of resource recovery efforts. A dynamic life cycle costing module and the decision support tool 'JalVishwa' have been developed and released, with 'JalVishwa 1.0' now available for urban local bodies, engineers, and academicians. Pilot study sites have been established in urban, peri-urban, and rural settings to assess the efficacy of selected NTS, with detailed physicochemical and microbiological analyses conducted on vertical flow and horizontal flow constructed wetlands. Furthermore, survey work and social cost-benefit analyses for 20 NTS projects, including constructed wetlands, have been undertaken to develop viable business models, highlighting a commitment to innovative and sustainable wastewater management solutions.



Figure – 7.33: Constructed Wetland in NIH Residential Colony, Roorkee, Uttarakhand



Figure – 7.34: Horizontal Subsurface Flow Constructed Wetland for Pesticide Removal from Synthetic Wastewater (NIH Campus)



Figure – 7.35: Experimental Setup for Biogas Generation from Canna indica as a Part of Resource Recovery

Isotopic and Geochemical Approach to Study Vulnerable Confined and Unconfined Drinking Water Aquifers in Varanasi and Surrounding Area, India

Densely populated region of Ganga Plain is facing aquifer vulnerability through waterborne pollutants and groundwater stress due to indiscriminate abstraction, causing environmental and socio-economic instabilities. To address long-term groundwater resilience, it is crucial to understand aquifer heterogeneity and connectivity, groundwater recharge sources, effects of groundwater abstraction, etc. In this context, present study aims to understand factors responsible for vertical and spatial variability of groundwater chemistry and to identify groundwater recharge sources in an intensively exploited agrarian region of the Ganga Plain. Interpretation of chemometric, statistical, and isotopic analysis categorizes the alluvial aquifer into zone 1 (G1; ground surface to 100 m) and zone 2 (G2; >100 m-210 m). The group G1 samples are characterized by a wide variation in hydrochemical species, noted with pockets of F^- and NO_3^- rich groundwater, and fresh to more evolved water types,

while group G2 groundwater is characterized by a sharp increase in freshwater types and limited variation in their isotopic and hydrochemical species. The G1 groundwater chemistry is governed by soil mineralogy, local anthropogenic inputs (SO_4^{2-}, Cl^-, and NO_3^-), and manifested by multiple recharge sources (local precipitation, river, canal water, pond). The G2 group is dominated by geogenic processes and mainly recharged by the local precipitation. Geospatial signatures confirm more evolved water type for group G1 in northwestern region, while freshwater type covers rest of the study area. F^- rich groundwater is attributed to sodic water under alkaline conditions and enriched $\delta^{18}O$ values emphasizing role of evaporation in F^- mobilization from micas and amphiboles abundant in the soil. The zone 3, south-eastern portion of the study area (located in the urban region) is characterized by fine loamy soil and freshwater types with pockets of evolved water types (saline) but comparatively enriched $\delta^{18}O$ values, an indication of slow recharge under high evaporation. Based on the hydrogeological conditions, hydrochemistry and isotopic results, the augmentation and development of groundwater can be achieved by the installation of recharge structures mainly in the well-drained loamy soil away from the canal command areas to avoid salinity in time to come.

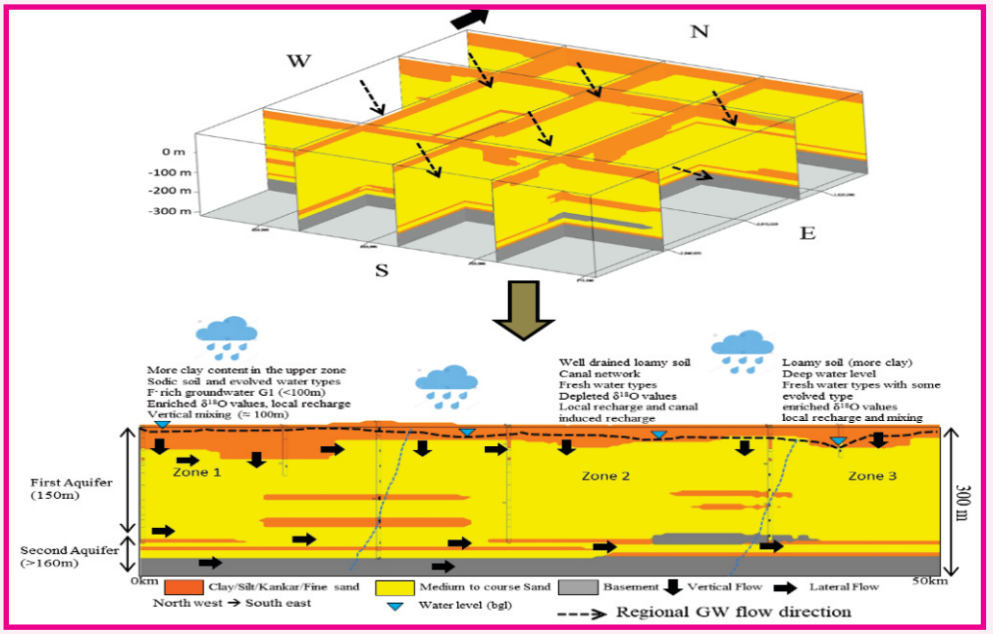


Figure – 7.36: Scheme showing various hydrochemical and isotopic processes in study area as a function of hydrological condition, soil mineralogy, and depth to water table

Comprehensive Characterization of Variably Processed Sewage Sludge in Ganga Basin to Classify its Suitability for Safe Disposal

Ganga Basin produces a voluminous amount of waste sludge from the wastewater treatment plants (STPs), which is usually a semi-solid waste or slurry that requires further treatment before being disposed or used for land application. In India, sewage sludge handling and maintenance is a great challenging issue due to the lack of infrastructure and policy framework for sludge management owe to the non-availability of waste sludge generation data. The sludge samples wer6e collected from 44 STPs and examined for physical-chemical parameters and microbiological parameters. All standard criteria specified by Fertilizer Control Order (FCO) 2009, US EPA Class A and Class B sludge are considered to compare the quality of sludge. Two reports providing the comprehensive characterization of the sludge from 44 STPs have been prepared and submitted to NMCG and CPCB. The report provides the suitability of sludge disposal and reuse through comparing with FCO (2009), USEPA Class A and Class B standard criteria. Later a 1-day

workshop on 'Characterization and Policy framework/Guidelines on Safe and Efficient Sludge Management' was conducted by NMCG involving the policy makers, researchers, academicians, and stakeholders.

Identifying Best Available Technologies for Decentralized Wastewater Treatment and Resources Recovery for India

(a) Ctech SBR Small Package Type Wastewater Treatment Plant: The water quality of the River Ganga upstream of Haridwar is very good. However, it deteriorates downstream due to water abstraction for agriculture and other public uses, as well as the discharge of untreated wastewater from villages and settlements along the riverbanks. To achieve bathing water quality from downstream Haridwar to Garhmukteshwar, advanced small-scale Sewage Treatment Plants (STPs) capable of maintaining BOD, TSS, and TN levels below 10 mg/L are required. In this project, a 100 m^3/day SBR system was evaluated for municipal wastewater treatment. During the start-up phase, with a cycle time of two hours, the system achieved removal efficiencies of over 80% for COD, over 85% for BOD, and over 88% for TSS. The nutrient (N and P) removal in the plant exceeded 50% and is currently being optimized. The Sludge Volume Index (SVI) of the plant's sludge averages below 55 mL/g, and the Mixed Liquor Suspended Solids (MLSS) is approximately 2769 mg/L.

(b) CAMBI Thermal Hydrolysis Process (THP): Managing waste sludge from STPs in metro cities of India is increasingly challenging due to the lack of landfill space and reluctance from farmers to use the sludge. The cost of sludge management has risen to 20-30% of the plant's operational costs. Anaerobic sludge treatment for biogas recovery is a viable option to reduce these costs, but technical and operational difficulties limit its effectiveness. To fully leverage the benefits of anaerobic digestion and improve gas yield, thermal hydrolysis by CAMBI is one of the most successful pre-treatment systems. THP was tested for treating municipal wastewater treatment plant sludge. Among various pre-treatment conditions, a temperature of 160°C for 30 minutes demonstrated the highest efficiency, with a cumulative methane yield of 507 mL CH_4/g VS added and a volatile solids (VS) removal rate of 54%. THP pre-treatment at 180°C, followed by anaerobic digestion, achieved up to 80% removal of organic micropollutants, outperforming other THP conditions.

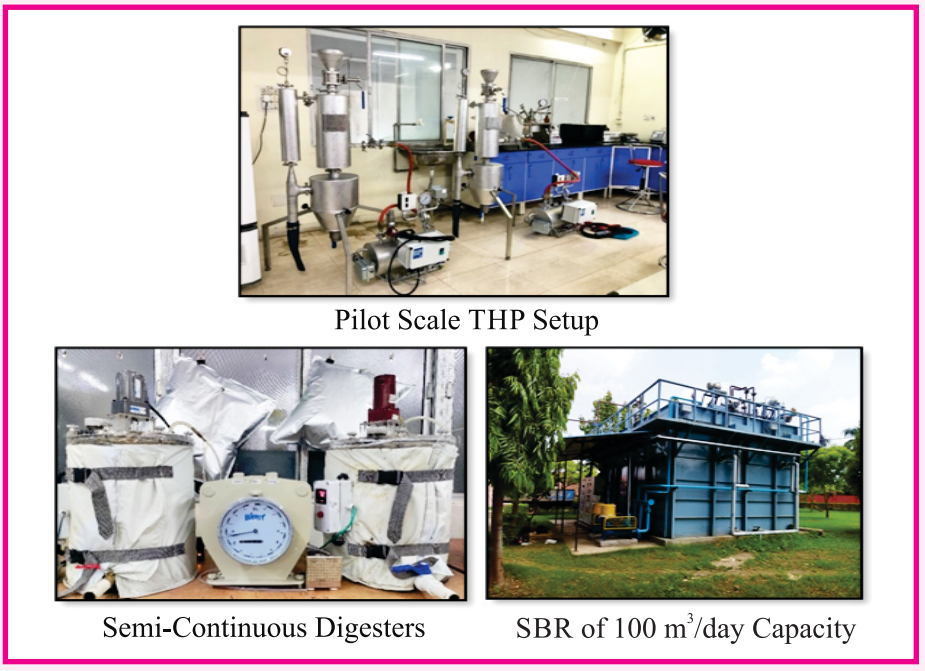
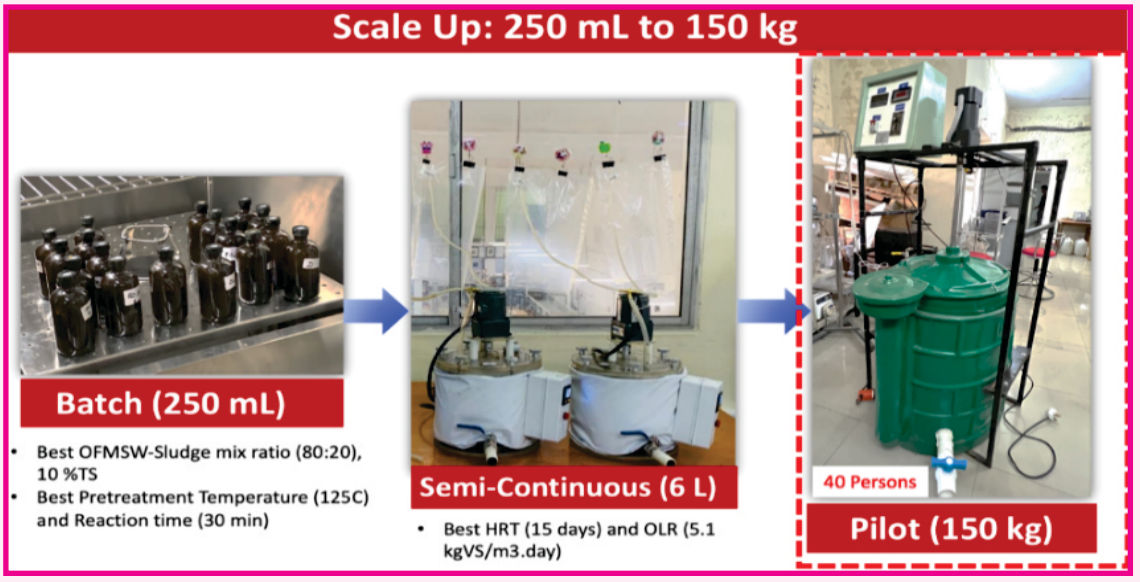


Figure – 7.37: THP Setup Showing Digesters and SBR

Both the process, i.e. SBR and THP, effectively treat the wastewater and sludge, respectively. The studied technologies have the potential to reduce the water pollution and recover the resources in terms of water for non-potable reuse purposes and methane and nutrient rich digestate for energy generation and as a soil amendment, respectively.

Anaerobic Co-Digestion of Thermo-Chemically Pretreated OFMSW and Sewage Sludge: Effect on Process Performance and Microbial Community Development

The novel thermal-alkali integrated anaerobic digestion process was started with 250 mL (batch) reactor followed by the upscaled reactors of 6 L (semi-continuous) and finally to 150 L. The highest biogas yield increment of 43% (474 mL/gVS $_{added}$) and 87% (618 mL/gVS $_{added}$) was observed at 125˚C and 125˚C+3g/L NaOH dose, respectively, over control (331 mL/gVS $_{added}$). The upscaled semi-continuous work shows the highest methane yield and VS removal (0.445 m3 CH4/kgVS, 52% VS removal) at 15 days HRT and 5.1 kg VS/m^3.d OLR under thermal-alkali pretreatment. Energy balance analysis revealed that thermal alkali pretreatment showed the highest positive energy balance of 114.6 MJ/ton with an energy ratio of 1.25 compared with thermally pretreated (81.5 MJ/ton) and control samples (-46.9 MJ/ton). The pilot scale study revealed that thermal pre-treatment at 125 °C increases soluble COD by almost 2.2 times. At 15 days HRT, Highest Biogas yield (510 mL/gVS $_{added}$), Methane yield (367mL/gVS $_{added}$) and VS removal (50%) was achieved. Highest CH_4 percentage of 72% in biogas was achieved. Energy analysis showed net positive energy factor [Total energy provided 459 MJ/Total Energy Recovered 517 MJ] of 1.126. It shows a positive energy balance of process studied.



Enhancing Food and Water Security in Arid Region through Improved Understanding of Quantity, Quality and Management of Blue, Green and Grey Water

The nodal institution for the DST funded WATER IC Project is ICAR-CAZRI, Jodhpur. The NIH, Roorkee, is one of the partner institutions. Other partner institutions include IISWC, Dehradun; CSWRI, Bikaner; CIAH, Bikaner; NIAM, Jaipur. Major objectives of the project are to (i) enhance water productivity in farming systems (districts Jodhpur, Jaisalmer, Barmer and Bikaner), (ii) develop improved methods for reusing industrial effluents in agriculture, (iii) analyse future demand and supply of water at regional and sub-regional level, and (iv) develop policy guidelines and capacity building of stakeholders.

NIH has worked towards estimation of spatial and

temporal variation in groundwater recharge in Indira Gandhi Nahar Project (IGNP) area using water balance model. In addition, climate change indices based on ETCCDI indices have been generated for IGNP area based on CMIP6 SSP2-4.5 and SSP5-8.5 scenarios. Field experiments were performed in CAZRI campus to study the impacts of different irrigation schedules on onion crop. Data collected from field experiments were used to numerically simulate flow in variably saturated porous media and study the impacts of different irrigation schedules on onion crop using HYDRUS software. The numerical simulations provided simulated soil moisture variation, and variation of moisture flux with days, in the respective scenarios for four different bed conditions 1) control flat-bed, 2) control raised bed, 3) mulched flat bed, and 4) mulched raised bed condition with three drip irrigation scenarios. The WA+ framework designed to provide explicit spatial information on water depletion and net withdrawal processes is being applied in Luni river basin using satellite measurements. The relevant sheets of WA+ for Luni Basin have been generated and results are being evaluated.

Groundwater Model Development in Micro Basin of Hard Rock in Krishna and Godavari River Basins of Telangana

The River Krishna and Godavari are the major source of water in Telangana. Due to insufficient reservoirs, farmers are shifted on groundwater irrigation and is on increasing trend in the state. The CGWB and State Ground Water Dept. has reported that many mandals are falling under critical condition. Overall, the groundwater situation in the state depicts a declining trend. Hence, the present study aims at initiating a comprehensive analysis by using groundwater modeling techniques in the selected micro-basins of river Krishna and Godavari. The objectives of the study are to (i) understand the dynamics groundwater aquifer systems by carrying out the statistical analysis of long-term groundwater level trends, and identify factors (natural or anthropogenic) influencing the trend, (ii) setting-up of models to analysis the impact of natural (like rainfall variations)/anthropogenic (like over exploitation, depletion due to sand mining and related activities) causes on recharge pattern, water levels, flow path and flow direction, and (iii) evolve plausible policy mechanisms to facilitate sustainable management of groundwater resources.

The preliminary rainfall-recharge analysis and various statistical test such as MK and Homogeneity test have been carried out on observed monthly data to estimate changes in rainfall pattern. Recharge due to different sources such as rainfall, irrigation return-flows, canals, rivers, tanks and other sources is examined for natural and anthropogenic activities.

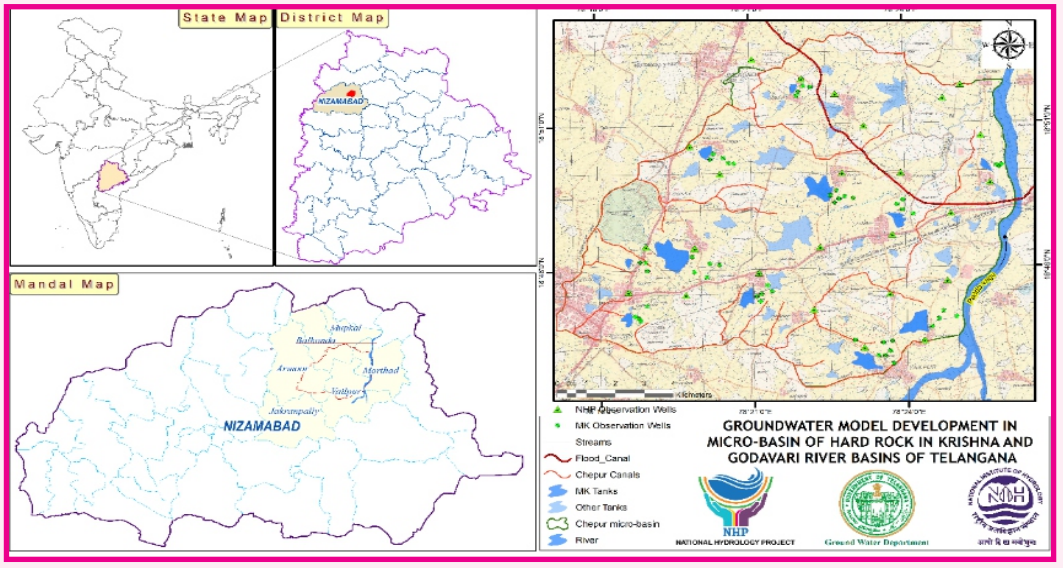


Figure – 7.38: Index Map of Cheppur Micro-Basin in Godavari Catchment

Recent changes in rainfall pattern were estimated using observed rainfall and its impact on groundwater recharge is analyzed. This helps the groundwater model to reliably segregate different recharge components.

Accordingly, the sensitivity analysis of recharge components is carried out using MODFLOW. Some of the secondary data were collected for Dindi. Piezometric levels of (38+22) stations for 2015-2023 and monthly data is correlated with rainfall data to quantifying the impact of rainfall on groundwater recharge. The steady and transient state model for study area under Krishna and Godavari has been completed, calibrated and validated with observed data. Transient state modeling for Dindi project is under progress.

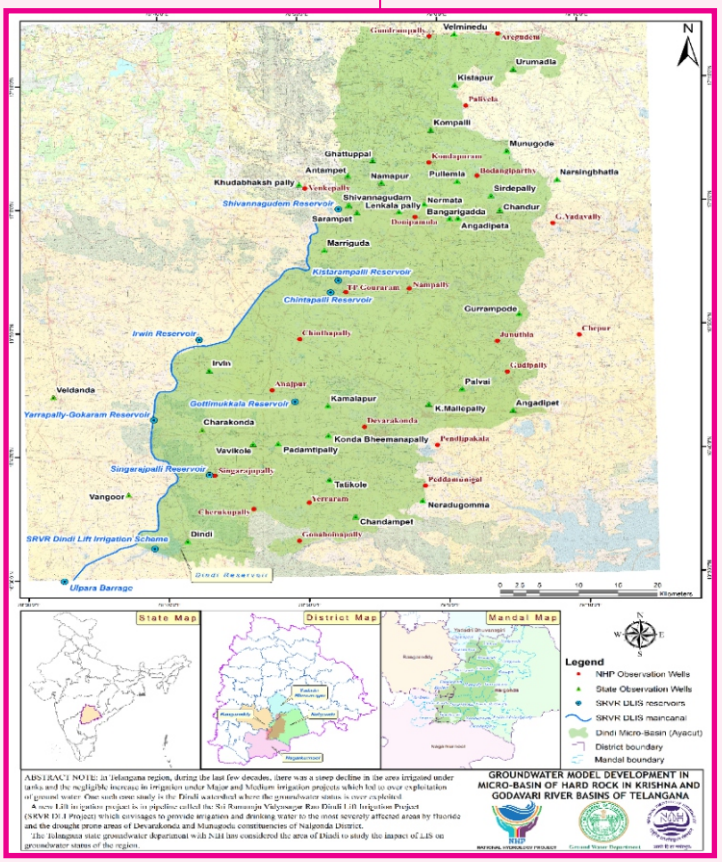


Figure – 7.39: Index Map of Dindi Micro-Basin in Krishna Catchment

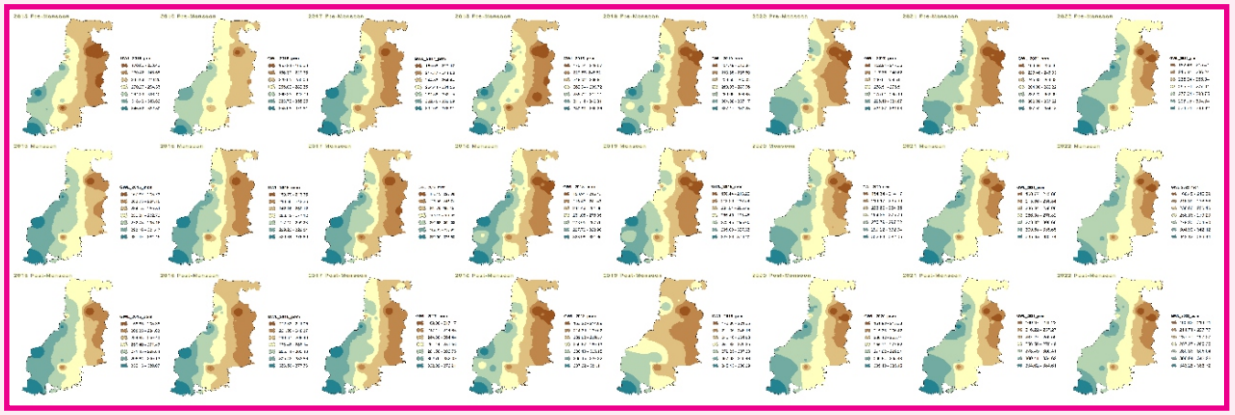


Figure – 7.40: Area under Different Depth to Groundwater Level (2015-2023)

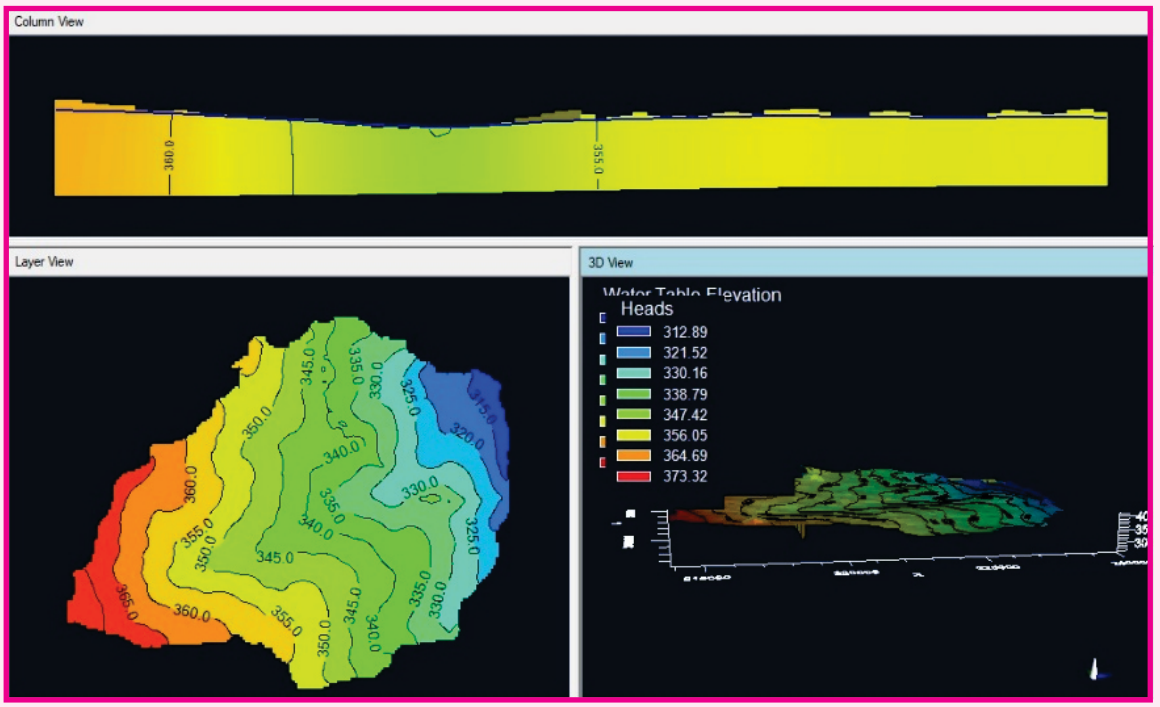
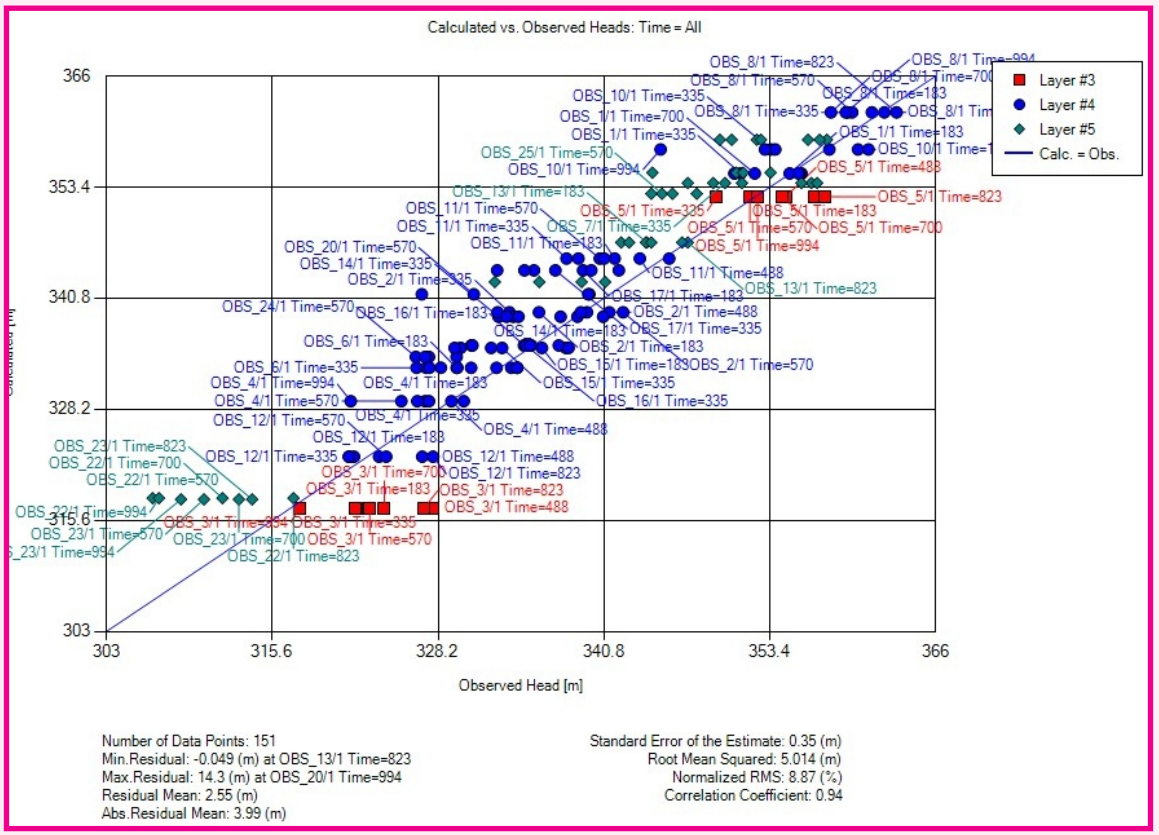


Figure – 7.41: Groundwater Model Setup



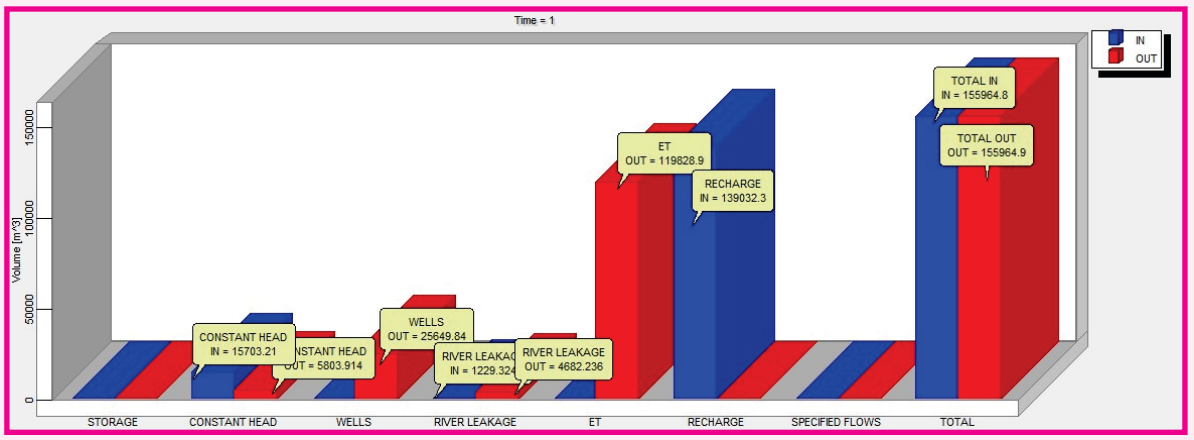


Figure – 7.42: Groundwater Model Development Results for Chepur Micro-Basin of Godavari

Impact of Sand Mining on Groundwater Regime in Parts of Manjira River Basin, Telangana State

The study has been taken up by the Ground Water Department, Telangana State under the NHP with NRSC, Hyderabad and HRRC, NIH, Belagavi as partner institutions. The HRRC Belagavi has taken up specific objective i.e., simulation of GW flow under various stress conditions. Under this particular objective a status report on river sand mining has been prepared in March 2024. The collection of necessary data for groundwater flow modelling is under progress. The conceptualization of groundwater flow model is completed based on available data. The lab test for surface hydraulic conductivity and water quality has been done. Rainfall analysis for the study area is completed to assess various stress conditions.

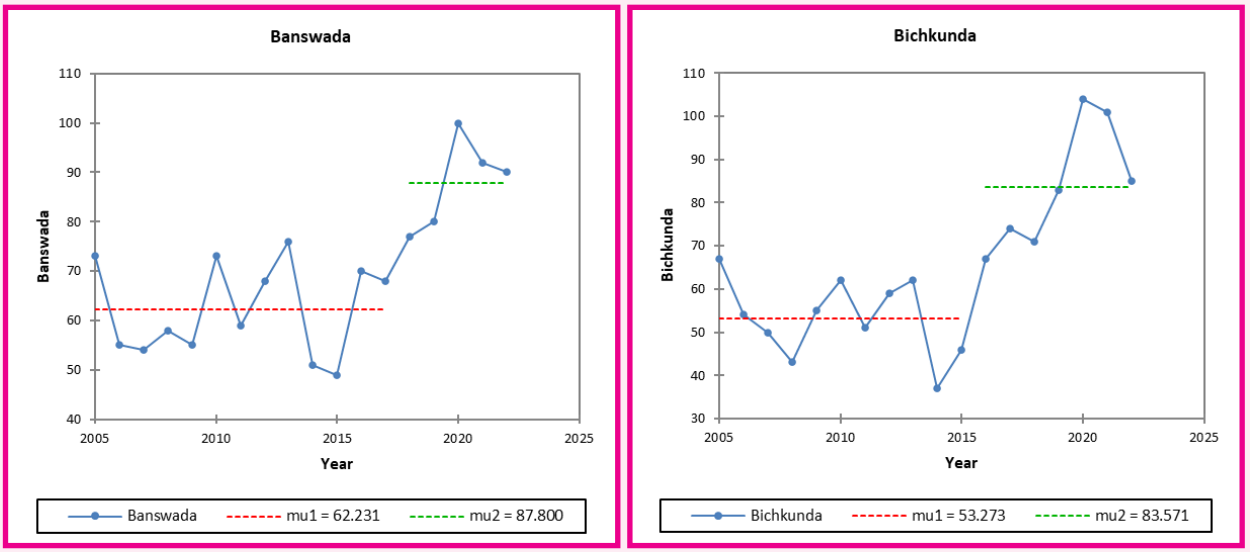


Figure – 7.43: Graph showing Non-Homogeneity in Rainy Days for Manjira Study Area

Comprehensive Assessment of Water Availability, Use and Issues for Goa State

The Goa state receives annual rainfall of > 4000 mm during monsoon. However, there is lack of storage facility to store water for rest of the year. There are many industries are being established in the state and state is witnessing a steady growth of population as well as a huge floating population during the tourist season. There is a need for an efficient mechanism to manage the water resources of the state. Therefore, a study on comprehensive assessment of water resources is initiated with objectives (i) development

of methodology (including mathematic models) to estimate the availability of water resources, (ii) assessment of present water demand and water use pattern for various sectors and forecast the future demands and use pattern, (iii) assessment of water availability under the climate change scenarios for future period, (iv) assessing the hydrological extremes in the future and possible mitigation measures with special reference to Chapora River, (v) assessing surplus and deficit catchments and possible augmentation of water resources, possibilities inter-basin and intra-basin water sharing, and (vi) formulating the policy framework for strategic management and optimal utilization of water resources considering the future demand and water availability. The models proposed for assessment of water availability for future period are ACCESS – CM2, ACESS-ESM1-5, BCC-CSM2-MR, CANESM5, EC-EARTH3, EC-EARTH3-VEG, INM-CM4-8, INM-CM5-0, MPI-ESM1-2-HR, MPI-ESM1-2-LR, MRI-ESM2, NORESM2-LM and NORESM2-MM. The HEC-HMS model has been set-up to arrive at the total outflow from Tillari dam and its tributary on which a medium dam is constructed. A unit hydrograph was developed as per the CWC flood reports to estimate the flood hydrograph for different return periods. The flood hydrograph was allowed into the reservoir assuming the water level in the reservoir at FRL. The resulted flood hydrograph is then used to demarcate the flood inundation within the Goa state. The study is in progress.

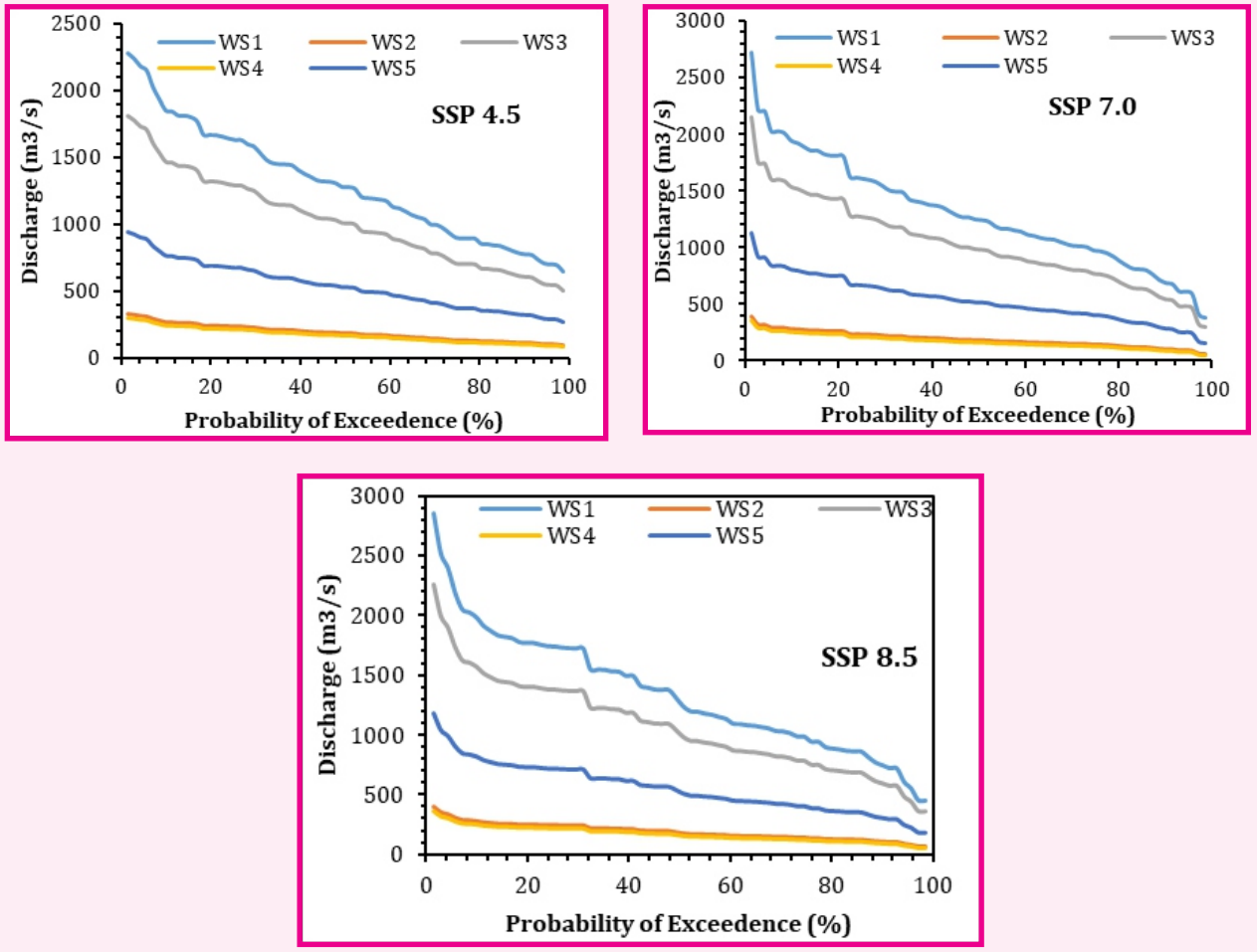


Figure – 7.44: Flow Duration Curve for Galgibag River for the Period 2030 to 2099 for LULC of 2005-2006

GW fluctuations and conductivity monitoring in Punjab - New evidence of GW dynamics in Punjab from high frequency GW level and salinity measurements

Among all the states of India, Punjab is drawing highest amount of groundwater from 'Indus Basin aquifer' resulting in its declination at an alarming rate. In recent years, a large volume of groundwater reported to be extracted in Hoshiarpur and Jalandhar districts for agriculture. The tracer data can help quantify groundwater renewal processes. In the joint study with BGS, UK high frequency water level and conductivity data is interpreted along with the analysis of water samples for a suite of tracers. In addition to the study in Bist-Doab, the study area has been extended to south-west (SW) Punjab where increasing demand for irrigation and improper irrigation policies led to water logging problems coupled with apprehension of saline zones formation by salinity ingression towards central Punjab. To assess the inter-connection between aquifers sampling has been planned in Faridkot, Fazilka and Muktsar districts of Punjab. For this study, water level loggers were installed in Saroya, Bhogpur and Sultanpur Lodhi in the month of May, 2019. In addition to these sites loggers were installed in Bhogpur, Tanda and Nakodar in October, 2019. The groundwater samples were collected for analysis of CFC, SF6 (at BGS, UK) for better understanding of aquifer systems from 10 sites from network of depth wise piezometers. Piezometers were developed in the depth range of 5 m-32 m and categorized as shallow (<10 m); intermediate 1st (10-15 m); intermediate 2nd (18-20 m) and deep (28-32m).

Isotopic analysis indicates that the River Beas and canal samples are isotopically depleted compared to the weighted rainfall values. The depleted end member relative to the meteoric rainfall is consistent with a higher altitude source of Himalayan water feeding the River Beas and associated canal networks. The River Sutlej data fall on a mixing line between an isotopically depleted end-member relative to meteoric rainfall where most of the data points are found, presumably again consistent with a high-altitude source of water, and the meteoric rainfall. For a small number of surface water samples there is possible evidence of evaporative enrichment relative to the meteoric rainfall end-member. Groundwater samples are more consistent with the weighted rainfall values, however, both shallow and deep groundwater samples show a majority of data points that are isotopically depleted (more negative) relative to weighted mean rainfall and are more consistent with more depleted values found in more

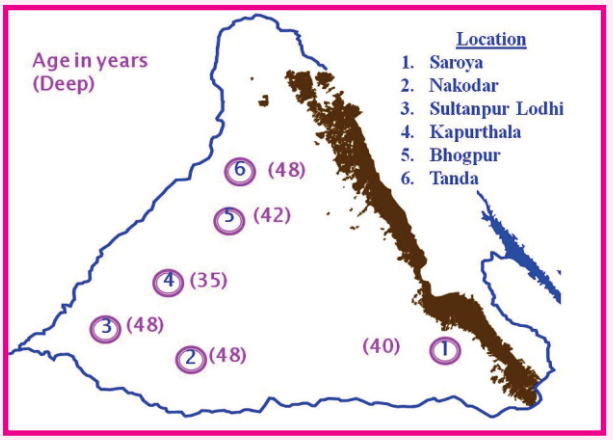


Figure – 7.45: Sites for Installation of Loggers in Bist Doab, Punjab

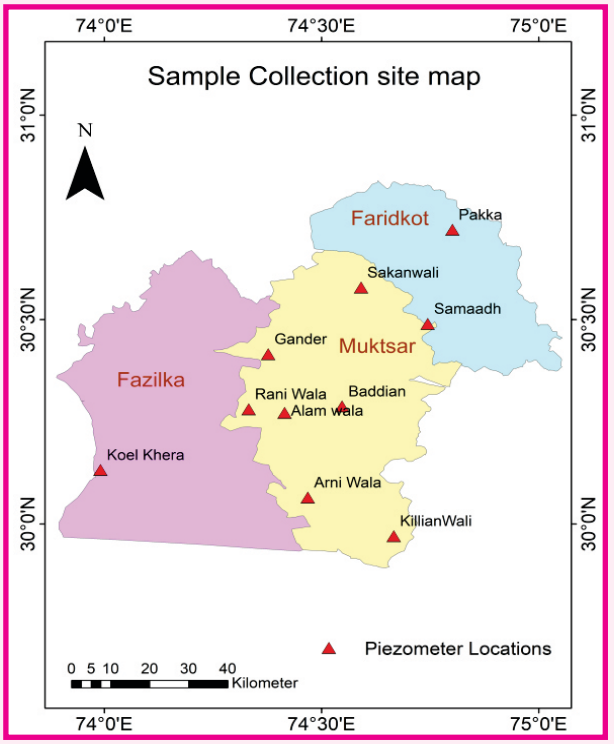


Figure – 7.46: Sites for Sample Collection in South-West, Punjab

intense rainfall events and fall between rainfall end members and surface water end members. There is also considerably more variability in the isotope data from the shallow groundwater relative to the deeper groundwater, consistent with the homogenization of the meteoric isotope signatures with depth due to groundwater mixing. In the SW Punjab, groundwater is The groundwater was observed to be recharged by two sources: Sutlej river canal water ($\delta^{18}O$ = -12.6‰ to -9.6‰) and rainwater ($\delta^{18}O$ = -14.5‰ to -0.1‰), as indicated by the depleted and enriched isotopic values. It was noted that saline groundwater (EC ≈ 9900 µS/cm) developed in the formations due to factors such as rock-water interaction, evaporation, return flow, rain, and other related human activities. Lateral and vertical interactions between aquifers suggest that there is mixing of water between different aquifer layers.

Partitioning Evapotranspiration into Evaporation and Transpiration Fluxes Using Stable Isotopes of Oxygen and Hydrogen

Agriculture is the single largest user of freshwater in India. A significant portion of the applied irrigation water eventually evapotranspires. The transpiration (T) component of the evapotranspiration (ET) is associated with crop productivity, while the undesirable soil evaporation I component represents losses. The knowledge of the relative magnitudes of E and T fluxes is, therefore, essential for designing efficient irrigation techniques and understanding energy and moisture transfer in the soil-plant atmosphere continuum. In this direction, the institute has developed methodologies for collection of air moisture samples, soil evaporation and evapotranspiration samples, and transpiration samples. Wherever possible, instruments are designed and fabricated inhouse to suit the local conditions and give reliable data at a low cost. For experimentation in the field, two sites are selected in Kanpur to study ET partitioning at plot and field scales. The sites are instrumented for measuring ET fluxes using hydrometric and isotopic methods. The following work has been completed till date (i) Soil moisture evaporation sampling: a fabricated model for collecting soil moisture evaporation involves placing a glass slab on bare soil. A compressor creates negative suction pressure, drawing evaporated water from the soil through a tube. Condensation in the tube allows the collection of the soil evaporated sample in a glass tube. (ii) Air Moisture sampling: moisture from the air is collected using a conical condensation instrument filled with ice cubes. The atmospheric moisture condenses into water droplets on the surface of the cone-shaped structure and is collected drop by drop in a sample bottle enclosed by a cylindrical structure. (iii) Transpiration sampling: the transpired water is collected in the polythene bag wrapped around the leaves of the potted plants. (iv) Collection of rainwater samples: A Standard non-recording rain gauge prescribed by the IMD (Symon's rain gauge) was used to collect the rainwater samples. The rainwater samples were also used to develop the LMWL for the region. (v) Collection of Groundwater samples: Standing water within a bore is exposed to atmospheric conditions and can undergo changes to its physical and chemical characteristics and is not representative of the water in the aquifer. Unless aquifer quality is known to be vertically uniform, samples collected may include a mixture of groundwater entering the borehole using

Table – 7.1: Sample Collection Details

Sr. no.	Sample Type	Frequency	Samples Collected (C) and Analysed (A)	
			C	A
1	Atmospheric air moisture	Daily	195	120
2	Soil moisture evaporation	Daily	140	110
3	Transpiration	Daily	86	70
4	Rain	Event Based	26	26
5	Irrigated water	Random	10	10-
Grand Total			457	336

the open or screened casing methodology and can be considered to produce a composite sample or one of approximately average composition.

It has been observed with the onset of monsoon in mid-June, after one or two initial light rain showers of enriched isotopic composition ($\delta^{18}O$= -5.9‰, D=-34.4‰), the isotopic composition of rainwater rapidly depleted and fluctuated at a value close to an average value: $\delta^{18}O$ =-9.7 ‰, D= -70.3 ‰. During the end of the monsoon, a few rains were of much depleted isotopic composition ($\delta^{18}O$ =-11.2‰, D=-77.6‰). The increased depletion in the isotope values of the transpired vapor after the first few showers indicates the replacing of pre-monsoon highly enriched vapors of local origin by monsoon moisture of depleted isotopic composition. The observed difference in the isotopic composition between the rain and the associated vapor was unexpected. As per the isotopic fractionation relation between water and its associated vapor, under isotopic equilibrium, at a temperature in the range of 25-30°C (which is the average temperature between cloud base and ground level during monsoon at Roorkee), the isotope value of water vapor with respect to its source water is expected to be depleted by ~9‰ in ^{18}O & ~74 ‰ in D.

After the end of the monsoon, the process of evaporation of the soil surface progresses parallel to other soil hydrological processes like the upward movement of soil moisture due to capillary action and the negative pressure gradient and the dynamics of a diffusion-driven flux of water molecules from the isotopically enriched layer towards the deeper layers. These processes lead to the broadening of an isotopically enriched layer in the vadose zone with time. When the isotopically enriched layer reaches the root zone, the plants and trees transpire this enriched water to the atmosphere, and the atmospheric vapour composition becomes more and more enriched with heavy isotopic composition.

Operational Coastal Flood Management through Short-To-Medium Range (Real-Time) Flood Vulnerability Mapping in the Brahmani-Baitarani River Basin Integrating Human and Climate-Induced Impacts

This study has been undertaken for Brahmani and Baitarani River basin with the objectives: i) assessment of historical flood inundation and sedimentation scenarios in the study area through field survey, secondary data, and remote sensing approaches, ii) detection of historical changes in land use and river cross-sections due to sedimentation and anthropogenic activities using survey data and satellite imageries, iii) forecasting of inflows into and releases from the Rengali/Mandira reservoirs in real-time up to 10-days lead-time accounting for the effects of urbanization, paddy land use, and river sedimentation, iv) to forecast the tidal effect/sea-surges at the river-ocean confluence in the Bay of Bengal, v) to simulate real-time 2-D flood inundation mapping in the deltaic river basin considering upstream streamflow forecasts, stream-aquifer exchange fluxes, and downstream tidal/sea-surge forecasts up to 10-days lead-time, and vi) to develop flood vulnerability maps in real-time (up to 10-days advance) for operational flood management using UNESCO-IHE guidelines.

Data on all the historical floods from 1960-2021 were collected from various sources. Corresponding to the flooding events, satellite imageries were procured for the mapping of flood-inundated areas. Based on the Landsat satellite imageries, LULC maps of the study area were generated at 5-year intervals to identify the land use change. It was observed that the Brahmani and Baitarani River basin have undergone major LULC changes. Similarly, Sentinel-1 satellite imageries were processed using an algorithm and computer codes to prepare flood inundation maps over the delta region by change detection technique. It is evident that there is a frequent occurrence of floods in the coastal region of Brahmani and Baitarani Basins. In the last 5 years, three major floods have occurred. It is also concluded from study that the cross-section changes in different years could be due to sedimentation problem. In this study, flood forecasting model is developed taking bias corrected Numerical weather prediction model forcings. The streamflow was simulated using the SWAT Pothole model and an error forecasting sub-model was implemented to minimize the error. The error-correction (forecasting) models are enlisted as: i)

AutoRegressive (ARu); ii) AutoRegressive Moving Average with eXogenous inputs (ARMAXu), iii) Wavelet-based neural network (WNNu); iv) Dynamic wavelet-based Non-linear AutoRessive with eXogenous inputs (WNARXu). It was observed that using an error forecasting model to minimize the random error helped to improve the streamflow forecast at different lead-time. The NSE improved and falls in the range of 0.84 to 0.75 for a lead day of 1 to 10, respectively. Further, the ehsB and SWAT-MODFLOW setup is under progress for stream-aquifer interaction modelling in the basin.

For assessing the contribution of wave-current interaction to coastal flooding, a tightly coupled ADCIRC-SWAN (Surge-wave) model to compute water surface elevations as a combined effect of wind, astronomical tides, and waves was set-up in the part of Bay of Bengal Ocean. The surge-wave model was calibrated for tropical Cyclone Fani (SIM1), which made its landfall on 3rd May 2019. Another Cyclone Yaas (SIM2), which hit the Bay of Bengal on 24th May 2021, was used to validate the model. At (Brahmani-Baitarani Delta) BBD mouth, the ADCIRC-SWAN estimated temporal tide values serve as a downstream boundary condition in the 2D HEC-RAS model used for flood inundation mapping. It could be seen that the flood inundation computed from HEC-RAS 2D model as a combined effect of storm tide, upstream discharge and rainfall could reproduce the benchmark SAR based flooding extent. During the cyclone 'Yaas', the maximum flood depth and the flooding area in the Brahmani-Baitarani delta as simulated by the HEC-RAS model were 8 m, and 1964 km^2 (around 20 % of the total area), respectively. This study is in progress.

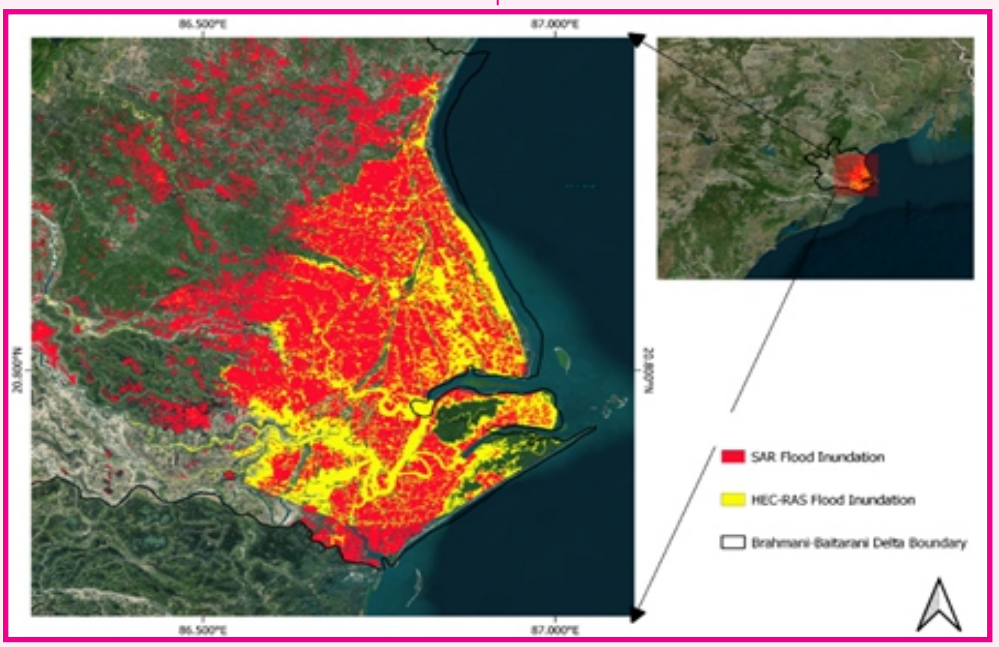


Figure – 7.47: Flood Inundation Map of BBD Generated based on HEC-RAS 2D Simulation and SAR (Sentinel-1) Extracted Inundation Extent

Land Surface Modelling and Remote Sensing based Generation of Evapotranspiration from Land Product

This study is framed with objectives to (i) quantify radiation fluxes in the North West Himalayan (Uttarakhand, Himachal Pradesh, Jammu & Kashmir and Ladakh) (NWH) region using remote sensing, modeled and available ground-based observations, (ii) set up and parameterize the suitable land surface model for the NWH region, (iii) estimate the ET over the entire NWH using remote sensing and land surface modeling approach. Expected scientific outcome from this study will be generation of ET product for entire NWH region. The study is in progress.

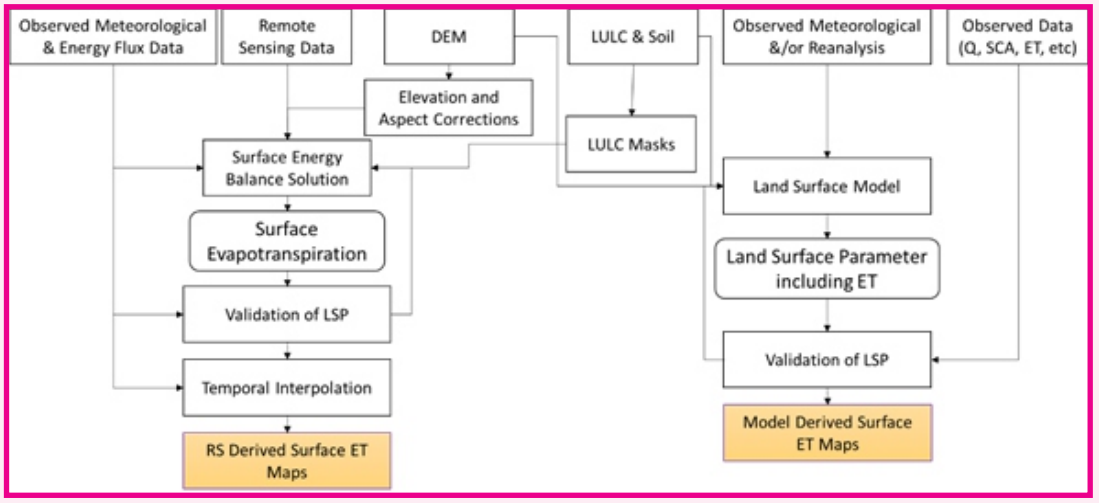


Figure – 7.47: Overall Methodology Flow Chart

Monitoring and Assessment of Mountain Ecosystem and Services in North-West Himalaya (Phase-II): Monitoring and Modeling of Hydrological Processes in Glaciated and Non-Glaciated Watersheds of NWH

Gauging of streams in hilly watersheds or rugged terrain is tedious task due to the limited accessibility and lack of suitable sites or infrastructure for installation of water level monitoring station, costly instrumentation, insecurity associated with the installed/field instruments, non-uniformity of river cross-section and flow velocity, meandering of rivers as well as huge erosion during rainy season affecting the infrastructure built across the river. Henval is the direct perennial tributary of river Ganga draining at Shivpuri upstream of Rishikesh, Uttarakhand. It is characterized as a spring-fed river with huge drop in watershed elevation ranging from 2676 to 362 m amsl, which is attributed to huge variations in seasonal flows.

Although as per the need of the project a suitable bridge site for water level monitoring has been identified through field visit. An AWLR has been installed at the selected bridge site in order to record, store and transmit (on cloud) river water level data at 10 min interval continuously. The AWLR setup is covered under wire cage so as to protect it from theft or damaging. This is to note that this is the last bridge constructed on a Henval River. One of the ends of the bridge is damaged during past extreme events. Although there is a wide bridge at the outlet (Shivpuri town), of Henval watershed but the intense anthropogenic activities such as laying of railway lines as well tourism or urbanization activities disturbed the natural river course at several places



Figure – 7.48: Location of AWLR Installed on a Bridge of a Henval River

which made it difficult to measure/record the natural flow depth. Additionally, it is very difficult to monitor wide river width (>100 m) with single AWLR setup. The flow spreads over a wide area when river descends from hilly region to plane region, which may further pose challenges in measurement of representative flow depth. The river cross-section has been surveyed at 0.96 to 1.23 m interval to estimate discharge on April 2, 2024. Due to the meandering as well as bulk deposits of rocks/pebbles in the river course the lean season flow is confined within a span of 8 m towards the right bank along the river flow/slope. However, the river cross-section needs to be surveyed regularly for accurate estimates of varying seasonal flows. The flow velocity may also vary seasonally due to varying flow volume as well as river bed subjected to erosive deposits. The water level recorded by AWLR at 10 min interval indicates that the flow seems to be following diurnal temperature cycle.

Hydrological Assessment of Ungauged Basins (Aghanashini, Dasanakatte, Sita Nadi, Madisala Hole, Swarna Nadi and Gurupur River Basins) of the West Flowing Rivers in the Western Ghat Region of Karnataka Lack of adequate hydrological data introduces uncertainty in both the design and management of water resources systems in ungauged catchments. Consequently, there is a need to develop methods for predicting flow characteristics at ungauged sites from catchment and meteorological parameters. The west flowing river basins in the Western Ghat region consist of small independent river basins originating at higher altitude and heavy rainfall region, and flow rapidly into the Arabian Sea. Keeping in view of the above, the study is undertaken with the freely available satellite earth observation datasets and the modelling techniques and with the specific objectives to: (a) collect, prepare and evaluate various thematic datasets such as DEM, land use/Land cover (LULC) map, soil map, and hydro-meteorological data-sets such as precipitation, temperature, discharge (if available) etc., (b) analyze long-term hydro-meteorological variables such as precipitation, evapotranspiration, and water consumption patterns in the basin and assessment of their possible impacts on water management in the basins, (c) assess water potential and demands of the west-flowing river basins, i.e., Aghanashini, Dasanakatte, Sita Nadi, Madisala Hole, Swarna Nadi and Gurupur, (d) assess the effects of climate and land use changes on the water yield and demands of these basins, (e) analyze the hydrological sensitivity and resilience capacity of the basins under adverse climatic impacts, (f) impart training on the hydrological models to the officials of the State WRDs including IAs of NHP, and (g) prepare the detailed sub-basin wise project report for the state water resources department for planning purposes.

The modelling tools/framework such as SWAT, WA+ and Budyko based approach will be applied for quantifying the basin water yield potential using satellite datasets and station rainfall datasets. The suitability of the best satellite precipitation dataset will be assessed using the goodness-of-fit statistics. The study will also assess the effects of climate and land use changes on the water yield. Further, the hydrological sensitivity and resilience capacity of these basins will also be assessed using the Budyko framework. For climate change analysis CMIP5/CMIP6 projections will be used in this study. For LULC change and impact assessment, decadal and projected LULC maps will be prepared and analyzed accordingly. For future projection of LULC change, Markov chain-based approach will be applied in this study.

Spatially averaged monthly series of various rainfall datasets for all basins were compared with the monthly rainfall recorded at the gauge(s) located within the corresponding basin. The monthly series of all datasets for all the basins is shown below. The peak station rainfall observed in each monsoon season was significantly higher than the peak rainfall of any other dataset. These differences between the observed rainfall and satellite/reanalysis datasets became more pronounced when plotted on an annual time scale as shown below. However, the APHRODITE and IMD datasets were found to be

comparable to annual observed rainfall each year. The performances of various satellite and reanalysis rainfall datasets were compared with the station rainfall based on statistical metrics such as R, R^2, NSE, PBIAS, MAE, MSE and RMSE for each basin. The IMD dataset was found to perform the best which was expected, as the dataset was created using measured rainfall from gauges across the country. APHRODITE and IMDAA showcased similar performances which varied across different basins while, CHIRPS dataset had a decent performance, though it performed poorly for Swarna basin. The PRINCETON and SM2RAIN dataset consistently performed poorly across all basins.

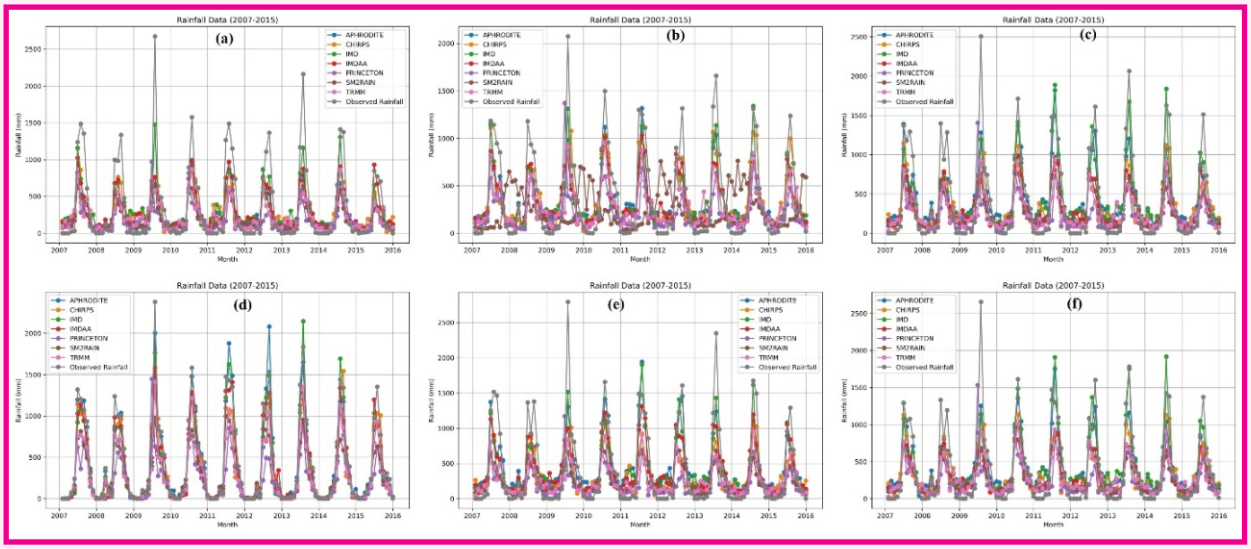


Figure – 7.49: Monthly Rainfall Time Series for (a) Aghanashini, (b) Gurupura, (c) Sita Nadi, (d) Swarna, (e) Dasanakatte and (f) Madisala

Table – 7.2: Rankings of different satellite and reanalysis datasets based on comparison with station rainfall

BASIN	SATELLITE AND REANALYSIS DATASET						
	APHRODITE	CHIRPS	IMD	IMDAA	PRINCETON	SM2RAIN	TRMM
Aghanashini	4	3	1	2	7	5	6
Gurupura	3	2	1	4	6	7	5
Sita Nadi	2	4	1	3	7	5	6
Swarna	1	5	3	2	7	6	4
Dasanakatte	3	4	2	1	7	5	6
Madisala	1	4	2	3	7	5	6

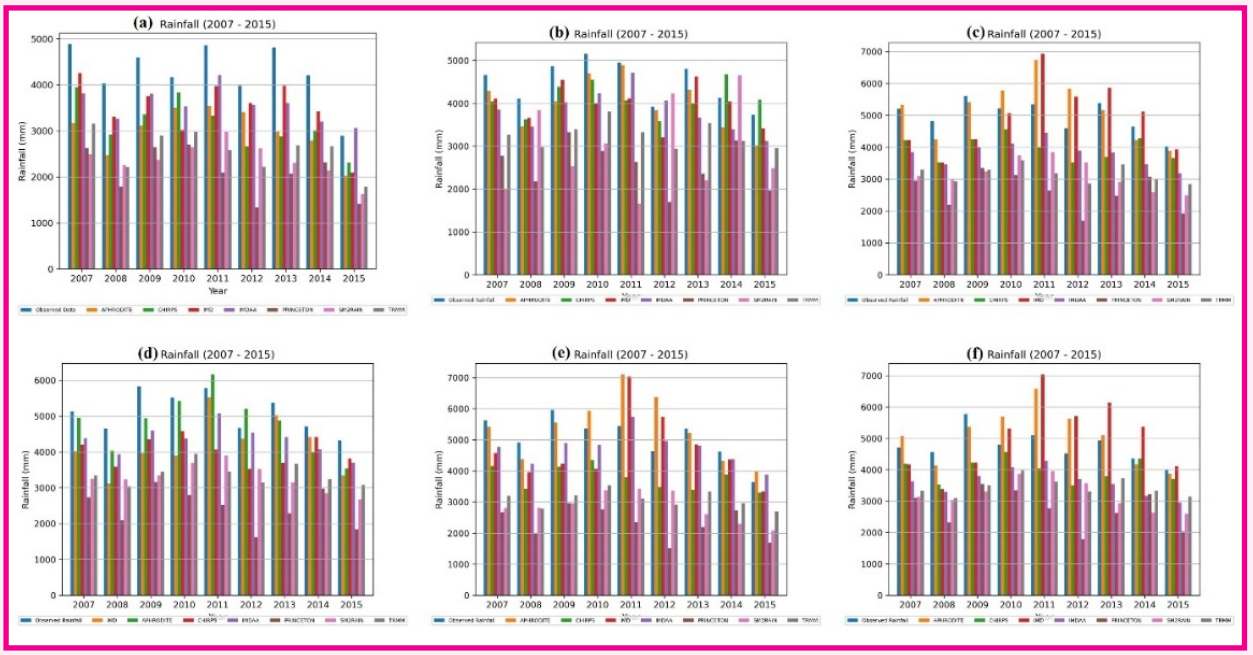


Figure – 7.50: Box Plots of Annual Rainfall for (a) Aghanashini, (b) Gurupura, (c) Sita Nadi, (d) Swarna, (e) Dasanakatte and (f) Madisala

Permafrost Mapping and Characterization of Western Himalayan Region

The cold-arid region of Ladakh has reported sporadic occurrence of permafrost and associated landforms with sorted patterned ground and other periglacial landforms such as ice-cored moraines. Catchment scale studies suggest that ground ice melt component may be a critical water source during dry years in the cold-arid regions of Ladakh. Continuous development of permafrost mounds and thermokarst features are also inferred during the last 60 years. As glaciers and snow cover is shrinking in the most part of the IHR in response to changing climate, the permafrost areas are also expected to respond in a comparable manner as evident from other similar cryospheric areas globally. At 35 sites identified during the first field expedition, miniature temperature data loggers were installed. Further, the collection of different water samples, permafrost leachates and soil sampling were carried out by the partner institutes. Input data for the GEOtop model, which will be used for the modelling of permafrost at the selected sites was prepared. Surface water and groundwater samples were collected from different sources like permafrost, active layer melt, glaciers, snow, surface for hydrochemistry and isotopic analysis. Model developed based on remote sensing products for the mapping of spatial distribution of permafrost in the Tso Kar basin.

A new methodology for permafrost mapping using remote sensing imagery and machine learning has been developed for the Tso Kar Basin and published. Modelling exercise for the estimation of permafrost characteristics is done. Input meteorological (climate) data needed to run the GEOtop model was prepared from ERA5 reanalysis data at all the 35 logger locations. Quality assessment of water and thawed active layer samples has been carried out through three-time sampling during the year 2020 and 2021, in terms of general water and soil quality parameters along with total and dissolved organic & inorganic carbon and nitrogen for Leh district, Ladakh. Isotopic results of waters (except ground ice) have been interpreted and published. The anion and cation analysis has been carried out and physical parameters of samples are recorded in the field. Interpretation of results is under process.

Initiatives for the North-East Region

8

To cater to the hydrological needs of the North Eastern Region, Sikkim and northern part of West Bengal (Teesta Basin), National Institute of Hydrology established a regional Center at Guwahati in August 1988, which is now known as North Eastern Regional Centre. Since its inception, the Centre has been actively interacting with various State, Central and Academic organizations working in the water resources of the northeastern region of India. As per the action plan, thrust areas for research and studies of the Centre are (i) Flood estimation and routing; (ii) Structural/non-structural measures for flood management; (iii) Integrated watershed management for flood control; (iv) Hydrological data base management system; (v) Drainage congestion and erosion problems; (vi) Water quality problems; (vii) Socio-economic aspect of flood disaster; (viii) Springshed management; (ix) Technology transfer through trainings and awareness programs; etc. The Institue conducted the 18th and 19th meetings of Regional Co-ordination Committee of the Regional Centre on 24th August, 2023 and 19th March, 2024 at Guwahati to review and take feed back on its research studies conducted during the year.

The Centre is actively involved in conducting field-based studies for many years. During the FY 2023-24, the Centre engaged in five Institute funded R & D Studies: i) Short Term Flood Forecasting Using Bootstrap based Artificial Neural Networks in Beki River Basin, Assam, ii) Rainfall Induced Flood Hazard Risk Vulnerability Assessment in East Jaintia Hills, Meghalaya, iii) Drought characterization and vulnerability assessment in Assam, iv) Linear Hydrological routing using Satellite precipitation datasets for flood forecasting in parts of Brahmaputra Basin, and v) Hydrodynamic modeling for riverbank protection- A case study. The Centre was also engaged in a sponsored project funded by DST-SERB entitled 'A coupled hydrodynamic and bank dynamic modeling approach for forensic analysis of bankline erosion process along Majuli Island - the largest inhabited river island in the world'. This sponsored project has been completed and its final report is being prepared. Based on the outcome of this study and the necessities to replicate in other tributaries of the Brahmaputra river, after consultant with the WRD Assam, similar study was taken up in Puthimari River as a case study.

In several northeastern Indian states, springshed management has lately grown in popularity as a subject of study. In this regard, talks have been initiated with the office of SLNA, WDC-PMKSY, Assam. Additionally, in association with NEHARI, Brahmaputra Board, Scientists from NERC, Guwahati along with scientists from NIH Roorkee trained several officers of the various state departments in the NER of India with the objective of capacity development in preparing a network of para-hydrogeologists. Further, a training program was conducted during 4–8 December, 2023 to train 14 newly appointed engineers of WRD Meghalaya on 'Basic Hydrology'. This training is an initiation of a series of trainings to be imparted to them for enabling themselves in conducting various R&D works of the WRD Meghalaya. Scientists from NERC Guwahati also catered in capacity development of 23 participants from among engineers, scientists, academicians and research scholars from the NER of India on 'Hydrological

Modeling using HEC-HMS' during 11–15 March, 2024. This training will help understand and solve a variety of water resource problems of the NE Region. Apart from training state officials of NER, NERC Guwahati contributed in training of master students and young professionals of NERIWALM in order to enable them to conduct researches in the field of hydrology using HEC-HMS, QSWAT, and HEC-RAS. Further, NERC Guwahati conducted six mass awareness activities in the FY 2023-24 to cater various sections of the society, such as children, students, youths, and village people. The themes of the awareness include cleanliness, hygiene, creation of wealth from waste, water conservation, and importance of wetlands to human well-being.



Figure – 8.1a: 18th RCC meeting on 24.08.23



Figure – 8.1b: 19th RCC meeting on 19.03.24



Figure – 8.2: Training programs conducted by NIH-NERC Guwahati in the FY 2023-24



Figure – 8.3: Mass awareness activities conducted by NIH-NERC Guwahati

Publications

9

National Institute of Hydrology publishes its research output in the form of various type of reports, books, chapters in books, research papers in peer reviewed International and National Journals; and in International and National conferences/ symposia, seminars, workshops, etc.

During the last 11 years from 2013-14 to 2023-24, the Institute has published total 2635 publications including 331 publications during 2023-24.

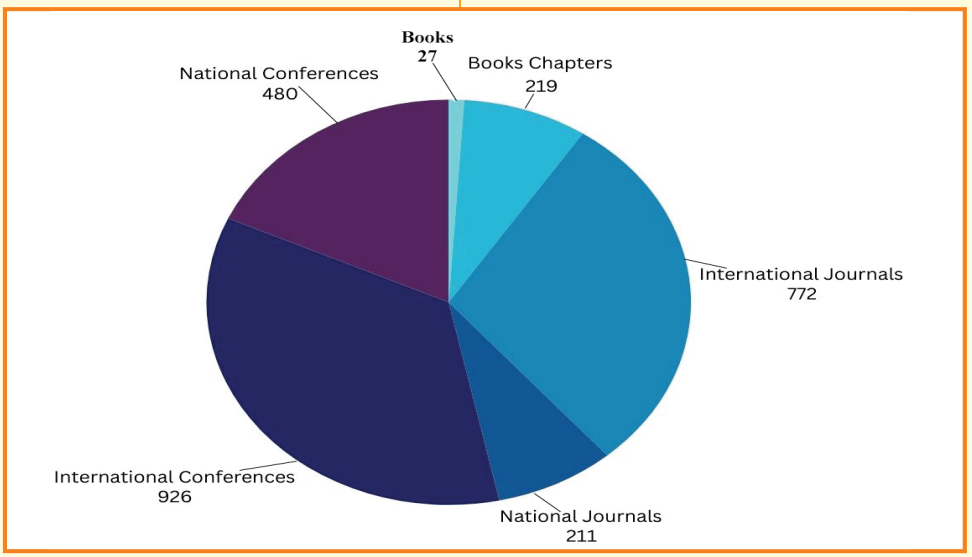


Figure – 9.1: Total publications of NIH during 2013-14 to 2023-24

Category wise Publications during the last decade (2014-15 to 2023-24) are shown below:

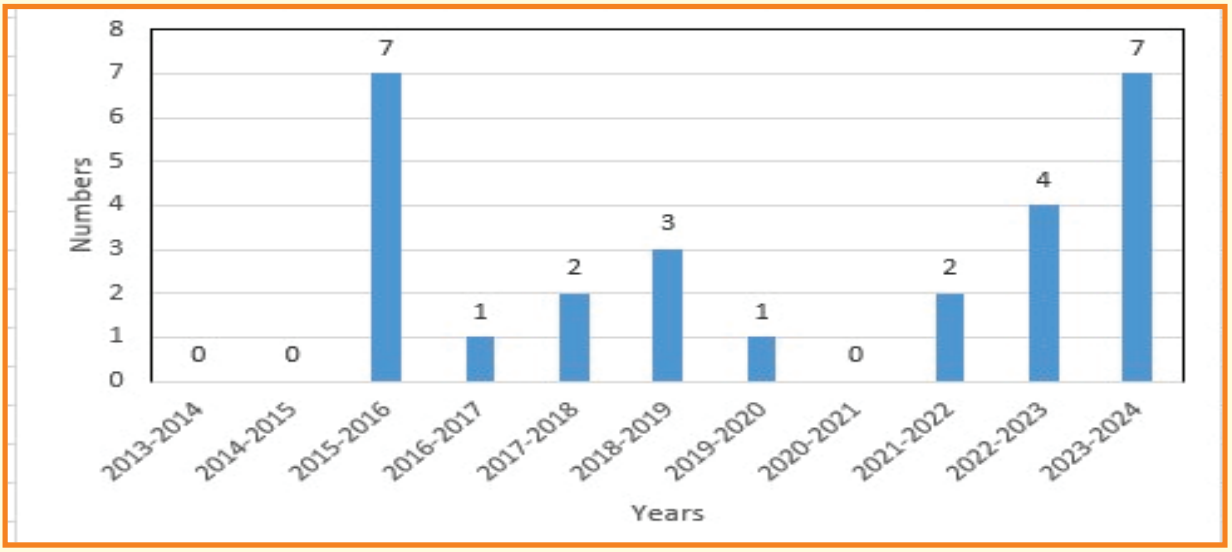


Figure – 9.2: Books published during 2013-14 to 2023-24

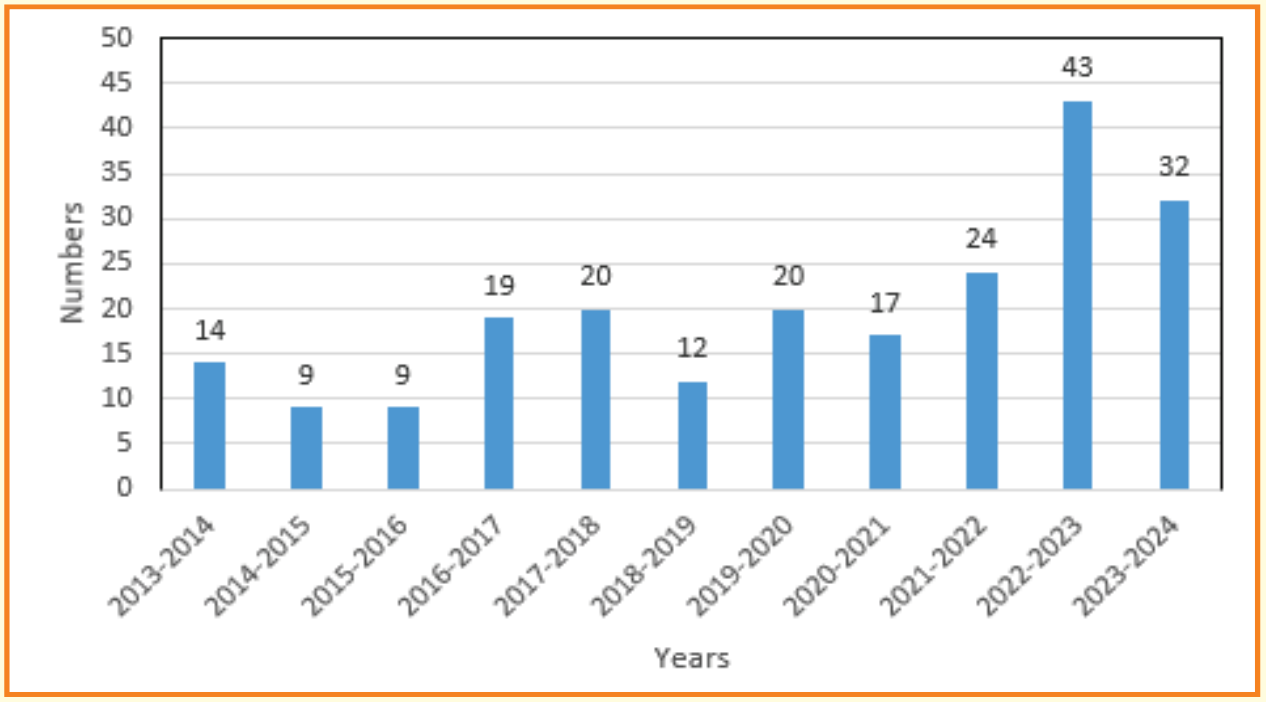


Figure – 9.3: Chapters in Books published during 2013-14 to 2023-24

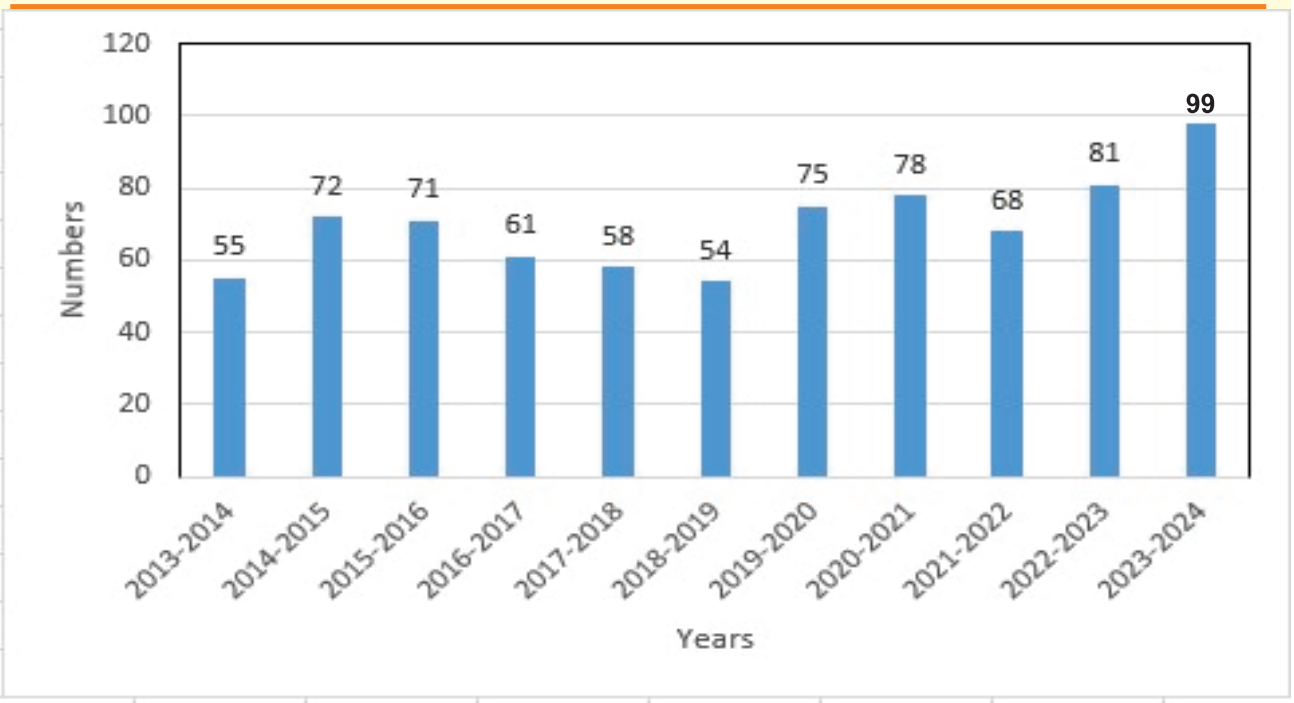


Figure – 9.4: Publications in International journals during 2013-14 to 2023-24

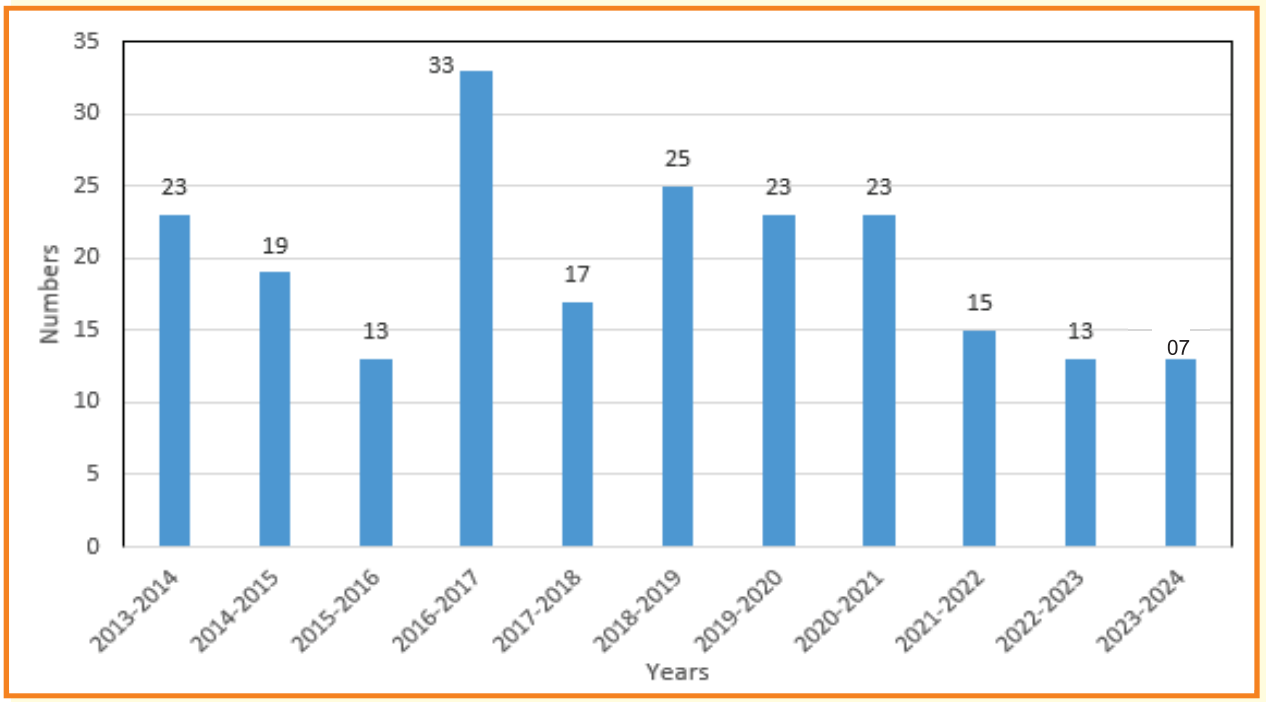


Figure – 9.5: Publications in National journals during 2013-14 to 2023-24

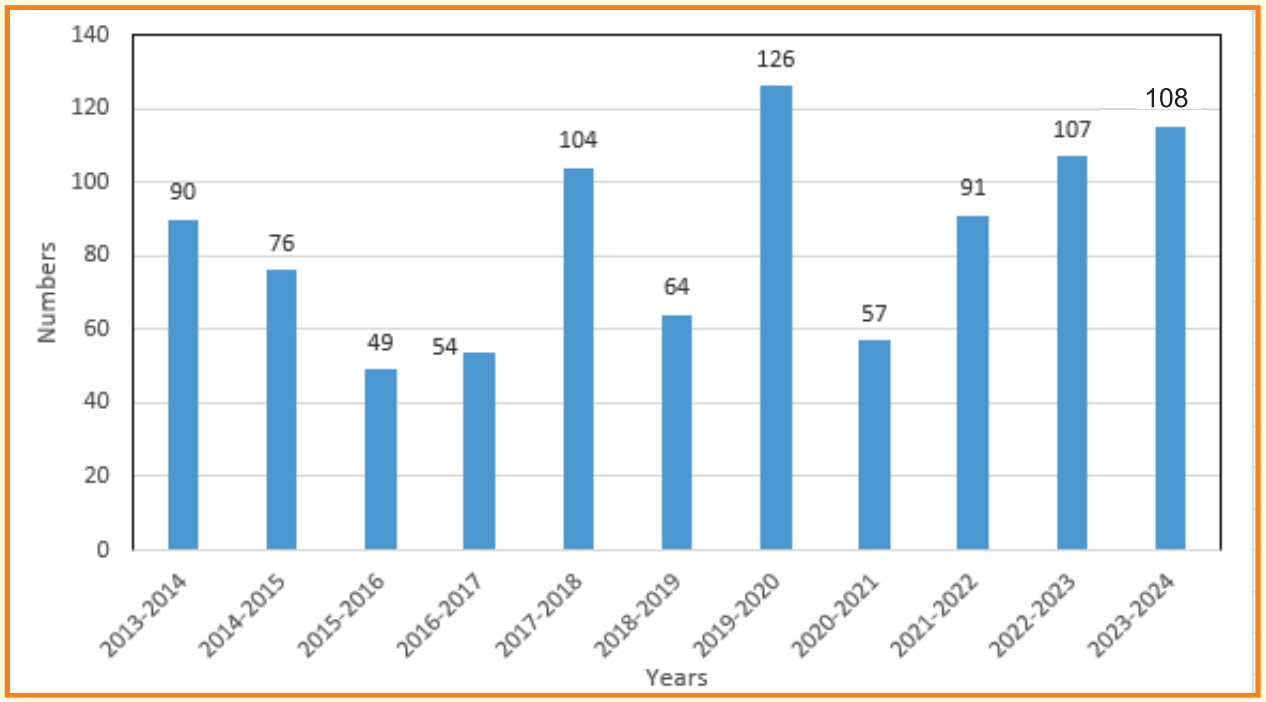


Figure – 9.6: Publications in International conferences during 2013-14 to 2023-24

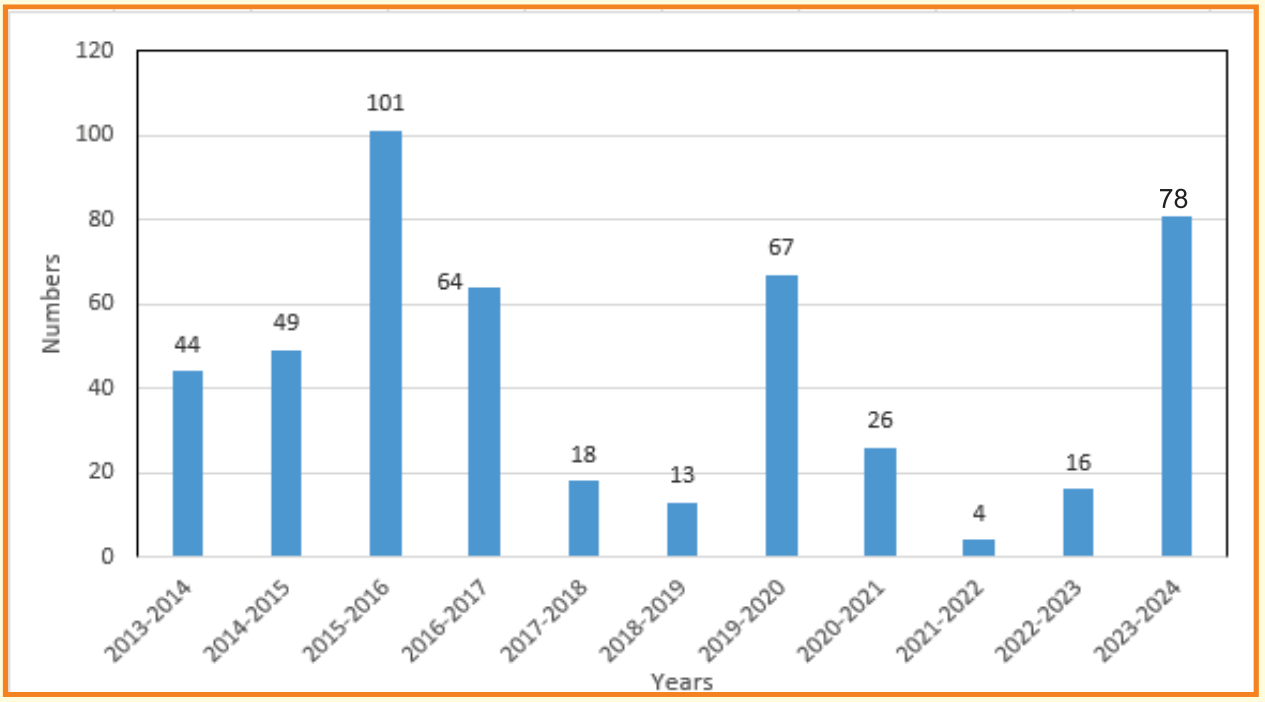


Figure – 9.7: Publications in National conferences during 2013-14 to 2023-24

Table – 9.1: Publications of the Institute during 2023-2024

S.No.	Item	Published
1.	Books	7
2.	Chapters in Books	32
3.	International Journal	99
4.	National Journal	07
5.	International Conference/ Seminar/ Symposium	108
6.	National Conference/ Seminar/ Symposium	78
Total		331

The detailed list of publications during 2023-24 is given in Appendix-X.

Technology Transfer 10

Technology transfer activities form an important component of the Institute's activities besides the publication and circulation of reports of studies and research. The Institute has been organizing International and National level conferences/ seminars and short duration workshops/brain storming sessions/training courses, etc. dealing with specialized areas in hydrology for the transfer of relevant theoretical knowledge as well as methodologies, including computer programs, to the field engineers of Central and State Government organizations in the country, academicians, students, and practitioners. In the last 11 years (2013-14 to 2023-24), the Institute has organized a total of 503 International/National activities in the form of Seminars, Symposia, Conferences, Training Courses, Workshops, Brain Storming Sessions, etc. as given in the figure below:

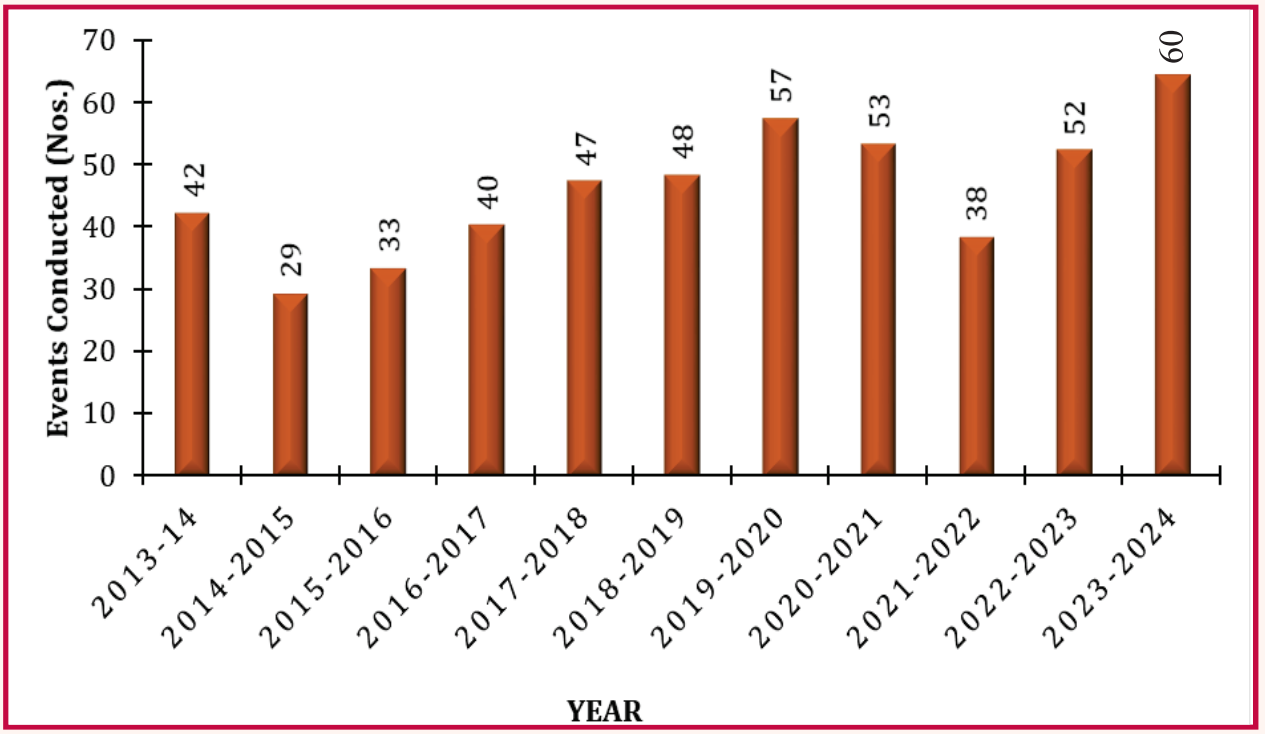


Figure – 10: Technology Transfer Activities Organized by Institute during Last 11 Years

During the year 2023-24, the Institute organized a total of 64 activities, which included 07 International activities and 57 National Level activities. The national-level activities include 03 symposia/ seminars/conferences, 50 training courses/ workshops/brainstorming sessions, and 04 other activities at various locations throughout India. The technology transfer activities were attended by a number of field engineers, researchers, academicians, administrators, etc.

A detailed list of technology transfer activities carried out by NIH during 2023-24 is given in Appendix XI.

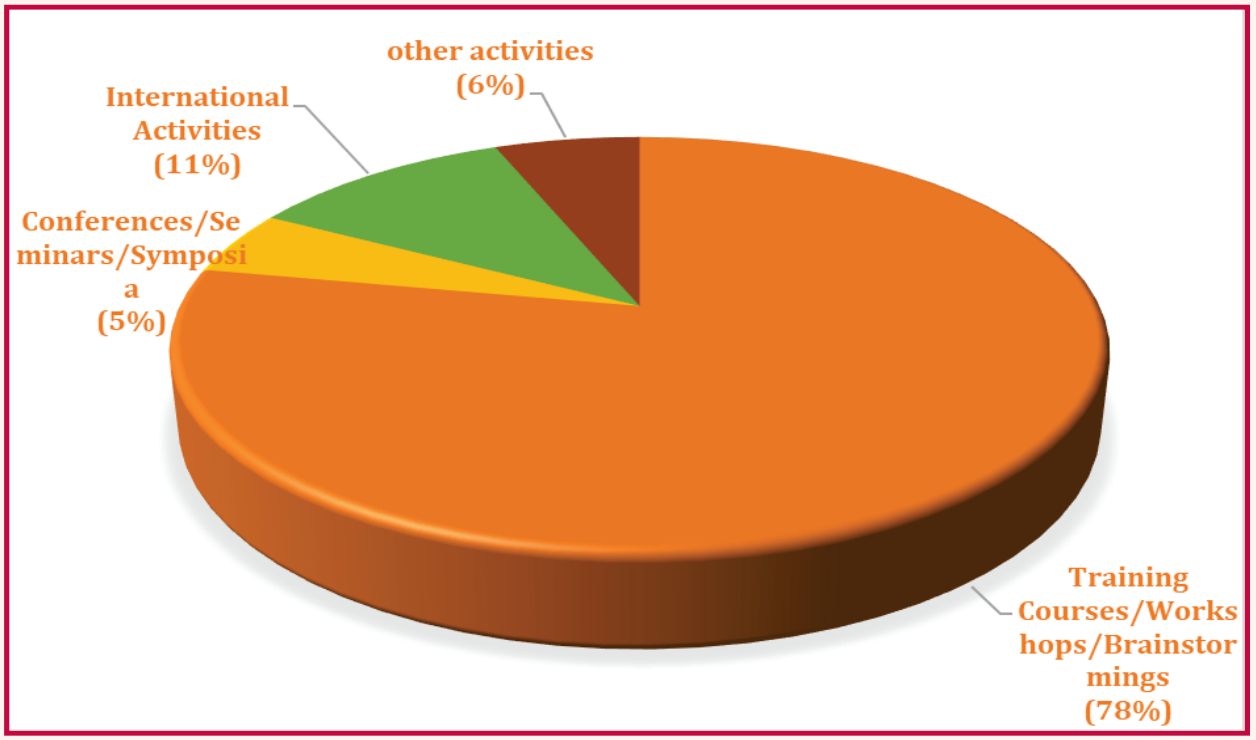


Figure – 10.1: Technology transfer activities organized by the Institute during 2023-2024



Figure – 10.2: Joint Research meeting at Nagaoka University of Technology Office in Tokyo during 5 - 10 November, 2023



Figure – 10.3: Hands-On Training of ICP-MS and GC-MS" for CWC Officers during 08-12 January, 2024 organized by NIH Roorkee



Figure – 10.4: Training Course on 'Greywater Management of Bihar State' in association with PSI, Dehradun and Aga Khan foundation, Patna during 06-07 March, 2024 at Patna



Figure – 10.5: Third edition of "Roorkee Water Conclave (RWC) – 2024", with the theme of 'Responsible Water Management & Circular Economy



Figure – 10.6: Workshop on capacity building on "Climate resilient hydrological systems in Uttarakhand"



Figure – 10.7: A six-day training course on "Hydrological Modeling using SWAT+.



Figure – 10.8: Training program on 'Hydro-Meteorological Data Analysis for Climate Change Studies' organized by NIH Roorkee during Nov. 20-24, 2023.

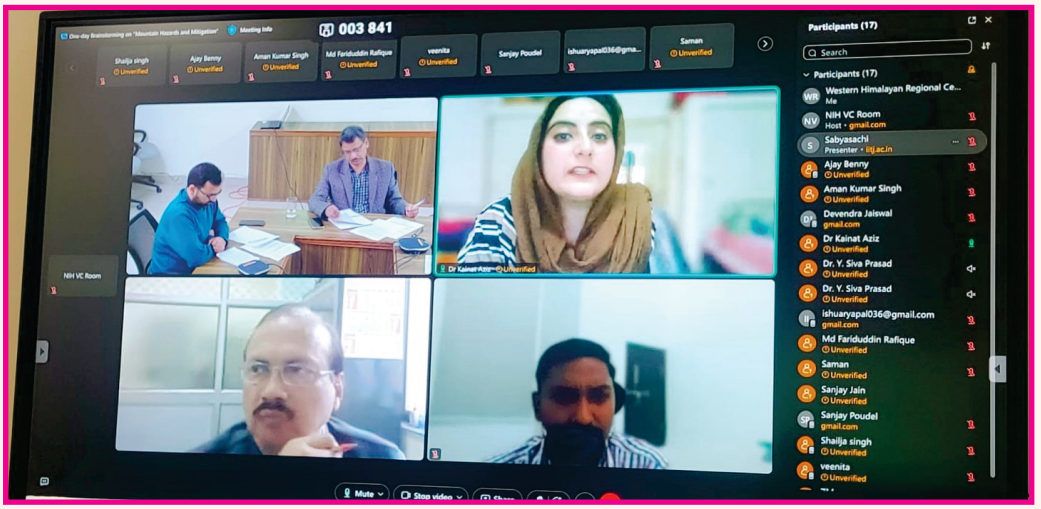


Figure – 10.9: Brainstorming session on Mountain Hazards and Mitigation; NIH-WHRC, Jammu (hybrid mode), 11 March 2024



Figure – 10.10: Participants of "Hydrological Modelling using HEC-HMS" training at CFMS, Patna



Figure – 10.11: Training Course on Analyzing Hydro-Meteorological Data Using R Programming Language, March 17, 2023 at RC, Jammu



Figure – 10.12: Training program on "Hydrological Modeling using HEC-HMS, NIRD&PR, NERC Guwahati (11–15 March 2024)



Figure – 10.13: Training programme on "Urban Hydrological Studies of Pilot Area using Hydrological Instruments in Greater Hyderabad Municipal Corporation (GHMC) Area" in the I&CAD, Hyderabad

Important Meetings and Visits 11

Activities of the National Institute of Hydrology are managed by various committees. A number of meetings of these committees are held every year. The Institute is also actively involved in various National and Regional committees constituted by various Ministries and Departments. A number of scientists of the Institute have representation in many such national and state-level committees. A number of national and international dignitaries and experts visit the Institute every year for various technical and official purposes. Similarly, scientists of the Institutes also visit abroad for various technical purposes. The status of important meetings held, representation of NIH in national and regional committees, dignitaries who visited NIH and visits abroad by NIH scientists for the year 2023-24 are given below:

Important Meetings Held

Following important meetings were organized by NIH and its regional centres during the year 2023-24:

S. No.	Meeting	Date	Place
1	Second meeting of the TF for review of the R0 draft of revised Safety Guide AERB/NF/SG/S6A	24 Jan., 2024	online
2	Third meeting of the TF for review of the R0 draft of revised Safety Guide AERB/NF/SG/S6A	06 Feb., 2024	online
3	77th Technical Advisoy Meeting of National Institute of Hydrology, Roorkee	19 Feb, 2024	NIH, Roorkee
4	Joint Working Group under the Chairmanship of AS & MD, NWM to know the status of MoC signed between India and Japan on 11/12/2019 in the field of Water Resources	19 Feb., 2024	New Delhi
5	54th working group meeting of National Institute of Hydrology, Roorkee	22-23 Feb., 2024	NIH, Roorkee
6	Fourth meeting of the TF for review of the R0 draft of revised Safety Guide AERB/NF/SG/S6A	26 Feb., 2024	online
7	Technical Committee Meeting of Rajasthan & Haryana	12 March, 2024	Online
8	2nd Regional Coordination Committee Meeting of North Western Regional Centre (NWRC), Jodhpur	15 March, 2024	Jodhpur
9	19th Regional Coordination Committee Meeting of NERC Guwahati	19 March, 2024	Guwahati
10	Twenty-third Meeting of Regional Coordination Committee of the Centre for Flood Management Studies, Patna	21 March, 2024	CFMS NIH Patna

11	33rd Regional Coordination Committee of HRRC, Belagum	10 April,2023	WRD, Panaji, Goa
12	Technical Committee Meeting of Andaman & Nicobar	11 April, 2023	Online
13	First Meeting of Steering Committee on 'Monitoring of Glaciers'	02 May, 2023	NIH, Roorkee
14	Meeting of DSS(PM) Review Committee to R eview the Final DSS(PM) Report and DSS(PM) Software	03 May, 2023	NPMU, New Delhi
15	20th Regional Coordinator Committee Meeting of CIHRC, Bhopal	17 May, 2023	NCA, Indore
16	Interaction with the Kakinada District Collector by Y.R. Satyaji Rao, Sc -G and R. V enkata Ramana, Sc - E, RC-Kakinada	11 June, 2023	Kakinada District Collectorate
17	27th meeting of the Regional Coordination Committee of Western Himalayan Regional Centre, Jammu	28 June, 2023	WHRC, Jammu
18	2nd Meeting of Sub - Committee for "Comprehensive Evaluation and System Studies on Interlinking of Rivers", Chaired by Sh. A. B. Pandya, Secretary General, ICID and Former Chairman, CWC.	June 30, 2023	NIH, Roorkee
19	Third Meeting of Steering Committee on "Springshed Mapping of Indian Himalayan Region (I HR) Including Mountainous Regions of the Country and Springshed Based Watershed Management Plan"	21 July, 2023	NIH, Roorkee
20	32nd Regional Coordination Committee (RCC) Meeting of RC-Kakinada	3 August, 2023	ICAR– IIWM, Bhubaneswar
21	18th Regional Coordin ation Committee Meeting of NERC Guwahati	24 Aug., 2023	Guwahati
22	First Regional Coordination Committee Meeting of North Western Regional Centre (NWRC), Jodhpur	20 Nov., 2023	Jodhpur
23	First meeting of the TF for review of the R0 draft of revised Safety Guide AERB/NF/SG/S6A	18 December, 2023	AERB, Mumbai
24	Meeting of NHP -SRC to review FDBA Report of Chandan dam & Inception Report of 5 Dams.	26 Dec.,2023	online

Representation in National, Regional and Other Committees

During the year 2023-24, scientists of the Institute participated and contributed in meetings of various national, regional and other Committees. The details of some of such committees are as follows:

S. No.	Name of the Committee	Member from NIH	Role	Ministry/ Department
1	BIS WRD-28 Sectional Committee	Dr S. V. Vijaya Kumar	Member	Bureau of Indian Standards

2	Technical Advisory Committee	Dr. Pankaj Mani	Member	FMISC, WRD, Govt. of Bihar
3	Standing Review Committee to review different reports of water resources projects funded by the World Bank	Dr. Pankaj Mani	Member	WRD, Govt. of Bihar
4	Task Force for review of 'R0' draft (being prepared by an in-house working group) of the revised guide and preparation of 'R1' draft towards revision of the AERB Safety Guide No. AERB/SG/S-6A	Dr. Pankaj Mani	Member	Atomic Energy Regulatory Board (AERB), Govt. of India
5	State Specific Action Plan for Bihar and Jharkhand	Er. Suryansh Mandloi	Nodal Officer	Dept. of Water Resources, RD&GR, MoJS, Govt. of India
6	Joint Committee chaired by the Chief Secretary, UT of Jammu and Kashmir, constituted vide Govt. Order No. 387-JK (GAD) of 2023 dated 24-03-2023 on the direction of National Green Tribunal in the matter of Original Application No. 93/2023 that met on 22 May 2023 and 08 February 2024.	Dr. P.G. Jose	Expert Member	National Green Tribunal /Govt. of J&K
7	Review meeting of the JJM and SBA chaired by the Secretary, DoDW, GoI on 24 and 26 April 2023.	Dr. P.G. Jose	Member EC, JJM, UT of J&K	Ministry of Jal Shakti, GoI
8	Meeting called on Delineation/Demarcation of land, which do not form part of any water course/source but have been recorded as Gair Mumkheen Khads/Daryas/Nallah on 29 April 2023.	Dr. P.G. Jose, Dr. D.S. Bisht	Attendee	Divisional Commissioner, Jammu, J&K

9	Meeting on Technical Support in Preparing Water, Snow Harvesting and Glacier Conservation in Ladakh" chaired by Addl. Secretary and Mission Director, NWM through virtual mode on July 14, 2023.	Dr. P.G. Jose	Attendee	Ministry of Jal Shakti, GoI
10	First Meeting of the UT Level Steering Committee for preparation of the UT Specific Action Plan (UTSAP) under National Water Mission (NWM) chaired by the Chief Secretary, UT of Jammu and Kashmir on 31st August 2023.	Dr. P.G. Jose	Attendee	UT of J&K
11	Online meeting to discuss preparedness to meet water deficiency during the ensuing summer of 2024 due to inadequate snowfall during Dec.23-Jan. 2024 in the Kashmir Division of J&K on 20 March 2024.	Dr. P.G. Jose, Dr. R.A. Mir	Attendee	JKWRRA, UT of J&K
12	Coastal Zone Water Management Sectoral Committee of Bureau of Indian Standards (BIS)	Y.R. Satyaji Rao	Member	Ministry of Consumer Affairs, Food and Public Distribution
13	Association of Hydrologists of India	Y.R. Satyaji Rao	Executive Committee Member	A Scientific Organisation of Department of Geophysics, Andhra University, Visakhapatnam, Andhra Pradesh
14	State Specific Action Plan (SSAP) for the Andaman & Nichobar Islands and Puducherry.	V.S.Jeyakanthan	Coordinating member	Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation
15	Interdepartmental Committee constituted as per the write petition in Hon. High Court o MP for formulation of strategy for protection of banks of river Narmada	Dr. Ravi Galkate Dr R. K. Jaiswal	Work on Flood plain zoning	Directorate, Urban Administration & Development, MP, Bhopal, Govt of MP.

16	Committee for fact-finding the reasons and fixing the responsibilities for breaking of Karam dam	Dr. R. K. Jaiswal	Technical Member	Water Resource Department, Govt. of MP
17	Expert member for State Specific Action Plan (SSAP) for water sector Madhya Pradesh	Dr. Ravi Galkate Dr T. Thomas Dr R. K. Jaiswal	Assessment of water availability under climate change	Water and land Management Institute, Bhopal, M/o Rural Development, Govt of MP.
18	To discuss the suggested course of action outlined in Preliminary report and the way forward to finalize the detailed assessment report of Joshimath issue, Chaired by Member Secretary NDMA	Dr. Gopal Krishan, Sc., 'E'	Expert	NDMA, New Delhi
19	19th Meeting of Central Geological Programming Board, Committee-IX (Geoscientific Investigation)	Dr. Gopal Krishan, Sc., 'E'	Member	GSI
20	Joint committee for addressing issues pertaining to the temple precinct DPR & works for Badrinath Dham, Chamoli headed by Director, NMCG, GoI.	SM Pingale, Scientist D	Member	NMCG, MoJ, Govt. of India
21	Member of Steering Committee for the development of SOP under theme "Treatment measures for springshed management" for "Springshed mapping of Indian Himalayan Region (IHR) including mountainous regions of the country and springshed based Watershed Management Plan"	SM Pingale, Scientist D	Team Member	Ministry of Jal Shakti, Dept. of RD, GR and
22	Member of the investigation team on Joshimath Disaster with reference to "Identification of source and causes of the gushing water in the premises of Jaypee Colony in the night of 02 January, 2023"	SM Pingale, Scientist D	Team Member	Uttarakhand State Disaster Management Authority (USDMA), Govt. of Uttarakhand
23	Global Hydro-climatology Panel (GHP) group of the	SM Pingale,	Panel Member	World Meteorological Organisation (WMO),

	Global Energy and Water Exchanges (GEWEX) Project, as part of the World Climate Research Programme (WCRP)	Scientist D		Geneva, Switzerland through Center for Ocean-Land-Atmosphere Studies (COLA), George Mason University, Fairfax, Virginia, U.S.A.
24	Associate Editor, Hydrological Sciences Journal, Taylor & Francis	SM Pingale, Scientist D	Coordinate Manuscripts from submission to acceptance and provide decisions to Chief Editor	International Association of Hydrological Sciences (IAHS), UK
25	High Level Technical Committee for evaluation of Red Oil Palm cultivation in Andaman. Committee formulated on the direction of Supreme court	Dr. R. P. Pandey	Member	MoEF & CC GOI, New Delhi
26	State Level Scheme Sanction Committee	Dr. R. P. Pandey	Member	Jal Jeevan Mission, Uttarakhand
27	Expert Committee for assessment of drinking water source sustainability for Karnataka	Dr. R. P. Pandey	Member	National Jal Jeevan Mission, DDWS, MoJS, GoI
28	Drinking Water Supply, Wastewater and Stormwater System Services Sectional Committee, SSD 14 on 28.04.2023 & 25.07.2023	Dr. M. K. Sharma	Principal Member	Bureau of Indian Standards (BIS), New Delhi
29	Sectional Committee of Bureau of Indian Standards for "WRD 24: Environmental Assessment and Management of Water resources projects"	Dr. Pradeep Kumar	Member	BIS, New Delhi
30	Committee for implementation of e-flows notification of MoJS for Ganga river from Haridwar to Unnao	Dr. Pradeep Kumar	Member	CWC, New Delhi
31	Uttarakhand State Wetlands Authority	Dr. Pradeep Kumar	Member	Govt. of Uttarakhand

32	ISO/TC 113/SC 1/Working Group Committee 9 for "ISO 24577 "Hydrometry - Use of non-contact methods for measuring water surface velocity and discharge"	Dr. Manish K Nema, Sci.-E	Member	BIS, GoI
33	Australia India Water Centre	Dr. Archana Sarkar	Member, Advisory Board	Western Sydney University, Australia
34	International Association of Hydrological Sciences (IAHS)	Dr. Archana Sarkar	Vice-President	IAHS Ltd, United Kingdom
35	The WMO Research Board Task Team on Hydrology Research (TTHydroResearch)	Dr. Archana Sarkar	Member	World Meteorological Organisation (WMO)
36	Indian National Committee on Ground Water (INCGW)	Dr. Anupma Sharma, Scientist-G	Member	CGWB, New Delhi
37	Accreditation Board for Granting Accreditation to Groundwater Professionals	Dr. Anupma Sharma, Scientist-G	Member	CGWB, New Delhi
38	Project Appraisal and Monitoring Committee (PAMC) for Hydrology & Cryosphere.	Dr. Anupma Sharma, Scientist-G	Member	Ministry of Earth Sciences
39	Ground Water and Related Investigation Sectional Committee, WRD 03	Dr. Anupma Sharma, Scientist-G	Member	BIS, New Delhi
40	Joint Committee Constituted in Compliance of Hon"ble National Green Tribunal Order in OA No. 481/2023.	Dr. Anupma Sharma, Scientist-G	Member	MoEF&CC
41	Central Level Expert Group (CLEG) for Periodic Re-assessment of Ground Water Resources of the Country	Dr. Anupma Sharma, Scientist-G	NIH Representation	CGWB, New Delhi
42	Ground Water Resource Estimation Committee	Dr. Anupma Sharma, Scientist-G	NIH Representation	CGWB, New Delhi
43	Expert Appraisal Committee (EAC) for evaluation of Impact Assessment Reports submitted to CGWA for NOC for groundwater withdrawal	Dr. Sumant Kumar, Scientist-E	External Expert	CGWB, Dehradun

44	India –Australia cooperation in the field of Water Resource Management	Dr. A.K. Lohani	Member	MoJS
45	State Ganga Rejuvenation, Protection and Management Committee for the State of Uttarakhand	Dr. A.K. Lohani	Member	
46	High Level Review Committee for Flood Forecasting and Inundation mapping Model for Rapti Basin in U.P.	Dr. A.K. Lohani	Expert Member	
47	Expert Group for Preparation of Flood Hazard Atlas, NDMA, New Delhi	Dr. A.K. Lohani	Member	
48	Regional Committee for Scientific Assessment of Flood Prone Areas in Odisha	Dr. A.K. Lohani	Expert Member	
49	Sub-committee for Hydro-met Equipment under National Hydrology Project.	Dr. A.K. Lohani	Member	
50	Task Force of Experts for Preparation of Guidelines for Management of Glacial Hazards and Risks especially Glacial Lake Outburst Floods(GLOFs), NDMA	Dr. A.K. Lohani	Member	NDMA
51	Joint Committee constituted for flood Plain of Mahanadi River at Cuttack by Hon‟ble NGT with its order dated 15.12.2020 in OA No. 22/2020(EZ).	Dr. A.K. Lohani	Member	Hon‟ble NGT
52	Uttarakhand Flood Committee	Dr. A.K. Lohani	Member	
53	Committee for formulation of Strategy for Flood Management Works in the entire country and River Management Activities and Work related to Border Areas	Dr. A.K. Lohani	Member	

54	Monitoring Committee for Haora Riverfront Development Project, Agartala Smart City Ltd.	Dr. A.K. Lohani	Member	
55	Mini Hydel Projects on Bhakra Main Line Canal, Ministry of New and Renewable Energy Govt of India	Dr. A.K. Lohani	Member	Ministry of New and Renewable Energy Govt of India
56	Programme Advisory Committee (PAC)-Earth & Atmospheric Sciences (E&AS) of Science and Engineering Research Board (SERB)	Dr. A.K. Lohani	Member	Science and Engineering Research Board (SERB)
57	Joint Committee in compliance to the Hon"ble National Green Tribunal (NGT) Order dated dated 07.02.2022 in the matter of Pradip Kumar Pattnaik Vs Union of India & Ors in OA No. 68/2020(EZ) Mahanadi Flood Plain Cuttack.	Dr. A.K. Lohani	Member	Hon"ble NGT
58	Joint committee constituted by the Hon"ble NGT (ONA 433/2022) to demarcate the flood plain zone on the left and right banks of Suav rive in Urban Municipal Limits of Balrampur City. (U.P.).	Dr. A.K. Lohani	Member	Hon"ble NGT
59	Study to analyses carrying capacity of Ratmau and Solani rivers in order to transfer water to Shukratal (U.P.).	Dr. A.K. Lohani	Member	
60	Committee constituted by the Hon"ble NGT (IA No. 99/2022) to demarcate the flood plain zone at Moga Resort Rishikesh (Uttarakhand).	Dr. A.K. Lohani	Member	Hon"ble NGT
61	State Committee on Dams Safety for the dams of Maharashtra (Maharashtra State Govt, Gazette, Dated 15.06. 2022 and 22.06. 2022)	Dr. A.K. Lohani	Member	Maharashtra State Govt

62	State Committee on Dams Safety for the dams of Uttar Pradesh (UP State Govt, Gazette, Dated 18.06. 2022)	Dr. A.K. Lohani	Member	UP State Govt,
63	State Committee on Dams Safety for the dams of Gujarat (Gujarat State Govt, Gazette, Dated 14.12. 2021).	Dr. A.K. Lohani	Member	Gujarat State Govt
64	State Committee on Dams Safety for the dams of Andman and Nicobar	Dr. A.K. Lohani	Member	
65	Committee on Flood Risk Management	Dr. R. V. Kale	Member	International Association for Hydro-Environment Engineering and Research (IAHR)
66	Sub Group B-1.4 on Preparation of Draft document Hydraulics of Bridges	Dr. R. V. Kale	Member	Indian Roads Congress (IRC), MORTH, GoI
67	Hydrology Expert at U. P. State Wetland Authority	Dr. R. V. Kale	Non-Official member	U. P. State Wetland Authority, U. P.
68	Joint Working Group (under India Japan Cooperation in the field of Water Resources)	Dr. R. V. Kale	Member	DoWR, RD&GR, Ministry of Jal Shakti, GoI, New Delhi
69	Water Resources Department (WRD), Bureau of Indian Standards (BIS)	Dr. Sanjay Kumar	Member	International Organization of Standards(ISO) ISO/BIS (TC 113) Committee.
70	State Specific Action Plan (SSAP)	Sourabh Nema	Coordinator-Rajasthan	National Water Mission, Min. of Jal Shakti
71	Expert Committee on Groundwater for Sikkim State	Dr. Surjeet Singh	To deal with the availability and scenario of groundwater in the state	Ministry of Water Resources, Govt. of Sikkim
72	Joint Committee in Compliance of the order passed by the Hon"ble NGT	Dr. Surjeet Singh, Dr. Akshaya Verma	Member	Ministry of Environment Forest & Climate Change Regional Office, Dehradun

73	Steering Committee of First Spring Census of the Country	Dr. S. S. Rawat	Nodal Officer (Technical)	D/o WR, RD & GR, Ministry of Jal Shakti
74	Steering committee on "Springshed Mapping of Indian Himalayan Region (IHR) Including Mountainous Regions of the Country and Springshed based Watershed Management Plan"	Dr. S. S. Rawat	Member Secretary	D/o WR, RD & GR, Ministry of Jal Shakti
75	Committee constituted by Ministry of Jal Shakti for Investigation of Joshimath Subsidence	Dr. S. S. Rawat	Investigation Member	Ministry of Jal Shakti
76	Committee constituted by NGT for estimation of carrying capacity of Mussoorie town Investigation of Joshimath Subsidence	Dr. S. S. Rawat	Member	NGT
77	High Power Committee (HPC) of Spring and River Rejuvenation Authority (SARRA)	S. S. Rawat,	Member	Govt. of Uttarakhand
78	Mitigation measures about risks arising from glacial lakes in Uttarakhand	Dr. Surjeet Singh, Dr. Lavkush Patel, Dr. Akshaya Verma	Members/ Technical partner for field investigations	Uttarakhand State Disaster Management Authority
79	State Specific Action Plan (SSAP)	Dr. Sunil Gurrapu	Member	National Water Mission, DoWR, RD, & GR, Ministry of Jal Shakti.
80	HKH CryoHub Meeting 2023	Dr. Vishal Singh	Member and participant	Ministry of Jal Shakti
81	G20 Summit, 2023 Gandhinagar	Dr. Vishal Singh	Exhibitor	Ministry of Jal Shakti
82	State/UT-wise Meetings to mitigate risk arising from Glacial lakes January 2023	Dr. Vishal Singh	Participants	Ministry of Jal Shakti

Dignitaries Who Visited NIH

Following International and National dignitaries and experts visited the National Institute of Hydrology, Roorkee and Regional Centres during 2023-24:

S. No.	Name	Department & Country	Date
1.	Dr. Rajendra Singh (Water Man of India)	NGO of Tarun Bharat Sangh (TBS) & India	February 1, 2024
2.	Prof. Thomas Grischek	Department of Civil Engineering, University of Applied Sciences, Germany	March 6, 2024
3.	Dr. Cornelius Sandhu	Department of Civil Engineering, University of Applied Sciences, Germany	March 6, 2024
4.	Dr. H. Börnick	TUD, Germany	March 6, 2024
5.	Dr. P. Yadav	Department of Civil Engineering, University of Applied Sciences, Germany	March 6, 2024
6.	Ing. M. Lohmann	TZWD, Germany	March 6, 2024
7.	Dr. J. Nowak	FHP, Germany	March 6, 2024
8.	Ing. H. Rustige	AKUT, Germany	March 6, 2024
9.	Prof. Berit Arheimer	Swedish Meteorological and Hydrological Institute Topp Navigation	March 6, 2024
10.	Prof. Sunil K. Sinha	Civil & Environmental Engineering, Virginia Tech	March 7, 2024
11.	Prof. Jean-Marie Kileshye Onema	North West University, South Africa	March 6, 2024
12.	Prof. Dr. Eduardo Mario Mendiondo	University of São Paulo, Brazil	March 6, 2024
13.	Dr. Salini Sasidharan	Department of Biological & Ecological Engineering, Oregon State University, USA	March 6, 2024
14.	Sh. Gajendra Singh Sekhawat (Union Minister of Jal Shakti)	Ministry of Jal Shakti, Govt. of India	June 13, 2023
15.	Prof. Bryan G. Mark	Department of Geography & Byrd Polar and Climate Research Centre Ohio State University, USA	March 7, 2024

VISITS ABROAD

Following scientists of NIH visited abroad during 2023-24 for various activities:

S. No.	Purpose	Period	Funding Agency	Place of Visit (City/ Country)	Name & Designation
1	To attend and participate "Fourth South Asia Hydromet Forum (SAHF-IV')"	6-9th February 2024	World bank	Colombo, Sri Lanka	Dr Kuldeep Sharma, Scientist-C
2	IAHS Annual Board Meeting	March 6-8, 2024	IAHS, UK	Wallingford, United Kingdom	Dr. Archana Sarkar, Sc F
3	Training on 'Ice Core Analysis Techniques'	18-22 September 2023	Self-Sponsored	Copenhagen/Denmark	Dr. Akshaya Verma, Sci 'C'
4	Panta Rhei Symposium and International Union of Geodesy and Geophysics (IUGG) General Assembly 2023	July 10-17, 2023	IAHS, UK	Potsdam & Berlin, Germany	Dr. Archana Sarkar, Sc F
5	Organization and attending International Riverbank Filtration Conference in Dresden; associated networking events	October 14-23, 2023	HTWD, Germany	Dresden, Germany	Dr. Gopal Krishan, Scientist E
6	Participation and attending the international conference & joint research meeting	5 -10 November, 2023	Nagaoka University of Technology, Japan	Nagaoka, Japan	Dr. V. K. Tyagi, Scientist 'D'
7	IAHS Bureau Meeting and Project Meeting	Dec 4-8, 2023	International Project (WaterRainHIM) Funds	Norkopping & Stockholm, Sweden	Dr. Archana Sarkar, Sc F
8	Post-doctoral research	09/12/2022 to 8/12/2023	Oregon State University	Corvallis, Oregon, USA	Dr. Sumant Kumar, Scientist-E



Figure – 11.1: 32nd RCC meeting of RC-Kakinada conducted at ICAR – IIWM, Bhubaneswar on 3rd August, 2023

Infrastructure 12

Laboratories provide a dynamic and broad-based research environment. The Institute has well-equipped laboratories with state-of-art monitoring and analytical instruments powered by a team of expert scientists, supporting scientific and technical staff. Besides, the laboratories the institute has a number of other units with ultra-modern facilities. Following laboratories and units have been established at the Institute.

12.1 Nuclear Hydrology Laboratory

The Nuclear Hydrology laboratory is equipped with modern instruments for measurement of stable and radioisotopes in water and sediments. The instruments are used to collect data on stable and radioactive isotopes of various sources of water as well as sediments. and for dating pf ground water and sediment. The generated isotopic data are used for various hydrological studies and analysis such as identification of recharge sources and recharge zones of ground water and springs, surface water-ground water interaction, identification of source of moisture for precipitation, hydrograph separation, assessment of relative contribution of different sources to a water reservoir, evapotranspiration studies, atmospheric air moisture analysis, ET portioning, site selection for river bank filtration, lakes sedimentation studies etc. The Nuclear Hydrology Laboratory has three units, (i) Stable Isotope Unit, (ii) Groundwater Dating Unit, and (iii) Sediment dating Unit. Important instruments available in the Stable Isotope Unit are: Dual Inlet Isotope Ratio Mass Spectrometer (DIIRMS) and Continuous Flow Stable Isotope Ratio Mass Spectrometer (CFIRMS) for measurement of δD, δ13C, δ18O and δ34S in water and solids; Isotopic Water Analyzer (Liquid+Vapor) for measuring δ2H, δ17O, δ18O. Groundwater Dating Unit is equipped with Tritium Enrichment Units (2 Nos.), Ultra Low Level Liquid Scintillation Spectrometer (Quantulus), Soil Moisture Extraction Units and Liquid Nitrogen Plant etc. Sediment Dating unit has a Multichannel Gamma Ray Spectrometer and Alpha Ray Spectrometer. Two sets of radon detectors are also available in the laboratory. The Nuclear Hydrology Laboratory is also equipped with Ion Chromatograph System-5000(Dionex) for analysis of major ions in water. Apart from the Hydrological Investigations Division, other divisions of the Institute and the Regional Centres also use the facilities of the laboratory for their technical studies. The facilities of the laboratory are also extended to various other departments/ agencies of state and central government, R & D and academic institutes.

During the year 2023-24, a total of 5360 water samples (precipitation, rivers, springs, lakes, and groundwater etc.) were analysed for stable isotopes including δD (2552 samples) and δ18O (2808 samples). Apart from this, 180 water samples were analysed for environmental tritium on Quantulus and 870 water samples were analysed for water chemistry on Ion Chromatograph. The facilities of the laboratory were also extended to various other departments/agencies like; Central Ground Water Board, NCESS, Trivendrum, NIT Hamirpur, IIRS, Dehradun, Deptt. of Earth Science, IIT Roorkee, DOH-IIT Roorkee, IIT Kanpur, BHU-Varanasi, SKUAST-Kashmir, NEHU-Shilong, SRM, University Chennai, NTPC-Solapur, Gadarwara, Nabinagar, Khargone, Geoscience Consultancy Services, Roorkee. Various dignitaries visited the lab during the year and appreciated the infrastructure as well as working environment of the lab.





Figure – 12.1: Visit of German and US dignitaries to NH lab

12.2 Remote Sensing and GIS Laboratory

The use of remotely sensed satellite based datasets and Geographic Information System applications is increasing and popular day by day in various aspects of hydrological and water resources research. Remote Sensing and GIS Application (RSA) Laboratory is a common computing facility of the institute. This laboratory is attached to the Water Resources Systems Division (WRSD) of NIH Roorkee. The scientific studies and research on various aspects of hydrology and water resources using remotely sensed data and GIS platforms were carried out in the laboratory. This laboratory assists in RS and GIS applications in various Institute Funded/ Sponsored/Consultancy studies and research projects of the institute. Different remote sensing and GIS software are available in the laboratory, namely ArcGIS, ERDAS Imagine, ENVI, and R2V (Raster to Vector Conversion software). The laboratory is equipped with A0 Colortrac Smart-F Image Scanner, Laser Printer and A0 size Cannon Colour plotter. The laboratory maintains a large inventory of maps from various organizations, namely the National Remote Sensing Centre (NRSC), Survey of India (SOI) and National Bureau of Soil Survey and Land Use Planning (NBSSLUP). Several topographic maps and state soil maps are available in the laboratory. The laboratory also has satellite remotely sensed data pertaining to different parts of the country. Software, maps and data available in the laboratory are utilized in various studies carried out by the institute. The laboratory also has Differential GNSS, Promark 120, to collect location and altitude information. The laboratory facilities are also used during the interactive awareness programmes on remote sensing applications and GIS in various fields, organised by the Institute for the students from different schools and colleges. In 2023-24, more than 120 students/ trainees and their teachers from different schools and institutes visited the laboratory.



Figure – 12.2: A view of Remote Sensing and GIS Laboratory



Figure – 12.3: Interactive session for the students at Remote Sensing and GIS Laboratory

12.3 Soil Water Laboratory

The Soil Water Laboratory has modern equipment for laboratory and field measurement of the soil physical and hydrologic properties. The major capabilities include determination of soil particle size distribution for textural analysis, permeability, porosity, infiltration, soil density, soil moisture at different suction for determination of the soil moisture characteristics curves, saturated hydraulic conductivity, sorptivity and matrix flux potential of soils, in-situ soil moisture, soil salinity and pH, leaf area index, foliage and other canopy measurements in command area etc. using advanced instrumentation and techniques. Major instruments available in the laboratory include Pressure Plate Apparatus, Soil Particle Size Analyzer, CHNS/O Analyzer, Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) Microwave Digestion System, Water Purification System, Guelph In-situ Permeameter, TDR Soil Moisture Probe, ICW Lab Permeameter, Multi Volume Pycnometer, Digital pH & Conductivity meter, Constant Head Permeameter, Falling Head Permeameter, Electromagnetic Sieve Shaker, Tensiometers, Double Ring Infiltrometers, and Plant Canopy Analyser. In addition to routine laboratory-based analysis of soil samples, the laboratory is providing services in the field for collecting disturbed/undisturbed samples, conducting in-situ measurement of various soil parameters and for field surveys related to the studies taken up by various divisions including the sponsored / consultancy projects. During the year 2023-24, various field and laboratory-based analysis were carried out for different projects. During the year a total of 837 samples were analysed in the laboratory using Sieve Shaker and master sizer (462), ICP-OES (240), CHNS analyser (6), ICW Lab Permeameter (10), pH-EC (28), bulk density (22) and pressure plate (69) for determination of various soil properties, such as CHNS (carbon, hydrogen, nitrogen, sulphur), presence of trace metals, soil texture, soil moisture characteristic curve, permeability, bulk density, soil moisture, etc. In addition, SW lab equipment such as Double Ring Infiltrometer and Guelph Permeameter etc. are also being used to conduct field experiments for measuring insitu soil properties.



Figure – 12.4: A view of some instruments in Soil-Water Laboratory

12.4 Centre of Excellence for Advanced Groundwater Research

In India, groundwater resource is under threat of depletion and contamination due to manifold inevitable causes like rapid urbanization and industrialization, intense irrigation withdrawals and limited natural recharge. To cope up such issues, NIH prospectively planned to strengthen the R&D activities with national and international organizations by developing a platform to work in groundwater domain. Accordingly, a Centre of Excellence for Advanced Groundwater Research (CEAGR) has been established under the Groundwater Hydrology Division. The centre has the state-of-art tools on hardware and software for dealing with computationally challenged problems.

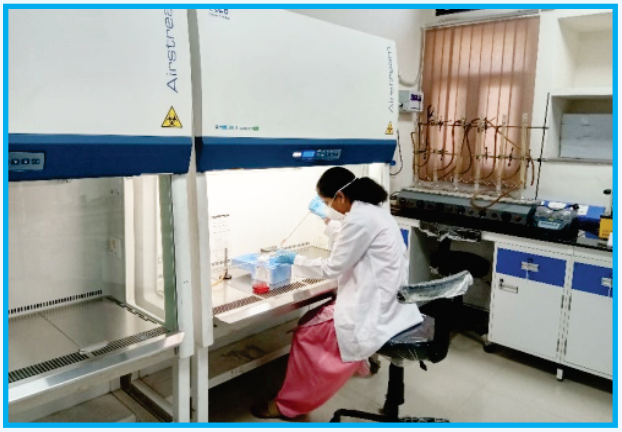
The centre is equipped with various soft-computing tools related to groundwater like: groundwater quantity and quality modeling using MODFLOW/ MODFLEX Premium/ FEFLOW; integrated catchment modelling using MikeSHE; unsaturated zone modelling using WHI UnSat Suite Plus; spatial analysis using ArcGIS/TNT Mips; geological characterizing using Hydro GeoAnalyst; 3D contouring using Surfer; water quality characterization using AquaChem; and aquifer parameter estimation using AquferTest pro. Some of these software has been recently upgraded.



Figure – 12.5: Centre of Excellence for Advanced Groundwater Research

12.5 Water Quality Laboratory

The Water Quality Laboratory is well-equipped with well qualified staff and state-of-art equipments to identify and quantify physical, chemical and bacteriological parameters in water. The laboratory has facilities and capabilities to determine major ions, trace elements, pesticides, PAHs and bacteriological parameters in water samples. The major equipments available in the laboratory include Ion Chromatograph with Auto Titrator, Voltammetry, Liquid Chromatography– Inductively Coupled Plasma – Mass Spectrometry (LC-ICP-MS), TOC Analyzer, Triple Quadrupole Gas Chromatograph Mass Spectrometer (GC-MS/MS), Autotitrator Potentiometric (ATP), UV-Vis Spectrophotometer, Flame Photometer, Portable Environmental Laboratory, Biosafety Cabinet, Research Microscope, Microwave Digester, Ultrapure Water Purification System, Deep Freezer, Autoclave, Orbital Shaker Incubator, BOD Incubator, Bacteriological Incubator, COD Digestion System, Total Kjeldahl Nitrogen (TKN) System, Parallel Evaporation and Concentration System, Bacteriological Testing Kit, Centrifuge, Toxicity Characteristic Leaching Procedure (TCLP) etc. The laboratory also provides its services for sample collection and analysis for outside agencies. Water Quality Laboratory was accredited by NABL in accordance with the standard ISO/IEC 17025: 2017– General Requirements for The Competence of Testing & Calibration Laboratories for 22 parameters for a period of two years w.e.f. 14.04.2021 (Certificate Number: TC-9421) (Lab ID: T-5679) and got renewal of accreditation by NABL for next two years (upto 26.07.2025) (Certificate Number: TC-12019).



Bacteriological Analysis in WQ lab



Total Kjeldahl Nitrogen (TKN) Analyzer in WQ Lab



Liquid Chromatography - Inductively Coupled Plasma – Mass Spectrometer (LC-ICP-MS) in WQ Lab



Tripple Quadrupole Gas Chromatograph – Mass Spectrometer (GC-MS/MS) in WQ Lab

Figure – 12.6: Advanced instruments in Water Quality Lab

12.6 Hydrological Instrumentation Laboratory

Hydrological Instrumentation (HI) Laboratory is equipped with conventional as well as modern equipment's for various hydrologic measurements. Important instruments available in the laboratory include: Automatic Infiltrometer, Automatic Weather Station, Automatic Rain Gauges (Tipping Bucket type), Current Meters, Depth Water Samplers, Digital Surface and Ground Water Level Recorders, Differential Global Positioning System (DGPS), Earth Resistivity Meter, Echo-sounder with DGPS for Bathymetric survey, Multi-parameter Water Quality Kit, Mini-Disc Infiltrometer, Sediment corer, Suspended Solid Analyzer, Time Domain Reflectometry (TDR) for soil moisture measurement, Water Level Indicators (Sounders), Water Temperature Profiler, Guelph Permeameter, Total Station, Portable TLC meter, Water level and water flow meter for wells, surface velocity radar for water velocity measurement, Radar based discharge monitor etc. During the year 2023-24, hydro-geological investigations were carried out by the laboratory for various R&D, Sponsored and Consultancy projects. Facilities of the laboratory were also provided to various divisions of the Institute on request. Some important instruments in HI Laboratory are given below:



Earth Resistivity Meter



Water Level Indicator



DGPS



Multi-parameter Water Quality kit



Sediment Corer



Depth Water Sampler



Mini-Disc Infiltrometer



Multi-parameter Water Quality Sonde



Portable Surface Velocity Radar & Portable Flow Probe



Guelph Permeameter

Figure – 12.7: Advanced instruments in Hydrological Instrumentation Lab

12.7 Hydro-Meteorological Observatory

The Meteorological Observatory at NIH campus has been operational since 1985. The instruments operational are: (i) ordinary rain gauge, (ii) autographic rain gauge (siphon), (iii) maximum and minimum temperature thermometer, (iv) dry and wet bulb thermometer, (v) thermograph, (vi) hygrograph, (vii) anemometer, (viii) pan evaporimeter, (ix) sunshine recorder, (x) automatic weather station (AWS). The observations such as maximum temperature, minimum temperature, relative humidity, rainfall, evaporation, sunshine hours, wind speed and wind direction are noted on daily basis at 08:30 AM and 05:30 PM. The data collected at NIH campus are provided to various research organizations, state government departments and research scholars on their requisition. A weather display unit has been installed at the main building for display of current recorded weather parameters for general public.



Figure – 12.7: Visit of students showing AWS in NIH Hydro-meteorological Observatory

12.8 Library

The Institute, since its inception, has been in the continuous process of building and updating a good technical library with latest publications in the area of hydrology and water resources. In the year 2023-24, 121 new books, 35 Technical reports and 405 issues of national and international periodicals have been added to the collection of the library. The total collection of the library has reached up to 25,599 publications, comprising 13,451 books, 4,425 bound periodicals, 6,330 technical reports, 322 Indian and foreign standards, 1036 technical papers/reprints. The library is currently subscribing 31 Indian and 34 foreign periodicals. Out of them, online versions of 33 International periodicals are also available. Nine periodicals are in Hindi. In addition to the Institute employees, library's resources are being utilized widely by users from other organizations.

For automated management of library's activities and services, latest version of KOHA software with Web OPAC and separate server and client PCs are in operation.

Institute Digital Repository (IDR) of institute's own publications have been created and being populated regularly.





Figure – 12.8: A view of NIH Library

12.9 Computer Centre

Computers of latest configuration are available in the Computer Centre of the Institute for conducting complex hydrological analyses and modeling studies. High-speed internet and email facilities are routinely provided for accessing scientific literature as well as transmission of information. The Centre also provides IT services to the administrative and finance wings of Institute. The Centre procures and provides maintenance to computers and related peripherals available within the Institute.

The Center is providing network in the Institute through local area network (LAN). The Centre has maintained 1Gbps internet connectivity in the institute under the National Knowledge Network (NKN) framework. A centralized server receives and stores/forwards emails to respective users. A dedicated web server (www.nihroorkee.gov.in) provides a platform for hosting institute information, research publications, important announcements, tender notices, recruitment, etc. and also maintains useful hydrologic information on its website. An intranet is also available for sharing office orders and forms, etc. The Wi-fi services have also been provided at different locations in the Institute. The Centre is providing training to NIH employee on various software & web applications. The Centre also supports NIH Administration in the operation and maintenance of the Aadhar Based Biometric Attendance System (BAS) at the Institute. NIH Website is STQC Certified. The Centre is also maintaining the account server for NIH employee.

During the year 2023-24, the Computer Centre has made regular procurements of latest version of Laptops, Desktop computers, Servers and accessories for the scientists. Computer Centre is also providing the facility of anti-plagiarism to the users for their publications. Computer Centre has also developed a NIH Scientist Web Profile Portal. Computer Centre is continuously developing in-



Figure – 12.9: Training Hall of Computer Centre at NIH Roorkee

house software utilities for various purposes and also develops web-based applications. The result framework document (RFD) system has been hosted by the Computer Centre. The STQC Certification is actively involved in handling social media activities of the Institute. The center is providing assistance in using of e-HRMS and e-office in the Institute.

12.10 Maintenance Division

The Maintenance Division is responsible for the creation of new infrastructural facilities as per the Institute's requirements, besides the regular work of maintaining the existing facilities including renovation and maintenance of existing buildings, laboratories, residential quarters, etc. During the year 2023-24, the division has taken up various renovation works within the institute. These works have been entrusted to the central construction agency CPWD. The details of the major works of the Division for the year 2023-24 are as follows:

S. No.	Name of Work	Agency
	Completed	
1	Renovation of Library in NIH office.	CPWD
2	Shifting of water supply line between water pump to overhead tank in NIH office.	CPWD
3	Civil works in quarter no. DG-6, CG-4 & CG-1 of NIH staff colony.	NIH
4	Fixing of aluminium frame window in Sub Station of NIH Staff colony.	NIH
5	Upgradation of kitchens in quarters of Narmada Block-I,II,III &IV.	NIH
6	Construction of road and toe wall near M.P. Hall of the Institute	
7	Water Proofing (kova) of Narmada Block (roofs of 1, 2,3,4)	NIH
8	GI Metal False Ceiling works at roof of Socity Room of the Instituite	NIH
9	Procurement of furnichure for newly appointed scientists in the Institute	NIH
10	GI Metal False Ceiling works at roof of Computer Centre of the Instituite	NIH
11	Civil works related to boundary wall in the NIH Staff Colony	NIH
12	Replacement of ceiling in Nuclear Hydrology Lab & its Gallery	NIH
	In progress	
1	Renovation of 08 Nos. Quarters (Type-V) of Ganga Block of NIH staff colony.	CPWD
2	Renovation of Brahmaputra Blocks at Jal Vihar Colony of NIH, Roorkee	CPWD
3	Extension of Car Parking/Garrages at Jal Vihar Colony of NIH, Roorkee	CPWD
4	Renovation of Kaveri - 1 Block at Jal Vihar Colony of NIH, Roorkee	CPWD
5	Construction of Connecting Corridor between Main Block and Lab Block at NIH, Roorkee	CPWD
6	Conversion of Old Committee Room into the Finance Section at NIH, Roorkee	CPWD
7	Vertical Extension of Lab Block II (North Wing) at NIH, Roorkee	CPWD
8	Construction of New Block of Type V Quarters (16 Nos.) at Jal Vihar Colony of NIH, Roorkee	CPWD

9	Conversion of Basket Ball Court into Multi Utility Complex at Jal Vihar Colony of NIH, Roorkee	CPWD
10	Renovation of Sub -Station, conversion of overhead electric supply line to underground and Provision of Community Lighting at Jal Vihar Colony of NIH, Roorkee	CPWD
11	Construction of new sub-station in NIH office.	CPWD
12	Extension of car parking in NIH office.	NIH
13	Coba on the roof of main building in NIH office.	NIH
14	Renovation of 10 rooms in lab block.	NIH
15	Renovation of toilet of M.P. Hall in NIH office.	NIH

12.11 Workshop

The Institute workshop plays an important role in developing and fabricating experimental set-ups and parts or accessories of the instruments used for field studies as well as in the laboratories. It also provides repair and maintenance support to laboratories, divisions, field instrumentation, guest house and Jal-Vihar colony. The workshop is involved in the regular maintenance of centralized air-conditioning system of Jal-Tarang auditorium and library. In addition to this, around 296 Air-Conditioners, 12 Water Coolers, 12 Water Purifiers and Refrigerators of the institute are also maintained by the workshop on regular basis. The workshop also provides technical support to the scientific divisions in field activities, particularly in installation of the instruments at the field sites. The workshop has a lathe machine, power saw machine, welding machine, drill machine and various other small machines and tools.



Figure – 12.10: A view of the Institute's Workshop

12.12 Vehicle Section

The vehicle section plays a significant role in assisting the institute in its day-to-day functioning by providing transportation facilities for local and out-station duties including official meetings at Delhi, Dehradun and nearby locations, field visits related to various studies, local market surveys by committees & local purchases etc. Vehicle section also provides transportation facility to the children of NIH employees residing in the NIH colony for drop-off and pick-up from school. In addition to the responsibilities assigned by the institute, the vehicle section attends to the duties assigned by the district administration (SDM Office, Roorkee; District Magistrate, Haridwar), Election Commission of India, and serves during the national disasters as per Government of India Rules.

As on 31st March, 2024, the Institute has a total no. of six official vehicles (Cars: 02-Innova; 02-Ciaz; 01-Tata Sumo and 01 staff bus) and all are in working condition. The institute also has an annual rate contract signed with a local travel agency for hiring vehicles (both big and small) on requirement basis to carry out various duties of scientific and administrative in nature.

13 National Committee on Climate Change (INCCC)

The Indian National Committee on Climate Change (INCCC), Department of Water Resources, River Development and Ganga Rejuvenation (DoWR, RD & GR), Ministry of Jal Shakti, Govt. of India is functioning at NIH Roorkee. The Chairman of INCCC is the Mission Director, National Water Mission (NWM). The INCCC has sponsored eight R & D studies on Climate Change assessment to different premier institutes as given in Table. The INCCC is coordinating, monitoring and reviewing the progress of these studies on impact of climate change. A total of eight numbers of studies have been completed and reports have been reviewed. The study on "dynamic downscaling (*Sl. no. 8 in Table*)" is expected to be completed by September 2024, whereas as two partner institutes have completed their components. The 24th meeting of Standing Advisory Committee (SAC) was organised on 04th May 2023 for presentation the completed studies and to review progress of one remaining study. The PIs/Co-PIs of various completed studies presented their respective study during the meeting. As per suggestion of 24th SAC meeting, a special meeting was held under the chairpersonship of the Special Secretary of DoWR, RD&GR on 24th July 2023. On the recommendation of this committee, six new climate change studies were reviewed by CWC under the Chairmanship of CE(P&DO) on 23rd February, 2024. These new proposals were accepted with some modifications for further processing and for formal approval in SAC meeting. The primary purpose of the INCCC meeting was to share the methodologies and techniques applied for different basins to arrive at/achieve comparable output and common deliverables from the various studies. The reported progress of all the ongoing and completed projects was satisfactory.

Table – 13.1: List of INCCC Sponsored Projects during 2023-24

S. No.	Name of the Project	Lead & Collaborating Institutions	Status
1.	Impact Assessment of Climate Change on Hydro -meteorological processes and Water Resources of Mahanadi River Basin	IISc, Bangalore; IIT Bhubaneswar	Completed
2.	Climate Change Impact Studies for Rajasthan (Area of Inland Drainage and Mahi basin	MNIT Jaipur; CU RAJ Ajmer; IIT Delhi	Completed
3.	Impact of Climate Change on Water Resources of Tapi Basin	SVNIT Surat; MNIT Jaipur; MANIT Bhopal	Completed
4.	Effects of Climate Change and land use/land cover changes on spatial and temporal water availability in Subarnarekha Basin	IIT Kharagpur	Completed

5.	Impact of Climate Variability and Climate Change on Water Resources in the Sabarmati River Basin	IIT Gandhinagar; SVNIT Surat	Completed
6.	Impact of Climate Change on Water Resources in River Basins from Tadri to Kanyakumari	IITB Mumbai; NIT Surakthal; CWRDM Kozhikode	Completed
7.	Statistical Downscaling for hydro-climatic projections with CMIP5 Simulations to assess Impact of Climate Change	IIT Bombay: IIT Guwahati; IISC Bangalore; IIT Gandhinagar; IIT Kanpur	Completed
8.	Dynamic Downscaling to study Climate change Impacts on Water Resources in India	IIT Delhi; IIT Madras; Anna University; BHU Varanasi	On-Going (Component of IIT Delhi is in progress; Expected completion by September 2024)

14 Human Resources

The Institute had a total sanctioned strength of 255 personnel, including all Group A (105 posts), Group B (76 posts) and Group C (74 posts) as on 31 March 2023. At the end of the year 2023-24 i.e. on 31 March, 2024, the Institute had a team of 92 Group A Officers (including Director and scientists); 46 Group B supporting scientific and technical staff; and 35 Group C other supporting personnel.

The position of staff as on 1.4.2023 and 31.3.2024 is given in Appendix-XII and the list of employees as on 31.03.2024 is given in Appendix XIII.

The scientists of the Institute are highly qualified and well trained to handle diverse hydrological problems being faced by the country. Most of the scientists have Ph.D. degree in Engineering and Science and have long research experience.

14.1 Promotion of Employees

During the year 2023-24, seven employees were promoted to higher grades through DPC as per details given below:

S. No.	Name	From	To	Date
1.	Shri Pankaj Kumar	Tech.Gr.III	Tech. Gr.II	26.05.2023
2.	Shri Sandeep Kumar	Tech.Gr.III	Tech. Gr.II	26.05.2023
3.	Shri. P.R.S. Rao	S.R.A.	P.R.A.	03.07.2023
4.	Shri M. Thrimurthulu	Driver Gr. II	Driver Gr. I	18.09.2023
5.	Shri Mahipal Singh	Tech. Gr.II	Tech.Gr.I	18.09.2023
6.	Shri Shyam Kumar	Tech. Gr.II	Tech.Gr.I	18.09.2023
7.	Shri V.K. Agarwal	P.R.A.	Scientist B	13.10.2023
8.	Mrs. Madhu Suman Kuchhal	S.O.	A.O.	29.01.2024
9.	Mrs. Babita Sharma	S.R.A.	P.R.A.	29.01.2024
10.	Shri Vishal Gupta	S.R.A.	P.R.A.	29.01.2024
11.	Shri T.R. Sapra	S.R.A.	P.R.A.	29.01.2024
12.	Shri Pawan Kumar	P.A.	P.S.	29.01.2024

Following scientists were also promoted during 2023-24:

S. No.	Name	From	To	Promotion W.E.F.
1.	Dr. Pankaj Mani	Scientist F	Scientist G	12.04.2023
2.	Dr. Surjeet Singh	Scientist F	Scientist G	12.04.2023
3.	Dr. R.K. Jaiswal	Scientist E	Scientist F	12.04.2023
4.	Dr. P.K. Singh	Scientist D	Scientist E	12.04.2023
5.	Dr. L.N. Thakural	Scientist D	Scientist E	12.04.2023

6.	Dr. R.V. Kale	Scientist D	Scientist E	12.04.2023
7.	Dr. Pradeep Kumar	Scientist D	Scientist E	12.04.2023
8.	Dr.(Mrs.) Jyoti P Patil	Scientist D	Scientist E	12.04.2023
9.	Dr. M.K. Nema	Scientist D	Scientist E	12.04.2023
10.	Dr. J.P. Patra	Scientist D	Scientist E	12.04.2023
11.	Dr. Sumant Kumar	Scientist D	Scientist E	12.04.2023
12.	Dr. M.S. Rao	Scientist F	Scientist G	13.10.2023
13.	Dr. Rajest Singh	Scientist D	Scientist E	13.10.2023
14.	Dr. Gopal Krishan	Scientist D	Scientist E	13.10.2023

14.2 New Appointments

During the year 2023-24, the following new scientists/staff have joined the Institute through direct recruitment (DR):

S. No.	Name	Designation	Date
1.	Sh. Madhusudan Thapliyal	S.R.A	05.04.2023
2.	Dr. Sourabh Nema	Scientist-C	01.05.2023
3.	Shri Raj Kumar Dewansi	R.A.	22-05-2023
4.	Sh. Ruchir Patidar	Scientist-B	28.07.2023
5.	Sh. Sachchidanand Singh	Scientist-B	28.07.2023
6.	Dr. Richa Pandey	Scientist-B	31.07.2023
7.	Dr. Satendra Kumar	Scientist-B	01.08.2023
8.	Dr. Ishan Sharma	Scientist-B	03.08.2023
9.	Sh. Rajat Kumar	Scientist-B	03.08.2023
10.	Dr. Shakti Suryavanshi	Scientist-C	03.08.2023
11.	Dr. Shailendra Kumar Kumre	Scientist-B	04.08.2023
12.	Dr. Soumyaranjan Sahoo	Scientist-B	04.08.2023
13.	Sh. Sudesh Kumar Chaudhary	Scientist-B	07.08.2023
14.	Dr. Umesh Kumar Singh	Scientist-C	09.08.2023
15.	Sh. Pintu Kumar Gupta	Scientist-B	11.08.2023
16.	Sh. Siddhartha Arora	Scientist-B	17.08.2023
17.	Sh. Shubham Shaurabh	Scientist-C	18.08.2023
18.	Dr. Akshay Verma	Scientist-C	18.08.2023
19.	Dr. Riyaz Ahmed Mir	Scientist-C	21.08.2023
20.	Dr. Kuldeep Sharma	Scientist-C	29.09.2023
21.	Mrs. Sushamita Wadde	Scientist-B	01.11.2023
22.	Sh. Harsh Upadhyay	Scientist-B	01.11.2023

23.	Sh. Chandra Prakash	Scientist-B	02.11.2023
24.	Dr. Tripati M.	Scientist-D	03.11.2023
25.	Sh. Dilip Barman	Scientist-B	10.11.2023
26.	Dr. Shiv Prasad Yellapu	Scientist-C	14.11.2023
27.	Dr. Prasanta Kumar Sahoo	Scientist-D	16.11.2023
28.	Sh. Akshay Vyankat Dahiwala	Scientist-B	20.11.2023
29.	Dr. Amit Pandey	Scientist-B	21.11.2023
30.	Sh. Rajesh Ranjan	Scientist-B	21.11.2023
31.	Dr. Surinaidu Lagudu	Scientist-D	22.11.2023
32.	Sh. Malkhan Singh Jatav	Scientist-B	23.11.2023
33.	Sh. Minotshing Maza	Scientist-B	23.11.2023
34.	Dr. Ajit Kumar Behera	Scientist-C	24.11.2023
35.	Dr. Lavkush Kumar Patel	Scientist-D	01.12.2023
36.	Dr. Kapil Kesarwani	Scientist-D	06.02.2024
37.	Sh. Sukant Jain	Scientist-C	12.02.2024
38	Dr. Sushindra Kumar Gupta	Scientist-C	21.02.2024

14.3 Employees who left the Institute

During the year 2023-24, the employees of the Institute who left the Institute due to various reasons are given as below:

S. No.	Name	Designation	Date	Reason
1.	Mrs. Nidhi Kalyani	Scientist-B	12.05.2023	Terminated
2.	Sh. Subhash Chand	PS	31.05.2023	Superannuation
3.	Dr. Chandra Mohan T.	Scientist-D	31.05.2023	Superannuation
4.	Sh. Sanjay Mittal	PRA	30.06.2023	Superannuation
5.	Sh. Rajneesh Kr. Goel	SAO	30.06.2023	Superannuation
6.	Sh. N. K. Bhatnagar	Scientist-B	30.06.2023	Superannuation
7.	Dr. M. K. Jose	Scientist-F	30.06.2023	Superannuation
8.	Sh. S. L. Srivastava	PRA	31.08.2023	Superannuation
9.	Dr. Manohar Arora	Scientist-F	31.08.2023	Superannuation
10.	Sh. R. V. Kavalekar	MTS	30.09.2023	Superannuation
11.	Dr. Sudhir Kumar	Director	30.11.2023	Superannuation
12.	Dr. Sanjay Kumar Jain	Scientist-G	30.11.2023	Superannuation
13.	Sh. Chandra Kumar S.	PRA	30.11.2023	Superannuation
14.	Sh. Ram Kumar	PS	31.12.2023	Superannuation
15.	Sh. Iftakhar Ahmed	SCD-I	31.01.2024	Superannuation
16.	Sh. R. N. Pandey	MTS	31.01.2024	Superannuation

17.	Dr. Sabyasachi Swain	Scientist –B	19.01.2024	Resigned
18.	Sh. Shubham Kr. Meena	SRA	16.02.2024	Resigned
19.	Dr. Tejram Nayak	Scientist-G	28.02.2024	Superannuation
20.	Sh. A. K. Banerjee	LDC	31.03.2024	Superannuation

14.4 Awards for Group A, B, and C Staff

Scientists of the Institute won the following awards during the year 2023-24.

S. No.	Name & Designation	Details	Date/Period
1.	Dr. M. K. Goel Scientist G	Awarded the best presentation of the session entitled "Surface Water Assessment and Management" in the 7th National Hindi Seminar – 2023 (Rashtriya Jal Sangoshti) organized by NIH Roorkee	August 17-18, 2023.
2.	Dr. Anil Kumar Lohani, Scientist G	Received First prize for the article " bandh bhang vishleshan aur aapda pravandhan yojna" published in Pravahini Hindi Magazine of NIH	14-30, September, 2023
3.	Head, RC-Kakinada	DRC, NIH, Kakinada awarded as the Best Central Govt. Institute within the Kakinada smart city as part of *Swactha Hi Seva* celebrations	October 02, 2023
4.	Dr. S.S. Rawat Scientist F	Consolation Prize for International Water Conclave (IWC) PSA Video Contest 2024 organized by Dept. of water Resources, Government of Meghalaya in collaboration with the Dept. of Mass media, St Anthony's College, Shillong	February 07, 2024
5.	Dr. Sumant Kumar Scientist-E	Postdoc position at Oregon State University, USA	9th Dec. 2022 to 8 th Dec. 2023
6.	Dr. Gopal Krishan Scientist E	Best paper award in a 7th National Seminar in Hindi on the topic Climate change and Water Management in a session on Groundwater assessment and management on the paper entitled "Aquifer characterization and mapping of salinity affected aquifers of SW Punjab" during August 17-18, 2023 at NIH, Roorkee	August 18, 2023
7.	Dr. Ashwini Ranade, Scientist D	Best technical paper award in 'Rashtriya Jal Sangosthi-2023	August 17-18, 2023
8.	Dr. Ashwini Ranade, Scientist D	Certificate of Appreciation in 28th International Conference on Hydraulics, water Resources and River Engineering, NIT Warangal	December 21-23, 2023
9.	Dr. Ashwini Ranade Scientist D	Narayani Sushma Swaraj National Woman's Award-2024 by Sarvhit Kalyan Samiti, Meerut and BDS school of law	March 06, 2024

10.	Dr. V. K. Tyagi, Scientist 'D'	Listed in top 2% scientists worldwide based on the list published by Stanford Universit y [https://elsevier.digitalcommonsdata.com/datasets/btchxktzyw/6]	October 2023
11.	Dr. Sourabh Nema, Scientist-C	Best Paper Award in a study entitled "Assessing Groundwater Trends in Water-Scarce Tons Basin: A Case Study of Satna and Rewa Districts, Madhya Pradesh" in 35 th National Convention & Seminar on Emerging Technologies for Advances in Agriculture & Horticulture, sponsored by Institution of Engineers.	12-13 Sep 2023
12.	Sh. Sabyasachi Swain Scientist-B	Excellence in Doctoral Research Award from IIT Roorkee for producing the best thesis among all the engineering disciplines of the Institute	April 06, 2023
13.	Sh. Sabyasachi Swain, Scientist-B	Best Water Resources Student -2023 from the Indian Water Resources Society	January 18, 2024
14.	Sh. Gurpreet Singh Research Assistant	Award of Rs 10000/- on passing the Hindi Parangat Exam with 70.5% from Raajbhasha Vibhagh	December 29, 2023



In addition to above, vaious cash awards for meritorious services by the Group B, C and D staff in the Institute were given on 15th August 2023 for the previous year. The list of awardees is given below:

Group	Name and Designation	Category
Group 'B'	Shri Ram Kumar, PS	Non-Technical
	Smt Kiran Ahuja, PS	Non-Technical
	Shri Kamal Sharma, Admn. Officer(Deputation)	Non-Technical
	Shri Praveen Kumar, Assistant	Non-Technical
	Shri Naresh Kumar, Assistant	Non-Technical
	Shri K.V.R. Varaprasad, Assistant	Non-Technical
Group 'C'	Smt. Priya Gagneja, Stenographer	Non-Technical
	Shri Santosh Kumar Sahay, LDC	Non-Technical
	Smt. Neelam Bohra, LDC	Non-Technical
	Shri Subhash Chand, LDC	Non-Technical

14.5 Scientists/staff of the institute pursuing Ph.D. Degree

To achieve the scientific goals of the Institute, the scientists and the staff is constantly working on enhancement of their skills through pursuing higher studies. During the year 2023-24, number of scientists/staffs were enrolled/awarded for Ph.D. degree, as per details given below:

S. No.	Name and Designation	Title of Ph.D. Thesis	Department/ University	Status
1	Sh. Ruchir Patidar, Scientist B	An integration of multiple hydro-meteorological variables for a comprehensive drought characterization in the changing climate	IIT - Roorkee	Ongoing
2	Sh. Siddharth Arora, Scientist B	Impact of Climate change on wate resources in Kameng river basin, North east India	Indian Institute of Science Bengaluru	Ongoing
3	Sh. Ishan Sharma, Scientist -B	A Critical Investigation of SCS-CN Methodology for Rainfall-Runoff Modelling	IIT - Roorkee	Completed
4	Sh. Sachchidanand Singh, Scientist -B	Cloudburst Induced Flash Floods And Landslides Assessment In An Indian Himalayan Region	IIT - Roorkee	Ongoing
5	Sh. Harsh Upadhyay Scientist B	Streamflow Modelling of the West Banas River of Rajasthan	Deptt. of Soil & Water Engineering, MPUAT, Udaipur	Completed

6	Ms Richa Pandey, Scientist 'B'	Irrigation System Performance Assessment of Narmada Canal Project in Rajasthan Using Surface Energy Balance Modelling Approaches	Indian Agricultural Research Institute, Pusa, New Delhi	Completed
7	Sh. Sudesh Singh Choudhary, Sc.-B	Crop health monitoring and yield assessment using geospatial techniques	MNIT, Jaipur	Ongoing
8	Sh. Malkhan Singh Jatav, Sc.-B	Simulation of water productivity using AquaCrop and Hydrus Model	IARI, New Delhi	Ongoing
9	Sh. Dilip Barman, Sc.-B	Transboundary water resources management through integration of water accounting plus framework and hydrological modeling: a comprehensive analysis for Cauvery river basin	Indian Institute of Technology, Roorkee	Ongoing

14.6 Guidance of Doctoral Thesis by the Scientists of the Division/RC during April, 2023-March, 2024:

S. No.	Supervisor	Title of Ph.D./ M. Tech/M.Sc. Thesis	Scholar/ Department/University
Ph.D. THESIS GUIDANCECOMPLETED during2023-24			
1.	Dr. Y.R. Satyaji Rao	River water quantity and quality modelling under hydro-climatic and Eflow scenarios using process-based models	M. Satish Kumar Lab for Spatial Informatics Civil engineering Department International Institute of Information Technology Hyderabad
2	Dr. Y.R. Satyaji Rao	Contaminant Transport and Designate Priority Areas for Groundwater Remediation	Kamalakanth Shahoo Water Resources Engineering Department of Civil Engineering IIT Delhi
3	Dr.B.Venkatesh	Spatio-Temporal Assessment of Mapping of Droughts for Arid and Semi-Arid Regions of Northern Karnataka	Bharath A L, HRRC, NIH, Visvesvaraya Technological University, Belagavi
4	Dr.B.Venkatesh	Impact of climate change on water availability in selected river basins of western ghats	Shilpa A Veerabhadrannavar, HRRC, NIH,Visvesvaraya Technological University, Belagavi
5	Dr. Surjeet Singh	Modelling the Impacts of Urban Land Use Change on Surface Temperature and Water Resource for Future Water Sustainability in Raipur District, Chhattisgarh	Ms. Tanushri Jaiswal, Deptt. of Applied Geology, National Institute of Technology (NIT), Raipur, Chhattisgarh

6	Dr. Surjeet Singh	Mapping of Ground Water Potential and Vulnerable Zones Using Indices and GIS-based MCDA Techniques	Mr. Anshu Gangwar, Institute of Agricultural Sciences, BHU, Varanasi
7	Dr. Ravi Galkate	Assessment of regional drought characteristics under climate change conditions	Rabindranath Tagore University, Raisen, Bhopal
8	Dr. T. Thomas	Climate Change Impact Assessments on the Vamsdhara river basin using Hydrological Modelling Approaches	Dr. Ritu Kumari Department of Farm Engineering, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.
9	Dr. M. K. Sharma	Hydrochemical Study of Groundwater of Bemetara District in Chhattisgarh	Mr. Mohit Kunar, Deptt. of Zoology and Environmental Sciences, Gurukula Kangri (Deemed to be University), Haridwar
10	Dr. Pradeep Kumar	Environmental flow assessment using habitat simulation modelling	Mr. Ashish Kumar, Department of Farm Engg. Institute of Agri. Sciences, Banaras Hindu University, Varanasi (U.P.)
11	Dr. Gopal Krishan	Assessment of Spatial and Temporal distribution of groundwater level and groundwater quality of Ghazipur district, Uttar Pradesh	Mr. P. Yadav, Department of Agriculture and Farm Engineering, BHU. Varanasi
12	Dr. Vinay Kumar Tyagi	Thermal Hydrolysis Pretreatment of Sewage Sludge.	Dr. Gowtham Balasundaram, Department of Civil Engineering, IIT - Roorkee
Ph.D. THESIS GUIDANCE ON-GOING during 2023-24			
1	Dr. R. P. Pandey	Study of drought propagation and its effect on reservoir network in a Semi-arid River Basin of Peninsular India	Mr. Ajay Gupta, Department of Hydrology, Indian Institute of Technology Roorkee
2	Dr. R. P. Pandey	Study of long term changes in drought characteristics and changes in water demand in bundelkhad region	Mr. Manish Dwivedi, Sam Higginbottom University of Agriculture Technology & Sciences (HSUATS), Prayagraj
3	Dr. R. P. Pandey	Soil Conservation Services-Curve Number (SCS-CN) Technique and its Application in Drought Assessment	Mr. Damodar Sharma, Department of WRDM, IIT Roorkee
4	Dr. B.Venkatesh	Integrated Water Resources Management for Doni River Catchment	Vijay Vastrad, HRRC,NIH, Visvesvaraya Technological University, Belagavi

5	Dr. Purandara B K	Impact of Land use/Land cover changes on the sustainability of natural springs in parts of Western Ghats in India	Ujval N Utagi, HRRC, NIH, Visvesvaraya Technological University, Belagavi
6	Dr. Ravi Galkate	Assessment of climate change and its impacts on hydrology in Malwa region of MP	Ms. Archana Koushal Dept of SWCE, College of Agril. Engg. JNKVV, Jabalpur
7	Dr. Ravi Galkate	Prediction of drought through analyzing the climatic parameters in pre-monsoon season of Bundelkhand region	Sh. Vijay Shankar Yadav Department of Farm Engineering, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.
8	Dr. Archana Sarkar	Hydrological Modelling of Bisalpur Reservoir including Climate Change	Sanjay Kumar Agarwal, Dept. of Civil Engg, MNIT, Jaipur
9	Dr. Archana Sarkar	Impact of Climate Change on Water Resources of Banas River Basin, Rajasthan	Vineet Kumar Sharma, Dept. of Civil Engg, MNIT, Jaipur
10	Dr. M. K. Sharma	Study of System Characteristics of River Alaknanda, A tribuatry of River Ganga	Ms. Kunarka Bhanot, Deptt. of Chemistry, Gurukula Kangri (Deemed to be University), Haridwar
11	Dr. S. S. Rawat	Vulnerability assessment and hydro-geological investigations of selected Himalayan springs for sustaining local water demand in Devika-Birun catchment of Jammu and Kashmir	Ms Anuradha, Dept. of Environmental Science, University of Jammu, UT of J&K
12	Dr. S. S. Rawat	Hydro-geo-Chemical and Isotopic Characterisation of Springs of Bhagirathi Valley of Uttarakhand.	Mr. Sumit Dept. of Geology, Hemvati Nandan Bahuguna Garhwal University (A Central University), Srinagar, Uttarakhand
13	Dr. S.S. Rawat	Hydro-geochemical and isotopic characterization for the development of rejuvenation protocols for Spring fed Henwal river in Garhwal Himalaya	Sh. Dharam Singh Meena Dept. of Zoology & Environmental Sciences, Gurukul Kangari Deemed to be University, Haridwar, Uttarakhand
14	Dr. R. K. Jaiswal	Assessing Climate change vulnerability using SWAT and CORODEXProjection under RCP4.5 and RCP8.5 Scenario: A Case study of Bah River, India.	Mr. Sohrat Ali, Dept. of Civil Engineering, Central University, Ranchi
15	Dr. R. K. Jaiswal	Development of Optimal Water Resources Utilization Plan Under Climate Change for Parbati Reservoir Project	Mr. Abhishek Agrawal, Maharana Pratap University, Udaipur

25	Dr. Pradeep Kumar	Assessment of Change in Hydrological Response due to Forest Fires in Madhya Pradesh	Ms. Deepa Sahu, Department of Soil and Water Engg., Swami Vivekananda College of Agricultural Engineering & Technology and Research Station, Faculty of Agricultural Engineering, Indira Gandhi Krishi Vishwavidyalaya, Raipur
26	Dr. Pradeep Kumar	Habitat Ecological Modelling of Himalayan Mahseer (Tor Species) in Upper Ganga Basin	Mr. Arvind Kumar Sharma, Department of Zoology and Environmental Sciences, Gurukula Kangri Vishwavidyalaya (Deemed to be University), Haridwar
27	Dr. Pradeep Kumar	Environmental Flow Assessment through Perception Analyses of Riparian Communities – A Case of Narmada Valley Dam Project	Mr. Govind M. P., Department of Environmental Planning, School of Planning and Architecture, Bhopal
28	Dr. Sumant Kumar	Replenishing Underground Reservoirs through Recharge Structure by Utilizing Surface Runoff in Eastern Part of India	Ms. Vijeta Singh, Department of Soil and Water Conservation Engineering, Vaugh Institute Of Agricultural Engineering And Technology, Sam Higginbottom University Of Agriculture, Technology And Sciences, Prayagraj-211007, UP
29	Dr. Sumant Kumar	Arsenic content in groundwater and its impact on soil of the Indo-Gangetic plain of Varanasi and its adjoining district, U.P	Mr. Manish Kumar, Department of Farm Engineering, Institute of Agriculture Science, Banaras Hindu University, Varanasi
30	Dr. Rajesh Singh	Source identification of trace toxic metals in the groundwater of Bathinda district and its mitigative measures	Kaptan Singh, Department of Civil Engineering Madan Mohan Malaviya University of Technology, Gorakhpur (U.P.).
31	Dr. Rajesh Singh	Eco-physiological studies of Arsenic transforming microbes in groundwater aquifers of Haridwar region for potential mitigation strategies	Saif Ali, School of Health Science and Technology, University of Petroleum and Energy Studies (UPES), Dehradun
32	Dr. Jose George Pottakkal	Assessment of hydrological and geochemical status of springs of district Kangra, Himachal Pradesh	Ms. Shikha Rawal, Dept. of Environmental Sciences, Central University of Himachal Pradesh, Dharamshala

33	Dr. Gopal Krishan	Investigation of groundwater potential of dolomite rock in Lesser Himalaya of Nepal, Kushma-Syanja area	Mr. Gunanidhi Pokhrel, Department of Geology, Institute of Science and Technology, Tribhuvan University, Kirtipur Kathmandu, Nepal
34	Dr. Gopal Krishan	Hydrogeological and isotopic studies of groundwater in Doodhganga watershed	Ms. Tanzeel Khan, Department of Soil and Water Engineering SKUAST-Kashmir
35	Dr. Gopal Krishan	Geochemical and Geophysical Studies of Springs in Kalsi Tehsil of Dehradun, Uttarakhand, India	Mr. Praveen Kumar, Department of Earth Sciences, IIT-Roorkee
36	Mrs. Shashi Poonam Indwar,	Modelling and Development of Reservoir Operation Policy under Climate Change for a Multi-Purpose Water Resource Project in Madhya Pradesh.	Rabindranath Tagore University, Raisen, Bhopal
37	Dr. P. K. Mishra	Urban Water Management Considering Water Harvesting And Climate Change	Ms. Sakshi Gupta Dept. of Water Resources Development and Management IIT Roorkee (UK)
38	Dr. P. K. Mishra	GEE-based Land and Water Productivity Assessment Using Open-Access Data	Ms. Nishtha Sharnagat Department of Farm Engineering Institute of Agricultural Sciences, BHU, Varanasi (UP)
39	Dr. P. K. Mishra	Sustainable Water Resources Management Under Climate Change	Mr. Sarthak Sahoo, School of Civil Engineering KIIT, Bhubaneswar (OD)
40	Dr. Vishal Singh	Effect of glacier changes on different runoff components under varying characteristics in Himalayan basins	Mr. Japjeet Singh, Dept. of Civil Engineering, IIT Roorkee
41	Dr. Vishal Singh	Improving the hydrological modeling framework in the Himalayan region under climate change	Mr. V. Saran Raaj, School of Civil Engineering, IIT Mandi
42	Dr. Vishal Singh	Himalayan Freshwaters: Assessing the Services and Vulnerability of Freshwater Ecosystems in the Himalayas	Miss. Anusha Dept. of Hydrology, IIT Roorkee
43	Dr. S.M. Pingale	Groundwater management in changing climate	Sourav Chaudhary, Water Resources Development and Management, IIT Roorkee

44	Dr. S.M. Pingale	An integration of multiple hydro-meteorological variables for a comprehensive drought characterization in the changing climate	Ruchir Patidar, Water Resources Development and Management, IIT Roorkee
45	Dr. Swapnali Barman	Hydro-geomorphic Impacts of Panyor Lower Hydro Power Station in the Ranganadi Watershed	Ms. Rudrakshi Gogoi Cotton University Panbazar, Guwahati – 781001, Assam, India
46	Dr. Vinay Kumar Tyagi	Anaerobic Co-Digestion Of Thermo-Chemically Pretreated Wheat Straw With Food Waste And Cow Manure For Enhanced Bio-Methane Production	Mr. Ali Mohammad Rahmani, Department of Civil Engineering, Indian Institute of Technology (IIT) Roorkee
47	Dr. Vinay Kumar Tyagi	Quality assessment of mined MSW from an open dumpsite for Leachate treatment and recycling potential	Mr. Mandeep Singh, Department of Civil Engineering, Indian Institute of Technology Roorkee
48	Dr. Vinay Kumar Tyagi	Wastewater Treatment by Hybrid Anaerobic Baffled and Aerobic Reactor	Mr. Anurag Tomar, Department of Civil Engineering, Indian Institute of Technology Roorkee
49	Dr. Vinay Kumar Tyagi	Hydrogen Recovery from Organic Fraction of Municipal Solid Waste	Mr. Hassan Mohammed, Department of Civil Engineering, IIT - Roorkee
50	Dr. Vinay Kumar Tyagi	DBPs in STPs and WTPs and their toxic effects	Mr. Mohammad Shakib, Department of Civil Engineering, Indian Institute of Technology Roorkee
51	Dr. P. K. Sahoo,	Application of modified heterogeneous photocatalyst system for enhanced photocatalytic degradation of recalcitrant pollutants from industrial wastewater	Mr. Anup Anang Das, Department of Chemistry, Siksha "O" Anusandhan University (Deemed to be University) Bhubaneswar, Odisha
52	Dr. Nitesh Patidar	Sustainable groundwater management: A MODFLOW-ML approach in assessing managed aquifer recharge scenarios	Mr. Mayank Raturi Department of Water Resources Development and Management, Indian Institute of Technology Roorkee, Uttarakhand
53	Dr. Nitesh Patidar	Integrated surface water-groundwater modelling for simulating river-aquifer interaction in upper Mahanadi basin	Mr. Prem Chand Department of Civil Engineering, Central University of Jharkhand, Ranchi-835205 Jharkhand

54	Dr. R. A. Mir	Impact of climate change and vulnerability assessment of Lidder catchment Springs of, Kashmir basin, NW Himalaya	Faisal Abbas Padder, Department of Geology, Annamalai University, Chennai (TN).
55	Dr. R. A. Mir	Monitoring mass movements and impact of climate change in Sind basin of Kashmir Himalaya	Nausheen Sakina, Department of Chemical Engineering, National Institute of Technology, Srinagar
56	Dr. Pravin Rangrao Patil	Rainfall Runoff and Sediment Yield Modeling of Gauged and Ungauged Catchments	Mr. Esmatullah Sangin WRDM, IIT Roorkee (UK)
57	Dr. Pravin Rangrao Patil	NRCS-CN Inspired Modeling of Rainstorm-Generated Sediment Yield	Mr. Shafiq Ahmad Siddiqui Civil Engineering Department Graphic Era (Deemed to be University) Dehradun (UK)
58	Dr. Shakti Suryavanshi	Effect of Climate change on hydrological response of Rapti River Basin under different global warming levels	Ms. Sonali Kumari, SWCE, SHUATS, Prayagraj
59	Dr. Shakti Suryavanshi	Hydrological sustainabilty of Ken-Betwa Link project under different global warming Levels	Ms. Huidrom Romita Devi, SWCE, SHUATS, Prayagraj
60	Dr. Shakti Suryavanshi	Climate change induces flood hazard prediction of a trans boundary river system	Ms. Madhulika Singh, SWCE, SHUATS, Prayagraj
61	Dr. A.K. Lohani	Hydrological Modelling and Climate Change	Prashant, Department: WRD&M, IIT Roorkee
62	Dr. A.K. Lohani	River Flow Forecasting Using conceptual and soft computing models	Jugdembae Sharma, Dept. of Civil Engineering, IIT(ISM) Dhanbad
63	Dr. Ravindra V. Kale Scientist E	Operational Coastal Flood Management in The Brahmani-Baitarani River Basin (Tentative)	Mr. Ashrumochan Mohanty Research Scholar Roll No. 20WM91R01 School of Water Resources Indian Institute of Technology Kharagpur, West Bengal – 721302
64	Dr. Ravindra V. Kale Scientist E	Integrated mHM Model based modeling framework for flood hazard assessment in Transboundary of Rapti River Basin under changing Climate" (Tentative)	Mr. Ankur Kumar, Research Scholar Department of Civil Engineering, Madan Mohan Malviya University of Technology, Gorakhpur, Uttar Pradesh.

14.7 Guidance of Masters (M.Tech/M.Sc) Thesis by Scientists of the Division/RC

S. No.	Supervisor	Title of Ph.D./ M. Tech./M.Sc. Thesis	Scholar/ Department/University
M.Tech/M.Sc. THESIS GUIDANCE (COMPLETED during 2023-24)			
1	Dr. Anupma Sharma	Modelling of Soil Water Movement in Agricultural Field	Ms. Akanksha Sharma, Department of Farm Engineering, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.
2	Dr. T. Thomas	Evaluation of Changing Rainfall Characteristics of Odisha State	Ms. Aishwarya Man Singh, Department of Farm Engineering, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.
3	Dr. Ravi Galkate	Planning of irrigation scheduling for dry and wet years in Upper Ganga Canal Command Area, Uttar Pradesh	Sh. Jageshvar Prasad Department of Farm Engineering, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.
4	Dr. M. K. Sharma	Cloning, expression, purification and in-silico analysis of enzyme arsenite oxidase (homologue) from Comamonas testosteroni KF1	Ms. Astha Bisht, M. Sc., Department of Bioscience and Biotechnology, Banasthali Vidyapith, Jaipur, Rajasthan
5	Dr. R. K. Jaiswal	Estimation of Probable Maximum Precipitation in Sindh Basin under Projected Climate Change Scenario	Mr. Shringar Mishra Department of Farm Engineering/Banaras Hindu University Varanasi
6	Dr. Manish K. Nema	Analysis of The Spatio-Temporal Fluctuation in Storage Capacity of The Hirakud Reservoir using Google Earth Engine	Mr. Abhishek Thakur Dept. of Water Resources Development and Management IIT Roorkee (UK)
7	Dr. Pradeep Kumar	Water Quality characterization and Assessment of pollutant load in Song River, Dehradun	Mr. Khude Raju Gangaram, Department of Farm Engg. Institute of Agri. Sciences, Banaras Hindu University, Varanasi (U.P.)
8	Dr. Rajesh Singh	Isolation and Characterization of Bacteria in Arsenic-Rich Aquifer	Ms. Aayushi Mittal, Department of Microbiology, Gurukul Kangri (Deemed to be University),Haridwar
9	Dr. Rajesh Singh	Performance evaluation of constructed wetland	Ms. Priya, Department of Allied Sciences (Chemistry), Graphic Era, Dehradun
10	Dr. Rajesh Singh	Geochemical evaluation of groundwater of Laksar	Ms. Priya Dimri, Department of Allied Sciences (Chemistry), Graphic Era, Dehradun

11	Dr. Gopal Krishan	Studies of ET changes using isotopes	Ms Nikita Saini Department of physics Gurukul Kangri Vishvavidyalaya, Haridwar
12	Dr. Gopal Krishan	ET partitioning using isotopes under controlled conditions	Ms Himanshi Department of physics Gurukul Kangri Vishvavidyalaya, Haridwar
13	Dr. Gopal Krishan	Precipitation source identification using isotopes at Roorkee	Ms Deepika S Department of Geology Anna University, Chennai
14	Dr. Vinay Kumar Tyagi	Effect of thermal pretreatment of sewage sludge for enhancing biogas generation.	Ms. Priyanshi Modi, Devi Ahilya University, Indore (MP).
15	Dr. Vinay Kumar Tyagi	Biomethanation of Thermal Pretreated Organic fraction of municipal solid waste and sewage sludge.	Mr. Rahul Sharma, Department of Civil Engineering, Indian Institute of Technology Roorkee
16	Dr. S. K. Sharma	Hydrological Modelling using SWAT analysis for Beki River Basin	Mr. Jyotirman Bordoloi, NERIWALM, Tezpur
17	Dr. S. Barman	Hydrological Analysis of Pagladiya River Basin	Ms. Himadri Baruah NERIWALM, Tezpur
18	Dr. Sunil Gurrapu	Application of VIC 4.2.d Macroscale Hydrological Modelling to simulate the streamflow and study the model performance for a Pennar River basin in India	Mr. Darshan M Department of Farm Engineering Institute of Agricultural Sciences, BHU, Varanasi Uttar Pradesh
19	Dr. D. S. Bisht	Delineating Watershed Dynamics through GIS-based Morphometric Analysis: A Case Study of the Ramnagar Khad Watershed, Tawi River Basin	Ms. Avantika Sharma Integrated M.Sc. in Geology Cluster University of Jammu
20	Dr. D. S. Bisht	Unveiling the Terrain Signature of the Duddar Basin: A Geospatial Exploration using Morphometric Analysis	Ms. Kritica Sharma Integrated M.Sc. in Geology Cluster University of Jammu
21	Dr. Nitesh Patidar	Site suitability mapping for MAR using a web based tool: G- MCDA	MS. Subadharani R Anna University, Chennai, Tamil Nadu
22	Sh. W.R. Singh	Hydrological Modelling of Puthimari River Basin Using HEC-HMS	Ms. Nayana Borah, NERIWALM, Tezpur

23	Dr. A.K. Lohani	Hydrological Modelling in Upper Narmada River Basin Using SWAT Model	Pallavi Chaudhary, Department: WRD&M, IIT Roorkee,
M.Tech./M.Sc. THESIS GUIDANCE (ONGOING during 2023-24)			
1	Dr P C Nayak	Hydrological Modeling Using NAM, AWBM, SACRAMENTO and Various rainfall-runoff Models	Mr Adarsh Kumar, Department of Civil Engineering, NIT Kurukshetra
2	Dr. R. K. Jaiswal	Estimation of Probable Maximum Precipitation for Upper Narmada Basin under Projected Climate Scenario	Mr. Yashwant Josi Indira Gandhi Krishi Vishwavidyalaya, Raipur
3	Dr. R. K. Jaiswal	Assessment of Water Availability in Ravishankar Sagar Reservoir under Climate Change Scenario	Ms. Preeti Varma Indira Gandhi Krishi Vishwavidyalaya, Raipur
4	Dr. R. K. Jaiswal	Assessment of Climate Change Impact on Water Availability in Narmada Basin (Madhya Pradesh)	Ms. Pratiksha Paraste Department of Farm Engineering/Banaras Hindu University Varanasi
5	Dr. Manish K. Nema	Assessment of the effects of land use land cover changes on hydrology in Wainganga river basin, India	Ms. Purneemaa R S Dept. of Geoinformatics, Bharathidasan University, Tiruchirappalli (TN)
6	Dr. Manish K. Nema	Quantative assessment of soil loss as a ecosystem service for Wain Ganga Basin using invest model	Ms. Deepika Kapri School of Environment & Natural Resources, Doon University, Dehradun (UK)
7	Dr. Ravindra V. Kale	A multivariable calibration of multivariable SWAT model (Case study: Sabarmati basin, Gujarat)	Mr. Vivek N Shaji, Environmental sciences, Central University of Gujarat
8	Dr. Rajesh Singh and Dr. P. K. Sahoo	Phytoaccumulation of arsenic in contaminated waters of luxor and haridwar by pistia stratiotes (water lettuce) and azolla pinnata (mosquito fern)	Ms. Nidhi Paliwal, Department of Ecology & Environmental Sciences, School of Life Sciences Pondicherry University, Puducherry
9	Dr. Rajesh Singh and Dr. P. K. Sahoo	Antibacterial activity of ZnS based composite material towards application in waste water material	Ms. Saliha Parveen, Department of Microbiology, Chaman Lal Mahavidhyalay, HNB Garhwal University, Uttarakhand
10	Dr. P. K. Mishra	Hydrological Modelling Of Urban Flood Using EPA SWMM:A Case Study Of Bhopal, India	Ms. Eti Khatri Dept. of Water Resources Development and Management IIT Roorkee (UK)

11	Dr. Sunil Gurrapu	Evaluation of the influence of changing climate and LULC on Hydrology of the Pennar River Basin, India	Mr Nandu Department of Farm Engineering Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh
12	Dr. Vishal Singh	Study of Assessment of Water Availability in Kali River Basin, Western Himalaya using SWAT Model	Miss. Disha Yadav Department of Environmental Sciences, CSJM University Kanpur
13	Dr. Vinay Kumar Tyagi	Anaerobic Digestate liquid fraction treatment	Mr. Ohm, Department of Civil Engineering, Indian Institute of Technology Roorkee
14	Dr. Vinay Kumar Tyagi	Thermal Hydrolysis of Sewage Sludge-Oragnic fraction of Municipal Solid Waste mix for enhanced biomethnation	Ms. Anjali Anand, Department of Civil Engineering, Indian Institute of Technology Roorkee
15	Dr. Vinay Kumar Tyagi	Sewage sludge reuse potential for land application	Ms. Prerna Yadav, Department of Civil Engineering, Indian Institute of Technology Roorkee
16	Dr. Nitesh Patidar	Identification of suitable sites for in-channel modifications for Managed Aquifer Recharge in Solani river basin.	Mr. Anurag Department of Farm Engineering, Institute of Agricultural Sciennces, Banaras Hindu University, Varanasi, Uttarpradesh
17	Dr. Nitesh Patidar	Prediction of missing Groundwater Data using Machine Learning Techniques	Khushhali Malav School of Earth Sciences, Banasthali Vidhyapith, Jaipur, Rajasthan
18	Dr. Kalzang Chhoden	Seasonal variations of water quality and quantity assessment of Rewalsar Lake, Mandi District, Himachal Pradesh, India	Mr. Abishek T., Department of Geography, School of Earth Sciences, Bharthidassan University, Tiruchirappalli, Tamilnadu
19	Dr. Shakti Suryavanshi	Prediction of hydrological drought of Wangchhu basin, Bhutan	Ms. Daptisani Khasain, SWCE, SHUATS, Prayagraj
20	Dr. Soumyaranjan Sahoo	Low-flow simulation of a river basin in Eastern India	Mr. Subhra Ranjan Jena, Department of Geology, Central University of South Bihar
21	Dr. Soumyaranjan Sahoo	Low-flow simulation of a river basin in Eastern India	Mr. Subhra Ranjan Jena, Department of Geology, Central University of South Bihar
22	Dr. Ravindra V. Kale, Scientist E	A multivariable calibration of multivariable SWAT model (Case study: Sabarmati basin, Gujarat)	Mr. Vivek N Shaji, Environmental sciences, Central University of Gujarat

23	Dr P C Nayak, Scientist F	Hydrological Modeling Using NAM, AWBM, SACRAMENTO and Various rainfall-runoff Models	Mr Adarsh Kumar, Department of Civil Engineering, NIT Kurukshetra
24	Dr. A.K. Lohani, Sc. G	Impact of Climate Change on Surface Water in Upper Cauvery Sub-basin India	Pallavi Chaudhary, WRD&M, IIT Roorkee

15 ISO 9001:2015

The National Institute of Hydrology was awarded the ISO 9001:2008 certificate on December 13, 2012. The Institute became one of the first few government organizations to have obtained an ISO-9001 certification after the issue of the relevant Guidelines by the PMD of Cabinet Secretariat in March 2012. The certificate was upgraded from ISO 9001:2008 to ISO 9001:2015 on December 13, 2015.

Following areas have been identified for the implementation of ISO 9001:2015 Quality

NIH Products	NIH Services	NIH Processes
• Technical reports • Consultancy Project Reports • Sponsored Project Reports • Research Papers • Software Packages; Instruments; Magazines; Newsletter; • Proc. of National/ International Conferences, Seminars, etc.	• Laboratories • Library • Maintenance • Computer Centre • Guest Houses • Vehicles; Telephones • Auditorium; M P Hall • Security • Short courses • Workshop	• Administrative Section work processes • Finance Section work processes • Scientific Divisions work processes • Grievances Cell work processes

During the year 2023-24, an internal audit was conducted by NIH auditees during Sept-Oct, 2023 at NIH, Roorkee followed by Management Review meeting on 13 March, 2024. The 2nd year year surveillance audit of ISO 9001:2015 of the Instititute was also conducted during 20-21 March, 2024 at NIH, Roorkee by M/s SWISSCERT Pvt. Ltd., New Delhi.



Figure – 15.1: 2nd Year Surveillance Audit of ISO 9001:2015 at NIH (20-21 March, 2024)

Hindi–The Official Language 16

The National Institute of Hydrology has a Hindi Cell functioning at its Headquarters at Roorkee to assist in proper implementation of the Official Language Policy of the Government of India in the Institute and to help the officials for compliance of the Official Language Act, the rules made there under and the instructions regarding use of Hindi in the Institute and its Regional Centers located in different states of the country. The Hindi Cell has been made responsible to execute various works related to Official Language implementation. Special efforts are being made to promote and propagate the progressive use of Hindi in the Institute so as to ensure strict compliance of the Official Language Policy of the Government and to achieve its targets regarding progressive use of Hindi in Official works as prescribed in the Annual Programme of the Department of Official Language. Awareness is being created among the officers and employees of the Institute to inspire them for carrying out the official work in Hindi through the OLIC meetings, Hindi Maas, Hindi award schemes etc. As a result, the Institute is showing a steady progress in implementation of Official Language Policy of the Government of India.

Keeping in view the targets fixed in the Annual Programme of the Department of Official Language, NIH remained active in organizing number of activities with great enthusiasm and zeal during the year 2023-24. The details of major activities organized by the Institute during the year 2023-24 are as under:

S. No.	Name of Activity	Date/Period	Venue	Remarks
1	Hindi Workshop for the employees of NIH	23-06-2023	NIH	22 participants
2	87th meeting of Official Language Implementation Committee, NIH	30-06-2023	NIH	-
3	Cash award for doing maximum work in Hindi during 2022 -23 under Incentive Scheme "Noting/drafting originally done in Hindi" during 2022-23	15-08-2023	NIH	10 employees
4	7th National Water Symposium on the topic "Jalwayu parivartan evam jal prabandhan"	17-08- 2023 To 18-08-2023	NIH	-
5	Hindi Workshop for the employees of NIH	20-09-2023	NIH	26 participants
6	Hindi Divas/Pakhwada -2023 (07 Hindi competitions held)	14-09-2023 To 29-09-2023	NIH	46 participants were given cash awards and merit certificates .

7	88th meeting of Official Language Implementation Committee, NIH	27-09-2023	NIH	-
9	Hindi Workshop (orientation) for newly appointed Scientists	08 -12- 2023	NIH	21 Scientists
10	89th meeting of Official Language Implementation Committee, NIH	28-12-2023	NIH	-
11	Hindi Workshop for the employees of NIH	20-03-2024	NIH	19 participants
12	90th meeting of Official Language Implementation Committee, NIH	26-03- 2024	NIH	-

In addition to above, NIH participated/Organized/ arranged the following Hindi activities:

- Inspection of Hindi works being done in NIH carried out by the Committee of Parliament on Official Language (2nd sub-committee) on 25-5-2023 at Dehradun.
- Two employees of NIH participated and received training in "Hindi/Unicode Workshop" organized by Power Grid Corp. Puhana , Haridwar on 20 Jun, 2023 at IIT Roorkee.
- Three officers including Director NIH participated in 36th Half Yearly meeting of Town Official Language Implementation Committee (TOLIC) organized on 22 August, 2023 at BHEL Haridwar.
- Under the Scheme "Technical Book writing in Hindi", one cash prize of Rs.50,000/- and a memento was given to the author of Book entitled "Varsha jal sanchayan evam jal sanrakshan" for the year 2020-21.
- On 01-09-2023, presentation for newly appointed Scientists of NIH was made by OIC Hindi on Rajbhasha related works.
- Two employees of NIH participated in "Akhil Bhartiya Rajbhasha sammelan evam puraskar viran samaroh " organized by Govt. of India, Ministry of Home Affairs, Department of Offical Language at Pune (Maharashtra) during 14-15 Sep 2023.
- Under the Rajbhasha Chal Shield Puraskar Scheme, two shields were awared to (i) Administrative Section (at Headquarters) and (ii) Regional Centre, Kakinada respectively for doing Maximum works in Hindi during the year 2022-23.
- Hindi version of Institute's Annual Report (2022-23) was prepared.
- One employee of the Institute participated in the Sanyukt Rajbhasha Sammelan and Puraskar vitran samaroh organized by Dept. of Official Language at IIT Jodhpur on 28-12-2023.
- Four officers including Director In-charge, NIH participated in 37th Half Yearly meeting of Town Official Language Implementation Committee (TOLIC) organized on 29 Jan, 2024.
- TOLIC Haridwar awared 2nd prize of Rajbhasha Chal Vaijayanti Shield to NIH on 29th Jan. 2024 for doing excellent works in Official Language Hindi.
- Two Hindi magazines were brought out by the Institute during the year 2023-24 namely 28th issue of Annual Hindi magazine "PRAVAHINI" (2023) and two issues of "JAL CHETNA" (July 2023 and January 2024).



Prize Distribution Ceremony; Hindi pakhwada Samapan Samaroh



190th meeting of Official Language Implementation Committee of NIH



Hindi Noting/Drafting Competition held during Hindi Pakhwada, 20 Sep, 2023



Director NIH presenting memento to Chief Guest of Hindi Pakhwada Samapan Samaroh on 06 Oct, 2023



Director-in-charge, NIH receiving Rajbhasha chal vaijayanti shield puraskar-II from Chairman TOLIC, Haridwar , 29 Jan, 2024.



Parliamentary Committee on Official Language (2nd sub- committee)



Prize Distribution Ceremony; Hindi pakhwada Samapan Samaroh



190th meeting of Official Language Implementation Committee of NIH



Hindi Noting/Drafting Competition held during Hindi Pakhwada, 20 Sep, 2023



Director NIH presenting memento to Chief Guest of Hindi Pakhwada Samapan Samaroh on 06 Oct, 2023



Director-in-charge, NIH receiving Rajbhasha chal vaijayanti shield puraskar-II from Chairman TOLIC, Haridwar , 29 Jan, 2024.



Parliamentary Committee on Official Language (2nd sub- committee)

Vigilance

17

Central Vigilance Commission (CVC), the apex integrity institution of the country, endeavours to promote integrity, transparency and accountability in public life. A Chief Vigilance Officer (CVO), appointed by Department of Water Recourses, River Development and Ganga Rejuvenation (DoWR, RD & GR), Ministry of Jal Shakti with approval from CVC, functions in the Institute to look after the vigilance matters of the Institute. The directives of CVC and DoWR, RD & GR, Government of India, are implemented for maintaining preventive vigilance in major purchases and construction activities of the Institute. Dr. A. K. Lohani, Scientist "G" served as the Chief Vigilance Officer of NIH during the year.

As a compulsory requirement, Annual Property Returns of all Group A and B employees for the year ending 31st December 2023 were received, checked and verified by the Chief Vigilance Officer. The Director, Senior Administrative Officer, Finance Officer and other officers were updated with the instructions of CVC and DoWR, RD & GR, Ministry of Jal Shakti from time to time for making the rules and procedures more transparent in day-to-day functioning of the Institute. Instructions of CVC regarding transparency in tendering system, e-governance, and adoption of e-purchase procedures were pursued with the Head of the Institution for compliance and transparent functioning in major procurement matters.

As per CVC directives and letter no. C-31018/6/2023-VIG dated 26 September, 2023, the Vigilance Awareness Week (VAW-2023) was observed in NIH and its Regional Centres from 30th Oct. – 5th Nov., 2023. The theme of VAW – 2023 was "Say no to corruption; Commit to the Nation" (**भ्रष्टाचार का विरोध करें: राष्ट्र के प्रति समर्पित रहें**").

During the VAW - 2023, a pledge was administered to all the employees of the Institute by the Director at NIH, Roorkee and by the respective Head/Officer-in-Charge at Regional Centres. Banners and posters were displayed at various locations for spreading the message of integrity and transparency. Special banners related to PIDPI initiative were also displayed and its information was widely spread. Further, to spread the message of Vigilance Commission among the general public, a slogan competition on the theme of VAW – 2023 was organized and 61 slogans were received from general public of Roorkee and NIH employees. The valedictory function of the VAW–2023 was organized on November 08, 2023. Shri Sharad Pardhy, Vice Chancellor, Dev Sanskrit Vishwavidyalaya Haridwar was the Chief Guest of the function. He, along with Director, distributed the prizes to the winners of various competitions. Following activities were organized at NIH Roorkee on this occasion:

S. No.	ACTIVITY	TOPIC	DATE
1.	Oath	Vigilance Awareness Week - 2023	30th October, 2023
2.	Drawing Competition	"Say no to corruption; Commit to the Nation"	30th October, 2023
3.	Debate Competition	Commitment to the Nation: Corruption is the only obstacle	31st October, 2023
4.	Essay Competition	"Say no to corruption; Commit to the Nation"	02nd November, 2023
5.	Slogan Competition	"Say no to corruption; Commit to the Nation"	Received upto 3rd Novemember 2023



Director, NIH administering the Integrity pledge to NIH employees



Winning children of Drawing competition receiving the prize



Winner of Essay competition receiving the prize



Essay competition in progress during VAW - 2022



Winner of Debate competition receiving the prize



Winner of Slogan competition receiving the prize

Right to Information (RTI) Act 18

The Right to Information Act-2005 provides for setting out the practical regime of right to information for citizens of India to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority. "Information", according to the Act, means any material in any form, including records, documents, memos, e-mails, opinions, advices, press releases, circulars, orders, log books, contracts, reports, papers, samples, models, and data material held in any electronic form. The "right to information" means the right to information accessible under this Act and includes the right to: (i) inspection of work, documents, records; (ii) taking notes, extracts or certified copies of documents or records; (iii) taking certified samples of material; and (iv) obtaining information in the form of diskettes, floppies, tapes, video cassettes or in any other electronic mode or through print-outs where such information is stored in a computer or in any other device.

As per section 5 of the Act, every public authority has to designate the Central Public Information Officers (CPIO) or State Public Information Officers (SPIO), in all administrative units or offices under them, as may be necessary to provide information. The CPIO or SPIO, as the case may be, may seek the assistance of any other officer as he or she considers it necessary for the proper discharge of his or her duties. Any officer, whose assistance has been sought, shall render all assistance to the CPIO or SPIO. Where an application is made to a public authority requesting for an information which is held by another public authority; or the subject matter of which is more closely connected with the functions of another public authority, the public authority, to which such application is made, shall transfer the application or such part of it as may be appropriate to that other public authority and inform the applicant immediately about such transfer.

Right to Information Act-2005 mandates timely response to citizen requests for government information. The name, designation and address of the appellate authority, PIO and APIO for HQ and the RC's of NIH are given under Right to Information Act menu in NIH website http://ww:nihroorkee.gov.in

During the year 2023-24, total 74 applications were received at the headquarters for seeking information under the RTI Act and all have been disposed of within the prescribed time limit.

19 Awareness Activities

Public or mass awareness is the process of informing the general public about the important issues like conservation and management of water resources in different hydrological regions. Department of Water Resources, River Development & Ganga Rejuvenation under Ministry of Jal Shakti, Government of India lays special emphasis on organization of public/mass awareness programs on water conservation and its management. The National Institute of Hydrology is carrying out mass awareness programs in different areas, participation and organization in various exhibitions, distribution of pamphlets and informative material, advertisements in newspapers, web publishing etc. Besides the awareness programme on water conservation, the Government of India is also giving special emphasis to various other mass awareness programmes like Azadi ka amrit mohatsav@ 75 years (Phase I & II), Swachhta Pakhwada, under Swachh Bharat Mission and Poshan Pakhwara. Azadi Ka Amrit Mahotsav is an initiative of the Government of India to celebrate and commemorate 75 years of independence and the glorious history of India' people, their culture and achievements. This Mahotsav is dedicated to the people of India who have not only been instrumental in bringing India thus far in its evolutionary journey but also hold within them the power and potential to enable government's vision of activating India 2.0, fuelled by the spirit of Aatmanirbhar Bharat. Accordingly, a large number of activities related to these programmes were organized at the Institute and its regional centers during 2023-24. The Institute celebrated a number of activities during Swachhta Pakhwada (15-31 March, 2024) under Swachh Bharat Mission. Various activities namely motivational and awareness programs for school children, and women on Swachhta and water conservation were held. A number of awareness activities related to the official language Hindi were also organized by the Institute during the year to promote the use of Hindi. Similarly, various awareness activities were also organized during the year under the Vigilance Awareness Week. The list of various mass awareness programs, organized by the Institute during 2023-24 is given at Appendix XV.





Workshop for Women on "नारी शक्ति स्वच्छता का प्रयास, हम सब मिलकर करेंगे देश का विकास" under Swachchata Pakhwada in the Institute on 28.03.2024.



Cleanliness drive conducted at Kalisot Dam, Bhopal on 19.03.2024 by NIH Bhopal



Cleanliness programs under Swachhata Hi Sewa campaign at Deltaic Regional Centres, NIH Kakinada during 02-31 October 2023.



Awareness Workshop on "Sustainable Environment" organized by NIH Roorkee on 27.03.2024 at Rashtriya Inter College, Village Bhalaswagaj, Block Bhagwanpur, Tehsil Roorkee



Mass awareness Program on "Groundwater Conservation and its Importance" conducted on 28.02.2024 in Mohammadpur Buzurg, Laksar, Haridwar



Mass Awareness program on "Management of water Scarcity in Kandi belt - Our Responsibility" at Khu Talab, Suchani Village, Samba, Jammu, on 14.03.2024



Technical discussion on World Water Day 22.03.2024 on the theme "Management of Water Scarcity in Kandi Belt" at Jammu



Speech Competition on "Sanitation as everyone's responsibility" conducted on 16.10.2023 by NIH Patna



Mass awareness program at ASD Govt. Degree College for Women, Kakinada on 22.02.2024.



Mass awareness activity on "Water Security" for the youths, children and village women under the "Swachhta hi Sewa" campaign, Rangia, Assam on 04.03.2024



NWRC Cleanliness Cum Mass Awareness Programme at Govt H. S. School, Jodhpur Under SHS 3.0 Special Campaign 2023



Mass Awareness Activity on 6.02.2024 at Khatakheri, Roorkee



Swachchata Pakhwada at Shantiniketan Public School, Khanapur, Belagavi District on 26.03.2024

Participation in National/International Level Exhibitions





Participation in Mega Expo- "उज्ज्वल राजस्थान आत्मनिर्भर भारत की ओर" at Udaipur, Rajasthan, 2023

20 E-Governance

A lot of emphasis is being given for implementing various e-Governance activities in the Institute. The e-Governance Cell headed by a Scientist-E has been working to plan and supervise various actions for the implementation of e-Governance in the Institute. Internet connectivity of 1Gbps is available in the institute under the National Knowledge Network (NKN) framework of the government of India and the BSNL Network is also available for backup. The Institute is availing the cloud services provided by NIC, Bhubaneshwar and is being used for e-office and website hosting. During the year 2023-24, the Institute website was regularly updated as per the Guidelines for Indian Government Website (GIGW). The Institute website has been granted the status of Certified Quality Website as per GIGW 2.0, Level 1 by the STQC Department, Ministry of Electronics and Information Technology, Govt. of India. The social media team of the Institute is actively working in posting the activities of the Institute and the Ministry of Jal Shakti on various social media platforms like Facebook, Twitter, LinkedIn, Instagram, YouTube etc. for public awareness.

Following e-Governance related activities are being implemented at NIH so far:

Library	• Operation of the library automation software Web-Centric LIBSYS 10 EJB • Subscription of online journals related to hydrology and water resources • Creation of Institutional Digital Repository (IDR) of NIH's publication. • Membership under the National Digital Library to most of the scientists.
Computer Centre	• Updating the NIH website as per Guidelines for Indian Government Website (GIGW 2.0). • Operationalization of High-Speed NKN Network connectivity as well as BSNL connectivity. • Providing gov.in email services to all the employees of the Institute including its regional centres. • Providing data and cyber security to the users of the Institute. • Providing support to organize video conferences, virtual meetings and online Interviews. • Providing operational and technical support to smoothly run the e-HRMS activities in the institute and its regional centres. • An online training session on e-HRMS was arranged on 01.02.2024 for NIH employees by e-HRMS team, NIC, New Delhi. • Providing the operational and technical support to smoothly run the e-Office in the Institute and its regional centres. • Regularly updating the information of R&D activities of the Institute and its Regional Centres on social media platforms like Facebook, Twitter, Instagram, LinkedIn, YouTube etc. for public awareness. • Spreading awareness among the employees of the Institute regarding the do's and don'ts for cyber security as directed by the Ministry.

	• Implementation of Aadhaar Based Attendance System (ABAS) in the Institute and its Regional Centres for regular employees of the Institute. • Implementation of Biometric Attendance System for temporary staff of the Institute • Generation of Salary slips of employees through software and its distribution through e-mail. • Implementation of digital inventory of Computer hardware provided by the Computer Centre to all regular employees of the Institute.
Administration/ Finance Section	• Implementation of e-HRMS • Implementation of e-Office • Implementation of Aadhaar Based Attendance System (ABAS) • Implementation of PFMS system • Operationalization of e-tendering and GeM procurement • Generation of Salary slips of employees through software and its distribution through e-mail. • Computation of income tax of individuals through spreadsheet and software • Online transfer of unspent balance under Non-Recurring head and interest earned to the Government account as "Bharat Kosh". • Online uploading of data of autonomous bodies' Bharat Kosh on the Government site • Online uploading of Form 16 through TDS Reconciliation Analysis and Correction Enabling System • Maintaining CPF account and interest calculation through software • Online transfer of funds to regional centres of NIH • Online payment to individuals/vendors and intimation through e-mail • Online uploading of NPS subscription & contribution and transaction of NPS funds • Online transaction of GST, GTDS amount of contactors and consultancy projects to the Government

21 Welfare of Women Employees

Various measures for welfare of women employees are taken by NIH.

1. Committee for Protection of Women against Harassment

As per directives of the Govt. of India, a committee was constituted to look into the complaints of women employees working in the Institute. The members of the committee include lady employees of Group A, B and C categories in the Institute with Senior Administrative Officer as the Member-Secretary. The terms of reference of the committee are as follows:

i) To receive complaints on incidents of sexual harassment in workplace in the Institute.

ii) To investigate all issues related with such complaints and report to Director for taking proper action against the offender(s).

iii) Evolve suitable mechanism for non-recurrence of such events and prevention of sexual harassment of women employees in workplace.

During the year 2023-24, the committee received no case or complaint of harassment.

2. Child Care Leave and Maternity Leave

During the year 2023-24, three (3) women employees of the Institute availed the Child Care Leave, Maternity Leave and Adoption leave admissible to the women employees.

3. Encouragement in Technical Activities

During the year 2023-24, the women employees were encouraged to participate in national/ international conferences, training courses and other activities of the institute.

Welfare of SC/ST and OBC Employees

22

The Institute is implementing Reservation Policy in vacancies to SC/ST and OBC employees as per the Govt. of India instructions. Accordingly, separate rosters for direct recruitment and promotions are being maintained in the Institute. Actions for filling the vacant posts of reserved category are taken up regularly.

The group-wise staff strength of the Institute indicating posts of SC/ST and OBC category at the end of the year 2023-24 is given below:

GROUP	TOTAL	SC	ST	OBC
A	105	13	06	26
B	43	10	01	08
C	75	10	-	07
TOTAL	**255**	**33**	**07**	**41**

Liaison Officers for SC/ST and OBC employees have been functioning in the Institute effectively. During the year 2023-24, the Liaison Officers ensured the compliance of various reservation orders and benefits admissible to SC/ST and OBC employees in the Institute. The rosters maintained in the Institute were scrutinized from time to time and the reports and returns were submitted to the DoWR, RD & GR, Ministry of Jal Shakti at regular intervals as specified. Queries and grievances of SC/ST and OBC candidates in connection with appointment/ promotion were also taken care of by the Liaison Officer.

At the end of year 2023-24, status of various activities for SC/ST/OBC employees of the Institute is given below:

Activity	Status
Promotion of eligible SC/ST employees	Nothing is pending
MACP's of eligible SC/ST & OBC employees	Nothing is pending
Grievances of SC / ST employees	Nothing is pending
SC/ST member in selection/promotion Committees	One officer in each committee
Study leave to SC/ST/OBC employees	-
SC/ST employee on Lien	-
Appointment of new SC/ST employee	Shri Dilip Barman, (Scientist B) Shri Akshay Vyankat Dahiwale (Scientist B) Shri Malkhan Singh Jatav (Scientist B) Dr. Shailendra Kr. Kumre (Scientist B) Shri Minotshing Maza (Scientist B)

Appointment of new OBC employees	Dr. Prasanta Kumar Sahu (Scientist D) Dr. Surinaidu Lagudu (Scientist D) Dr. Lavkush Kumar Patel (Scientist D) Dr. Umesh Kumar Singh (Scientist C) Dr. Siva Prasad Yellapu, (Scientist C) Dr. Ajit Kumar Bahera (Scientist C) Dr. Sushindra Kumar Gupta (Scientist C) Shri Ruchir Patidar (Scientist B) Dr. Satendra Kumar (Scientist B) Dr. Somya Ranjan Sahu (Scientist B) Shri Sudesh Singh Chaudhary (Scientist B) Shri Pintu Kumar Gupta (Scientist B) Shri Rajesh Ranjan (Scientist B)

Welfare of Differently Able Employees

23

For effective implementation of the Persons with Disabilities (Equal Opportunities, Protection of Rights and Full Participation) Act, 1995; the Institute is following reservation in vacancies for the persons with disabilities, as per Government of India instructions. Accordingly, the Institute is maintaining separate reservation roster register in the prescribed format for determining/effective reservation for the disabled – one each for Group A, Group B and Group C posts filled by direct recruitment; and one for Group C posts by promotion.

Relaxation in upper age limit for persons with disabilities is also given as per Government of India guidelines.

The Institute has appointed a Liaison Officer to ensure that all the reservation orders and benefits admissible to persons with disabilities are implemented to the Institute. The Liaison Officer is also required to ensure that the roster is being maintained properly in the Institute and the relevant reports and returns are submitted to the Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation, Government of India at regular intervals as specified.

At the end of the year 2023-24, the group-wise staff strength of the disabled persons is given below:

GROUP	TOTAL STAFF STRENGTH	PERSONS WITH DISABILITIES		
		Visually Handicapped	Hearing Handicapped	Orthopedically Handicapped
Group A	105	01	-	-
Group B	76	-	-	-
Group C	74	-	-	
Total	**255**	01	-	-

24 NIH Employees Welfare Activities

The Institute is working for the welfare of its employees through various activities. Main activities are as given below:

NIH Benevolent Fund Scheme

The NIH Benevolent Fund Scheme for the staff of the Institute was approved in the 44th meeting of the Governing Body of NIH held on March 18, 1994. The scheme has been implemented and working smoothly through contribution by employees and an equal matching grant from Government of India since 1994. Assistance is being provided to the Member/Member's Family from NIH Benevolent Fund. During 2023-24, 03 request for assistance were received. Total 13 employees of the Institute have received the benefit under this scheme since its inception until 31.03.2024.

NIH Cooperative Society

The NIH Cooperative Society was formed with the objective to create thrift and savings among the employees; to make available loans at low interest without any security; to start a 'General Provision Store' for the benefit of the employees etc. The NOC for opening the 'General Provision Store' was approved in 48th meeting of Governing Body of NIH held on 25 March, 1996. NIH Cooperative Society was registered with Registration No. 2349 vide letter No. 996-98/Nibandhan, dated 4/11/1997, from the Office of Assistant Registrar, Cooperative Societies, Saharanpur, Uttar Pradesh. The NIH Cooperative Society is run by a "Sanchalak Mandal" elected from amongst its members. At present, there are nine members in the "Sanchalak Mandal". NIH Cooperative Society functions with the money collected under Compulsory Deposit (CD) Scheme. Presently, each member deposits @ Rs. 1000/- per month under CD scheme. This CD money is returned only at the time of surrendering the membership of the Cooperative Society. Presently NIH Cooperative Society collects funds of Rs. 14.79 Lakhs per month in March 2024 from Compulsory Deposits, Recurring Deposits and recovery of loans. The Society had 114 members as on 31.03.2024.

NIH Society

APPENDIX-I

PRESIDENT			
1	Hon'ble Union Minister for Jal Shakti, Government of India, Shram Shakti Bhawan, Rafi Marg, New Delhi-110 001		
VICE-PRESIDENT			
2	Hon'ble Minister of State for Jal Shakti, Government of India, Shram Shakti Bhawan, Rafi Marg, New Delhi-110 001		
MEMBERS			
3	Advisor (Water Resources), National Institution for Transforming India (NITI), Room No. 233, Yojna Bhawan, Sansad Marg, New Delhi-110 001	4	Hon'ble Minister of Jal Shakti, Irrigation and Water Res. Dept., Bapu Bhawan, Govt. of UP, Lucknow-226001
5	Hon'ble Minister of Water Resources Punjab Vidhan Sabha Secretariat Sector -1, Chandigarh-160 001	6	Hon'ble Minister of Water Resources Secretariat Panaji , Goa
7	Hon'ble Chief Minister and Minister for Water Resources, Govt. of Telangana 5th Floor, Burgula Rama Krishna Rao Bhawan, NH44, Hill Fort, Adarsh Nagar, Hyderabad – 500063	8	Hon'ble Minister for Water Resources, Water Resources Department, Govt. of Madhya Pradesh Jal Sansadhan Bhawan, Tulsi Nagar Bhopal - 462003
9	Dr. Rajeev Rai Bhatnagar, Advisor to Hon'ble Lieutenant Governor, UT of Jammu & Kashmir, Jal Shakti Department, 2/44, Main Building, Civil Secretariat Jammu -180001	10	Hon'ble Minister-in-Charge, Dept. of Water Resources, Govt. of Odisha Kehari Nagar Bhubaneswar-51001
11	Hon'ble Minister of Irrigation Govt. of Tripura New Secretariat, New Capital Complex Agartala (Tripura)	12	Hon'ble Minister of Irrigation (Water Resources), Government of Andhra Pradesh, Mogalrajapuram, Vijayawada (AP)-520010
13	Hon'ble Minister of Irrigation (Water Resources Department) Govt. of Arunachal Pradesh Civil Secretariat Itanagar-791111	14	Director Indian Institute of Technology, Roorkee-247 667

15	Dr. Narendra Singh Raghuwanshi Director Maulana Azad National Institue of Technology, Link Road Number 3, Near Kali Mata Mandir, Bhopal-462003	16	Director, Indian Institute of Remote Sensing 4, Kalidas Road, Hathi Barkala Dehradun-248001
17	Director, Centre for Environment and Developent Studies, BB-92, Nityanand Nagar, Gandhi Path, Queen Road Jaipur-302021	18	Dr. Rajendra Singh, Brahmaputra Chair Professor for Water Resources, Department of Agricu lture and Food Engineering, Indian Institue of Technology, 1 -161, IIT Campus, Kharagpur-721302
19	Er. R. D. Singh Ex-Director, NIH 348, Friends Lane, Solanipuram Roorkee-247667	20	Prof. N. K. Goel Department of Hydrology Indian Institue of Technology Roorkee-247667
21	Sh. A. K. Bajaj, Ex-Chairman Central Water Commission, C-71, GF, Defence Colony, New Delhi-110024	22	Prof. Chandan Mahanta, Professor and Head Department of Civil Engineering Indian Institute of Technology Guwahati
23	Dr. Debasis Chaterjee Profesor and Ex -Head, Department of Chemistry, University of Kalyani, Flat No. A/1/10, 312, B.B. Chaterjee Road, Kolkata-700042 (WB)	24	Shri. Gopal Singh Bhati, Chief Engineer (Retired), Royal Cottage, Krsna Kunj Enclave, Ramdeora Road, Gomat Pokhran – 345021 (Rajasthan)
25	Secretary to Govt. of India, Department of Water Resources, RD & GR, Ministry of Jal Shakti, Shram Shakti Bhawan, Rafi Marg, New Delhi-110 001	26	Secretary to Govt. of India, Ministry of Science & Technology, Department of Science & Technology, Technology Bhawan, New Mehrauli Road, New Delhi-110 029
27	Secretary to Govt. of India, Ministry of Agriculture & Co -operation, Krishi Bhawan, New Delhi-110 001	28	Secretary to Govt. of India, Ministry of Power, Shram Shakti Bhawan, Rafi Marg, New Delhi-110 001.
29	Joint Secretary & Financial Advisor, Dept. of Water Resources, RD & GR, Ministry of Jal Shakti Shram Shakti Bhawan, Rafi Marg, New Delhi-110 001	30	Secretary to Govt. of India, Ministry of Urban Development, Nirman Bhawan, New Delhi-110 002
31	Chief Executive Officer (CEO), National Institution for Transforming India (NITI), Yojna Bhawan, Sansad Marg, New Delhi-110 001	32	Secretary to Govt. of India, Ministry of Environment, Forest & Climate Change, Indira Paryavaran Bhawan , Aliganj, Jor Bagh Road, New Delhi-110 003

33	Secretary to Govt. of India, Department of Drinking Water and Sanitation, Ministry of Jal Shakti C Wing, 4 th Floor, Paryavaran Bhawan, CGO Complex, Lodhi Road, New Delhi – 110 003	34	Chairman, Central Water Commission, R. No. 315, Sewa Bhawan, R.K. Puram, New Delhi-110 066
35	Additional Secretary to Govt. of India, DoWR, RD & GR, Ministry of Jal Shakti, Shram Shakti Bhawan, Rafi Marg, New Delhi -110 001	36	Member (D&R), Central Water Commission, Seva Bhawan, R.K. Puram, New Delhi – 110 066
37	Chief Engineer (Hydrology Studies Organization), Central Water Commission, Seva Bhawan, R.K. Puram, New Delhi-110 066.	38	Chairman, Central Electricity Authority, Seva Bhawan, R.K. Puram, New Delhi-110 066.
39	Chairman, Central Ground Water Board, Jamnagar House, Man Singh Road, New Delhi-110 001	40	Director General, India Meteorological Department, Lodhi Road, New Delhi-110 003
41	Director General, Geological Survey of India, 27, Jawaharlal Nehru Road, Dharmatala, Taltala, Kolkata (W.B.)-700016	42	Chairman, Central Pollution Control Board, CBD-cum-Office, East Arjun Nagar, New Delh-110 021
43	Director (R&D), Dept. of Water Resources, RD & GR, Min. of Jal Shakti, 1 st Floor, Wing -4, West Block, R.K. Puram, New Delhi-110 066	44	Joint Secretary (Admn), Dept. of Water Resources, RD & GR, Min. of Jal Shakti,Shram Shakti Bhawan, Rafi Marg, New Delhi-110 001
45	Joint Secretary (RD & PP), Dept. of Water Resources, RD & GR, Min. of Jal Shakti, Shram Shakti Bhawan, Rafi Marg, New Delhi-110 001	46	Commissioner (FM), Dept. of Water Resources, RD & GR, Min. of Jal Shakti, Block 11, 8 th Floor, CGO Complex, Lodhi Road, New Delhi-110 001
		MEMBER SECRETARY	
47	Commissioner (SPR), Dept. of Water Resources, RD & GR, Shram Shakti Bhawan, Rafi Marg, New Delhi-110 001	48	Director, National Institute of Hydrology, Roorkee (Uttarakhand)-247 667

APPENDIX-II

Governing Body

CHAIRMAN			
1.	Secretary to Govt. of India, Department of Water Resources, River Development and Ganga Rejuvenation Ministry of Jal Shakti, New Delhi		
VICE-CHAIRMAN			
2.	Director Indian Institute of Technology, Roorkee		
MEMBERS			
3.	Chairman or Member, Central Water Commission, New Delhi	4.	Additional Secretary, Dept. of Water Resources, RD & GR Ministry of Jal Shakti, New Delhi
5.	Joint Secretary (Finance) and Financial Advisor, Dept. of Water Resources, RD & GR Ministry of Jal Shakti, New Delhi	6.	Advisor (Water Resources), NITI Ayog (Planning Commission), New Delhi (Representative of Planning Commission)
7.	Head (NRDMS & NSDI), Ministry of Science & Tech., (Dept. of Science & Technology), New Delhi (Representative of Ministry of Science & Technology, Govt. of India)	8.	Adviser (PHEE), CPHEEO, Ministry of Urban Development (Dept. of Urban Development), New Delhi (Representative of Ministry of Urban Development, Govt. of India)
9.	Advisor / Joint Secretary, National River Conservation Directorate, Ministry of Environment, Forests & CC , New Delhi (Representative of Min. of Environment, Forests & CC)	10.	Chief Engineer (Hydrology), Water Resources Development Organization, Govt. of Karnataka Bangaluru (Representative of Govt. of Karnataka)
11.	Principal Secretary (Irrigation), Government of UP, Lucknow	12.	Secretary (Irrigation) Govt. of Uttarakhand, Dehradun
13.	Chief Engineer (I&FCD), Govt. of Jammu & Kashmir, Jammu (Representative of Govt. of J & K)	14.	Engineer-in-Chief (Irrigation Wing), Govt. of Andhra Pradesh Hyderabad (Representative of Govt. of A.P.)
15.	Chief Engineer, Major Irrigation Irrigation Department, Govt. of Assam, Guwahati (Representative of Govt. of Assam)	16.	Chief Engineer (BODHI), Water Resources Development Govt. of Madhya Pradesh, Bhopal (Representative of Govt. of M.P.)
17.	Secretary Water Resources Department, Govt. of Bihar, Patna (Representative of Govt. of Bihar)	**MEMBER SECRETARY**	
		18.	Director, National Institute of Hydrology, Roorkee

Standing Committee

APPENDIX-III

CHAIRMAN	
1.	Special Secretary/Additional Secretary to Govt. of India, Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti New Delhi
MEMBERS	
2.	Financial Advisor & Joint Secretary (Finance), Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti New Delhi
3.	Joint Secretary, Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti New Delhi
4.	Representative of DST (not below the rank of joint Secretary) Department of Science & Technology, New Delhi
MEMBER SECRETARY	
5.	Director, National Institute of Hydrology, Roorkee

APPENDIX-IV

Technical Advisory Committee

CHAIRMAN			
1.	Chairman, Central Water Commission Govt. of India New Delhi		
MEMBERS			
2.	Member (D&R) Central Water Commission, New Delhi	3.	Chief Engineer (HSO) Central Water Commission New Delhi
4.	Director National Institute of Hydrology, Roorkee	5.	Chairman, Central Ground Water Board, Bhujal Bhawan, NH-IV, Faridabad-121001
6.	Representative of India Meteorological Department, New Delhi		
7.	A Professor engaged in research in Water Resources areas from IIT, Roorkee		
8.	A Professor engaged in research in Water Resources areas from any one of the other six IITs		
9.	A Professor engaged in research in Water Resources areas from one of the State Universities		
10.	Director of one of the Water Technology Centres: Water Technology Centre, Indian Agricultural Research Institute (IARI), Pusa, New Delhi – 110012		
11 & 12	Two Experts of Hydrology in individual capacity: i) Dr. Suhas P. Wani, International Rice Research Institute South Asia Regional Centre NSRTC Campus, G.T. Road, Collectry Farm P.O. Industrial Estate Varanasi (U.P.) - 221 106 ii). Prof. Rohit Goyal, Department of Civil Engineering MNIT, Jaipur		

13.	Head of one of the State Hydrology Cells: State Water Data Centre near WALMI Campus, Gandhinagar, Gujarat
14.	Expert from Non-Government Scientific Organization in the field of Hydrology: Dr. Himanshu Kulkarni, ACWDAM, Pune
15.	Commisiner PP, Dept. of Water Res., Ministry of Jal Shakti, New Delhi
16 & 17	Two Nominees of the Water related industries: i). Nominee of NHPC ii). Nominee of WAPCOS
18	Special Nominee: Prof. Arup Sarma Department of Civil Engineering IIT Guwahati
19	Representative of IWMI, New Delhi
20.	Representative of UNESCO, New Delhi
21	**MEMBER SECRETARY** (Scientist G/F, to be nominated by Director, National Institute of Hydrology, Roorkee)
	Head, Technical Cell, NIH, Roorkee

APPENDIX-V

Working Group

(As approved by 78th Governing Body)

CHAIRMAN			
Director, National Institute of Hydrology Roorkee			
MEMBERS			
A) Central Government Organizations (Including R & D Organizations)			
1.	Two Nominees (Director Level) CWC, New Delhi	2.	Nominee of CGWB, Faridabad
3.	Nominee of IMD, New Delhi	4.	Nominee of CPCB, New Delhi
5.	Nominee of NWDA, New Delhi	6.	Nominee of Department of Drinking Water and Sanitation, Ministry of Jal Shakti Govt. of India, New Delhi
7.	Nominee of Ministry of Environment & Forest (NRCD), GoI	8.	Nominee of North East Council, Shillong
9.	Nominee of Ministry of Earth Sciences, Govt. of India	10.	Nominee of Ministry of Agriculture (NRM), Govt. of India
11.	Nominee of Geological Survey of India, Kolkata	12.	Director, NIC, New Delhi
13.	Indian Institute of Tropical Meteorology, Pune	14.	ICAR-Indian Institute of Soil & Water Conservation, Dehradun
15.	Wadia Institute of Himalayan Geology, Dehradun	16.	GBP National Institute of Himalayan Environment & Sustainable Development, Almora
17.	National Institute of Disaster Management, New Delhi	18.	BARC, Mumbai
19.	Physical Research Laboratory, Ahmedabad	20.	CAZRI, Jodhpur
21.	NEERI, Nagpur	22.	Forest Research Institute, Dehradun
23.	IIRS, Dehradun	24.	NGRI, Hyderabad
25.	ICAR-IARI, New Delhi	26.	Nominee of Brahmaputra Board, Guwahati
B) State Government Organizations (including R & D Organizations)			
27.	Nominee of Water Resources Department, Karnataka	28.	Nominee of State Water Investigation Directorate, West Bengal
29.	Nominee of Water Resources Department, Orissa	30.	Nominee of Water Resources Department, Madhya Pradesh

31.	Nominee of Ground Water Department, Maharashtra	32.	Nominee of Water Resources Department, Punjab
33.	Nominee of Water Resources Department, Chhattisgarh	34.	Nominee of Jal Sansthan, Uttarakhand
35.	Nominee of Ground Water Department, Andhra Pradesh	36.	Nominee of Ground Water Department, Telangana
37.	Gujarat Pollution Control Board, Gandhinagar	38.	CWRDM, Kozhikode
39.	Nominee of Water Resources Department, Rajasthan	40.	Irrigation Research Institute, Roorkee
C) Members from Academic Institutions			
41.	Dr. Varun Joshi, Professor University School of Environment Management, Guru Gobind Singh Indraprastha University, New Delhi	42.	Prof. K. K. Singh Department of Civil Engineering NIT Kurukshetra, Haryana
43.	Prof. Vimal Mishra Civil Engineering Department IIT Gandhinagar, Gujarat	44.	Prof. A. K. Saraf Department of Earth Sciences IIT Roorkee, Uttarakhand
45.	Prof. M L Kansal Department of Water Resources Development & Management IIT Roorkee, Uttarakhand		
D) Members in Individual Capacity (including NGOs)			
46.	Dr. Bhishm Kumar Prof. Staff & Advisor (Retd.), IAEA, Roorkee	47.	Dr. S. S. Grewal Director (Retd), Reg. Station of PAU-Ludhiana, Chandigarh
48.	Dr. C. T. Dhanya Assistant Professor, IIT Delhi, New Delhi	49.	Dr. Kaushal K. Garg Senior Scientist-NRM ICRISAT, Hyderabad, Telangana
50.	Prof. Ramakar Jha NIT Patna, Bihar	51.	Prof. A. P. Dimri Jawaharlal Nehru University, New Delhi
52.	Dr. Debashish Sen, Director Peoples Science Institute, Dehradun	53.	Dr. Sadhna Malhotra (Economist) Director, Mindspace, Dehradun
54.	Mr. Sudhindra Mohan Sharma Consultant, Ex-Nodal Officer National Drinking Water Security Pilot Projects, MoDWS (GoI), Indore		
E) Internal (NIH)			
55.	Divisional Head, SWH Div. NIH	56.	Divisional Head, GWH Div. NIH

57.	Divisional Head, EH Div. NIH	58.	Divisional Head, HI Div. NIH
59.	Divisional Head, WRS Div. NIH	60.	Divisional Head, RMOD Div. NIH
MEMBER SECRETARY			
Head, Technical Cell, NIH, Roorkee			

Regional Coordination Committees

APPENDIX-VI

Deccan Hard Rock Regional Centre, NIH, Belagavi			
CHAIRMAN			
1.	Director, National Institute of Hydrology, Roorkee		
MEMBERS			
Central Govt. Institutions			
2.	Regional Director Central Ground Water Board, Bangalore	3.	Chief Engineer Krishna and Godavari Basin Organization, CWC, Hyderabad
4.	Nominee of Director Indian Institute of Tropical Meteorology (IITM), Pashan, Pune	5.	Nominee of Director NRSC, Balanagar, Hyderabad (Telangana)
State Govt. Institutions			
6.	Chief Engineer Water Resources Development Organization, Bangalore	7.	Chief Engineer Water Resources Dept., Goa
8.	Chief Engineer (Project II and HP-II) Kerala State Irrigation Department, Thiruvanthapuram, Kerala	9.	Chief Engineer Hydrology Project (Surface Water), Nashik
10.	Chief Engineer State Ground and Surface Water Resources Data Centre, Chennai	11.	Director Groundwater Survey and Development Agency, Pune
12.	Director State Groundwater Dept., Thiruvanthapuram	13.	Director, State Ground Water Department, Hyderabad
14.	Chief Engineer (Hydrology) I&CAD Dept., Hyderabad	15.	Director, WTC, TNAU, Coimbatore, Tamil Nadu
Academic Institutions			
16	Nominee of Director NIT Trichy, TN	17.	Nominee of Director IISc Bangalore
NGOs and Individual Experts			
18.	Prof. Lakshman Nandagiri Dept. of Applied Mechanics, NIT Surathkal, Karnataka	19.	Prof. AG Chachadi Dept. of Earth science, Goa University, Goa
20.	Director Ashoka Trust for Research in Ecology and Environment, Bangalore	21.	Director Dhan Foundation, Madurai, Tamil Nadu

MEMBER SECRETARY	
22.	Head, Deccan Hard Rock Regional Centre, NIH, Belagavi

Western Himalayan Regional Centre, NIH, Jammu			
CHAIRMAN			
1.	Director, National Institute of Hydrology, Roorkee		
MEMBERS			
Central Govt. Institutions			
2.	Regional Director North West Himalayan Region (NWHR), Central Ground Water Board, Jammu	3.	Nominee of Director Snow & Avalanche Study Establishment (RDC), Him Parisar, Chandigarh
4.	Nominee of Director GB Pant Institute of Himalayan Environ. & Development, Almora	5.	Chief Engineer (Indus Basin) Central Water Commission, Chandigarh
6.	Director India Meteorological Department (IMD), Srinagar	7.	Nominee of Director Wadia Institute of Himalayan Geology, Dehradun
8.	Regional Director Geological Survey of India, Jammu	9.	Director Central Water Commission, Jammu
10.	Representative of Bhakra Beas Management Board, Chandigarh		
State Govt. Institutions			
11.	Chief Engineer Irrigation and Flood Control Department (I&FC, J&K), Jammu	12.	Nominee of Engineer-in-Chief Irrigation and Public Health (I&PH) Department (HP), Shimla
13.	Nominee of Engineer-in-Chief Irrigation Department (Uttarakhand Govt.), Dehradun	14.	Regional Director J & K State Pollution Control Board, Jammu
Academic Institutions			
15.	Chief Scientist & Head (WM) Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST), Jammu	16.	Nominee of Director National Institute of Technology (NIT), Srinagar
17.	Nominee of Vice-Chancellor Himachal Pradesh Krishi Vishav-vidalaya (HPKV), Palampur		
NGOs and Individual Experts			
18.	Prof. M. N. Kaul Department of Geography, University of Jammu, Jammu	19.	Mr. Chewang Norphel Chief Project Officer, Leh Nutrition Project, Leh, Laddakh, J&K
20.	Maj. Gen. (retd) G. S. Jamwal President, J&K Paryavaran Sansthan, Jammu		

MEMBER SECRETARY	
21.	Head, Western Himalayan Regional Centre, NIH, Jammu

Central India Hydrology Regional Centre, NIH, Bhopal			
	CHAIRMAN		
1.	Director, National Institute of Hydrology, Roorkee		
MEMBERS			
Central Govt. Institutions			
2.	Chief Engineer Narmada Basin, Central Water Commission (CWC), Bhopal	3.	Regional Director North Central Region (NCR), Central Ground Water Board, Bhopal, MP
4.	Director Meteorological Centre, India Meteorological Department (IMD), Bhopal	5.	Nominee (dealing with water resources) of Director, CSIR-AMPRI Regional Research Laboratory (RRL), Bhopal
6.	Representative of Central Pollution Control Board (CPCB) Zonal Office, Bhopal		
State Govt. Institutions			
7.	Chief Engineer BODHI, Bhopal	8.	Chief Engineer Chambal Betwa Basin, Water Resources Department (WRD), Bhopal
9.	Chief Engineer Dhasan-Ken Basin, WRD, Sagar	10.	Chief Engineer MG Basin, Raipur, Chhattisgarh
11.	Chief Engineer Betwa Pariyojna, Jhansi (UP)	12.	Chief Engineer Sone Basin, Bihar
13.	Superintending Engineer Ground Water Survey, WRD, Bhopal	14.	Nominee of MP Council of Science & Technology
Academic Institutions			
15.	Chief Engineer, & Director Irrigation Management and Training Institute (IMTI), Kota	16.	Nominee of Director (dealing with water resources) MANIT Bhopal, Madhya Pradesh
17.	Nominee of Director Water and Land Management Institute (WALMI), Bhopal		
NGOs and Individual Experts			
18.	Samaj Pragati Sahyog, Dewas	19.	Development Alternatives, Jhansi
20.	Dr. Salim Romani Chairman (Retd.), Central Ground Water Board (CGWB), Bhopal		

MEMBER SECRETARY	
21.	Head, Central India Hydrology Regional Centre, NIH, Bhopal

Deltaic Regional Centre, NIH, Kakinada			
CHAIRMAN			
1.	Director, National Institute of Hydrology, Roorkee		
MEMBERS			
Central Govt. Institutions			
2.	Director Meteorological Centre, Bhubaneswar	3.	Regional Director Central Ground Water Board (CGWB), SE Coastal Region, Chennai
4.	Chief Engineer (Krishna & Godavari Basin) CWC, Hyderabad	5.	Nominee (dealing with water resources) of Director NGRI, Hyderabad
6.	Head WR Division, National Remote Sensing Centre (NRSC), Hyderabad	7.	Director Directorate of Water Management, Indian Council of Agricultural Research (ICAR), Bhubaneswar
8.	Nominee of Director, Water Resources Centre, Anna University, Chennai	9.	Nominee of Director, National Institute of Ocean Technology (NIOT), Chennai
State Govt. Institutions			
10.	Engineer-in-Chief, Rural Water Supply and Sanitation (RWS & S), Vijayawada	11	Nominee of Director General AP State Remote Sensing Applications Centre (APSRAC), Vijayawada
12.	Managing Director West Bengal Minor Irrigation Corporation, State Water Investigation Directorate, Kolkata	13	Nominee of Member Secretary Andhra Pradesh Pollution Control Board, Hyderabad
Academic Institutions			
14.	Nominee (dealing with water resources) of Vice Chancellor Jawahar Lal Nehru Technological University (JNTU), Kakinada		
15.	Prof. L Elango Anna University, Chennai	16.	Dr. K. P. Sudheer IIT Madras
17.	Prof B. E. Vijayam PROGRESS, Hyderabad	18.	Dr. T. P. Raghunath Pondicherry Science Forum, Puducherry

MEMBER SECRETARY	
19.	Head, Deltaic Regional Centre, NIH Kakinada

North Eastern Regional Centre (NIH), Guwahati			
CHAIRMAN			
1.	Director, National Institute of Hydrology, Roorkee		
MEMBERS			
Central Govt. Institutions			
2.	Advisor (IFC&WSM) North East Council Secretariat, Shillong	3.	Chief Engineer (B&B Basin) Central Water Commission, Shillong
4.	Regional Director Central Ground Water Board, Guwahati	5.	Deputy Director General (DDG) Regional Meteorological Centre (RMC), India Meteorological Department (IMD), Guwahati
6.	General Manager Brahmaputra Board, Guwahati	7.	Director, North-East Space Application Centre (NE-SAC), Shillong
State Govt. Institutions			
8.	Meghalaya State Pollution Control Board, Shillong	9.	Chief Engineer, Department of Water Resources, Govt. of Assam, Guwahati
10.	Chief Engineer, Water Resources Department, Govt. of Meghalaya	11.	Nominee of Sikkim State Council of Science & Technology, Sikkim
Academic Institutions			
12.	Nominee of Director North Eastern Regional Institute of Science and Technology (NERIST), Nirjuli	13.	Nominee of Director North Eastern Regional Institute of Water and Land Management (NERIWALM), Tezpur
14.	Nominee (dealing with water resources) of Director, IIT Guwahati	15.	Nominee (dealing with water resources) of Vice-Chancellor, Manipur University, Imphal
16.	Nominee (dealing with water resources) of Vice-Chancellor North Eastern Hill University (NEHU), Shillong		
NGOs and Individual Experts			
17.	Dr. Biswajit Sarma Director Confederation of Indian Industry (CII) TDB T Net Centre, Jorhat Engg. College, Jorhat	18.	Dr. Biplab B. Basu Director, School of Fundamental Research, Kolkata
19.	Aaranyak, Guwahati		

MEMBER SECRETARY	
20.	Head, North Eastern Regional Centre (NIH), Guwahati

Centre for Flood Management Studies, NIH, Patna			
CHAIRMAN			
1.	Director, National Institute of Hydrology, Roorkee		
MEMBERS			
Central Govt. Institutions			
2.	Chief Engineer Central Water Commission (CWC), Patna	3.	Representative of Chairman Ganga Flood Control Commission (GFCC), Patna (not below the rank of Director)
4.	Director India Meteorological Department, Patna	5.	Regional Director Central Ground Water Board (CGWB), Patna
6.	Indian Council of Agricultural Research Research Complex for Eastern Region, Patna	7.	Central Pollution Control Board (CPCB) Zonal Office, Kolkata
State Govt. Institutions			
8.	Chief Engineer (Civil) Damodar Valley Corporation (DVC), Maithon	9.	Chief Engineer Irrigation and Waterways, Kolkata
10.	Chief Engineer (Design, Master Planning & Hydrology), Ranchi	11.	Chief Engineer (WR) UP Irrigation Department, Lucknow
12.	Chief Engineer (Monitoring), Water Resources Department, Patna		
Academic Institutions			
13.	Nominee (dealing with water resources) of Director, NIT Patna	14.	Nominee (dealing with water resources) of Director, IIT Patna
15.	Chief Engineer & Director Water and Land Management Institute (WALMI), Patna		
NGOs and Individual Experts			
16.	Society for Rural Industrialization, Ranchi	17.	Prof S. P. Sinha Society for Hill Resource Management School, Daltonganj-Jharkhand

MEMBER SECRETARY	
18.	Head, Centre for Flood Management Studies, NIH Patna

North Western Regional Centre, NIH, Jodhpur			
CHAIRMAN			
1.	Director, National Institute of Hydrology, Roorkee		
MEMBERS			
Central Govt. Institutions			
2.	Regional Director Central Ground Water Board-Western Region, Jaipur	3.	Chief Engineer, Indus Basin Organization, CWC, Chandigarh
4.	Nominee of Director, Central Arid Zone Research Institute, Jodhpur	5.	Regional Director, Central Ground Water Board, West Central Region, Ahmedabad
State Govt. Institutions			
6.	Chief Engineer, Water Resources, Department of Water Resources, Punjab, Chandigarh	7.	General Manager, Regional Remote Sensing Centre (RRSC)-West, ISRO, Jodhpur
8.	Chief Engineer Irrigation & Water Resources Department, Panchkula, Haryana	9.	Chief Engineer, Rajasthan River Basin and Water Resource Planning Authority, Jaipur
10.	Chief Engineer, State Ground Water Department, Jodhpur	11.	Chief Engineer, Indira Gandhi Nahar Pariyojna (IGNP), Bikaner
12.	Chief Engineer & Director, Gujarat Engineering Research Institute (GERI), Vadodara	13.	Chief Engineer & Director, Water and Land Management Institute (WALMI), Anand
14.	Nominee of Managing Director, Gujarat Water Resources Development Corporation Ltd. (GWRDC), Gandhinagar	15.	Nominee of Director, ICAR - Central Soil Salinity Research Institute, Karnal, Haryana
Academic Institutions			
16.	Nominee of Director (dealing with Water Resources) IIT Jodhpur	17.	Nominee of Director (dealing with Water Resources) NIT Surat
18.	Nominee of Director (dealing with Water Resources) IIT Ropar	19.	Nominee of Director (dealing with Water Resources), NIT Kurukshetra

NGOs and Individual Experts			
20.	Dr. Shiv Singh Rathore, Ex-Chairman & Ex-Member, Rajasthan Public Service Commission	21.	Executive Director, Gramin Vikas Vigyan Samiti (Gravis), Jodhpur
MEMBERSECRETARY			
22.	Head, North Western Regional Centre, NIH, Jodhpur		

Institute Funded R & D Studies During 2023-24
(Completed and On-going)

APPENDIX-VII

Institute funded R & D Studies during April, 2023-March, 2024:

S. No.	Title of the Study	PI	Duration & Status
CENTRE FOR CRYOSPHERE AND CLIMATE CHANGE STUDIES			
1	Impacts of Glacier and Climate Change on Runoff for Selected Basins of Himalaya	Vishal Singh	11/2021–03/2023 Completed
2	Early Signatures of 21st Century on Snow Cover Dynamics in Zanskar River Basin, Ladakh	D.S. Bisht	07/2021-06/2024 Ongoing
3	Ascertaining the efficacy of use of State-of-the-art technologies for spring mapping and sustainability of springs through suitable interventions	S. S. Rawat	04/2022-03/2025 Ongoing
4	Climate Change Scenarios for Andhra Pradesh and its Impact on Streamflow and groundwater levels in Pennar River Basin	Sunil Gurrapu	04/2022 – 03/2024 Extended for 6 months until 10/2024 Ongoing
5	Investigation on occurrences of extreme rain events across Northwest Himalaya in relation to global atmospheric thermal and circulation changes’	Ashwini Ranade	04/2022-03/2025 Ongoing
6	Comparative Analysis of Fine Scale Satellite & Reanalysis Precipitation Products in Upper Ganga Basin using Multi-criterion Decision Making	D. S. Bisht	06/2022-06/2024 Ongoing
7	Real time monitoring of snow-glacier related parameters and Ensemble Hydrological Modeling (EHM) to study the Triloki Group of Glaciers and Khatling glaciers part of Western Himalaya, India under climate change scenarios	Vishal Singh	03/2023 - 02/2028 Ongoing
8	Geo-Hydro-Chemical and Isotopic Aspects of occurrence of Springs: A case study from the major settlement areas of Bhagirathi basin, Uttarakhand, India	S. S. Rawat	04/2023 - 03/2026 Ongoing

9	Monitoring and Modelling of Gangotri watershed (Bhojwasa) under different Climate Scenarios	Lavkush K. Patel	04/2023 - 03/2026 Ongoing
ENVIRONMENTAL HYDROLOGY DIVISION			
1	Characterisation of Groundwater Dynamics in Krishna-Godavari Delta interims using groundwater levels, Hydrochemistry, Isotopes and Emerging Contaminants	M. K. Sharma	04/2022-03/2024 Completed
2	Understanding Arsenic Mobilization in Groundwater of Haridwar and Formulating Remediation Measures	Rajesh Singh	07/2021–06/2025 Ongoing
3	Simulation of Non-Point Source Pollution Processes in Song River	Pradeep Kumar	11/2019-06/2024 Ongoing
4	Hydrological Studies for the Conservation of Rewalsar Lake	Kalzang Chhoden	04/2023-03/2026 Ongoing
5	Comprehensive Evaluation of Disinfection Units of STPs in Ganga Basin: Formation & Control of Emerging Oxidation Precursors	V. K. Tyagi	04/2023-03/2026 Ongoing
GROUNDWATER HYDROLOGY DIVISION			
1	Studying arsenic genesis and developing alternate water supply management strategies in Ganga basin	Sumant Kumar	04/2022 – 03/2025 Ongoing
2	Conjunctive Management of Water Resources in IGNP Command	Nitesh Patidar	04/2022 – 06/2024 Ongoing
3	Development of Archive of Soil Hydraulic Characteristics	Nitesh Patidar	04/2023 – 06/2024 Ongoing
4	Enhancement and application of NIH_WISDOM	Nitesh Patidar	10/2023 – 09/2025 Ongoing
HYDROLOGICAL INVESTIGATIONS DIVISION			
1	Assessment of the Possible Impact of Climate Change on Evapotranspiration for Different Climatic Regions Of India	S.D. Khobragade	04/2022-03/2025 Ongoing
2	Hydrogeological and Isotopic investigation of groundwater in Himalayan Watershed of Kashmir, India	Gopal Krishan	09/2022-03/2024 Ongoing
3	Developing a Stable Isotopic Analysis System for analyzing the dissolved Nitrates in water	M. S. Rao	04/2023-09/2024 Ongoing
4	Feasibility of Open Sources Data for the Estimation of Runoff and Water Storage Capacity for Rainwater Harvesting Strategies	S.M. Pingale	04/2023- 03/2025 Ongoing
5	Sedimentation and Water Quality Studies of Phulahar Lake, Pilibhit (U.P.)	Rajeev Gupta	04/2023- 03/2025 Ongoing

SURFACE WATERHYDROLOGY DIVISION			
1	Development of Cloud Data Bases Integrated Framework to Forecast Flood for Efficient Operation of Reservoirs	A.K. Lohani	04/2022-03/2024 Completed
2	Hydraulic force-inversion equation for exact modeling of hydraulic jumps in rectangular channels	S.K. Singh	04/2023-03/2024 Completed
3	Investigation of hydrodynamic approach of flood inundation mapping along with assessment of changes in river planforms using a cloud-based Google Earth Engine (GEE) computing platform in data-scarce Western Himalayan River basin	R. V. Kale	09/2021- 10/2024 Ongoing
4	Flood Forecasting under Changing Climate Conditions - Role of Machine Learning and Conceptual/Physical based Mode	P C Nayak	07/2022-03/2025 Ongoing
5	Hydrological Study for revival and restoration of traditional water bodies in Bikaner, Rajasthan	L. N. Thakural	04/2022–06/2024 Ongoing
6	Review of design flood and dam break analysis of Khadakhai Dam in Odisha	J.P. Patra	04/2022-03/2025 Ongoing
7	Estimation of confidence intervals of index flow duration curves	Sanjay Kumar	04/2023-03/2025 Ongoing
8	Hydrologic and hydraulic study for Jata Ganga river at Jageshwar dham	J.P. Patra	07/2023-07/2024 Ongoing
WATER RESOURCES SYSTEMS DIVISION			
1	Monitoring and hydrological modeling of Henval watershed in lesser Himalaya	M. K. Nema	08/2020-03/2024 Completed
2	Spatio-temporal water availability under changing climate and land-use scenarios in Wainganga river basin	M. K. Nema	04/2022-03/2025 Ongoing
3	Investigating gap areas, current trends and future directions of research in climate change impact on hydrology and water resources in India through Scientometrics	Archana Sarkar	04/2022-04/2024 Completed
4	Hydrology-based scenario planning for water productivity and optimization of income from farming practices in Mewat region, Haryana	A. R. Senthil Kumar	09/2020-06/2023 Completed

WORK PROGRAMME OF NIH REGIONAL CENTRES AND CENTRE FOR FLOOD MANAGEMENT STUDIES FOR YEAR 2023-24

S. No.	Title of the Study	PI	Duration & Status
HARD ROCK REGIONAL CENTRE, BELAGAVI			
1	Monitoring and Evaluation of Ground Water Quality of Belagavi City, Karnataka, India	N. Varadarajan	05/2022-04/2024 Completed
2	Comprehensive Assessment of Hydrology of Large Rivers basins of Western Ghats of Karnataka	Venkatesh.B	4/2023-4/2026 On going
3	Studies on Occurrence, Distribution of Springs in parts of Western Ghats, India	Abhilash.R	4/2023-3/2024 On going
4	Water Productivity assessment in Irrigation Projects by Geo-Spatial Optimization Techniques	Abhilash. R	4/2023-4/2026 On going
WESTERN HIMALAYAN REGIONAL CENTRE, JAMMU			
1	Estimation of changes in snow cover and climate-cryosphere interaction in Upper Chenab River Basin	P. G. Jose	08/2020–10/2023 Ongoing
2	Mass Balance of Phuche and Khardung glaciers, Ladakh Range with implications for downstream water availability under changing climate	P. G. Jose	07/2021-06/2024 Ongoing
3	Investigation of hydrodynamic approach of flood inundation mapping along with assessment of changes in river planforms using a cloud -based Google Earth Engine (GEE) computing platform in data-scarce Western Himalayan River basin	R. V. Kale	09/2021- 07/2024 Ongoing Transferred to SWD, NIH-HQ
4	Early Signatures of 21st Century on Snow Cover Dynamics in Zanskar River Basin, Ladakh	D. S. Bisht	07/2021–12/2023 Ongoing Transferred to C4S, NIH-HQ
5	Comparative analysis of fine-scale satellite & reanalysis precipitation products in UGB using Multi-Criterion Decision-Making	D. S. Bisht	06/2022–12/2023 Ongoing Transferred to C4S, NIH-HQ
CENTRAL INDIA HYDROLOGY REGIONAL CENTRE, BHOPAL			
1	Re-assessment of evapotranspiration (*ETo*) estimation for irrigation planning in Madhya Pradesh	Ravi Galkate	11/2021–10/2024 Ongoing
2	Water Availability Assessment for Project Formulation in Sub Basins of Ganga River in Madhya Pradesh	R. K. Jaiswal	11/2021–10/2024 Ongoing

3	Development of Reservoir Operation Plan under Climate Change Scenarios for Kolar Reservoir in Madhya Pradesh.	Shashi Indwar	10/2021–09/2024 Ongoing
DELTAIC REGIONAL CENTRE, KAKINADA			
1	Identification of Recharge and Discharge areas of Palar river basin in Tamil Nadu	V.S.Jeyakanthan	09/2021-03/2024 Completed
2	Impact assessment of backwater through drains, creeks and river mouths on groundwater salinity in the Godavari Delta, Andhra Pradesh	Y.R. Satyaji Rao	08/2022–07/2024 Ongoing
3	Storm water flood management in the coastal city - A case study	R. Venkata Ramana	04/2023–03/2025 Ongoing
4	Climate Change Impact Assessment under Future Scenarios over the East Coast of India: A focus on the Hydroclimatic Extremes	Sabyasachi Swain	04/2023–03/2025 Ongoing
5	Evaluation and post -processing of multi - model short -to-medium-range precipitation forecasts: Towards developing a flood early warning system over Subarnarekha Basin	Sabyasachi Swain	04/2023–03/2026 Ongoing
NORTH EASTERNREGIONAL CENTRE, GUWAHATI			
1	Short Term Flood Forecasting Using Bootstrap based Artificial Neural Networks within Beki River Basin, Assam	S. K. Sharma	07/2023–06/2024 Ongoing
2	Rainfall Induced Flood Hazard Risk Vulnerability Assessment in East Jaintia Hills, Meghalaya	S. K Sharma	06/2023–03/2025 Ongoing
3	Drought characterization and vulnerability assessment in Assam	W.R. Singh	07/2022-06/2024 Ongoing
4	Linear Hydrological routing using Satellite precipitation datasets for flood forecasting in parts of Brahmaputra Basin	S. Arora	10/2023–03/2025 Ongoing
5	Hydrodynamic modeling for riverbank protection- A case study	S. Barman	10/2023–03/2025 Ongoing
CENTRE FOR FLOOD MANAGEMENT STUDIES, PATNA			
1	Design flood estimation for small structures in the South Bihar area.	Pankaj Mani	04/2021-09/2023 Completed
2	Influence of Non -Stationarity on Flood Frequency of South-Bihar Region	Pravin R. Patil	05/2023-03/2025 Ongoing
3	Evaluation of hydrologic models for Gandak river basin	Suryansh Mandloi	05/2023-03/2025 Ongoing

APPENDIX-VIII

Sponsored Projects During 2023-24

(Completed and On-going)

S. No.	Title	Sponsoring Agency	PI	Duration & Status	Budget
INTERNATIONAL SPONSORED PROJECTS					
1	High performance Advanced Septic System for Villages and Roadside Restaurants	IC-IMPACT Canada	Y.R. Satyaji Rao	04/2018–06/2024 Ongoing	Nil
2	Groundwater Fluctuations and Conductivity Monitoring in Punjab - New Evidence of Groundwater Dynamics in Punjab from High Frequency GW Level and Salinity Measurements	BGS, UK	Gopal Krishan	12/2017-11/2024 On-going	39,300 pounds
3	Expansion of the Indo-German Competence Centre for Riverbank Filtration – CCRBF	Federal Min. of Education and Research, Germany	Gopal Krishan	07/2020-03/2024 Completed	Rs. 16.1 Lakh
NATIONAL SPONSORED PROJECTS					
1.	Innovation Centre for Eco-Prudent Wastewater Solution (IC-EcoWS)	DST, GoI	VC Goyal/ Omkar Singh	04/2019-08/2024 Ongoing	Rs. 510.00 Lakhs
2.	Irrigation Efficiency Improvement for Shah Nehar Medium Irrigation Project	NHP, MoJS	R. P. Pandey	01/2018-6/2024 Ongoing	Rs. 75 Lakhs
3.	DST NWO Consortia "Changing the Fate of the Hindon River by Evaluating the Impact of Agriculture on the Water Balance: Developing a Template for a Cleaner Ganga River"	DST, GoI	M. K. Sharma	11/2021-11/2026 Ongoing	Rs. 240 lakhs

4.	Anaerobic Co-digestion of Thermochemically Pretreated Organic Fraction of Municipal Solid Waste and Sewage Sludge: Effect on Process Performance and Microbial Community Development	DBT, GoI	V. K. Tyagi	04/2018-3/2023 Ongoing	Rs. 106 Lakhs
5.	Innovative Approach towards Enhancement of Bio-hydrogen and Bio-methanation in Two Stage Anaerobic Co-digestion of Municipal Solid Waste and Sewage Sludge by Hydrothermal Pretreatment	Tehri Hydro Development Corporation (THDC) India Ltd.	V. K. Tyagi	03/2024-3/2027 Ongoing	Rs. 98.50 Lakhs
6.	Development of Innovative Sewage Treatment Technology with Minimum Energy Requirement	Tehri Hydro Development Corporation (THDC) India Ltd.	V. K. Tyagi	03/2024–03/2027 Ongoing	Rs. 97.50 Lakhs
7.	Isotopic and Geochemical Approach to Study Vulnerable Confined and Unconfined Drinking Water Aquifers in Varanasi and Surrounding Area, India	BHU, Varanasi	Rajesh Singh S. P. Rai (BHU)	07/2021-06/2024 Ongoing	Rs. 10 Lakhs
8.	Comprehensive Characterization of Variably Processed Sewage Sludge in Ganga Basin to Classify its Suitability for Safe Disposal	CPCB and NMCG	V. K. Tyagi A. A. Kazmi (PI, IITR)	01/2022-06/2024 Ongoing	Rs. 58.11 Lakhs
9.	SARASWATI 2.0- Identifying Best Available Technologies for Decentralized Wastewater Treatment and Resources Recovery for India	DST, GoI	V. K. Tyagi A. A. Kazmi (PI, IITR)	03/2020-06/2024 Ongoing	Rs.160.77 Lakhs
10.	Operational coastal flood management through short-to-medium range (real-time) flood vulnerability mapping in the Brahmani-Baitarani River Basin integrating human and climate induced impacts	Funded under STARS by MoE (formerly MHRD), GoI.	B. Sahoo (PI, IIT-Kgp) R. V. Kale	07/2020–06/2024 Ongoing	Rs. 56.06 lakh (at IIT KgP)

11.	Land surface modelling and remote sensing based generation of evapotranspiration from land product	NICES, NRSC, Hyderabad	Arpit Choukey (PI) Richa Pandey, Vaibhav Garg	01/2024-06/2028 Ongoing	Rs. 85 lakh (IIRS, Dehradun)
12.	State Specific Action Plan (SSAP) for Water Sector for 16 States/UTs	National Water Mission (NWM), DoWR RD & GR, MoJS	Sanjay Kumar	02/12/2016-01/12/2024 ongoing	6.30 Crores
13.	Assessment of Seasonal Variations in Hydrology and Cryosphere of Upper Ganga	DST	Vishal Singh	04/2019-03/2023 Ongoing	Rs. 23.00 Lakh
14.	Long term hydrological assessment for the development of water security plan into three sub-basins namely Barak, Minor rivers draining into Bangladesh and Minor rivers draining into Myanmar subbasins in the state of Mizoram.	NHP	Vishal Singh	06/ 2021-05/2024 Ongoing	Rs. 25.23 Lakh
15.	Assessment of glacier-climate functional relationships across the Indian Himalayan region through long-term network observations	GBPNIHE	Vishal Singh	07/2023-07/2026 Ongoing	Rs. 9.24 Lakh
16.	Satellite based mountain hazard assessment and monitoring (MHAM) in Uttarakhand, joint with IIRS Dehradun	IIRS, Dehradun	Vishal Singh	06/2023-05/2024 Ongoing	Rs. 10.25 Lakh
17.	Hydrological Assessment of Ungauged Basins (Aghanashini, Dasanakatte, Sita Nadi, Madisala Hole, Swarna Nadi and Gurupur River Basins) of the West Flowing Rivers in the Western Ghat Region of Karnataka	NHP	Vishal Singh	02/2021-09/2024 Ongoing	Rs. 45.00 Lakhs
18.	Isotopic and Hydrogeochemical Characterization of Hot Springs of Uttarakhand Himalayas	Uttarakhand Council of Science and Technology, Uttarakhand (UCOST), Dehradun	S. S. Rawat	02/2024- 02/2026 Ongoing	6.00 Lakhs

19.	Integrated Management of Water Resources for Quantity and Quality in Upper Yamuna Basin up to Delhi	Special Study under "Centre of Excellence for Hydrological Modeling" (NHP)	Anupma Sharma	04/2018-03/2024 Completed	248.21 lakh
20.	Enhancing Food and Water Security in Arid Region through Improved Understanding of Quantity, Quality and Management of Blue, Green and Grey Water	DST (Water IC Project)	Anupma Sharma (NIH Lead) Nodal Institution: ICAR-CAZRI, Jodhpur	2/2019 – 7/2024 Ongoing	105.68 lakh (NIH component)
21.	Leachate Transport Modeling for Gazipur landfill site for suggesting ameliorative measures	NHP, DoWR, RD & GR	Anjali	11/ 2019-03/ 2024 Completed	76.10 lakh
22.	Partitioning ET into Evaporation and Transpiration fluxes using Stable Isotopes of Oxygen and Hydrogen	DST-SERB	Gopal Krishan	04/2021– 09/2024 Ongoing	71.83 Lakh
23.	Changing the fate of the Hindon river by evaluating the impact of agriculture on the water balance: Developing a template for a cleaner Ganga river	DST	Sudhir Kumar	04/2022-03/2022 Ongoing	2.4 Crores
24.	Snow and glacier contribution and impact of climate change in Teesta river basin in Eastern Himalaya	NMHS-MoEF	P. K. Singh	11/2019-03/2024 Completed	143 Lakhs
25	Development of Water Accounts for the different sub-basins of Brahmaputra and Barak river basins in the state of Meghalaya using WA+ Framework.	NHP	P. K. Singh	08/2020-03/2024 Completed	14.50 Lakhs
26.	Development of Water Accounts for the selected sub-basins of Brahmaputra, Barak and Irrawady-Chindwin in the state of Nagaland using Water Accounting Plus (WA+) Framework.	NHP	P.K. Mishra	04/2021- 03/2024 Completed	9.0 Lakhs

27.	Hydrological Assessment of ungauged basins (Aghanashini, Dasanakatte, Sita Nadi, Madisala Hole, Swarna Nadi and Gurupur River Basins) of the west flowing rivers in the western ghat region of Karnataka	NHP	P. K. Singh	04/2022-03/2025 on-going	54 Lakhs
28.	Monitoring and assessment of mountain ecosystem and services in north-west Himalaya (Phase-II): Monitoring and modeling of hydrological processes in glaciated and non-glaciated watersheds of north-west Himalaya	Dept. of Space	M. K. Nema	04/2022-03/2025 on-going	30.91 Lakhs
29.	Groundwater Model development in Micro Basin of Hard Rock in Krishna and Godavari River Basins of Telangana	Telangana state Ground Water Department (under NHP-PDS)	B. Venkatesh	09/2019- 08/2022 Draft report submitted	80 Lakhs
30.	Impact of Sand Mining on Groundwater Regime in Parts of Manjira River Basin, Telangana State	Telangana state GWD (under NHP-PDS)	M. K. Jose	04/2021-03/2023 Need an Extension Ongoing	46.44 Lakhs
31.	Comprehensive Assessment of Water Availability, Use and Issues for Goa State	Water Resources Department, Goa under NHP-PDS	B. Venkatesh	01/2022 - 12/2023 Need an Extension Ongoing	--
32.	Permafrost mapping and characterization of Western Himalayan Region	NMHS, MoEFCC, GoI	P. G. Jose	11/2019-03/2024 Ongoing	197.48 lakhs
33.	A Coupled Hydrodynamic and Bank Dynamic Modeling Approach for Forensic Analysis of Bankline Erosion Process Along Majuli Island-the Largest Inhabited River Island in the World	DST SERB	S. Barman	04/2021 - 03/2024 Completed	27.34 Lakhs
34.	Modeling and management of erosion and sedimentation processes in Gandak river using morphodynamic modeling	National Hydrology Project (NHP-PDS)	Pankaj Mani	5/2021-07/2024 ongoing	52.42 Lakhs

35.	Integrated Assessment of the Impacts of Climate Change and Land use Change on the Hydrology of the Narmada basin through Hydrological Modelling Approaches	NHP	T. Thomas	02/2018-03/2024 Completed	Rs 250 Lakhs
36.	Hydrological Modeling for Evaluation of Return Flow and Irrigation Planning for Optimal Utilization of Water Resources in the Command of Sanjay Sagar Project in Madhya Pradesh	NHP	R. K. Jaiswal	04/2019-03/2024 Completed	Rs. 64.36 Lakhs

APPENDIX-IX

Consultancy Projects During 2023-24

(Completed and On-going)

S. No.	Project Title	Sponsoring Agency	PI
PROJECTS COMPLETED			
1.	System Studies for Proposed Farakka – Sundarban Link Project	National Water Development Agency (NWDA), Bhubaneswar	Surjeet Singh
2.	Hydrological Study for Design of Drainage System for Safe Disposal of Upland Runoff Passing through New Kendriya Vidyalaya Campus, Bhimtal	CPWD, Haldwani	R. P. Pandey
3.	Hydrological Study for Water Availability Assessment in Sukhnai River and Runoff Diversion to Saprar Dam	Irrigation Construction Division, Mauranipur	R. P. Pandey
4.	Sampling/Analysis of Ground Water Samples for Confirming the Present Status of Petroleum Contamination at Akolner Village, Tal. & Dist. Ahmednagar, Maharashtra	MPCB, Nasik	M. K. Sharma
5.	Analysis of Water and Soil Samples for Major Ions, Trace Metals and Isotope Studies	Geosciences Consultancy Services, Roorkee	M. K. Sharma
6.	VOC Analysis for Water Samples	NEERI, Nagpur	M. K. Sharma
7.	Hydro-geological Study of Goindwal Sahib Area of Tarn Taran District, Punjab	GVK Power (Goindwal Sahib) Limited	Nitesh Patidar
8.	Hydro geological study for Harduaganj, 1x660 MW HTPS Distt Aligarh, UP	UPRVUNL, Aligarh	Sudhir Kumar
9.	Water logging issue in the villages surrounding the ash dyke area of APCPL, Jhajjar	APCPL, Jhajjar	Sudhir Kumar

10.	Review of hydro-geology to assess impact on surface water and ground regime (especially around ash dyke) and propose specific mitigation measures for NTPC, Khargone	NTPC, Khargone	S D Khobragade
11.	Study of Rainwater Harvesting Structure/Facilities/Systems at NTPC Jhanor-Gandhar	NTPC, Jhanor-Gandhar	S D Khobragade
12.	Study of Rainwater Harvesting Structure/Facilities/Systems at NTPC Kawas	NTPC, Kawas	S D Khobragade
13.	Study of Rainwater Harvesting Structure/Facilities/Systems at NTPC Anta	NTPC, Anta	S D Khobragade
14.	Hydrogeological Study to Assess the Impact of Dewatering on Groundwater and its Quality in the Nearby Areas of Rajpura Dariba Mine of Hindustan Zinc Limited	Euro Smile Facility Management pvt ltd for Hindustan Zinc Limited	Gopal Krishan
15.	Calculation of rainwater harvesting potential and performance of recharge wells	Sehgal Foundation	Gopal Krishan
16.	Rainwater harvesting potential assessment and design of rainwater harvesting structures/facilities /systems at NTPC Unchahar	NTPC, Unchahar	SM Pingale
17.	Rainwater harvesting potential assessment and design of rainwater harvesting structures/facilities /systems at NTPC Singrauli	NTPC, Singrauli	SM Pingale
18.	Rainwater harvesting potential assessment and design of rainwater harvesting structures/facilities /systems at NTPC Solapur	NTPC, Solapur	SM Pingale
19.	Development of rain water harvesting and recycling system at 250 MW Mandsaur Solar PV Project	NTPC, Mandsaur	SM Pingale
20.	Dam Break Analysis & Flooding simulation, Preparation of Inundation Maps and Emergency Action Plan for Vasna Barrage, Ahmedabad, Gujarat	Ahmedabad Municipal Corporation	A. K. Lohani

21.	Hydrological Studies of the Banganga river in view of the Proposed Diversion Weir and Link Channel to Baruwa Bandh	Irrigation Construction Division, Irrigation & Water Res. Dept. Govt. of Uttar Pradesh	A. K. Lohani
22.	Hydrological studies (including Design Flood Estimation, Water Availability, Sedimentation Studies & River diversion studies) in view of updation of Hydrological aspects of Kishau DPR	Kishau Corporation Limited	J. P. Patra
23	Study of Rainwater Harvesting Structure/Facilities/Systems at NTPC Lara	NTPC, Lara	T Thomas (via HID)
24.	Study of Rainwater Harvesting Structure/Facilities/Systems at NTPC Korba	NTPC, Korba	T Thomas (via HID)
25.	Study of Rainwater Harvesting Structure/Facilities/Systems at NTPC Sipat	NTPC, Sipat	T Thomas (via HID)
26.	Study of rainwater harvesting potential assessment and its review / design to increase the water positivity at Talaipalli coal mining project	National Thermal Power Corporation (NTPC) Coal Mining	Pankaj Mani
27.	Verification of Hydrology and Hydraulic Study for Watershed Development of Sabarmati River Banks with Waterbody near GIFT City Ta. & Distt. Gandhinagar	Executive Engineer Gandhinagar Irrigation Const. Division Gandhinagar	R. K. Jaiswal
28.	Dam break analysis and preparation of emergency action plan for Kanhar Dam	Executive Engineer, Kanhar Construction Division 3rd, Pipri, Sonbhadra (UP)	R. K. Jaiswal
PROJECTS ONGOING DURING 2023-24			
1.	Preparation of District Action Plans (DAPs) for the Priority Districts under the Jal Jeevan Mission, Uttarakhand	Jal Jeevan Mission, State Water and Sanitation Mission, Dehradun	R. P. Pandey
2.	Water Quality Studies for Tehri Reservoir Tehri HPP (4x250MW)	THDC India Limited	M. K. Sharma
3.	Hydrological Study for Safe Disposal of Upland Runoff and Design of Drainage System for Official and Residential Premises of CRPF Group Centre, Kathgodam	CPWD, Haldwani	R. P. Pandey

4.	Hydrological Study to Assess Groundwater Contamination in and Around Federal Mogul Goetze India Limited (Punjab)	Federal Mogul Goetze, Patiala, Punjab	Nitesh Patidar
5.	Sustainable Ground Water Management Plan for 04 Industrial Districts of Western UP	Invest UP, Lucknow	Sudhir Kumar
6.	Hydro Geological Study for Tanda Thermal Power Station Stage-II (2x660MW)	NTPC Tanda	Sudhir Kumar
7.	Pollution Source identification using stable isotopic studies in and around chemical division, Nagda, MP	NEERI Hyderabad	Sudhir Kumar
8.	Study of Rainwater harvesting potential assessment (RWH) and design of rainwater harvesting structures/facilities/systems/pits at NSPCL Rourkela	NSPCL Rourkela	S D Khobragade
9.	Review of Hydrogeology to assess Impact of NTPC Mouda on surface water and ground regime (especially around ash dyke St-I & II and propose specific measures	NTPC, Mouda	S D Khobragade
10.	Review of hydro-geology to assess impact on surface water and ground regime (especially around ash dyke) and propose specific mitigation measures for NTPC, Gadarwara	NTPC, Gadarwara	S D Khobragade
11.	Study of seasonal changes in the quality of Ujjani dam water and identifiation of sources of contamination w.r.t. increase in ionic concentration at Solapur STPP	NTPC, Solapur	S D Khobragade
12.	RWH Methodology & action plan Survey/Study Durgapur PP2	NSPCL Durgapur	SM Pingale
13.	Study of Rainwater Harvesting Structure/Facilities/Systems at NTPC Rihand	NTPC, Rihand	SM Pingale
14.	Hydrodynamic modelling of Krishna River to study backwater effect of Almatti dam and barrages in Karnatak State	Water Resources Department, Government of Maharashtra	A. K. Lohani
15.	Flood plain zone delineation from Unnao to Balia.	Irrigation & Water Resources department, UP	A. K. Lohani

16.	Flood plain zone delineation of River Ramganga from District Bijnor to Kannauj	Irrigation & Water Resources department, UP	A. K. Lohani
17.	Dam break analysis, preparation of inundation map and mitigation plan against downstream lives & properties for Vijayanagar PSP (130 MW) in Karnataka	JSW Renewable Energy (Vijayanagar) Ltd	A. K. Lohani
18.	Hydrological studies of the proposed Dhasan Weir in the Dhasan River	Irrigation & water Resources Department, UP	J.P Patra
19.	Hydrological Studies of the Proposed Balabehat Dam Project in Sounr River at Lalitpur, UP	Irrigation & water Resources department, UP	J.P Patra
20.	Hydrodynamic Mathematical Model Study of Water Channel & Ghats Near Vidur Kuti	Irrigation & water Resources department, UP	J.P Patra
21.	Dam break analysis of NHPC Ravi Basin projects Chamera-I, Chamera-II, Chamera-III and Baira Siul Power station	NHPC	A. K. Lohani
22.	Studies of Glacial Lake Outbrust Flood for Jyapee Vishnuprayag Hydro-Electric Plant	Jaiprakash Power Ventures Ltd.	A. K. Lohani
23.	Engineering Services for carrying out extreme value analysis and statistical analysis of latest meteorological data for Mahi Banswara Rajasthan Atomic Power Project (MBRAPP)- 1 to 4	Nuclear Power Corporation of India Limited, Mumbai	J.P.Patra
24.	Flood Review in Kali and Sharavathy river basin, Dam Break analysis, inundation mapping and preparation of Emergency Action Plan for Dams in Kali, Sharavathi and Varahi river basin	KPCL, Govt of Karnataka	B. Venkatesh
25.	Comprehensive Hydrological Analysis of Harangi Catchment	CNNL, Govt of Karnataka	B. Venkatesh
26.	Land use planning of Farakka Barrage Project (FBP) area-Land use mapping	Farakka Barrage Project (FBP)	Pankaj Mani

27.	Carrying Area drainage study using coupled 1-D&2-D hydrodynamic model in MIKE FLOOD software for proposed 2x700 MWe Kaiga-5&6 at Kaiga, Karnataka with additional survey data including (i) Drainage study around Kaiga-5&6 (ii) Inundation in downstream of Kadra Dam, and (iii) Area Drainage Study around OESC Building	Nuclear Power Corporation Ltd. Mumbai	Pankaj Mani
28.	Carrying out plant area drainage study for proposed Mahi-Banswara Rajasthan atomic power project	Nuclear Power Corporation Ltd. Mumbai	Pankaj Mani
29.	Dam break analysis and preparation of emergency action plan for Ravishankar Sagar Dam	Mahanadi Reservoir Project, Raipur	R. K. Jaiswal
30.	Dam break analysis and preparation of emergency action plan for Kosarted dam	Mahanadi Reservoir Project, Raipur	R. K. Jaiswal
31.	Dam break analysis and preparation of emergency action plan for Tandula dam	Mahanadi Godavari Basin, Raipur	R. K. Jaiswal
32.	Dam break analysis and preparation of emergency action plan for Sikasar dam	Mahanadi Godavari Basin, Raipur	R. K. Jaiswal
33.	Dam break analysis and preparation of emergency action plan for Minimata (Hasdeo) dam	Hasdeo Ganga Basin, WR Deptt, Ambikapur (C.G.)	R. K. Jaiswal
34.	Dam break analysis and preparation of emergency action plan for Maniyari dam	Hasdeo Basin W.R. Department, Bilaspur (Chhattisgarh)	R. K. Jaiswal
35.	Dam break analysis and preparation of emergency action plan for Shyam Ghunghutta dam	Hasdeo Ganga Basin Ambikapur, (Chhattisgarh)	R. K. Jaiswal
36.	Floodplain zoning of Narmada river in Madhya Pradesh	Narmada Valley Development Agency, Bhopal	R. K. Jaiswal
37.	Study of Rainwater Harvesting Structure/Facilities/Systems at NTPC Farrakka	NTPC, Farrakka	Pankaj Mani (via HID)
38.	Study of Rainwater Harvesting Structure/Facilities/Systems at NTPC Ramagundam	NTPC, Ramagundam	Y R S Rao (via HID)
39.	Development of Rain Water Harvesting and Recycling System at 50MW NTPC Rajgarh Solar PV Plant	NTPC, Rajgarh	T Thomas (via HID)

Technology Transfer Activities

APPENDIX-XI

S. No.	ACTIVITES	PERIOD	VENUE
	INTERNATIONAL ACTIVITIES		
1	International Conference on Alternative Fuels, Energy and Environment 2023 (ICAFEE 2023)	October 6-8, 2023	Erciyes University, Kayseri, Turkey
2	An event on "Enabling policymakers in facilitating water security and source sustainability throught creation of web GIS enable inventory of Himalayan Spring in UN COP 28	December 9, 2023	Dubai
3	HKH CryoHub workshop organized by ICIMOD throught online mode.	December 14-15, 2023	ICIMOD Nepal
4	Special Session on "Impact of Climate Change on the Water Resources System of the Indus Basin" during International Conference on "Future of Water Resources" organized by Deptt. of Water Resources Development and Management, IIT Roorkee and NIH Roorkee	January 19, 2024	NIH Roorkee
5	Training workshop on River bank Filtration and constructed wetlands- source sustainability, distribution network and decentralized waste water management"	March 3, 2024	NIH Roorkee
6	Special Session on IAHS HELPING Decade: Science for Solutions during Roorkee Water Conclave (RWC) – 2024	March 3, 2024	IIT Roorkee
7	Third edition of "Roorkee Water Conclave (RWC)– 2024", with the theme of 'Responsible Water Management & Circular Economy	March 4-6, 2024	IIT Roorkee, NIH Roorkee
	NATIONAL ACTIVITIES		
	SEMINARS/SYMPOSIA/CONFERENCES		
1	EO data analysis for Disaster management	July 12, 2023	ISI, Kolkata
2	Status of Traditional Water Resources (Springs) of Ravi River Catchment	October 20, 2023	Government Degree College, Chamba, Himachal Pradesh
3	National Conference on the Role of Science Engineering and Technology	November 3, 2023	TMU, Moradabad

TRAINING COURSES/WORKSHOPS/BRAINSTORMINGS			
1	Workshop on "Basic Hydrology-Measurement and Use of Hydrological Data"	April 11-13, 2023	Water Resources Department, Panaji, Goa
2	Second Training of Trainers Course on Usage and Applications of DSS(PM)	April 17 - 28, 2023	NIH, Roorkee
3	Training on "Consultation Workshop on Reservoir Bathymetry and Water Accounting in Irrigated Systems using Google Earth Engine (GEE)" jointly organized by NIH Roorkee and World Bank	April 24-May 03, 2023	NIH Roorkee
4	Consultants' workshop under NHP	April 29, 2023	Online
5	Training on "Hydrological Modelling" jointly organized by NERIWALM Tezpur & CFMS Patna	May 05-19, 2023	NERIWALM Tezpur
6	Training on "Use of Geospatial Technologies In Flood Management and Erosion Control" jointly organized by NIH Roorkee and NEHARI, Brahmaputra Board.	May 08-12, 2023	NEHARI, Guwahati
7	Internship training program on "Exposure to Various Research Activities of NIH Roorkee".	May 08-12, 2023	NIH, Roorkee
8	Brainstorming Workshop on "Development of Standard Operating Procedure (SOP) for Springshed Management"	May 15, 2023	NIH, Roorkee
9	Workshop on the State Specific Action Plan (SSAP) for all States/UTs coordinated by NIH under NWM.	May 17, 2023	New Delhi
10	Training course on "Hydrological Modelling using SWAT+".	May 22-27, 2023	NIH, Roorkee
11	Himalayan 1st FRESH WATER Workshop organized by IIT Roorkee and NIH Roorkee	June 6, 2023	IIT Roorkee
12	Training course on 'TUFLOW Hydraulic modelling: Flood Inundation modelling (1D, 2D & 3D) including Coastal and Urban floods, Sediment transport and Water quality'	June 26-28, 2023	NIH Roorkee
13	Orientation program on "Study of Various Possible Scenarios for Understanding the Long-term Effect of en-route Canal Irrigation for Proposed Mahanadi-Godavari Link"	June 30, 2023	NIH, Roorkee
14	Workshop on DSS(PM) Pilot Basin Applications for Maharashtra State WRD Officers	July 18, 2023	Online
15	Training program on "Watershed & Waterbodies Management" jointly organized by NIH, Roorkee and NEHARI, Guwahati.	August 21-25, 2023	NEHARI, Guwahati
16	Orientation program for newly appointed Scientists of NIH Roorkee	August 28-September 01, 2023	NIH, Roorkee
17	SSAP Inception workshop for J&K	September 9, 2023	IIT Jammu Hybrid Mode
18	Training on "Ground-Penetrating Radar (GPR)" through M/s Logis Geotech to the Scientists/Staff of NIH.	September 15, 2023	NIH Roorkee

19	Training on "Evapotranspiration (ET) & Eddy Covariance (EC) measurement instrument" through M/s LI-COR to the Scientists/Staff of NIH.	September 19, 2023	NIH Roorkee
20	Training course on Springshed Management	October 03-07, 2023	NEHARI, Brahmaputra Board, Guwahati
21	Training Course on Hydrological Modelling	October 9-13, 2023	NERIWALM, Assam
22	Training Course on "Application of Space Technology for Flood-relate Disaster Management Support" sponsored by ISRO	October 9-14, 2023	NIH Roorkee
23	Hydrological problem in the costal and deltaic region	October 31, 2023	RC-Kakinada
24	Workshop on 'Natural treatment systems: Understanding technology, economics, and decision criteria' and Project Review Meeting in association with IRMA, Anand	November 03-04, 2023	IRMA, Anand
25	Technical Session on "Latest Trends and Technologies in Geospatial Domain" by M/S Hexagon Geospatial (Intergraph – SG&I) through Online Mode	November 6, 2023	NIH Roorkee
26	Training program on 'Hydro-Meteorological Data Analysis for Climate Change Studies'	November 20-24, 2023	NIH Roorkee
27	Training program on "System modelling for the Proposed Mahanadi-Godavari Link"	December 4-8, 2023	NIH, Roorkee
28	Training program on "Basic Hydrology"	December 4-8, 2023	WRD Meghalaya
29	Hands-On Training of ICP-MS and GC-MS for Scientific Cadre Officials of CWC	December 11-15, 2023	NIH Roorkee
30	Urban Hydrological Studies of Pilot Area using Hydrological Instruments in Greater Hyderabad Municipal Corporation (GHMC) Area	December 14, 2023	I&CAD, Hyderabad
	Brainstorming Session on 'Vision for the NIH: 2023-24 & Beyond' on the 46th Foundation Day of NIH	December 15-16, 2023	NIH, Roorkee
31	National Workshop on "Risk Informed Dam Safety Management" Training Centre, Aam Bagh, Rishikesh, Uttarakhand	December 21-22, 2023	THDC-TAKSHASHILA, Rishikesh
32	Training course on Hydrological Modelling Using Soil and Water Assessment Tool (SWAT): Theory and Hands-on	December 29-30, 2023	NIH Roorkee
33	Hands-On Training of ICP-MS and GC-MS for Scientific Cadre Officials of CWC	January 08-12, 2024	NIH Roorkee
34	Training Course on "ArcGIS Enterprise Management" sponsored by World Bank	Jan 15-17, 2024	NIH Roorkee
35	Training course on Application of isotopes in water resources investigations and management	January 15-20, 2024	NIH, Roorkee
36	Workshop on "Basics of Hydrology and Importance of Water Resources Management in the Context of Sivagangai District"	January 19-20, 2024	Karaikudi Tamil Nadu

37	Training on 'Tools and Techniques for Springshed Management'	January 22-27, 2024	NIH Roorkee
38	Hands-On Training of ICP-MS and GC-MS for Scientific Cadre Officials of CWC	February 19-23, 2024	NIH Roorkee
39	Training on Cryosphere, Climate Change and Hazards (CCCH): Theory and Practice.	February 19-23, 2024	NIH-WHRC, Jammu.
40	Workshop on capacity building "Climate resilient hydrological systems in Uttarakhand"	March 1, 2024	Dehradun
41	Training on 'Greywater Management of Bihar State' in association with PSI, Dehradun and Aga Khan foundation, Patna	March 06-07, 2024	Hotel Crown Plaza, Patna
42	Training course on "Tools and techniques for hydrological investigations".	March 11-15, 2024	NIH Roorkee
43	Training course on "Hydrological Modelling using HEC-HMS"	March 11-15, 2024	CFMS NIH Patna
44	Training program on "Hydrological Modelling using HEC-HMS'	March 11-15, 2024	NIRD&PR, NERC Guwahati
45	Brainstorming on Mountain Hazards and Mitigation.	March 11, 2024.	NIH-WHRC, Jammu
46	SSAP Progress Review of 16 States/UTs under NWM	March 13, 2024	online mode
47	Training on "Hydrological Modelling on impact assessment related to mining activity" sposored by CMPDI.	March 18-22, 2024	NIH Roorkee
48	Workshop on capacity building "Climate resilient hydrological systems in Himachal Pradesh"	March 21, 2024	Shimla
49	Workshop on 'Preparation of district action plans for sustainability of drinking water sources in priority districts under Jal Jeevan Mission, Uttarakhand'	March 22, 2024	JJM-SWSM, Dehradun
50	Brainstorming session on "Efforts at local level to solve water and sanitation crisis"	March 22, 2024	CFMS Patna

OTHER ACTIVITIES

1	Water Quality Lab visit by Diploma students of Civil Engineering students, Andhra Polytechnic, Kakinada	June 26, 2023	RC-Kakinada
2	Training cum final presentation of the project entitled "Study of Various Possible Scenarios for Understanding the Long-term Effect of en-route Canal Irrigation for Proposed Mahanadi-Godavari Link" in the 2nd Meeting of Sub - Committee for "Comprehensive Evaluation and System Studies on Interlinking of Rivers", Chaired by Sh. A. B. Pandya, Secretary General, ICID and former Chairman, CWC.	June 30, 2023	NIH, Roorkee
3	Water Quality Lab visit by B.Tech. Civil Engineering students of Vishnu College, Bhimavaram and Aditya College, Surampalem	July 10, 2023	RC-Kakinada
4	Water Quality Lab visit by the Govt. Degree College Students (B.Sc.), Pithapuram	March 12, 2024	RC-Kakinada

APPENDIX-XII

Position of Staff

Group	Post	As On	
		31.03.2023	31.03.2024
A	Director	01	01
A	Scientist F	01	01
A	Scientist D	07	11
A	Scientist C	14	23
A	Senior Administrative Officer	01	-
A	Finance Officer	01	-
A	Scientist B	43	56
	Sub Total	**68**	**92**
B	Administrative Officer	01	01
B	Principal Research Assistant	08	08
B	Assistant Engineer	01	01
B	Section Officer	02	01
B	Private Secretary	05	05
B	Senior Research Assistant	08	04
B	Senior Technician	01	01
B	Senior Translation Officer	01	01
B	Asstt. Library& Information Officer	01	01
B	Library and Information Assistant	01	01
B	Research Assistant	07	08
B	Junior Engineer (Senior Grade)	02	02
B	Technician Grade-I	02	03
B	Assistant	04	05
B	Personal Assistant	04	02
B	Draughtsman Grade-I	01	01
B	Staff Car Driver Special Grade	01	01
	Sub-Total	**50**	**46**
C	Technician Grade-II	04	04
C	Stenographer	02	02
C	Upper Division Clerk	01	00
C	Receptionist	01	01
C	Technician Grade-III	04	02
C	Lower Division Clerk	07	07
C	Staff Car Driver Grade-I	03	02
C	Staff Car Diver Grade-II	01	00
C	Driver Ordinary grade	00	00
C	Multi-Tasking Staff	20	17
	Sub total	43	35
	GRAND TOTAL	**161**	**173**

List of Employees as on March 31, 2024

APPENDIX-XIII

S. No.	NAME	DIVISION / REGIONAL CENTRE
	DIRECTOR	
1.	Dr. M.K. Goel	Director
	SCIENTIST `G'	
1.	Dr. A.K. Lohani	Head, Surface Water Hydrology Division
2.	Dr. R.P. Pandey	Head, Environmental Hydrology Division
3.	Dr. Y R S Rao	Head, Deltaic Regional Centre, Kakinada
4.	Dr. S.V. Vijay Kumar	Head, North Eastern Regional Centre, Guwahati
5.	Dr. B. Venkatesh	Head, Deccan Hard Rock Regional Centre, Belagavi
6.	Dr. S.D. Khobragade	Head, Hydrological Investigations Division
7.	Er. Omkar Singh	Head, Technical Cell
8.	Dr. A.R. Senthil Kumar	Head, Water Resources Systems Divn.
9.	Dr. (Miss) Anupama Sharma	Head, Ground Water Hydrology Division
10.	Er. Pankaj Mani	Centre for Flood Management Studies (Ganga Basin), Patna
11.	Dr.Surjeet Singh	C4S
12.	Dr. M. Someswar Rao	Hydrological Investigations Division
	SCIENTIST 'F'	
1.	Dr. S.K. Singh	Surface Water Hydrology Division
2.	Dr.Puran Chandra Nayak	Surface Water Hydrology Division
3.	Dr. V.S. Jayakanthan	D.R.C. Kakinada
4.	Shri R. V. Galkate	Head, Central India Hydrology, RC, Bhopal
5.	Dr. Sanjay Kumar	Surface Water Hydrology Division
6.	Dr. (Mrs.) Archana Sarkar	Water Resources Systems Divn.
7.	Dr. T. Thomas	Central India Hydrology Regional Centre, Bhopal
8.	Dr. M.K. Sharma	Environmental Hydrology Division
9.	Dr.Soban Singh Rawat	Hydrological Investigations Division
10.	Dr. R.K. Jaiswal	Central India Hydrology Regional Centre, Bhopal
	SCIENTIST 'E'	
1.	Dr.Pottakkal George Jose	Western Himalayan Regional Centre, Jammu
2.	Er. R. Venkataraman	Deltaic Regional Centre, Kakinada
3.	Dr.Pushpendra Kumar Singh	Water Resources Systems Division
4.	Dr. L.N. Thakural	Water Resources System Division
5.	Dr.Ravindra Vitthal Kale	Surface Water Hydrology Division

6.	Dr. Pradeep Kumar	Environmental Hydrology Division
7.	Dr. (Mrs.) Jyoti P. Patil	Research Management and Outreach Division (posted at LCU, New Delhi)
8.	Er. Manish Kumar Nema	Water Resources Systems Division
9.	Er. Jagdish Prasad Patra	Surface Water Hydrology Division
10.	Dr.Sumant Kumar	Ground Water Hydrology Division
11.	Dr. Rajesh Singh	Environmental Hydrology Division
12.	Dr.Gopak Krishan	Hydrological Investigation Division
	SCIENTIST `D'	
1.	Dr. (Mrs.) Ashwini A. Ranade	Climate Hydrology Division
2.	Dr. (Mrs.) Shashi P. Induwar	Central India Hydrology Regional Centre, Bhopal
3.	Dr.Prabhash Kumar Mishra	Climate Hydrology Division
4.	Dr. Vinay Kumar Tyagi	Environmental Hydrology Division
5.	Dr. Sanjay Kumar Sharma	North Eastern Regional Centre, Guwahati
6.	Dr. Santosh Murlidhar Pingale	Hydrological Investigation Division
7.	Dr. (Ms.) Swapnali Barman	North Eastern Regional Centre, Guwahati
8.	Dr. Sunil Gurrapu	Climate Hydrology Division
9.	Dr. Vishal Singh	Climate Hydrology Division
10.	Dr. Tripti M.	Hydrological Investigation Division
11.	Dr. Prasanta Kumar Sahoo	Environmental Hydrology Division
12.	Dr. Surinaidu Lagudu	Ground Water Hydrology Division
13..	Dr. Lavkush Kumar Patel	Climate Hydrology Division
14.	Dr. Kapil Keserwani	C4S
	SCIENTIST `C'	
1.	Dr. Kalzang Chhoden	Environmental Hydrology Division
2.	Shri Abhilash R.	HRRC, Belagavi
3.	Dr. Pravin Rangarao Patil	CFMS, Patna
4.	Mrs. Anjali	Ground Water Hydrology Division/NMCG, New Delhi
5.	Shri Deepak Singh Bisht	Hydrological Investigation Division
6.	Shri Nitesh Patidar	Ground Water Hydrology Division
7.	Shri Waikhom Rahul Singh	North Eastern Regional Centre, Guwahati
8.	Dr. Sourabh Nema	NWRC, Jodhpur
9.	Dr. Shakti Suryawanshi	Environmental Hydrology Division
10.	Dr. Umesh Kumar Singh	Water Resources Systems Division
11.	Shri Shubham Shaurabh	CFMS, Patna
12.	Dr. Akshay Verma	Climate Hydrology Division
13.	Dr. Riyaj Ahmad Mir	WHRC, Jammu
14.	Dr. Kuldeep Sharma	Climate Hydrology Division
15.	Dr. Shiv Prasad Yellapu	DRC, Kakinada

16.	Dr. Ajit Kumar Behera	Ground Water Hydrology Division
17.	Shri Sukant Jain	Surface Water Hydrology Division
18.	Dr. Sushindra Kr. Gupta	Ground Water Hydrology Division
SCIENTIST `B'		
1.	Shri Suryansh Mandaloi	CFMS Patna
2.	Shri Ruchir Patidar	Hydrological Investigation Division
3.	Sh. Sachchidanand Singh	WHRC, Jammu
4.	Dr. Richa Pandey	Surface Water Hydrology Division
5.	Dr. Satendra Kumar	Ground Water Hydrology Division
6.	Dr. Ishan Sharma	WHRC, Jammu
7.	Shri Rajat Kumar	Climate Hydrology Division
8.	Dr. Shailendra Kumar Kumre	Environmental Hydrology Division
9.	Dr. Soumyaranjan Sahu	Surface Water Hydrology Division
10.	Shri Sudesh Kumar Chaudhary	NWRC Jodhpur
11.	Shri Pintu Kumar Gupta	Ground Water Hydrology Division
12.	Shri Siddharth Arora	NERC, Guwahati
13.	Mrs. Sushamita Wadde	HRRC, Belagavi
14.	Shri Harsh Upadhyay	Water Resources Systems Division
15.	Shri Chandra Prakash	Surface Water Hydrology Division
16.	Shri Dilip Barman	NWRC Jodhpur
17.	Shri Akshary Vyankat Dahiwala	NWRC Jodhpur
18.	Dr. Amit Pandey	Hydrological Investigations Division
19.	Shri Rajesh Ranjan	CFMS Patna
20.	Shri Malkhan Singh Jatav	NWRC Jodhpur
21.	Shri Minotshing Maza	CFMS, Patna
22.	Dr. N. Va radarajan	Deccan Hard Rock Regional, Belagavi
23.	Shri Rajeev Gupta	Hydrological Investigations Division
24.	Shri Om Prakash	Surface Water Hydrology Division
25.	Shri V.K. Agarwal	Hydrological Investigations Division
SENIOR ADMINISTRATIVE OFFICER		
1.		
FINANCE OFFICER		
2.		
ADMINISTRATIVE OFFICER		
1.	Smt. Madhu Suman Kuchhal	Admn. Section
ASSISTANT ENGINEER		
3.	Shri Mukesh Kumar Sharma	Maintenance Division

PRINCIPAL RESEARCH ASSISTANT		
1.	Shri JatinMahrotra	C4S
2.	Shri Rajesh Agarwal	Technical Cell
3.	Shri Atam Prakash	Centre for Flood Management Studies,(Ganga Basin), Patna
4.	Shri Drona Khurana	Hydrological Investigations Division
5.	Shri P.R.S. Rao	RC Belgavi
6.	Shri T.R. Sapra	Computer Centre
7.	Smt. Babita Sharma	Environmental Hydrology Division
8.	Shri Vishal Gupta	Hydrological Investigations Division
SENIOR RESEARCH ASSISTANT		
1.	Shri Ram Chander	Ground Water Hydrology Division
2.	Smt. Bina Prasad	Environmental Hydrology Division
3.	Shri Nageswara Rao Allaka	DRC Kakinada
4.	Sh. Madhusudan Thapliyal	Climate Hydrology Division.
SENIOR TECHNICIAN		
1.	Shri N K Lakhera	Ground Water Hydrology Division
TECHNICIAN GRADE II		
1.	Shri C S Chowhan	Ground Water Hydrology Division
2.	Shri Mahipal Singh	Remote Sensing Laboratory
3.	Shri Shyam Kumar	Maintenance Division (Electrical)
RESEARCH ASSISTANT		
1.	Shri Gaurav Kumar	Surface Water Hydrology Division
2.	Shri Hakim Singh Meena	NERC Guwahati
3.	Shri Gurpreet Singh	WHRC Jammu
4.	Shri Anil Kumar	DRC Kakinada
5.	Shri Rahul Kumar	CIHRC Bhopal
6.	Shri Asif	Water Resources Systems Division
7.	Shri Amit Sharma	HRRC Belagavi
8.	Shri Rajkumar Dewansi	Hydrological Investigations Division
ASSISTANT LIBRARY & INFORMATION OFFICER		
1.	Mrs. Charu Pandey	Library
LIBRARY & INFORMATION ASSISTANT		
1.	Rohit Negi	Library
JUNIOR ENGINEER (SENIOR GRADE)		
1.	Shri Sanjeev Kumar Satyarathi	Maintenance Division (Electrical)
2.	Shri Deepak Saha	Maintenance Division (Civil)
TECHNICIAN GRADE III		
1.	Shri Naresh Kumar Saini	Workshop
2.	Shri Ved Pal	Surface Water Hydrology Division

3.	Shri Pankaj Kumar	Workshop
4.	Shri Sandeep Kumar	Workshop
TECHNICIAN GRADE III		
1.	Shri Alok Kumar	Ground Water Hydrology Division
2.	Shri Amit Rawat	Water Quality Lab
DRAFTSMAN GRADE I		
1.	Shri G Babu	Deccan Hard Rock Regional Centre, Belagavi
SECTION OFFICER		
1.	Shri J.S. Bist	Procurement Section

PRIVATE SECRETARY		
1.	Shri Sandeep Kumar	Director's Office
2.	Shri Mahendra Singh	Finance Section
3.	Mrs. Nisha Kichlu	Ground Water Hydrology Division
4.	Smt. Kiran Ahuja	Water Resources Systems Division/Climate Change Hydrology
5.	Shri Pawan Kumar	Technical Cell
PERSONAL ASSISTANT		
1.	Shri Daulat Ram	Administration
2.	Shri Parmanand Rajak	Centre for Flood Management Studies (Ganga Basin), Patna
STENOGRAPHER		
1.	Shri Arun Kumar	Environmental Hydrology Division
2.	Mrs Priya Gandhi	Administration
ASSISTANT		
1.	Shri Naresh Kumar	Administration
2.	Mrs. Hansi	Finance Section
3.	Shri K.V.R. Vara Prasad	Deltaic Regional Centre, Kakinada
4.	Shri Praveen Kumar	Finance Section
5.	Shri S.R. Majaletti	Deccan Hard Rock Regional Centre, Belagavi
SENIOR TRANSLATION OFFICER		
1.	Shri Pradeep Kumar Uniyal	Hindi Cell
UPPER DIVISION CLERK		
1.		
LOWER DIVISION CLERK		
1.	Mrs. Neelam Bohra	Procurement Section
2.	Miss Kajal Pal	Bill Section
3.	Shri Pradeep Singh Panwar	Administration Section
4.	Shri Santosh Kumar	Finance Section
5.	Shri Jony Waker	Procurement Section

6.	Shri Ashis Kumar Banerjee	Bill Section
7.	Shri Subhash Chand	Administration Section
RECEIPTIONIST		
1.	Mrs. Seema Bhatia	Administration Section/Vigilance
DRIVER (SPECIAL GRADE)		
1.	Shri Kameshwar Tiwari	Vehicle Section
DRIVER GRADEI		
1.	Shri Naresh Kumar	Vehicle Section
2.	Shri Munasala Thrimurthulu	Vehicle Section
DRIVERS GRADEII		
DRIVERS ORDINARY GRADE		
MULTI TASKING STAFF (TECHNICAL)		
1.	Shri Ashok Kumar	Communication & Telephones
2.	Shri Dinesh Kumar	Soil Water Laboratory – Ground Water Hydrology Division
3.	Shri Iftkharul Hassan	Maintenance Division (Elect.)
4.	Shri Pradeep Kumar	Library/Information Section
5.	Shri Satya Prakash	Hydrological Instrumentation Laboratory – Hydrological Investigations Division
6.	Shri Jagdish Choudhary	Nuclear Hydrology Laboratory – Hydrological Investigations Division
7.	Shri Suraj Prakash Kotwal	Western Himalayan Regional Centre, Jammu
8.	Smt C. Ambica	Library/Information Section
MULTI-TASKING STAFF (MINISTERIAL)		
1.	Shri Chandra Prakash Sharma	Maintenance Civil (Guest House)
2.	Shri Sri Ram Prasad	Maintenance Civil (Guest House)
3.	Shri Biren Das	North Eastern Regional Centre, Guwahati
4.	Smt. Kiran	Administration Section
5.	Smt. Savitri Devi	Bill Section
MULTI-TASKING STAFF (WATCH & WARD)		
1.	Shri Padam Kumar Sharma	Security Cell
2.	Smt. Anita Dhyani	Hydrological Investigations Division
MULTI-TASKING STAFF(GARDENING)		
1.	Shri Bhagat Singh	Maintenance
MULTI-TASKING STAFF (CLEANING)		
1.	Shri Rajendra Kumar	Maintenance

Guidance of Doctoral and Masters Research

APPENDIX-XIV

S. No.	Supervisor	Title of the Ph.D./ M. Tech/M.Sc. Thesis	Scholar/ Department/University
PH.D. THESIS GUIDANCE (COMPLETED during 2023-24)			
1.	Dr. Y.R. Satyaji Rao	River water quantity and quality modelling under hydro-climatic and Eflow scenarios using process-based models	M. Satish Kumar Lab for Spatial Informatics Civil engineering Department International Institute of Information Technology Hyderabad
2.	Dr. Y.R. Satyaji Rao	Contaminant Transport and Designate Priority Areas for Groundwater Remediation	Kamalakanth Shahoo Water Resources Engineering Department of Civil Engineering IIT Delhi
3.	Dr.B.Venkatesh	Spatio-Temporal Assessment of Mapping of Droughts for Arid and Semi-Arid Regions of Northern Karnataka	Bharath A L, HRRC, NIH, Visvesvaraya Technological University, Belagavi
4.	Dr.B.Venkatesh	Impact of climate change on water availability in selected river basins of western ghats	Shilpa A Veerabhadrannavar, HRRC, NIH,Visvesvaraya Technological University, Belagavi
5.	Dr. Surjeet Singh	Modelling the Impacts of Urban Land Use Change on Surface Temperature and Water Resource for Future Water Sustainability in Raipur District, Chhattisgarh	Ms. Tanushri Jaiswal, Deptt. of Applied Geology, National Institute of Technology (NIT), Raipur, Chhattisgarh
6.	Dr. Surjeet Singh	Mapping of Ground Water Potential and Vulnerable Zones Using Indices and GIS-based MCDA Techniques	Mr. Anshu Gangwar, Institute of Agricultural Sciences, BHU, Varanasi
7.	Dr. Ravi Galkate	Assessment of regional drought characteristics under climate change conditions	Rabindranath Tagore University, Raisen, Bhopal
8.	Dr. T. Thomas	Climate Change Impact Assessments on the Vamsdhara river basin using Hydrological Modelling Approaches	Dr. Ritu Kumari Department of Farm Engineering, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.

9.	Dr. M. K. Sharma	Hydrochemical Study of Groundwater of Bemetara District in Chhattisgarh	Mr. Mohit Kunar, Deptt. of Zoology and Environmental Sciences, Gurukula Kangri (Deemed to be University), Haridwar
10.	Dr. Pradeep Kumar	Environmental flow assessment using habitat simulation modelling	Mr. Ashish Kumar, Department of Farm Engg. Institute of Agri. Sciences, Banaras Hindu University, Varanasi (U.P.)
11.	Dr. Gopal Krishan	Assessment of Spatial and Temporal distribution of groundwater level and groundwater quality of Ghazipur district, Uttar Pradesh	Mr. P. Yadav, Department of Agriculture and Farm Engineering, BHU. Varanasi
12.	Dr. Vinay Kumar Tyagi	Thermal Hydrolysis Pretreatment of Sewage Sludge.	Dr. Gowtham Balasundaram, Department of Civil Engineering, Indian Institute of Technology (IIT) Roorkee
PH.D. THESIS GUIDANCE (ONGOING DURING 2023-24)			
1	Dr. R. P. Pandey	Study of drought propagation and its effect on reservoir network in a Semi-arid River Basin of Peninsular India	Mr. Ajay Gupta, Department of Hydrology, Indian Institute of Technology Roorkee
2	Dr. R. P. Pandey	Study of long term changes in drought characteristics and changes in water demand in bundelkhad region	Mr. Manish Dwivedi, Sam Higginbottom University of Agriculture Technology & Sciences (HSUATS), Prayagraj
3	Dr. R. P. Pandey	Soil Conservation Services-Curve Number (SCS-CN) Technique and its Application in Drought Assessment	Mr. Damodar Sharma, Department of WRDM, IIT Roorkee
4	Dr. B.Venkatesh	Integrated Water Resources Management for Doni River Catchment	Vijay Vastrad,HRRC,NIH, Visvesvaraya Technological University, Belagavi
5	Dr. Purandara B. K.	Impact of Land use/Land cover changes on the sustainability of natural springs in parts of Western Ghats in India	Ujval N Utagi, HRRC, NIH, Visvesvaraya Technological University, Belagavi
6	Dr. Ravi Galkate	Assessment of climate change and its impacts on hydrology in Malwa region of MP	Ms. Archana Koushal Dept of SWCE, College of Agril. Engg. JNKVV, Jabalpur

7	Dr. Ravi Galkate	Prediction of drought through analyzing the climatic parameters in pre-monsoon season of Bundelkhand region	Sh, Vijay Shankar Yadav Department of Farm Engineering, Institute of Agricultural Sciences, BHU, Varanasi.
8	Dr. Archana Sarkar	Hydrological Modelling of Bisalpur Reservoir including Climate Change	Sanjay Kumar Agarwal, Dept. of Civil Engg, MNIT, Jaipur
9	Dr. Archana Sarkar	Impact of Climate Change on Water Resources of Banas River Basin, Rajasthan	Vineet Kumar Sharma, Dept. of Civil Engg, MNIT, Jaipur
10	Dr. M. K. Sharma	Study of System Characteristics of River Alaknanda, A tribuatry of River Ganga	Ms. Kunarka Bhanot, Deptt. of Chemistry, Gurukula Kangri (Deemed to be University), Haridwar
11	Dr. S. S. Rawat	Vulnerability assessment and hydro-geological investigations of selected Himalayan springs for sustaining local water demand in Devika-Birun catchment of J & K	Ms Anuradha, Dept. of Environmental Science, University of Jammu, UT of J&K
12	Dr. S. S. Rawat	Hydro-geo-Chemical and Isotopic Characterisation of Springs of Bhagirathi Valley of Uttarakhand.	Mr. Sumit Dept. of Geology, Hemvati Nandan Bahuguna Garhwal University (A Central University), Srinagar, Uttarakhand
13	Dr. S.S. Rawat	Hydro-geochemical and isotopic characterization for the development of rejuvenation protocols for Spring fed Henwal river in Garhwal Himalaya	Sh. Dharam Singh Meena Dept. of Zoology & Environmental Sciences, Gurukul Kangari Deemed to be University, Haridwar, Uttarakhand
14	Dr. R. K. Jaiswal	Assessing Climate change vulnerability using SWAT and CORODEX Projection under RCP4.5 and RCP8.5 Scenario: A Case study of Bah River, India.	Mr. Sohrat Ali, Dept. of Civil Engineering, Central University, Ranchi
15	Dr. R. K. Jaiswal	Development of Optimal Water Resources Utilization Plan Under Climate Change for Parbati Reservoir Project	Mr. Abhishek Agrawal, Maharana Pratap University, Udaipur
16	Dr. R. K. Jaiswal	Irrigation water requirements under climate change and development of mitigation strategies for the future.	Ms. Pushpajali Deptt. of Civil Engineering, Central University, Ranchi

17	Dr. R. K. Jaiswal	Studies on Climate Change Pattern for Ravishankar Sagar Reservoir Using Mike Hydro Basin Model	Ms. Gunja Dhruv Indira Gandhi Krishi Vishwavidyalaya, Raipur
18	Dr. R. K. Jaiswal	Development of Framework for Flood-Risk Assessment and Management of Downstream area of Ravishankar Sagar Reservoir under Climate Change Scenario	Sh. Bhupendra Dhankar Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.)
19	Dr. Mathew K Jose	Environmental significance of conjunctive use of water in irrigation command	Ranjeet Satish Sabal, HRRC, NIH, Visvesvaraya Technological University, Belagavi
20	Dr. Manish K. Nema	Comprehensive Water Resources Vulnerability Assessment under the Changing Climate in a River Basin	Mr. Abhishek Gupta Dept. of Water Resources Development and Management IIT Roorkee (UK)
21	Dr. Manish K. Nema	Assessment and Monitoring of Agricultural Drought Using Fine-scaled Satellite-Based Soil Moisture	Ms. Harshita Rani Ahirwar Institute of Agri. Sciences, BHU, Varanasi (UP)
22	Dr. Ravindra V. Kale Scientist E	Operational Coastal Flood Management in The Brahmani-Baitarani River Basin (Tentative)	Mr. Ashrumochan Mohanty Research Scholar School of Water Resources Indian Institute of Technology Kharagpur West Bengal – 721302
23	Dr. Ravindra V. Kale Scientist E	Integrated mHM Model based modeling framework for flood hazard assessment in Transboundary of Rapti River Basin under changing Climate" (Tentative)	Mr. Ankur Kumar, Research Scholar Department of Civil Engineering, Madan Mohan Malviya University of Technology, Gorakhpur, UP
24	Dr. Pradeep Kumar	Simulation of point and non-point source pollution processes	Mr. Shams Quamar, Department of Water Engineering and Management, School of Engineering and Technology, Central University of Jharkhand, Ranchi
25	Dr. Pradeep Kumar	Assessment of Change in Hydrological Response due to Forest Fires in Madhya Pradesh	Ms. Deepa Sahu, Department of Soil and Water Engg., Swami Vivekananda College of Agricultural Engineering & Technology and Research Station, Faculty of Agricultural Engineering, Indira Gandhi Krishi Vishwavidyalaya, Raipur

26	Dr. Pradeep Kumar	Habitat Ecological Modelling of Himalayan Mahseer (Tor Species) in Upper Ganga Basin	Mr. Arvind Kumar Sharma, Department of Zoology and Environmental Sciences, Gurukula Kangri Vishwavidyalaya (Deemed to be University), Haridwar
27	Dr. Pradeep Kumar	Environmental Flow Assessment through Perception Analyses of Riparian Communities – A Case of Narmada Valley Dam Project	Mr. Govind M. P., Department of Environmental Planning, School of Planning and Architecture, Bhopal
28	Dr. Sumant Kumar	Replenishing Underground Reservoirs through Recharge Structure by Utilizing Surface Runoff in Eastern Part of India	Ms. Vijeta Singh, Department of Soil and Water Conservation Engineering, Vaugh Institute Of Agricultural Engineering And Technology, Sam Higginbottom University Of Agriculture, Technology And Sciences, Prayagraj, UP
29	Dr. Sumant Kumar	Arsenic content in groundwater and its impact on soil of the Indo-Gangetic plain of Varanasi and its adjoining district, U.P	Mr. Manish Kumar, Department of Farm Engineering, Institute of Agriculture Science, Banaras Hindu University, Varana si
30	Dr. Rajesh Singh	Source identification of trace toxic metals in the groundwater of Bathinda district and its mitigative measures	Kaptan Singh, Department of Civil Engineering Madan Mohan Malaviya University of Technology, Gorakhpur (U.P.).
31	Dr. Rajesh Singh	Eco-physiological studies of Arsenic transforming microbes in groundwater aquifers of Haridwar region for potential mitigation strategies	School of Health Science and Technology, University of Petroleum and Energy Studies (UPES), Dehradun
32	Dr. Jose George Pottakkal	Assessment of hydrological and geochemical status of springs of district Kangra, Himachal Pradesh	Ms. Shikha Rawal, Dept. of Environmental Sciences, Central University of HP, Dharamshala
33	Dr. Gopal Krishan	Investigation of groundwater potential of dolomite rock in Lesser Himalaya of Nepal, Kushma-Syanja area	Mr. Gunanidhi Pokhrel, Department of Geology, Institute of Science and Technology, Tribhuvan University, Kirtipur Kathmandu, Nepal
34	Dr. Gopal Krishan	Hydrogeological and isotopic studies of groundwater in Doodhganga watershed	Ms. Tanzeel Khan, Department of Soil and Water Engineering SKUAST-Kashmir

35	Dr. Gopal Krishan	Geochemical and Geophysical Studies of Springs in Kalsi Tehsil of Dehradun, Uttarakhand, India	Mr. Praveen Kumar, Department of Earth Sciences, IIT-Roorkee
36	Mrs. Shashi Poonam Indwar,	Modelling and Development of Reservoir Operation Policy under Climate Change for a Multi-Purpose Water Resource Project in Madhya Pradesh.	Rabindranath Tagore University, Raisen, Bhopal
37	Dr. P. K. Mishra	Urban Water Management Considering Water Harvesting And Climate Change	Ms. Sakshi Gupta Dept. of Water Resources Development and Management IIT Roorkee (UK)
38	Dr. P. K. Mishra	GEE-based Land And Water Productivity Assessment Using Open-Access Data	Ms. Nishtha Sharnagat Department of Farm Engineering Institute of Agricultural Sciences, BHU, Varanasi (UP)
39	Dr. P. K. Mishra	Sustainable Water Resources Management Under Climate Change	Mr. Sarthak Sahoo, School of Civil Engineering KIIT, Bhubaneswar (OD)
40	Dr. Vishal Singh	Effect of glacier changes on different runoff components under varying characteristics in Himalayan basins	Mr. Japjeet Singh, Dept. of Civil Engineering, IIT Roorkee
41	Dr. Vishal Singh	Improving the hydrological modeling framework in the Himalayan region under climate change	Mr. V. Saran Raaj, School of Civil Engineering, IIT Mandi
42	Dr. Vishal Singh	Himalayan Freshwaters: Assessing the Services and Vulnerability of Freshwater Ecosystems in the Himalayas	Miss. Anusha Dept. of Hydrology, IIT Roorkee
43	Dr. SM Pingale	Groundwater management in changing climate	Sourav Chaudhary, Water Resources Development and Management, IIT Roorkee
44	Dr. SM Pingale	An integration of multiple hydro-meteorological variables for a comprehensive drought characterization in the changing climate	Ruchir Patidar, Water Resources Development and Management, IIT Roorkee
45	Dr. Swapnali Barman,	Hydro-geomorphic Impacts of Panyor Lower Hydro Power Station in the Ranganadi Watershed	Ms. Rudrakshi Gogoi Cotton University Panbazar, Guwahati – 781001, Assam, India

46	Dr. Vinay Kumar Tyagi	Anaerobic Co-Digestion Of Thermo-Chemically Pretreated Wheat Straw With Food Waste And Cow Manure For Enhanced Bio-Methane Production	Mr. Ali Mohammad Rahmani, Department of Civil Engineering, Indian Institute of Technology (IIT) Roorkee
47	Dr. Vinay Kumar Tyagi	Quality assessment of mined MSW from an open dumpsite for Leachate treatment and recycling potential	Mr. Mandeep Singh, Department of Civil Engineering, Indian Institute of Technology Roorkee
48	Dr. Vinay Kumar Tyagi	Wastewater Treatment by Hybrid Anaerobic Baffled and Aerobic Reactor	Mr. Anurag Tomar, Department of Civil Engineering, Indian Institute of Technology Roorkee
49	Dr. Vinay Kumar Tyagi	Hydrogen Recovery from Organic Fraction of Municipal Solid Waste	Mr. Hassan Mohammed, Department of Civil Engineering, Indian Institute of Technology Roorkee
50	Dr. Vinay Kumar Tyagi	DBPs in STPs and WTPs and their toxic effects	Mr. Mohammad Shakib, Department of Civil Engineering, Indian Institute of Technology Roorkee
M.E./M.TECH./M.Sc. THESIS GUIDANCE (COMPLETED IN 2023-24)			
1	Dr. Anupma Sharma	Modelling of Soil Water Movement in Agricultural Field	Ms. Akanksha Sharma, Department of Farm Engineering, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.
2	Dr. T. Thomas	Evaluation of Changing Rainfall Characteristics of Odisha State	Ms. Aishwarya Man Singh, Department of Farm Engineering, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.
3	Dr. Ravi Galkate	Planning of irrigation scheduling for dry and wet years in Upper Ganga Canal Command Area, Uttar Pradesh	Sh. Jageshvar Prasad Department of Farm Engineering, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.
4	Dr. M. K. Sharma	Cloning, expression, purification and in-silico analysis of enzyme arsenite oxidase (homologue) from Comamonas testosteroni KF1	Ms. Astha Bisht, M. Sc., Department of Bioscience and Biotechnology, Banasthali Vidyapith, Jaipur, Rajasthan

5	Dr. R. K. Jaiswal	Estimation of Probable Maximum Precipitation in Sindh Basin under Projected Climate Change Scenario	Mr. Shringar Mishra Department of Farm Engineering/Banaras Hindu University Varanasi
6	Dr. Manish K. Nema	Analysis of The Spatio-Temporal Fluctuation in Storage Capacity of The Hirakud Reservoir using Google Earth Engine	Mr. Abhishek Thakur Dept. of Water Resources Development and Management, IIT Roorkee
7	Dr. Pradeep Kumar	Water Quality characterization and Assessment of pollutant load in Song River, Dehradun	Mr. Khude Raju Gangaram, Department of Farm Engg. Institute of Agri. Sciences, Banaras Hindu University, Varanasi (U.P.)
8	Dr. Rajesh Singh	Isolation and Characterization of Bacteria in Arsenic-Rich Aquifer	Ms. Aayushi Mittal, Department of Microbiology, Gurukul Kangri (Deemed to be University), Haridwar
9	Dr. Rajesh Singh	Performance evaluation of constructed wetland	Ms. Priya, Department of Allied Sciences (Chemistry), Graphic Era (Deemed to be University), Dehradun
10	Dr. Rajesh Singh	Geochemical evaluation of groundwater of Laksar	Ms. Priya Dimri, Department of Allied Sciences (Chemistry), Graphic Era (Deemed to be University), Dehradun
11	Dr. Gopal Krishan	Studies of ET changes using isotopes	Ms Nikita Saini Department of physics Gurukul Kangri Vishvavidyalaya, Haridwar
12	Dr. Gopal Krishan	ET partitioning using isotopes under controlled conditions	Ms Himanshi Department of physics Gurukul Kangri Vishvavidyalaya, Haridwar
13	Dr. Gopal Krishan	Precipitation source identification using isotopes at Roorkee	Ms Deepika S Department of Geology Anna University, Chennai
14	Dr. Vinay Kumar Tyagi	Effect of thermal pretreatment of sewage sludge for enhancing biogas generation.	Ms. Priyanshi Modi, Devi Ahilya University, Indore (MP).
15	Dr. Vinay Kumar Tyagi	Biomethanation of Thermal Pretreated Organic fraction of municipal solid waste and sewage sludge.	Mr. Rahul Sharma, Department of Civil Engineering, IIT-Roorkee

16	Dr. S. K. Sharma	Hydrological Modelling using SWAT analysis for Beki River Basin	Mr. Jyotirman Bordoloi, NERIWALM, Tezpur
17	Dr. S. Barman	Hydrological Analysis of Pagladiya River Basin	Ms. Himadri Baruah NERIWALM, Tezpur
18	Dr. Sunil Gurrapu	Application of VIC 4.2.d Macroscale Hydrological Modelling to simulate the streamflow and study the model performance for a Pennar River basin in India	Mr. Darshan M Department of Farm Engineering Institute of Agricultural Sciences, BHU, Varanasi Uttar Pradesh
19	Dr. D. S. Bisht,	Delineating Watershed Dynamics through GIS-based Morphometric Analysis: A Case Study of the Ramnagar Khad Watershed, Tawi River Basin	Ms. Avantika Sharma Integrated M.Sc. in Geology Cluster University of Jammu
20	Dr. D. S. Bisht,	Unveiling the Terrain Signature of the Duddar Basin: A Geospatial Exploration using Morphometric Analysis	Ms. Kritica Sharma Integrated M.Sc. in Geology Cluster University of Jammu
21	Dr. Nitesh Patidar	Site suitability mapping for MAR using a web based tool: G- MCDA	MS. Subadharani R Anna University, Chennai, Tamil Nadu
22	Sh. W.R. Singh	Hydrological Modelling of Puthimari River Basin Using HEC-HMS	Ms. Nayana Borah, NERIWALM, Tezpur
M.E./M.TECH./M.Sc. THESIS GUIDANCE (ONGOING IN 2023-24)			
1	Dr P C Nayak,	Hydrological Modeling Using NAM, AWBM, SACRAMENTO and Various rainfall -runoff Models	Mr Adarsh Kumar, Department of Civil Engineering, NIT Kurukshetra
2	Dr. R. K. Jaiswal	Estimation of Probable Maximum Precipitation for Upper Narmada Basin under Projected Climat e Scenario	Mr. Yashwant Josi Indira Gandhi Krishi Vishwavidyalaya, Raipur
3	Dr. R. K. Jaiswal	Assessment of Water Availability in Ravishankar Sagar Reservoir under Climate Change Scenario	Ms. Preeti Varma Indira Gandhi Krishi Vishwavidyalaya, Raipur
4	Dr. R. K. Jaiswal	Assessment of Climate Change Impact on Water Availability in Narmada Basin (Madhya Pradesh)	Ms. Pratiksha Paraste Department of Farm Engineering/Banaras Hindu University Varanasi

5	Dr. Manish K. Nema	Assessment of the effects of land use land cover changes on hydrology in Wainganga river basin, India	Ms. Purneemaa R S Dept. of Geoinformatics, Bharathidasan University, Tiruchirappalli (TN)
6	Dr. Manish K. Nema	Quantative assessment of soil loss as a ecosystem service for Wain Ganga Basin using invest model	Ms. Deepika Kapri School of Environment & Natural Resources, Doon University, Dehradun (UK)
7	Dr. Ravindra V. Kale	A multivariable calibration of multivariable SWAT model (Case study: Sabarmati basin, Gujarat)	Mr. Vivek N Shaji, Environmental sciences, Central University of Gujarat
8	Dr. Rajesh Singh and Dr. P. K. Sahoo	Phytoaccumulation of arsenic in contaminated waters of luxor and haridwar by pistia stratiotes (water lettuce) and azolla pinnata (mosquito fern)	Ms. Nidhi Paliwal, Department of Ecology & Environmental Sciences, School of Life Sciences Pondicherry University, Puducherry
9	Dr. Rajesh Singh and Dr. P. K. Sahoo	Antibacterial activity of ZnS based composite material towards application in waste water material	Ms. Saliha Parveen, Department of Microbiology, Chaman Lal Mahavidhyalay, HNB Garhwal University, Uttarakhand
10	Dr. P. K. Mishra	Hydrological Modelling Of Urban Flood Using EPA SWMM: A Case Study Of Bhopal, India	Ms. Eti Khatri Dept. of Water Resources Development and Management, IIT Roorkee
11	Dr. Sunil Gurrapu	Evaluation of the influence of changing climate and LULC on Hydrology of the Pennar River Basin, India	Mr Nandu Department of Farm Engineering Institute of Agricultural Sciences, BHU, Varanasi, UP
12	Dr. Vishal Singh	Study of Assessment of Water Availability in Kali River Basin, Western Himalaya using SWAT Model	Miss. Disha Yadav Department of Environmental Sciences, CSJM University Kanpur
13	Dr. Vinay Kumar Tyagi	Anaerobic Digestate liquid fraction treatment	Mr. Ohm, Department of Civil Engineering, Indian Institute of Technology Roorkee

Awareness Activities

APPENDIX-XV

S. No.	Activity	Date	Venue
Activities organized under Swachh Bharat Mission (Swachhta Hi Sewa & Swachhta Pakhwada)			
1.	Cleanliness drive organized under "Swachhata Hi Sewa"	15-09-2023 to 31-09-2023	Irrigation & Flood Control Division, Satwari Cantt. Jammu
2.	Cleanliness drive conducted under "Swachhata Hi Sewa" (SHS) campaign.	21-09-2023	Govt. School Bochachak, Phulwari Sharif, Patna
3.	Cleanliness & Awareness Program under "swachhta hi sewa" campaign	22-09-2023	Kerva Dam, Bhopal
4.	Cleanliness cum Mass Awareness Campaign at Kaylana Lake Front, Jodhpur under SHS 2023 conducted by NWRC, NIH Jodhpur	25.09.2023	Kaylana Lake front Jodhpur, Rajasthan
5.	Swachchata Pakhwada	26-09-2023	GGC English Medium School, Tilakwadi, Belagavi
6.	Swachhta Hi sewa, Garbage Free India	29-09-2023	Basistha Mandir, Guwahati
7.	Awareness campaign organized under "Swachh Hi Sewa"-2023 campaign	01-10-2023	Narayan Ghat to Solani Park, Roorkee
8.	Mass awareness & IEC activities, like speeches, painting competition & and compost pit with security fence made for the school's mid-day meal kitchen under "Swachhata Hi Sewa"-2023 Special Campaign 3.0	02-10-2023 to 31-10-2023	Government Boys High School, Jammu Cantt. Satwari, Jammu
9.	Cleanliness Drive under SHS 3.0 special campaign at NWRC office premise at Jodhpur	04.10.2023	NWRC office, Shastri Nagar
10.	Cleanliness & Awareness Program under "swachhta hi sewa" campaign	06-10-2023	Shapura Lake, Bhopal
11.	Cleanliness Drive under SHS 3.0 special campaign at Shastri Circle Jodhpur	11.10.2023	Shastri Circle Park, Jodhpur
12.	Cleanliness drive	16-10-2023	ML Bharatesh Polytechnic, Nilaji, Mutaga village, Belagavi

13.	Awareness activity for school students of DAV Public School, WALMI Patna under theme "Sanitation as everyone's responsibility" during Swachhata Hi Sewa (SHS) main campaign	16-10-2023	CFMS, NIH Patna
14.	Mass Awareness program under Swacchta hi Sewa Campaign on the theme "Creating wealth from waste"	17-10-2023	Guwahati
15.	SHS Cleanliness cum Mass Awareness Program under SHS 3.0 special campaign	18.10.2023	Govt. Higher Secondary School, Vishisth Poorv, Jodhpur
16.	Drawing and debate competition during a mobilization program on "Best practices for garbage free India" under special campaign 3.0 (SHS-2023)	19-10-2023	Kaushik Public School, Imli Kheda, Roorkee
17.	Swachh Bharat Abhiyan	20-10-2023	Tilakwadi Garden, Belagavi
18.	Cleanliness & Awareness Program under "swachhta hi sewa" campaign	20-10-2023	Sairsapata tourist spot on Bhopal lake, Bhopal
19.	Cleanliness Drive under SHS 3.0 special campaign	25.10.2023	Shani Mandir, Shastri Nagar, Jodhpur
20.	Cleanliness drive	27-10-2023	HRRC office campus, Belagavi
21.	Swachh Bharat Abhiyan	30-10-2023	Shivraj Gov.School, Old Age Home, Benkanahalli, Belagavi
22.	Various "Swachhat Hi Sewa"-2023 activities	31-10-2023	At Various Locations in the Kakinada City
23.	Cleanliness drive has been conducted under "Swachhata Hi Sewa" (SHS) main campaign	31-10-2023	Canal Ghat, near Khagaul, Patna
24.	Cleanliness & Awareness Program under "swachhta hi sewa" campaign in the Labs and library of NIH and WALMI	31-10-2023	NIH and WALMI campus, Bhopal
25.	One-day Cleanliness Drive under SHS 3.0 special campaign	31.10.2023	Shaheed Bhagat Singh Park, Jodhpur
26.	Mass Awareness Program on "Water Conservation and Water Security"	06.11.2023	Bal Mandir Public School, Jodhpur
27.	Mass awareness programme on the topic "Rainfall Measurements and Conservation Methods"	22-02-2024	ASD Govt. Degree College for Women, Kakinada
28.	Mass awareness activity on "Water Security" for the youths, children and village women under the "Swachhta hi Sewa" campaign.	04-03-2024	Rangia, Assam

29.	One-day mass awareness & cleanliness drive program on "management of water Scarcity in Kandi belt - Our Responsibility"	14-03-2024	Khu Talab, Suchani Village, Samba District, Jammu
30.	Swachhta Pakhwada	15-03-2024 to 31-03-2024	National Institute of Hydrology and nearby areas (villages, schools, colleges, public ghats, etc.)
31.	Swachhata Pakwada activities	16-03-2024 to 31-03-2024	At Various Locations in the Kakinada City
32.	Awareness workshop on "Swachhata Pakhwada-2024"	19-03-2024	Village Mehvad Kala, Roorkee
33.	Follow-up compost pit program and cleanliness drive organized under "Swachhata Pakhwada"	19-03-2024	Government Boys High School, Jammu Cantt. Satwari, Jammu
34.	Cleanliness drive and awareness program conducted under 'Swachhta Pakhwara' 2024	19-03-2024	Kaliasot Dam, Bhopal
35.	Mass Awareness & IEC activities like painting competition done under Swachhata Pakhwada in 16-31 March 2024	20-03-2024	Government model middle school, Satwari, Jammu, J&K
36.	Plantation at CFMS Patna under "Swacchata Pakhwara"	21-03-2024	CFMS, NIH Patna
37.	Cleanliness drive and awareness program conducted under 'Swachhta Pakhwara' 2024	22-03-2024	Kerwa Dam, Bhopal
38.	Awareness activity under which speech competition on "Swaccha Bharat and Urban Challenges" for students of DAV WALMI Public School, Phulwarisharif held at CFMS NIH Patna under "Swacchata Pakhwara"	22-03-2024	CFMS, NIH Patna
39.	Drawing competition for students of Govt. High School Phulwari sharif held at CFMS NIH Patna under "Swacchata Pakhwara"	22-03-2024	CFMS, NIH Patna
40.	Swachchata Pakhwada	26-03-2024	Shantiniketan Public School, Khanapur, Belagavi
41.	Mass awareness program on "Swacctha Pakhwada 2024" Cleaning drive	27-03-2024	NERC Office, Guwahati
42.	Awareness Workshop on "Sustainable Environment"	27-03-2024	Rashtriya Inter College, Village Bhalaswagaj, Block Bhagwanpur, Roorkee

43.	Workshop for Women on theme "नारी शक्ति स्वच्छता का प्रयास, हम सब मिलकर करेंगे देश का विकास" during Swachhata Pakwada-2024	28-03-2024	NIH, Roorkee
Activities organized on World Water Day			
1.	Technical discussion event & cleanliness drive organized on the occasion of "World Water Day – 2024", on the theme "Management of Water Scarcity in Kandi Belt"	22-03-2024	Irrigation & Flood Control Complex, Satwari Cantt. Jammu, J&K
2.	Drawing Competition with theme on "Cleanliness and Hygiene" on occasion of World Water Day	22-03-2024	Kerakuchi, Guwahati
3.	Mass Awareness Program conducted on the occasion of "World Water Day" at Jodhpur	22.03.2024	Govt. Girls Higher Secondary School, Shastri Nagar Jodhpur
Participation in Exhibitions			
1.	Mega Expo - "उज्ज्वल राजस्थान आत्मनिर्भर भारत की ओर"	27.07.2023 to 29.07.2023	Udaipur, Rajasthan
Other activities			
1.	Mass awareness activity on "जल संरक्षण जागरूकता और शिक्षा was organized for Students of Government Degree College Mangalore, Haridwar.	31.05.2023	NIH, Roorkee
2.	Mass awareness activity on Status of Traditional Water Resources (Springs) of Ravi River Catchment	20.10.2023	Govt. Degree College, Chamba, Himachal Pradesh
3.	Vigilance Awareness Week with a theme "Say no to corruption; commit to the Nation"	31-10-2023 to 05-11-2023	CFMS, NIH Patna
4.	Mass awareness on World Wetlands Day on the theme 'Wetlands and Human Wellbeing'	02-02-2024	NEC, NIH Guwahati (virtual mode)
5.	Mass awareness activity on Water Conservation and water security	06.02.2024	Govt. Junior High School, Khatakheri, Iqbalpur, Roorkee
6.	Mass awareness program on "Groundwater Conservation and its Importance"	28-02-2024	Mohammadpur Buzurg, Block Laksar, District Haridwar

APPENDIX-X List of Publications

BOOKS	
1.	Bezzeghoud, M., Ergüler, Z.A., Rodrigo-Comino, J., Jat, M.K., Kalatehjari, R., Bisht, D.S., Biswas, A., Chaminé, H.I., Shah, A.A., Radwan, A.E. and Knight, J. (2024). "Recent Research on Geotechnical Engineering, Remote Sensing, Geophysics and Earthquake Seismology." Springer, Cham.
2.	Chenchouni, H., Zhang, Z., Bisht, D.S., Gentilucci, M., Chen, M., Chaminé, H.I., Barbieri, M., Jat, M.K., Rodrigo-Comino, J., Panagoulia, D. and Kallel, A., (2024). "Recent Advancements from Aquifers to Skies in Hydrogeology, Geoecology, and Atmospheric Sc iences". Springer, Cham.
3.	Kumar, Manish, Keisuke Kuroda, Santanu Mukherjee, Long D. Ngiehm, Meththika Vithanage, Tyagi, V.K. (2024). Wastewater Surveillance for Covid-19 Management. The Handbook of Environmental Chemistry Series, Springer Cham, pp 374, ISBN: 978-3-031-53905-3.
4.	Rawat, S.S., Bisht, D.S., Raina, G. (2023) "Spring Atlas of Ravi River Catchment of Himachal Pradesh". National Institute of Hydrology, Roorkee.
5.	Rawat, S.S., Bisht, D.S., Raina, G. (2023) "Spring Atlas of Tawi River Catchment of Jammu & Kashmir". National Institute of Hydrology, Roorkee.
6.	Rawat, S.S., Bisht, D.S., Kulkarni, H., Kumar, S. (2024) "Springshed Management in the Mountainous Regions of India." DoWR, RD & GR, Ministry of Jal Shakti, Government of India (ISBN: 978-93-340-3741-8)
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NATIONAL CONFERENCE	
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76.	Venkata Ramana, R., Satyaji Rao, Y.R., and Jeyakanthan, V.S. (2023). Urban flood simulation using hydrodynamic model-SWMM and HEC RAS. Proceedings of the National Seminar on Hydrology with special reference to Hydrological Solutions for Sustainable Development organized by the Association of Hydrologists of India (AHI) and PSG Institute of Advanced Studies during 1-2 December 2023, at Coimbatore, Tamilnadu.
77.	Venkata Ramana, R., Jeyakanthan, V .S. and Satyaji Rao, Y.R. (2023). Spatial Variations of Land Use Land Cover Changes in Urban Catchment". National Seminar on Hydrology with special reference to Hydrological Solutions for Sustainable Development organized by the Association of Hydrologists of India (AHI) and PSG Institute of Advanced Studies during 1-2 December 2023, at Coimbatore, Tamilnadu.
78.	Venkatesh, B., Abhilash, R., and Ananda Havannavar (2023). Flood Inundation Maps for Krishna River – A Case Study of 2019 flood of Belagavi District. 38th National Convention on Civil Engineering, Water Management for Sustainability using emerging Technolo gies"on 8th and 9th Oct.2023 at KLE Centenary Convention centre, JNMC Campus, Belagavi.

Audited Statement of Accounts 2023-24

APPENDIX-XVI

SINGH AMIT & ASSOCIATES
CHARTERED ACCOUNTANTS/ADVOCATES/LEGAL ADVISORS
CA AMIT SINGH
(FCA,LLB)
GOLD MEDALIST(ICAI)

Revised

AUDITOR'S REPORT

To,

The Director,
National Institute of Hydrology,
Roorkee – 247667

We have audited the Balance Sheet, the Income & Expenditure Account and the Receipts & Payments Account for "National Institute of Hydrology, Roorkee", for Scheme, Non- Scheme and NHP, Sponsored Projects, Consultancy Projects, R&D Support Fund, Employee Welfare Fund, Training Course & NMSHE Funds as on 31st March, 2024. These financial statements are responsibility of the management. Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with the auditing standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosure in the financial statement. An audit also includes assessing the accounting principles used by management, as well as evaluating the overall financial statement presentation, we believe that our audit provides a reasonable basis for our opinion.

1. We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purpose of our audit.

2. In our opinion, proper books of accounts have been kept by Management so far as it appears from our examination of the books.

3. Management is responsible for preparation of financial statements for the financial year 2023-24 and is also responsible for maintenance of accounting records in accordance with generally accepted accounting principles in India.

4. The Balance Sheet and Income and Expenditure Account dealt with by the report are in agreement with the books of account.

5. In our opinion, and to the best of our information and according to the explanation given to us, the said accounts exhibit a true and fair view:

   a) In the case of the Balance Sheet, of the state of affairs of the Organization as at March 31, 2024.
   b) In the case of Income & Expenditure account, of the surplus for the year ended on that date.
   c) In the case of Receipts & payment account, for the year ended on that date.

For Singh Amit & Associates
Chartered Accountants
FRN : 019157C



CA Amit Singh
FCA, LLB
(Partner)
M.No. – 425374

Place : Roorkee
Date : 11/4/2025

UDIN: 25425374BMJRMM5219

NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
BALANCE SHEET AS ON 31ST MARCH, 2024

(Amount - Rs.)

PARTICULARS	Schedule	SCHEME	NON-SCHEME	NHP	SPONSORED	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	TOTAL
CORPUS/CAPITAL FUND AND LIABILITIES											
CORPUS/ CAPITAL FUND	1	31,79,04,262	(32,09,88,831)	72,76,012	7,32,12,002	20,20,04,168	14,58,05,862	1,92,12,267	31,36,754	46,33,921	45,21,96,416
RESERVES AND SURPLUS	2	7,29,28,189	94,77,351	2,48,43,374	-	-	-	-	-	-	10,72,48,913
EARMARKED/ ENDOWMENT FUNDS	3	1,69,45,466	-	-	-	-	-	-	-	-	1,69,45,466
SECURED LOANS AND BORROWINGS	4	-	-	-	-	-	-	-	-	-	-
UNSECURED LOANS AND BORROWINGS	5	-	-	-	-	-	-	-	-	-	-
DEFERRED CREDIT LIABILITIES	6	-	37,20,77,525	-	-	-	-	-	-	-	37,20,77,525
CURRENT LIABILITIES AND PROVISIONS	7	34,20,413	2,86,00,194	10,51,013	20,76,506	2,72,65,014	3,49,573	1,35,123	-	1,18,651	6,30,16,487
TOTAL (In Rs.)		**41,11,98,330**	**8,91,66,238**	**3,31,70,400**	**7,52,88,508**	**22,92,69,182**	**14,61,55,435**	**1,93,47,390**	**31,36,754**	**47,52,571**	**1,01,14,84,808**
ASSETS											
FIXED ASSETS	8	33,59,39,986	4,65,82,010	2,72,08,589	2,36,43,821	1,09,926	75,308		20,448	47,52,571	43,83,32,659
INVESTMENTS - FROM EARMARKED/ ENDOWMENT FUNDS	9	-	-	-	-	15,00,00,000	13,93,17,116	-	-	-	28,93,17,116
INVESTMENTS - OTHERS	10	-	-	-	-	-	-	-	-	-	-
CURRENT ASSETS, LOANS, ADVANCES ETC.	11	7,52,58,344	4,25,84,228	59,61,810	5,16,44,687	7,91,59,256	67,63,011	1,93,47,390	31,16,306	-	28,38,35,032
TOTAL (In Rs.)		**41,11,98,330**	**8,91,66,238**	**3,31,70,400**	**7,52,88,508**	**22,92,69,182**	**14,61,55,435**	**1,93,47,390**	**31,36,754**	**47,52,571**	**1,01,14,84,807**
SIGNIFICANT ACCOUNTING POLICIES	24										
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25										

FOR NATIONAL INSTITUTE OF HYDROLOGY

FINANCE OFFICER
Finance Officer
National Institute of Hydrology
Roorkee (U.K.)

DIRECTOR
डॉ. मनमोहन कुमार गोयल / Dr. M. K. Goel
निदेशक / Director
राष्ट्रीय जलविज्ञान संस्थान
National Institute of Hydrology
रुड़की / Roorkee-247 667

AS PER OUR SEPARATE REPORT OF EVEN DATE ATTACHED
For Singh Amit & Associates
Chartered Accountants
FRN-019157C

SINGH AMIT & ASSOCIATES CA AMIT SINGH INDIA CHARTERED ACCOUNTANTS FRN-019157C M.No-425374 ROORKEE

CA Amit Singh
Partner
M.No.-425374

Date :- 11.04.2025
Place :- Roorkee
UDIN :-25425374BMJRMM5219

NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st March 2024

(Amount in Rupees)

Particulars	Schedule	Current Year									TOTAL
		Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
INCOME											
Income from Sales/Services	12	1,00,068	32,17,887	-	2,438	5,66,73,171	-	20,676	-	-	6,00,14,240
Grants/Subsidies	13	3,57,00,000	48,02,59,123	2,36,28,372	2,03,16,971	-	-	11,96,715	-	-	56,11,01,181
Fees/Subcriptions	14	-	-	-	-	-	-	-	-	-	-
Income from Investments	15	-	-	-	-	-	-	-	-	-	-
Income from Royalty, Publication etc.	16	-	-	-	-	-	-	-	-	-	-
Interest Earned	17	-	-	-	-	-	80,89,340	1,55,715	99,351	-	83,44,406
Other Income	18	-	-	-	7,21,455	-	9,89,544	-	-	-	17,10,999
Increase/(decrease) in stock of Finished goods	19	-	-	-	-	-	-				-
Other Income - Amortization of Grants	3	4,12,37,520	22,649	60,02,304	-		-				4,72,62,474
TOTAL(In Rs.) (A)		**7,70,37,588**	**48,34,99,659**	**2,96,30,676**	**2,10,40,864**	**5,66,73,171**	**90,78,884**	**13,73,106**	**99,351**	**-**	**67,84,33,299**
EXPENDITURE											
Establishment Expenses	20	2,06,16,821	45,57,12,023	1,34,44,753	50,34,547	13,22,984	26,56,558	3,26,000	-	-	49,91,13,686
Other Administrative Expenses etc.	21	2,05,85,712	3,92,01,903	47,76,492	85,85,639	43,06,453	-	9,74,714	15,31,749	40,32,118	8,39,94,781
Expenditure on Grants, Subsidies etc.	22	-	-	-	-	-	-	-	-	-	-
Interest	23	-	-	-	-	-	-	-	-	-	-
Depreciation	8	4,12,37,520	22,649	60,02,304	39,58,472	33,566	42,820		3,608	6,15,984	5,19,16,923
TOTAL(In Rs.) (B)		**8,24,40,054**	**49,49,36,576**	**2,42,23,549**	**1,75,78,658**	**56,63,003**	**26,99,378**	**13,00,714**	**15,35,357**	**46,48,101**	**63,50,25,390**
Balance being excess of Income over Expenditure (A-B)		(54,02,465)	(1,14,36,916)	54,07,127	34,62,206	5,10,10,168	63,79,506	72,392	(14,36,006)	(46,48,101)	4,34,07,910
Transfer to Speical Reserve		-	-	-	-	-	-	-	-	-	-
Transfer to/ from General Reserve		-	-	-	-	-	-	-	-	-	-
SURPLUS/(DEFICIT) CARRIED TO CORPUS/CAPITAL FUND		**(54,02,465)**	**(1,14,36,916)**	**54,07,127**	**34,62,206**	**5,10,10,168**	**63,79,506**	**72,392**	**(14,36,006)**	**(46,48,101)**	**4,34,07,910**
SIGNICANT ACCOUNTING POLICIES	24										
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25										

FOR NATIONAL INSTITUTE OF HYDROLOGY

FINANCE OFFICER

Finance Officer
National Institute of Hydrology
Roorkee (U.K.)

DIRECTOR

डॉ. मनमोहन कुमार गोयल / Dr. M. K. Goel
निदेशक / Director
राष्ट्रीय जलविज्ञान संस्थान
National Institute of Hydrology
रुड़की / Roorkee-247 667

AS PER OUR SEPARATE REPORT OF EVEN DATE ATTACHED
For Singh Amit & Associates
Chartered Accountants
FRN-019157C

SINGH AMIT & ASSOCIATES CA AMIT SINGH CHARTERED ACCOUNTANTS FRN-019157C M.No-425374 ROORKEE

CA Amit Singh
Partner
M.No-425374

Date :- 11.04.2025
Place :- Roorkee
UDIN :-25425374BMJRMM5219

NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
RECEIPT & PAYMENTS FOR THE PERIOD/YEAR ENDED 31st MARCH 2024

Receipts	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	TOTAL
I. Opening Balances -										
a) Cash in Hand	-	-	-	-	-	-	-	-	-	-
b) Bank Balances	2,05,66,806	2,51,41,527	9,85,101	3,15,67,393	5,43,89,008	3,03,35,905	52,60,357	45,48,704	46,52,009	17,74,46,810
II. Grants Recevied -										
a) From Government of India -										
i) Capital Grants	5,80,00,000	95,00,000	-	-	-	-	-	-	-	6,75,00,000
ii) General Grants *	3,57,00,000	10,00,00,000	2,36,28,372	-	-	-	-	-	-	15,93,28,372
iii) Salary Grants	-	39,00,00,000	-	-	-	-	-	-	-	39,00,00,000
b) Earmarked/Endowment Funds -										
i) For Jal Shakti Abhiyan	15,00,000	-	-	-	-	-	-	-	-	15,00,000
ii) For R&D Activities -MOWR	2,58,93,987	-	-	-	-	-	-	-	-	2,58,93,987
iii) For SSAP Grants	1,63,16,298	-	-	-	-	-	-	-	-	1,63,16,298
c) Sponsored Grant	-	-	-	2,45,46,244	-	-	11,96,715	-	-	2,57,42,959
III. Increase in Liabilities -										
a) Duties & Taxes	71,895	3,72,644	1,983	64,075	33,73,656	3,39,400	1,89,790		1,262	44,14,705
b) Interest Payable to Bharatkosh	10,63,818	87,32,309	38,879	8,96,493	72,43,916	-	-	-	-	1,79,75,415
c) Interest on SSAP - Received	2,85,904	-	-	-	-	-	-	-	-	2,85,904
d) Security Deposits Received	3,87,250	1,36,000	1,83,500	1,99,000	31,000	-	-	-	-	9,36,750
e) Provision for Expenses Payable	14,66,501	2,64,15,728	7,630	-	-	-	-	-	-	2,78,89,859
f) Other Current Liabilities	2,82,474	7,19,861	10,022	10,20,666	-	-	-	-	63,436	20,96,459
g) Earnest Money Deposits	-	-	5,00,000	-	-	-	-	-	-	5,00,000
IV. Decrease in Current Assets -										
a) Loans, Advances etc.										
i) Departmental Advance	68,457	37,179	-	53,307	61,331	35,80,957	2,07,340	-	-	40,08,571
ii) Advance to Regional Centres	2,60,069	1,43,045	47,391	-	-	-	-	-	-	4,50,505
iii) T.A Advance	22,234	-	9,000	-	-	-	4,084	-	-	35,318
iv) Advance from Firm	-	-	-	19,199	-	-	-	-	-	19,199
b) Staff Imprest	7,079	413	1,125	-	-	-	-	-	-	8,617
c) Advance for Construction	6,12,903	-	-	-	-	-	-	-	-	6,12,903
d) Advance to Employees	-	2,63,653	-	-	-	-	-	-	-	2,63,653
V. Other Income										
a) Tender Cost	2,500	-	-	-	-	-	-	-	-	2,500
b) Guest House Receipts and ancilliaries	97,570	-	-	-	-	-	-	-	-	97,570
c) Income from Sale of Vehicle	-	5,49,685	-	-	-	-	-	-	-	5,49,685
d) Income from Services (As per List - IV)	-	32,17,887	-	-	7,42,25,822	-	-	-	-	7,74,43,709
e) Interest Income - Savings	-	-	-	-	-	9,13,539	1,55,714	99,351		11,68,604
f) Interest Income - FDR	-	-	-	-	-	71,75,801	-	-	-	71,75,801
g) Overhead Charges	-	-	-	-	-	8,29,544	-	-	-	8,29,544
h) Other Misc. Income	-	-	-	7,21,455	-	1,60,000	-	-	-	8,81,455
VI. Amount Borrowed	2,08,600	3,48,34,416	-	-	-	-	-	-	-	3,50,43,016
VII. FDR Maturity	-	-	-	-	7,00,00,000	10,00,00,000	-	-	-	17,00,00,000
TOTAL (In Rs.)	**16,28,14,345**	**60,00,64,347**	**2,54,13,003**	**5,90,87,832**	**20,93,24,733**	**14,33,35,146**	**70,14,000**	**46,48,055**	**47,16,707**	**1,21,64,18,168**

FOR NATIONAL INSTITUTE OF HYDROLOGY

FINANCE OFFICER

Finance Officer
National Institute of Hydrology
Roorkee (U.K.)

Date :- 11.04.2025
Place :- Roorkee
UDIN :- 25425374BMJRMM5219

DIRECTOR

डॉ. मनमोहन कुमार गोयल / Dr. M. K. Goel
निदेशक / Director
राष्ट्रीय जलविज्ञान संस्थान
National Institute of Hydrology
रुड़की / Roorkee-247 667

AS PER OUR SEPARATE REPORT OF EVEN DATE ATTACHED
For Singh Amit & Associates
Chartered Accountants
FRN-019157C

CA Amit Singh
Partner
M.No.-425374

SINGH AMIT & ASSOCIATES CA AMIT SINGH INDIA CHARTERED ACCOUNTANTS FRN-019157C M.No-425374 ROORKEE

NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
RECEIPT & PAYMENTS FOR THE PERIOD/YEAR ENDED 31st MARCH 2024

(Amount- Rs)

Payments	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	TOTAL
I. Expenses										
a) Establishment Expenses (List - II)	2,03,46,894	42,85,68,543	1,23,27,353	18,00,265	14,35,738	26,36,585	3,26,000	-	-	46,74,41,378
b) Administrative Expenses (List- III)	1,62,00,573	3,44,00,665	39,83,544	60,65,135	28,35,656	-	5,71,876	15,31,749	40,32,119	6,96,21,317
II. Payments made against funds for various projects										
i) For R&D Activities -MOWR	2,32,11,997	-	-	-	-	-	-	-	-	2,32,11,997
ii) For SSAP Grants	46,52,027	-	-	-	-	-	-	-	-	46,52,027
III. Decrease in Liabilities -										
a) Interest Paid to Bharatkosh	16,10,785	86,34,461	3,15,221	12,38,405	-	-	-	-	-	1,17,98,872
b) Interest on SSAP - Paid	2,85,904	-	-	-	-	-	-	-	-	2,85,904
c) Security Deposits Paid	1,43,600	57,000	2,95,500	2,55,034	81,500	-	-	-	-	8,32,634
d) Duties & Taxes	58,186	2,46,191	5,492	66,241	1,27,30,503	3,34,620	73,313	-	1,262	1,35,15,808
e) Provision for Expenses Paid	14,66,501	2,81,57,233	7,630	-	-	-	-	-	-	2,96,31,364
f) Other Current Liabilities	-	-	-	-	-	-	-	-	6,83,326	6,83,326
g) Earnest Money Deposits	10,000	-	2,50,000	-	-	-	-	-	-	2,60,000
h) Retention money witheld - Paid	-	17,492	39,175	-	-	-	-	-	-	56,667
i) Prov. - Contribution of CPF Bills - TSA	-	1,56,00,000	-	-	-	-	-	-	-	1,56,00,000
IV. Expenditure on Fixed Assets -										
a) Creation of Capital Assets (List - I)	3,87,73,224	3,04,659	26,79,170	37,11,949	9,814	-	-	-	-	4,54,78,816
b) Expenditure on Capital Work-in-progress	-	-	-	-	-	-	-	-	-	-
V. Increase in Current Assets -										
a) Advance to Regional Centres	48,07,195	47,26,361	-	-	-	-	-	-	-	95,33,556
b) Loans, Advances etc.										
i) Departmental Advance	7,15,910	4,40,128	1,10,320	4,43,000	3,15,000	36,00,930	3,79,540	-	-	60,04,828
ii) T.A Advance	1,53,800	5,65,885	42,700		11,56,101	-	-	-	-	19,18,486
iii) Advance to Firms	15,34,146	7,57,988	20,359	20,000	12,15,024	-	16,000	-	-	35,63,517
iv) Advance to third parties				75,10,464	-	-	-	-	-	75,10,464
v) LTC Advance	-	9,01,414	-	-	-	-	-	-	-	9,01,414
c) Staff Imprest	38,000	32,000	2,000	-	-	-	-	-	-	72,000
d) Advance for Construction	1,93,72,571	25,00,000	-	-	-	-	-	-	-	2,18,72,571
e) Deposits made to UPCL Board	-	1,54,642	-	-	-	-	-	-	-	1,54,642
VI. Amount Borrowed - Paid	2,08,600	3,48,34,416	-	-	-	-	-	-	-	3,50,43,016
VII. Other Payments										
a) Grants Lapsed as on 31st March 2024	-	97,40,877	-	-	-	-	-	-	-	97,40,877
b) Grants Refunded	-	-	-	46,08,669	-	-	-	-	-	46,08,669
VIII. Investments Made										
a) FDR	-	-	-	-	15,00,00,000	13,00,00,000	-	-	-	28,00,00,000
IX. Closing Balances										
a) Cash in hand	-	-	-	-	-	-	-	-	-	-
b) Bank Balances	2,92,24,432	2,94,24,392	53,34,539	3,33,68,670	3,95,45,397	67,63,011	56,47,271	31,16,306	-	15,24,24,019
TOTAL (In Rs.)	16,28,14,345	60,00,64,347	2,54,13,003	5,90,87,832	20,93,24,733	14,33,35,146	70,14,000	46,48,055	47,16,707	1,21,64,18,168

FOR NATIONAL INSTITUTE OF HYDROLOGY

FINANCE OFFICER

Finance Officer
National Institute of Hydrology
Roorkee (U.K.)

Date :- 11.04.2025
Place :- Roorkee
UDIN :- 25425374BMJRMM5219

DIRECTOR

डॉ. मनमोहन कुमार गोयल / Dr. M. K. Goel
निदेशक / Director
राष्ट्रीय जलविज्ञान संस्थान
National Institute of Hydrology
रुड़की / Roorkee-247 667

AS PER OUR SEPARATE REPORT OF EVEN DATE ATTACHED
For Singh Amit & Associates
Chartered Accountants
FRN-019157C

CA Amit Singh
Partner
M.No.-425374

SINGH AMIT & ASSOCIATES CA AMIT SINGH CHARTERED ACCOUNTANTS FRN-019157C M.No-425374 ROORKEE

Notes To Receipts and Payments Account-

i) Grants received in NHP A/c during the year consists of Grant amounting to Rs. 1,46,86,116 received in April 2023, in lieu of Grant lapsed as on 31st March 2023 respectively.

List - I - Creation of Capital Assets

Particulars	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support	Training	Employee	NMSHE
Computers and Parts	58,44,445	-	21,53,650	-	9,814	-	-	-	-
Electrical Fixture	1,86,245	-	-	-	-	-	-	-	-
Furniture & Fixture	22,87,709	8,000	-	-	-	-	-	-	-
Lab & Field Equipment	68,51,898	-	5,20,144	37,11,949	-	-	-	-	-
Library Books	1,57,472	-	-	-	-	-	-	-	-
Library Journal	89,52,327	-	-	-	-	-	-	-	-
Maps & Imagery	83,686	-	-	-	-	-	-	-	-
Office Equipment	78,05,449	2,96,659	5,376	-	-	-	-	-	-
Computer Software	66,03,993	-	-	-	-	-	-	-	-
TOTAL (In Rs.)	**3,87,73,224**	**3,04,659**	**26,79,170**	**37,11,949**	**9,814**	**-**	**-**	**-**	**-**

List - II - Establishment Expenses - Payments

Particulars	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support	Training	Employee	NMSHE
Honorarium & Others	2,37,400	3,83,167	80,880	52,000	-	-	3,26,000	-	-
CPF Contribution	-	3,79,78,120	-	-	-	-	-	-	-
Pay & Allowance	-	26,02,82,923	-	-	-	12,51,665	-	-	-
Medical Exp.	-	61,74,232	-	-	-	-	-	-	-
Retirement/Death Graduity	-	3,86,39,788	-	-	-	-	-	-	-
LTC Claim	-	17,23,676	-	-	-	-	-	-	-
Leave Encashment of Retirement	-	2,79,31,138	-	-	-	-	-	-	-
Wages/Salary of Resource Person	2,01,09,494	5,54,55,499	1,22,46,473	17,48,265	14,35,738	13,84,920	-	-	-
TOTAL (In Rs.)	**2,03,46,894**	**42,85,68,543**	**1,23,27,353**	**18,00,265**	**14,35,738**	**26,36,585**	**3,26,000**	**-**	**-**

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List - III - Other Administrative Expenses - Payments

Particulars	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support	Training	Employee	NMSHE
OFFICE EXP. -									
Travelling Exp.	50,20,794	33,34,802	8,06,950	1,79,898	-	-	3,300	-	-
Elec/Water & Gen Exp./Running Cost of DG Set	-	61,47,351	-	-	-	-	-	-	-
Advertisement Exp.	10,518	4,73,545	11,453	4,158	-	-	-	-	-
CHEMICALS/GLASSWARE(R&D)	16,84,668	-	-	-	-	-	-	-	-
CONTINGENCY	4,22,410	15,21,807	24,011	1,48,418	1,40,573	-	-	-	-
Hospitality Exp.	4,30,615	1,20,795	-	-	-	-	-	-	-
MISC. EXPENSES	32,53,173	3,79,963	30,559	-	27,806	-	-	-	1,67,801
News Paper/Periodicals	1,484	6,46,925	-	-	-	-	-	-	-
Payment of Professional Services	10,28,182	4,00,490	20,68,431	77,576	-	-	-	-	14,898
Postage Exp.	3,645	-	-	-	-	-	-	-	-
PRINTING	6,17,806	91,752	-	-	-	-	-	-	-
Printing of Tech Report	99,780	(9,513)	-	-	-	-	-	-	-
Rent, Rate & Taxes	45,355	19,88,130	-	-	-	-	-	-	-
Running Cost of Lab/Computers	17,84,625	9,73,880	-	-	-	-	-	-	-
Seminar & Conferences	12,52,574	4,10,659	-	-	-	-	74,662	-	-
STATIONERY	1,30,626	3,90,247	-	-	-	-	-	-	-
SWACHHTA ACTION PLAN (SAP)	1,82,436	-	-	-	-	-	-	-	-
Training Courses/Workshop	2,31,882	(13,288)	8,75,155	6,80,858	55,644	-	3,65,399	-	-
Telephone Exp.	-	14,35,513	-	-	-	-	-	-	-
T.A Claim	-	3,54,784	-	2,13,727	-	-	1,28,515	-	-
Consumables	-	-	1,04,091	66,443	52,725	-	-	-	-
Field Work	-	-	62,894	1,26,254	6,74,950	-	-	-	-
Fellowship	-	-	-	28,62,927	-	-	-	-	-
Overheads	-	-	-	9,97,482	-	-	-	-	-
Manpower	-	-	-	3,03,295	-	-	-	-	-
Other Misc Expenses	-	-	-	3,48,159	14,36,894	-	-	-	-
Analysis Charge	-	-	-	55,940	-	-	-	-	-
Interest	-	-	-	-	-	-	-	-	-
Transfer Unspent Balance	-	-	-	-	-	-	-	-	38,49,420
Staff Welfare	-	-	-	-	-	-	-	15,31,749	-
Experimental Charges	-	-	-	-	4,47,064	-	-	-	-
POL		11,02,226							
MAINTAINANCE EXP. -									-
Maintinance of Lab Equpments	-	12,50,104	-	-	-	-	-	-	-
Maint. of Building	-	99,12,105	-	-	-	-	-	-	-
MAINT. OF COMMUNICATION SYSTEM	-	5,398	-	-	-	-	-	-	-
Maint of Computer Machinery	-	14,23,355	-	-	-	-	-	-	-
Maint of Furniture & Fixture	-	2,36,559	-	-	-	-	-	-	-
Maint. Of Generator Set	-	2,97,561	-	-	-	-	-	-	-
MAINT. OF LIBRARY BOOKS	-	7,000	-	-	-	-	-	-	-
Maint of Office Equipment	-	11,74,926	-	-	-	-	-	-	-
Maint. of Vehicle	-	3,43,589	-	-	-	-	-	-	-
TOTAL (In Rs.)	**1,62,00,573**	**3,44,00,665**	**39,83,544**	**60,65,135**	**28,35,656**	**-**	**5,71,876**	**15,31,749**	**40,32,119**

List - IV - Income from Services

Particulars	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support	Training	Employee	NMSHE
License Fee	-	6,32,767	-	-	-	-	-	-	-
Other Receipts	-	1,21,778	-	-	1,72,475	1,72,475	1,72,475	1,72,475	1,72,475
APPLICATION FEE	-	1,16,550	-	-	-	-	-	-	-
Guest House Receipts	-	19,33,921	-	-	-	-	-	-	-
Misc Recpt(Water Testing)	-	3,92,861	-	-	-	-	-	-	-
RTI	-	10	-	-	-	-	-	-	-
Consultancy Fees Receipts	-	-	-	-	7,40,53,347	7,40,53,347	7,40,53,347	7,40,53,347	7,40,53,347
TENDER COST / FEE	-	20,000	-	-	-	-	-	-	-
TOTAL (In Rs.)	**-**	**32,17,887**	**-**	**-**	**7,42,25,822**	**7,42,25,822**	**7,42,25,822**	**7,42,25,822**	**7,42,25,822**

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE - 1 : CORPUS/CAPITAL FUND (Amount- Rs)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
Balance as at the beginning of the year	33,59,33,810	(29,38,22,667)	-	7,02,58,612	15,19,88,631	13,94,26,356	1,91,39,875	45,93,029	98,82,694	43,74,00,340
Add: Contributions towards Corpus/Capital Fund	-	-	1,72,04,536							1,72,04,536
Deduct : Prior-Period Adjustments (Annexure - 1)	(1,26,27,083)	(1,57,29,248)	(1,53,35,651)	(5,08,816)	(9,94,631)	-	-	(20,269)	(6,00,672)	(4,58,16,370)
Add/(Deduct): Balance of net income/(expenditure)transferred from the Income and Expenditure Account.	(54,02,465)	(1,14,36,916)	54,07,127	34,62,206	5,10,10,168	63,79,506	72,392	(14,36,006)	(46,48,101)	4,34,07,910
BALANCE AS AT THE YEAR - END	**31,79,04,262**	**(32,09,88,831)**	**72,76,012**	**7,32,12,002**	**20,20,04,168**	**14,58,05,862**	**1,92,12,267**	**31,36,754**	**46,33,921**	**45,21,96,416**

SCHEDULE - 2 : RESERVES AND SURPLUS (Amount- Rs)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
1. Capital Reserve:										
As per last Account	5,61,65,709	-	3,08,45,678	-						8,70,11,387
Addition : Capital Grants received during the year	5,80,00,000	95,00,000	-	-						6,75,00,000
Less: Grant Amortization during the year	(4,12,37,520)	(22,649)	(60,02,304)	-						(4,72,62,474)
TOTAL (In Rs.)	**7,29,28,189**	**94,77,351**	**2,48,43,374**	**-**	**-**	**-**	**-**	**-**	**-**	**10,72,48,913**
2. Revaluation Reserve:										
As per last Account	-	-	-	-	-	-	-	-	-	-
Addition during the year	-	-	-	-	-	-	-	-	-	-
Less: Deductions during the year	-	-	-	-	-	-	-	-	-	-
TOTAL (In Rs.)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
3. Special Reserves:										
As per last Account	-	-	-	-	-	-	-	-	-	-
Addition during the year	-	-	-	-	-	-	-	-	-	-
Less: Deductions during the year	-	-	-	-	-	-	-	-	-	-
TOTAL (In Rs.)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
4. General Reserve:										
As per last Account	-	-	-	-	-	-	-	-	-	-
Addition during the year	-	-	-	-	-	-	-	-	-	-
Less: Deductions during the year	-	-	-	-	-	-	-	-	-	-
TOTAL (In Rs.)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total (1+2+3+4)	**7,29,28,189**	**94,77,351**	**2,48,43,374**	**-**	**-**	**-**	**-**	**-**	**-**	**10,72,48,913**

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Notes To Schedule -1 :

1) The interest payable to Bharatkosh was erroneously booked under Income & Expenditures in previous financial years, which should be booked in Current Liabilities, now being rectified as prior period item as per AS -5.

2) The Bank opening Balance was erroneously inflated by Rs.9,94,631 /- , due to totalling error of Consultancy project fund's Balances in last FY 2022-23, which is being rectified now by Prior Period Adjustment as per AS-5.

Annexure - 1 : Prior Period Adjustments :-

PARTICULARS	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE
Grant lapsed in FY 2023-24	-	-	(1,46,86,116)	-	-	-	-	-	-
Interest payable to Bharatkosh *1	-	-	(3,15,221)	(1,29,420)	-	-	-	-	-
Depreciation on Building	(1,25,86,063)	-	(3,34,314)		-	-	-	(20,269)	(6,00,672)
CPF Contribution Bills of FY 2022-23 paid	-	(1,56,00,000)	-	-	-	-	-	-	-
+ Electricity Deposit(NIH Office)	-	1,15,824	-	-	-	-	-	-	-
+ Electricity Deposit(Staff Colony)	-	54,376	-	-	-	-	-	-	-
Depreciation on Fixed Assets sold as scrap	(41,020)								
Sale of Scrap		(2,99,448)							
Bank Openings Difference *2	-	-	-		(9,94,631)	-	-	-	-
Refund of Grant	-	-	-	(3,79,396)	-	-	-	-	-
BALANCE AS AT THE YEAR - END	**(1,26,27,083)**	**(1,57,29,248)**	**(1,53,35,651)**	**(5,08,816)**	**(9,94,631)**			**(20,269)**	**(6,00,672)**

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE - 3 : EARMARKED/ENDOWMENT FUNDS (Amount- Rs)

Particulars	Current Year											
	SCHEME FUNDS			NON-SCHEME FUNDS	NHP FUNDS	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	Total
	NATIONAL WATER MISSION (NWM) FUNDS											
	R&D Activity (MOWR)	Jal Shakti Abhiyan	SSAP Grants									
a) Opening Balance of the Funds	10,99,205	-	-	-	1,72,04,536	-	-	-	-	-	-	1,83,03,741
- Less: Transferred to Capital Fund - Sch. 1 *	-	-	-	-	(1,72,04,536)	-	-	-	-	-	-	(1,72,04,536)
TOTAL	10,99,205	-	-	-	-	-	-	-	-	-	-	10,99,205
b) Addition to the Funds:												
i. Grants	2,58,93,987	15,00,000	1,63,16,298	-	-	-	-	-	-	-	-	4,37,10,285
ii. Income from Investments made on account of funds	-	-	-	-	-	-	-	-	-	-	-	-
iii. Other additions (Interest)	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL(In Rs.) (a+b)	2,69,93,192	15,00,000	1,63,16,298	-	-	-	-	-	-	-	-	4,48,09,490
c) Utilisation/Expenditure towards objectives of funds												
I. Capital Expenditure												
- Fixed Assets			-								-	-
- Others	2,32,11,997		46,52,027								-	2,78,64,024
TOTAL	2,32,11,997	-	46,52,027	-	-	-	-	-	-	-	-	2,78,64,024
II. Revene Expenditure												
- Honorarium											-	
- Wages											-	
- Other Administrative expenses											-	
TOTAL	-	-	-	-	-	-						-
TOTAL(In Rs.) (c)	2,32,11,997	-	46,52,027		-	-	-	-	-	-	-	2,78,64,024
NET BALANCE AS AT THE YEAR - END (a+b-c)	37,81,195	15,00,000	1,16,64,271		-	-					-	1,69,45,466

Notes To Schedule - 3 :

i) * The opening balance of funds available in NHP A/c under Schedule -3, was wrongly booked under earmarked funds, which now b

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Amit

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE - 4 : SECURED LOANS AND BORROWINGS : (Amount- Rs)

Particulars	Current Year											TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	Total	
1. Central Government												
2. State Government (Specify)												
3. Financial Institutions												
(a) Term Loans												
(b) Interest accrued and due												
4. Banks :												
(a) Term Loans												
- Interest accrued and due												
(b) Other Loans (specify)												
- Interest accrued and due												
5. Other Institutions and Agencies												
6. Debentures and Bonds												
7. Other (Specify)												
Total(In Rs.)												

NIL

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE - 5 : UNSECURED LOANS AND BORROWINGS : (Amount- Rs)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
1. Central Government 2. State Government (Specify) 3. Financial Institutions 4. Banks : (a) Term Loans (b) Other Loans (specify) 5. Other Institutions and Agencies 6. Debentures and Bonds 7. Fixed Deposits 8. Others (Specify)	NIL									
Total(In Rs.)										

Note: Amounts due within one year

SCHEDULE - 6 : DEFERRED CREDIT LIABILITIES : (Amount- Rs)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
Long - Term Provisions -										
(a) Gratutiy	-	20,68,98,179	-	-	-	-		-	-	20,68,98,179
(b) Leave Encashments	-	16,51,79,346	-	-	-	-		-	-	16,51,79,346
Total(In Rs.)	-	**37,20,77,525**	-	-	-	-		-	-	**37,20,77,525**

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE - 7 : CURRENT LIABILITIES AND PROVISIONS - (Amount- Rs)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
A. CURRENT LIABILITIES										
1. Sundry Creditors :										
(a) For Capital Goods (As per List 'I')	-	-	-	-	-	-	-	-	-	-
(b) Others	-	-	-	-	-	-	-	-	-	-
2. Deposit Received	13,00,728	1,04,350	5,07,251	2,75,966	57,500	-	-	-	-	22,45,795
3. Outstanding Expenses (As per List 'II')	2,57,255	2,61,69,549	53,503	20,906	32,439	10,173	1,093	-	-	2,65,44,918
4. Earnest Money Deposit	3,02,450	(5,000)	4,43,559	-	-	-	-	-	39,000	7,80,009
5. Retention Money witheld of Firms	7,66,950	66,436	-	-	-	-	-	-	-	8,33,386
6. Payable to CPF	-	-	-	-	-	-	-	-	-	-
7. Employees Contribution to COVID Fund	-	42,575	-	-	-	-	-	-	-	42,575
8. R&D Support Fund (SSAP Maint. Fees)	96,000	-	-	-	-	-	-	-	-	96,000
9. Other current Liabilities	2,82,474	7,28,914	-	13,75,624	-	-	-	-	-	23,87,012
TOTAL(In Rs.) (A)	**30,05,857**	**2,71,06,824**	**10,04,313**	**16,72,496**	**89,939**	**10,173**	**1,093**	**-**	**39,000**	**3,29,29,695**
B. PROVISIONS										
1. For Taxation (As per List 'III')	(86,404)	(1,18,467)	(341)	27,673	42,12,432	3,39,400	1,34,030	-	135	45,08,458
2. Gratuity	-	-	-	-	-	-	-	-	-	-
3. Superannuation/Pension	-	-	-	-	-	-	-	-	-	-
4. Accumulated Leave Encashment	-	-	-	-	-	-	-	-	-	-
5. Trade Warranties/Claim	-	-	-	-	-	-	-	-	-	-
6. Others (as per list 'IV')	5,00,960	16,11,837	47,041	3,76,337	2,29,62,643	-	-	-	79,516	2,55,78,334
TOTAL(In Rs.) (B)	**4,14,556**	**14,93,370**	**46,700**	**4,04,010**	**2,71,75,075**	**3,39,400**	**1,34,030**	**-**	**79,651**	**3,00,86,792**
TOTAL(In Rs.) (A + B)	**34,20,413**	**2,86,00,194**	**10,51,013**	**20,76,506**	**2,72,65,014**	**3,49,573**	**1,35,123**	**-**	**1,18,651**	**6,30,16,487**

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निदेशक / Director
राष्ट्रीय जलविज्ञान संस्थान
National Institute of Hydrology
रुड़की / Roorkee-247 667

Annexures to Schedule - 7 -

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
List-'I' CAPITAL	-	-	-	-	-	-	-	-	-	
Library Journals	-	-	-	-	-	-	-	-	-	-
Furniture & Fixture	-	-	-	-	-	-	-	-	-	-
Buildings	-	-	-	-	-	-	-	-	-	-
Software	-	-	-	-	-	-	-	-	-	-
Total(In Rs.)	-	-	-	-	-	-	-	-	-	-

Annexures to Schedule - 7

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
List-'II' - OUTSTANDING EXPENSES										
(a) ESTABLISHMENT										
Salary	-	2,48,45,121	-	-	-	-	-	-	-	2,48,45,121
DA Arrear		4,548	-	-	-	-	-	-	-	4,548
HRA Payable	-	-	403	-	-	-	-	-	-	403
Wages	2,21,937	5,32,276	-	-	-	-	-	-	-	7,54,213
Honorarium Payable	12,600	-	-	-	-	-	-	-	-	12,600
Total(In Rs.) (a)	2,34,537	2,53,81,945	403	-	-	-	-	-	-	2,56,16,885
										-
(b) OFFICE EXPENSES										-
Elect/Water charges & Running cost of DG Set	-	-	-	-	-	743	-	-	-	743
Other Charges	-	-	-	-	180	-	-	-	-	180
Rent, Rates & Taxes	-	62,277	-	-	-	-	-	-	-	62,277
T.A. to Non-officials	-	9,635	-	-	50	-	-	-	-	9,685
Professional & Other Services	-	-	53,100	-	-	-	-	-	-	53,100
Misc. Expenses	-	-	-	-	-	6,480	-	-	-	6,480
Professional Fees Payable	-	-	-	1	-	-	-	-	-	1
Audit Fees Payable	22,718		-	20,905	32,209	2,950	1,093	-	-	79,875
Total(In Rs.) (b)	22,718	71,912	53,100	20,906	32,439	10,173	1,093	-	-	2,12,341
(c) MAINTENANCE										
Furniture & Fixture	-	-	-	-	-	-	-	-	-	-
electric &fixture	-	-	-	-	-	-	-	-	-	-
Computer Centre	-	-	-	-	-	-	-	-	-	-
Lab Equipment	-	-	-	-	-	-	-	-	-	-
Vehicle	-	-	-	-	-	-	-	-	-	-
Total(In Rs.) (c)	-	-	-	-	-	-	-	-	-	-

SINGH AMIT & ASSOCIATES CA AMIT SINGH CHARTERED ACCOUNTANTS FRN-019167C M.No-425374 ROORKEE

Finance Officer
National Institute of Hydrology
Roorkee (U.K.)

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National Institute of Hydrology

Annexures to Schedule - 7

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
(d) RECOVERIES FROM SALARY										-
Benovalent Fund	-	8,700	-	-	-	-	-	-	-	8,700
House Rent (IIT Roorkee)	-	(1,890)	-	-	-	-	-	-	-	(1,890)
Elect. Charges (IIT Roorkee)	-	(2,098)	-	-	-	-	-	-	-	(2,098)
C.P.F. Recovery	-	(1,55,654)	-	-	-	-	-	-	-	(1,55,654)
NIH GSLI	-	-	-	-	-	-	-	-	-	-
NPS Recovery	-	(22,57,095)	-	-	-	-	-	-	-	(22,57,095)
NPS Hold	-	18,16,389	-	-	-	-	-	-	-	18,16,389
Court Attachment	-	-	-	-	-	-	-	-	-	-
Recreation Club	-	8,130	-	-	-	-	-	-	-	8,130
NIH Society	-	1,500	-	-	-	-	-	-	-	1,500
GSCA Pension Scheme	-	4,02,411	-	-	-	-	-	-	-	4,02,411
Licence Fee of HQ	-	9,07,946	-	-	-	-	-	-	-	9,07,946
CGSA	-	44,500	-	-	-	-	-	-	-	44,500
GSLI	-	(57,147)	-	-	-	-	-	-	-	(57,147)
Total(In Rs.) (d)	**-**	**7,15,692**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**7,15,692**
Total(In Rs.) (a)+(b)+(c)+(d)	**2,57,255**	**2,61,69,549**	**53,503**	**20,906**	**32,439**	**10,173**	**1,093**	**-**	**-**	**2,65,44,918**
List-'III' - TAXATION										
TDS of Employees	(8,475)	16,450	(400)	-	-	-	-	-	-	7,575
TDS of Firms	(72,136)	(1,03,379)	-	5,656	3,116	3,39,400	58,829	-	-	2,31,486
TDS on GST	(9,216)	(96,491)	59	22,017	5,29,531	-	-	-	-	4,45,900
VAT	-	-	-	-	-	-	-	-	135	135
GST	3,423	64,953	-	-	36,79,785	-	75,201	-	-	38,23,362
Total(In Rs.) (e)	**(86,404)**	**(1,18,467)**	**(341)**	**27,673**	**42,12,432**	**3,39,400**	**1,34,030**	**-**	**135**	**45,08,458**
LIST-'IV' - OTHER PROVISIONS										
Rajbala w/o S K Yadav (Retained for exp)	-	50,000	-	-	-	-	-	-	-	50,000
Security Deposit	-	-	-	-	-	-	-	-	98,734	98,734
Other Misc. Receipts	-	-	4,040	-	1,93,150	-	-	-	-	1,97,190
Interest Payable to Bharathkosh	5,00,960	7,12,704	38,879	3,58,564	1,77,39,204	-	-	-	-	1,93,50,311
Interest Payable	-	-	-	17,773	-	-	-	-	(19,218)	(1,445)
Payable to NMSHE	-	-	-	-	9,994	-	-	-	-	9,994
Sponsored Research Projects	-	-	-	-	10,000	-	-	-	-	10,000
Advance Consultancy Receipts	-	-	-	-	45,54,055	-	-	-	-	45,54,055
Refund payable of Advance	-	-	-	-	12,708	-	-	-	-	12,708
Payable to PMRF	-	-	-	-	1,032	-	-	-	-	1,032
Advance from RC Bhopal	-	-	-	-	4,42,500	-	-	-	-	4,42,500
Scheme Fund (Sale of Vehicle)		5,49,685								
Scheme Fund (Sale of Scrap)		2,99,448								
Penalty Charges	-	-	4,122	-	-	-	-	-	-	4,122
Total(In Rs.) (f)	**5,00,960**	**16,11,837**	**47,041**	**3,76,337**	**2,29,62,643**	**-**	**-**	**-**	**79,516**	**2,47,29,201**

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SINGH AMIT & ASSOCIATES
CA AMIT SINGH
CHARTERED ACCOUNTANTS
FRN-018157C
M.No-425374
ROORKEE

NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024
NHP

SCHEDULE-8 : PROPERTY, PLANT & EQUIPMENT (Amount - Rs.)

Descriptions	GROSS BLOCK					DEPRECIATION				NET BLOCK	
	Cost as on 1-Apr-23	Additions Before 30-Sep-23	Additions After 30-Sep-23	Deletions during the year	Cost as on 31-Mar-24	Rate of Depreciation	At the beginning of the year	For the Year	Value as on 31-Mar-24	As on 31-Mar-24	As on 31-Mar-23
A. PROPERTY, PLANT & EQUIPMENT											
Civil Work	44,49,891			-	44,49,891	10%	18,65,153	2,58,474	21,23,627	23,26,264	25,84,738
Computer & Machinery	1,67,10,628	21,20,447	33,203	-	1,88,64,278	40%	1,40,86,358	19,04,527	1,59,90,885	28,73,393	26,24,270
Office Equipment	97,99,387	5,376		-	98,04,763	15%	47,72,017	7,54,912	55,26,929	42,77,834	50,27,370
Lab Equipment	1,94,98,380	-	2,02,960	-	1,97,01,340	15%	1,00,14,640	14,37,783	1,14,52,423	82,48,917	94,83,740
Furniture & Fixture	8,16,036			-	8,16,036	10%	2,12,208	60,383	2,72,591	5,43,445	6,03,828
Car Parking (Kakinada)	12,91,000				12,91,000	10%	4,43,975	84,703	5,28,678	7,62,322	11,61,900
Equipment (LC)	98,36,406	3,17,184			1,01,53,590	15%	7,37,730	14,12,379	21,50,109	80,03,481	90,98,676
Water Quality Lab (Kakinada)	79,700				79,700	10%	27,409	5,229	32,638	47,062	71,730
B. INTANGIBLE ASSETS					-		-	-	-	-	
Software	2,60,812	20,359		-	2,81,171	40%	71,386	83,914	1,55,300	1,25,871	1,89,426
TOTAL (In Rs.)	**6,27,42,240**	**24,63,366**	**2,36,163**	**-**	**6,54,41,769**		**3,22,30,876**	**60,02,304**	**3,82,33,180**	**2,72,08,589**	**3,08,45,678**

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024
NMSHE

SCHEDULE-8 : PROPERTY, PLANT & EQUIPMENT (Amount - Rs.)

Descriptions	GROSS BLOCK					DEPRECIATION				NET BLOCK	
	Cost as on 1-Apr-23	Additions Before 30-Sep-23	Additions After 30-Sep-23	Deletions during the year	Cost as on 31-Mar-24	Rate of Depreciation	At the beginning of the year	For the Year	Value as on 31-Mar-24	As on 31-Mar-24	As on 31-Mar-23
A. PROPERTY, PLANT & EQUIPMENT											
Computer	73,103	-	-	-	73,103	40%	-	29,241	29,241	43,862	73,103
Office Furniture	42,56,483	-	-	-	42,56,483	10%	-	4,25,648.30	4,25,648	38,30,835	42,56,483
Lab Equipment	10,17,974	-	-	-	10,17,974	15%	-	1,52,696	1,52,696	8,65,278	10,17,974
B. INTANGIBLE ASSETS					-		-	-	-	-	
Software	20,995	-		-	20,995	40%	-	8,398	8,398	12,597	20,995
TOTAL (In Rs.)	**53,68,555**	-		-	**53,68,555**		-	**6,15,984**	**6,15,984**	**47,52,571**	**53,68,555**

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024
NON SCHEME

SCHEDULE-8 : PROPERTY, PLANT & EQUIPMENT (Amount - Rs.)

Descriptions	GROSS BLOCK					DEPRECIATION				NET BLOCK	
	Cost as on 1-Apr-23	Additions Before 30-Sep-23	Additions After 30-Sep-23	Deletions during the year	Cost as on 31-Mar-24	Rate of Depreciation	At the beginning of the year	For the Year	Value as on 31-Mar-24	As on 31-Mar-24	As on 31-Mar-23
A. PROPERTY, PLANT & EQUIPMENT											
Building/Civil Construction					-						
Furniture			8,000		8,000	10%		400	400	7,600	
Office Equipments			2,96,659		2,96,659	15%		22,249	22,249	2,74,410	
	-	-	-	-			-	-	-	-	-
TOTAL (In Rs.)	**-**	**-**	**3,04,659**	**-**	**3,04,659**		**-**	**22,649**	**22,649**	**2,82,010**	**-**
Capital Work in Progress	4,63,00,000		-		-				0.00	4,63,00,000	4,63,00,000
TOTAL (In Rs.)	**4,63,00,000**	**-**	**-**	**-**	**-**			**22,649**	**22,649**	**4,65,82,010**	**4,63,00,000**

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024
R&D Support Fund

SCHEDULE-8 : PROPERTY, PLANT & EQUIPMENT (Amount - Rs.)

Descriptions	GROSS BLOCK					DEPRECIATION				NET BLOCK	
	Cost as on 1-Apr-23	Additions		Deletions during the year	Cost as on 31-Mar-24	Rate of Depreciation	At the beginning of the year	For the Year	Value as on 31-Mar-24	As on 31-Mar-24	As on 31-Mar-23
		Before 30-Sep-23	After 30-Sep-23								
A. PROPERTY, PLANT & EQUIPMENT											
Office Equipment	17,725	-		-	17,725	15%	-	2,658.75	2,659	15,066	17,725
B. INTANGIBLE ASSETS					-		-	-	-	-	
Software	1,00,403	-		-	1,00,403	40%	-	40,161	40,161	60,242	1,00,403
TOTAL (In Rs.)	**1,18,128**	-		-	**1,18,128**		-	**42,820**	**42,820**	**75,308**	**1,18,128**

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024
SCHEME

SCHEDULE-8 : PROPERTY, PLANT & EQUIPMENT (Amount - Rs.)

Descriptions	GROSS BLOCK					DEPRECIATION					NET BLOCK	
	Cost as on 1-Apr-23	Additions during the year		Deductions during the year	Cost/valuation as at 31.3.24	Rate of Depreciation	At the beginning of the year	On Additions during the year	For the Year	Value as on 31-Mar-24	As on 31-Mar-24	As on 31-Mar-23
		Before 30-Sep-23	After 30-Sep-23									
A. PROPERTY, PLANT & EQUIPMENT												
Furniture & Fixture	3,02,17,862	18,973	22,68,736	88,188	3,24,17,383	10%	2,03,78,946	1,15,334	9,84,773.60	2,14,79,054	1,09,38,330	98,47,736
Library Books	84,39,301	40,660	1,16,812	-	85,96,773	40%	79,58,052	39,626	1,92,500	81,90,178	4,06,595	4,81,249
Library Journals	7,55,01,643	63,921	88,88,406	-	8,44,53,970	40%	6,18,40,409	18,03,250	54,64,494	6,91,08,152	1,53,45,818	1,36,61,234
Maps & Imagery	1,04,73,808	-	83,686	-	1,05,57,494	15%	86,45,948	6,276	2,74,179	89,26,403	16,31,091	18,27,859
Lab & Field Equipment	22,56,63,936	20,15,151	48,36,747	1,93,548	23,23,22,286	15%	16,76,75,969	6,65,029	87,02,550	17,70,43,548	5,52,78,738	5,80,16,999
Auxiliary Equipments	52,56,029			-	52,56,029	15%	50,90,429	-	24,840	51,15,269	1,40,760	1,65,600
Communications System	11,89,708			-	11,89,708	15%	10,03,029	-	28,002	10,31,031	1,58,677	1,86,679
Vehicle	93,76,579	-	8,46,965	5,49,685	96,73,859	15%	80,87,177	63,522	1,93,410	83,44,110	13,29,749	12,89,402
Office Equipment	4,24,84,129	42,07,152	36,06,997	15,664	5,02,82,614	15%	3,29,48,284	9,01,598	14,30,729	3,52,80,610	1,50,02,004	95,38,194
Computer & Peripherals	11,79,56,451	16,05,317	42,41,108	2,048	12,38,00,828	40%	11,35,56,492	14,90,348.40	17,60,311.20	11,68,07,152	69,93,676	44,00,778
Building/Civil Construction	37,58,66,835	-		-	37,58,66,835	10%	22,69,79,533	-	1,48,88,730.20	24,18,68,263	13,39,98,572	15,96,25,273
Electrical Fixture & Fittings	62,23,158	1,86,245		-	64,09,403	10%	39,20,391	18,625	2,30,277	41,69,292	22,40,111	23,02,766
Land for Colony	17,43,991			-	17,43,991	0%	-	-	-	-	17,43,991	17,43,991
Land Purchase for Office(Belgaum)	8,75,180			-	8,75,180	0%	-	-	-	-	8,75,180	8,75,180
Fiber Hut	3,32,950			-	3,32,950	15%	2,77,232	-	8,358	2,85,590	47,360	55,717
Generator Set	88,56,011			-	88,56,011	15%	69,56,038	-	2,84,996	72,41,034	16,14,977	18,99,974
	-			-	-		-	-	-	-	-	-
B. INTANGIBLE ASSETS	-			-	-		-	-	-	-	-	-
Software	17,19,642	1,264	66,02,729	-	83,23,635	40%	8,57,862	13,21,051.40	3,44,712	25,23,626	58,00,009	8,61,781
TOTAL (In Rs.)	**92,21,77,213**	**81,38,683**	**3,14,92,186**	**8,49,133**	**96,09,58,949**	-	**66,61,75,791**	**64,24,659**	**3,48,12,861**	**70,74,13,311**	**25,35,45,638**	**26,67,80,412**
Capital Work in Progress	8,23,94,348	3,13,744	15,34,347	-1848091.00	8,23,94,348		0.00			0.00	8,23,94,348	8,23,94,348
TOTAL (In Rs.)	**1,00,45,71,561**	**84,52,427**	**3,30,26,533**	**(9,98,958)**	**1,04,70,49,479**	-	**66,61,75,791**	**64,24,659**	**3,48,12,861**	**70,74,13,311**	**33,59,39,986**	**34,91,74,760**

SINGH AMIT & ASSOCIATES CA AMIT SINGH INDIA CHARTERED ACCOUNTANTS FRN 019157C M.NO-425374 ROORKEE

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024
Sponsored

SCHEDULE-8 : PROPERTY, PLANT & EQUIPMENT (Amount - Rs.)

Descriptions	GROSS BLOCK					DEPRECIATION				NET BLOCK	
	Cost as on 1-Apr-23	Additions Before 30-Sep-23	Additions After 30-Sep-23	Deletions during the year	Cost as on 31-Mar-24	Rate of Depreciation	At the beginning of the year	For the Year	Value as on 31-Mar-24	As on 31-Mar-24	As on 31-Mar-23
A. PROPERTY, PLANT & EQUIPMENT											
Lab Equipment	2,32,41,320	-	38,67,189	-	2,71,08,509	15%	-	37,76,237	37,76,238	2,33,32,271	2,32,41,320
Civil Work	50,939				50,939	10%	-	5,094	5,095	45,844	50,939
Computer & Machinery	4,42,485	-	-	-	4,42,845	40%	-	1,77,138	1,77,139	2,65,706	4,42,845
TOTAL (In Rs.)	**2,37,34,744**	-	**38,67,189**	-	**2,76,02,293**		-	**39,58,469**	**39,58,472**	**2,36,43,821**	**2,37,35,104**

SINGH AMIT & ASSOCIATES CA AMIT SINGH INDIA CHARTERED ACCOUNTANTS FRN-019157C M.No-525374 ROORKEE

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राष्ट्रीय जलविज्ञान संस्थान
National Institute of Hydrology
रूड़की / Roorkee-247 667

NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024
Employee Welfare Fund

SCHEDULE-8 : PROPERTY, PLANT & EQUIPMENT (Amount - Rs.)

Descriptions	GROSS BLOCK					DEPRECIATION				NET BLOCK	
	Cost as on 1-Apr-23	Additions Before 30-Sep-23	Additions After 30-Sep-23	Deletions during the year	Cost as on 31-Mar-24	Rate of Depreciation	At the beginning of the year	For the Year	Value as on 31-Mar-	As on 31-Mar-24	As on 31-Mar-23
A. PROPERTY, PLANT & EQUIPMENT											
Equipment	44,326	-	-	-	44,326	15%	20,269	3,608	23,878	20,448	24,056
TOTAL (In Rs.)	**44,326**	**-**		**-**	**44,326**		**20,269**	**3,608**	**23,878**	**20,448**	**24,056**

SINGH AMIT & ASSOCIATES
CA AMIT SINGH
CHARTERED ACCOUNTANTS
FRN-019157C
M.No-425374
ROORKEE

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

CONSULTANCY

SCHEDULE-8 : PROPERTY, PLANT & EQUIPMENT

(Amount - Rs.)

Descriptions	GROSS BLOCK					DEPRECIATION				NET BLOCK	
	Cost as on 1-Apr-23	Additions		Deletions during the year	Cost as on 31-Mar-24	Rate of Depreciation	At the beginning of the year	For the Year	Value as on 31-Mar-24	As on 31-Mar-24	As on 31-Mar-23
		Before 30-Sep-23	After 30-Sep-23								
A. PROPERTY, PLANT & EQUIPMENT											
Lab Equipment	95,325	-	-	-	95,325	15%	-	14,299	14,299	81,026	95,325
Computer	38,352	9,815	-	-	48,167	40%	-	19,267	19,267	28,900	38,352
TOTAL (In Rs.)	1,33,677	9,815	-	-	1,43,492		-	33,566	33,568	1,09,926	1,33,677

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE - 9 : INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS (Amount in Rupees)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
1. In Government Securities	-	-	-	-	-	-	-	-	-	-
2. Other approved Securities	-	-	-	-	-	-	-	-	-	-
3. Shares	-	-	-	-	-	-	-	-	-	-
4. Debentures and Bonds	-	-	-	-	-	-	-	-	-	-
5. FDR made	-	-	-	-	15,00,00,000	13,93,17,116	-	-	-	28,93,17,116
6. Other (to be specifiecd)	-	-	-	-	-	-	-	-	-	-
TOTAL (In Rs.)	-	-	-	-	**15,00,00,000**	**13,93,17,116**				**28,93,17,116**

SCHEDULE - 10 : INVESTMENTS - OTHERS

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
1. In Government Securities	-	-	-	-	-	-	-	-	-	-
2. Other approved Securities	-	-	-	-	-	-	-	-	-	-
3. Shares	-	-	-	-	-	-	-	-	-	-
4. Debentures and Bond	-	-	-	-	-	-	-	-	-	-
5. Subsidiaries and Joint Ventures	-	-	-	-	-	-	-	-	-	-
6. Others (to be specified)	-	-	-	-	-	-	-	-	-	-
TOTAL (In Rs.)	-	-	-	-	-	-	-	-	-	-

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE - 11 : CURRENT ASSETS, LOANS, ADVANCES ETC. (Amount - Rs.)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
A. CURRENT ASSETS:										
1. Inventories:										
a) Stores and Spares	-	-	-	-	-	-	-	-	-	-
2. Sundry Debtors:										
a) Debts Outstanding for a period exceeding six months	2,41,900	-	-	-	3,12,17,905	-	-	-	-	3,14,59,805
b) Others	-	-	-	-	-	-	-	-	-	-
3. Cash balances in hand (including cheques/drafts and imprest)	-	-	-	-	-	-	-	-	-	-
4. Bank Balances:										
a) With Scheduled Banks:										-
- On Savings Bank Accounts at Headquarter	2,92,24,432	2,94,24,392	53,34,539	3,33,68,670	3,95,45,397	67,63,011	56,47,271	31,16,306	-	15,24,24,019
5. G-TDS & TDS Assets	-	-	-	8,14,684	-	-	-	-	-	8,14,684
										-
TOTAL(In Rs.) (A)	**2,94,66,332**	**2,94,24,392**	**53,34,539**	**3,41,83,354**	**7,07,63,302**	**67,63,011**	**56,47,271**	**31,16,306**	**-**	**18,46,98,508**
B. LOANS, ADVANCES AND OTHER ASSETS										
1. Loans										
a) Staff (as per list 'I')	3,61,794	18,76,674	16,000	-	-	-	-	-	-	22,54,468
b) Others - Departmental Advances (as per list 'II')	16,56,061	9,672	66,676	1,92,809	2,07,868	-	31,250	-	-	21,64,336
2. Advances and other amounts recoverable in cash or in kind or for value to be received:										
a) Staff Imprest A/c	33,777	-	-	-	-	-	-	-	-	33,777
b) Advances to Firms	1,57,83,352	82,33,247	5,44,595	53,65,335	26,45,654		1,36,68,869			4,62,41,052
c) Advances for Constructions (As per list 'III')	2,73,29,407	25,00,000	-	-	-	-	-	-	-	2,98,29,407
d) Advance to Govt. Institutions	-	-	-	-	-	-	-	-	-	-
e) Third Party Advances	-	-	-	1,19,03,189	-	-	-	-	-	1,19,03,189
d) Pre-paid Expenses	-	-	-	-	-	-	-	-	-	-
e) Deposits (As per list 'IV')	6,27,620	5,40,243	-	-	-	-	-	-	-	11,67,863
f) Central Ground Water Board , Faridabad	-	-	-	-	-	-	-	-	-	-
g) Other Advances	-	-	-	-	1,89,415	-	-	-	-	1,89,415
h) GST Input	-	-	-	-	7,65,797	-	-	-	-	7,65,797
i) Service Tax receivable	-	-	-	-	93,549	-	-	-	-	93,549
j) GTDS receivable	-	-	-	-	18,806	-	-	-	-	18,806
k) TDS Recoverable	-	-	-	-	44,74,865	-	-	-	-	44,74,865
TOTAL(In Rs.) (B)	**4,57,92,011**	**1,31,59,836**	**6,27,271**	**1,74,61,333**	**83,95,954**	**-**	**1,37,00,119**	**-**	**-**	**9,91,36,524**
TOTAL(In Rs.) (A + B)	**7,52,58,344**	**4,25,84,228**	**59,61,810**	**5,16,44,687**	**7,91,59,256**	**67,63,011**	**1,93,47,390**	**31,16,306**	**-**	**28,38,35,032**

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Annexures to Schedule - 11

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
List 'I' Staff										
Festival Advance	-	525	-	-	-	-	-	-	-	525
Cycle Advance	-	7,429	-	-	-	-	-	-	-	7,429
House Building Advance	-	(125)	-	-	-	-	-	-	-	(125)
Interest Accrued on House Building Advance	-	11,36,033	-	-	-	-	-	-	-	11,36,033
Medical Advance	-	(22,249)	-	-	-	-	-	-	-	(22,249)
L.T.C. Advance	1,18,936	1,46,142	-	-	-	-	-	-	-	2,65,078
T.A. Advance	2,42,858	4,28,265	16,000	-	-	-	-	-	-	6,87,123
CPF Recoverable	-	1,80,654	-	-	-	-	-	-	-	1,80,654
Total(In Rs.)	**3,61,794**	**18,76,674**	**16,000**	**-**	**-**	**-**	**-**	**-**	**-**	**22,54,468**
List 'II' Others - Departmental Advances										
Departmental Advances	7,06,212	40,997	66,676	1,32,809	2,07,868	-	31,250	-	-	11,85,812
Advance to RC		-	-	60,000	-	-	-	-	-	60,000
RC Belgaum	64,423	(36,475)	-	-	-	-	-	-	-	27,948
RC Guwahati	3,000	-	-	-	-	-	-	-	-	3,000
RC Jammu	(1)	26	-	-	-	-	-	-	-	25
RC Kakinada	13,795	557	-	-	-	-	-	-	-	14,352
RC Patna	(3,809)	3,000	-	-	-	-	-	-	-	(809)
RC Bhopal	23,310	1,567	-	-	-	-	-	-	-	24,877
RC Jodhpur	-	-	-	-	-	-	-	-	-	-
Non Scheme Fund (Sale of Vehicle)	5,49,685									
Non Scheme Fund (Sale of Scrap)	2,99,448									
Total	**16,56,061**	**9,672**	**66,676**	**1,92,809**	**2,07,868**	**-**	**31,250**		**-**	**13,15,203**

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Annexures to Schedule - 11										
List 'III' Advances for Constructions										-
EE, CPWD, Kakinada	1,45,630	-	-	-	-	-	-	-	-	1,45,630
EE, CPWD, Patna	1,02,72,200	25,00,000	-	-	-	-	-	-	-	1,27,72,200
EE, CPWD, Dehradun	1,87,59,668	-	-	-	-	-	-	-	-	1,87,59,668
NPCC Dehradun		-	-	-	-	-	-	-	-	-
Less: Capital WIP	(18,48,091)	-								(18,48,091)
Total(In Rs.)	**2,73,29,407**	**25,00,000**	-	-	-	-	-	-	-	**2,98,29,407**
List 'IV' Deposits										
Security Deposits for Gas Cylinders	3,300	350	-	-	-	-	-	-	-	3,650
Security Deposits With UPCL Roorkee	2,65,030	4,24,109	-	-	-	-	-	-	-	6,89,139
Deposits to UPSEB for Sub-Station	-	8,480	-	-	-	-	-	-	-	8,480
SDO (Telegraph) for Telephones	13,840	10,649	-	-	-	-	-	-	-	24,489
Security Deposits for Telephones at RC Belgaum	21,100	-	-	-	-	-	-	-	-	21,100
D.G.M. Telecom for Telephones at Guwahati	10,000	-	-	-	-	-	-	-	-	10,000
Deepti Gas Agency, Guwahati	502	530	-	-	-	-	-	-	-	1,032
Accounts Officer (Tel), Jammu	2,880	-	-	-	-	-	-	-	-	2,880
Accounts Officer (Tel.), Patna	16,950	-	-	-	-	-	-	-	-	16,950
Accounts Officer (Tel.), Kakinada	11,710	-	-	-	-	-	-	-	-	11,710
SDO (Tel), Sagar	12,000	-	-	-	-	-	-	-	-	12,000
R.C. Sagar	7,604	-	-	-	-	-	-	-	-	7,604
A.P. State Elect. Board, Kakinada	87,220	-	-	-	-	-	-	-	-	87,220
Accounts Officer (Tel.) Roorkee	5,600	-	-	-	-	-	-	-	-	5,600
Deposits made by NIH to outside Parties	16,970	-	-	-	-	-	-	-	-	16,970
Security deposit from Gangotri project	25,000	-	-	-	-	-	-	-	-	25,000
E.E. UPCL, Roorkee for staff colony	1,26,714	96,125	-	-	-	-	-	-	-	2,22,839
BSNL, Kakinada	1,200	-	-	-	-	-	-	-	-	1,200
Total(In Rs.)	**6,27,620**	**5,40,243**	-	-	-	-	-	-	-	**11,67,863**

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE - 12 : INCOME FROM SALES/SERVICES (Amount - Rs.)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
1) Income from Sales	-	-	-	-	-	-	-	-	-	-
(a) Sale of Services	-	-	-	-	-	-	-	-	-	-
2) Income from Services										
(a) Water Testing Charges	-	3,92,861	-	-	-	-	-	-	-	3,92,861
(b) Guest House Receipts	-	19,33,921	-	-	-	-	-	-	-	19,33,921
(c) Sale of Tender Documents	2,500	20,000	-	-	-	-	-	-	-	22,500
(d) Licence fee	-	6,32,767	-	-	-	-	-	-	-	6,32,767
(e) Income from RTI	-	10	-	-	-	-	-	-	-	10
(f) Application Fees	-	1,16,550	-	-	-	-	-	-	-	1,16,550
(g) Consultancy Fees	-	-	-	-	5,66,73,171	-	-	-	-	5,66,73,171
(h) Others	97,568	1,21,778	-	2,438	-	-	20,676	-	-	2,42,460
Total(In Rs.)	**1,00,068**	**32,17,887**	**-**	**2,438**	**5,66,73,171**	**-**	**20,676**	**-**	**-**	**6,00,14,240**

SCHEDULE - 13 : GRANTS/SUBSIDIES
(Irrevocable Grants & Subsidies Received) (Amount - Rs.)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP *	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
1) Central Government										
Grant from MOWR, Govt. of India	3,57,00,000	49,00,00,000	2,36,28,372	-	-	-	-	-	-	54,93,28,372
Less: Lapsed	-	(97,40,877)	-	-	-	-	-	-	-	(97,40,877)
2) State Government(s)	-	-	-	-	-	-	-	-	-	-
3) Government Agencies	-	-	-	-	-	-	-	-	-	-
4) Institutions/Welfare Bodies	-	-	-	2,03,16,971	-	-	11,96,715	-	-	2,15,13,686
5) International Organisations	-	-	-	-	-	-	-	-	-	-
Total(In Rs.)	**3,57,00,000**	**48,02,59,123**	**2,36,28,372**	**2,03,16,971**	**-**	**-**	**11,96,715**			**56,11,01,181**

Note - The above grants consists of General & Salary grants received, for incurring revenue expenditures of Institute.

- Grants received in NHP A/c during the year consists of Grant amounting to Rs. 1,47,46,372 received in April 2023, in lieu of Grant lapsed as on 31st March 2023 respectively.

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE - 14 : FEES/SUBSCRIPTIONS (Amount - Rs.)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
1) Entrance Fees 2) Annual Fees/Subscriptions 3) Seminar/Program Fees 4) Consultancy Fees 5) Others (Specify)	NIL									
Total(In Rs.)										

SCHEDULE - 15 : INCOME FROM INVESTMENTS
(Income on Investment from Earmarked/Endowment Funds transferred to Funds)

(Amount - Rs.)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
1) Interest a) On Govt Securities b) Other Bonds/Debentures 2) Dividends a) On Shares b) On Mutual Fund Securities 3) Rents 4) Others (Specify)	NIL									
Total(In Rs.)										
TRANSFERRED TO EARMARKED/ENDOWMENT FUNDS										

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE - 16 : INCOME FROM OTHER SOURCES (Amount - Rs.)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
1) Seminar, Courses and Workshops	-	-	-	-	-	-	-	-	-	-
2) Registration fee for training course	-	-	-	-	-	-	-	-	-	-
3) Others	-	-	-	-	-	-	-	-	-	
Total(In Rs.)	-	-	-	-	-	-	-	-	-	-

SCHEDULE - 17 : INTEREST EARNED (Amount - Rs.)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
1) On Fixed Deposits with Scheduled Bank	-	-	-	-	-	71,75,801	-	-	-	71,75,801.00
2) On Savings Accounts	-	-	-	-	-	9,13,539	1,55,715	99,351	-	11,68,605.00
3) On T A Advance	-	-	-	-	-	-	-	-	-	-
4) on NIH P.F. balances	-	-	-	-	-	-	-	-	-	-
5) Interest accrued on the house building advances	-	-	-	-	-	-	-	-	-	-
6) Interest accrued on scooter advance	-	-	-	-	-	-	-	-	-	-
7) Interest on Intt. Bearing Advance	-	-	-	-	-	-	-	-	-	-
8) Interest accrued on Security with UPFCL RKE	-	-	-	-	-	-	-	-	-	-
9) Interest on Leave Travel Claim	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
Total(In Rs.)	-	-	-	-	-	80,89,340	1,55,715	99,351	-	83,44,406

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE 18 : OTHER INCOME - (Amount - Rs.)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
1) Profit on Sale/disposal of Assets :										
a) Owned assets	-	-	-	-	-	-	-	-	-	-
b) Assets acquired out of grants	-	-	-	-	-	-	-	-	-	-
2) Miscellaneous Income										-
a) Misc. Receipt	-	-	-	7,21,455	-	1,60,002	-	-	-	8,81,456.78
b) Licence Fee R.C	-	-	-	-	-	-	-	-	-	-
c) Application Fees	-	-	-	-	-	-	-	-	-	-
d) Workshop	-	-	-	-	-	-	-	-	-	-
	-	-								-
3) Income from Overhead Charges	-	-	-	-	-	8,29,542	-	-	-	8,29,542.00
4) Income from hindi Snghoshthi	-	-	-	-	-	-	-	-	-	-
5) Refund of Income Tax	-	-	-	-	-	-	-	-	-	-
6) Mandays	-	-	-	-	-	-	-	-	-	-
Total(In Rs.)	**-**	**-**	**-**	**7,21,455**	**-**	**9,89,544**	**-**	**-**	**-**	**17,10,999**

SCHEDULE 19 - INCREASE/(DECREASE) IN STOCK OF FINISHED GOODS (Amount - Rs.)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
a. Closing stock										
-Finished Goods	-	-	-	-	-	-	-	-	-	-
-Work-in-progress	-	-	-	-	-	-	-	-	-	-
b. Less: Opening Stock										
-Finished Goods	-	-	-	-	-	-	-	-	-	-
-Work-in-progress	-	-	-	-	-	-	-	-	-	-
NET INCREASE/(DECREASE) [a-b]	**-**	**-**	**-**	**-**	**-**	**-**	**-**			**-**

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[illegible]-247 667

NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE 20 : ESTABLISHMENT EXPENSES

(Amount - Rs.)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
(a) Pay & Allowances (Annexure 1)	-	28,51,22,111	-	-	-	26,56,558	-	-	-	28,77,78,669
(b) Bonus	-	-	-	-	-	-	-	-	-	-
(c) Medical	-	63,19,795	-	-	-	-	-	-	-	63,19,795
(d) Leave Salary & Pension Contribution	-	-	-	-	-	-	-	-	-	-
(e) Employer's Contribution CPF	-	95,05,214	-	-	-	-	-	-	-	95,05,214
+Contribution towards shortfall in Intt. On CPF (Annexure 2)	-	2,84,72,906	-	-	-	-	-	-	-	2,84,72,906
(f) Honorarium	2,85,390	3,86,167	80,880	52,000	-	-	3,26,000	-	-	11,30,437
(g) Leave Encashment	-	2,79,31,138	-	-	-	-	-	-	-	2,79,31,138
(h) Leave Travel Expenses	-	15,56,956	-	-	-	-	-	-	-	15,56,956
(i) Wages/Salary of Resource Person	2,03,31,431	5,67,40,946	1,33,63,873	49,82,547	13,22,984	-	-	-	-	9,67,41,781
(j) NPS Contribution	-	-	-	-	-	-	-	-	-	-
(k) Retirement / Death Gratuity	-	3,86,39,788	-	-	-	-	-	-	-	3,86,39,788
(l) Leave Encashment LTC	-	10,37,002	-	-	-	-	-	-	-	10,37,002
Total(In Rs.)	**2,06,16,821**	**45,57,12,023**	**1,34,44,753**	**50,34,547**	**13,22,984**	**26,56,558**	**3,26,000**			**49,91,13,686**

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(Annexure 1 to SCHEDULE 20)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
(a) Basic Pay	-	17,04,51,562	-	-	-	-	-	-	-	17,04,51,562
(b) Dearness Allowances	-	7,39,55,154	-	-	-	-	-	-	-	7,39,55,154
(c) House Rent Allowances	-	1,45,80,301	-	-	-	-	-	-	-	1,45,80,301
(d) Overtime Allowances	-	-	-	-	-	-	-	-	-	-
(e) Increament	-	-	-	-	-	13,84,920	-	-	-	13,84,920
(f) Professional Allowance	-	-	-	-	-	12,51,665	-	-	-	12,51,665
(g) Transport Allowances	-	87,71,546	-	-	-	-	-	-	-	87,71,546
(h) Training Course	-	-	-	-	-	19,973	-	-	-	19,973
(i) Special Pay	-	1,60,50,671	-	-	-	-	-	-	-	1,60,50,671
(j) Deputation Allowance	-	-	-	-	-	-	-	-	-	-
(k) Reimb. Of Tuition Fees	-	13,12,875	-	-	-	-	-	-	-	13,12,875
Total(In Rs.)	**-**	**28,51,22,111**	**-**	**-**	**-**	**26,56,558**	**-**	**-**	**-**	**28,77,78,669**

(Annexure 2 to SCHEDULE 20)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
Interest on										
(a) On CPF on Employees own subscription	-	1,26,65,175	-	-	-	-	-	-	-	1,26,65,175
(b) On CPF on Employer's contribution	-	1,58,07,731	-	-	-	-	-	-	-	1,58,07,731
Total (a+b)	**-**	**2,84,72,906**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2,84,72,906**
(c) Less : Interest Received on CPF Investments	-	-								-
Total (a+b-c)	**-**	**2,84,72,906**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2,84,72,906**

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE - 21 : OTHER ADMINISTRATIVE EXPENSES ETC. (Amount - Rs.)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
OFFICE EXPENSES :										
(1) Elect./Water charges & Generator Running Cost	-	72,02,466	-	-	-	-	-	-	-	72,02,466
(2) Stationery & Printing	9,05,293	5,52,346	-	-	-	-	-	-	-	14,57,639
(3) Postage	27,976	1,56,867	-	-	-	-	-	-	-	1,84,843
(4) Telephone	1,164	17,58,956	-	-	-	-	-	-	-	17,60,120
(5) Rent, Rates & Taxes	60,298	27,63,513	-	-	-	-	-	-	-	28,23,811
(6) Liveries	-	1,15,000	-	-	-	-	-	-	-	1,15,000
(7) Hospitality Expenses	6,24,014	2,40,316	-	-	-	-	-	-	-	8,64,330
(8) Advertisement	12,700	4,89,684	11,453	4,158	-	-	-	-	-	5,17,995
(9) Running cost of Lab./Computer	18,67,423	9,74,258	-	-	-	-	-	-	-	28,41,681
(10) Publication (Printing of Tech. Reports)	99,780	30,387	-	-	-	-	-	-	-	1,30,167
(11) Training Courses/Workshops	2,31,882	(10,788)	-	-	-	-	7,62,322	-	-	9,83,416
(12) Seminar & Conference	20,52,285	6,95,641	-	-	-	-	74,662	-	-	28,22,588
(13) Conveyance Charge	57,920	73,440	-	-	-	-	-	-	-	1,31,360
(14) Payment for Professional & Other Services	10,28,182	4,06,490	20,68,431	-	-	-	-	-	14,897	35,18,000
(15) T.A. to Candidates	-	-	-	-	-	-	-	-	-	-
(16) T.A. to Non-Officials	3,25,643	3,54,784	-	-	11,60,826	-	81,644	-	-	19,22,897
(17) Maintainance Fees - R&D Support Fund	96,000	-	-	-	-	-	-	-	-	96,000
(18) Newspapers/Periodicals	3,894	6,55,807	-	-	-	-	-	-	-	6,59,701
(19) Misc. Expense	37,92,899	4,54,665	30,559	13,81,386	27,806	-	-	-	1,67,640	58,54,955
(20) Travelling Expenses	-	-	-	2,73,199	-	-	3,300	-	-	2,76,499
(21) Field expenses	66,55,575	-	62,894	1,45,498	6,58,703	-	-	-	-	75,22,670
(22) Contingency	6,10,385	15,45,596	59,530	4,08,758	1,66,510	-	7,430	-	-	27,98,209
(23) Bank Charges	2,447	3,455	-	-	-	-	-	-	161	6,063
(24) Consumables	-	-	1,09,631	5,49,397	3,36,308	-	2,569	-	-	9,97,905
(25) Office Expenses	-	-	-	-	-	-	-	-	-	-
(26) T.A Claim	-	37,78,047	8,24,650	7,27,267	-	-	42,787	-	-	53,72,751
(27) Audit Fees	-	-	-	77,576	-	-	-	-	-	77,576
(28) Overhead Charges	-	-	2,27,649	9,97,482	-	-	-	-	-	12,25,131
(29) Fellowship	-	-	-	28,62,927	-	-	-	-	-	28,62,927
(30) Consultancy Service/ Training courses fee	-	-	10,93,457	7,98,756	72,342	-	-	-	-	19,64,555
(31) Manpower	-	-	-	3,03,295	-	-	-	-	-	3,03,295
(32) Transfer Unspent Balance	-	-	-	-	-	-	-	-	38,49,420	38,49,420
(33) Staff Welfare	-	-	-	-	-	-	-	15,31,749	-	15,31,749
(34) Swachta Action Plan	2,89,546	14,314	-	-	-	-	-	-	-	3,03,860
(35)Experimental Charges	-	-	2,88,238	-	4,47,064	-	-	-	-	7,35,302
(36)Chemical & glassware (R&D)	17,29,406	-	-	-	-	-	-	-	-	17,29,406
(37) External Expenditure	-	-	-	-	14,36,894	-	-	-	-	14,36,894
(38) Analysis Charges	-	-	-	55,940	-	-	-	-	-	55,940
(39) Meeting	-	-	-	-	-	-	-	-	-	-
(40) POL	1,11,000	11,99,292	-	-	-	-	-	-	-	13,10,292
Total(In Rs.) (a)	**2,05,85,712**	**2,34,54,536**	**47,76,492**	**85,85,639**	**43,06,453**		**9,74,714**	**15,31,749**	**40,32,118**	**6,82,47,413**

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MAINTENANCE EXPENSES :										
(1) Lab./Workshop Equipment	-	12,92,705	-	-	-	-	-	-	-	12,92,705
(2) Communications	-	5,398	-	-	-	-	-	-	-	5,398
(3) Generator Set	-	3,12,506	-	-	-	-	-	-	-	3,12,506
(4) Computer Peripherals	-	15,50,437	-	-	-	-	-	-	-	15,50,437
(5) Buildings & Bulk Services	-	1,03,69,398	-	-	-	-	-	-	-	1,03,69,398
(6) Office Equipment	-	14,59,764	-	-	-	-	-	-	-	14,59,764
(7) Furniture & Fixture	-	2,38,565	-	-	-	-	-	-	-	2,38,565
(8) Vehicle	-	5,11,595	-	-	-	-	-	-	-	5,11,595
(9) Library Books	-	7,000	-	-	-	-	-	-	-	7,000
(10) Other Auxilary Equipments	-	-	-	-	-	-	-	-	-	-
Total(In Rs.) (b)	-	**1,57,47,368**	-	-	-	-	-	-	-	**1,57,47,368**
Total(In Rs.) (a+b)	**2,05,85,712**	**3,92,01,903**	**47,76,492**	**85,85,639**	**43,06,453**	-	**9,74,714**	**15,31,749**	**40,32,118**	**8,39,94,781**

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NATIONAL INSTITUTE OF HYDROLOGY , ROORKEE
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2024

SCHEDULE - 22 : EXPENDITURE ON GRANTS, SUBSIDIES ETC. (Amount - Rs.)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
(a) Grants given to Institutions/Organisations	NIL									
(b) Subsidies given to Institutions/Organisations										
Total(In Rs.)										

SCHEDULE - 23 : Interest (Amount - Rs.)

Particulars	Current Year									TOTAL
	Scheme	Non-Scheme	NHP	Sponsored	Consultancy	R&D Support Fund	Training Course	Employee Welfare Fund	NMSHE	
(a) On Fixed Loans	NIL									
(b) On Other Loans (including Bank Charges)										
(c) Others (specify)										
Total(In Rs.)										

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NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE

SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE PERIOD ENDED 31st MARCH 2024

SCHEDULE 24 – SIGNIFICANT ACCOUNTING POLICIES-

1. ACCOUNTING CONVENTION

The financial statements are prepared on the basis of historical cost convention, unless otherwise stated and on the actual method of accounting.

2. INVESTMENTS

2.1 Investments classified as "long term investment" are carried at cost. Provision for decline, other than temporary, is made in carrying cost of such investments.

2.2 Investments classified as "Current" are carried at lower of cost and fair value. Provision for shortfall on the value of such investments is made for each investment considered individually and not on a global basis.

2.3 Cost includes acquisition expenses like brokerage, transfer stamps.

3. FIXED ASSETS

3.1 Fixed Assets are stated at cost of acquisition inclusive of inward freight, duties and taxes and incidental and direct expenses related to acquisition. In respect of projects involving construction, related pre-operational expenses (including interest on loan for specific project prior to its completion), form part of the value of the assets capitalized.

3.2 Fixed Assets received by way of non-monetary grants, (other than towards the Corpus Fund), are capitalized at values stated, by corresponding credit to Capital Reserve.

4. DEPRECIATION

4.1 Depreciation is provided on Written-Down Value method as per rates specified in the Income-tax, 1961 except depreciation on cost adjustments arising on account of conversion of foreign currency liabilities for acquisition of fixed assets, which is amortized over the residual life of the respective

4.2 In respect of additions to/deductions from fixed assets during the year, depreciation is considered on pro-rata basis.

4.3 Assets costing Rs. 5,000/- or less each are fully provided.

5. MISCELLANEOUS EXPENDITURE

Deferred revenue expenditure is written off over a period of 5 year from the year it is incurred.

6. ACCOUNTING FOR SALES / SERVICES

Sales/Services include excise duty and are net of sales returns, rebate and trade discount.

7. GOVERNMENT GRANTS/SUBSIDIES

7.1 Government grants of the nature of contribution towards capital cost of setting up projects are treated as Capital Reserve.

7.2 Grants in respect of specific fixed assets acquired are shown as a deduction from the cost of the related assets.

7.3 Government grants/subsidy are accounted on realization basis.

8. RETIREMENT BENEFITS

8.1 Liability towards gratuity payable on death/retirement of employees is accrued based on actuarial valuation.

8.2 Provision for accumulated leave encashment benefit to the employees is accrued and computed on the assumption that employees are entitled to receive the benefit as at each year end.

For Singh Amit & Associates
Chartered Accountants
FRN : 019157C



CA Amit Singh
FCA, LLB
(Partner)
M.No. – 425374

Place : Roorkee
Date : 11/4/2025

UDIN: 25425374BMJRMM5219

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE

SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE PERIOD ENDED 31st MARCH 2024

SCHEDULE 25 – CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS -

1. CONTINGENT LIABILITIES

a) Claims against the Entity not acknowledged as debts – NIL (Previous year Rs. NIL)

b) In respect of:
- Bank guarantees given by/on behalf of the Entity – Rs. NIL (Previous year Rs NIL)
- Letters of Credit opened by Bank on behalf of the Entity – Rs. NIL (Previous year Rs. NIL)
- Bills discounted with bank Rs NIL (Previous year Rs. NIL)

c) Demands in respect of:
Income-tax – TDS Rs. 6080 (Previous year Rs. NIL)
Sales-tax Rs NIL (Previous year Rs NIL)
Municipal Taxes NIL (Previous year RsNIL)

d) In respect of claims from parties for non-execution of orders, but contested by the Entity – Rs. NIL (Previous year Rs NIL)

2. NOTES TO ACCOUNTS –

a) Corresponding figures for the previous year have been regrouped/rearranged, wherever necessary.

b) Schedules 1 to 25 are annexed to and form an integral part of the Balance sheet as at 31st March, 2024 and the Income and Expenditure Account for the year ended on that date.

c) As per the requirements of the Comptroller & Auditor General of India, the excess of Income over Expenditure/ Expenditure over Income have been transferred to Corpus/Capital Fund instead of earlier practice of NIH to transfer in General Reserve.

d) As per requirement of Comptroller & Auditor & General of India, the capital grant received is shown under Capital Reserves (Schedule-2), and general grant will be shown under Income & Expenditure Accounts respectively.

e) The receipts of Interest by NIH in any form that is payable to Bharatkosh has been treated as current liability instead of earlier practice of NIH to treat it as an interest income.

f) The Journal Vouchers for the Regional Centers are prepared on 31st March ,2024 at Head Office, NIH Roorkee. In case of acquisition of fixed assets, we have taken the actual purchase date for calculation of depreciation.

g) Advance due to and due from parties are subject to confirmation and these balances are shown as appearing in the books of account as on 31st March, 2024.

h) The Institute has obtained the exemption certificate from Income Tax Department under Income Tax Act Section 12AA. The Institute has also obtained the exemption certificate from Income Tax Department under section 35(1) on 15.05.2017.

i) For ensuring proper recording and classifications, the balance sheet for consultancy & Sponsored projects for year ending 31st March, 2024, had been regrouped and totaled again, so that the financial statement show the correct and full picture of financial position of all the Consultancy & Sponsored Projects in FY 2023-24 respectively.

j) The Capital Fund (Schedule-1), Reserves & Surplus (Schedule -2), Earmarked/Endowment Funds (Schedule-3) for the Scheme, Non- Scheme and NHP Projects are majorly revised in compliance with accounting standards, uniform format of accounts for Autonomous Bodies & audit observations raised by respected C&AG for FY 2023-24. These following changes in original balance sheet and revised balance sheet had been highlighted along with reasons as follows –

Reconciliation of Old Audited Accounts with Revised Accounts for FY 2023-24 -

For Scheme Funds – Schedule -

Particulars	Scheme Funds Schedule - 1	Remarks
Old Balance	**35,31,54,672**	
Revised Balance	**31,79,04,262**	
Differences :-	**(3,52,50,410)**	
Changes in Income Over Expenditure	(2,24,43,878)	Since the general Grants had been mixed up with the Capital Grants, the same have been included in Income Head earlier, which is now being rectified vide Audit Para - C.1 , for Scheme Funds.
Prior Period Adjustments - Electricity Security	(5,20,234)	Electricity Security was adjusted with prior Period item, which was found untraceable and same has been rectified vide Audit observation ML- 6
Prior Period Adjustments - Tax Payable	3,40,785	Tax payable was adjusted with prior Period item, which was found untraceable and same has been rectified vide audit observation ML-7
Prior Period Adjustments - Depreciation on Building	(1,25,86,063)	The Depreciation was provided on assets capitalized in current year, but put to use in earlier years as per Observation S.no 5 & ML-9
Prior Period Adjustments - Depreciation to Assets Scrapped	(41,020)	The Depreciation was provided on Assets sold as scrap, but the same has not been deducted from assets, thus, the depreciation for previous year has been

		provided, vide Audit observation No. ML-10

For Scheme Funds – Schedule -2 :-

Particulars	Scheme Funds Schedule - 2	Remarks
Old Balance	**9,17,31,544**	
Revised Balance	**7,29,28,189**	
Differences :-	**(1,88,03,355)**	
Prior Period Adjustment - Fixed Asset	(23,59,625)	This adjustment was provided earlier to record assets purchased in FY 22-23, But since the assets shall be capitalized into Schedule - 8 only, the above entry is now rectified properly vide observation No. E.2
Addition of Fixed Asset	(3,96,30,869)	The fixed assets purchased in FY 23-24, were erroneously also added into Capital Reserve, but since the assets were purchased out of monetary grants only, the assets shall be capitalized into Schedule - 8 only, and not by corresponding credit to Capital Reserve as per the audit observation E.2, and thus, the same has been rectified .
Deduction - Depreciation	64,24,659	The depreciation on only Addition of fixed assets, was deducted from capital reserve earlier, but since all the assets were purchased from monetary grants, the capital grants shall be amortized annually with amount equal to depreciation provided during the year as a whole as per audit observation no. C.1
Addition of Capital Grants	5,80,00,000	The capital grant earlier was mixed with general grant, and thus, the capital grant was now recorded separately into Schedule - 2 vide audit observation No. C.1
Grant amortization during the year	(4,12,37,520)	The depreciation provided during the year, is being deducted from Capital grant to record the annual amortization of Capital Reserve in Schedule -2.

For Scheme Funds – Schedule -3 :-

Particulars	Scheme Funds Schedule - 3	Remarks
Old Balance	**(2,53,02,822)**	
Revised Balance	**1,69,45,466**	

Differences :-	**4,22,48,288**	
R&D Activity (MOWR)	(1,14,48,455)	Earlier amount recorded as grants received under R&D Activity was Rs. 37342442 /-, but after reconciliation of same, it was found that only Rs. 25893987 /-, had been received in FY 2023-24 and the excess balance was now reversed correctly vide observation no. A.4
Expenditure towards R&D activity	4,05,32,472	Earlier amount recorded as expenditure under R&D Activity was Rs. 63744469/-, but after reconciliation of same, it was found that only Rs. 23211997 /-, had been expended towards these funds in FY 2023-24 and thus, the excess expenditure was now reversed correctly vide observation no. A.4
Jal Shakti AbhiyanFunds	15,00,000	The grants received under the Jal Shakti Abhiyan, were earlier mixed with R&D Grants, which has now been reconciled and recorded properly.
State Specific Action Plan (SSAP) Funds	1,16,64,271	The grants received under the SSAP Funds in FY 2023-24 was earlier mixed with R&D Grants, which is now recorded separately under Schedule -3, the related expenditure was also had been recorded properly vide audit observation No. A.3 for FY 2023-24

For Non-Scheme Funds – Schedule -1 :-

Particulars	Non-Scheme Funds Schedule - 1	Remarks
Old Balance	**(28,57,28,230)**	
Revised Balance	**(32,09,88,831)**	
Differences :-	**(3,52,60,601)**	
Changes in Income Over Expenditure	(2,00,03,894)	The expenditures were recorded on cash basis earlier, but since uniform format of accounts for autonomous bodies shall be prepared on accrual basis, all the expenditures related to FY 2023-24, were now being recorded into expenditures, and due to which, the expenditure has exceeded the general grants for FY 2023-24, this deficit has been transferred into Schedule -1 - Capital Funds respectively.
Prior Period Adjustments - Tax Payable	4,72,541	Tax payable was adjusted with prior Period item, which was found unnecessary and same has been rectified vide audit observation ML-7

CPF Contribution Bills for FY 2022-23	(1,56,00,000)	The Establishment Expenditure earlier included amount of Rs. 1.56 Cr. For payment towards CPF Contribution in FY 2023-24, but which pertains to FY 2022-23, thus these has been recorded prior period item vide audit observation no. ML-1
Electricity Deposit(NIH Office)	1,15,824	The electricity security pertaining to earlier years, has been reconciled and recorded as prior period item as per audit observation No. ML-5.
Electricity Deposit(Staff Colony)	54,376	The electricity security pertains to earlier years, has been reconciled and recorded as prior period item as per audit observation No. ML-5.
Sale of Assets as Scrap	(2,99,448)	The management sold some assets amounting to Rs. 299448 /- in FY 2022-23, but these assets had not been reduced from Fixed assets in the same year, and thus, these had been rectified as prior period vide audit observation no. ML-10.

For Non-Scheme Funds – Schedule -2 :-

Particulars	**Non-Scheme Funds**	**Remarks**
	Schedule - 2	
Old Balance	**4,65,82,010**	
Revised Balance	**94,77,351**	
Differences :-	**(3,71,04,659)**	
Prior Period Adjustment - Fixed Asset	(4,63,00,000)	This adjustment was provided earlier to record assets purchased in FY 22-23, But since the assets shall be capitalized into Schedule - 8 only, the above entry is now rectified properly vide observation No. E.2
Addition of Fixed Asset	(3,04,659)	The fixed assets purchased in FY 23-24, were erroneously also added into Capital Reserve, but since the assets were purchased out of monetary grants only, the assets shall be capitalized into Schedule - 8 only, and not by corresponding credit to Capital Reserve as per the audit observation E.2, and thus, the same has been rectified .
Addition of Capital Grants	95,00,000	The capital grant earlier was mixed with general grant, and thus, the capital grant was now recorded separately into Schedule - 2 vide audit observation No. C.1

For Non-Scheme Funds – Schedule -3 :-

Particulars	Non-Scheme Funds Schedule - 3	Remarks
Old Balance	**(4,66,04,659)**	
Revised Balance	-	
Differences :-	**4,66,04,659**	
Expenditure towards Earmarked Funds	4,66,04,659	During the FY 2023-24, the grants received under Non-Scheme Funds does not include any earmarked/endowment funds unlike scheme funds, and resultantly, no expenditure towards earmarked funds is incurred. But despite the fact, expenditure related to fixed assets was arbitrarily recorded as expenditure towards these funds, the adjustment of which is now had been rectified properly.

For NHP Funds – Schedule -1 :-

Particulars	NHP Funds Schedule - 1	Remarks
Old Balance	-	
Revised Balance	**72,76,012**	
Differences :-	**72,76,012**	
Wrong Classification of Capital Funds	1,72,04,536	The opening balance of funds available in NHP A/c under Schedule -3, was wrongly booked under earmarked funds, which now being rectified and transferred into Corpus/Capital Fund - Sch. -1
Closing Bank Balance (Schedule -11)	(1,46,86,116)	The closing Bank Balance of NHP funds included an amount of Rs. 14686116 /-, which comprises the grant lapsed as on 31st March 2023, yet the same was erroneously carried into current FY 2023-24, resulting into overstatement of closing balance of Rs. 20020655 /- (14686116+5334539). The same has been rectified by prior period adjustment vide audit observation no. A.2
Interest payable to Bharatkosh	(3,15,221)	The interest payable to Bharatkosh was erroneously booked under Income & Expenditures in previous financial years, which should be booked in Current Liabilities, and the opening balance is now being recorded as prior period item as per AS -5.

Depreciation on Building	(3,34,314)	The depreciation on "Construction of Car Parking Shed" was provided as prior period item into NHP funds, from the date of put to use of this asset, as observed into audit observation No . ML-9.
Income over Expenditure	54,07,127	The general incomes & Expenditure was wrongly recorded into Schedule -3 of NHP Funds, which shall be recorded in Income & Expenditure Account like other accounts, and thus it has been recorded properly in revised balance sheet of NHP Funds.

For NHP Funds – Schedule -2 :-

Particulars	NHP Funds	Remarks
	Schedule - 2	
Old Balance	**2,74,99,319**	
Revised Balance	**2,48,43,374**	
Differences :-	**(26,55,945)**	
Addition of Fixed Asset	(26,99,529)	The fixed assets purchased in FY 23-24, were erroneously also added into Capital Reserve, but since the assets were purchased out of monetary grants only, the assets shall be capitalized into Schedule - 8 only, and not by corresponding credit to Capital Reserve as per the audit observation E.2, and thus, the same has been rectified .
Prior Period Adjustments - Tax Payable	10,153	Tax payable was adjusted with prior Period item, which was found untraceable and without base, thus the same has been rectified

For NHP Funds – Schedule -3 :-

Particulars	NHP Funds	Remarks
	Schedule - 3	
Old Balance	**1,96,35,792**	
Revised Balance	-	
Differences :-	**(1,96,35,792)**	
Wrong Classification of Capital Funds	(1,72,04,536)	The opening balance of funds available in NHP A/c under Schedule -3, was wrongly booked under earmarked funds, which now being rectified and transferred into Corpus/Capital Fund - Sch. -1

General Grants	(2,36,28,372)	The general grants received for NHP Funds in FY 2023-24, amounting to Rs. 23628372 /- was erroneously recorded into Schedule -3, instead of Income & Expenditure Account.
Interest payable to Bharatkosh	(38,879)	The interest earned in NHP accounts for Rs. 38879 was wrongly booked as income, rather than recording into Schedule - 7 "Current Liabilities & Provision". However, proper classification of grants and interest payable has been made in compliance with audit observation no. ML-8.
Expenditure towards Earmarked Funds	2,12,35,995	The capital as well as revenue expenditure was wrongly booked into Schedule -3, however the same has been now correctly classified according to their nature of transactions into respective schedules

k) The Specific Action Plans (SSAP) funds were recorded and shown separately under Schedule-3 of Scheme Fund, and the Income in form of Maintenance Fees @ 2% of Project Cost were also recorded amounting to Rs. 96,000 under Schedule -7 as payable to R&D Support Fund of NIH.

l) The funds received for SSAP funds were allocated to the specific state agencies through CNA account. However, since the SSAP funds are received into CNA account, the closing bank account balance in respect of these funds, comprise of unallocated amount as well as amount which is allocated yet pending to be expended by respective state agencies, to whom such funds were allocated.

m) The funds in respect to SSAP, R&D activities as well as Jal Shakti Abhiyan received under CNA account, is properly recorded and listed hereby for transparency and reference are mentioned below: -

Details of R&D Fund under Schedule- 3:

Sl. No.	NAME OF AGENCY	Opening Balance 2023-24	Fund Received 2023-24	Allocated	Expenditure as per bank 2023-24	Closing Balance 2023-24
		(a)	(b)	(c)	(d)	(e) = (a+b-d)
1	Association of Agrometeorologists, Gujrat		1,96,000	1,96,000	1,96,000	-
2	Assam Agricultural University, Jorhat		5,00,000	5,00,000	5,00,000	-
3	SRM University - AP		3,50,000	3,50,000		3,50,000
4	Environmental Watch and Management Institute, Guwahati		3,00,000	3,00,000	2,09,808	90,192
5	Banasthali Vidyapith, Rajasthan		2,10,000	2,10,000	1,72,972	37,028
6	Central Arid Zone Research Institute, Jodhpur		2,10,000			2,10,000
7	Centre For Ecology Development And Research Dehradun	-	53,85,491	53,85,491	53,67,697	17,794

8	Center for Environment & Development Study, Jaipur	996	60,000	60,996	45,360	15,636
9	Centre for Water Resources Development and Management, Kerala	35,115	2,74,138	3,09,253	2,74,138	35,115
10	Indian Society of Agriculture Engineers-New Delhi	-	9,50,000	9,50,000	7,10,000	2,40,000
11	IIT Delhi		79,33,450	79,33,450	72,89,837	6,43,613
12	ISG Pune		2,10,000	2,10,000		2,10,000
13	Mody University of Science & Technology, Sikar		2,10,000	2,10,000	2,10,000	-
14	Indian Soicety of Soil Salinity and Water Quality, Karnal		3,50,000			3,50,000
15	ICAR-Indian Institute of Soil Science, Bhopal		2,10,000	2,10,000	2,10,000	-
16	IIT BHU, Varanasi		3,50,000	3,50,000	3,46,030	3,970
17	IIT Bombay		8,61,514	8,61,514	8,61,514	-
18	IIT Hyderabad		1,40,000	1,40,000		1,40,000
19	IIT Kanpur		1,53,206	1,53,206	1,53,206	-
20	IIT Kharagpur	90,104	6,50,000	7,40,104	7,40,104	-
21	IIT Roorkee (NWM)	1,04,420	21,50,280	22,54,700	22,52,088	2,612
22	IIT Jammu		77,000	77,000	77,000	-
23	NIT Srinagar		5,00,000	5,00,000	5,00,000	-
24	Vyakti Vikas Kendra India	2,10,000		2,10,000		2,10,000
25	Karunya Institute of Technology and Sciences, Coimbatore	1,40,000	60,000	2,00,000	60,000	1,40,000
26	Baselios Mathews II College of Engineering		2,55,000	2,55,000	2,55,000	-
27	Karnataka Science and Technology, Academy		2,10,000	2,10,000		2,10,000
28	Dayanand Sagar College of Engineering, Karnataka		1,19,000	1,19,000		1,19,000
29	Navsari Agricultural University, Navsari Gujarat	-	90,000	90,000	90,000	-
30	CSIR NIIST, Thiruvananthapuram		2,10,000	2,10,000	50,000	1,60,000
31	NIT Warangal, Telangana		3,50,000	3,50,000		3,50,000
32	Green Jack Pot International		1,40,000	1,40,000	1,40,000	-
33	Sri Sri University		2,00,000	2,00,000	2,00,000	-
34	Association for Development Initiative, Bhuwneswar		2,10,000	2,10,000	2,10,000	-
35	PEC University of Technology, Chandigarh	-	1,50,000	1,50,000	1,50,000	-
36	SP college, Sirohi	2,08,600	89,400	2,98,000	2,98,000	-
37	Rashtrasant Tukdoji Maharaj, Nagpur, University	-	1,50,000	1,50,000	1,50,000	-
38	Soil Conservation Society of India, New Delhi		3,50,000	3,50,000	3,50,000	-
39	JNTUH College of Engineering Hyderabad	3,05,000	4,29,508	7,34,508	7,34,508	-
40	Environmentalist Foundation of India (EFI)					-
41	Indian Association of Soil & Water Conservationists, Dehradun	4,970	90,000	94,970	92,860	2,110

42	Indian Water Resources Society (IWRS), IITR		3,50,000	3,50,000	3,15,875	34,125
43	SDRK Manavadhikar Foundation		2,10,000			2,10,000
44	AFRI Jodhpur	-				-
45	Experimental Study of Jack Jetty & Porcupine System of River Training	-				-
46	Centre for Water Resources Development and Management, Kerala	-				-
47	Darshak Sanstha, Jaipur					-
	Total Amount	**10,99,205**	**2,58,93,987**	**2,62,23,192**	**2,32,11,997**	**37,81,195**

Details of Jal Shakti Abhiyan Fund under Schedule - 3:

Sl. No.	NAME OF AGENCY	Unique Code	Fund Received 2023-24	Allocated	Expenditure as per bank 2023-24	Balance 2023-24
1	**Pali District**	**RJPA00006539**	5,00,000	5,00,000	-	5,00,000
2	**Thane District**	**MHTH00019762**	5,00,000	5,00,000		5,00,000
3	**Pune District**	**MHPU00030858**	5,00,000	5,00,000		5,00,000
	Total Amount		**15,00,000**	**15,00,000**	**-**	**15,00,000**

Details of SSAP under Schedule – 3:

Sl. No.	NAME OF AGENCY	Fund Received 2022-23	Fund Received 2023-24	TOTAL FUNDS ALLOCATED	Expenditure as per bank 2023-24	Balance of funds available 2023-24
		(a)	(b)	(c)	(d)	(e) = (a+b-d)
1	**State of Kerela (IDRB)**	-	20,00,000	20,00,000	20,00,000	-
2	**Haryana Irrigation**	80,000		80,000		80,000
3	**Water Resources Administration of Punjab**	10,60,000		10,60,000		10,60,000
4	**Municipal Corporation Chandigarh**	4,08,000	9,18,000	13,08,000	6,28,000	6,98,000
5	**Water Resources Department, Jharkhand**	12,00,000		12,00,000		12,00,000

6	**Puduchari**	12,00,000				12,00,000
7	**Dadar Nagar Hewali**	12,00,000				12,00,000
8	**Andman Nikobar**	2,72,298		2,72,298		2,72,298
9	**Bihar**		15,30,000	15,00,000	24,027	15,05,973
10	**Himachal Pradesh**	20,00,000		20,00,000	20,00,000	-
11	**Rajasthan (State water Resources Department, Jaipur)**		20,00,000			20,00,000
12	**Delhi Jal Board**		12,24,000	12,00,000		12,24,000
13	**Lakshadeep**		12,24,000	12,00,000		12,24,000
	Total Amount	**74,20,298**	**88,96,000**	**1,18,20,298**	**46,52,027**	**1,16,64,271**

n) The assets capitalized in FY 2022-23, but put to use in earlier Financial Years were also provided depreciation as prior period item as per AS-5. These assets have been capitalized as and when the utilization certificates were provided to NIH by respective third parties and agencies. However, it was ensured that the depreciation is provided from the date of put to use of these assets respectively as per AS-10. The audit observation raised for same concern under DSAR Point No. 5 & ML-9 is now properly rectified into respective accounts.

o) As per audit observation No. E.2 - The Significant Accounting Policies as prescribed in Form of Financial Statements (Non-Profit Organizations) stipulate in (clause 5.2) under Fixed Assets stipulate that "Fixed Assets received by way of non-monetary grants only, are capitalized at values stated by corresponding credit to Capital Reserve." It is however, noticed that the Assets purchased by NIH during the 2023-24 under Scheme, Non-scheme and NHP amounting to Rs. 396.31 lakh, Rs. 3.05 lakh and 26.99 lakh respectively and Prior period purchased assets of Rs. 23.59 lakh, were credited in Capital Reserve despite the fact these assets were not received as non-monetary grant, rather purchased from the Capital / Monetary Grants received by NIH. Thus, the Fixed assets purchased in FY 2023-24 are capitalized only in Schedule-8, and the Capital Reserve (Sch.-2), is reduced with corresponding amount of depreciation provided to Fixed Assets during the year.

p) As noticed under audit observation No. ML-1, "The Establishment Expenditure (Shedule-20) includes an amount of Rs.1.56 Crore in respect of payment of TSA bills (Interest on CPF EMP Contribution/Subscription) which is pertains to previous year 2022-23". Thus, the same concern had been addressed and rectified as prior period item under the Non-Scheme Funds.

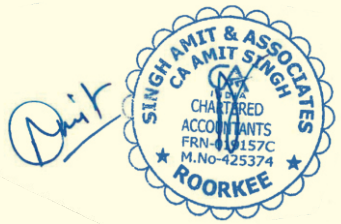
q) The expenditures pertaining to FY 2023-24, but outstanding to be paid as on year end date had been recorded into Sch.20 and Sch.21 as current year expenditures, with corresponding provisions provided into Sch.-7 "Current Liabilities & Provisions" for the FY 2023-24, in compliance of accrual method of accounting.

r) The Electricity Deposits under Sch.-11 of Scheme & Non-Scheme Funds had been properly reconciled and the same had been properly recorded into Deposits (As per list 'VI') as Electricity Deposits for NIH and NIH Colony respectively as also noticed under audit observation ML-5.

s) The Management had sold some assets as Scrap Sale in FY 2022-23 amounting to Rs. 299448 /- which was earlier shown as Income also, these assets were not reduced from Sch.8 "Fixed Assets" correspondingly this has now been rectified in FY 2023-24 along with consideration of Depreciation on these assets on pro-rata basis.

t) The software of Computers purchased amounting to Rs. 36,22,478/ are erroneously added into Computer & Peripherals Assets of Scheme Funds. However, this wrong classification of asset is now had been rectified and corresponding depreciation on these assets had also been recorded respectively.

For Singh Amit & Associates
Chartered Accountants
FRN : 019157C



CA Amit Singh
FCA, LLB
(Partner)
M.No. – 425374

Place: Roorkee
Date : 11/4/2025

UDIN: 25425374BMJRMM5219

APPENDIX-XVII

Separate Audit Report of Comptroller and Auditor General of India for the year 2023-24

Separate Audit Report of the Comptroller & Auditor General of India on the Revised Accounts of National Institute of Hydrology (NIH), Roorkee, Uttarakhand for the year ended 31 March 2024

We have audited the Consolidated Financial Statement of Scheme, Non-Scheme, NHP, Consultancy, Sponsored Project, Training Courses, R&D Support Fund, Welfare Fund & NMSHE (Revised Account) of the National Institute of Hydrology (NIH), Roorkee, Uttarakhand as at 31 March 2024 and the Income & Expenditure Accounts and Receipt & Payment Accounts for the year ended on that date under Section 20(1) of the Comptroller & Auditor General's (Duties, Powers & Conditions of Service) Act, 1971. The audit has been entrusted for the period up to 2025-26. These financial statements are the responsibility of Autonomous Body's Management. Our Responsibility is to express an opinion on these financial statements based on our audit.

2. This Separate Audit Report contains the comments of the Comptroller & Auditor General of India (CAG) on the accounting treatment only with regard to classification, conformity with the best accounting practices, accounting standards and disclosure norms, etc. of National Institute of Hydrology (NIH), Roorkee, Uttarakhand. Audit observation on financial transactions with regards to compliance with the Laws, Rules and regulations (Propriety and Regularity) and efficiency-cum-performance aspects, etc. if any, are reported through Inspection Reports/CAG's Audit Reports separately.

3. We have conducted our audit in accordance with auditing standards generally accepted in India. These standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatements. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of financial statements. We believe that our audit provides a reasonable basis for our opinion.

4. Based on our audit, we report that:

(i) We have obtained all the information and explanations, which to the best of our knowledge and belief were necessary for the purpose of our audit;

(ii) The Balance Sheet, Income and Expenditure Account and Receipt and Payment Accounts dealt with by this report are drawn up in the format as prescribed by the Ministry of Finance, Government of India.

(iii) In our opinion, proper books of accounts and other relevant records have been maintained by National Institute of Hydrology (NIH), Roorkee, Uttarakhand in so far as it appears from our examination of such books.

(iv) We further report that:

A. Income and Expenditure Account

Grant/Subsidies (Schedule 13) – Rs. 56.11 crore

Received Under NHP– Rs. 2.36 crore

The above includes Rs. 88.82 lakh (Rs. 44.41 lakh as general grants – revenue grant; and Rs. 44.41 lakh as grants for creation of capital assets – capital grant) as the grant received under National Hydrology Project as Central Assistance during the year 2023-24. However, NIH showed all the grants received during the year as Revenue Grant which resulted in understatement of Capital Reserve (Schedule 2) and assets created out of grant (fixed assets) during the year by Rs. 44.41 lakh each with corresponding overstatement of surplus by the same amount.

B. General

(i) As per Uniform Format of Accounts for the Central Autonomous Bodies as adopted by National Institute of Hydrology, Roorkee for the year 2023-24 onwards, previous year balance should also be shown in the books of accounts. However, scrutiny of revised consolidated Accounts of NIH Roorkee for the year 2023-24 revealed that NIH did not show the previous year's balances in its books of accounts. Only current year's balances were shown. Thus, NIH did not comply with the approved format adopted by it.

(ii) Non-Compliance with AS 15 – Employee Benefits

Scrutiny of annual accounts for the year revealed that NIH has not complied with the requirements of Accounting Standard (AS) 15 – Employee Benefits.

NIH has not recognized its liability towards gratuity and leave encashment benefits on actuarial valuation in contravention to AS 15The, non-provisioning for retirement benefits on actuarial valuation has an impact on surplus/deficit in the annual accounts, consequently impacting Corpus Fund as well as Current Liabilities and Provisions.

(iii) The head "Current Liabilities and Provisions (Schedule 07)" includes interest payable to Bharatkosh amounting to Rs. 1.77 crore under Consultancy head for interest received on Consultancy Project Saving Bank account. As this is the income/ interest earned on the bank balances from its internal resources, the same should be routed through the Income & Expenditure Account instead of showing it as payable to Bharatkosh.

(iv) The head 'Current assets, Loans, Advances Etc. (Schedule 11)' includes sundry debtors amounting to Rs. 314.60 lakh (Rs. 2.42 lakh under Scheme head & Rs. 312.18 lakh under Consultancy) which were outstanding for a period exceeding six months. However, in contravention to the Uniform Format of Accounts, debts considered good for recovery and those considered doubtful were not shown separately.

Further, these sundry debtors include some receivables amounting to Rs. 42.27 lakh from different firms which have been pending for more than five years. As these receivables have been pending for a long time, the chances of recovery are doubtful. Hence, these should have been provided for in the books of account.

(v) The head 'Current assets, Loans, Advances Etc. (Schedule 11)'includes receivables from different parties under Consultancy head against the consultancy services provided to them by NIH. It was observed that 97 firms made payments to NIH against the bills submitted to them after deductions of Rs. 94.12 lakh.

Out of this, Rs. 82.78 lakh pertains to TDS which have been deposited by the parties against the PAN of NIH which was consequently reflected in 26 AS of the financial year in which payment was made. The remaining amount of Rs. 11.34 lakh deducted by the parties also relates to be other deductions such as GST TDS/ TDS /LDs deductions.

It was ascertained that NIH had claimed a refund of Rs 82.78 lakh from the Income Tax Department which was eventually refunded. However, this amount was still reflected in the books as receivable. The same needs to be reconciled.

C. Revision of Accounts

(i) The Institute, on the basis of audit observations, has revised the accounts. The impact of revision on consolidated financial statements is that the Assets & Liabilities increased by Rs. 45.11 crore and Surplus carried to Corpus/Capital Fund increased by Rs. 1.78 crore.

(ii) The Institute had prepared its earlier accounts on cash basis but it has now prepared its financial statements on accrual basis.

D. Grants in aid

Out of the grants in aid of Rs. 70.47 crore (Rs. 60.20 crore received during the year, Rs. 10.27[1] crore previous year balance and Rs. 0.004 crore interest received), the organization could utilize a sum of Rs. 58.41 crore and interest of Rs. 0.03 crore was refunded, leaving a balance of Rs. 12.03 crore as unutilized grant as on 31 March 2024.

E. Management Letter

Deficiencies which have not been included in this Separate Audit Report have been brought to the notice of the Institute through a Management Letter issued separately for remedial/corrective action.

(v) Subject to our observations in the preceding paragraphs, we report that the Balance Sheet, Income and Expenditure Account and Receipt and Payment Account dealt with by this report are in agreement with the books of accounts.

[1] The closing balance in the SAR for 2022-23 was shown as Rs. 18.72 crore, which was based on incorrect calculation by the Auditee. The same has now been rectified.

(vi) In our opinion and to the best of our information and according to the explanations given to us, the said financial statement read together with the Accounting Polices and Notes on Accounts, and subject to the significant matters stated above and other matters mentioned in Annexure to this Audit Report give a true and fair view in conformity with accounting principles generally accepted in India.

a. *In so far it relates to the Balance Sheet of the state of affairs of the NIH, Roorkee, as at 31 March 2024 and*

b. *In so far as it relates to the Income and Expenditure Account of the surplus for the year ended on that date.*

For and on behalf of C&AG of India

Place: New Delhi
Date: .09.2025

(Kavita Prasad)
Director General of Audit,
Central Expenditure (Agriculture, Food & Water Resources)

NATIONAL INSTITUTE OF HYDROLOGY

MAJOR LABORATORY CAPABILITIES

HYDROLOGICAL INSTRUMENTATION

- Collection, transmission and processing of Hydrometeorological.
- Design & development of Hydrometeoro-logical instruments and data acquisition system.
- Flow/discharge measurement
- Infiltration rate measurement
- Measurement of water level in wells
- Water sampling fro rivers, lakes etc.

NUCLEAR HYDROLOGY

- C^{14}/H^{3} dating of ground water
- Sediment dating using Cs^{137}/Pb^{210}
- Discharge of rivers
- Groundwater velocity measurement
- Leakage/seepage detection from dam/reservoir
- Recharge to ground water
- Soil moisture measurement
- Stable isotopic measurements (D, C^{13}, N^{15}, O^{16}, S^{34})
- Identification of recharge source & zones

REMOTE SENSING APPLICATIONS AND GIS

- Visual and digital image processing
- Ground water zonation mapping
- Food plain mapping
- Land use mapping
- Soil erosion and sedimentation studies
- Snow cover mapping
- Salinity and water logging mapping

CENTRE OF EXCELLENCE FOR ADVANCED GROUNDWATER RESEARCH

- Groundwater quantity and quality modeling
- Integrated catchment modeling
- Unsaturated zone modeling
- Spatial & statistical analysis of groundwater data
- Geological characterizing
- 3D contouring
- Water quality characterization

SOIL-WATER

- Determination of soil moisture characteristic curves (0.1 to 15 bar)
- Determination of soil suction (0 to 0.85 bar)
- In-situ soil mosture measurement
- Premeability measurement
- Particle size analysis of soil
- Infiltration rate measurement
- Soil density measurement

WATER QUALITY

- Analysis of organic carbon, inorganic carbon, total carbon
- Analysis of pesticides & organic compounds
- Bacteriological analysis
- Digestion of BOD & COD samples
- Field measurement of pH, conductivity, and anions
- Analysis of trace elements.

SNOW AND GLACIER

- Stremflow measurement in high altitute region analysis of snow cover
- Degree-day factors for snow and ice melt
- Assessment of suspended sediment concentration
- Modelling of stream flow and snow fed rivers
- Hydrological investigations on glaciers

FACILITIES AT REGIONAL CENTRES

- Hydrological modelling & analysis
- Digital image processing and GIS
- Groundwater exploration
- Hydrometerology
- Remote sensing application Soil Moisture measurement
- Soil sampling & analysis
- Water quality

Regional Centres



National Institute of Hydrology
राष्ट्रीय जल विज्ञान संस्थान
आपो हि ष्ठा मयोभुवः

Contact :

Director,

NATIONAL INSTITUTE OF HYDROLOGY

Department of Water Resources, River Development & Ganga Rejuvenation,
Ministry of Jal Shakti,
Jal Vigyan Bhawan, Roorkee- 247667 (Uttarakhand), INDIA
E-mail : dir.nihr@gov.in
Web : www.nihroorkee.gov.in
Ph.: +91 1332 272106 Fax: +91 1332 272123
Facebook tag : https://www.facebook.com/nihroorkee.gov.in/
Twitter tag : http://twitter.com/NIH_Hydrology