CAPACITY BUILDING OF AFRICAN CENTRES OF EXCELLENCE (ACEs) IN WATER SECTOR – IIT Roorkee at a Glance

Presented by

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MILESTONES

1847 First Engineering College as Roorkee College of Civil Engineering

1854 Renamed as Thomason College of Civil Engineering

1949 Elevated as University of Roorkee

2001 Declared as Indian Institute of Technology, Roorkee

Location

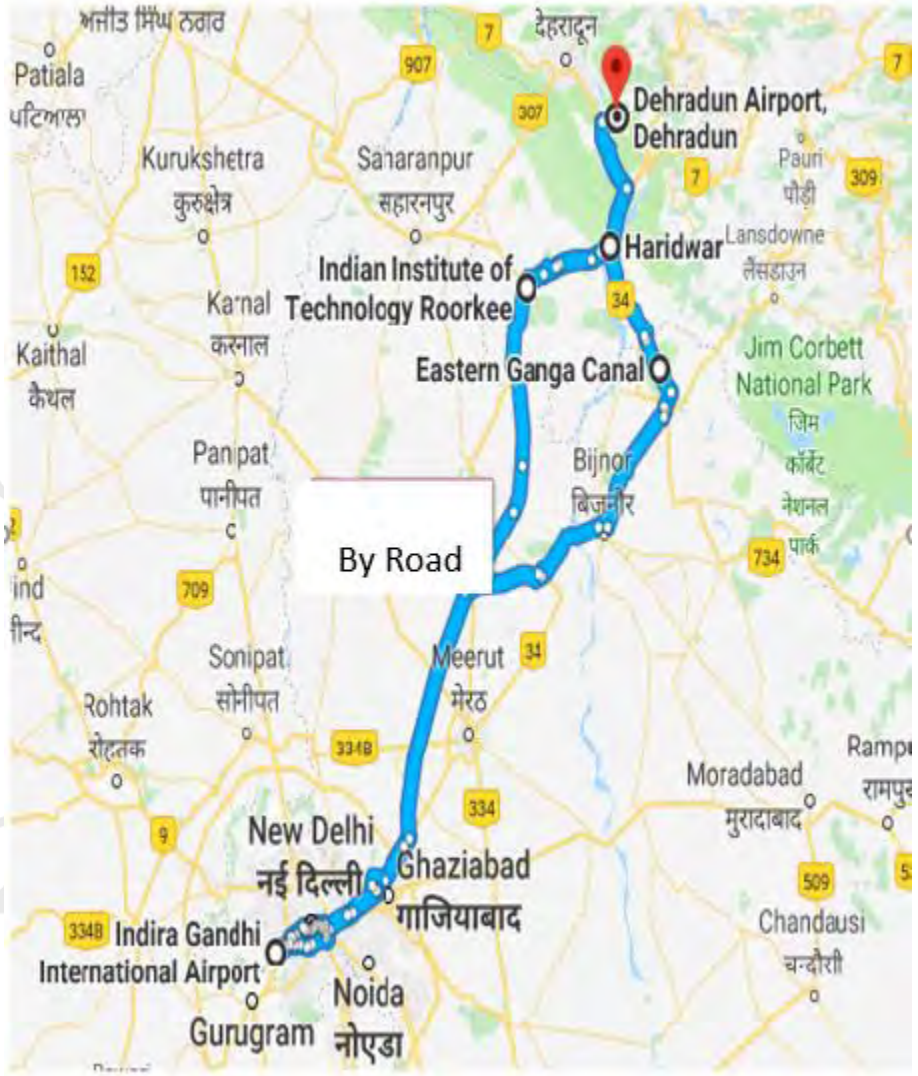
- **Roorkee is the last City in plain before the Himalayas**
- **Three campuses at**

Roorkee (146 ha)

Saharanpur (10 ha)

Greater Noida Extension Center (4 ha)

Estimated Distance TO IIT Roorkee	
Place (**From**)	Kilometers (km)
New Delhi (IGIA)	200
Dehradun Airport	70
Haridwar	30



Icons of Roorkee …

Academic Departments/Centres

- Architecture & Planning
- Bio-technology
- Chemical Engineering
- Chemistry
- **Civil Engineering**
- Earth Sciences
- Earthquake Engineering
- Electrical Engineering
- Electronics & Communication Engineering
- Computer Science and Engineering
- Humanities & Social Sciences
- **Hydrology**
- Management Studies
- Mathematics
- Mechanical & Industrial Engineering
- Metallurgical & Materials Engineering
- Pulp and Paper Technology
- Polymer and Process Engineering
- Applied Sciences and Engineering
- Physics
- **Water Resources Develop and Management**
- **Alternate Hydro Energy Centre (Hydro & Renewable Energy Department)**
- Centre of Excellence for Disaster Mitigation & Management
- Centre of Excellence for Transportation Systems
- Centre of Excellence for Nano Technology
- Institute Instrumentation Centre
- Institute Computer Centre
- Information Superhighway Centre
- Continuing Education Centre
- Educational Technology Cell

…some facts

Only at IIT Roorkee

- Undergraduate program in
  - Pulp and Paper
- Postgraduate programs in
  - **Environmental management of Rivers and Lakes**
  - **Hydraulics Engineering**
  - **Hydrology (SW, GW, Watershed Management)**
  - **Hydro Energy Systems**
  - **Water Resources Development**
  - **Irrigation Water Management**
  - **Disaster Mitigation and Management**
  - Seismic Earthquake Engineering
  - Vulnerability and Risk Assessment
  - Infrastructure System
  - Pulp and Paper
  - Industrial Pollution Abatement

Students Strength	Total
B.Tech / B. Arch./IDD	4441
Integrated M.Tech and M. Tech	2040
Ph.D	1590
TOTAL	**8071**
Girls	**15%**

Faculty Strength 470+

- **Highest Density of Water Experts**
- **Largest strength of International students**
- **So far 5000+ engineers have been trained from 65 countries in the Water Sector**

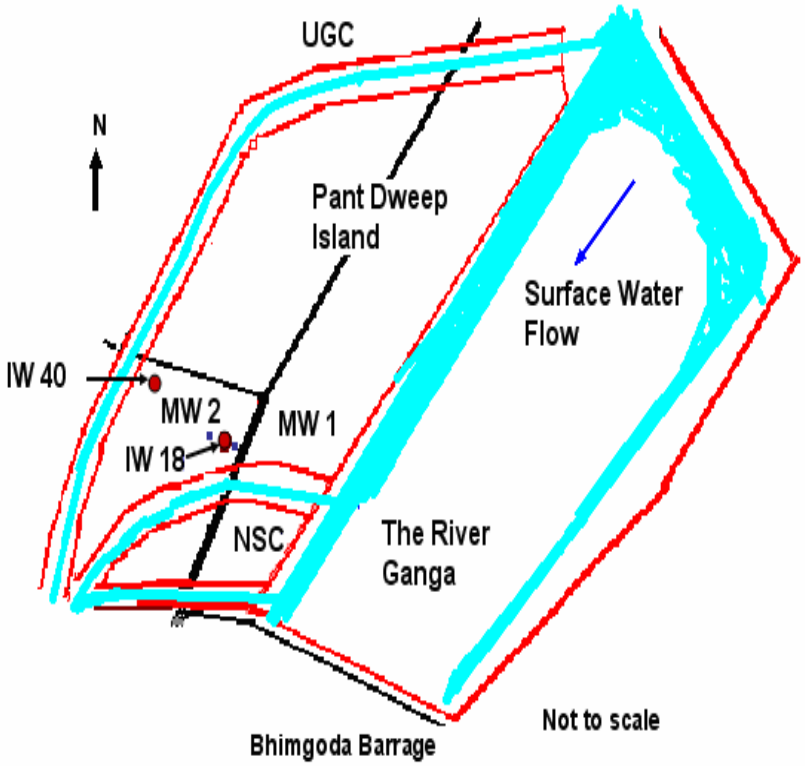
For more information, please visit ***www.iitr.ac.in***

Research in Hydraulics Section of Civil Engineering

- River Engineering
- Climate change studies including low flow and flood forecasting
- Irrigation Scheduling Under Changing Climate
- Irrigation and Drainage in Saline Soils
- River Bank Filtration
- Environmental Hydraulics
- Dam-break studies
- GIS and remote sensing applications in hydraulic engineering
- Groundwater modeling
- Hydraulic and hydrologic modeling
- Physical and mathematical modeling of rivers and hydraulic structures
- Pollutant transport in rivers
- Reservoir sedimentation
- Subsurface flow and transport modeling

Experimental Research in Irrigation Field Lab of CED

INFILTERATION WELL



Well Locations

Well No- 18

Geomatics Group, CED

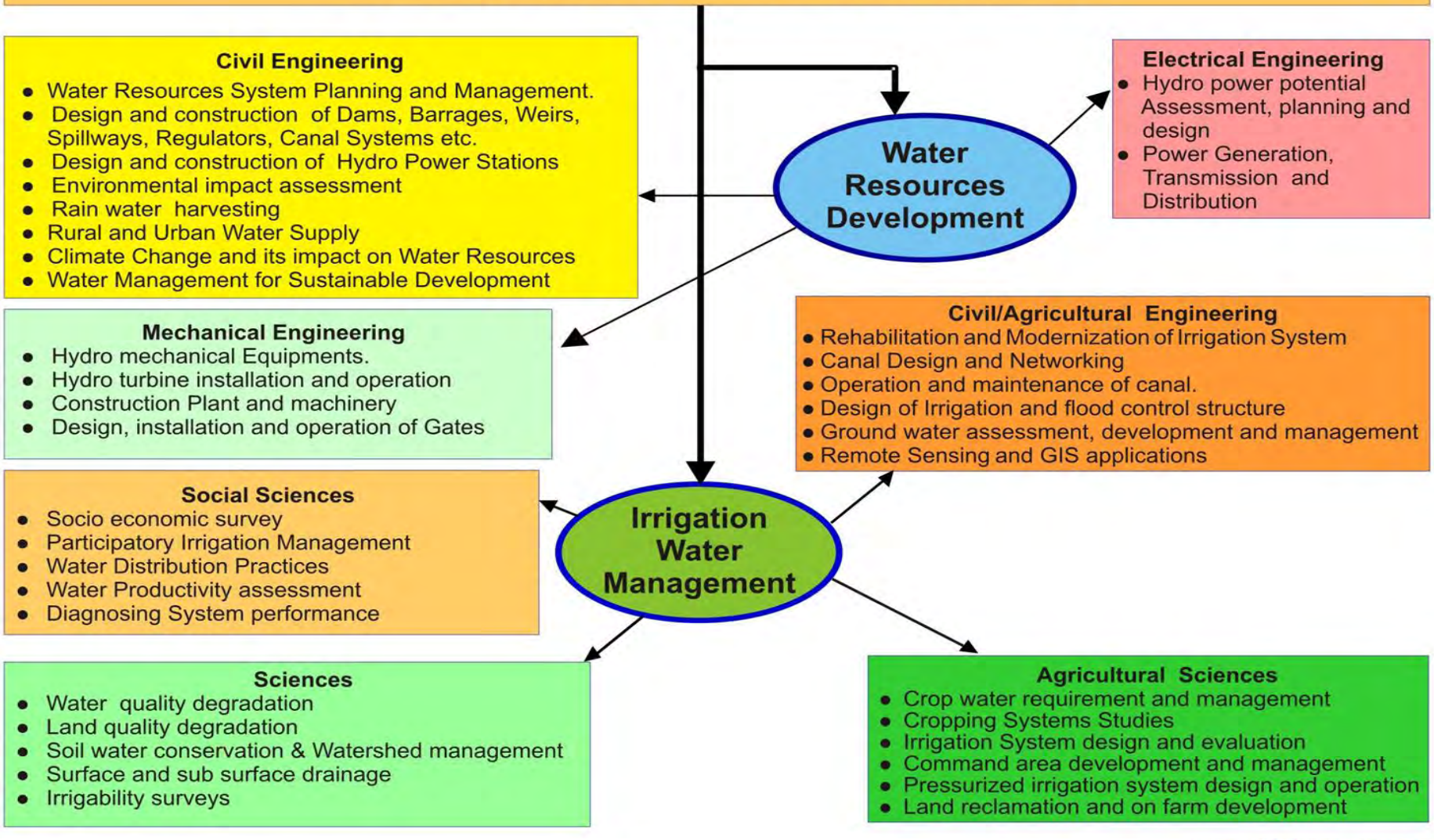
- The group has carried out studies and operational projects in the following fields:
  - Damage assessment of Dam using Total Station survey
  - Canal alignment survey using modern survey techniques
  - Geomorphological studies of river behavior using Remote Sensing and GIS
  - Reservoir sedimentation studies using Remote Sensing
  - Flood inundation mapping and forecasting, flood damage assessment using geospatial techniques
  - Watershed characterization using DEM (Digital Elevation Model)
  - Soil erosion and sediment yield studies in a watershed

- The group has organized several training programs in hydrological applications using Geomatics Techniques for DST, MoWR, NNRMS (ISRO), Survey of India etc.

- The group has modern Surveying equipments e.g. Total Station (including Robotic TS), Digital Level, Multi-frequency Geodetic GPS, Terrestrial Laser Scanner etc.

Department of WRD&M

STRENGTHS OF THE DEPARTMENT



List of Officers Trained at WRD&M

S.No.	Country	WRD	IWM	Total
1	Afghanistan	35	8	43
2	Bangladesh	13	4	17
3	Brazil	1	-	1
4	Bhutan	-	3	3
5	China	3	-	3
6	Costarica	1	-	1
7	Cuba	-	1	1
8	Egypt	7	-	7
9	Eritrea	-	1	1
10	Ethiopia	17	8	25
11	Ghana	11	2	13
12	Guyana	-	1	1
13	India	**1470**	**185**	**1655**
14	Indonesia	446	55	501
15	Iran	1	-	1
16	Iraq	15	1	16
17	Japan	1	-	1
18	Jordan	2	-	2
19	Kenya	4	2	6
20	Kazakhstan	-	2	2
21	Lao PDR	3	6	9
22	Liberia	2	1	3
23	Malawi	3	1	4
24	Malaysia	6	1	7
25	Maldives	1	-	1
26	Mauritius	1	1	2

S.No.	Country	WRD	IWM	Total
27	Mexico	1	-	1
28	Magnolia	-	1	1
29	Myanmar	13	2	15
30	Nicaragua	1	-	1
31	Nepal	135	45	180
32	Nigeria	-	2	2
33	Panama	1	-	1
34	Pakistan	1	-	1
35	Philippines	33	9	42
36	Senegal	-	1	1
37	Sierra Leone	7	-	7
38	S. Korea	3	-	3
39	Somalia	1	-	1
40	Singapore	1	-	1
41	Sri Lanka	28	9	37
42	Sudan	31	5	36
43	South Sudan	1	5	6
44	Syria	10	-	10
45	Tanzania	12	15	27
46	Thailand	18	2	20
47	UAE	1	-	1
48	Uganda	1	1	2
49	Uzbekistan	3	9	12
50	Vietnam	41	11	52
51	Yemen	5	2	7
52	Zambia	3	-	3
Grand Total		**2394**	**402**	**2796**

Field Visits and Diagnostic Analysis

Department of Hydrology

The Department of Hydrology (formerly known as School of Hydrology) came into existence with the inception of the International Post-Graduate Course in Hydrology in 1972. WMO recognized DoH as Regional Training Centre in Hydrology in 2015.

- Core Areas of Competence:
  - Watershed Management
  - Surface Water Hydrology
  - Ground Water Hydrology
  - Integrated Water Resources Management
  - Real-time inflow forecasting
  - Extended hydrological prediction
  - Reservoir Operation Studies
  - Climate Change Studies
  - Water Availability & Design Flood studies
  - Catchment Erosion Assessment

Website: https://www.iitr.ac.in/departments/HY/pages/index.html

Glimpse of Laboratory Facilities

Tilting Flow Channel

Study of Hydraulic Jump

Important Projects Completed by Department of Hydrology in recent past

- **Real time inflow forecasting system for Tehri Dam**

The entire project right from the network design, specifications and commissioning of instrumentation, model development has been envisaged by IIT Roorkee in collaboration with THDC IL. This is the first dam project in the country wherein the forecasts are being issued in real time through indigenous model developed by IIT Roorkee in real time. The system can be accessed by anyone through the website.

- **Design flood estimation and spillway design for Kalpasar Project**

Design flood and spillway capacity determination for a dam across the Gulf of Khambhat where 11 rivers are contributing from the land side and there is influence of sea tides on the other side has been completed in October 2018. This is the unique and first project of its kind in India.

- **Hydrological modelling of Godavari, Krishna and Penneru basins**

Developed and operationalized a distributed hydrological modelling for simulation of discharge at multiple locations in Godavari, Krishna and Pennuru systems for flood prediction and warning assessment based on likely inundation.

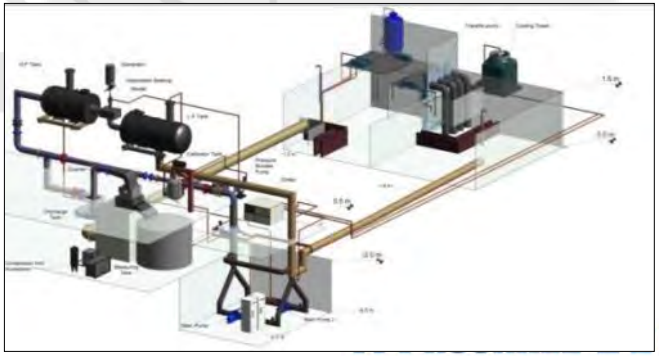
- **Rejuvenation of springs in Aglar watershed of Uttarakhand**

R&D HYDRAULIC TURBINE LAB at AHEC

- NABL accredited
- research & development
- turbine-model testing,
- human resource development (HRD)
- generation of design data
- design validation through CFD analysis
- Third party evaluation

First independent facility in the region

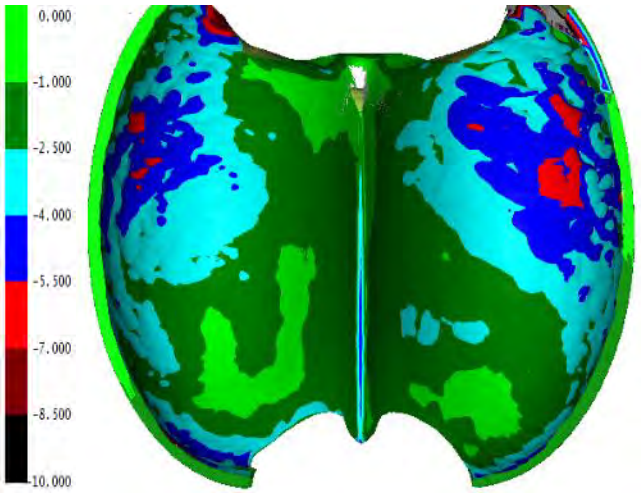
- Head 15-60 m and discharge upto 950 lps
- Building 15 x 24 m height +13.5 to – 6.5 m
- Water storage 300 cubic m



- Laboratory was inaugurated in April 2018
- Turbine Manufacturers and project developers may take benefit of the lab.

Sediment Monitoring and Impact Analysis Laboratory

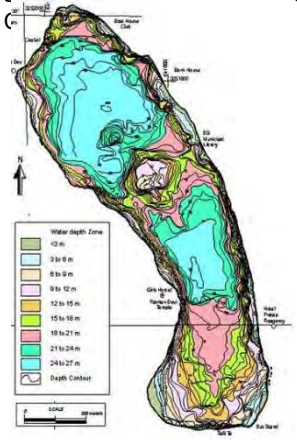
- Laboratory for sediment monitoring and impact analysis studies in hydropower plant is under establishment.
- to be a depository of silt data and online monitoring of silt flow for all hydropower stations experience gained by different power utilities and manufacturers
  - Online Turbidity Sensor and Suspended Solids
  - Laser Diffraction sediment sensor,
  - Acoustic based sediment measurement,
  - Digitizer for quantifying shape and size
  - High speed camera system



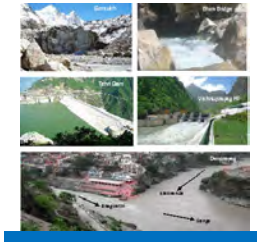
ENVIRONMENTAL MANAGEMENT OF RIVERS AND LAKES

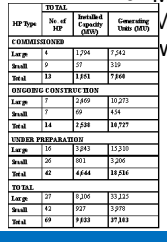
MAJOR ADVISORY SUPPORT PROVIDED IN UTTARAKHAND

- Conservation and Management Plan for Nainital Lake, Bhimtal, Naukuchia Tal, Sat Tal and Khurpa Tal in Nainital District.
- Conservation Measures: Planned and designed, vetted
- Plan and Design of Artificial Lake at Champawat
- Status Paper on River Ganga: State of Environment and Water Quality
- Review of proposals for River Pollution abatement through sewage treatment and sewer network of Muni ki Reti and C



- Cumulative Impacts of Hydropower Projects on River Alaknanda and Bhagirathi





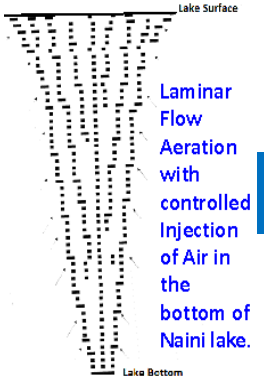
HP Type	No. of HP	Installed Capacity (MW)	Generating Units (MU)
COMMISSIONED			
Large	6	1,794	7,542
Small	9	57	319
Total	13	1,851	7,860
ONGOING CONSTRUCTION			
Large	7	2,469	10,273
Small	7	69	454
Total	14	2,538	10,727
UNDER PREPARATION			
Large	16	3,843	15,210
Small	26	801	3,206
Total	42	4,644	18,416
TOTAL			
Large	27	8,106	33,125
Small	42	927	3,978
Total	69	9,033	37,103

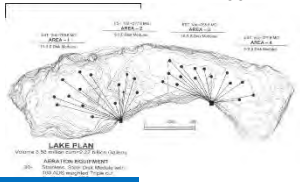
Interventions outside Lake

- Slope stabilisation
- Drainage line treatment
- Strengthening and protection the outlet / nallah from lake
- Sanitation around the lake
- Shoreline development
- Institutional development
- Management of Sewage
- Management of

NAINITAL LAKE 2011

NAINITAL LAKE 2007





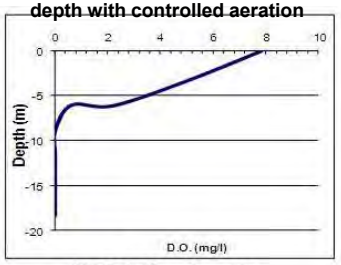
Interventions within Lake

- Oxidation at the bottom of the lake without disturbing thermal stratification through controlled aeration.
- Control fish Gambusia affinis by putting minnow traps.
- Renovation of outflow slucies.
- Regular monitoring of water quality.

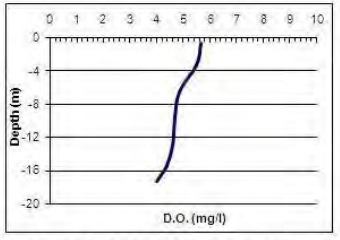
Main Recommendations:

- Variable Environmental Flow (EF) to be released.
- Regular flushing of beds at barrages
- Sufficient gap between two consecutive projects for river recuperation
- Construction of fish passes at barrages
- Regular collection of data on Valued Ecosystem Components to ensure sustainability
- Adaptive management and regular monitoring

Variation in dissolve Oxygen with depth with controlled aeration



2007 Before Aeration



Oct 22, 2007 After Aeration

Status Paper on River Ganga

A two year M.Tech Programme on "Environmental Management of Rivers and Lakes" and organizes training

SUPPORT PROVIDED TO ENVIRONMENTAL MANAGEMENT OF OTHERS RIVERS AND LAKES INCLUDING PREPARING GUIDELINES

- Conservation and Management Plan for Dal and Nagin Lakes in J&K
- Conservation and management Plan for Kailana Lake (Jodhpur) and Gadisar Lake (Jaisalmer) Rajasthan
- Mangement Plan for Daya and Kuakhai River in Bhubneshwar, Orrisa and River Kshipra, Ujjain, Madhya Pradesh
- Reviewed Project Proposals of lakes of Hussain Sagar (Hyderabad), Kodaikanal (TN), Sukna (Chandigarh), Pushkar, Gapsagar, Goverdhann Sagar, Gundovlav Talab, Jaisagar, Kushal, Rajasamand, Sambhar, Sujan Ganga and Udai Sagar of Rajasthan
- Prepared Guidelines for Ministry of Environment & Forests, GoI
- Preparation of project reports under National River Conservation Plan and National Ganga River Basin Authority
- Guidelines for National Plan for Conservation of Aquatic Ecosystems

ALTERNATE HYDRO ENERGY CENTRE

Earth Sciences – areas of water related research

- Geochemistry (Aqueous, Isotopes, Experimental, Analytical and Modeling);
- Hydro-geophysics (Electrical Resistivity Tomography, Seismic Methods)
- Seepage from Reservoirs - Water Source Identification- using Stable Isotopes and ERT
- Reservoir siltation - based on Geochemical analysis and modeling
- Glacial/snow melts Fraction Identification in River Discharge- based on Geochemical and Isotopic analysis and modeling
- RS & GIS based studies on ground water assessment

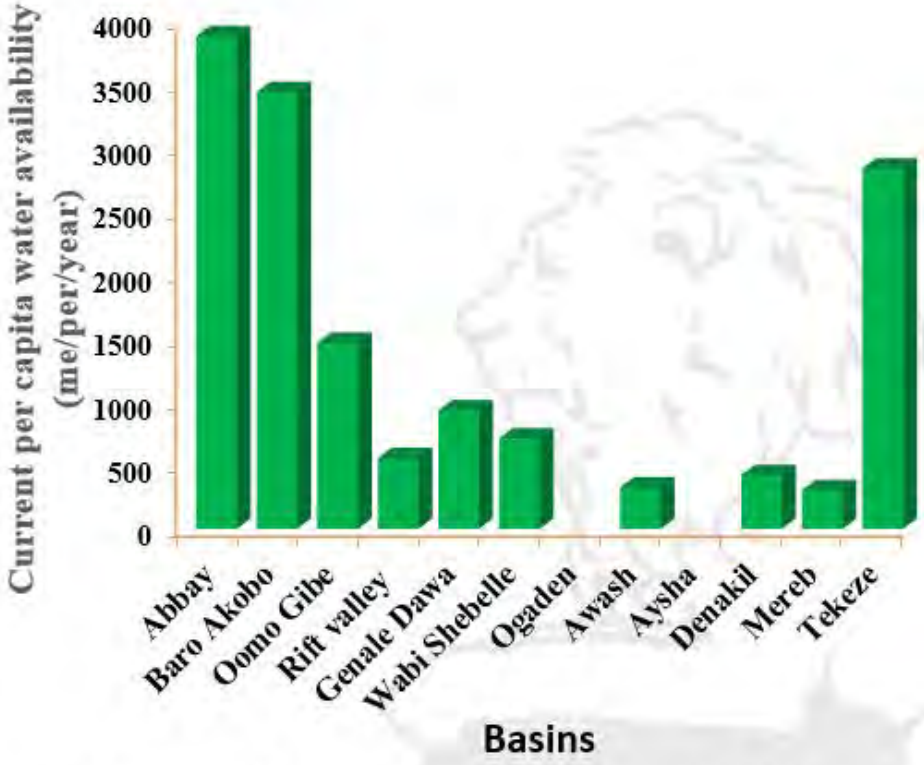
Some of Research/Studies Carried out by African Students at IIT Roorkee

Ethiopian Study – Inter Basin Water Transfer

1) To assess water availability, present and future demands and thereafter to identify the surplus and deficit river basins in Ethiopia
2) To identify and suggest water transfer links from surplus to deficit river basins
3) To assess the economic, environmental, and social impacts of one of the proposed water transfer links

The seven countries in yellow make up the Horn of Africa

Per capita Water Availability in Ethiopian Basins



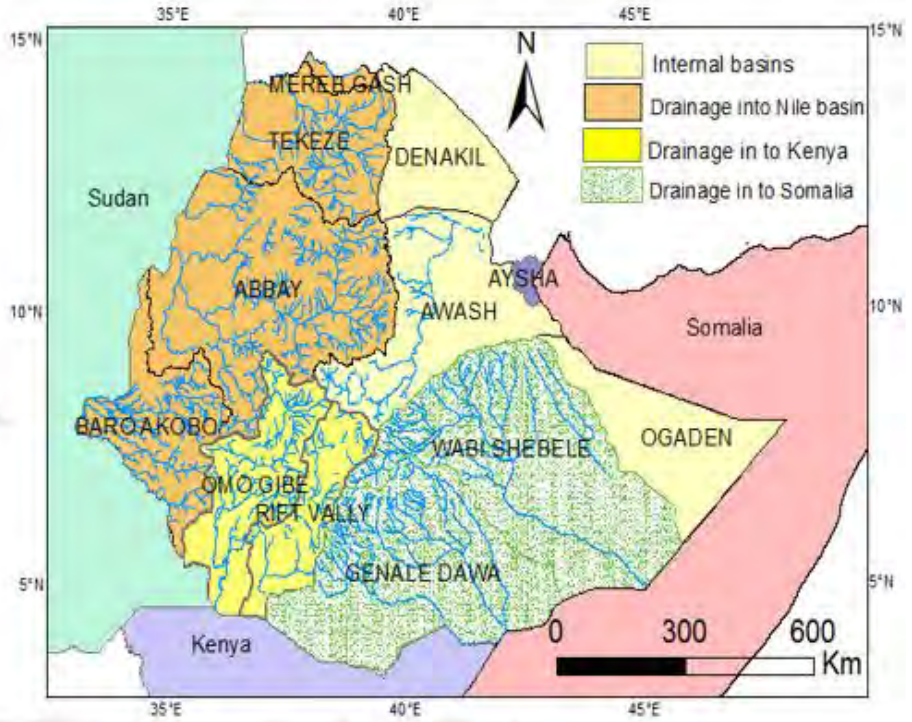


Figure. Per capita water availability of basins

Inter-basin Water Transfer Proposals from Three Basins

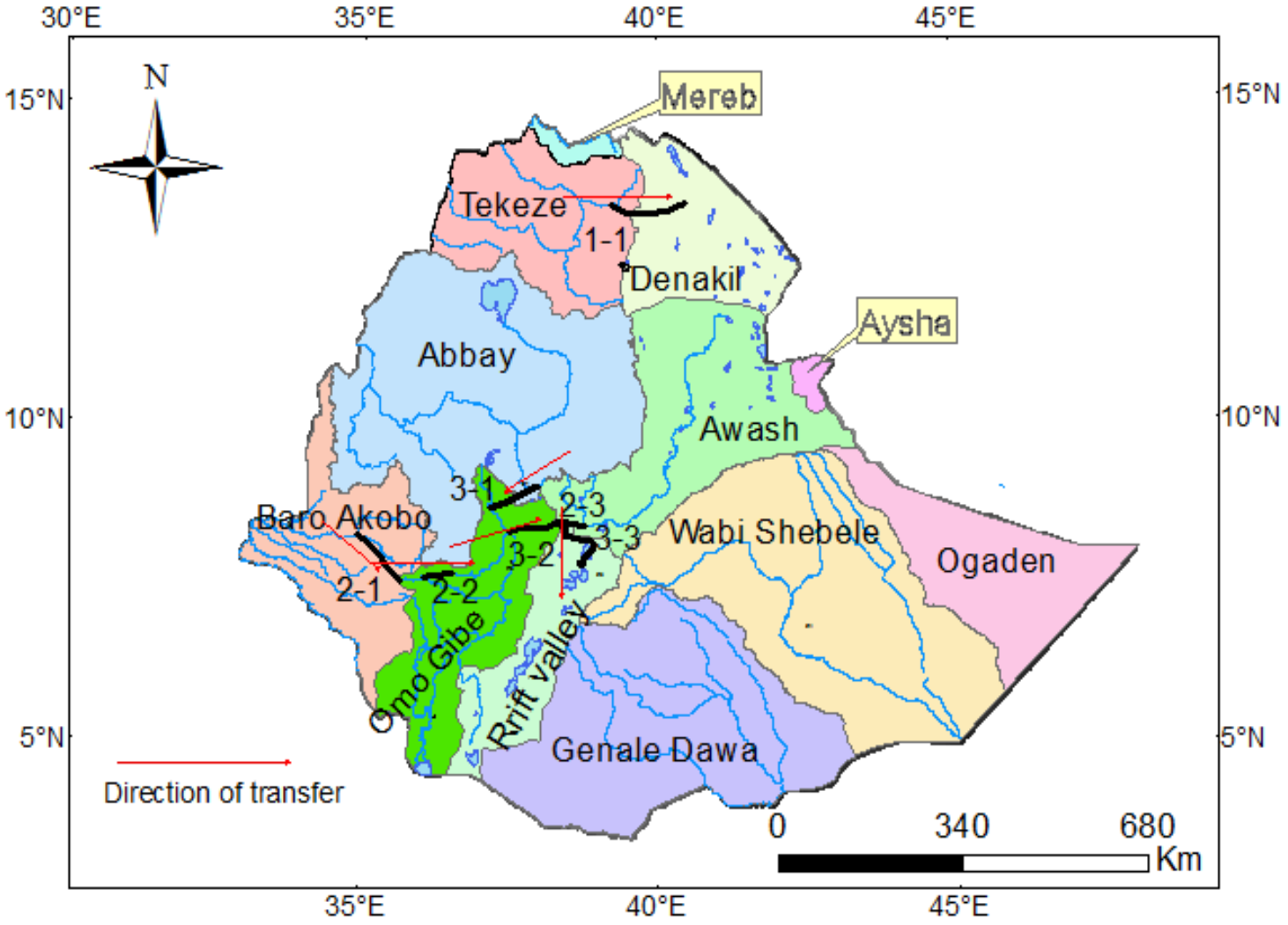


Figure. Possible Water Transfer Options

A case study for Africa

Effect of Climate Change on Runoff Generation: Application to Rift Valley Lakes Basin of Ethiopia

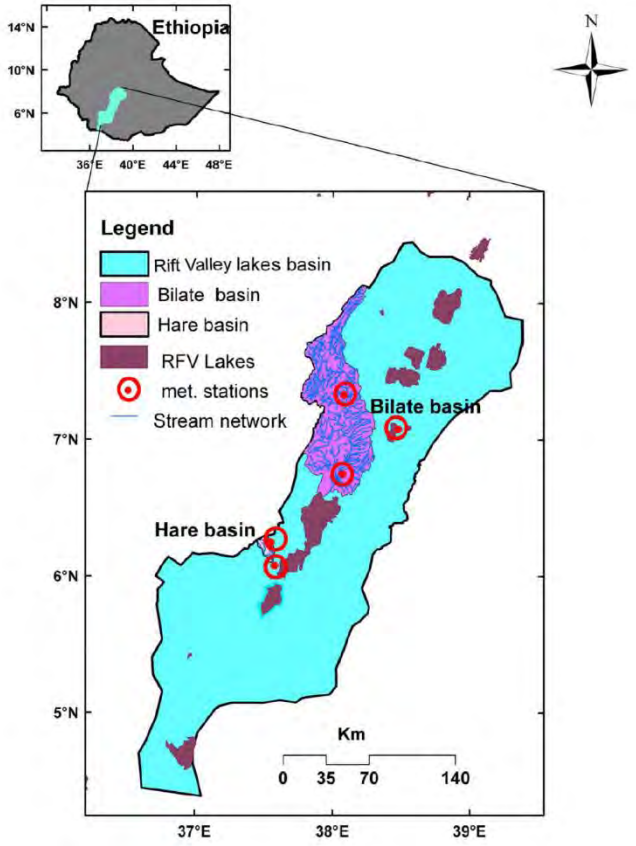
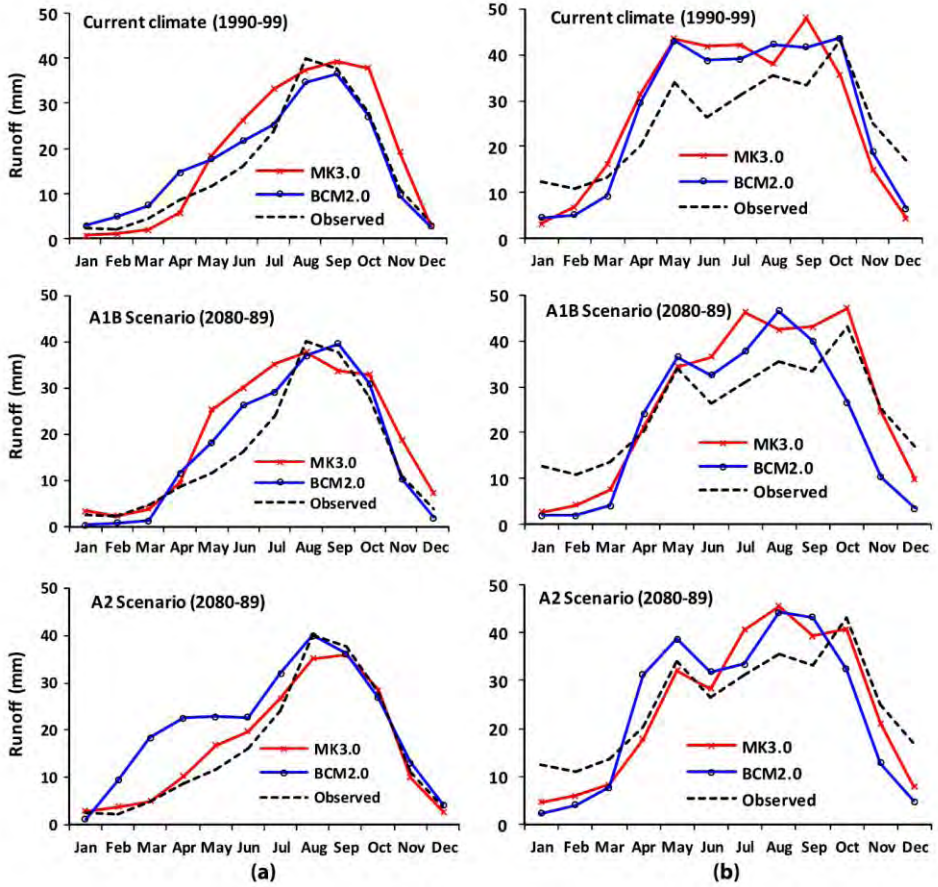
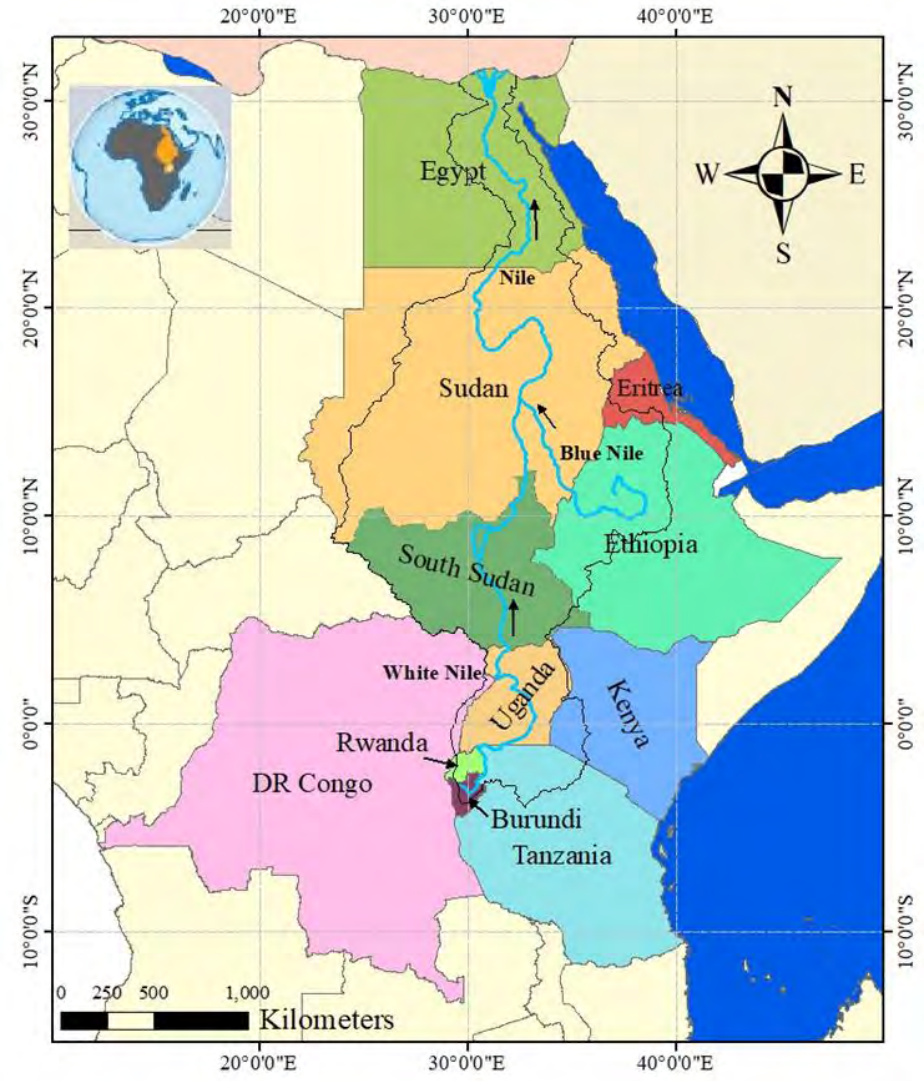


Fig. 1. Location map of the study watersheds and selected meteorological stations in the adjoining vicinity



Average monthly runoff simulated for current and future climate (A1B and A2 scenarios) conditions: (a) Bilate watershed; (b) Hare watershed

Hydropolitics in Water Governance of the Nile River



The Study Paper presented at World Environmental & Water Resources Congress held in USA on June 3-7, 2018

Basin Area:

- 3,176,543 km^2

Length:

- 6,695 km (longest in the world)

Riparian Countries:

- 11 Countries

Basin Population:

- 284 million (54% population of basin countries; *2017)*

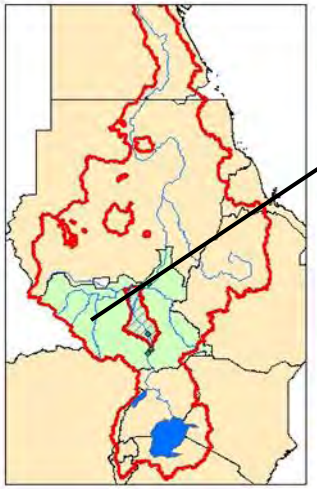
Nile Water Flows

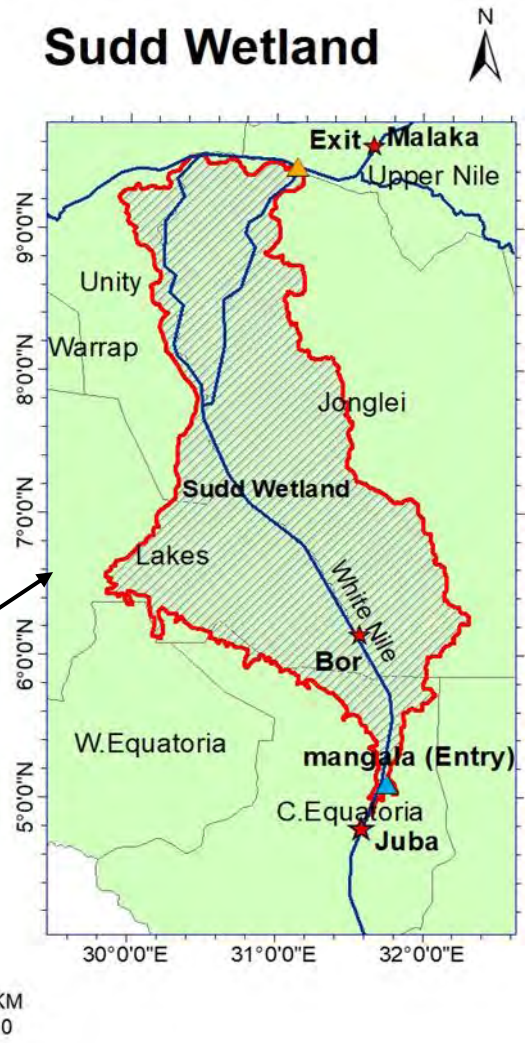
Rainfall:

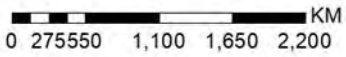
- Mean Max: 2,093 mm/yr (Gore, Ethiopia)
- Mean Min: 0 mm/yr (Lake Nasser, Egypt)

Wetland - Impact of Sudd on the hydro-climatic conditions of South Sudan

- Area: 60453.4 km^2
- Lat 43°57′–46°46′N, and Lon. 121°38′–126°22′E
- Temp. of 30 – 33c in the dry season 26 – 28c in the wet(rainy) season
- Annual rainfall of 800 – 900 mm/yr
- relative Humidity of up to 80% in the wet season and below 50% in the dry season







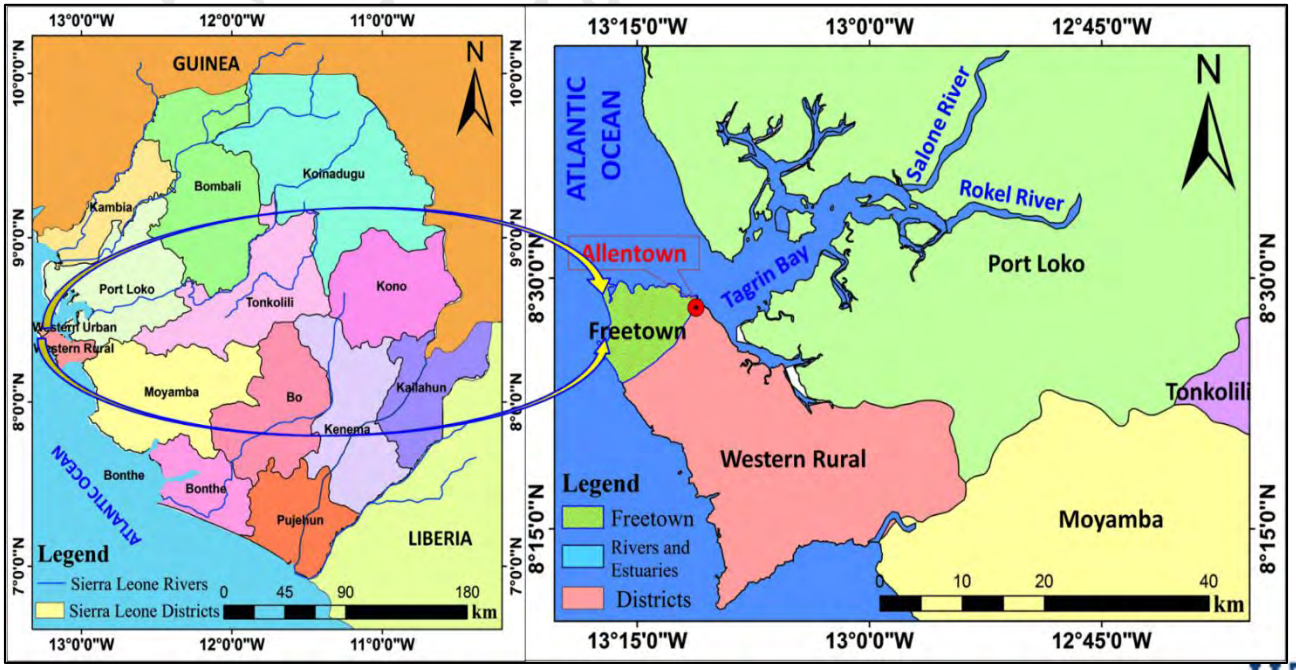
Water, Sanitation and Hygiene

Water Sanitation and Hygiene (WASH)

Water Supply

Sanitation

Hygiene promotion



Water supply in Freetown

Hygiene Conditions

- Unhygienic promotion have led to the poor health conditions of the people in Kailahun
- It has the lowest budgetary line of about 0.001% of the total GDP of the country.
- Hygiene coverage is unknown across the country.

Broad Areas of Water Related Issues

- **Quantity related** – Fresh water scarcity, Floods & droughts, Inter-Basin Water Transfers,.
- **Quality related** - safe water for drinking & eating, water pollution & wastewater management,
- **WASH** and Water for **Food & Energy** Security
- **Safety Issues –** Natural & Manmade
- **Climate Change, Uncertainties, Social and Environmental issues, etc.**
- **Technology for Management –** Innovative Techniques – Radial Collector Wells, Low Cost effective techniques

Specific Areas relevant to ACEs

- Development of Sustainable Water Systems to ensure safe and adequate drinking water to the masses.
- Design of Radial Collector Wells
- Inter-Basin Water Transfers (IBWT).
- Rainwater Harvesting
- Water, Sanitation and Health (WASH)
- Food security through More Crop per Drop - Agricultural and water productivity.
- Improvement of Irrigation Water Management and related activities.
- Surface and Ground Water Hydrology
- Watershed management
- Climate change variability assessment and its impact on water resources.
- Design of hydraulic structures such as dams, spillways, weirs & barrages, and stilling basins etc.
- Natural and manmade risk assessment and its management
- Sediment Flow and its management
- River lakes health and their management
- Water chemistry
- E-flow assessments and GHG emission assessment from water bodies
- Wastewater management
- Energy Security through the development of renewable sources of energy.
- Off Grid hydro project alongwith rural livelihood options
- Small and large hydropower development & Management Decision Support System and Institutional governance.
- Applications of Remote Sensing & GIS in Water Resources Management.
- Applications of newer technologies like Drones & Artificial Intelligence in condition assessment
- Applications of Internet of Things and software utilisation for effective operation and management.
- Public-private partnership in resource management.
- Actions for improving life expectancy, education and per capita income.
- Regional support and strengthening of technical institutions in the African countries.
- Build education, research, and consultancy capacity and improve governance.
- Capacity building in the area of water resources development and management and environment management for social upliftment.

Conclusions

- Africa is similar to India in many ways such as Hydro-climatic conditions, environmentally, socially and economically.
- India has rich experience in the area of Water Resources Development & Management.
- African countries can learn a lot from the Indian experience in the water sector.
- IIT Roorkee (one of the oldest institution in Asia) can contribute towards the capacity building of African countries by way of short term training programmes, offering Masters and Ph.D. programs as well as Training of Trainers & research / sponsored projects.
- African researchers can take advantage of various laboratory of IIT Roorkee and do experimentation for 1 to 2 semesters.


THANK YOU