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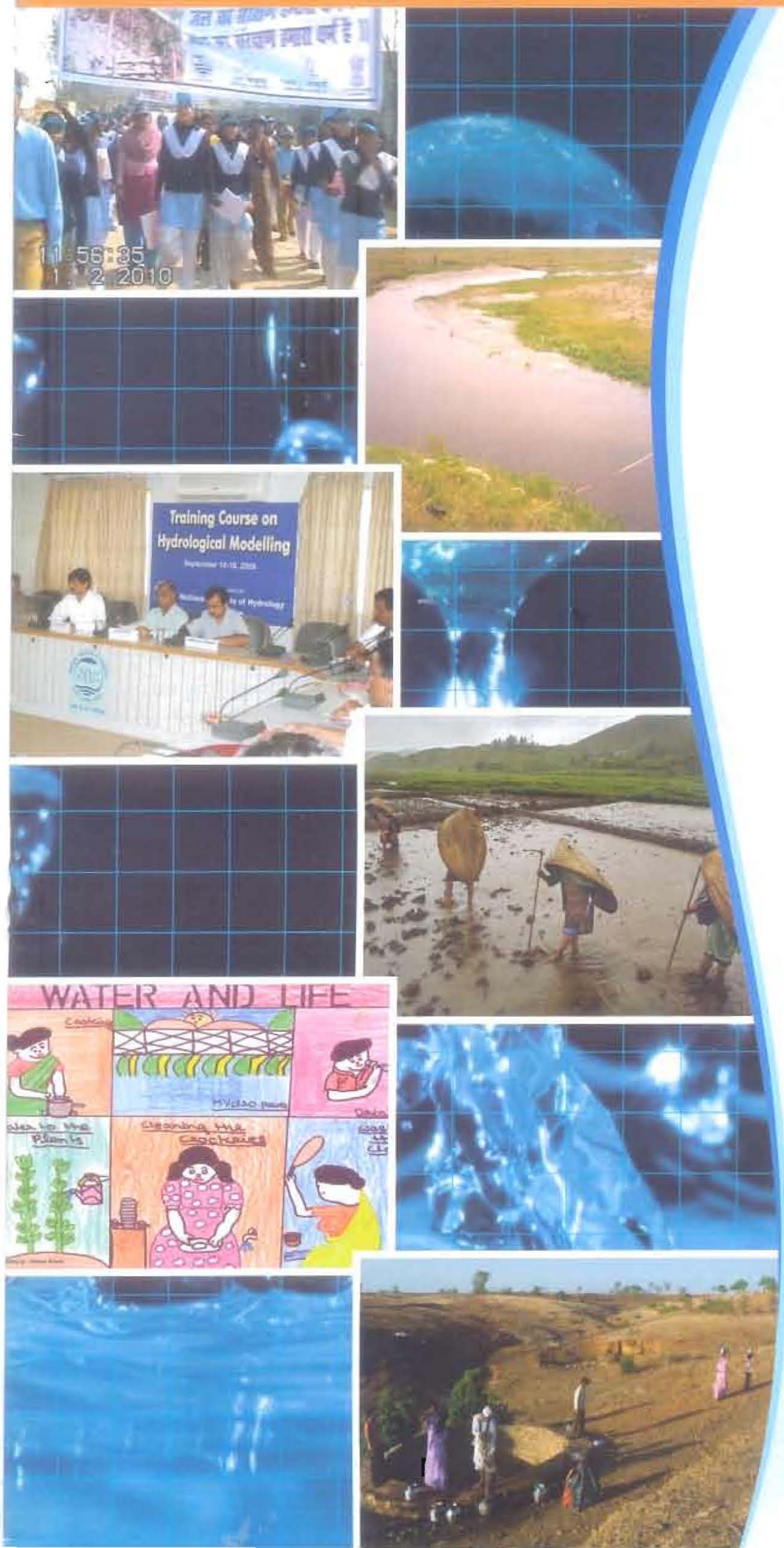
Hydrology for People™

Newsletter of National Institute of Hydrology, Roorkee (India)



From Director's Desk

Society's growing water resource needs include hazard mitigation (floods, droughts, and landslides), agriculture and food production, human health, municipal and industrial supply, environmental quality, and sustainable development in a changing global environment. Desertification and drought are problems of global dimension that affect more than 900 million people in about 100 countries. Irrigation already accounts for more than 70% of freshwater withdrawn from lakes, rivers, and groundwater aquifers, and according to the UN's recent estimates, perhaps 80% of the additional food supplies required to feed the world's population in the next 30 years will depend on irrigation. Today, about one-third of world's population live in countries that are experiencing moderate to high water stress, that is, renewable freshwater availability is below 1700 cubic meters per person.With increased prospects of feeding increased population in 2050, the industrial, individual and agricultural demand is expected to escalate dramatically. Also, the climate change is becoming a more and more important issue for growing water scarcity. This calls for awareness that water is very scarce and valuable natural resource and that we need to initiate innovative technological and management changes.

National Institute of Hydrology has been conducting the research in the field of hydrology and water resources, over the last three decades. Many purpose driven studies and strategic projects were carried out to solve the various need based problems touching almost every sphere of water resources development. With growing interest of managing water resources under the constant threat of climate change, the Institute is gearing-up to conquer the challenges and fulfill the needs of the country via demand driven strategic studies. The Institute is also pro-actively contributing to the knowledge dissemination, mass awareness and capacity building programmes.

R D Singh

Editorial

Rapid demographic and industrial development is increasing stress on India's water resources resulting in declining water quantity and quality. These demands on India's water resources are predicted to continue to grow and to be exacerbated by climate change, land-use change, population growth and urbanisation. Ensuring water security is therefore a priority for India's water sector, but achieving this goal requires a good understanding of the amount, movement, storage, quality and usage of water in any given basin, and how each of these is likely to change in future. A scientific understanding is needed to understand the wide range of basin processes at a temporal and spatial resolution that enables informed decision-making about the management of India's water resources and contribute to the economic development and welfare of the society.

Publication of this newsletter is an attempt to rejuvenate the knowledge dissemination efforts of the Institute, with a flavour of 'connecting to the people'. The intent is to take the research findings to the community so that they are incited to develop interest in the scientific developments taking place in the country. This is the time to make information related with water reach all nooks of the country. And, NIH fraternity is zestful enough to do its bit in this endeavour.

Response to the previous issues has been encouraging. Your suggestions and feedback are welcome, and will help us in improving future issues!

V C Goyal

About National Institute of Hydrology

The National Institute of Hydrology (NIH), established in 1978 as an autonomous organization under Ministry of Water Resources (Government of India), is a premier R&D institute in the country to undertake, aid, promote and coordinate basic, applied and strategic research on all aspects of hydrology and water resources development. The Institute has its headquarters at Roorkee (Uttarakhand). To carry out field related research covering different regions of the country, the Institute has four Regional Centers located at Belgaum, Jammu, Kakinada and Bhopal, and two Centres for Flood Management Studies at Guwahati and Patna in Hydrology, Water Quality, Soil Water, Remote Sensing & GIS Applications, Groundwater Modelling and Hydrological Instrumentation.

The Institute acts as a centre of excellence for the transfer of technology, human resources development and institutional development in specialized areas of hydrology, and conducts user defined, demand-driven research through collaboration with relevant national and international organizations. The Institute vigorously pursues capacity development activities by organizing training programmes for field engineers, scientists, researchers and NGOs. NIH has so far completed more than 150 sponsored research and consultancy projects- the sponsors included Indian Army, PSUs, Planning Commission, National Productivity Council, State Government Departments, and central ministries of Science & Technology, Environment & Forests, Agriculture, Rural Development, etc. The Institute has undertaken a number of internationally funded projects, including those from UNDP, USAID, UNESCO, The World Bank, The Netherlands, Sweden and European Union. The Institute is presently participating in the World Bank funded Hydrology Project Phase-II.

Some of the significant contributions of NIH include studies for solution of real-life problems related to augmentation of water supply and water management in cities, glacier contribution in streamflow of Himalayan rivers for hydro-electric power projects, watershed development, water quality management plan for lakes, watershed development, storm water drainage network in cities, flood inundation mapping and flood risk zoning, and water quality assessment in major cities. The Institute is actively pursuing the IEC activities and mass awareness programmes of the Ministry of Water Resources. NIH works as a nodal centre of the Ministry for effective implementation of the National Water Mission.

VISION

Providing innovative and effective S&T for hazard-free sustainable development and management of water and water-related disasters

MISSION

- Develop methodologies for optimum utilization of water resources and environment
- Propagate applications of emerging technologies for water resources development and management

- Find ways to save the society from water-related hazards
- Develop mass awareness for water conservation and optimum utilization

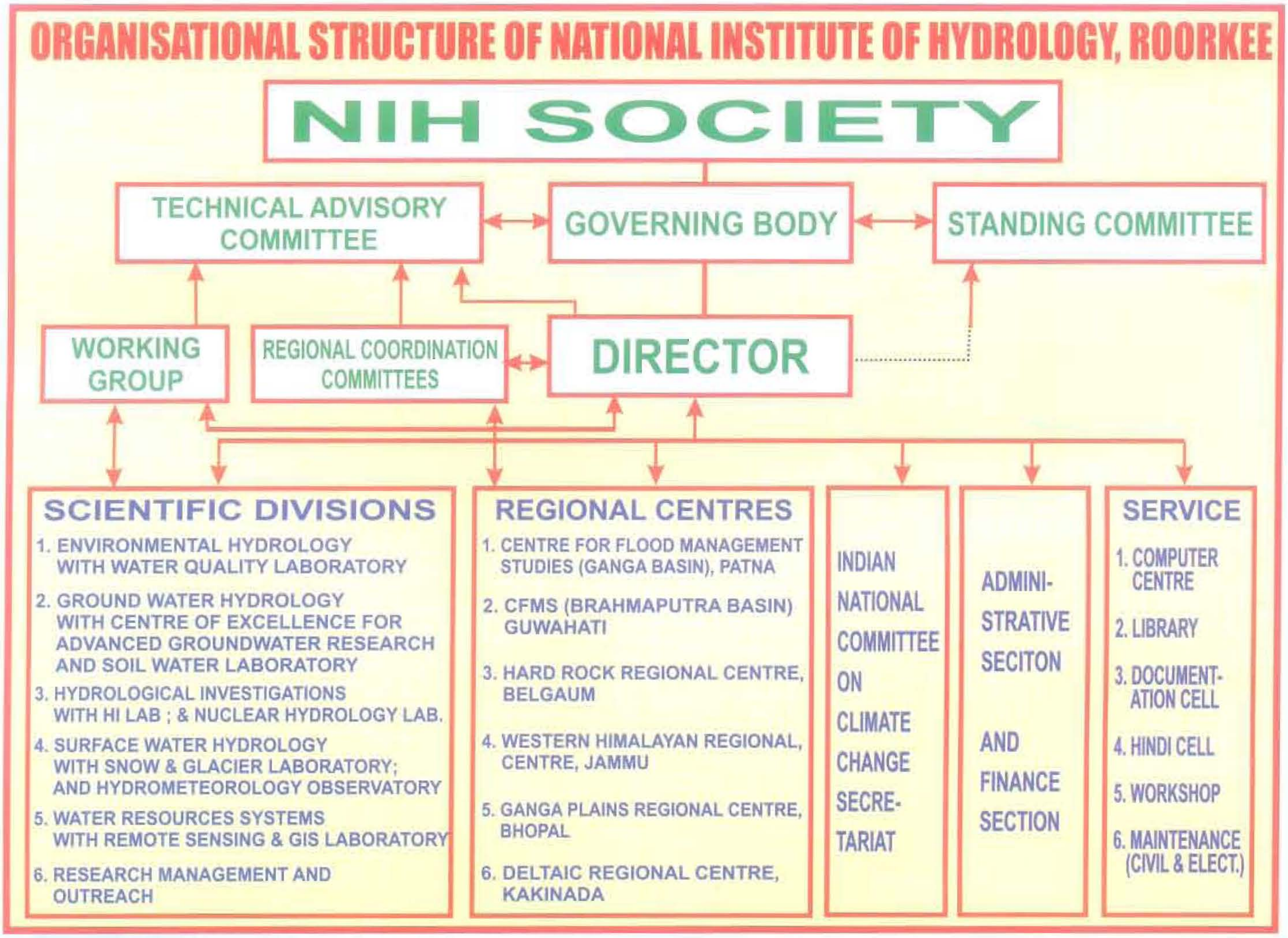
Thrust Areas

- Water Resources Planning and Management
- Ground Water Modeling and Management
- Flood and Drought Prediction and Management
- Snow and Glacier Melt Runoff Estimation
- Prediction of Discharge in Ungauged Basins
- Water Quality Assessment in specific areas
- Hydrology of Arid, Semi-arid, Coastal & Deltaic Zones
- Reservoir / Lake Sedimentation
- Impact of Climate Change on Water Resources
- Application of modern techniques to provide the solution to hydrological problems

Hydrology Primer

Hydrology is the science that treats the waters of the earth, their occurrence, circulation, movement and distribution, their chemical and biological properties and their reaction with the environment, including their relation to living things. The domain of hydrology embraces the full life history of water on the earth.

- The hydrologic cycle is a continuous process that exists on the earth by which the water from over and beneath the earth's surface (including the ocean) is transported to the atmosphere through the process of evaporation and evapo-transpiration from the vegetative cover and to the land surface through the process of rainfall and snowfall, and reaches to the surface and groundwater storages, and the ocean by means of the various paths.



- The various phases of the hydrologic cycle may be short, or it may take millions of years. Water may be captured for millions of years in polar ice caps, groundwater reservoirs (aquifers) and in the sea.
- The hydrological cycle moves enormous quantities of water about the globe. However, much of the world's water has little potential for human use because 97.5% of all water on earth is saline water. Out of remaining 2.5% fresh water, most of which lies deep and frozen in Antarctica and Greenland, only about 0.26% flows in rivers, lakes and in the soils and shallow aquifers which can be readily used.
- Certain hydrological problems and weaknesses have affected a large number of water resources all over the world due to the effect of Climate Change due to Global Warming.
- In case of India, floods and droughts affect vast areas of the country, transcending state boundaries. One-sixth area of the country is drought-prone. Out of 40 million hectares of the flood prone area in the country, on an average, floods affect an area of around 7.5 million hectares per year.

Role of Hydrologist

- The hydrologist plays very important role in solving water-related problems in society such as quantity, quality and water availability or basin water budgeting through application of the proper scientific knowledge and mathematical principles.
- The hydrologist studies the fundamental transport processes to be able to describe the quantity and quality of water as it moves through the hydrologic cycle (evaporation, precipitation, streamflow, infiltration, groundwater flow, and other components).
- Hydrologists estimate the volume of water stored underground by measuring water levels in local wells and by examining geologic records from well-drilling to determine the extent, depth and thickness of water-bearing sediments and rocks. Before an investment is made in full-sized wells, hydrologists may supervise the drilling of test wells. They note the depths at which water is encountered and collect samples of soils, rock and water for laboratory analyses. They may run a variety of geophysical tests on the completed hole, keeping and accurate log of their observations and test results. Hydrologists determine the most efficient pumping rate by monitoring the extent that water levels drop in the pumped well and in its nearest neighbors.
- The engineering hydrologist, or water resources engineer, is involved in the planning, analysis, design, construction and operation of projects for the control, utilization, and management of water resources.
- He may also deal with the study concerning the municipal water supply, irrigation water supply and management, mitigation of floods and droughts, integrated watershed management, ground water recharge and solving reservoir sedimentation problems.
- Scientists and engineers in the field of hydrology may be involved both in the field investigation and office work.
- In the field investigation, they may collect basic hydrological, geological, meteorological and water quality data, sometimes from remote and rugged terrains with use of measuring instruments and equipments. While, in the office, they may do many jobs that includes the assessment of water quality in the laboratory, remote sensing data processing and analysis using GIS, interpretation and analysis of field data, modelling studies for flood hazards mitigation, groundwater replenishment, water-logging problems, sea water intrusion, reservoir operations in the command area and assessment of their impacts on environment.

Jal Kranti Abhiyan

Jal Kranti Abhiyan" shall be celebrated during year 2015-16 to consolidate water conservation and management in the country through holistic and integrated approach involving all stake holders, making it a mass movement.

- With a rapidly growing population and increasing needs of a fast developing nation, coupled with likely adverse impact of climate change, per capita availability of water would be declining year after year.
- If not addressed properly in a timely manner, the fast growing water demand is likely to lead to water conflicts among different user groups as well basin states.
- There is an urgent need to promote as well as to consolidate the activities of water conservation, optimization of water use efficiency and water demand management in the country through a holistic and integrated approach.
- It is important to create mass awareness on these issues or in other words, we need" Jal Kranti Abhiyan" throughout the country.

Objectives:

- Strengthening grass root involvement of all stake holders including Panchayati Raj Institutions and local bodies in the water security and development schemes (e.g. Participatory Irrigation Management (PIM);
- Encouraging the adoption / utilization of traditional knowledge in water resources conservation and its management;
- To utilize sector level expertise from different levels in government, NGO's, citizen setc; and
- Enhancing livelihood security through water security in rural areas.

Activities proposed under Jal Kranti Abhiyan

(I) Jal Gram Yojana

(ii) Development of Model Command Area

(iii) Pollution abatement

(iv) Mass Awareness Programme

(v) Other Activities

Projects Solving Real Life Problems

Managed Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)

The study was aimed to examine feasibility of Managed Aquifer Recharge (MAR) through a lake (Teliabandha Lake (Figure 1)), of Raipur city, Chhatisgarh by conserving monsoon surface runoff and its water quality constituents. The Raipur city had 154 small and large water bodies, out of which 85 talabs are existing. The Teliabandha lake has spread area of 0.12 km^2 covers a catchment area of 1.14 km^2. The components of water balance equation were estimated by comprehensive analysis of hydrological and hydrogeological aspects of the selected lake which included analysis of rainfall-runoff, evaporation rate, lake water quality, lake geometry, aquifer characterization, parameters estimate, ambient groundwater level and quality. The semi-analytical mathematical model was developed to estimate unsteady groundwater recharge (Figure 2)

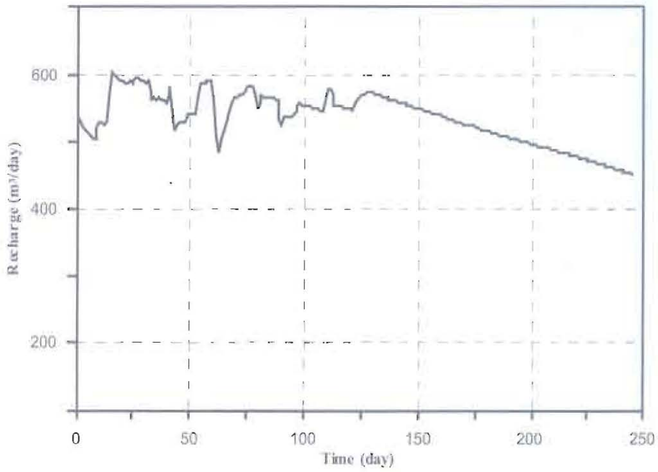


Fig. 2: Computed time varying groundwater recharge, $Q_{gt}(n\Delta t)$ from the Teliabandha Lake

resulting from variable depth of water in the lake, influenced by time variant inflows and outflows. The recharge rates from the lake found very less, which ranged between 3.75 mm/day and 4.82 mm/day. The lake water quality indicated contamination by bacteriological parameters (viz. Fecal coliform and Total coliform), turbidity and COD, exceeding the

Fig. 1: Location map of the Raipur Municipal area, Raipur, Chhatisgarh

Fig.3. A view of the 'Well Test' conducted At Satnami Mohalla,Raipur

permissible limit of drinking water standards (IS-10500:2012). Lake Catchment possessed favourable hydrological and hydrogeological features except the geological stratum of massive limestone configuration, MAR-ASTR by additional engineered hydrological interventions has been found not viable because of restraining purification capacity of limestone formations.

Fig.4. Bathymetry survey being conducted by NIH team at Telibandha Lake

Web Enabled -Groundwater Recharge Estimation Model (WE-GREM)

Artificial groundwater recharge is promoted in India in large scale as a technique to replenish and re-pressurize depleted aquifers, controlling saline intrusion or land subsidence and improving water quality through filtration and chemical and biological processes. There are number of techniques for artificial recharge that their uses depend on the hydrogeology and field conditions. Recharge basin in one of the popular techniques normally prefer in alluvium formations. Groundwater recharge from a recharge basin is time variant, and the rate of recharge depends on potential heads difference between the water in the basin and the underneath groundwater table and sub-surface formation below the basin. Water surface evaporation and recharge basin geometry also govern the recharge rate. Correct estimation of recharge component and other hydrological components is essential for judicious management of both surface and ground water. This 'Groundwater Recharge Estimation Model' is aimed to help groundwater professionals and researchers to use it as a tool for correct estimation of groundwater recharge and other hydrological components associated with a recharge basin. Thus, the objectives of the task were framed as:

- To develop a comprehensive user friendly web-enabled time-varying *"Groundwater Recharge Estimation Model"*.

Front Screen of WE-GREM

Input Module of WE-GREM

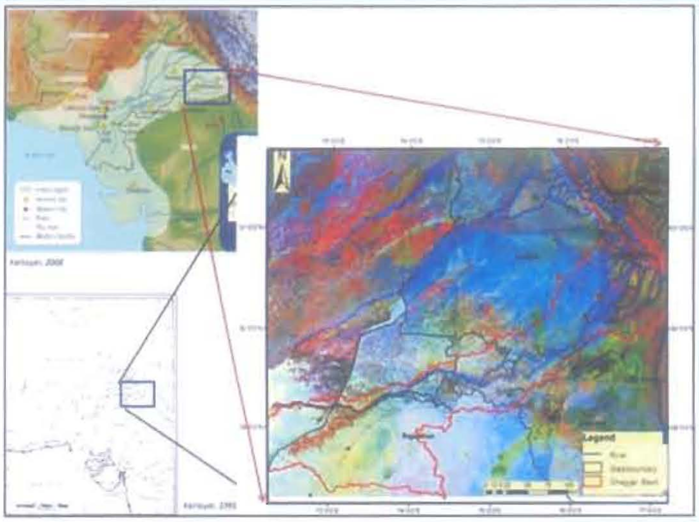
Final output of WE-GREM

- To provide a platform to users and professionals for calculating time-varying depth of water in , and groundwater recharge from, a surface water body without using any third party software.
- To facilitate users and professionals in estimation of groundwater recharge from a large surface water body and depth of water in it and to visualize the output in graphical as well as tabular format.
- To host the module in the public domain for its large uses by stakeholders and groundwater professionals.

The above objectives were achieved by developing, a process based web application model written in HTML,CSS and JavaScript using the semi-analytical mathematical model developed by Ghosh et al, (2015) based on water balance equation of a recharge basin to estimate unsteady groundwater recharge resulting from variable depth of water in a large water body, influenced by time variant inflows and outflows. The water balance components include estimate of: inflows from the basin catchment by SCS-CN model, water surface evaporation by widely used methods depending upon availability of databases, and recharge by Hantush's basic equation for water table rise due to recharge from a rectangular spreading basin in absence of pumping well. The application offers the facility to assign measured values of inflows and evaporation rate and calculate the same on the fly. The output of the application is in the form of interactive charts and tables.The userfriendly interface is designed intuitively along with the help at every step.TheWE-GREM has scope add more modules related to the groundwater because of its structure and flexibility. The application can be accessed freely through the NIH's website (www.nih.ernet.in) and can be used for both research and field application.

The Structure and Dynamics of Groundwater Systems in Northwestern India under Past, Present and Future Climates

India is the largest agricultural user of groundwater in the world. The last 40 years have seen a revolutionary shift from large scale surface water management to widespread groundwater abstraction, particularly in the northwestern states of Punjab, Haryana and Rajasthan. As a result of this, groundwater depletion of this region is under vulnerable condition and became a hotspot for groundwater management. The groundwater depletion rates in states of northwestern India are



reported highest in the world. Further, unmanaged use of groundwater becomes more challenging due to increasing demands from population and industrial development under the climate change scenario. Thus, there is a major task to replenish the groundwater depletion through rainfall recharge. Therefore, present study has been sponsored by Ministry of Earth Sciences, Government of India under Changing Water Cycle (CWC) Program in collaboration with Natural Environment Research Council, U.K (NERC, UK). The Institutions participating in the project are IIT, Kanpur; NIH, Roorkee; and Geology Department, University of Delhi, NGRI, Hyderabad from India and Geography Department, Druham University; and Earth Sciences Department, Imperial College, London from U.K. The major objective of the project is to develop integrated geological and hydrological understanding of groundwater system in the study area. The role of NIH is to study the isotopic characteristics of groundwater, stream and rain water in order to understand dynamics of groundwater.

The study area covers the North Western India. However, Ghaghar basin has been selected to carry out detailed investigations, which covers the states of Himachal Pradesh, Punjab, Haryana and Rajasthan.

The groundwater level data of Haryana and Punjab have been collected from 1974 to 2010 to study the groundwater level pattern and trend analysis. Groundwater level data indicates decline in groundwater level by 12-18 meters during 1974 to 2010 in few parts of Punjab and Haryana. However, groundwater is continuously rising in a few pockets in the southwest and western part of the Punjab and Haryana, where the salinity is high, although the maximum area has shown a groundwater decline since 1974. The depth to water level maps show marked spatial and temporal variability, and we observe distinct hotspots of groundwater depletion at the tens of kilometer scale in the study area. Initially, groundwater has shown lateral expansion of the area of depletion from 1974 to 1996, and after that both marked expansion and rapid decline in water levels from 1999 to 2010. The maximum decline in water level is observed along the Ghaggar River. It is concluded that the extensive groundwater abstraction for irrigation and other uses have resulted into the depletion of groundwater storage. Initially, groundwater storage gains between 1974 and 1996, and then loss at the rate ~3.74 km3/yr between 1999 and 2010. The total loss of groundwater storage is ~36.01 km^3 over the 36 year between 1974 and 2010 with the annual rate of decline ~0.84 km3/yr. This study can be useful for micro scale planning and groundwater management practices.

The isotopic signature of source water i.e., precipitation, river and canal has been developed in order to understand the recharge sources. Ghaggar river samples have been collected from its origin near to Nahan in Himachal Pradesh to downstream upto Sirsa in Haryana. To develop Local Meteoric Water Line, rain samples have been collected from Sirsa, Patiyala and Chandigarh.

The groundwater samples have been collected from dug well, hand pump and tube wells. The depth of dug well, hand pumps and tube wells represents to different depth of water level. The isotopic composition of groundwater upto depth of 80 m is depleted in nature while below the depth of 80m isotopic composition is enriched. It reveals vertical inhomogenity of the aquifer system. The spatial variation reveals that groundwater, above 80 m depth, in the middle and downstream parts of the basin has a depleted isotopic signature with high d-excess and high tritium concentrations, indicating modern recharge is dominated by leakage of canal system or irrigation return flow of Sutlej river water that is redistributed through the canal network. The stable isotopic composition of samples below 80 m bgl, in contrast, shows a close affinity with AWAP (Annual weighted mean of Precipitation), indicating dominant recharge source is local modern precipitation, but low tritium concentrations indicate relatively long residence times in the down reaches of the basin. The spatial and vertical variations in isotopic signature can be linked to the spatial and vertical connectivity of the aquifer system, which is due to lithological variations controlled by fluvial process.

Application of DSS (P) for Integrated Water Resources Development and Management

The management of water resources requires integration of large volumes of disparate information from diverse sources. An efficient and easy to use framework is required to couple this information with hydrological modelling tools for assessment and evaluation that allow broad, interactive participation in water resources planning and decision making process and effective methods of communicating results to a broader audience. A Decision Support System (DSS) helps in attaining this objective. DSS (planning) developed under Hydrology Project-II pertains to a decision support system for integrated water resources development and management. The proposed study will demonstrate the implementation steps and applicability of the DSS(P) for a selected basin. The main objectives of the study are: (i) to collect and process hydrological time series data and spatial data, (ii) to carry out rainfall-runoff modelling using NAM, (iii) to implement Mike basin in the study area, and (iv) to generate scenarios for integrated water resources management.

The Seonath River Originates near village Panabaras in the Rajnandgaon District. The Basin area of river up to confluence with the Mahanadi River is 30,860 Sq Km. The river traverses a length of 380 Km. The main tributaries of Seonath river are Tandula, Kharun, Arpa, Hamp, Agar and Maniyari Rivers. The mean annual rainfall in the basin varies from 1005 mm to 1255 mm. The application of MIKE 11 model for rainfall runoff modeling of Arpa basin can be divided into two stages: (i) the calibration process to determine an optimum values of the NAM model parameters and (ii) streamflow simulation using the estimated model parameter. The computation for the mean areal rainfall carried out during this study was based on the rainfall data of three stations. Observed and simulated runoff hydrographs of calibration are plotted in Figure 1.

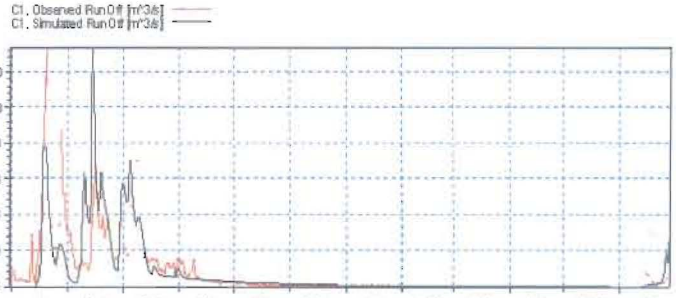


Fig. 1: Observed and simulated runoff hydrographs: Calibration results of NAM-MIKE-11 Model (2000-2001)

The reliability of the MIKE11-NAM was evaluated based on the Correlation coefficient and Nash and Sutcliffe (1970) Efficiency Index (EI). Correlation coefficient is obtained as 0.73 during calibration and 0.80 in validation. The RMSE value obtained during this study was 18.08 in calibration and 45.44 in validation.

Further water resources planning have been carried out for different rainfall conditions in the Arpa basin. When the average rainfall is observed the crop planning has been done to utilize optimum water. Water requirement during kharif and rabi season have been computed as presented in figure 2 & 3. Further the water requirement from minor tanks during normal rainfall year is presented in Figure 4. Various scenarios have been developed considering different cropping patterns in the command area so as to utilize the available water more judicially.

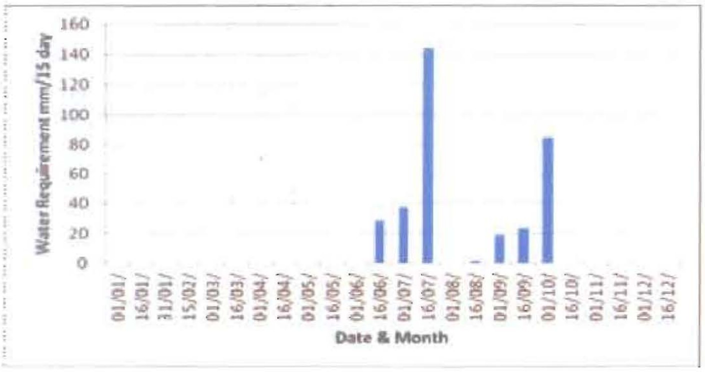


Fig. 2: Water Requirement in Kharif

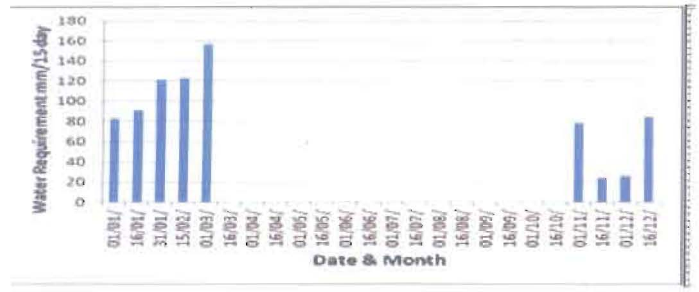


Fig. 3: Water Requirement in Rabi

Fig. 4: Water Requirement from minor tanks

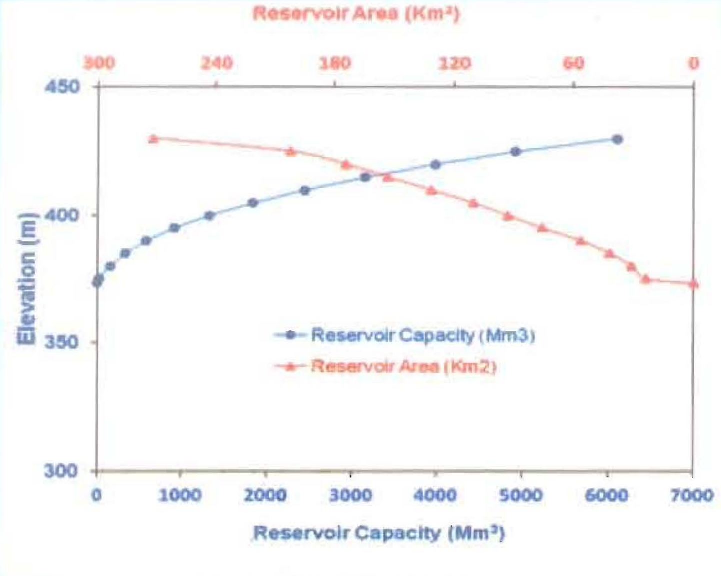
Sedimentation Studies for Pong Reservoir, Himachal Pradesh

The main objective of the study is to predict elevation-area-capacity curve of Pong reservoir for future 25, 50, 75 and 100 years considering the historical rainfall and flow volume of the catchment. The study area is catchment of Beas River up to Pong Dam. The catchment area of the reservoir is of 12,562 km^2 out of which the permanent snow catchment is 780 km^2.

In this study, ANN models have been developed to simulate the sediment yield for the catchment of Beas River up to Pong reservoir based on the historical data of rainfall, runoff and sediment yield. The data of rainfall and runoff for future 25, 50, 75 and 100 years have been generated by the time series modelling with available data of rainfall and runoff series. The best developed sediment yield model has been applied to simulate the sediment volume for future 25, 50, 75 and 100 years. The unit weights of deposited sediment in the reservoir have been computed from particle size distribution of suspended sediment concentration, hydrographic survey and porosity of uniformly distributed sediment in the reservoir. The consolidated unit weights of the sediment have been arrived at by empirical equation as well as statistical methods. The consolidated unit weights computed by different methods have been used to compute the possible range of sediment volume expected to be deposited in the reservoir for the future 25, 50, 75 and 100 years. The percentage loss in reservoir capacity by different methods is presented in the following table.

Year	Percentage of reservoir capacity lost				
	Particle size distribution	Porosity of Uniform Sediment	Hydrographic survey	Frequency analysis	Empirical formula
25 (2034)	15.01	14.52	15.16	14.87	16.66
50 (2059)	19.74	18.64	20.03	19.19	24.19
75 (2084)	22.23	20.65	22.59	21.26	31.64
100 (2109)	26.83	24.36	27.31	25.17	38.95

The percentage of reservoir capacity lost by sediment volume computed by the method of porosity of uniform sediment is lowest among all. The percentage of reservoir capacity lost by sediment volume computed by empirical method is highest among all. The variation in the percentages of reservoir capacity lost for the prediction period of 25 and 50 years are low. The variation in the percentages of reservoir capacity lost for the prediction period of 75 and 100 years are high. The estimation of elevation-area-capacity curve for future periods from consolidated sediment volume is carried out by empirical area-reduction method. The Elevation-area-capacity curve for sediment volume by particle size distribution after 25 years is given as follows:



Reservoir Capacity (Mm^3)

Evaluation and Modeling of Hydrological Support System for Watersheds of Garhwal, Uttarakhand Hills

Study area of the study are Chandrabhaga and Danda watersheds of Uttarakhand that lies in 'Western Himalaya' agro-ecological region of the Sub-humid to humid ecosystem at an elevation of 720 m to 2350 m respectively. Climate of this region is warm with air temperature 3°C to 35°C with average annual rainfall 900 mm to 1200 mm. Reliable source of water during non monsoon period in the watersheds is only through existing springs. Objectives of the study in brief are the development of rainfall-runoff, rainfall-spring flow relationships and assessment of climatic variability and its impact on runoff and spring flow. Monitoring of watersheds continued with a network of instrumentation over the watersheds (Chandrabhaga, Danda) with automatic weather station, automatic rain gauges, v-notches and with manual recording of daily spring flow of around twenty locations in each watershed. The spring flow in the watershed is important and is major source of available water during the periods of unavailability of rain water.

Spring-shed demarcation and development is subjected to geological similarity within the watershed and is attempted with a new concept by delineating the boundaries of a spring subjected to conditions as; (1) The flow in the aquifer can not cross the stream path which is normally the lineament and also the other lineaments that are not along the defined visible stream paths present in the watershed, (2) The flow in the aquifer follows the same flow path that is defined by on the surface for surface flow as flow direction based on the topography, (3) The spring shed normally will not cross the well defined sub watershed boundaries, (4) The delineated spring shed boundaries can be corrected and adjusted subjected to condition as; (a) The area of the spring shed must follow the exponential relationship with maximum spring flow, (b) The spring shed area/relief must follow the exponential relationship with maximum spring flow. The equivalent spring order (ESO) and spring-shed area are identified.

Relative performance of springs by four methods viz. (1) Based on spring flow variability, (2) Based on normalized mass spring flow, (3) Based on rainfall spring flow lag and (4) Based on spring flow gradient was carried out and springs are classified as being good or bad.

A spring being good is classified only when at least three methods classify spring as good. For Chandrabhaga watershed springs 1, 3, 6, 9, 13 & 16 are classified as good and 4A, 7, 10A, 11 & 14 are classified as bed. Similarly, for Danda watershed the springs 2, 3, 4A, 4B, 5, 11, 15, 16, 20 & 28 are classified as good and springs 6, 7 & 8 are classified as bad in table 1 & 2.

Publications in Journal

1. Varekar, Vikas, Subhankar Karmakar, R. Jha, and N. C. Ghosh. (2015). Design of sampling locations for river water quality monitoring considering seasonal variation of point and diffuse pollution loads. Environ. Mont. Assess (Springer). 187:376, DOI: 10.1007/s10661-015-4583-6.

2. Singh, Vikrant Vijay, Sharma Anupma, Joshi P.C. (2015), 'Modelling of runoff response in a semi-arid coastal watershed using SWAT' International Journal of Engineering Research and Applications, Vol. 5, Issue 6, , pp.50-57

3. Garg, P.K., Gopal Krishan and Sudhir Kumar (2015), 'Radon concentration in groundwater of Haridwar, Uttarakhand, India', International Journal of Earth Science and Engineering, 8(2): 1-4.

4. Narayan Gautam, Manohar Arora amd N K Goel (2015), 'Prediction of Precipitation for considering Climate Change and GCM Outputs: Satluj River, Ecopersia, Vol 2, issue 4, Autumn 2014, 757-765.

Table 1: Relative performance, springs of Chandrabhaga watershed by four methods.

Sl. no.	Chand Spring	Chand Grouping	Elevation m	Max Vs Min	Jun01 May 13	Based onlag	Based on skill
1	Spr-1	Continuous flow	1432	Good	Good	Bad	Good
2	Spr-2	Continuous flow	1413	Good	Bad	Bad	Good
3	Spr-3	Continuous flow	1387	Good	Good	Good	Good
4	Spr-4A	Continuous flow	1169	On line	Bad	Bad	Bad
5	Spr-4B	Continuous flow	1220	Bad	Good	Good	Bad
6	Spr-5	Interrupted 01 times	1415	Bad	Good	Good	Bad
7	Spr-6	Continuous flow	1460	Good	Good	Good	Good
8	Spr-7	Interrupted 01 times	1569	Bad	Bad	Good	Bad
9	Spr-8	Interrupted 02 times	1543	Bad	Good	Good	Bad
10	Spr-9	Continuous flow	1431	Good	Bad	Good	Good
11	Spr-10A	Continuous flow	1608	On line	Bad	Bad	Bad
12	Spr-11	Interrupted 07 times	1506	Bad	Bad	Good	Bad
13	Spr-13	Continuous flow	1115	Good	Good	Good	Good
14	Spr-14	Spring dead	1681	Bad	Bad	Bad	Good
15	Spr-15	Interrupted 01 times	1742	Bad	Good	Bad	Good
16	Spr-16	Interrupted 01 times	1661	Good	Good	Bad	Good
17	Spr-17	Interrupted 01 times	1694	Bad	Good	Bad	Good

Table 2: Relative performance, springs of Danda watershed by four methods.

Sl. no.	Danda Spring	Danda Grouping	Elevation m	Max Vs Min	June 01 May 13	Based on lag	Based on skill
1	Spr-1	Continuous flow	1239	Bad	Good	Good	Bad
2	Spr-2	Continuous flow	1285	Good	Good	Bad	Good
3	Spr-3	Continuous flow	1259	Good	Good	Bad	Good
4	Spr-4A	Continuous flow	1232	Good	Good	Good	Good
5	Spr-4B	Continuous flow	1239	Good	Good	Good	Good
6	Spr-5	Continuous flow	1227	Good	Good	Bad	Good
7	Spr-6	Interrupted 04 times	1184	Bad	Bad	Bad	Bad
8	Spr-7	Continuous flow	1113	Bad	Good	Bad	Bad
9	Spr-8	Interrupted 01 times	1148	Bad	Good	Bad	Bad
10	Spr-9	Interrupted 01 times	1204	Bad	Good	Good	Bad
11	Spr-11	Interrupted 02 times	932	Good	Good	Good	Good
12	Spr-13	Interrupted 03 times	1191	Bad	Good	Bad	Good
13	Spr-15	Continuous flow	1148	Good	Good	Bad	Good
14	Spr-16	Interrupted 01 times	1112	Bad	Good	Good	Good
15	Spr-20	Continuous flow	1256	On line	Good	Good	Good
16	Spr-28	Interrupted 02 times	1267	On line	Good	Good	Good

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Workshop/ Conference/ Symposium/ Training attended by the Scientists/ Staff

S.No.	Name of the Training Course	Date & Month	Place
1	Geospatial Technologies	July 21-Aug.10, 2015	Chitkara Univ., Solan, H.P.
2	International Training program 'On Leadership & Career Advancement for women scientist/ Technologista'	Sept. 2-6, 2015	IIE, Guwahati
3	Public Procurement	Sept.7-12, 2015	NIFM, Faridabad
4	Training Program 'On Winter School on Implications of Climate Change on Padagogical Issues of Water Resources Management'	Sept.21-Oct.11, 2015	Junagadh Agri. Univ., Junagadh, Gujarat
5	Training on 'Climate Change and Carbon Mitigation'	Nov.2-6, 2015	ICFRE, Dehradun
6	Hydrology-Basic Hydrological Sciences for Professionals from RA-II (Asian) Countries	Nov.2 -Dec.18, 2015	NWA, Pune
7	Environmental Aspects of Water Resources Projects	Nov. 16-20, 2015	NWA, Pune
8	ISO 9001:2015 Internal Auditor Training Course	Nov.17-18, 2015	NIH, Roorkee

Organization of Workshops/ Training Courses/ Seminar/ Symposium

S.No.	Name of the Training Course	Date & Month	Place
1.	Training Course on 'Flood Risk Mitigation and Management'	Sept. 7-11, 2015	Roorkee
2.	Course on 'Integrated Water Resources Development & Management'	Sept.14-18, 2015	Roorkee
3.	Indo-German Workshop on 'Consolidation and Future of Riverbank Filtration Projects in India'	Sept. 28, 2015	Roorkee
4.	Workshop on 'Integrated Water Resources Development & Management'	Sept.28-Oct.3, 2015	Roorkee
5.	Training Course on 'Remote Sensing and GIS Applications in Water Sector'	Nov.2 – 6, 2015	HIRMI, Kurukshetra
6.	Training program on 'Basic Hydrology'	Nov.2 – 7, 2015	WALAMTARI, Hyderabad
7.	International workshop on 'Changes in Water Resources and Adaptation options in the Indian-Himalayans Basins' jointly organized by NIH, SMHI & SEI, Sweden	Nov.16-17, 2015	Roorkee
8.	Training Course on 'Planning and Management of Hydropower Projects (Hydrological Aspects)' for officers of Meghalaya Electricity Corp., Umaim	Nov.17-19, 2015	Meghalaya
9.	5th Rashtriya Jal Sangoshthi -2015 on 'Badalate Parivesh me Jal Sansadhan Prabandhan ki Bhumika'	Nov.19-20, 2015	Roorkee
10.	Training Program on "Integrated Water Resources Development & Management"	Nov. 30 – Dec.5, 2015	Roorkee
11.	National Seminar on 'R & D Perspective for Rejuvenation of River Ganga'	Dec 16-17, 2015	Roorkee
12.	National Conference on 'Mointoring and Management of Drinking Water Quality (NCMMDWQ)-2015	Dec.21-23, 2015	UCOST, Dehradun
13.	Symposium of Hydrology in collaboration with IAH, NIH & CWC	Dec.22-23, 2015	New Delhi

Mass Awareness

S.No.	Activities	Organised by & Date
1	Hindi Month	17th August to 16th September, 2015, Roorkee
2	Vigilance Awareness week	Oct.26-31, 2015, Roorkee
3	Swachh Bharat Abhiyan program	Oct 2015 at RC, Belgaum
4	Preventive Vigilance as a tool of Good Governance	Nov.3, 2015, Patna

Other News

Institute Important Meetings

1. 68th TAC Meeting held at New Delhi during 21 July, 2015.
2. 43rd Working Group Meeting, held at Roorkee during 8-9 December, 2015.
3. 38th Foundation Day, held on 16 Dec., 2015 at NI Roorkee

68th TAC Meeting

पाँचवी राष्ट्रीय जल संगोष्ठी "बदलते परिवेश में जल संस्थान प्रबंधन की भूमिका"
19–20 नवम्बर 2015 राष्ट्रीय जल संस्थान, रूड़की

Vigilance Awareness Week

Indo-German Workshop on Consolidation & Future of Riverbank Filtration Projects in India

National Seminar on R & D Perspective for Rejuvenation of River Ganga

IITF - 2015

पाँचवी राष्ट्रीय जल संगोष्ठी ''बदलते परिवेश में जल संस्थान प्रबन्धन की भूमिका'' 19-20 नवम्बर 2015

Training Course on 'Integrated Water Resources Development & Management

Brain storming Session on Himalayan River Basins : Hydrology and Glacial regimes

43rd Working Group Meeting

38th Foundation Day of NIH

38th Foundation Day of NIH

Editor
Dr V C Goyal, Head,
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& Outreach Division

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Sri Rajesh Agrawal, SRA

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