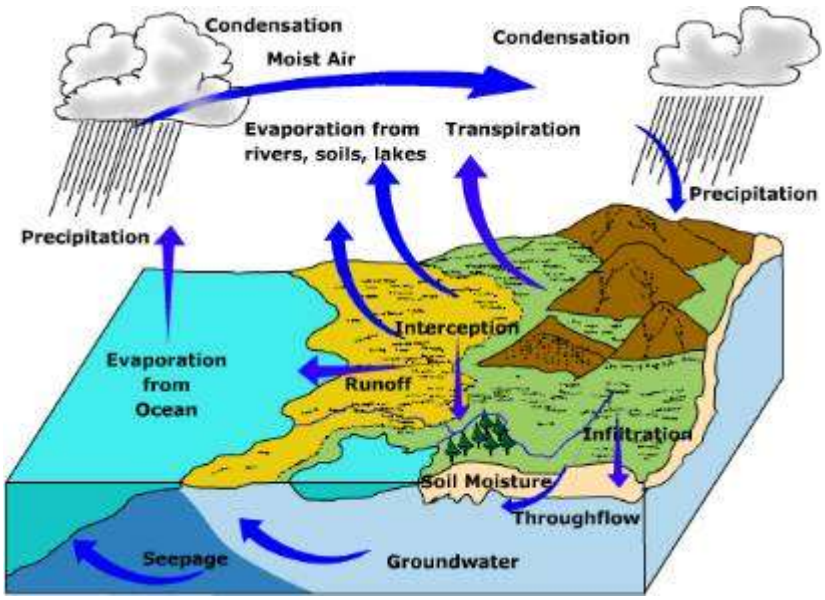
AGENDA AND AGENDA NOTES FOR THE 42nd MEETING OF THE WORKING GROUP OF NIH

MARCH 19-20, 2015
AT 1100 HRS



NATIONAL INSTITUTE OF HYDROLOGY ROORKEE-247667

AGENDA AND AGENDA NOTES FOR THE 42nd MEETING OF THE WORKING GROUP OF NIH

AGENDA ITEMS

ITEM NO. 42.1 Opening Remarks by the Chairman

ITEM NO. 42.2 Confirmation of the minutes of 41st meeting of the Working Group

The 41st meeting of the Working Group was held during November 26-17, 2014. The minutes of the meeting were circulated to all the members and invitees vide letter **No. RCMU/WG/NIH-10 dated Dec. 10, 2014**. No comments were received on the circulated minutes. A copy of the minutes of the 41st Working Group is given in **Annexure A.**

The Working Group may please confirm the minutes.

ITEM NO.42.3 Action taken on the decisions/ recommendations of the previous Working Group meeting

During the 38th Working Group meeting, recommendations/ suggestions were made by the Working Group members and the actions taken shall be informed by the respective Divisions during the meeting.

ITEM NO.42.4 Presentation and discussion on the status and progress of the work programme for the year 2014-2015.

The approved Work Programme of the six Divisions of the Institute for the year 2014-15 has been given in the **Annexure B** in the following order**:**

The numbers of studies/projects being handled by each division under different categories are given below:

Division	Studies		Total
	Internally funded	Sponsored (including HP-II)	
Environmental Hydrology	03	02	**05**
Ground Water Hydrology	01	03	**04**
Hydrologic Investigation	06	09	**15**
Surface Water Hydrology	11	-	**11**
Water Resources System	11	03	**14**
RMOD	03	01	**04**
Total			**53**

During the present meeting, Division-wise progress and status of the work programme for the year 2014-15 shall be presented in detail. The Working Group may please consider the progress and status of the Work Programme for the year 2014-2015.

ITEM NO. 42.5: Presentation and finalization of the work programme for the year 2015-2016.

The proposed Work Programme of the six divisions of the Institute for the year 2015-16 has been given in the Annexure – B in the following order:

The work programme has been categorized into three groups: (a) Internally funded studies, (b) Sponsored projects and (c) Consultancy Projects. During the present meeting, Division-wise proposed work programme for the year 2015-16 shall be presented.

	No. of Studies/Projects During the Year 2015-2016					
Division	**New**		**Ongoing**		**Total**	
	Internally funded	Sponsored	Internally funded	Sponsored		Consultancy Projects
Environmental Hydrology	-	-	2	2	**04**	**-**
Ground Water Hydrology	3	-	2	1	**06**	**-**
Hydrologic Investigation	2	1	5	4	**12**	**2**
Surface Water Hydrology	4	-	6	-	**10**	**-**
Water Resources System	2	-	10	2	**14**	**-**
Research Management & Outreach	1	1	3	1	**06**	**-**
Total					**52**	2

ITEM NO. 42.6: Any Other Item with Permission of the Chair.

ANNEXURE – A

MINUTES OF THE 41ST MEETING OF WORKING GROUP

MINUTES OF THE
41ST MEETING OF WORKING GROUP OF NIH
HELD AT NIH, ROORKEE, DURING NOVEMBER 26-27, 2014

The 41st meeting of the Working Group of NIH was held at NIH, Roorkee, during November 26-27, 2014 under the Chairmanship of Director, NIH. The list of the participants of the meeting is given in Annexure-I.

ITEM NO. 41.1: OPENING REMARKS BY THE CHAIRMAN

Dr Sharad K Jain, Director-in-charge, NIH & Chairman, WG welcomed the Working Group members and the Scientists of the Institute. After a round of introductions, the Chairman requested Dr V C Goyal, Member-Secretary, to take up the agenda of the meeting.

ITEM No. 41.2: CONFIRMATION OF THE MINUTES OF 40TH MEETING OF THE WORKING GROUP

The 40th meeting of the Working group was held during June 4-5, 2014. The minutes of the meeting were circulated to all the members and invitees vide letter No. RCMU/WG/NIH-10 dated July 7, 2014. Er. R.K. Khanna conveyed the following suggestions: (i) Training Course on EIA (ii) Taking up EIA studies by NIH and (iii) Certificate or PG Diploma Course on IWRM.

The members confirmed the Working Group minutes.

ITEM No. 41.3: ACTION TAKEN ON THE DECISIONS/RECOMMENDATIONS OF THE PREVIOUS WORKING GROUP MEETING

Dr V C Goyal gave a brief account of the actions taken on the recommendations/decisions of the 40th working group meeting.

ITEM No. 41.4: PRESENTATION AND DISCUSSION ON THE STATUS AND PROGRESS OF THE WORK PROGRAMME FOR THE YEAR 2014-15.

The Member-Secretary requested the respective Divisional Heads to present the progress of studies carried out during 2014-15. Accordingly, the progress of various studies and sponsored projects was presented by all Scientific Divisions on their turn during two day deliberations of the Working Group. The Division wise minutes of each study/project presented during the meeting are given below:

ENVIRONMENTAL HYDROLOGY DIVISION

S.No.	Project Study, Study Team, Date of Start and Completion	Recommendation/Suggestion
	Research Studies 2014-15	
1.	Water Quality Modelling using Soft Computing Techniques **Study Team:** Rama Mehta (PI), C. K. Jain and Anju Chowdhary Duration**: 2 Years (06/14-03/16)**	Results were appriciated by members. Dr. N.C. Ghosh suggested that the Water Quality Index should also be developed for other uses of water. Dr. V.K. Sharma, Director, GSI, Dehradun, suggested that sample locations presented in GIS map could be related with the soil and geology of that area.
2.	Himalayan River Water Quality Assessment in a Stretch from Gangotri to Haridwar. **Study group:** Rajesh Singh (PI) , C. K. Jain, M. K. Sharma, S. P. Rai , Renoj J. Thayyan, J. P. Patra **Duration:** 3 Years (07/14-06/17)	**No comments.**
	Consultancy Project 2014-15	
1.	Water Safety Impact Assessment through Sanitary Improvement of India Mark 2 Hand Pumps in Moradabad Division, Uttar Pradesh **Study team:** C. K. Jain (PI),Babita Sharma, Rakesh Goyal and Dayanand **UNICEF Lucknow,** **Amount: Rs. 12 lacs** Duration: **6 months (10/14-03/15)**	**No comments.**
	Sponsored Projects 2014-15	
1.	Low Cost Technology for Purification of Arsenic and Microbes Contaminated Water using Nanotechnology **Study team:** Vijaya Aggarwala, IITR (PI) & Rama Mehta, NIH (Co-PI) **Duration**: 2 Years (04/14-03/16) DST Sponsored	**No comments.**
2.	Ionic Enrichment Dynamics of Glacial Sediment and Melt Water of Gangotri Glacier **Study Team:** M. K. Sharma (PI), C. K. Jain , Renoj Thayyan , Manohar Arora , Naresh Saini , Jatin Malhotra, Rakesh Goyal , Daya Nand **Duration:** 3 Years (04/14-03/17) DST Sponsored	**Study was appreciated by member.**

GROUND WATER HYDROLOGY DIVISION

Dr. Anupma Sharma, Scientist-D, presented an overview and progress of studies and activities carried out by the Division during the period June-November, 2014. She informed that out of 4 R&D studies approved for the year 2014-15, one is in-house study and 3 are sponsored continued studies of the year 2013-14. Out of the 3 sponsored studies, one study on 'Saph Pani' Project has been successfully completed, while 2 studies are being continued as in-house studies. The 'Saph Pani' Project was concluded in September, 2014 with organization of the International Conference at New Delhi.

The Division has proposed one training course to be organized in collaboration with DHI-India during 2014-15. As professional scientific activities, scientists of the Division have submitted/published a number of research papers in various journals/ conferences/ symposia, delivered lectures in various training courses and guided summer trainees during the period.

The study-wise progress reported and suggestions emerged are given below.

Project Ref. Code: NIH/GWD/NIH/13-14: **Estimation of specific yield and storage coefficient of aquifers**

Dr. Surjeet Singh (PI) presented the progress of the study and also demonstrated the software developed on the estimation of specific yield and storage coefficient. The work was appreciated by the Working Group Members as well as NIH Scientists. Dr. R.D. Deshpande suggested to include an option for the ranking of the suitable methods of specific yield estimation. Dr. S.N. Rai suggested preparing a professional paper for the scientific community on the developed software rather than preparing a study report. The professional paper can be in two parts (i) Part-1 should deal with unconfined aquifer, and (ii) Part-2 should deal with confined aquifer. Sh. S.K. Bhartya suggested to also explore suitable options of specific yield estimation for the hilly areas of Uttarakhand State. Dr. V.C. Goyal suggested to take 4-5 more months for value addition of this software.

An extension of four months was requested to make the software web-enabled which was approved by the WG Members.

Project Ref. Code: NIH/GWD/NIH/11-14: **Managed Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)**

Mr. Sumant Kumar (PI) presented the progress of the study. It was informed that, the study as per requirement of the 'Saph Pani' project has been completed and the report has been submitted to the Saph Pani consortium.

Because of contains in hydrogeological formations, the feasibility of MAR in Raipur area has been found limited, while the Raipur city area has about 85 surface water bodies, which with some scientific approaches can be used to meet city's water supply. To work out a water management plan based on these water bodies, PI suggested continuing this study as an internal project till March, 2015. .

Project Ref. Code: Flow and Contaminant Transport Modeling of Riverbank Filtration.

Ms. Shashi Poonam Indwar, Scientist-B presented the progress made and work carried out in the study since April, 2014. She informed that model setup and its input data preparation using MODFLOW coupled with MT3D is in progress. It was also mentioned, because of her long leave, the completion of the study got delayed.

Project Ref. Code: NIH/GWD/INT/14-17: **Management of Water Resources for Quantity and Quality in Yamuna-Hindon Inter-basin**

Dr. Anupma Sharma (PI) presented the new study to be taken up for three years under collaboration with Dept. of Civil Engg., IIT Roorkee. Dr. N.C. Ghosh described the background of the study. The need for undertaking the comprehensive research study was also explained. Dr. S.N. Rai informed about related works carried out in different parts of the region by various other organizations which will be useful in the present study. Dr M.K. Sharma of NIH gave information about studies pertaining to water quality of River Hindon. PI informed that data from all such studies would be compiled for building up the historical database of the study area.

The work programme of the division for the year 2014-15 is given at annexure-I.

Annexure-I

WORK PROGRAMME OF THE GROUND WATER HYDROLOGY DIVISION FOR THE YEAR 2014-15

S. No.	Project	Project Team	Duration & Status	Funding Source
1. NIH/GWD/NIH/13-14	Estimation of specific yield and storage coefficient of aquifers	Surjeet Singh (PI) N.C. Ghosh (Co-PI) Sumant Kumar	1&1/2 year (04/13 – 10/14) Extension of 4 months up to March, 2015 was granted	NIH
Sponsored & HP-II Projects				
2. NIH/GWD/NIH/11-14	Management of Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)	Sumant Kumar (PI) Rajan Vatsa, N.C. Ghosh C.P. Kumar, Surjeet Singh, Sanjay Mittal	3 years (04/11 – 03/14) **Status:**. Etension up to March, 2015 was granted .	**NIH (**after September, 2014)
3.	Flow and Contaminant Transport Modeling of Riverbank Filtration	Shashi Poonam Indwar (PI), N.C. Ghosh Anupma Sharma, Rajan Vatsa	2 ½ years (04/12 – 09/14) **Status:** Extension up to September, 20/15 was granted	NIH (after September, 2014)
Proposed New Study				
4.	Ganges Aquifer management for Ecosystems services (GAMES)	Sharad Jain (PI), N.C. Ghosh, Sudhir Kumar, Sanjay Jain, M.K. Goel, Anupma Sharma, Surjeet Singh	1 year (01/06 – 31/05) **Status**: in progress.	IWMI, Hyderabad
5. NIH/GWD/INT/14-17	Management of Water Resources for Quantity and Quality in Yamuna-Hindon Inter-basin	Anupma Sharma (PI) N. C. Ghosh & other NIH study team member Collaborating Institute; IIT Roorkee, CED	3 years (December, 2014 –Nov., 2017) Status : New	Initially by NIH, later on by sponsoring agency.

HYDROLOGICAL INVESTIGATIONS DIVISION

INTERNAL STUDIES:

1. PROJECT REFERENCE CODE: NIH/HID/INT/2012-14/2:

Title of the Study: Water Quality, Hydrogeology and Isotopic Investigations in SW Punjab

Dr. M. Someshwar Rao, PI of the project brifly explained the objectives of the project and responsibilities of NIH and collaborative partner, Punjab University, Chandigarh in executing the project. He then explained the work components accomplished by NIH and the results obtained by samples analysis at NIH, Roorkee. He explained the results through spatial distribution maps on EC, nitrate, fluorides, sulphates and $\delta^{18}O$ in groundwater etc. Using correlation plot between water quality and stable isotopes he explained the groundwater contamination arising due to anthropogenic and geogenic sources. He told that due to non-receiving of funds at the collaborative organization (Punjab University), the component of work in relating hydrogeology with water quality could not be completed by Punjab University. However, as NIH component of the project is completed the report will be submitted with the accomplished results. Dr Rao concluded the presentation by highlighting measures that can be taken up to overcome the contamination problems in the Bhatinda district of Punjab and informed completion of the project.

2. PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/1

Title of the Study: **Water Availability Studies for Sukhna Lake, Chandigarh**

The study was presented by Dr. S. D. Khobragade, Sc-E and PI. He informed that the major objectives of the study are: (i) To study inflow regime of the lake, (ii) To study seepage losses from the lake, (iii) To analyze long term trends in rainfall and evaporation (iv) To study water availability in the lake.

Dr. Khobragae presented the analysis carried out so far and the results in details including the water balance of the years 2011-12, 2012-13. He discussed the relative significance of various factors in the water balance of the lake. He also presented the analysis of variation of the lake water levels to understand the possible impact of the check dams on inflow to the lake. Detailed analysis of the inflow and the runoff coefficients of the lake and their trend over the past 10 years was also presented. In the end Dr. Khobragade presented the results of the prediction of the water availability of the lake in the coming summer of 2015. He informed that as per the predictions, the lake shall be on the verge of drying on 1st July, 2015. Although, the lake shall have a significant water spread area, but the depth of the water shall be only about a feet. He further added that if the monsoon is significantly delayed, the lake may dry up during July 2015.

The working group noted progress of the study. No comments were received.

3. PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/2

Title of the Study: Isotope Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains

Dr. Sudhir Kumar (PI) presented the progress of the work done carried out since the last meeting. He informed that the analysis of the noble gases for 12 samples has been completed from IAEA Vienna. The results on noble gases indicate that there is a good correlation between the age of groundwater with built up of He in the groundwater. He

further informed the working group that $^{3}He/^{4}He$ v/s Ne/He plot indicates that the source of helium in the groundwater is from continental crust.

Dr. Sudhir Kumar further informed that as the study is being funded by IAEA under the project "Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains", the sponsorer has requested that a deep borehole be drilled to verify the finding of the isotopic investigations. It is proposed to drill a deep well (upto 350 m) tapping all the three aquifer systems, and samples will be collected for isotopic analysis from each aquifer. He further informed that sampling work of deep groundwater shall start in the month of December 2014 and shall finish by February 2015. The samples shall be shipped to Netherland and Vienna for dating and noble gas analysis.

Dr. RD Deshpande suggested computing the noble gas temperature from the analysis of different noble gases.

Working group noted the progress of the work done under the study.

4. PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/4

Title of the Study: Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes

Sh. S. K. Verma, the principal investigator of the study, presented the study before the members of the WG meeting. He mentioned about the objectives of the study along with the location of study area, brief methodology, action plan, achievement so far received for the study etc. He also mentioned that there were no comments or suggestions raised during the last working group meeting i.e. 40th meeting of working group.

While discussing the progress of the study, he informed that 1st objective of the study has been partially achieved. The groundwater samples collected from intermediate/deep tube wells from 5 districts located in the study area have been analysed for radon concentration. The radon concentrations monitored in these districts were found within the maximum permissible limit for drinking water as per the guide lines of WHO. A small part of the study area is left to be investigated for radon measurement which will be taken up during the next field trip. Sh. Verma further informed that in order to meet 2nd objective of the study, the analysis of environmental tritium in 39 groundwater samples which were collected during the field trips is in progress to identify the location for carbon dating.

The working group noted the progress of the study.

SPONSORED PROJECTS:

5. PROJECT REFERENCE CODE: NIH/HID/MOES/2012-15

Title of the Study: **The Structure and Dynamics of Groundwater Systems in North-western India under Past, Present and Future Climates**

Based on results of stable and radio-isotope, Dr. S. P. Rai presented the progress study. The main highlights of the presentation were the identification of recharge source of the shallow and deeper groundwater aquifer. On a query from Dr. R. D. Deshpande, Dr. S. P. Rai informed about the variation of tritium values in shallow aquifer 1 TU to 7 TU and deeper aquifer <3 TU. Dr. S. K. Bartarya asked the source of groundwater level data and Dr. Rai replied that water level data have been collected from the CGWB and State Groundwater Department.

The working group noted the progress of the study.

6. PROJECT REFERENCE CODE: NIH/HID/IAEA-1/2012-15

Title of the Study: **The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India**

Dr M. S. Rao, P. I. of the project explained depletion in water resources in the study area using falling water level data of Dholwaha reservoir (along with rainfall data). Using environmental tritium activity data for shallow and deep groundwater he told that shallow groundwater is getting poorly recharged in area falling diagonally along SE-NW zone in the study region. Along this zone, groundwater in shallow aquifer is about 20 years old and in the remaining region it is relatively young (about 10 years old). In the north of this zone, groundwater age is low due to modern recharge occurring from reservoirs of Kandi region whereas, in the southern side of this zone, modern recharge is occurring due to over pumping induced recharge from surface water sources (canal & rainfall). The deeper aquifer water is twice the age of shallow groundwater. In the deeper aquifer, groundwater is old towards river side (southern end towards river Satluj and western end towards river Beas). Stable isotope results show that shallow aquifer groundwater is formed from rainfall recharge all throughout the region except at few locations where recharge from canal is also seen. Isotopic data shows groundwater in deeper aquifer, in area close to the river Satluj, as water of canal origin. Since this water is old, it indicates a few decade old canal irrigated return flow water. PI Informed that the sampling and analysis will be continued for the premonsoon of 2015.

7. PROJECT REFERENCE CODE: NIH/HID/IAEA-2/2012-15

Title of the Study: **Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques**

Dr. S. P. Rai presented the progress of the study. He informed that rainfall, river, canal and groundwater samples were to collect from the study area and stable isotopes (δD and δ^{18}O) radioactive isotope (^{3}H) were measured. The results of the isotopes were presented in detail along with details of hydrogeological conditions. Dr. Rai also presented findings of surface water groundwater interaction of the study area. Results of modelling approach to assess the base flow component were also discussed.

The working group noted the progress of the study and appreciated the progress of the study.

8. PROJECT REFERENCE CODE: NIH/HID/BGS/2013-14

Title of the Study: **Review of Groundwater Resources in the Indo-Gangetic Basin: A Case Study on Resilience of Groundwater in the Punjab to Withdrawal and Environmental Change**

Dr M. S. Rao, PI of the project informed that the BGS funded project has two components; (i) preparing a review report by collating data from the published reports and (ii) groundwater dating using CFC & noble gas technique in Bist Doab region. For the review report, (i) landuse/landcover data at 1:50,000 has been collected, (ii) 20 years district average pre-monsoon/post monsoon water level data of UP, Bihar, West Bengal and Assam has been collected and (iii) water quality data from CPCB has been collected. To accomplish the 2nd

objective of the project, major ions analysis of groundwater of Bist Doab region was done NIH, Roorkee and heavy metals & trace metals were analyzed at BGS, UK. Groundwater samples were collected for CFC dating and these were analyzed at BGS, UK. The CFC dating results were also compared with the tritium dating results obtained in the IAEA-CRP project. The two results obtained by two different technique and conducted at two different laboratories grossly show agreement and internal consistency. Groundwater Age using CFC dating technique has provided mean age of shallow groundwater as 25 years (range: 15 – 48 years) and mean age of deep groundwater (> 100m depth) is 46 years (age range: 38-54 years). The results has shown that withdrawal of groundwater from deeper wells for irrigation and its subsequent transfer to shallow aquifer through irrigation return flow has resulted into mixing of shallow aquifer water by deeper aquifer water, thereby, isotopic and chemical mixing of the two waters in the shallow aquifer. Similar to environmental tritium results, the CFC dating has shown that deeper aquifers of the Bist Doab region are getting recharged mainly at Bhabhar region. The excessive groundwater withdrawal in the central Bist Doab region especially from deeper aquifers has induced enhanced flow of groundwater from recharge zones to the central Bist Doab region. The excessive withdrawal of groundwater from deeper aquifer has accelerated groundwater movement from shallow to deeper aquifer (recharge to deeper aquifer) at points wherever interaction between the two exists. The results of the report are presented in 4 publications (3 international conferences and 1 in international journal). Dr Rao informed successful completion of the project.

NEW STUDIES:

1. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/1

Title of the Study: **Interaction between groundwater and seawater along the north east coast of India**

Dr M. S. Rao as a PI of this new study informed that the study is taken up as a pilot project as per the suggestion of the Working Group. Dr Rao presented the objectives and methodology of the proposed new project and informed that this 2 years project (Jan 2015-Dec 2016) project will be executed through internal funds with budget of Rs. 5.0 lakhs. He informed that the interaction between groundwater and seawater in the parts of east coast will be examined through measurement of groundwater salinity (EC), stable isotope composition of groundwater and dissolved radon in groundwater. Dr Rao provided importance of the study and methodology to achieve the objectives of the study. Under the project, groundwater sampling will be conducted in pre & post monsoon periods and the collected data will be analyzed in NIH, Roorkee.

Approved Activity Schedule:

S. No.	**Activities**	**Quarters**							
		1	2	3	4	5	6	7	8
1.1	Review of literature	√	√	√					
1.2	Site selection & preparation of index map of the study area	√	√						
1.3	Collection and compilation of data	√	√						
1.4	Field work, sample collection and analysis of water samples		√	√	√	√	√		
1.5	Data interpretation					√	√	√	
1.6	**Project report & publications**							√	√

Budget Details:

Sl. No.	Budget Head	Amount (lakhs)
1	Travel Expenditure (2-3 field work of aprox. 15 days each)	2.0 lakhs
2	Analytical charges, field & lab assistance	2.0 lakhs
3	Miscellaneous expenses	1.0 lakhs
	Total	5.0 lakhs

The project is envisaged to bring out map on submarine groundwater discharge/seawater intrusion for the study area and research publication based on the results. The Working Group approved the project programme and the budget.

Suggestion by Working Group members: Shri Niladri Naha informed that he may be contacted for data and in the field support for the above study.
Dr Rao noted the suggestion of Shri Naha.

2. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/2

Title of the Study: **Isotopic investigation of benchmark Himalayan glaciers**

Dr M. S. Rao, PI of the project informed that the proposed study was submitted in the 40th Working Group of NIH with the title "Monitoring Isotopes in Air Moisture in Parts of Himalaya (Himachal Pradesh & Uttarakhand) for investigating the Cloud Condensation". However, the title is modified in light of the following reason:

Under National Action Plan on Climate Change (NAPCC), Government of India launched a National Mission for Sustaining the Himalayan Eco-system *(NMSHE)"*. Of various objectives of the mission -NMSHE, one objective is to address Himalayan Glaciers and the associated hydrological consequences. To address this issue, DST, GoI, has asked NIH to submit a proposal to address "impact of water, snow and ice on Himalayan ecosystem".

Considering the above recent developments and to fulfill the objective of the mission, it was decided to take up a pilot project to evaluate the feasibility of isotopes techniques for investigation of Himalayan glaciers. Accordingly, the previously submitted title of the project was modified as "Isotopic investigation of benchmark Himalayan glaciers". The modified title directly addresses the glacial systems using isotopes.

Dr M. S. Rao, informed that the project is taken up as a pilot study to examine the feasibility of isotopes to investigate Himalayan glaciers using isotope and chemical analysis of glacial components. Technical support for field work will be taken up from Prof. AL Ramanathan, JNU, New Delhi. Prof. Ramanathan has agreed to provide glacial melt, snow-melt and shallow glacial core samples for the study with no financial support from NIH, Roorkee. The project will be completed in 2 years (January 2015 to December 2016) with budget of Rs. 5.0 lakhs from NIH internal funds. Dr Rao informed that for the pilot study, shallow glacial cores, melt-water and surface snow will be collected from glaciers of Uttarakhand, Himachal Pradesh and Ladakh parts of Himalayas. The isotopic and chemical analysis will be done at NIH Roorkee. As per the availability of stations in the study area, meteorological data will be collected and as per availability of sites, air-moisture sampling units for isotopic analysis will be installed. Isotopic and chemical data will be suitably inter-compared to interpret glacial environment at this regions. The study is expected to (i) generate the isotope database on snow & glaciers in the Himalayan region at Uttarakhand, H.P. and Ladakh (ii) assess spatial

variability in isotopic & chemical characteristic of glacial environment (iii) isotope based interpretation of accumulation and ablation process of these glaciers.

Approved Activity Schedule:

S. No.	Activities	Quarters							
		1	2	3	4	5	6	7	8
1.1	Review of literature	√	√	√	√				
1.2	Site selection & preparation of index map of the study area	√	√						
1.3	Collection and compilation of data	√	√						
1.4	Workshop & training programme	√				√			
1.5	Field work, sample collection and sample analysis		√	√	√	√	√		
1.6	Data interpretation					√	√	√	
1.7	**Project report & publications**							√	√

Budget Details:

Sl. No.	Budget Head	Amount (lakhs)
1	Travel Expenditure	2.0 lakhs
2	Analytical charges , field & lab assistance, minor instrument purchase	2.0 lakhs
3	Miscellaneous	1.0 lakhs
4	Total	5.0 lakhs

The working group approved the project and budget requirements without any specific recommendations or suggestions.

3. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/3

Title of the Study: Assessment of dissolved radon concentration for groundwater investigations in Haridwar

The study was presented by Sh. P. K. Garg, Scientist-B. He informed that temporal variation in dissolved radon concentration in groundwater may provide a new way to look into the aquifer system and recharge conditions. So the study has been undertaken with the objectives: (i) Mapping the spatial distribution and temporal fluctuation in radon levels in groundwater in Haridwar district, (ii) To investigate the effect seasonal groundwater levels fluctuations on fluctuation in radon levels. He told that the study will be conducted in the district Haridwar which is considered to be the major recharge zone spanned in the Bhabhar-Siwalik region and, the local recharge zones along the canal length and along the western bank of the river Solani. Discussing the methodology he informed that the groundwater samples from the study region will be analyzed for radon concentration during pre and post monsoon seasons to generate the background radon concentration in the shallow aquifer, to investigate the recharge induced variation in radon concentration and to decipher change in radon concentration along the confined aquifer due to variation in radioactivity in the aquifer matrix. Samples will also be collected and analyzed for stable isotope analyze to support and collaborate the results and the inferences of radon measurements.

Activity Schedule:

S. No.	Activities	Quarter			
		1	2	3	4
1.1	Review of literature	√	√		
1.2	Site selection	√			
1.3	Collection and compilation of data		√		
1.4	Field work, sample collection and analysis of water samples	√	√	√	
	Data interpretation		√	√	
1.5	**Project report & publications**			√	√

Budget Details:

Sl. No.	Budget Head	Amount (lakhs)
1	Travel Expenditure	0.40 lakhs
2	Analytical charges , field & lab assistance, minor instrument purchase	0.25 lakhs
3	Miscellaneous	0.15 lakhs
4	Report Printing	0.20 Lakh
	Total	1.00 lakhs

The working group approved the project and budget requirements without any specific recommendations or suggestions.

REVISED WORK PROGRAMME OF HYDROLOGICAL INVESTIGATIONS DIVISION FOR THE YEAR 2014-2015

S. No.	Study	Team	Duration/ Status
	INTERNAL STUDIES		
1.	Water Quality, Hydrogeology and Isotopic Investigations in SW Punjab	M. S. Rao (PI), C. P. Kumar Gopal Krishan	3 years **(07/12-06/15)** Completed Study
2.	Water Availability Studies for Sukhna Lake, Chandigarh	S. D. Khobragade (PI) C. P. Kumar Sudhir Kumar A. R. Senthil Kumar P. K. Garg V. K. Agarwal	**2 years** (04/13-03/15) Continuing Study

S. No.	Study	Team	Duration/ Status
3.	Isotopic Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains	Sudhir Kumar (PI) C. K. Jain S. P. Rai S. D. Khobragade P. K. Garg B. C. Joshi (CGWB, Lucknow) Tejdeep Singh (CGWB, Chandigarh)	**2 years** (07/13-06/15) **Continuing Study**
4.	Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes	S. K. Verma (PI) S. P. Rai (Co-PI) M. S. Rao C. P. Kumar Mohar Singh	**2 years** (10/13-09/15) **Continuing Study**
5	Sub-marine Groundwater Discharge and Sea-water Intrusion in Coastal Aquifers of East Coast, India	M. S. Rao (PI)	**2 years** (06/14-05/16) **Revised Study as given as S No. 7**
6.	Monitoring Isotopes in Air Moisture in Parts of Himalayas (Himachal Pradesh & Uttarakhand) for investigating the Cloud Condensation	M. S. Rao (PI) C. P. Kumar Gopal Krishan	**2 years** (06/14-05/16) **Revised Study as given as S No. 8**
7.	Interaction between groundwater and seawater along the northern part of east coast of India	M. S. Rao (PI), Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16) **New Study**
8.	Isotopic investigation of benchmark Himalayan glaciers.	M. S. Rao (PI), Sudhir Kumar	**2 years** (01/15 - 12/16) **New Study**
9.	Assessment of dissolved radon concentration for groundwater investigations in Haridwar district	Pankaj Garg (PI), Sudhir Kumar, M. Someshwar Rao	**1 year** (01/15 – 12/15) **New Study**
	SPONSORED PROJECTS		
10.	The Structure and Dynamics of Groundwater Systems in Northwestern India under Past, Present and Future Climates	S. P. Rai (PI) M. S. Rao Surjeet Singh S. K. Verma C. P. Kumar Sudhir Kumar V. K. Agarwal Rajeev Gupta S. L. Srivastava Vishal Gupta Mohar Singh	**3 years** (06/12-05/15) **Continuing Study**
11.	The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India	M. S. Rao (PI) C. P. Kumar S. P. Rai	**3 years** (09/12-08/15) **Continuing Study**

S. No.	Study	Team	Duration/ Status
12.	Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques	S. P. Rai (PI) R. V. Kale M. S. Rao C. P. Kumar Sudhir Kumar V. K. Agarwal Vishal Gupta Mohar Singh	**3 years** (10/12-09/15) **Continuing Study**
13.	Review of Groundwater Resources in the Indo-Gangetic Basin: A Case Study on Resilience of Groundwater in the Punjab to Withdrawal and Environmental Change	M. S. Rao (PI) C. P. Kumar Gopal Krishan	**One year 8 months** (02/13-09/14) **Continuing Study**
14.	Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains	Sudhir Kumar (PI) S. P. Rai S. D. Khobragade C. K. Jain P. K. Garg	**2 years** (05/13-04/15) **Continuing Study**
CONSULTANCY PROJECTS			
15.	Integrated Hydrological Investigations of Sukhna Lake, Chandigarh for its Conservation and Management	Suhas Khobragade (PI)	**Initially 2 years** (7/11-12/13) **(extended upto 3/15)**
16.	Hydrogeological Study for Dewatering of Jhamarkotra Mines, Distt. Udaipur	Sudhir Kumar (PI)	**3 years** (05/13-04/16) **Continuing Study**
17.	Impact Assessment of Ash Pond on the Groundwater Quality in the Surrounding Villages of NTPC Simhdri through Stable Isotopic Studies	Sudhir Kumar (PI)	**1 year** (07/13-06/14) **Completed**
18.	Isotopic Characterization of Groundwater of District Raigarh, Chhattisgarh	S. P. Rai (PI)	**6 months** (04/14-09/14) **Extended till 3/15**
19.	Hydrogeological Studies for Ash Pond of 2 X 525 MW Maithon Power Limited and an Abandoned Coal Mine, District Dhanbad, Jharkhand	Sudhir Kumar (PI)	**3 months** (06/14-8/14) **Extended till 12/14** **Interim report sunbmitted**
20.	Possible impact of construction activities in Kansal area (Mohali, Punjab) on water flow to Sukhna lake in Chandigarh	Suhas Khobragade (PI)	**2 months** (9/14-11/14) **Draft Report Submitted.**

SURFACE WATER HYDROLOGY DIVISION

S.N.	Title of Project/Study, Study Team, Start/Completion Dates	Status and Recommendations/Suggestions
1.	Sedimentation Studies for Pong Reservoir, Himachal Pradesh Team **A. R. Senthil kumar** Manohar Arora Suhas D Khobragade Avinash Agarwal and Sanjay Jain DOS:April 2012 DOC: March 2015	Dr. A. R. Senthil Kumar, PI of the project, presented the objectives, methodology and progress of the study for the period from June 2014 to November 2014 and overall progress in brief. The PI presented the development of sediment yield model for pong dam using ANN and the simulation of sediment yield for future 25, 50, 75 and 100 years using the generated series of rainfall and flow volume. The PI presented the uncertainty analysis of the rainfall and flow volume of 10%, 50% and 90% dependable series for future 25, 50, 75 and 100 years. The PI presented the determination of average simulated sediment yield using the sets of weights of ANN model by boots trap method and the dependable series of rainfall and flow volume. The PI also presented results on the computation of unit weight of sediment and consolidated unit weight of sediment in the reservoir by different methods such as particle size distribution of suspended sediment concentration, porosity of the settled sediment and hydrographic survey.
2.	Study Of Hydro-Meteorological Droughts For Chitrakoot Bundelkhand Region In India R.P. Pandey DOS: April 2012 DOC: March 2015	The Head, Surface Water Hydrology Division reported the progress of studies in brief and invited Dr R.P. Pndey, PI of the project, to presented details of activities and work carried out in respect of ongoing study for the period after last working group meeting held in May 2014. Dr Pandey presented the analysis and results based on past records of long-term meteorological data. He informed that the study site had faces acute drinking water shortages from time to time during summer months and this problem was very severe during drought years in the recent past i.e. 2004-2008. The major objective of the study is to quantify water scarcity during droughts and to identify possible options for augmenting water supply and minimizing crop loss due to droughts**.** The PI further reported that th**e** data processing & analysis and preparation of base maps, dryspell analysis and estimation of supplemental irrigation water requirement for dry-spell periods for kharif season, village-wise domestic drinking water demand assessment and water availability have been completed. It was informed that a new methodology has been devised and verifies for regular drought monitoring using rainfall data. The method has been compared with Standardized Precipitation Index (SPI) and Effective Drought Index (EDI). The method provides comparable assessment of onset of drought and its progression. Further, it was informed the villages have been grouped in to different clusters based on local topographic features, potential

		source of water supply, population, source-wise water availability, and magnitude of demand. It was reported that a comprehensive plan drinking water supply and supplemental irrigation water supply to kharif crop during dry spells has been and the same was presented for comments from the distinguished members of the Working Group. It was informed that the second Interim Report of this study has been submitted in June 2014. The final report is expected to be completed by the April 2014.
3.	Application of DSS (P) for Integrated Water Resources Development & Management **Team** A.K. Lohani, Surjeet Singh, Rahul Jaiswal, D K Sonkusale and Akilesh Verma DOS: April 2013 DOC: March 2015)	Dr. A K Lohani presented the background the DSS(P) activity completed under HP-II and objectives of the study. Dr Lohani mentioned that the DSS(P) software has been developed under HP-II and the same model is being applied in Arpa basin of Seonath river basin to demonstrate the capabilities of the DSS(P) model. Dr Lohani mentioned that the data has been collected from Chhattisgarh for the application of DSS(P) software. Dr Lohani asked that the names of Shri D.K. Sonkusale and Shri Akilesh Verma of Water Resources Department, Raipur may be included in the study group of this project. Members and the Chairman, of the working group have approved the inclusion of these officers in the study group. Dr Lohani further mentioned that the collected data has been computerized and a NAM rainfall-runoff model has been setup in Mike basin and Mike-11 RR. He further mentioned that as an academic exercise the NAM model results have been compared with the ANN model results. He informed that an interim report of this project on rainfall-runoff modelling using NAM model has been submitted. Members of the working group appreciated the work.
4.	Quantitative assessment of uncertainties in river discharge estimation **Team** Sanjay Kumar and Sharad Jain DOS: April 2013 DOC: March 2016	Dr. Sanjay Kumar presented the study on “Quantitative assessment of uncertainties in river discharge estimation”. He explained the background and objectives of the study and mentioned that study is a part of the systemic review of uncertainty clause of the ISO 9123 document. He explained the methodology based on ISO documents GUM (Guide to the expression of uncertainty in measurement), HUG (Hydrometric uncertainty guidance) and presented the progress made in the study. He mentioned that the working draft of the ISO 9123 was circulated to SC1 member bodies for call of experts. Accordingly the experts were nominated to review the draft ISO 9123 documents. He informed that the review comments have been received from experts and currently being resolved. He also mentioned that the revised draft ISO document will be considered in the ISO meeting scheduled during May 2015 in Tokyo. There were no comments from WG members

5.	Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills **Team** Avinash Agarwal, Manohar Arora and R K Nema DOS: November 2013 DOC: October 2016	Dr. Agarwal presented the study entitled "Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills". Objective wise progress was presented. It was informed that rainfall-runoff-sediment model with using SWAT and CCH1D is in progress. Regarding rejuvenation of springs, it was concern of the house to use isotope techniques to exactly locate the points of recharge within the identified springshed. Working group accepted the study progress.
6.	Estimation of Water Balance for Integrated Water Resources Management in Yerrakalva Pilot Basin, A.P. **Team:** J.V.Tyagi and YRS Rao DOS: April 2014 DOC: March 2015	Dr. J.V. Tyagi presented the study and informed the house that NIH has taken up Pilot Basin Studies (PBS) for IWRM in Yerrakalva river basin in coastal Andhra Pradesh under 12th five-year plan program. The program involves detailed studies on various components of the hydrologic cycle including water balance study of the basin. The components of water balance of a basin are influenced by climate, the physical characteristics of the basin such as morphology, land use and soil. Therefore, understanding the relationship between these physical parameters and hydrological components are very essential for integrated water resources management and long term sustainability of water resources in the basin. Dr. Tyagi explained that the SWAT, one of the most recent models developed by the USDA, will be used to analyse and quantify the water balance of the Yerrakalva river basin. He informed that the observed data on rainfall, runoff has been collected and the base maps in GIS have been prepared. The progress of the study is as per the approved schedule. There were no comments on the study.
7.	Systematic treatment and analytical solutions for surges and bores in rectangular channels (research study) **Team:** S.K. Singh DOS: April 2014 DOC: March 2015	Dr. S. K. Singh presented the study highlighting the technical and innovative content of the study, which are the formulating nondimensional hydraulic force equation in a moving frame of reference for a systematic treatment of surges and bores in rectangular channels and, deriving its analytical solution. The positive surges and bores are characterized by increased depth of flow moving upstream or downstream and are formed due to sudden increase or decrease in discharge in the channel on account of sudden opening or closing of a gate, sudden tides, or sea wave of increased height. The derived analytical solutions help solve the concerning problems in a single step, avoiding the trial and error method currently being practised. The

		Chairman opined this type of basic research is also required and stressed that the application of the study is important and should be presented in the next meeting. Dr. Singh informed, few illustrative examples are complete and, distributed hard copy of it to the Chairman and the Members of the Working Group.
8.	Status Report on "Impact of Anthropogenic and Climate Change on Sediment Load of Rivers" **Team:** Archana Sarkar DOS: April 2014 DOC: March 2015	Mrs Archana Sarkar, PI of the study presented the background, objectives, methodology and expected deliverables of the new study. Mrs Sarkar informed that the sediment load of a river represents a key component of its hydrology, and in turn exerts an important influence on its aquatic ecology, its morphology and the exploitation of its water resources. She further informed the house that changes in the sediment loads of rivers can therefore have wide-ranging environmental and social and economic implications. She also informed about the growing evidence (reported by various authors for different rivers of the world) that the sediment loads of many rivers of the world, especially Asian rivers have changed significantly in recent years due to many reasons, including anthropogenic as well as climate change impact). Mrs Sarkar presented some of the findings of various research workers in the subject area. Dr Deshpande from PRL, Ahemdabad enquired about the double mass curve plots of sediment yield. Mrs Sarkar explained about the double mass curve plots. Mrs Sarkar further informed about the work plan for the next two quarters. Working group members noted the progress of the study and appreciated the work.
9.	Study of Rainfall Patterns and Comparison of Rainfall Data from different Sources for Uttarakhand State **Team:** Archana Sarkar, N.K. Bhatnagar, Vaibhav Garg and Rakesh Kumar DOS: April 2014 DOC: March 2016	Mrs Archana Sarkar, PI of the study presented the background, objectives, methodology and expected deliverables of the new study. Mrs Sarkar informed that the study area is the Uttarakhand State, often referred to as the "Land of the Gods" due to the many holy Hindu temples and pilgrimage centres found throughout the state which observed a massive flood disaster in June 2013. Mrs Sarkar informed the house that a good knowledge of local rainfall-regime is crucial for planning and management of domestic, urban as well as industrial water use, irrigation and crop practices besides forecasting and management of extreme events like floods and droughts. She further informed that in view of the recent flood disaster in the Uttarakhand state, it becomes all the more important to carry out a scientific analysis of the rainfall regime of the

		region. Mrs Sarkar also informed that a comparative accuracy assessment of various data sources of rainfall viz, Rain gauges, satellite sensors (TRMM), and high resolution gridded re-analysis rainfall (APHRODITE) is of prime importance as the rainfall data from these data sources are further provided to hydrological models to produce forecasts. Mrs Sarkar presented the progress of the study with preliminary results of trend analysis of historical rainfall data (annual and seasonal) by parametric and non-parametric methods for four rainfall stations two each in Kumoan and Garhwal regions. Dr Deshpande suggested to carry out the trend analysis for extreme events. Mrs Sarkar informed that the IMD guidelines would be followed to carry out the trend analysis work for extreme events. Working group members noted the progress of the study and appreciated the work.
10.	Monitoring and modelling of streamflow for the Gangotri Glacier **Team:** Manohar Arora and Rakesh Kumar DOS: May 2014 DOC: March 2017	Dr. Arora presented the progress of the study. He informed the house that the data collection for the ablation period of 2014 has been analyzed and the results were presented. He informed the house that the total volume of water from the glacier for the entire melt season was 853 MCM with the date of peak discharge on 15th July 2014. Dr R D Deshpande suggested some minor changes in the map of the study area. He was interested in knowing whether some noticeable changes have been observed in the discharge pattern. The PI replied that since it is a big glacier there is inter seasonal variability and no such noticeable changes have been observed. Dr N C Ghosh enquired about the trend line fitted in the graph of daily melt depth with daily mean temperature. The PI answered that the R^2 obtained for this was very poor therefore the mean monthly values of melt depth were plotted with the mean monthly temperature which resulted in significant improvement of R^2 values.
11.	Effect of climate change on evaporation at point scale **Team:** Digambar Singh, A. R. Senthil kumar and Manohar Arora DOS: June 2014 DOC: March 2017	Shri Digambar Singh, PI of the study, presented the objectives, methodology and progress of the study from June 2014 to Nov 2014. The PI, presented the computation of evaporation using the data of temperature, humidity and wind speed observed at the NIH observatory. The computed evaporation is computed with observed data of the pan evaporation and presented in graphical form. Dr. Anshuman asked the method of observation of evaporation data. The PI replied that the observation is made from the standard or class A pan (dia 1.22 m and depth 0.254 m, filled up to 0.180 m) evaporimeter installed at the observatory. Dr. N.C.Ghosh querried about the developer of

		empirical formula. The PI replied that it is taken from the text book “Engg. Hydrology” written by E.M.Wilson.
12.	Hydrological Modelling of Brahmani Baitarani River Basin using eWater Source Platform **Team:** J.P.Patra, Dr. Rakesh Kumar and Pankaj Mani DOS: April 2014 DOC: March 2017	Mr. Jagadish Prasad Patra, PI of the study presented the objectives, present state of art, brief description of study area and methodologies with progress made during last six months. There were no specific comments from the members.

WATER RESOURCES SYSTEM DIVISION

Dr. Sharad K Jain, Sc. G and Head (WRS Div.), presented an overview of the division – scientific strength, the ongoing studies, technical publications and training courses organized. Following are the comments received from working group on the presentations of the various studies.

PI: Dr. M. K. Goel, Scientist "F"
Study title: *NIH_Basin* – A WINDOWS based model for water resources assessment in a river basin (Ongoing)

Dr. M. K. Goel (MKG) presented the progress for the study. He informed that envisaged objectives of the study included modifications in the modeling methodology and development of WINDOWS interface (named as NIH_Basin – NIH_Basin-Simulation) of the model. Since the last working group meeting, a number of modifications have been made in the FORTRAN program of the model which include: a) incorporation of EAC tables for a reservoir (3 options), b) incorporation of rule-curve based operation analysis (for hydropower, irrigation, and domestic supply including environmental flows) for reservoir systems, c) incorporation of hydropower simulation analysis (with eight different options for supply of releases for various purposes through power plant), and d) simplification of groundwater representation in the model. MKG explained the two modes of model application: monthly and continuous simulation. For application of the model to larger basins, dimensions in the model for sub-basins, cities, hydraulic structures, rainfall stations, and river segments have been significantly increased. Various existing options in the model have been preserved and new modifications have been added as additional options.

In WINDOWS interface of the model, various data input forms have been developed in Visual BASIC environment. He presented some forms for the data entry. It was informed that forms will be finalized after completing model modifications as input requirements are getting revised with increased options.

Dr. R. D. Deshpande (RDD) suggested for the inclusion of industrial demands separately. MKG replied that at present the same is clubbed with the domestic demand but it is possible and preferable to give industrial demand a separate identity in the model. Further, RDD enquired about the model availability after its development. MKG informed that it is planned to put the model on NIH website for download and wider usage. Dr. S. C. R. Vishwakarma (SCRV) enquired whether the model is applicable in Himalayan basins? MKG informed that as yet, snow melt has not been included in the model and it can be used for the rainfall areas only. However, snowmelt can be calculated separately (through another model) and given as an input series for a specified downstream river segment. For this purpose, option is provided in the model to attach daily import/export time series with any river segment. In response to a query from Dr. S. K. Mittal (SKM), MKG confirmed that irrigated and rain-fed areas are treated separately in the model methodology.

PI: Dr. Sanjay K. Jain, Scientist "F"
Study title: Glacier change and glacier runoff variation in the upper Satluj river basin (Ongoing)

Dr. Sanjay K Jain presented the objectives of the study as well as the progress made so far. He informed that three sub basins of Upper Satluj basin have been taken for this

study. Glacier change detection in all three sub basins has been carried out using temporal satellite data. The meteorological and discharge data have been collected. Dr. Jain presented the analysis of temperature and snow water equivalent data and explained correlation between these with glacier change. Dr. Ritesh Arya asked about the glacier change in different period of the study. Dr. Jain said that change is almost uniform but in recent years there is less change. He also said that the retreat is comparable with the other studies carried out in the region. Dr. Bartarya asked about the comparison of glacier retreat of western Himalayan and central Himalayan region. Dr. Jain said that as per the literature and a study carried out for Gangotri glacier the retreat in central Himalayan region is less and has reduced in recent years. Dr. S K Mittal asked about the software used and whether & RADARSAT data has been used in the study. Dr. Jain replied that ERDAS image processing software has been used and no RADARSAT data have been used. He said that the possibility of using RADARSAT will be explored.

PI: D. S. Rathore, Scientist "F"
Study titles:

1. **Decision Support System for Water Resources Planning in Upper Bhima basin, Maharashtra**
2. **Web GIS based snow cover information system for Indus basin (Ongoing)**

The progress of the study on DSS for water resources planning in Upper Bhima basin was presented by Mr D.S. Rathore. Study area was described and information on availability of the data was presented. Mula, Mutha and Ghod are main tributaries. Information on Taluka wise gross crop area and livestock population, district wise N and P- Fertilizer are available and these will be used for non-point pollution load estimation for watersheds. Daily discharge data, meteorological data and reservoir performance data are available and utilized for hydrological modelling in catchments. Water quality data were available at six sites on Mutha and Bhima rivers. Lumped conceptual model NAM in Mike Hydro was used for rainfall runoff simulation in 24 sub basins (14 head water and 10 intermediate). Models setup is in progress for simulating water allocation of Khadakwasla reservoir complex and Mutha RBC command, and for water quality simulation of Bhima basin. RDD asked regarding outcomes from the study that may be of interest to water resources manager and whether location of water purification facilities may be identified through study. Mr Rathore replied that among many uses, typically simulating water allocation in post monsoon period may be of interest to water managers. Further, through model locating suitable site for facilities may not be possible, but water quality in the river network may be simulated.

The progress of the study on Web GIS based snow cover information for Indus basin was presented by Mr D.S. Rathore. The objective of the study is to develop snow delineation methodology and to publish snow cover maps on web/ intranet using Web GIS software. During the period of review, MODIS Aqua data for 2010- 12 were downloaded. Snow mapping was done by using 8-day composite MODIS data using NDSI and NIR bands. Cloud scenes were identified by visually inspecting FCC using QGIS software. The information will be used to modify snow statistics at sub basin level. Statistics from cloud free preceding and/ or succeeding scene will be used for that of clouded scene. Snow cover statistics for years 2007- 08 to 2011- 12, and median snow cover were presented for sub basins. Snow accumulation was visible in post monsoon period of September to December and its relation to snow availability in ablation period could be seen in temporal snow statistics. Mr Ritesh Arya stated that the graph indicates that this phenomenon is visible in Indus basin as well. Mr Rathore affirmed this and informed that though in all basin snow is

accumulating in these months, but in general the phenomena is more pronounced in Satluj basin.

PI: D. Chalisgaonkar, Scientist "F"
Study title: Assessment of Water Footprint of the National Capital Territory (NCT) of India (Ongoing)

Mrs. Deepa informed that the objective of this study is to estimate the water footprints of NCT Delhi by quantifying green, blue and grey water footprints and the methodology used in this study is largely based on earlier studies supported by Water Footprint Network. She also informed that in the present study, the previous methodologies are integrated and upgraded where possible and the water footprint of NCT Delhi is being assessed for three major sectors i.e. domestic, agriculture and industrial. She informed that the assessment of the domestic water footprint has been done as a first step during 2013-14. It has been done by computing the environmental pressure exerted by the population of NCT Delhi in terms of the water it uses directly and indirectly. The assessment of agriculture water footprint has been taken up and industrial water footprint will be assessed in the next step. For the computation of crop water requirement, CROPWAT software is being used. It uses precipitation data, crop growth inputs, and soil data to calculate crop water requirements. After all yields and variables in the CROPWAT program are accounted for, the blue and green water footprints can be determined.

Dr Anshuman suggested including supply-chain perspective in the assessment. He also suggested to define the boundaries for the assessment and differentiate between water demand and use. Mrs Deepa replied that two levels of water consumption in supply chain are being considered and the boundaries of the study will be separately indicated. Working group noted the progress of the study.

PI: Dr. Renoj J Thayyen, Scientist "D"
Dr Renoj presented three studies.

1. Glaciological studies of Phuche Glacier, Ladakh Range (Ongoing- Sponsored)

Dr. N.C. Ghosh suggested that future research may look into the relationship between Positive Degree Days and energy balance of glacial systems in the cold-arid climate. RJT agreed to this point and mentioned that monitoring of soil heat flux is needed for such study and will be taken up during next phase of the project.

A member queried how the snowfall during May and June could retard the glacial melt as suggested in the study as it is widely seen that snowfall during May -June period generally lead to increased discharge in the stream. RJT explained that the May - June snowfall on glacier occur over the winter snow pack which further reduced the snow pack albedo leading to prolonged stay of snow over the glacier ice leading to retarded glacier melt. However, the snow falling in May-June over non-glacial lower reaches melts faster, resulting into higher discharge in the streams.

2. Cryospheric system studies and runoff modeling of Ganglass catchment, Leh, Ladakh Range (Ongoing)

No specific suggestions/ comments from any Working Group Members.

3. Runoff modeling of Shyok River, Karakorum Range (New)

Mr. Ritesh Arya said that the proposed bridge by Border Roads Organisation (BRO) is an important bridge for the supply to the forward post in a very difficult terrain. He appreciated the NIH effort to set up a discharge station in this area.

PI: Shri L N Thakural, Scientist "B"
Study Title: Trend and variability analysis of Rainfall and Temperature in Himalayan region (Ongoing)

The study was presented by Sh. L. N. Thakural. The objectives of the study are to create the database for Rainfall and Temperature variables for the Himalayan region and to carry out statistical analysis to detect trend and variability in these variables in the Himalayan region, India. The parametric (Linear regression) and non-parametric (Mann-Kendall and Sen's estimator of Slope) approaches are being used to determine the trends in the time series data of these meteorological variables. During the presentation, trend analysis of rainfall and temperature data for the Himalayan region was presented. RDD mentioned that this study for the Himalayan region will be useful. Moreover, he suggested that the rainfall intensity may also be considered and attempts be made to determine regional patterns. Dr. Naha and Dr. Vishvakarma offered to provide data on rainfall & temperature of some stations. The same will be collected by Mr Thakural and analyzed.

PI: Shri P. K. Mishra, Scientist "B"
Study title: Assessing Climate Change Impact across KBK (Kalahandi- Bolangir-Koraput) region of Odisha (Ongoing)

The status of the study was presented by Shri P.K. Mishra on behalf of his team. He informed about the progress made in the study since inception as well as during last six months (June'14-November '14). Shri Mishra presented the results for the 2nd objective of the study, i.e. to analyze the future climate in the region based on downscaled GCM data. He informed that future rainfall for the region has been generated based on downscaled HadCM3 A2 and HadCM3 B2 GCM data utilizing SDSM model. The study has been carried out using SDSM tool version 4.2.9.

RDD suggested to find the physiographic relationship for the trends observed for rainfall and temperature for the KBK region. Dr. Sharad K. Jain, Head, WRS Division also suggested to ponder on the trend findings and if possible, present findings. Mr. Mishra compiled the same and gave a brief presentation next day highlighting the possible impact of slopes and land cover. Another suggestion of RDD to find the relationship between the trend and atmospheric air temperature for the region will be explored based on data availability.

Shri Mishra ended the presentation informing the next course of actions analyzing downscaled GCM data for temperature using different models and running Soil and Water Assessment Tools (SWAT) for the Tel basin during the next six months.

PI: Shri M. K. Nema, Scientist "B"
Study titles:

1. **Variability of the Hydro-climatic variables in Punjab Plains of lower Satluj (Ongoing)**
2. **Hydrological Processes and Characterization of Lesser Himalayan Catchments**

For the ongoing study on variability of the hydro-climatic variables in Punjab plains of lower Satluj, no specific comments were made during the presentation. Dr. Renoj Thayyen suggested to examine the monsoonal cyclic effect on the trend of rainfall and temperature series.

While, presenting the proposed new study, Dr. NC Ghosh, suggested to modify the title of the study orienting towards its objectives. Accordingly, the new title of the study is proposed as “Hydrological Processes and Characterization in Lesser Himalayan Catchments”. Dr. S.K. Bartarya (WIHG) suggested that while inter-comparing the various results from two different watersheds, the size and geologic condition of them should be proportionate. Dr. J.V. Tyagi suggested to take care of interception loss measurements in the proposed study.

PI: Shri P. K. Agarwal, Scientist “B”
Study title: Hydrologic Modelling of a part of Satluj Basin using SWAT Model (Ongoing)

The status and progress of the study was presented by Shri P.K. Agarwal, Scientist B. Shri Agarwal presented the DEM, drainage network, land use map prepared from landsat data, and soil map prepared for the study area. He informed that classification of the soil map as well as landuse map is in progress.
No specific comments were received on the study. However, Dr Anshuman, suggested ground truth verification of the data.

RESEARCH MANAGEMENT AND OUTREACH DIVISION (RMOD)

S.N.	Title of Project/Study, Study Team, Start/Completion Dates	Status and Recommendations/Suggestions
1.	Pilot Basin Studies (PBS) at six identified sites, jointly with the RCs and CFMSs (**Joint Study)** **NIH HQs:** V C Goyal (Leader), Omkar Singh, R V Kale **NIH RCs/CFMSs:** RC-Belgaum, RC-Jammu, RC-Kakinada, RC-Sagar, CFMS-Guwahati, CFMS-Patna DOS: Apr 2012; DOC: Mar 2015	No comments
2.	Water Conservation and Management in Ibrahimpur Masahi Village of Hardwar District (Uttarakhand) **Team:** Omkar Singh, V.C. Goyal and C.K. Jain, J.V. Tyagi and Sanjay K. Jain DOS: Apr 2013; DOC: March 2015	Er. Anshuman (TERI University) wanted to know about water conservation mesures being adopted in the study. The PI responded to his query. Dr. V.C. Goyal, Head, RMOD, also suplemented.
3.	Participatory development of structure for IWRM Framework in identified sub-basins under Pilot Basin Studies (PBS) program **(New Study)** **Team:** V C Goyal (PI), Omkar Singh and R V Kale DOS: July 2014 DOC: June 2015	No comments
4.	Customization of WEAP model for application in Ur river watershed in Tikamgarh district of Bundelkhand region. **(Under TIFAC Project)** **Team:** R V Kale (PI), T Thomas- RC Bhopal, Jyoti Patil, Rajesh Agarwal DOS: Apr 2014 DOC: Sep 2015	Er. Anshuman (TERI University) wanted to know about different scenarios considered for planning & decesion making in agriculture water management. The PI responded to his query. Er. Anshuman was keen in this study and offered PI to provide his relevant research pulications.

Dr. V C Goyal thanked the members for their valuable contributions during deliberations in the Working Group meeting.

The meeting ended with vote of thanks to the Chair.

ANNEXURE-I

List of Working Group Members attended the 41th WG meeting

1.	Er. R.D. Singh, Director, NIH	Chairman
2.	Dr. V K Sharma, Director, GSI, State Unit-Uttarakhand, Dehradun	Member
3.	Dr. S.K. Bartarya, WIHG, Dehradun	Member
4.	Dr. S.K. Mittal, Chief Scientist, CSIO, Chandigarh	Member
5.	Dr. S C R Vishvakarma, Sc.F, GBPIHED, Almora	Member
6.	Sh. Niladri Naha, State Water Invest. Dir., Kolkata	Member
7.	Dr. R D Deshpande, Sc.SF, PRL, Ahmedabad	Member
8.	Dr. S N Rai (Retd.) CSIR-NGRI, Hyderabad	Member
9.	Dr. Ritesh Arya, Panchkula, Haryana	Member
10.	Dr. Anshuman, TERI, New Delhi	Member
11.	Dr. S.K. Jain, Sc. G & Head WRS Division, NIH	Member
12.	Dr. N.C. Ghosh, Sc. G & Head GWH Division, NIH	Member
13.	Dr. Rakesh Kumar, Sc.G & Head SWH Division, NIH	Member
14.	Dr. Sudhir Kumar, Sc. G & Head HI Division, NIH	Member
15.	Dr. V C Goyal, Sc.F & Head, RMO Division, NIH	Member-Secretary

Scientists from National Institute of Hydrology, Roorkee

1. Dr. J.V. Tyagi, Sc.G
2. Dr. Sanjay Jain, Sc.F
3. Dr. Avinash Agarwal, Sc.F
4. Dr. M.K. Goel, Sc.F
5. Er. D. S. Rathore, Sc. F
6. Smt. D.Chalosgaonkar, Sc.F
7. Dr. A.K. Lohani, Sc.F
8. Dr. R.P. Pandey, Sc.F
9. Er. Omkar Singh, Sc.E
10. Dr. S.P. Rai, Sc.D
11. Dr.A R Senthil Kumar, Sc.D
12. Dr. Anupama Sharma, Sc.D
13. Dr. Sanjay Kumar, Sc.D
14. Dr. Surjeet Singh, Sc.D
15. Dr. R.D. Mehta, Sc.D
16. Sh. S.K. Verma, Sc.D
17. Dr. Renoj J. Thayyen, Sc.D
18. Dr. Archana Sarkar, Sc.C
19. Dr. Manohar Arora, Sc.C
20. Dr. M.K. Sharma, Sc.C
21. Sh. P.K. Garg, Sc.B
22. Sh.Rajan Vatsa, Sc.B
23. Sh. Digamber Singh, Sc.B
24. Dr. Ravindra Vitthal Kale, Sc.B
25. Sh. J.P. Patra, Sc.B
26. Sh. Sumant Kumar, Sc.B
27. Dr. Rajesh Singh, Sc.B
28. Sh. L.N. Thakural, Sc.B
29. Mrs. Shashi Poonam, Sc.B
30. Sh. P.K. Mishra, Sc.B
31. Sh. Manish Nema, Sc.B
32. Sh. Tanveer Ahmad, Sc.B
33. Sh. P.K. Agrawal, Sc.B

ANNEXURE – B

Division-wise Work Programme

ENVIRONMENTAL HYDROLOGY DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr. C K Jain	Scientist G & Head
2	Dr. (Mrs.) Rama Mehta	Scientist D
3	Dr. M K Sharma	Scientist D
4	Dr. Rajesh Singh	Scientist B
5	Smt. Babita Sharma	RA
6	Smt. Bina Prasad	RA

Progress of Work Program for the Year 2014-15

S.No.	Study	Study Team	Duration
Internal Studies			
1.	Water Quality Modelling using Soft Computing Techniques	Rama Mehta (PI) C. K. Jain	2 Years (05/14-05/16)
2.	Himalayan River Water Quality Assessment in a Stretch from Gangotri to Hardwar	Rajesh Singh (PI) C. K. Jain M. K. Sharma S. P. Rai Renoj J. Thayyan J. P. Patra	3 Years (07/14-06/17)
Sponsored Projects			
1.	Ionic Enrichment Dynamics of Glacial Sediment and Melt water of Gangotri Glacier	M. K. Sharma (PI) C. K. Jain Renoj Thayyan Manohar Arora Naresh Saini Jatin Malhotra Rakesh Goyal Karan Jamwal	3 Years (04/14-03/17) Sponsored by DST, New Delhi
2.	Low Cost Technology for Purification of Arsenic and Microbes Contaminated Water using Nanotechnology	Vijaya Aggarwala, IITR (PI) Rama Mehta, NIH (Co-PI)	2 Years (04/14-03/16) Sponsored by DST, New Delhi
Consultancy Project			
1.	Water Safety Impact Assessment through Sanitary Improvement of India Mark 2 Hand Pumps in Moradabad Division, Uttar Pradesh	C. K. Jain (PI) Babita Sharma Rakesh Goyal Daya Nand	6 Months (10/14 – 03/15) Sponsored by: UNICEF Office for Uttar Pradesh Amount: 12 Lakh

Training Course Organized during 2014-15

S.No.	Topic	Sponsored by	Venue	Period
1.	Water Quality and its Management	NIH and CSMRS	NIH, Roorkee	1-5 September 2014
2.	Monitoring of Non-point Source (NPS) Pollution in a riverine system	CPCB, Delhi	NIH, Roorkee	13-15 October, 2014
3.	Advanced Soft Computing Techniques in Hydrology and its Applications (ASCTHA-2014).	Paid Course	NIH, Roorkee.	27th November to 02 December, 2014
4.	One Awareness program for Teachers about Water Conservation	NIH, Roorkee with Education department, Uttarakhand	NIH, Roorkee	06 December, 2014
5.	Advanced Instrumentation Technique and Preventive Maintenance	CPCB, Delhi	NIH, Roorkee	8-10 December, 2014
6.	Hands on Advanced Instruments of Water Quality Testing" sponsored by during	WQAA, MoWR, RD & GR, New Delhi	NIH, Roorkee	12-16 January, 2015

Study – 1 (Internal Research Project)

1. Title of the Study: Water Quality Modeling using Soft Computing Techniques

2. Study Group:

Project Investigator Dr. Rama Mehta, Sc. 'D'
Co-Investigator Dr. C. K. Jain, Sc. 'G'
Scientific/Technical Staff Ms. Anju Chowdhary, SRA

3. Type of Study: Internal

4. Nature of Study: Applied Research

5. Date of start: May 2014

6. Scheduled date of completion: May 2016

7. Duration of the Study: Two years

8. Study Objectives:

To develop the models for assessment of the quality of water with its quality parameters for Najafgarh, Mehrauli, Delhi City and Shahdara blocks of NCR using conventional and soft computing techniques.

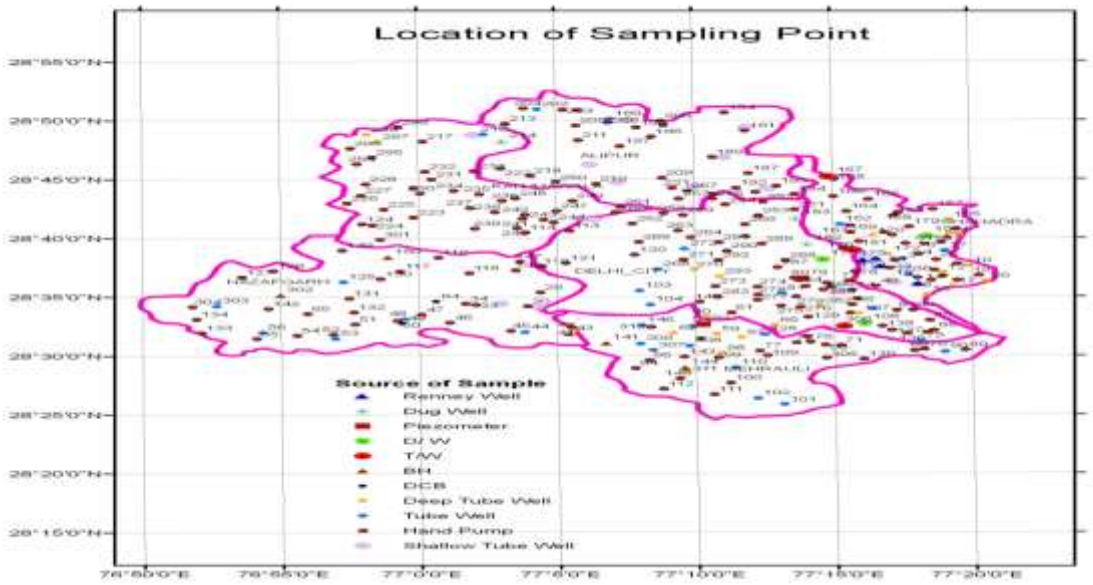
9. Statement of the Problem:

The quality of ground water within National Capital Region (NCR) Delhi varies from place to place along with the depth of water table. The kind and concentration of dissolved salts depend on their source and nature of sub surface environment.

Various methods are discussed in literature on drinking water quality criteria and decision-making. But most of the reports on the water quality revealed that deterministic approach in decision making by comparing values of parameters of water quality with prescribed limits provided by different regulatory bodies is used without considering uncertainties involved at various steps throughout the entire procedure. To overcome the difficulties of complex ground water quality there has been a need to develop techniques that can help to find meaningful solutions. Soft computing techniques are relatively new emerging techniques used in hydrologic and water resources systems. Fuzzy logic technique used in uncertainties in water resources system arises not only due to randomness of hydrological variable but also due to imprecision, subjectivity, vagueness associated with decision making and lack of adequate data. Such uncertainties are best addressed through fuzzy logic technique. Therefore, new emerging techniques as Neuro-Fuzzy techniques and ANN are

frequently used to develop the models. Fuzzy_Mamdani Inference technique has been used during the study.

The NCT of Delhi having Six administrative blocks namely Alipur, Kanjhawala, Najafgharh, Mehrauli, City and Shahdara. The ground water sampling locations have been depicted as below (Fig. 1):



Water quality Modeling for two administrative blocks viz. Delhi City & Shahdara have been done with three different techniques and results have been analyzed with empirical techniques for Water Quality Index during this year. Data analysis and modeling for other two blocks is in progress.

10. Approved Action Plan / Methodology:

Water quality indices (WQI) giving a single value to the water quality of a source, which translates the list of constitutes and their concentrations present in a sample in a single value. One can compare different samples for quality on the basis of the index value of each sample. The use of WQI has been strongly advocated by agencies responsible for water supply and control of water pollution.

Following methods have been employed to calculate the water quality index:

- Empirical Method
- Soft Computing Techniques (SCT)-Mamdani_ Fuzzy Inference System (M_FIS)
- Canadian Water Quality Guidelines

11. Timeline:

Activities	**2014-15**				**2015-16**			
	1st Qr.	2nd Qr.	3rd Qr.	4th Qr.	1st Qr.	2nd Qr.	3rd Qr.	4th Qr.
Data collection for four administrative								

blocks								
Model Development with application of Empirical method & CCME-WQI technique for all four blocks.								
Model Development with application of soft computing method as M_FIS technique.								
Testing, evaluation, and comparison with conventional method.								
Result analysis & Report writing								

12. Objectives and achievement during last six months:

Objectives	Achievements
i) Model Development with application of soft computing methods. ii) Data analysis for other two blocks as Najafgarh & Mehrauli. iii) Model development for other two blocks.	i) Three models (Each model with Empirical method, CCME_ WQIG and Fuzzy Inference Technique) have been developed for Shahdara block. ii) Data analysis for other two blocks as Najafgarh & Mehrauli has been completed. iii) Model development for other two blocks is under progress.
Testing, Evaluation and comparison with conventional method.	Results via Fuzzy model have been compared with conventional method and Canadian formula (CCME) For Delhi city block. Results via Fuzzy model have been compared with conventional method and Canadian formula (CCME) For Shahdara block. Comparative results have shown through graphs and performance indices.

13. Recommendation / Suggestion:

Recommendation / Suggestion	Action Taken
Results are appriciated by members. Dr. N.C. Ghosh suggested that the Water quality Index should be analyzed for other uses of water as	Proper actions as per suggestions are considered in the study.

for irrigation purpose etc. Dr. V.K. Sharma, Director, GSI, Dehradun, suggested that all sample locations can be presented in GIS map could be related with the soil & geology of the land of that block.	

14. Analysis & Results:

- The ground water quality of the City & Shahdara Block has been assessed with all three methods as Empirical method, CCME Water Quality Index guidelines (CCME_WQI) and Fuzzy Inference method.
- Comparative graphs with all results have been drawn.

15. End Users / Beneficiaries of the study: Hydrologist, Public, & Water agencies working for NCR region

16. Deliverables: Technical report, research papers and manual

17. Major items of equipment procured: None

18. Lab facilities used during the study: None

19. Data procured or generated during the study: None

20. Study Benefits / Impacts:

Measurable indicators	Achievements
Model development for block Delhi City & Shahdara with new emerging techniques to get the Water Quality Index for specific use of ground water	Completed for two blocks
Solution of identified problem	Completed for two blocks

21. Involvement of end users/beneficiaries: Local people of the NCR region.

22. Specific linkage with Institution and /or end users/beneficiaries: Nil

23. Shortcoming/Difficulties: No

24. Future Plan: Models can be developed for other two administrative blocks of NCR as Najafgarh and Mehrauli using same techniques.

PROFORMA FOR SUBMITTING INTERNAL RESEARCH PROJECTS

1. Thrust Area under XII Five Year Plan: Water quality monitoring and modeling

2. Project Team

- **a. Project Investigator :** Dr. Rama Mehta, Sc. D, EHD
- **b. Project Co-investigator :** Dr. C. K. Jain, Sc. G, EHD
- **c. Technical staff :** Anju Chowdhary, SRA

3. Title of the Project: Assessment of Water Quality Index for two administrative blocks of NCT Delhi using Soft Computing technique (**DOS:** May 2014, **DOC:** May 2016)

4. Objectives:

To develop the models for assessment of the water quality index with its quality parameters for four blocks viz. Delhi City & Shahdara, Najafgarh & Mehrauli of NCR region using conventional and soft computing techniques.

5. Present state-of-art: annex 1

6. Methodology:

Following methods have been employed to calculate the water quality index.

- Empirical Method
- Soft Computing Techniques (SCT) -Mamdani_ Fuzzy Inference System (M_FIS)
- Canadian Council of Ministry of Environment Water Quality Index Guidelines

7. Research Outcome from the Project:

- **a.** Developed models with new emerging techniques as M-FIS and CCME-WQIG.
- **b.** GIS presentation of water quality of different samples with respect to the outcomes of the models.
- **c.** Technical report and papers.

8. **Cost estimate:**

a) Total cost of the project: Rs. 80,000/-
b) Source of funding: NIH, Internal
c) Sub Head-wise abstract of the cost

Sl.No.	Sub-head	Amount (in Rupees)
1.	Salary	
2.	Travelling expenditure	30,000
3.	Infrastructure/Equipment	Nil
4.	Experimental charges	Nil
5.	Misc. expenditure	50,000
	Grand Total:	80,000

d) Justification for Sub-head-wise abstract of the cost
Travel expenditure: The outcomes of the study will be presented in a form of research papers in National and International conferences/workshops.
Misc. exp.: The stationary, printing the report, registration fee for conf/workshop, & consumables will be born with this head.

9. Quarterly Break up of cost estimate for each year: Year: 2015-16

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary				
2.	Travelling expenditure			15,000	15,000
3.	Infrastructure/Equipment				
4.	Experimental charges				
5.	Misc. expenditure	5000	5000	10000	30000
	Sub- Total:	5000	5000	25000	45000
	Grand Total	80000/-			

Note:
(i) The above table has to be prepared for each year of the project period
(ii) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

10. Work Schedule:

a. Probable date of commencement of the project: May 2016
b. Duration of the project: Two Years.
c. Stages of work and milestone: The modeling and analysis for two blocks viz. Najafgarh & Mehrauli has to be done during year 2015-16.

Sl. No.	Work Element	First Quarter	Second quarter	Third quarter	Forth quarter
1	Data Analysis	***			
2	Modeling		***	***	
3	Result analysis & Report Writing.			***	***

Study -2 (Internal Research Project)

1. Title of the Study: Himalayan river water quality assessment in a stretch from Gangotri to Haridwar.

2. Study Group:

Project Investigator Dr. Rajesh Singh, Sc. 'B'
Project Co-investigator Dr. C. K. Jain, Sc. 'G', EHD Dr. M. K. Sharma, Sc. D, EHD Dr. S. P. Rai, Sc. E, HID Dr. Renoj J. Thayyan, Sc. D, WRSD Dr. J. P. Patra, Sc. B, SWHD
Scientific/Technical Staff Shri Rakesh Goyal, Tech. Gr. I Shri Dayanand, Tech. Gr. II

3. Type of Study: Internal

4. Nature of Study: Applied Research

5. Date of start: 01.07.2014

6. Scheduled date of completion: 30.06.2017

7. Duration of the Study: 3 Years

8. Study Objectives:

i) Catchment characterization affecting river water quality
ii) River water quality assessment for different designated uses
iii) Decipher the different sources of solutes controlling the river water quality
iv) Nutrient loading due to anthropogenic activity
v) CO_2 consumption during chemical weathering

9. Statement of the Problem:

The purity and sanctity of Himalayan Rivers is challenged now by the technological development and growing financial strength of the nation. Construction of plethora of roads along the fragile mountain slopes facilitated movement of more men and material to the fragile Himalaya. Tourist activities in this region have increased many folds in recent years. More land is being brought under cultivation and more and more fertilisers and pesticides are being used to manage the crop productivity. As a by product of these developmental activities, the pristine rivers of the Himalaya are getting polluted more and more. Moreover, the increase in temperature and CO_2 in atmosphere will results in change in the pattern of chemical weathering and transport of solute through these rivers.

Therefore, there is a need for water quality assessment of Himalayan Rivers to understand the multifold impact of urbanization, tourist influx, and climate change on water quality of rivers.

10. Approved Action Plan / Methodology:

i) Collection of river water, suspended sediments, and bed sediment samples from Gangotri to Haridwar on monthly basis.
ii) Analysis of river water samples for physico-chemical, isotopic, and bacteriological composition.
iii) Analysis of river bed sediments for elemental and mineral composition.
iv) Processing the data to understand the contamination of water and consumption of CO_2 during the weathering process.

11. Timeline:

Sr. No.	Major Activities	2014-15			2015-16				2016-17				17-18
		2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.
1	Literature Survey												
2	Field Investigation												
3	Sample Collection and Analysis												
4	Data Collection and Interpretation												
5	Status Report												
6	Interim Report												
7	Final Report												

12. Objectives and achievement during last six months:

Objectives	Achievements
Literature Survey	• Literature survey completed.
Field investigation, Sample Collection & Analysis	• Field investigation completed. • Samples were collected in Dec. 2014. Analysis is under progress.

13. Recommendation / Suggestion:

Recommendation / Suggestion	Action Taken
1. No Specific comments	

14. Analysis & Results:

- Geo-spatial map showing sampling locations prepared.
- Samples collected in December 2014.

- Physico-chemical, bacteriological, and isotopic (δO^{18} & δD) analysis of samples completed.

15. End Users / Beneficiaries of the study: State Govt. Planners

16. Deliverables: Technical report & research papers

17. Major items of equipment procured: None

18. Lab facilities used during the study: Water Quality Laboratory (NIH)

19. Data procured or generated during the study: None

20. Study Benefits / Impacts:

Measurable indicators	Achievements
River water quality assessment	Under progress
Nutrient loading	Under progress

21. Involvement of end users/beneficiaries: -----

22. Specific linkage with Institution and /or end users/beneficiaries: Nil

23. Shortcoming/Difficulties: No

24. Future Plan:

- Sampling and analysis of river water, suspended sediments, and bed sediments on bi-monthly basis.
- Processing the data to understand the contamination of water and consumption of CO_2 during the weathering process.

PROFORMA FOR SUBMITTING INTERNAL RESEARCH PROJECT

1. Thrust Area under XII Five Year Plan: Surface, ground, and wastewater quality monitoring and modelling

2. Project Team :

a. Project Investigator : Dr. Rajesh Singh, Sc. B, EHD

b. Project Co-investigator : Dr. C. K. Jain, Sc. F, EHD
Dr. M. K. Sharma, Sc. C, EHD
Dr. S. P. Rai, Sc. D, HID
Dr. Renoj J. Thayyan, Sc. D, WRSD
Dr. J. P. Patra, Sc. B, SWHD

3. Title of the Project : Himalayan River Water Quality Assessment in a Stretch from Gangotri to Haridwar

4. Objectives :

i) Catchment characterization affecting river water quality
ii) River water quality assessment for different designated uses
iii) Decipher the different sources of solutes controlling the river water quality
iv) Nutrient loading due to anthropogenic activity
v) CO_2 consumption during chemical weathering

5. Present state-of-art :

Water of sound quality is the key for vital socio-economic functions on Earth. Most users of water depend on adequate levels of water quality. When these levels are not met, these water users must either pay an additional cost for water treatment or incur at least increased risks of damage or loss. As populations and economies grow, more pollutants are generated and degradation of water resources has become one of the most pressing global concerns currently facing mankind. Increasingly, the major efforts and costs involved in water management are devoted to water quality protection and management. Conflicts among various users of water are increasingly over issues involving water quality as well as water quantity. Evidently, there is a need for effective management efforts, where one possible action is to focus on minimizing pollutant load from pollutant-producing areas to water resource areas. In September 2000, the European Union (EU) passed a new water framework directive (WFD) with the goal of increasing and establishing a good ecological status on a long-term basis. Groundwater, surface waters and coastal waters are affected by this regulation making extensive management of rivers and their catchment areas indispensable. River basin management consists of coordinating all activities which can affect the water resources with the goal of maintaining good quality of water. The management decisions for improving the health of the water bodies can be possible with the help of modeling techniques.

Generally, water quality is the process to determine the chemical, physical and biological characteristics of water bodies and identifying the source of any possible pollution or contamination which might cause degradation of the water quality. Chemical weathering of the rocks leads to introduction of dissolved solids in the river water and conversely stream

chemistry provides information on chemical erosion processes (Chetelat et al., 2008). Chemical weathering is a chemical reaction; therefore it requires a "substrate" and "reacting agents" for it to occur. The substrates on the earth surface are the minerals in rocks and the reacting agents are acids, such as, carbonic acid (HCO^-_3 derived from dissolution of CO_2); sulfuric acid (H_2SO_4 derived from pyrite oxidative weathering and a number of organic acids (oxalic, acetic and humic), which liberate protons to weather the minerals. In addition to these acids, H_2O also acts an agent in dissolving evaporite minerals. Among the various acids, H_2CO_3 is the dominant source of protons for chemical weathering reactions and a regulator of atmospheric CO_2. In addition to H_2CO_3, weathering through organic acids and H_2SO_4 may also be important on local and regional scales (Galy and France- Lanord, 2001). Globally, rivers carry about 2130 x 10^6 tons/yr dissolved material from weathering of rocks (Gaillardet et al., 1999) and transport it to sea. In India, the stream erosion study in Himalayan region dates back to 1970 (Raymahasay, 1970) followed by geochemical characterization of River Ganga water (Handa, 1972). Afterwards, Abbas and Subramanian (1984) described the erosion and sediment transport pattern in the Ganga basin. In a pioneering study, Sarin and Krishnaswami (1984) reported major ion chemistry of Ganga River, which was followed by a number of studies related to geochemistry of Himalayan Rivers in India and abroad (Harris, 1995; Jain et al., 1998; Pierson-Wickmann et al., 1998; France-Lanord and Galy, 1999; Jain, 2002; Semwal and Akolkar, 2006; Singh and Singh, 2007; Trivedi et al., 2010; Singh et al., 2012; Tyagi et al., 2013).

Our main interest is to analyze the river water sample for physico-chemical and bacteriological parameters to understand the different sources of solutes controlling the river water quality. We will also model the pollutant load reaching the river and its behavior in a river stretch.

6. Methodology :

i) Collection of river water, suspended sediments, and bed sediment samples from Gangotri to Haridwar on monthly basis.
ii) Analysis of river water samples for physico-chemical, isotopic, and bacteriological composition.
iii) Analysis of river bed sediments for elemental and mineral composition.
iv) Processing the data to understand the contamination of water and consumption of CO_2 during the weathering process.

7. Research Outcome from the Project :

i) Geo-spatial data base of river water quality
ii) Annual dissolved and suspended solid flux in the river
iii) CO_2 consumption due to chemical weathering
iv) Technical report and papers

8. Cost Estimate

a. Total cost of the project : Rs. 22 36 000.00
b. Source of funding : NIH (Internal)
c. Sub headwise abstract of the cost :

Sr. No.	Sub-Head	II Year	III Year	Total
1	Salary for Resource Person / Staff (1 no.)	3 00 000	3 36 000	**6 36 000**
2	Travelling expenditure	1 50 000	1 50 000	**3 00 000**

3	Infrastructure / Equipment / Consumable	9 00 000	2 00 000	**11 00 000**
4	Experimental charges	50 000	50 000	**1 00 000**
5	Misc. Expenditure	50 000	50 000	**1 00 000**
	Grand Total	14 50 000	7 86 000	**22 36 000**

d. Justification for sub-head-wise abstract of the cost

- Salary: One JRF is required for sample collection, data collection, analysis etc.
- Travelling expenditure: For visit to study area, attending conferences, data collection, surveys etc.
- Equipment: Ion selective meter along with electrodes (DO, NH_3, NO_3, etc.) for field analysis.
- Consumables: Purchase of chemicals, glasswares, plastics, etc.
- Experimental charges: Towards analysis of samples in outside laboratories

9. Quarterly Break up of Cost Estimate for Each Year

Year: 2015-16

Sr. No.	Sub-Head	Amount in Rupees			
		I Qtr.	**II Qtr.**	**III Qtr.**	**IV Qtr.**
1	Salary for Resource Person / Staff (1 no.)	75 000	75 000	75 000	75 000
2	Travelling expenditure	37 500	37 500	37 500	37 500
5	Infrastructure / Equipment / Consumables	7 00 000	1 00 000	50 000	50 000
6	Experimental charges	10 000	10 000	20 000	10 000
7	Misc. Expenditure	10 000	10 000	20 000	10 000
8	Sub Total	8 32 500	2 32 500	2 02 500	1 82 500
	Grand Total				**14 50 000**

10. Work Schedule

a. Probable date of commencement of the project **:** July 2014

b. Duration of the project **:** 3 Years

c. Stages of work & milestone

Sr. No.	Major Activities	2014-15			2015-16				2016-17				17-18
		2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.
1	Literature Survey												
2	Field Investigation												
3	Sample Collection and Analysis												
4	Data Collection and Interpretation												
5	Status Report												
6	Interim Report												
7	Final Report												

Study -3 (sponsored Project)

1. Title of the Study: Ionic Enrichment Dynamics of Glacial Sediment and Melt water of Gangotri Glacier

2. Study Group:

Project Investigator Dr. M. K. Sharma, Sc. 'D'
Co-Investigator Dr. C. K. Jain, Sc. 'G' Dr. Renoj Thayyan, Sc. 'D' Dr. Manohar Arora, Sc. 'D'
Scientific/Technical Staff Sri. Naresh Saini, PRA Sri. Jatin Malhotra, SRA Sri. Rakesh Goyal, Tech. Gr. I Sri. Dayanand, Tech. Gr. II Sri Karan Jamwal, JRF

3. Type of Study: Sponsored project by DST, New Delhi, **Budget: Rs 30.60 lacs**

4. Nature of Study: Applied Research

5. Date of start: April 2014

6. Scheduled date of completion: March 2017

7. Duration of the Study: 3 Years

8. Study Objectives:

i) To characterize the seasonal variability of the major-ion chemistry of glacial meltwater.
ii) Chemical characterization of the suspended sediment of Gangotri glacial system
iii) To study Ionic enrichment dynamics of meltwater-glacial sediment interaction
iv) To investigate open and closed system low temperature ionic enrichment process

9. Statement of the Problem:

Higher level of pollutant load in the lower reaches of River Ganges is as an unresolved problem for the past many decades. There were number of projects launched by the Government of India to address this issue, but failed to achieve the desired result during the past two decades. Contribution of Himalaya rivers originating from snow and glacier fields of higher Himalaya spread across India, Nepal and Tibet, play an important role in controlling the solutes levels in the River Ganges. As these mountain waters with significant amount of snow, glacier meltwaters and rainfall is characterised by low ionic concentrations and play a major role in diluting the high solute load emanating from Ganga plain catchments. Hence any change in the quality and quantity of the Himalayan tributaries of

River Ganga under the climate change regime will impact the quality parameters of River Ganga. Understanding of low temperature solute acquisition processes is therefore very important for assessing the solute acquisition and pollutant loading further downstream. Higher sediment load in the glacier fed streams play a significant role in solute acquisition by its interaction with dilute glacial and snow melt waters. Further downstream, higher sediment load due to anthropogenic activities added another dimension to the problem. As Gangotri glacier is the biggest glacier in the region as well as the source of River Ganga, it is imperative to study the dynamics of solute acquisition by dilute glacier waters in interaction with freshly grinded glacier sediments. Hence this study is conceptualised to build the existing knowledge gap on solute acquisition of glacier melt waters during its transit with high sediment load under prevailing low temperature conditions close to the glacier.

10. Approved Action Plan/Methodology:

i) Literature survey through international publications (research papers/ reports)
ii) Reconnaissance survey of Gangotri glacier catchment for site selection.
iii) Collection Suspended sediment samples and meltwater samples from selected sites seasonally.
iv) Chemical analysis for major cations, anions and trace metals in the collected suspended sediment and meltwater.
v) Geochemical analysis of suspended sediments
vi) Study of closed system characteristics and open system dynamics
vii) Dissolution experiments of glacial meltwater-suspended sediment interaction

11. Timeline:

Activity	2014-15				2015-16				2016-17			
	1st Qr.	2nd Qr.	3rd Qr.	4th Qr.	1st Qr.	2nd Qr.	3rd Qr.	4th Qr.	1st Qr.	2nd Qr.	3rd Qr.	4th Qr.
Literature survey	■	■										
Reconnaissance Survey	■	■										
Collection of SS and meltwater samples	■	■	■		■	■	■		■	■	■	
Chemical analysis of SS and meltwater samples		■	■	■		■	■	■		■	■	
Geochemical analysis of SS			■	■	■	■	■	■	■	■	■	
Open and close system study			■	■		■	■		■	■		
Dissolution experiments of glacial meltwater -SS interaction					■	■	■	■				
Interim Report Writing				■				■				
Final Report Writing											■	■

12. Objectives and achievement during last six months:

Objectives	Achievements
Chemical analysis of SS and meltwater samples	• Measurement of suspended sediment concentration is completed. • Physico-chemical analysis of unfiltered meltwater samples is completed.

13. Recommendation / Suggestion: None

Recommendation / Suggestion	Action Taken
None	None

14. Analysis & Results:

i) Processing of measurement of suspended sediment concentration for the suspended sediment samples collected from Gomukh, Bhojwasa and Gangotri completed for the ablation period of year 2014 has been completed.
ii) Physico-chemical analysis of unfiltered meltwater sample collected from Gomukh, Bhojwasa and Gangotri completed.
iii) Sieving of bed sediment samples collected from Gomukh, Bhojwasa and Gangotri completed and digestion of the samples is under progress.
iv) Processing of hydro-chemical data is under progress.

15. End Users / Beneficiaries of the Study: Policy makers and planners of State/Central Government Organizations

16. Deliverables: Technical report and research papers

17. Major items of equipment procured: i) Low Temperature pH Meter ii) Low Temperature EC Meter iii) Temperature probe with data logging iv) Deep Freezer

18. Lab facilities used during the study: Water Quality Laboratory (NIH)

19. Data procured or generated during the study: Hydro-chemical data of Gangotri Glacier

20. Study Benefits / Impacts:

- Study of low temperature ionic enrichment during interaction between glacial sediment and melt water especially for glaciers with huge supraglacial debris cover.
- Ionic enrichment dynamics of meltwater-glacial sediment interaction under open and close system.
- Provide a strong basis extending studies of solute variability and sediment and pollutant loading further downstream.

21. Involvement of end users/beneficiaries: Local people

22. Specific linkage with Institution and /or end users / beneficiaries: None

23. Shortcoming/Difficulties: No

24. Future Plan:

- Collection Suspended sediment samples and meltwater samples from selected sites for the ablation period of year 2015.
- Study of closed system characteristics and open system dynamics
- Geochemical analysis of suspended sediment
- Processing of hydro-chemical data.

PROPOSED WORK PROGRAMME OF ENVIRONMENTAL HYDROLOGY DIVISION FOR THE YEAR 2015-16

S.No.	Study	Study Team	Duration
	Internal Studies		
1.	Water Quality Modelling using Soft Computing Techniques	Rama Mehta (PI) C. K. Jain	2 Years (05/14-05/16)
2.	Himalayan River Water Quality Assessment in a Stretch from Gangotri to Hardwar	Rajesh Singh (PI) C. K. Jain M. K. Sharma S. P. Rai Renoj J. Thayyan J. P. Patra	3 Years (07/14-06/17)
	Sponsored Projects		
1.	Ionic Enrichment Dynamics of Glacial Sediment and Melt water of Gangotri Glacier	M. K. Sharma (PI) C. K. Jain Renoj Thayyan Manohar Arora Naresh Saini Jatin Malhotra Rakesh Goyal Karan Jamwal	3 Years (04/14-03/17) Sponsored by DST, New Delhi
2.	Low Cost Technology for Purification of Arsenic and Microbes Contaminated Water using Nanotechnology	Vijaya Aggarwala, IITR (PI) Rama Mehta, NIH (Co-PI)	2 Years (04/14-03/16) Sponsored by DST, New Delhi

Quarterly Break up of Cost Estimate for Year : 2015-16 for Internal study no. 1:

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary				
2.	Travelling expenditure			15,000	15,000
3.	Infrastructure/Equipment				
4.	Experimental charges				
5.	Misc. expenditure	5000	5000	10000	30000
	Sub- Total:	5000	5000	25000	45000
	Grand Total	80000/-			

Quarterly Break up of Cost Estimate for Year : 2015-16 for Internal study no. 2.

Sr. No.	Sub-Head	Amount in Rupees			
		I Qtr.	II Qtr.	III Qtr.	IV Qtr.
1	Salary for Resource Person / Staff (1 no.)	75 000	75 000	75 000	75 000
2	Travelling expenditure	37 500	37 500	37 500	37 500
5	Infrastructure / Equipment / Consumables	7 00 000	1 00 000	50 000	50 000
6	Experimental charges	10 000	10 000	20 000	10 000
7	Misc. Expenditure	10 000	10 000	20 000	10 000
8	Sub Total	8 32 500	2 32 500	2 02 500	1 82 500
	Grand Total				**14 50 000**

PROPOSALS FOR ORGANISING TRAINING WORKSHOPS/SEMINARS/ SYMPOSIA/ MASS AWARENESS PROGRAMME ETC. DURING THE YEAR 2015-16

TRAINING WORKSHOP - 1

PROFORMA FOR SUBMITTING PROPOSALS FOR ORGANISING TRAINING WORKSHOPS/SEMINARS/SYMPOSIA/MASS AWARENESS PROGRAMME ETC.

1. **Thrust Area under XII five year Plan :**

2. **Topic of Training Workshops/Seminars/Symposia/Mass Awareness Program etc :** Advanced Soft Computing Techniques in Hydrology and its Applications (ASCTHA-15)

3. **Convener :** Dr. Rama Mehta

4. **Co-ordinator :** Dr. A.K. Lohani

5. **Co Co-ordinator (S)/ Co-Organising Secretary (ies):**

6. **Faculty:** From NIH & IITR

7. **Duration of the programme :** One Week

8. **Tentative Schedule :** November, 2015

9. **Place at which Programme would be organized:** NIH, Roorkee

10. **No of Participants Expected:** 30-40

11. **Budget Estimate**

S.No.	Sub-Head	Amount (Rs.)
1.	Inaugural tea (for 50 persons)	3000/-
2.	Valedictory tea (for 50 persons)	3000/-
3.	Working lunch, Session tea (Morning and Evening)	50000/-
4.	Registration kits (bag, writing pad, pen and pen drive)	35000/-
5.	Lecture notes	15000/-
6.	Honorarium to faculty (As per Institute's norm)	35000/-
7.	Travel expenditure for Guest Faculty	nil
8.	Field Trip (by Institute vehicle)	nil
9.	Miscellaneous	3000/-
Total		**1,44,000/-**

12. Justifications for budget estimate (please specify how the amount under different sub- heads at sl. no. 10 are computed)

All expenditure for sub-heads sl. no. 1 to 10 will be calculated based on Institutes' norms. Here on same basis, the approximate budget has been given.

TRAINING WORKSHOP - 2

PROFORMA FOR SUBMITTING PROPOSALS FOR ORGANISING TRAINING WORKSHOPS/SEMINARS/SYMPOSIA/MASS AWARENESS PROGRAMME ETC.

1	**Thrust Area under XII five year Plan**	Water Quality
2	**Topic of Training Workshops/ ~~Seminars/Symposia/~~ ~~Mass Awareness Programmes~~ etc.**	**Water Quality Monitoring and Assessment**
3	**Convener**	Dr. C. K. Jain, Sc. G & Head, EHD
4	**Coordinator/ Organising Secretary**	Dr. M. K. Sharma, Sc. D, EHD
5	**Co-coordinator/ Co-organising Secretary**	Dr. Rajesh Singh, Sc. B, EHD
6	**Faculty**	From NIH, IITR, JNU and CPCB
7	**Duration of the programme**	5 days
8	**Tentative schedule**	December 2015
9	**Place at which Programme would be organized**	NIH Roorkee
10	**Number of participants expected**	30
11	**Budget Estimate: Rs. 1,90,000/-**	
S. No.	Sub-Head	Amount (Rs.)
i)	Inaugural tea for 50 persons @ Rs. 50/- per person	2,500.00
ii)	Valedictory tea for 50 persons @ Rs. 50/- per person	2,500.00
iii)	Working lunch, Session tea (Morning and Evening) for 35 persons for 5 days @ Rs. 200/- per person per day	35,000.00
iv)	Registration kits (bag, writing pad, pen and pen drive) for 40 persons (Participants + Faculty) @ Rs. 1000/- per person	40,000.00
v)	Lecture notes, 40 Sets @ Rs. 500/- each	20,000.00
vi)	Honorarium to faculty (As per Institute's norm)	30,000.00
vii)	Travel expenditure/hospitality for Guest Faculty	20,000.00
viii)	Field trip	20,000.00
ix)	Miscellaneous	20,000.00
	Total	**1,90,000/-**

TRAINING WORKSHOP - 3

PROFORMA FOR SUBMITTING PROPOSALS FOR ORGANISING TRAINING WORKSHOPS/SEMINARS/SYMPOSIA/MASS AWARENESS PROGRAMME ETC.

1	**Thrust Area under XII five year Plan**	Water Quality
2	**Topic of Training Workshops/ ~~Seminars/Symposia/Mass Awareness Programmes~~ etc.**	Design, Operation, and Maintenance of STPs and CETPs
3	**Convener**	Dr. C. K. Jain, Sc. G & Head, EHD
4	**Coordinator/ Organising Secretary**	Dr. Rajesh Singh, Sc. B, EHD
5	**Co-coordinator/ Co-organising Secretary**	Dr. M. K. Sharma, Sc. D, EHD Dr. Sumant Kumar, Sc. B, GWHD
6	**Faculty**	Annexure 'A'
7	**Duration of the programme**	5 days
8	**Tentative schedule**	Annexure 'B'
9	**Place at which Programme would be organized**	NIH Roorkee
10	**Number of participants expected**	25
11	**Budget Estimate**	Annexure 'C'

Annexure 'A'

DETAILS OF FACULTY MEMBERS

S.No.	Name	Designation	Qualification	Experience (Years)
1.	Er. R. D. Singh	Director	M. Tech.	33
2.	Dr. C. K. Jain	Sc. 'G'	Ph.D.	30
3.	Dr. M. K. Sharma	Sc. 'D'	Ph.D.	20
5.	Dr. Rajesh Singh	Sc. 'B'	Ph.D.	13
6.	Er. Sumant Kumar	Sc. 'B'	M. Tech.	7
7.	Dr. I. M. Mishra	Professor, IITR	Ph.D.	35
8.	Dr. A. A. Kazmi	Professor, IITR	Ph.D.	15
9.	Dr. Sudipta Sarkar	Asst. Professor, IITR	Ph.D.	18
10.	Dr. R. C. Trivedi	Chief Consultant, DHI	Ph.D.	35
11	Dr. R. M. Bhardwaj	Scientist 'D', CPCB	Ph.D.	25

Annexure 'B'

TENTATIVE SCHEDULE

Day 1, Monday		**Faculty**
0930 – 1030	Registration	-
1030 – 1130	Inauguration	-
1130 – 1200	Inaugural Tea	-
1200 – 1300	Status and Strategies for Management of Water Resources in India	Er. R. D. Singh
1300 – 1400	Lunch	-
1400 – 1500	Status of Water Supply, Wastewater Generation, & Treatment in India	Dr. R. C. Trivedi
1500 – 1600	Status of Sewage Treatment Plants in India	Dr. R. M. Bhardwaj
1600 – 1630	Tea	-
1630 – 1730	Water Quality Issues in India	Dr. C. K. Jain
Day 2, Tuesday		
0930 – 1030	General Principals of Wastewater Treatment – Chemistry & Wastewater Analyses	Dr. C. K. Jain
1030 – 1130	Basic Principles of Aerobic Digestion	Dr. Rajesh Singh
1130 – 1200	Tea	-
1200 – 1300	Sizing calculation for Aerobic Reactors	Dr. Rajesh Singh
1300 – 1400	Lunch	-
1400 – 1500	Operational issues related to CETPs	Dr. Sumant Kumar
1500 – 1600	Life cycle assessment of Treatment Plants	Dr. Sumant Kumar
1600 – 1630	Tea	-
1630 – 1730	Advanced instruments for Water Quality Monitoring	Dr. M. K. Sharma
Day 3, Wednesday		
0930 – 1030	Basic Principles of Anaerobic Digestion	Dr. Rajesh Singh
1030 – 1130	Sizing calculation for Anaerobic Reactors	Dr. I. M. Mishra
1130 – 1200	Tea	-
1200 – 1300	Operational Issues Related to Aerobic / Anaerobic Treatment Plants	Dr. Rajesh Singh
1300 – 1400	Lunch	-
1400 – 1500	Membrane Bioreactor - Basic Principles & Sizing Calculations	Dr. Rajesh Singh
1500 – 1600	Membrane Bioreactor - Operational Issues	Dr. Rajesh Singh
1600 – 1630	Tea	-
1630 – 1730	Tutorial	Dr. Rajesh Singh / Dr. M. K. Sharma
Day 4, Thursday	**Field Visit**	
Day 5, Friday		
0930 – 1030	Sequencing Batch Reactor – Basic Principles & Sizing Calculations	Dr. A. A. Kazmi
1030 – 1130	Sequencing Batch Reactor – Operational Issues	Dr. A. A. Kazmi
1130 – 1200	Tea	-
1200 – 1300	Bio-medical Waste Handling Practices in India	Dr. Sudipta Sarkar
1300 – 1400	Lunch	-
1400 – 1500	Health & Safety Aspects of Operating Treatment Plants	Dr. Rajesh Singh
1500 – 1600	Presentation by Participants on Sewage Treatment Plants & Panel Discussion	Dr. C. K. Jain / Dr. Rajesh Singh
1600 – 1700	Valedictory	-
1700 – 1730	Valedictory Tea	

Annexure 'C'

BUDGET ESTIMATE

Sr. No.	Sub-Head	Amount (Rs.)
1.	Inaugural tea (Rs. 50 x 50 Persons)	2 500.00
2.	Valedictory tea (Rs. 50 x 50 Persons)	2 500.00
3.	Working lunch, Session tea (Morning and Evening) (Rs. 200 x 35 Persons)	35 000.00
4.	Registration kits (bag, writing pad, pen and pen drive) (Rs. 700 x 35 Kits)	24 500.00
5.	Lecture notes (Rs. 500 x 35 nos.)	17 500.00
6.	Honorarium to faculty (As per Institute's norm)	20 000.00
7.	Travel expenditure for Guest Faculty	20 000.00
8.	Field trip	30 000.00
9.	Miscellaneous	30 000.00
Total		1 82 000.00

GROUND WATER HYDROLOGY DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr. N C Ghosh	Scientist G & Head
2	Er. C.P. Kumar	Scientist F
3	Dr. Anupma Sharma	Scientist D
4	Dr. Surjeet Singh	Scientist D
5	Sri Rajan Vatsa	Scientist B
6	Sri Sumant Kumar	Scientist B
7	Ms. Shashi Poonam Indwar	Scientist B
8	Sri Sanjay Mittal	SRA
9	Sri S.L. Srivastava	SRA
10	Sri Ram Chandra	RA

APPROVED WORK PROGRAMME OF THE DIVISION FOR THE YEAR 2014-15

S. No.	Project	Project Team	Duration & Status	Funding Source
1. NIH/GWD/NIH/11-14	Management of Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)	Sumant Kumar (PI) Rajan Vatsa N. C. Ghosh C. P. Kumar Surjeet Singh Sanjay Mittal	4 years (04/11 – 03/15) **Status: Completed**	Saph Pani Project/ extended period as internal funding
2.	Flow and Contaminant Transport Modeling of Riverbank Filtration	Shashi P. Indwar (PI) N.C. Ghosh Anupma Sharma Rajan Vatsa	3 ½ years (04/12 – 09/15) **Status: In progress**	Extended period as internal funding
3. NIH/GWD/NIH/14-17	Management of Water Resources for Quantity and Quality in Yamuna-Hindon Inter-basin	Anupma Sharma (PI) N. C. Ghosh Other NIH study team members Collaborating Institute: CED, IIT-Roorkee	3 years (12/14 – 11/17) Status: **In progress**	Internal Funding
4.	Ganges Aquifer Management for Ecosystems services (GAMES)	Sharad Kumar Jain (PI) N. C. Ghosh Sudhir Kumar Sanjay Kumar Jain M. K. Goel Anupma Sharma Surjeet Singh	1 year (06/14 – 05/15) **Status**: **In progress**	IWMI, Hyderabad
Proposed New Studies				
5. NIH/GWD/NIH/15-18	Development of Website and e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*"	C. P. Kumar (PI) Anupma Sharma Shashi P. Indwar Sanjay Mittal	2.5 years (04/15 – 9/17) **Status**: **New**	Internal Funding
6. NIH/GWD/NIH/15-16	Diagnosis Survey and Selection of Suitable Sites for Development of Riverbank Filtration Demonstration Schemes in Different States	Surjeet Singh (PI) N.C. Ghosh C. P. Kumar Sumant Kumar Sanjay Mittal	1 year (04/15 – 3/16) **Status: New**	Internal Funding
7. NIH/GWD/NIH/15-16	Alternate Water Supply Management Strategies in Arsenic Affected/Vulnerable Areas: Mapping of Arsenic Affected Zones/Regions in Eastern U.P.	Sumant Kumar (PI) & S. P. Indwar (PI) N. C. Ghosh R. P. Singh Rajesh Singh S. L. Srivastava	1 year (04/15 – 3/16) **Status: New**	Internal Funding

The detailed status of the studies is given in Annexure-I.

Staff Strength and Facilities Available

Scientists : 7 (Dr. N. C. Ghosh, Sc.-G; Mr. C. P. Kumar, Sc.-F; Dr. Anupma Sharma, Sc.-D; Dr. Surjeet Singh, Sc.-D; Mr. Rajan Vatsa, Sc.-B; Mr. Sumant Kumar, Sc.-B; Ms. Shashi Poonam Indwar, Sc.-B)

Scientific Staff: 8 (SRA-2, RA-1; Tech-3; PS-1; MTS-1)
Resource Person -1

Soil-Water Laboratory is functioning under the division.

The division is in the process of establishing the '*Centre of Excellence for Advanced Groundwater Research*".

Status of Outreach Activities Carried Out During the Year 2014-2015

1. Organized a one-week training course on "*Groundwater Modeling using MODFLOW and MIKESHE*" during 02-06 February, 2015.

2. Scientists of the division published/accepted 8 papers in international journals, 8 papers in national journals and 2 papers in international conferences.

3. Scientists/scientific staff delivered 16 lectures/tutorials in different training courses and workshops.

1. PROJECT REFERENCE CODE: NIH/GWD/NIH/11-14

Title: **Managed Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)**

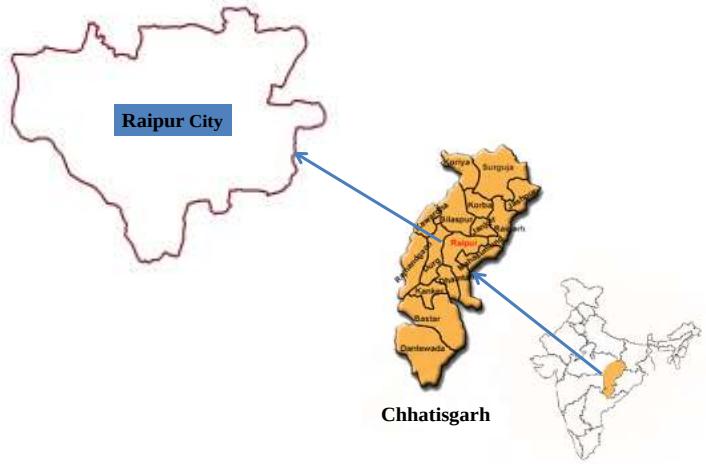
Team members : 1) Mr. Sumant Kumar - PI
2) Mr. Rajan Vatsa - Co-PI
3) Dr. N. C. Ghosh
4) Mr. C. P. Kumar
5) Dr. Surjeet Singh
6) Mr. Sanjay Mittal
7) Dr. R. P. Singh

Type of study : Internal under the framework of "Saph Pani" Project.

Date of start : April, 2011

Scheduled date of completion : March, 2015 (with 1 year extension)

Location map Raipur Municipal boundary forms the study area which lies between 21°10'and 21°21' N latitudes and 81°32' to 81°44'E longitudes. Raipur is the capital of Chhattisgarh state.



Objectives

1) To identify the potential recharge sites for groundwater resources augmentation,
2) To model and analyze aquifer responses due to the recharge from the identified potential recharge sites,
3) To manage the augmented groundwater resources for subsequent potential uses.

Statement of the problem, end users/beneficiaries of the study:

Raipur city has 154 small and large water bodies. These water bodies are natural and manmade, locally called "talab". These talabs are connected by storm water channels and hence specific catchment area. Out of the 154 talabs, 85 talabs are in place, remaining talabs

have lost their entity because of the developmental activities. Most of the existing talabs face deteriorating water quality due to disposal of municipal wastes both solid and liquid.

Raipur area also faces problem of depleting groundwater levels due to its excessive withdrawal. To overcome these problems, a Managed Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR) scheme has been envisaged, as a pilot study with objectives to enhance groundwater recharge from Teliabandha talab through aquifer storage treatment. It has been found out that recharge is very less through the talab. Therefore, we are attempting to study other talabs so that we can make possible best use of surface water from these water bodies.

Approved action plan

- Literature review
- Field investigation and data collection
- Determination of availability of surface water and groundwater
- Recharge site identification
- Estimation of groundwater recharge and simulation of aquifer response
- Analysing water supply and demand Pattern
- Demand management

Objectives & Achievements

To identify the potential recharge site for groundwater augmentation	Recharge site (Teliabanda lake) has been identified.
To model & analyze aquifer response due to the recharge from the identified potential recharge site	Semi-analytical model has been developed to estimate recharge.
To manage the augmented GW resources for subsequent potential uses	It has been estimated that recharge from selected recharge site (Teliabandha lake) is very less due to hydro-geological condition and water quality is also bad. Other prominent talabs have also been assessed for water quality to make best possible uses of surface water. Studied the feasibility of joint optimal surface water and groundwater uses for sustainability of groundwater potential.

Analysis and Results

A comprehensive analysis of hydrological, hydrogeological and water quality aspects of Teliabandha lake and its catchment has been carried out. The analysis of hydrological components included: rainfall-runoff modelling, evaporation rate and lake water quality assessment. The hydrogeological components included: aquifer characterization, aquifer parameters estimation, groundwater level and quality analysis. The groundwater recharge rates for variable inflows and outflows to/from the lake have been quantified by developing a semi-analytical model integrating Hantush's (1967) analytical expression for water table rise

due to recharge from a rectangular spreading basin into the basic water balance equation of the lake. The basic concept followed in estimating the unsteady groundwater recharge consequent from variable inflows and outflows is water balance of the lake. The groundwater recharge rate has been found very low varying between 3.75 mm/day and 4.82 mm/day for depth of water in the lake ranging between 2.5 m and 3.36 m. The geological formation of thick limestone formation for the site poses constraints - a limiting factor for MAR-ASTR proposition. The lake water quality data analysis show that the turbidity and chemical oxygen demand exceed the permissible limits mentioned in BIS (10500-2012) guidelines for drinking water. In addition to this, the presence of fecal coliform and total coliform have been found in the lake water.

MAR and ASTR are not feasible due to hydrogeological conditions and bad water quality of Teliabandha lake. Therefore, it is proposed to study other prominent lakes for management of surface water. The reduced level of lake bed has been measured using DGPS. Using the lake bed R.L., critical path for the connectivity of different water sources has been studied but it is found that it is not a feasible option due to densely populated habitation and also there are topographical mounds in between the lakes. To assess the suitability of surface water and groundwater for different purposes, water samples were collected from both the sources. The chemical water quality data of twenty seven prominent lakes and 8 groundwater samples have been analyzed, classified and studied for their suitability for drinking and irrigation purposes.

The water samples were collected and analyzed for pH, Turbidity, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Alkalinity, Hardness, Sodium (Na^+), Potassium (K^+), Calcium (Ca^{++}), Magnesium (Mg^{++}), Bicarbonate ($HCO3^-$), Sulphate (SO_4^{2-}), Nitrate (NO_3^-), Fluoride(F^-), Chloride (Cl^-), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Total Coliform (TC) and Fecal Coliform (FC). There are variations for pH (6.59-8.29), EC (382-2330 µS/cm), Turbidity (1-232 NTU), TDS (244-1491 mg/L), Alkalinity (120-600 mg/L), Hardness (66-330 mg/L), Na^+(37-430 mg/L), K^+ (8-253 mg/L), Ca^{++} (9-90 mg/L), Mg^{++}(3-26 mg/L), SO_4^{2-} (5-200 mg/L), NO_3^-(0-19 mg/L), F^-(0.18-1.41 mg/L) and Cl^- (46-388 mg/L), DO(1-8.6 mg/L), BOD (0.1-11.3 mg/L), COD (8-118 mg/L), Total Coliform (15-3600 MPN/100ml) and Fecal Coliform (4-240 MPN/100 ml). The results have been compared with the drinking water standard prescribed by Bureau of Indian Standards (BIS). All the physio-chemical parameters are within the prescribed limit except turbidity, fecal and total coliform. The Sodium Adsorption Ratio (SAR), salinity hazards have been studied to classify the water for irrigation uses. It is found that lake water is suitable for irrigation purposes. It may be concluded that solid and liquid wastes of any kind should not be discharged in the lakes. The solid wastes deposited on the lake bottom should be dredged out to enhance the recharge.

2. **PROJECT REFERENCE CODE: EU-sponsored Project no. 282911**

Title of the study: Flow and Contaminant Transport Modeling of Riverbank Filtration.

Name of PI: Mrs. Shashi Poonam Indwar, Sc-B
Co-PI: Dr. N. C. Ghosh, Sc-G
Team Members: Dr. Anupma Sharma, Sc-D
Mr. Rajan Vatsa, Sc-B
Mr. Sanjay Mittal, SRA

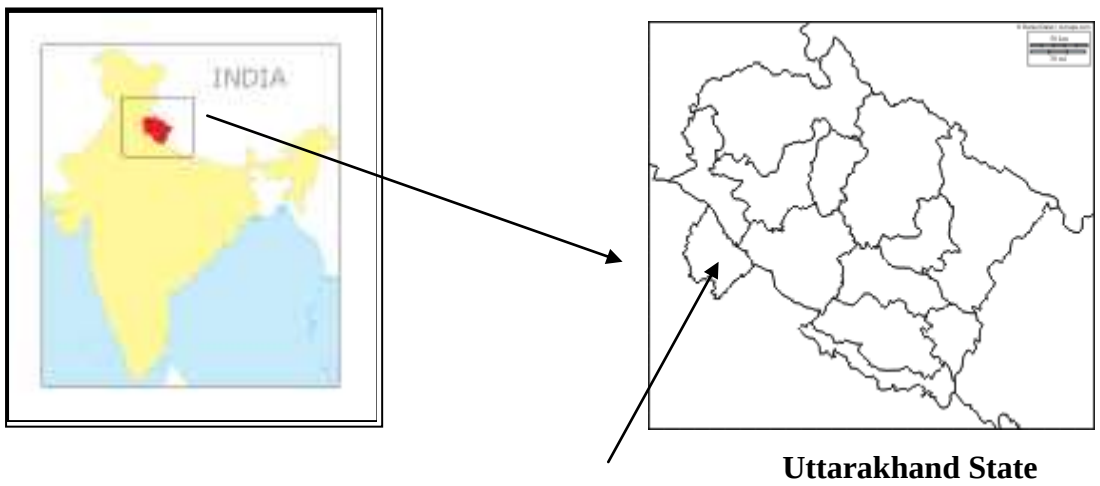
Type of study: Internal under the framework of 'Saph Pani' Project

Nature of study: Technology or technique development

Date of start: April 2012

Scheduled date of completion: September 2015 (with extension)

Location map



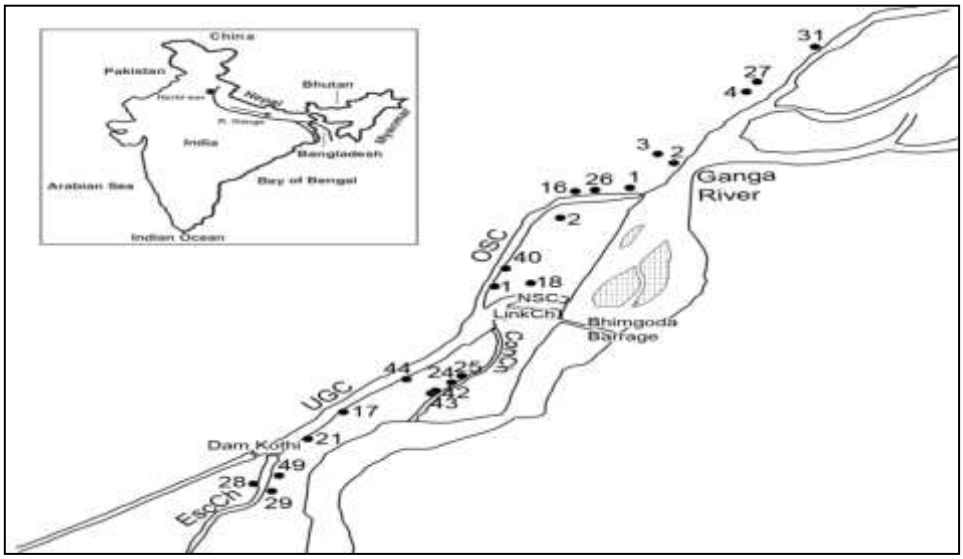


Figure1. Study area of the riverbank filtration site with 22 Infiltration wells in Haridwar, India

Study objectives:

(i) To analyze and model the flow paths and travel times of the existing bank filtration sites along the bank of Ganga river in Haridwar,

(ii) To model and evaluate removal performance of organic pollutants, coliform bacteria and other pathogens by bank filtration.

Statement of the problem:

Uttarakhand Jal Sansthan, Haridwar has installed 22 infiltration wells along the bank of Ganga river. These wells are operated to supply drinking water to the nearby areas in the Haridwar City with post treatment. During monsoon period, as post treatment, sodium hypochlorite is used in the well as disinfection. These wells are located at varying distances (50-495m) from the river centerline and have been constructed at varying depths (7-10m) below ground surface. It is considered that due to bank filtration and mixing of nearby groundwater, these wells are producing good quality of water, to the extent of permissible limit, and removing the pathogenic loads satisfactorily.

The present study is intended to analyze and model the flow paths, travel times of bank filtrate water from river to the well for the given hydrogeological setups and varying flow conditions in the river. It would further be attempted to develop a flow and contaminant transport model based on the existing scenario.

Approved action plan:

- Data collection and base data computerization
- Conceptualization of the problem, model setup, model data preparation
- Part-I report preparation - model calibration, validation and analysis
- Contaminant transport modeling and analysis etc.
- Final report preparation

Action plan for the years (2012-2015)

Review of literature	Completed
Reconnaissance survey of study sites	Completed
Data collection and base data analysis	Completed
Analysis of field data (conceptualization of the problem, model setup, model data preparation)	Completed
Contaminant transport modeling and analysis	Under progress

Objectives and Achievements:

Objectives	Achievements
• To analyze and model the flow paths and travel times of the existing bank filtration sites along the bank of Ganga river in Haridwar	• The baseline data for flow and contaminant transport modelling has been collected and assimilation of various other data related to flow modelling is complete. • The conceptual framework for the flow model has been prepared. Steady-state modelling of bank filtrate travel-time and flow path is complete.
• To model and evaluate removal performance of organic pollutants, coliform bacteria and other pathogens by bank filtration	• Will be followed up after first objective

Analysis and Results:

To determine the water quality improvement of riverbank filtrate, samples of groundwater, surface water and RBF wells water were collected once a month. Comparison of water quality parameters for surface water, groundwater and infiltration wells enables in assessment of natural treatment process of riverbank filtrate as it moves in the subsurface. Analysing major ions such as Na^{2+}, K^{+}, $Ca^{2+,}$ Mg^{2+} SO_4^{2-} NO_3^{-} which are essential elements enables to assess the mineralization process of water during the subsurface passage. Concentration graph showing the major ions present in surface water, groundwater and infiltration wells has been plotted to depict the same for Bhupatwala, Pantdweep and Beragi Camp area. Ferrous and Manganese are essential dietary elements present in water and according to WHO (2011), the recommended health based limit values for Fe^{2+} and Mn^{2+} are 2 mg/L and 0.4 mg/L, respectively. Concentration plot for Ferrous and Manganese present in river and nearby RBF wells for Bhupatwala, Pantdweep and Bairagi camp depict that surface water is having higher concentration of Ferrous and Manganese ranging from 2.1 to 5.5 mg/L and from 1.9 to 6.7 mg/L, respectively during monsoon, as higher discharge and flow velocities cause erosion of Fe^{2+} and Mn^{2+} which is accumulated in riverbed during low flow in river. Turbidity is the measure of relative clarity of a liquid. The turbidity of Ganga river (upstream and downstream of Bhimgoda barrage) is 2 to 15 times more in monsoon season due to high flow velocities, high runoff and erosion of soil and riverbed materials respectively. The turbidity of the abstracted water is below the Indian Standard limit of 5 NTU (IS 10500, 1993) during monsoon and non-monsoon.

Analysis of field data (conceptualization of the problem, model setup, model data preparation): The conceptualization of the flow model has been completed. DEM (Digital Elevation Model) for the study area using ASTER data has been generated. Aquifer

characterization is complete and various hydrogeological and hydraulic data for setting up the flow model completed. Modelling of bank filtrate flow-path in steady state condition for existing bank filtration sites in Haridwar is completed. Modelling of bank filtrate travel time and calibration is under progress.

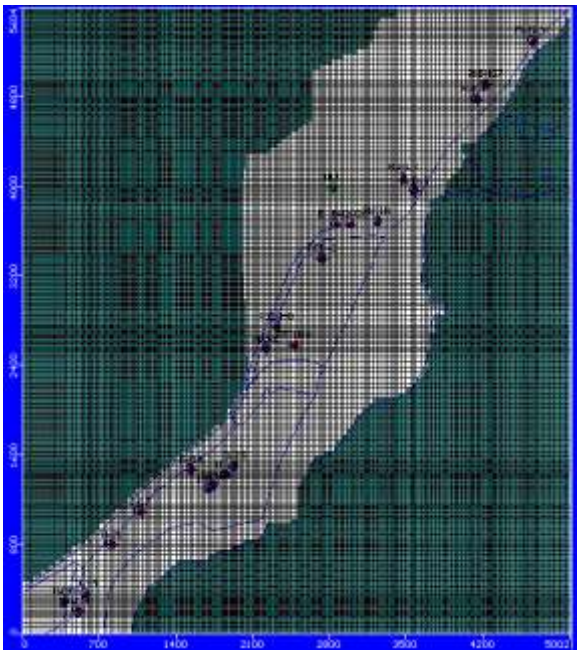


Figure 2. Discretized setup of MODFLOW domain: red circles - pumping wells; green circles - observation points. Total of 50*60 grids, each of size 100m*93.3m, refined by 2 i.e 12.5m*11.6m grid size

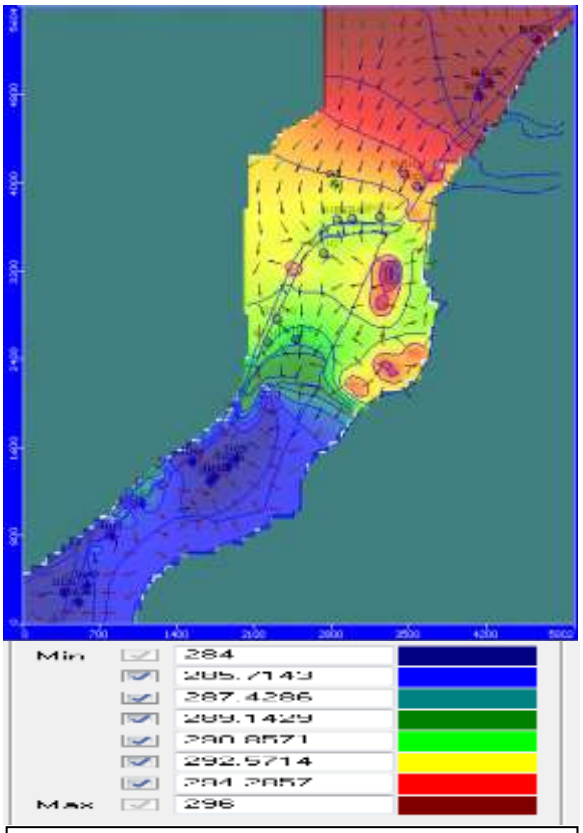


Figure 3. Flow path generated for pumping wells, Ganga river and canal in steady state condition under monsoon period (23.08.12)

List of deliverables: Technical Reports, training programmes, user's interaction workshop and papers

3. PROJECT REFERENCE CODE: NIH/GWD/INT/14-17

Title of the study: **Management of Water Resources for Quantity and Quality in Yamuna-Hindon Inter-basin**

Study team:

- Coordinator : Dr. N. C. Ghosh, Scientist-G, GWH Div.
- PI : Dr. Anupma Sharma, Scientist-D, GWH Div.
- Study Group : Groundwater Hydrology division in collaboration with study group from IIT Roorkee

Type of study (sponsored/consultancy/referred/internal): Internal (at present)

Date of start: December 2014

Duration of study: Three years

Study objectives:

1. Numerical modeling for optimal management of surface water and groundwater in Yamuna-Hindon inter-basin
2. Strategies for groundwater management associated with climate variability events
3. Assessment of surface water and groundwater quality degradation due to disposal of municipal and industrial effluents and impact on groundwater pumpage

Need for study and Specific linkages with Institutions and/or end-users/beneficiaries:

Severe water quality degradation issues have affected domestic and irrigation water supply in the fertile Yamuna-Hindon inter-basin. Need to develop strategies for conjunctive management of water resources in the region.

Project Budget:

S.No.	Sub-heads	Amount (in Rupees)		
		Ist year	IInd year	IIIrd year
1	Salary (two JRFs)	600000	600000	600000
2	Field surveys/ tests	300000	100000	100000
3	Lab and field equipment, Column assembly fabrication	2000000	370000	200000
4	Software	500000	-	-
5	Data procurement	150000	50000	20000
6	Travel	100000	100000	60000
7	Miscellaneous	50000	50000	50000
	Sub-total	3700000	1270000	1030000
	Grand Total		**Total**	**6000000**

Location map:

Objectives vis-à-vis Achievements:

Objectives	Achievements
Literature review	Completed till date
Data collection	Collection of historical data groundwater levels, river stage data, crop cultivation, irrigation schemes, relevant reports and maps, meteorological data, data collection during field visit
Field experiments and Laboratory investigations	- Soil samples collected - Soil sample analyses in laboratory for soil moisture characteristics
Database preparation	DEM, Fence diagram, Land use, Water balance (under progress)
Data analysis	Analysis of water table and water quality data, satellite data, land use, Analysis of soil samples and data for infiltration and saturated hydraulic conductivity

Adopters of the results of the study and their feedback: Study yet to be completed

List of deliverables (e.g. equipment, papers, reports, softwares, manuals, brochures, flyers, training programs, users interaction workshops)

1. Reports
2. Research Papers

Lab facilities used during the study:

1. Soil and Groundwater Lab, NIH
2. Water Quality Lab, NIH

Future plan:

1. Field surveys and data collection
2. Groundwater and surface water quality analysis to continue
3. Numerical simulations

4. PROJECT REFERENCE CODE: NIH/GWD/INT/15-18

Thrust Area under XII five year Plan: Technology Transfer and Outreach Activities

2. Project team:

a) Project Investigator — Mr. C. P. Kumar
b) Project Co-Investigator(s) — Dr. Anupma Sharma, Ms. Shashi Poonam Indwar, Mr. Sanjay Mittal

3. Title of the Project: Development of Website and e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*"

4. Objectives:

- To develop website and e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*".
- Information dissemination as well as gathering responses and opinions through e-Portal.

5. Present state-of-art

Presently, no website/e-Portal exists in India where information related to mitigation and remedy of arsenic menace in India is disseminated and responses and opinions are gathered.

6. Methodology

- Presentation by NIC empanelled vendors on suitable designs of website/e-Portal on "Mitigation and Remedy of Arsenic Menace in India" and/or Brain Storming Session to finalize the requirements of website/e-Portal
- Registration of domain name (gov.in)
- Procurement of server (to be hosted in Computer Centre of NIH, Roorkee) and other necessary hardware and software
- Development of website and e-Portal on "Mitigation and Remedy of Arsenic Menace in India"
- Release of website/e-Portal and Brain Storming Session to discuss the relevant issues
- Information dissemination, gathering responses and opinions through e-Portal
- Maintaining and updating the website/e-Portal

7. Research outcome from the project

Website/e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*" and responses/opinions on related issues.

8. Cost estimate:

a) Total cost of the project : Rs. 75,00,000
b) Source of funding : NIH internal funds
c) Sub Headwise abstract of the cost

S.No.	Sub-head	Amount (in Rupees)
1.	Salary	7,50,000
2.	Travelling expenditure	14,00,000
3.	Infrastructure/Equipment	7,00,000
4.	Experimental charges	20,00,000
5.	Misc. expenditure	26,50,000
	Grand Total:	**75,00,000**

d) Justification for Sub-head-wise abstract of the cost

(1) **Salary** for one JRF @ 25,000 per month to support in various activities (procurements, development and maintenance of website, information dissemination etc.)

(2) **Travelling expenditure** - Visits for website development, discussions, field visits to gather information and opinions

(3) **Infrastructure/Equipment**

Procurement of server and other required hardware and software

(4) **Experimental charges**

Development of website/e-Portal through NIC empanelled vendors

(5) **Misc. expenditure**

- Presentation of proposed website design and/or Brain Storming Session to finalize the requirements of website/e-Portal
- Release of website/e-Portal and Brain Storming Session to discuss the relevant issues
- Information dissemination, gathering responses and opinions
- Other miscellaneous expenditure

9. Quarterly Break up of cost estimate for each year

Year: 2015-16

S.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	**Salary**	75,000	75,000	75,000	75,000

2.	**Travelling expenditure**	2,00,000	1,50,000	1,50,000	1,50,000
3.	**Infrastructure/Equipment**	-	7,00,000	-	-
4.	**Experimental charges** Website development	-	20,00,000		-
5.	**Misc. expenditure** Presentation/BSS-1 BSS-2 Dissemination, opinions Other miscellaneous	 3,00,000 - - 2,00,000	 - - - 1,50,000	 - 3,00,000 - 1,00,000	 - - 2,00,000 1,00,000
	Sub- Total:	7,75,000	30,75,000	6,25,000	5,25,000
	Grand Total	**50,00,000**			

Year: 2016-17

S.No.	**Sub-head**	**Amount (in Rupees)**			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	**Salary**	75,000	75,000	75,000	75,000
2.	**Travelling expenditure**	1,00,000	1,00,000	1,00,000	1,00,000
3.	**Infrastructure/Equipment**	-	-	-	-
4.	**Experimental charges** Website development	-	-	-	-
5.	**Misc. expenditure** Presentation/BSS-1 BSS-2 Dissemination, opinions Other miscellaneous	 - - 1,00,000 1,00,000	 - - 1,00,000 1,00,000	 - - 1,00,000 1,00,000	 - - 1,00,000 1,00,000
	Sub- Total:	3,75,000	3,75,000	3,75,000	3,75,000
	Grand Total	**15,00,000**			

Year: 2017-18

S.No.	**Sub-head**	**Amount (in Rupees)**			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	**Salary**	75,000	75,000	-	-
2.	**Travelling expenditure**	1,75,000	1,75,000	-	-
3.	**Infrastructure/Equipment**	-	-	-	-
4.	**Experimental charges**	-	-	-	-

	Website development				
5.	**Misc. expenditure**				
	Presentation/BSS-1	-	-	-	-
	BSS-2	-	-	-	-
	Dissemination, opinions	1,50,000	1,50,000	-	-
	Other miscellaneous	1,00,000	1,00,000	-	-
	Sub- Total:	5,00,000	5,00,000	-	-
	Grand Total	**10,00,000**			

Note:

(iii) The above table has to be prepared for each year of the project period

(iv) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

10. Work Schedule:

a) Probable date of commencement of the project: April 2015
b) Duration of the project: 2.5 Years (April 2015 to Sept. 2017)
c) Stages of work and milestone:

S. No.	Work Element	First Year	Second Year	Third Year
1.	Presentation by NIC empanelled vendors on suitable designs of website/e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*" and/or Brain Storming Session to finalize the requirements of website/e-Portal			
2.	Registration of domain name (gov.in)			
3.	Procurement of server (to be hosted in Computer Centre of NIH, Roorkee) and other necessary hardware and software			
4.	Development of website and e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*"			
5.	Release of website/e-Portal and Brain Storming Session to discuss the relevant issues			
6.	Information dissemination, gathering responses and opinions through e-Portal			
7.	Maintaining and updating the website/e-Portal *(to be continued beyond the project period)*			

5. PROJECT REFERENCE CODE: NIH/GWD/INT/15-16

Thrust Area under XII five year Plan: Sustainable Management of Surface and Groundwater.

1. Project team:

a. Project Investigator	Dr. Surjeet Singh
b. Project Co-Investigator(s)	Dr. N.C. Ghosh
	Mr. C. P. Kumar
	Mr. Sumant Kumar
	Mr. Sanjay Mittal

2. Title of the Project: Diagnosis Survey and Selection of Suitable Sites for Development of Riverbank Filtration Demonstration Schemes in Different States.

3. Objectives:

i. Baseline data collection and database generation for selected river bank filtration demonstration schemes,

ii. Preliminary analysis of data and selection of suitable sites for development of riverbank filtration scheme.

4. Present state-of-art

Based on the successful demonstration of "Saph Pani" (Saph Pani, 2011-2014) results on "Bank Filtration (BF)" and recommendations of the final conference of the project, as follow up action on promotion of bank filtration technique in India for different hydrogeological settings to attain drinking water security, Secretary (WR, RD & GR) in the 75th meeting of Governing Body of NIH held on 19th January, 2015 desired that NIH should develop 6 (six) pilot demonstrate schemes on BF in different feasible locations particularly in the Ganga basin as implementable R & D project and submit the project proposal in the Ministry of Water Resources, River Development and Ganga Rejuvenation, Govt. of India for financial support. The primary purpose of Ministry of WR, RD & GR in developing pilot study schemes in different locations is to demonstrate drinking water department about effectiveness of BF technique in supply of safe drinking water in peri-urban and rural areas.

NIH together with a number of other organizations (IIT Roorkee; Uttarakhand Jal Santhan, and University of Applied Sciences Dresden (HTWD), Germany) had carried out 3 years extensive studies on various aspects of 'Riverbank Filtration (RBF)' technique based on the schemes developed at Haridwar, Srinagar and Nainital in Uttarakhand and in Delhi region. The performance and results of those schemes reported in the final Conference and reports of the project showed promising potential of extending the technique in other parts of the Country.

The Institute is proposing to develop 6 pilot riverbank filtration (RBF) schemes at

different places namely; one site at Laksar area in Uttarakhand; two sites in Uttar Pradesh, one at Mathura area and other one at Agra, one site in Bhojpur area in Bihar; one site in Sahebganj area in Jharkhand; and one site in at Visakhapatnam area in Andhra Pradesh.

5. Methodology

- Literature survey on the guidelines and pre-requisites for the selection of river bank filtration sites.
- GIS database development.
- Collection of exiting river flows and groundwater related data including water quality.
- Field visits and collection of water samples and analysis.
- Collection of hydro-meteorological and hydro-geological data and processing.
- Identification of suitable RBF sites.

6. Research outcome from the project

The outcome of the study will help in development of the demonstration sites for the riverbank filtration.

7. Cost estimate:

a. Total cost of the project : Rs. 9,20,000
b. Source of funding : NIH internal funds
c. Sub Headwise abstract of the cost

Sl. No.	Sub-head	Amount (in Rupees)
1.	Salary	3,00,000
2.	Travelling expenditure	2,00,000
3.	Infrastructure/Equipment	Nil
4.	Experimental charges	1,00,000
5.	Misc. expenditure	3,20,000
	Grand Total:	**9,20,000**

d. Justification for Sub-head-wise abstract of the cost

(1) **Salary** for one JRF @ 25,000 per month to support the GIS, water sample collection and analysis.

(2) **Travelling expenditure** – Field visits in the study area and visits to gather data and information from various line departments.

(3) **Experimental charges**

Reagents for water sample analysis in laboratory.

(4) **Misc. expenditure**

- Procurement of meteorological and hydro-geological data.
- Stationary charges.
- Other miscellaneous field expenditure.

8. Quarterly Break up of cost estimate for each year

Sl. No.	Sub-head	Amount (in Rupees)				Annual Total (Rs.)
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	
1	**Salary**	75,000	75,000	75,000	75,000	3,00,000
2	**Travelling expenditure**	50,000	50,000	50,000	50,000	2,00,000
3	**Experimental charges**	25,000	25,000	25,000	25,000	1,00,000
4	**Misc. expenditure**	2,00,000	10,000	10,000	1,00,000	3,20,000
	Sub- Total:	3,50,000	1,60,000	1,60,000	2,50,000	**9,20,000**
	Grand Total	**9,20,000**				

Note:

(i) The above table has to be prepared for each year of the project period
(ii) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

9. Work Schedule:

a. Probable date of commencement of the project: April 2015
b. Duration of the project: 1 Year (April 2015 to March 2016)
c. Stages of work and milestone:

Sl. No.	Work Element	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1	Literature survey				
2	GIS database development				
3	Collection and procurement of meteorological & Hydro-geological data				
4	Field visit and collection of data & information				
5	Data analysis				
6	Collection of water samples and analysis				
7	Identification of suitable RBF sites and dissemination workshop with line departments				
8	Preparation of final report				

5. PROJECT REFERENCE CODE: NIH/GWD/INT/15-16

Thrust Area under XII five year Plan: Groundwater Contamination-remediation Modeling

1. Project team:

a. **Project Investigators:** Sumant Kumar Sc-B and Shashi Poonam Indwar Sc-B, GWHD

b. **Project Co-Investigator(s):** Dr. N.C.Ghosh Sc-G, GWHD
Dr. R.P. Singh, SRP, GWHD
Dr. Rajesh Singh, Sc-B, EHD
Sri S.L. Srivastava, S.R.A, GWHD

2. **Title of the Project: Alternate Water Supply Management Strategies in Arsenic Affected/Vulnerable Areas: Mapping of Arsenic Affected Zones/Regions in Eastern U.P.**

3. Objectives:

(i) Diagnosis survey of the area affected by and vulnerable to arsenic contamination.

(ii) Baseline data collection from arsenic affected areas and analyses for arsenic risk mapping.

(iii) Characterization of hydrogeological units in respect of arsenic toxicity in groundwater.

(iv) Groundwater quality sampling campaign and assessment for affirmation and validation of databases.

4. Present state-of-art: Selected demand driven R & Ds on "Arsenic Mitigation"

Occurrence of arsenic in groundwater, in excess to the permissible limit of 50 µg/L in the Ganges-Brahmaputra fluvial plains in India covering 10 states namely West Bengal, Jharkhand, Bihar, Uttar Pradesh in flood plains of Ganga river; Assam and Manipur in flood plain of Brahmaputra and Imphal rivers and Rajnandgoan village in Chhattisgarh state, is one such large scale groundwater quality disaster, described internationally as the World biggest natural groundwater calamity to the mankind after Bangladesh. These fluvial plains represent Holocene aquifers of recent alluvial sediments and have the routes originated from the Himalayan region. Since the groundwater arsenic contamination first surfaced in 1983 from nearly 33 villages in 4 districts in West Bengal, up till 2008; 9 districts covering 3417 villages in 111 blocks in West Bengal, 15 districts covering 68 villages in 3 blocks in Jharkhand, 3 districts covering 9 blocks in Assam, 4 districts in Manipur, and 1 district covering 4 villages in 1 block in Chhattisgarh have been detected for groundwater arsenic contamination. With every new survey, new arsenic affected villages and people suffering from arsenic related diseases are being reported and the problem resolving issues are getting complicated by a number of unknown factors. Further to those, Arsenic groundwater contamination has far-reaching consequences including its ingestion through food chain, which are in the form of social disorders, health hazards and socio-economic dissolution besides its sprawling with movement, and exploitation of groundwater. Whether the knowledgebase, understandings and technological options

available are adequate to resolve the issues or, there are further needs of more investigations and studies to strengthen understanding of geochemical processes to mitigate and remediate arsenic from groundwater, are some of the concerns to be addressed for attaining sustainability in supply of arsenic safe groundwater to affected areas.

Groundwater arsenic contamination in UP was first exposed in 2003 by SOES from survey of 25 villages in Ballia district. Thereafter, with continued survey two more districts, Gazipur and Varanasi were detected for arsenic groundwater contamination. As of 2008, 3 districts covering 69 villages in 7 blocks in Uttar Pradesh were found affected by arsenic groundwater contamination and people suffering from arsenical skin lesions. They used to drink water of hand pump operated tube wells. All those tube wells tap groundwater from shallow aquifer below 20-30 m. All the arsenic affected districts in UP and 12 districts in Bihar are aligned along the linear track of the Ganga river. The Ganga alluvium is divided into (i) older alluvium of middle to late Pleistocene age and (ii) newer alluvium of Holocene age. The results of studies carried out by different agencies/researchers have one commonality that the concentration of arsenic (As^{3+}) more than permissible limit of 50 µg/l occurs in the groundwater from newer alluvium of Holocene age and the groundwater occurring in the older alluvium. This suggests that the arsenic contamination is of geogenic nature. The proposed study focuses on mapping and zoning the arsenic concentration and hence the methodology is devised with the central idea to map the geographical spread and vertical continuity of older and newer alluvium both.

The proposed study has been undertaken in light of the recommendation given by Inter-Ministerial Group (IMG) on "Arsenic Mitigation" constituted by Ministry of Water Resources, River development & Ganga Rejuvenation and Public Accounts Committee (PAC, eighth report, 16th Lok Sabha) on 'Water Pollution in India'. PAC recommended under Groundwater Pollution: "Alternate sustainable programmes be launched for ensuring supply of arsenic-free water through conjunctive use of surface water and in situ groundwater after thorough scientific studies". The proposed study will be a step forward in understanding the root causes and magnitude of arsenic contamination in eastern U.P. and for attaining sustainable supply of arsenic safe groundwater to affected areas.

5. Methodology

- Compilation of available literature on arsenic contamination in the area.
- Data acquisition on hydrogeology (lithologs, historical data on water level, aquifer parameters and well characteristic etc.), hydrochemistry, health effects due to arsenic contamination and arsenic removal technologies.
- Preparation of fence diagrams showing the lateral and vertical extensions of older alluvium and newer alluvium and correlating the arsenic concentration with geology.
- Collection of groundwater samples from eastern U.P. (Kushi Nagar, Deoria, Ballia, Ghazipur, Chandauli, Sonbhadra, Maharajganj, Gorakhpur, Azamgarh, Mau, Varanasi and Mirzapur). Analyzing the samples with an emphasis on arsenic speciation.
- Data analysis and interpretation to understand the source of contamination.
- Preparation of the arsenic speciation zone maps in the GIS environment.

6. **Research Outcome from the Project :**

a. Geo-spatial data base of arsenic contamination
b. Correlation of arsenic concentration with geology
c. Technical report and papers

7. Cost Estimate

e. Total cost of the project : Rs. 16, 00,000
f. Source of funding : NIH (Internal)
g. Sub headwise abstract of the cost :

Sr. No.	Sub-Head	Total
1	Salary for JRF/SRF/RA (JRF 1 no., salary per month@ Rs. 25,000+10% HRA)	3,30,000
2	Travelling expenditure	5,00,000
3	Infrastructure / Equipment / Consumable	4,20,000
4	Experimental charges	3,00,000
5	Misc. Expenditure	50,000
	Grand Total	**16,00,000**

h. Justification for sub-head-wise abstract of the cost

- **Salary**: One JRF is required for sample collection, data collection, analysis etc.
- **Travelling expenditure**: To visit the study area, water sample collection, data acquisition from various sources, field investigation etc.
- **Equipment**: Portable arsenic kit (1 digital+ 1 manual), Multiparameter kit for field analysis.
- **Consumables**: Purchase of chemicals, glasswares, plastics, etc.
- **Experimental charges**: Towards analysis of samples in outside laboratories

8. Quarterly Break up of Cost Estimate for Each Year

Year: 2015-16

Sr. No.	Sub-Head	Amount in Rupees			
		I Qtr.	II Qtr.	III Qtr.	IV Qtr.
1	Salary for JRF/SRF/RA (1 no.)	82,500	82,500	82,500	82,500
2	Travelling expenditure	1,50,000	1,50,000	1,50,000	50,000
3	Infrastructure / Equipment / Consumables	3,50,000	25,000	25,000	20,000
4	Experimental charges	1,00,000	1,00,000	50,000	50,000
5	Misc. Expenditure	15,000	15,000	10,000	10,000
	Sub Total	6,97,500	3,72,500	3,17,500	2,12,500
	Grand Total				**16,00,000**

9. Work Schedule

a. Probable date of commencement of the project **:** April, 2015
b. Duration of the project **:** 1 Year
c. **Stages of work & milestone**

S.No.	Major Activities	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
1	Literature Survey				
2	Field Investigation				
3	Sample Collection and Analysis				
4	Data Collection and Interpretation				
5	Final Report				

PROPOSED WORK PROGRAM OF GROUND WATER HYDROLOGY DIVISION FOR THE YEAR 2015-16

S. No.	Project	Project Team	Duration & Status	Funding Source
1.	Flow and Contaminant Transport Modeling of Riverbank Filtration	Shashi P. Indwar (PI) N.C. Ghosh Anupma Sharma Rajan Vatsa	3 ½ years (04/12 – 09/15) **Status: In progress**	Extended period as internal funding
2. NIH/GWD/ NIH/14-17	Management of Water Resources for Quantity and Quality in Yamuna-Hindon Inter-basin	Anupma Sharma (PI) N. C. Ghosh Other NIH study team members Collaborating Institute: CED, IIT-Roorkee	3 years (12/14 – 11/17) Status: **In progress**	Internal Funding
3.	Ganges Aquifer Management for Ecosystems services (GAMES)	Sharad Kumar Jain (PI) N. C. Ghosh Sudhir Kumar Sanjay Kumar Jain M. K. Goel Anupma Sharma Surjeet Singh	1 year (06/14 – 05/15) **Status**: **In progress**	IWMI, Hyderabad
4. NIH/GWD/ NIH/15-18	Development of Website and e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*"	C. P. Kumar (PI) Anupma Sharma Shashi P. Indwar Sanjay Mittal	2.5 years (04/15 – 9/17) **Status**: **New**	Internal Funding
5. NIH/GWD/ NIH/15-16	Diagnosis Survey and Selection of Suitable Sites for Development of Riverbank Filtration Demonstration Schemes in Different States	Surjeet Singh (PI) N.C. Ghosh C. P. Kumar Sumant Kumar Sanjay Mittal	1 year (04/15 – 3/16) **Status: New**	Internal Funding
6. NIH/GWD/ NIH/15-16	Alternate Water Supply Management Strategies in Arsenic Affected/ Vulnerable Areas: Mapping of Arsenic Affected Zones/ Regions in Eastern U.P.	Sumant Kumar (PI) & S. P. Indwar (PI) N. C. Ghosh R. P. Singh Rajesh Singh S. L. Srivastava	1 year (04/15 – 3/16) **Status: New**	Internal Funding

HYDROLOGICAL INVESTIGATION DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr. Sudhir Kumar	Scientist G & Head
2	Dr. S D Khobragade	Scientist E
3	Dr. S P Rai	Scientist E
4	Dr. M S Rao	Scientist D
5	Sri S K Verma	Scientist D
6	Sri P K Garg	Scientist B
7	Sri Rajeev Gupta	SRA
8	Sri U K Singh	SRA
9	Sri V K Agarwal	SRA
10	Sri Jameel Ahmed	SRA
11	Sri. Raju Juyal	RA
12	Sri Vishal Gupta	RA

ITEM NO. 42.2: ACTIONS TAKEN ON THE ADVICE / DECISIONS OF THE 41st MEETING

Actions taken on the suggestions by the members during the 41st meeting of working group and the action taken are given below:.

Study / Project	Comment	Action Taken
Isotope Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains	Dr. RD Deshpande suggested computing the noble gas temperature from the analysis of different noble gases.	Noble gas temperatures have been computed and shall be presented during the presentation of the progress of the study.
Interaction between groundwater and seawater along the north east coast of India	Shri Niladri Naha informed that he may be contacted for data and in the field support for the above study.	

ITEM NO. 42.3: PROGRESS OF THE WORK PROGRAM OF THE DIVISION FOR THE YEAR 2014-15

As per the approved work program during the 41st meeting of working group held on 26th – 27th November, 2015, the Hydrological Investigations Division had to carry out 7 Internal studied, 5 sponsored projects and 6 consultancy project (See annexure-I). Status of studies carried out during 2014-15 is given below:

Annexure - I

APPROVED WORK PROGRAMME OF HYDROLOGICAL INVESTIGATIONS DIVISION FOR THE YEAR 2014-2015

S. No	Study	Team	Duration/ Status
INTERNAL STUDIES			
1.	Water Quality, Hydrogeology and Isotopic Investigations in SW Punjab	M. S. Rao (PI), C. P. Kumar Gopal Krishan	**3 years** (07/12-06/15) **Completed**
2.	Water Availability Studies for Sukhna Lake, Chandigarh	S. D. Khobragade (PI) C. P. Kumar Sudhir Kumar A. R. Senthil Kumar P. K. Garg V. K. Agarwal	**2 years** (04/13-03/15) **Continuing Study**

S. No	Study	Team	Duration/ Status
3.	Isotopic Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains	Sudhir Kumar (PI) C. K. Jain S. P. Rai S. D. Khobragade P. K. Garg Two officers each from Lucknow and Chandigarh office of CGWB)	**2 years** (07/13-06/15) **Continuing Study**
4.	Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes	S. K. Verma (PI) S. P. Rai (Co-PI) M. S. Rao C. P. Kumar Mohar Singh	**2 years** (10/13-09/15) **Continuing Study**
5.	Interaction between groundwater and seawater along the northern part of east coast of India	M. S. Rao (PI), Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16) **New Study**
6.	Isotopic investigation of benchmark Himalayan glaciers.	M. S. Rao (PI), S.P. Rai, Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16) **New Study**
7.	Assessment of dissolved radon concentration for groundwater investigations in Haridwar district	Pankaj Garg (PI), Sudhir Kumar, M. Someshwar Rao	**1 year** (01/15 – 12/15) **New Study**
SPONSORED PROJECTS			
8.	Review of Groundwater Resources in the Indo-Gangetic Basin: A Case Study on Resilience of Groundwater in the Punjab to Withdrawal and Environmental Change	M. S. Rao (PI) C. P. Kumar, Gopal Krishan	**One year 8 months** (02/13-09/14) **Completed**
9.	The Structure and Dynamics of Groundwater Systems in Northwestern India under Past, Present and Future Climates	S. P. Rai (PI) M. S. Rao, Surjeet Singh, S. K. Verma C. P. Kumar, Sudhir Kumar, V. K. Agarwal Rajeev Gupta, S. L. Srivastava, Vishal Gupta, Mohar Singh	**3 years** (06/12-05/15) **Continuing Study**
10.	The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India	M. S. Rao (PI) C. P. Kumar S. P. Rai	**3 years** (09/12-08/15) **Continuing Study**

S. No	Study	Team	Duration/ Status
11.	Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques	S. P. Rai (PI) R. V. Kale, M. S. Rao C. P. Kumar, Sudhir Kumar, V. K. Agarwal Vishal Gupta, Mohar Singh	**3 years** (10/12-09/15) **Continuing Study**
12.	Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains	Sudhir Kumar (PI) S. P. Rai, S. D. Khobragade, C. K. Jain P. K. Garg	**2 years** (05/13-12/15)* **Continuing Study** ***Extended by IAEA***
CONSULTANCY PROJECTS			
13.	Integrated Hydrological Investigations of Sukhna Lake, Chandigarh for its Conservation and Management	Suhas Khobragade (PI)	**Initially 2 years** (7/11-12/13) **Completed**
14.	Hydrogeological Study for Dewatering of Jhamarkotra Mines, Distt. Udaipur	Sudhir Kumar (PI)	**3 years** (05/13-04/16) **Continuing Study**
15.	Impact Assessment of Ash Pond on the Groundwater Quality in the Surrounding Villages of NTPC Simhdri through Stable Isotopic Studies	Sudhir Kumar (PI)	**1 year** (07/13-06/14) **Completed**
16.	Isotopic Characterization of Groundwater of District Raigarh, Chhattisgarh	S. P. Rai (PI)	**6 months** (04/14-09/14) **Completed**
17.	Hydrogeological Studies for Ash Pond of 2 X 525 MW Maithon Power Limited and an Abandoned Coal Mine, District Dhanbad, Jharkhand	Sudhir Kumar (PI)	**3 months** (06/14-8/14) **Completed**
18.	Possible impact of construction activities in Kansal area (Mohali, Punjab) on water flow to Sukhna lake in Chandigarh	Suhas Khobragade (PI)	**2 months** (9/14-11/14) **Completed**

Type of study/Project	*Completed in FY 2014-15*	*To be Continued in FY 2015-16*	*Total as per approved program*
Internal Studies	2	5	7
Sponsored Projects	1	4	5
Consultancy Projects	5	1	6
Total	8	10	18

The progress and the results of the internal studies and the sponsored projects is given below:

INTERNAL STUDIES:

1. *PROJECT REFERENCE CODE: NIH/HID/INT/2012-14/2*

Thrust Area under XII five year Plan:

Water Quality and Health

Title of the Study:

Water Quality, Hydrogeology and Isotopic Investigations in SW Punjab

Status: *Study completed and presented in 41st Working Group Meeting held on 26-27 November, 2014*

2. PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/1

Thrust Area under XII five year Plan:

Hydrology for watershed management (Hydrology of lakes & other water bodies)

Title of the Study:

Water Availability Studies for Sukhna Lake, Chandigarh

Project Team :

(a) Project Investigator: S. D. Khobragade (PI)

(b) Project Co-Investigator(s): Sudhir Kumar, C. P. Kumar, A. R. Senthil Kumar, P. K. Garg, V. K. Agarwal

Duration : April 2013 to March 2015

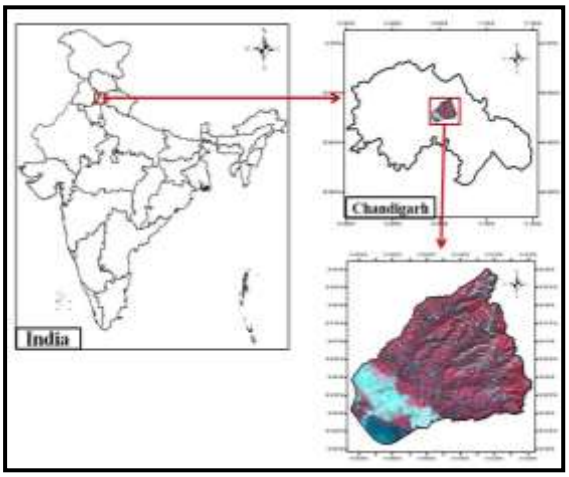
Statement of the Problem

Sukhna Lake in Chandigarh is a popular destination for recreation and tourism. However, the lake is in limelight in recent years due to various problems being faced by it. One of the serious problems of the lake is declining water availability in recent years. Water availability analysis has already been carried out based on limited available data, under a consultancy project for the lake carried out by NIH. Further detailed investigations are required on this aspect. The present study has therefore been proposed as Phase-II of the investigation being carried out on Sukhna Lake by the Institute.

Objectives

1. To study inflow regime of the lake
2. To study seepage losses from the lake
3. To analyze long term trends in rainfall and evaporation
4. To study the impact of aquatic weeds on lake evaporation, and
5. To study water availability in the lake

Study Area



Objectives vis-à-vis Achèvements:

Objectives	Achievements
To study inflow regime of the lake	Inflow has been estimated using water balance approach for 2011, 2012, 2013 and 2014
To study seepage losses from the lake	Seepage has been estimated using water balance approach and based on analysis of long term of lake water levels
To analyze long term trends in rainfall and evaporation	Analysis has been completed using trend line method and statistical tests.
To study the impact of aquatic weeds on lake evaporation	In view of the fact that after the complete drying of the lake in 2012 summer and subsequent dredging, the weeds have vanished from the lake for the time being. So this objective has been dropped.
To study water availability in the lake	Water balance has been completed for the years 2011-12, 2012-13, and 2013-14.

Analysis and Results

Following observations have been made based on the water balance of the lake:

(i) Depending upon the rainfall characteristics, the lake can get a total inflow of about 200 Ham to 700 Ham in a water year (July to June), including direct rainfall over it and through surface runoff from the catchment. The contribution of direct rainfall may vary from 120 Ham to 200 Ham while the contribution by surface runoff from catchment may vary from 80 Ham to 500 Ham. During deficit rainfall years, the contribution from direct rainfall over the lake may be more than the runoff from the catchment.

(ii) Depending upon the rainfall characteristics, during monsoon season (July to September), the lake can receive about 200 Ham to 560 Ham of total inflow. The contribution of direct rainfall may vary from 100-150 Ham while the contribution of runoff from catchment may vary from 100-410 Ham.

(iii) Depending upon the water received by the lake during monsoon, the total losses from the lake in a water year (July to -June) may vary from 300 Ham - 450 Ham.

(iv) Depending upon the water levels of the lake, the seepage losses from the lake in a water year (July-June) can vary from 0 (zero) to 175 Ham. The seepage losses may vary from 0-60 Ham during monsoon (July-September) and 0-150 Ham during the post monsoon months (October-June). Higher is the post monsoon water level reached by the lake, more would be the seepage losses. At levels of 1956.3 m and below, the losses would be almost zero or negligibly small.

(v) Depending upon the water available in the lake, evaporation losses in a water year can be upto 300 Ham. The water losses due to evaporation during monsoon can be upto 80 Ham. As far as post monsoon season of October to June is concerned, the evaporation losses may vary from about 150 Ham- 220 Ham.

(vi) Inflow to lake in post monsoon season is almost 100% by rainfall falling directly over the lake.

(vii) In deficit rainfall years when the water levels are significantly low, evaporation is the single most important factor determining water losses from the lake with contribution above 90%, (if the water level is below 1156.3 ft level). Evaporation is always the important cause of water loss in summer irrespective of the water availability in lakes.

(viii) Seepage losses are very significant during monsoon months and during the months immediately succeeding the monsoon months till the water levels come down to the below critical mark. If the water levels are above the critical mark, then in the winter months, when evaporation rates are generally very low, seepage is a dominant factor in deciding the decline in water level.

Status: Study has been completed.

3. ***PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/3***

Thrust Area under XII five year Plan

Dynamics of deeper aquifers

Title of the Study:

Isotope Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains

Project Team:

(a) Project Investigator: Sudhir Kumar (PI)

(b) Project Co-Investigator(s): C. K. Jain, S. P. Rai, S. D. Khobragade, P. K. Garg, Two officers each from Lucknow and Chandigarh Regional Offices of CGWB

Duration : July 2013 to June 2015

Study Objectives: Objectives of the study are

i. To identify the various aquifers present in alluvial tract of the Upper Yamuna Plains.
ii. To identify the source of recharge of different aquifers, and the interaction between various aquifers.
iii. To investigate the continuity of aquifers on both the sides of the river Yamuna,
iv. To determine the groundwater dynamics in different identified aquifers, and
v. To estimate the groundwater velocity and replenishment potential of the deeper aquifers

Details are given under sponsored project "Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains"

4. PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/4

Thrust Area under XII five year Plan:

Water Quality and Health

Project team:

d) Project Investigator: S. K. Verma
e) Project Co-Investigator(s): S. P. Rai, M. S. Rao, C. P. Kumar, Mohar Singh

Title of the Project:

Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes

Objectives:

i. To measure radon concentration in water
ii. To identify paleo-groundwater in the study area

Present state-of-art:

A National Working Group IGCP-571 has been constituted by GSI, Govt. of India to study the radon concentration in different materials. NIH is entrusted to study the radon concentration in waters. Radon is a decay product of Uranium with a half-life of 3.8 days. It can cause serious disease like lung cancer. In USA more than 25,000 deaths occur every year due to high radon concentration in water as well as in air. High concentrations of Radon has been observed in certain parts of India.

Groundwater from deeper aquifers is being withdrawal without the knowledge of groundwater dynamics in aquifer. Some of the deeper aquifers may have paleo water which may not serve the needs for water supply for longer time. Therefore, there is a need to map the paleo-waters to avoid huge investments on other industrial and/or urbanizational developments in such areas.

Methodology:

In order to study the radon contamination in the study area at different locations, groundwater samples from intermediate/deep aquifers will be collected for in-situ radon concentration measurement. Spatial and temporal variation of radon concentration in groundwater samples will be studied. The groundwater samples from intermediate/deep aquifers for existing tube wells will also be collected for tritium and ^{14}C measurement. The hydro-geological data will also be collected for the study area in order to study the hydro-geological features to be linked with the radon concentration in waters and paleo-groundwater.

Research outcome from the project:

i. Generation of data base for radon concentration & groundwater age
ii. Publication of report and research papers

Cost estimate:

a) Total cost of the project: 1,70,000/-

b) Source of funding: Internal

c) Sub Headwise abstract of the cost

Sl. No.	Sub-head	Year (2015-16)
		Amount (in Rupees)
1.	Salary	
2.	Travelling expenditure	50,000.00
3.	Infrastructure/Equipment	-
4.	Experimental charges	1,00,00.00
5.	Misc. expenditure	20,000/-
	Grand Total:	1,70,000/-

Justification for Sub-head-wise abstract of the cost: as above

Travel (Rs. 50,000/-): The fund is required for travelling to the study area for survey for selecting sites, sample collection for pre-monsoon and post monsoon seasons

Experimental Charges: An amount of Rs.1,00,000/- is required for procurement chemicals and glassware for analysis of water samples.

Miscellaneous expenditure (Rs. 20,000/-): The fund is required for hiring of daily wages worker and other contingencies etc.

Quarterly Break up of cost estimate for each year:

Year: 2015-2016

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	-	-	-	-
2.	Travelling expenditure	25,000.00	25,000.00	-	-
3.	Infrastructure/Equipment	-	-	-	-
4.	Experimental charges	60,000.00	40,000.00	-	-
5.	Misc. expenditure	10,000.00	10,000.00	-	-
	Sub- Total:	95,000.00	75,000.00		
	Grand Total	1,70,000.00			

Work Schedule:

f. Date of commencement of the project: Oct. 2013

g. Duration of the project: Oct. 2013 to Sept. 2015 (2 years)

h. Stages of work and milestone:

Sl. No.	Work Element	Apr-Jun, 2015	July-Sep, 2015
1.	Monitoring of radon concentration	*	

2.	Identification of paleo-groundwater		*

Analysis and Results

- The analysis of radon concentration in groundwater has been carried out for a total of 20 groundwater samples collected from intermediate/deep aquifers using tube wells for drinking water supply from different locations in the study area.

- It is found that the radon concentration in water varies from 1 Bq/litre to 14 Bq/litre in Nawanshahar district, from 5.5 Bq/litre to 24 Bq/litre in district Hoshiarpur and from 0 Bq/l to 4 Bq/l in district Ropar. These values fall under the safe limit recommended by the World Health Organization (WHO) for drinking water i.e. 100 Bq/litre.

- The electrical conductivity of groundwater samples has been measured at 20 locations at the time of sampling which varies from 250 µS/cm to 470 µS/cm in the study area.

- In addition to above, a total of 20 ground water samples were collected from intermediate/deep aquifers using tube wells for drinking water supply each from 20 locations. These samples are being analysed for tritium dating using Tritium Enrichment unit and Quantulus available in Nuclear Hydrology laboratory.

Future Plan: As per activity chart

5. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/3

Thrust Area under XII five year Plan:

Water Management in Coastal and Hard rock aquifers

Project team:

a) Project Investigator: Dr. M. Someshwar Rao
b) Project Co-Investigator(s): Dr. Sudhir Kumar, & Sh. SK Verma
c) Technical Collaborators:
   i. Sh. Niladri Naha, Additional Director, SWID, Kolkata
   ii. Dr. Abhijit Chakraborty, Asstt. Prof., IIT, Kharagpur

Title of the Project:

Interaction between groundwater and seawater along the parts of east coast of India

Objectives: The study the following objectives:

i. Mapping the salinity variation and stable isotopic composition in the coastal groundwater
ii. Mapping the dissolved radon in groundwater and its implication to fresh groundwater discharge to sea or sea-water intrusion
iii. Mapping the groundwater-seawater interaction regions vis-à-vis the operating hydrological process (SGD/Seawater intrusion)

Present state-of-art

In the coastal aquifer, the difference in hydrostatic pressure between groundwater and sea water results into fresh groundwater discharge into the sea as submarine groundwater discharge (SGD) or inflow of seawater into groundwater system as seawater intrusion. SGD and seawater intrusion (SI) are the pathways of interaction between groundwater and sea. Seawater intrusion and SGD are the issues of global importance. The change in sea level (due to climate change or tidal effects) and groundwater levels (due to excess withdrawal, land use change, climate change etc) influence both SGD and SI. While SGD is the direct loss of freshwater to sea, the seawater intrusion causes groundwater salinization thereby reducing the available freshwater volume. It is also known that SGD causes loading of nutrient and release of contaminant near shore line causing the increased biological activity at the location of SGD. India has over 2000 km length of shore line. Therefore, for development of water resource potential of coastal groundwater it is important to delineate zones of groundwater falling in SGD or seawater intrusion process. With the increasing population and the demand of freshwater such maps are important to formulate management practices to safeguard the fresh water and for sustainability of fresh groundwater resources.

Although submarine springs and seeps have been known since Roman period, the scientific investigation of SGD started in sixties (Kohout, 1964). In India, saltwater contamination due to seawater intrusion, saltpan deposit and mining activities have been reported through major ion analysis of groundwater (see for example, Chandrasekar et al, 2014). However, results of such studies need to be taken carefully as seawater-groundwater interaction involve cation-exchange interaction which may not result from a direct flow of water mass from sea to groundwater or vise-a-versa. In a combined geophysical and geochemical investigation of coastal groundwater in Godawari Basin (Gurunadh Rao et al. 2011) it was shown that TDS and Chloride concentrations are the simplest indicators for assessment of salinization process. In the study they observed that salinity is mainly due to dissolved salts of marine clays left

out during the recession of sea and not due to the lateral movement of sea water from Bay of Bengal and the interpretation was supported by groundwater level contours which showed groundwater flow direction towards the sea and also by ERT data. In an isotopic investigation of groundwater in the west coast of India near Mangalore, Lambs et al., (2011) observed a difference in isotopic composition and d-excess of groundwater in the summer and winter periods, with a predominantly lighter isotopes in the latter periods. Use of radon for studying the seawater-groundwater interaction started with the work of BARC team SGD in the west coast region of India near Thiruvananthpuram (Jacob et al, 2009) who successfully employed radon for estimating the SGD component. However, other than few such studies not much work has been reported on use of isotopes in integration with the conventional techniques to examine and map the zones of seawater-groundwater interaction regions in accordance with the operating processes SI/SGD.

Methodology

In the present project it is proposed to map the safe zones, vulnerable zone and potential risk zones for groundwater withdrawal by delineating areas of SI and SGD using EC, stable isotope, radon and water level data in parts of east coast falling in the south-east coastal region of West Bengal and north-east coastal region of Odisha. As a part of the study, literature survey will be on the conventional and isotope techniques available to investigate the SI/SGD zones in the coastal aquifers. For the study, groundwater samples will be collected in pre- & post monsoon seasons. In-situ analysis will be done for EC, temperature and radon (^{222}Rn) concentration. Select number of samples will be collected and analyzed for stable isotope composition at NIH, Roorkee. As these parameters (EC, Temp, stable isotope composition, ^{222}Rn concentration) are expected to change during monsoon and non-monsoon season, samples will be collected in two seasons: before and after the monsoon for both the years 2015 and 2016. Long term data on water table will be collected to examine the seasonal dependency of groundwater flow conditions. Rainfall data will also be collected to interpret the results. Technical support from state groundwater department will be taken in groundwater sampling and for collating the archival data. The knowledge that will be gained by the study will be published in journals and conferences and also will be disseminated through training programmes.

Research outcome from the project:

- Thematic maps of variation of (i) stable isotopic composition, (ii) salinity, (iii) major ions, and (iv) radon in groundwater during pre & post monsoon periods. Interpretation of the above data with respect to the changing groundwater levels before and after the monsoon periods.
- Mapping the areas of safe groundwater, vulnerable and potential risk zone according to SI & SGD operating process
- Knowledge dissemination in terms of publications (report, papers in journals and conferences etc) and training programs etc.

Cost estimate:

a) Total cost of the project : Rs. 26,82,000/-

b) Source of funding: Internal

c) Sub Headwise abstract of the cost

Sl.No.	Sub-head	Amount (in Rupees)		
		1st Year	2nd Year	Total

1.	Salary	1,80,000	1,92,000	3,72,000
2.	Travelling expenditure	2,00,000	200,000	400,000
3.	Infrastructure/Equipment	60,000	60,000	1,20,000
4.	Experimental charges	7,05,000	705,000	14,10,000
5.	Misc. expenditure	2,80,000	100,000	3,80,000
	Sub- Total:	14,25,000	12,57,000	26,82,000
	Grand Total	26,82,000		

d) Justification for Sub-head-wise abstract of the cost

Salary (Project Officer): The Project Officer will help PI in field work, in the tritium, stable isotope and chemical analysis of samples in the NIH laboratory, in data analysis, interpretation, publications and general support in knowledge dissemination.

Travelling Expenditure: This include travel from NIH, Roorkee to study area (east coast of West Bengal & Odisha for 2 seasons of 20 days each in each year (total 80 days) and for travel to conferences for knowledge dissemination, meetings etc

Experimental charges: The study involves analysis of large number of samples (approx 500 samples per year) for stable isotopes and major ion analysis. The cost together for chemical and isotopic analysis per sample is about Rs. 1,200/- Accordingly, sample analysis requires Rs. 6,00,000/-. Further, during sample collection in the field and analysis in the laboratory, an un-skilled/semi-skilled daily wage labor will be employed. For employing a labour for 300 mandays @ Rs. 350 per day requires an amount of Rs. 1,05,000 per year. Thus, the cost together will be Rs. 7,05,000/-

Miscellaneous Expenditure: One training programme/workshop will be conducted at the end of the 1st year for which an amount Rs. 2.0 lakhs is allocated.

Quarterly Break up of cost estimate for each year

Year: 1st April 2015- 31st March 2016

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	36,000	48,000	48,000	48,000
2.	Travelling expenditure	80,000	20,000	80,000	20,000
3.	Infrastructure/Equipment	---	30,000	--	30,000
4.	Experimental charges	50,000	300,000	55,000	3,00,000
5.	Misc. expenditure	20,000	20,000	20,000	2,20,000
	Sub- Total:	186,000	418,000	203,000	618,000
	Grand Total	14,25,000			

Year: 1st April 2015- 31st March 2016

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	48,000	48,000	48,000	48,000
2.	Travelling expenditure	80,000	20,000	80,000	20,000
3.	Infrastructure/Equipment	---	30,000	--	30,000

4.	Experimental charges	50,000	3,00,000	55,000	3,00,000
5.	Misc. expenditure	20,000	20,000	20,000	40,000
	Sub- Total:	198,000	4,18,000	203,000	438,000
	Grand Total	12,57,000			

Work Schedule:

a) Probable date of commencement of the project: April, 2015
b) Duration of the project: 2 years
c) Stages of work and milestone:

Year 2015-16

Sl. No.	Work Element	First Qr	Second Qr	Third Qr	Fourth Qr
1	Literature collection	✓	✓		
2	Field work for water sampling and data collection	✓		✓	
3	Sample analysis		✓	✓	
4	Data interpretation, interim report, publications				✓
5	Training programme/workshop				✓

Year 2016-17

Sl. No.	Work Element	First Qr	Second Qr	Third Qr	Fourth Qr
2	Field work for water sampling and data collection	✓	✓	✓	
3	Sample analysis	✓	✓	✓	✓
4	Data interpretation, Final report, publications	✓	✓	✓	✓

6. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/3

Thrust Area under XII five year Plan:

Himalayan ecosystem

Project team:

a. Project Investigator: Dr. M. S. Rao
b. Project Co-Investigator(s): Dr Sudhir Kumar
Technical Collaboration: Prof. A. L. Ramanathan, JNU

Title of the Project:

Isotopic investigation of benchmark Himalayan glaciers

Objectives

The objectives of the project are:

(i) Generating the isotope data base on snow & glaciers of benchmark Himalayan glaciers distributed between Uttarakhand to Ladakh

(ii) Assessment of spatial variability in isotopic & chemical characteristic of glacial environment

(iii) Use of isotope technique to understand the accumulation and ablation processes of (Himalayan) glaciers

Present state-of-art

Himalayan glaciers are the major sources of fresh water for the livelihood of population of northern India and it exerts strong influence over the river flow of several major rivers like River Ganga, River Yamuna, River Indus, River Brahamaputra and their tributaries by storing and releasing water in accordance with the climate of this region. Climate change (e.g. temperature and precipitation) results into advancement/ recession, of these glaciers. Therefore, the glaciers are considered to be as a sensitive indicators of climate change. Globally, climate change has been projected to cause major changes in glacier, snow and their melt contribution to streamflow.

Stable isotopic composition of precipitation reflects the integrated effect of source of origin of air-moisture and the local weather conditions during the precipitation. During accumulation period, isotopic variations resulted from changing weather pattern get locked in the glaciers and the locked information may be retrieved by raising and analyzing the glacial cores for isotopic details. The isotopic composition of precipitation, in general, also depletes with increasing altitude of precipitation ('altitude effect'). The information of precipitation at different altitude can be investigated by investigating and analyzing snow or surface ice along altitude gradient. During ablation, snow and ice melting contributes to stream discharge. A continuous melting of snow/ice may result into progressive enrichment in isotopic composition of snow/glacial melt and therefore, evaporation and melting can be investigated by isotopic details of snow melt discharge. However, process such as integrated discharge from snow melt from multiple altitudes, percolation of snow melt, ice erosion etc can complicate the data interpretation. Thus, isotopic analysis of snow, ice, glacial core and their melt may provide useful information on accumulation, ablation and climate change. Chemical analysis of glacial & snow melt components may further be used in resolving englacial and subglacial components and thereby hydrograph separation. Tritium dating of glacial core and meltwater can further provide immense information on origin of melting

water as from modern snow or old ice.

A major problem in most of the conventional studies comes from the fact that these are based on the glacial data which is non-continuous for discharge data, sediment data or precipitation data (including snow). Therefore, interpretation on glacial advance, retreat, mass balance, correlation with river discharge data etc., derived using the non-continuous data has limited scope for modelling or for future prediction. In-fact, in several glaciers of Himalaya, glacier mass balance has been found to show an inverse-relation with the monsoon precipitation which is an intriguing factor.

From the existing literature it can be seen that there are very few studies conducted in Himalayan glaciers on combined stable isotope, environmental tritium & chemical aspects of glacial layers. A study based on multi-parameter approach provides immense information to characterize the glacier and its vulnerability to climate change and its implication to water resources for future prediction. The present project is intended to provide a first-hand data on stable isotope, chemical and environmental tritium data on Himalayan glaciers and its interpretation to glacial ablation and accumulation due to climate variability.

Methodology

A detailed literature survey will be conducted to get the details on glacial cover extent, its temporal variation, hydrometerological details of the area, snow melt and river data etc Study area map will be prepared using survey of India toposheet and remote sensing data. Snow, rain, air-moisture and river discharge samples will be collected from sites wherever possible. Ice core will be raised from multiple locations. The collected samples will be analyzed for stable isotopic composition, tritium dating and chemical quality details. Air temperature and humidity recorders will be installed at suitable places or the data will be collected from the nearby stations. The isotope details will be transformed into air-temperature by comparing with the instrumental meteorological data. Snow density and tritium data will be used to estimate annual snow accumulation rate. Radon survey will be done at suitable sites. In the project, JNU will support in getting snow, glacier core and melt water samples, and in getting the hydrometerological data. The collected samples will be analyzed for water chemistry and isotopic details in NIH Roorkee. Wherever possible, NIH will install air-moisture sampling units to get the dynamic changes in isotopic composition of atmospheric vapour. The knowledge dissemination will be done jointly with JNU.

Research outcome from the project

The present project will provide first ever use of combined techniques: tritium, stable isotope, radon and chemical data in survey of some of the important glaciers of Himalaya. Further, as stated in the literature survey, the only stable isotope measurements made on Uttarakhand glaciers (core samples) is that by PRL group (Nijampurkar et al., 1984). Stable isotope variability over 3 decades since the study by PRL will provide changes if anything occurred since then.

The present project is also important in the sense that it is purely field based study in the area where there is a big paucity data. The survey that will be conducted will provide a base for developing several new projects in the Himalayan region in the future.

The results will be disseminated through publications in journals and conferences and through trainings.

Cost estimate:

a) Total cost of the project : Rs. 29,34,000/-

b) Source of funding : Internal

c) Sub Headwise abstract of the cost

Sl.No.	Sub-head	Amount (in Rupees)		
		2015-2016	2016-2017	Total
1.	Salary	2,10,000	2,24,000	4,34,000
2.	Travelling expenditure	2,00,000	2,00,000	4,00,000
3.	Infrastructure/Equipment	1,20,000	1,20,000	2,40,000
4.	Experimental charges	6,80,000	8,00,000	14,80,000
5.	Misc. expenditure	90,000	2,90,000	3,80,000
	Grand Total:	13,00,000	16,34,000	29,34,000

d) Justification for Sub-head-wise abstract of the cost

Junior Resource Person: The Junior Resource person will help PI in field work, in the tritium, stable isotope and chemical analysis of samples in the NIH laboratory, in data analysis, interpretation, publications and general support in knowledge dissemination.

Travel Expenses: The travel expense include expenses for regular visits to field, visits to various offices for literature survey, data collection & meetings and for conferences etc

Infrastructure/Equipment: Expenses towards field based instruments like ORG, EC, pH, Rh, EH, ORP meters, etc.

Experimental charges: Analytical cost of samples for stable isotope, tritium dating, radon survey, chemical analysis and sampling bottles & consumables is approx Rs. 13.0 lakhs (total sample analysis cost: 1000 samples x Rs. 1300 per sample = 13,00,000), general purpose support of semiskilled/unskilled manpower in field and assistance in laboratory (Rs. 300 x 300 days = Rs. 90,000/-) and stationary (pen drive, papers, cartridge) cost for two years (this is estimated to about Rs. 1.0 lakh).

Miscellaneous expenditure; This expenditure will be utilized for deployment of field staff for regular collection of water, snow samples on weekly basis or rainfall samples on event basis etc., security charges, civil work and other expenses for items to be installed in field, contingencies for organizing meetings and trainings (Rs. 200,000/- included for this in the last quarter of the project), for purchase of high altitude clothing etc..

Quarterly Break up of cost estimate for each year

April 2015- March 2016

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1.	**Salary:** Junior Resource Person	42,000	56,000	56,000	56,000
2.	Travelling expenditure	80,000	20,000	80,000	20,000
3.	Infrastructure/Equipment	30,000	30,000	30,000	30,000
4.	Experimental charges	80,000	200,000	200,000	200,000
5.	Misc. expenditure	20,000	20,000	20,000	30,000
	Sub- Total:	2,52,000	326,000	3,86,000	3,36,000
	Grand Total	13,00,000			

April 2016- March 2017

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1.	**Salary :** Junior Resource Person	56,000	56,000	56,000	56,000
2.	Travelling expenditure	80,000	20,000	80,000	20,000
3.	Infrastructure/Equipment	30,000	30,000	30,000	30,000
4.	Experimental charges	300,000	200,000	200,000	100,000
5.	Misc. expenditure	20,000	20,000	20,000	230,000
	Sub- Total:	4,86,000	3,26,000	3,86,000	436,,000
	Grand Total	16,34,000			

Work Schedule:

a. Probable date of commencement of the project : April 2015
b. Duration of the project : 2 years
c. Stages of work and milestone:

Year 2015-16

Sl. No.	Work Element	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	Literature collection & data survey	✓	✓		
	Purchase of equipments and items for study, hiring of project staff etc	✓	✓		
2	Field work for water sampling, installation of equipment (precipitation, air-moisture, snow & snow melt, river water, groundwater and spring water etc)		✓	✓	✓
3	Sample analysis		✓	✓	✓
4	Data interpretation, interim report, publications				✓

Year 2016-17

Sl. No.	Work Element	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	Field work for water sampling	✓	✓		
2	Sample analysis	✓	✓	✓	
3	Data interpretation, publications	✓	✓	✓	
4	Training programme/workshop, Final report				

7. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/3

Thrust Area under XII five year Plan

Water Quality and Health

Project team:

a. Project Investigator: Sh. P.K. Garg, Sc. 'B'
b. Project Co-Investigator(s): Dr. Sudhir Kumar, Sc. 'G', Dr. M.S. Rao, Sc. 'D'

Title of the Project:

Assessment of dissolved radon concentration for groundwater investigations in Haridwar district

Objectives:

(i) Mapping the spatial distribution and temporal fluctuation in radon levels in groundwater in Haridwar district

(ii) To investigate the effect of seasonal groundwater levels fluctuations on radon levels.

Present state-of-art

Radon in groundwater originates due to decay of parent radioactive member radon-226 which is derived from the decay of the ultimate parent source uranium-238. The uranium-238 is present in groundwater as uranyl complex or is present in the host aquifer matrix as radioactive contaminant. Solubility of parent members of radon (radium and uranium) in groundwater depends upon geochemical conditions and temperature of groundwater. Radon-222 concentration in groundwater is a function of radioactivity concentration of radium (and hence uranium) in aquifer matrix, aquifer porosity (dry pores may lead to escape of radon) and physico-chemical condition of groundwater. During rainfall recharge, moisture filled pores in the vadose zone may slow down the escape rate of radon and also rise in groundwater levels due to rainfall induced groundwater recharge may dilute the radon levels in the groundwater. Thus, radon concentration in groundwater at a given location depends on the local hydrogeology, groundwater fluctuation and soil moisture conditions. Thus, a temporal variation in dissolved radon concentration in groundwater may provide a new way to look into the aquifer system and recharge conditions. Due to the short half-life of radium & radon isotopes compared to timescales at which groundwater levels and soil moisture fluctuation take place; the variation of these hydrological parameters may get recorded in the radon signals.

Methodology

In order to study the radon contamination in the study area at different locations, groundwater samples from shallow as well as deeper aquifers for pre and post monsoon seasons will be collected for in-situ radon measurement for studying the spatial and temporal variation of radon concentration. The hydro-geological data will also be collected for the study area in order to study the hydro-geological features to be linked with the radon concentration in pre and post monsoon season groundwater samples.

Research outcome from the project

Spatial and temporal distribution of radon groundwater in Haridwar area

Cost estimate:

a. Total cost of the project: Rs. 2,25, 000
b. Source of funding: Internal
c. Sub Headwise abstract of the cost

Sl.No.	Sub-head	Amount (in Rupees)
1.	Salary	-
2.	Travelling expenditure	70,000
3.	Infrastructure/Equipment	25,000
4.	Experimental charges	25,000
5.	Misc. expenditure	30,000
	Grand Total:	Rs. 1,50,000

d. Justification for Sub-head-wise abstract of the cost

Travel (Rs. 70,000/-): The fund is required for travelling to the study area for survey for selecting sites, sample collection for pre-monsoon and post monsoon seasons

Experimental Charges: An amount of Rs.25,000/- is required for procurement chemicals and glassware for analysis of water samples.

Miscellaneous expenditure (Rs. 30,000/-): The fund is required for hiring of daily wages worker and other contingencies etc.

Infrastructure/Equipment: Rs. 25,000/- required for procurement of small field equipment like pH meter, EC meter and temperature probes etc.

Quarterly Break up of cost estimate for each year

Year 2015:

Sl. No.	Sub-head	Amount (in Rupees)				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1.	Salary					
2.	Travelling expenditure	20,000	20,000	20,000	10,000	70,000
3.	Infrastructure/Equipment	10,000	10,000	5,000	-	25,000
4.	Experimental charges	10,000	5,000	5,000	5,000	25,000
5.	Misc. expenditure	10,000	5,000	-	15,000	30,000
	Sub- Total:	50,000	40,000	30,000	30,000	
	Grand Total	1,50,000				

Work Schedule:

a. Date of commencement of the project: April, 2015
b. Duration of the project: 1 year
c. Stages of work and milestone:

Sl.	Work Element	First Qr	Second Qr	Third Qr	Fourth Qr

No.					
1	Review of literature	√	√		
2	Site selection	√			
3	Collection and compilation of data		√		
4	Field work, sample collection and analysis of water samples	√	√	√	
5	Data interpretation		√	√	
6	**Project report & publications**			√	

SPONSORED PROJECTS

8. PROJECT REFERENCE CODE: NIH/HID/MOES/2012-15

Title of the Study : **The Structure and Dynamics of Groundwater Systems in Northwestern India under Past, Present and Future Climates**

Study Team : S. P. Rai (PI), S. K. Verma, S. Khobragade, Surjeet Singh, Sudhir Kumar, V. K. Agarwal, Rajeev Gupta, S. L. Srivastava, Vishal Gupta, Mohar Singh

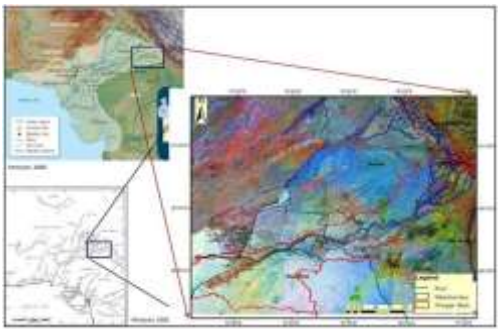
Funding Agency : MoES, Government of India

Budget : Rs. 210 Lakh (NIH component Rs. 35 lacs)

Date of Start : June 2012

Date of Completion : May 2015 (extend to March 2016 by MOES, Govt. of India)

Study Area



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.

Land use: Agriculture dominated

Major problem of the area is declining of groundwater levels at a very fast rate, but at few places groundwater level is raising also.

Study Objectives

1. Isotopic characterization ($\delta^{18}O$ and $\delta^{2}H$) of groundwater, stream and rain water
2. Groundwater dating using Tritium and Carbon-14
3. Delineation of flow direction and recharge zones
4. Identification of recharge source and zones of groundwater in the study area

Statement of the Problem

India is 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 has become under the vulnerable condition and a hotspot for groundwater management. The groundwater depletion rates in the states of northwestern India are reported highest in the world. This unmanaged use of groundwater becomes more challenging due to increasing demands from population and industrial developments under the climate change scenario. There is a major task to replenish the

groundwater depletion through rainfall recharge. Therefore, this study is proposed to study groundwater dynamics in the region.

Action Plan

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th
Selection of study area	♦															
Literature survey	♦	♦	♦	♦	♦											
Collection of previous years data	♦	♦	♦	♦	♦											
Identification of data gaps	♦	♦	♦													
Selection of sites for stable isotope (δ^2H and $\delta^{18}O$) analysis	♦	♦	♦													
Selection of sites for radio-isotope (^3H and ^{14}C) analysis	♦	♦	♦													
Site selection and installation of raingauges	♦	♦	♦													
Measurement of δ^2H and $\delta^{18}O$ of rain, river and groundwater		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦			
Sample collection and Measurement of ^3H activity of groundwater, rain and river		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		
Sample collection and measurement of ^{14}C activity of groundwater										♦	♦	♦	♦	♦	♦	
Preparation of geological and hydrogeological maps				♦	♦	♦	♦	♦								
Preparation of water table and flow direction map		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦			
Interpretation of isotopic data					♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		
Estimation of natural recharge to groundwater												♦	♦	♦	♦	
Impact of climate change on groundwater										♦	♦	♦	♦	♦	♦	
Identification of recharge zones									♦	♦	♦	♦	♦	♦	♦	
First Draft Report				♦												
Second Draft Report										♦						
Final Report																♦

Objectives vis-à-vis Achievements

Objectives	Achievements
Isotopic characterization ($\delta^{18}O$ and δ^2H) of groundwater, stream and rain water	Pre-monsoon & post-monsoon samples of groundwater, river and canal have been collected and laboratory analysis completed.
Groundwater dating using tritium and Carbon-14	To date the groundwater, enrichment of about 40 samples has been completed and further analysis of

	40 samples is in progress. For carbon dating, a proposal was submitted at NERC, UK for funding, NERC has been agreed to support for carbon-14 dating of 25 groundwater samples.
Delineation of flow direction and recharge zones	Water level data and tritium data are used to delineate the flow direction and recharge zones of groundwater.
Identification of recharge source and zones of groundwater in the study area.	$\delta^{18}O$, $\delta^{2}H$ and tritium data of groundwater and other sources have been analysed and source identification of the groundwater is in progress

Analysis and Results:

Variation of Groundwater Level Data

Groundwater level data of last 30 years of Ghaghar basin were analysed to study the groundwater fluctuation. Water level data show dramatic decline in groundwater level by 12-18 meters during this period. The initial trend between 1974 and 1998 is much gentler compared to a steep decline between 1998 and 2010 as observed on time series plots. Southwest part of the study area show rise in groundwater level varying from 10-18 meters during this period.

Isotopic Composition of Rainfall, River and Canal Water

The stable isotope data of precipitation of study area and surrounding are used to characterize the isotopic composition of precipitation. The $\delta^{18}O$ varies from -19.4‰ (minimum) to 9.8‰ (maximum) and $\delta^{2}H$ from -150.1‰ (minimum) to 59.1‰ (maximum). The local meteoric water line is

$\delta^{2}H = 7.9 * \delta^{18}O + 5.4$, $r^2 = 0.98$, n = 148

Ghaggar river samples have been collected from its origin near to Nahan in Himachal Pradesh to downstream upto Siras in Haryana. The $\delta^{18}O$ of river varies from -7.3‰ to -5.3‰ and $\delta^{2}H$ vary between -50.6‰ to -43.8‰. The $\delta^{18}O$ in origin area (between Nahan to Panchkula) varies between -7.3‰ and -6.7‰ for $\delta^{18}O$ and between -50.6‰ and -46.4‰ for $\delta^{2}H$. Near Patiala and Sirsa isotopic composition of river is found -6.1‰ and -5.3‰ for $\delta^{18}O$ and -49.8‰ to -43.8‰ for $\delta^{2}H$ respectively. The canal water samples were collected from various sites in the catchment. The isotopic variation of canal water are found between -12.1‰ and -11.5‰ for $\delta^{18}O$ and -80.9‰ and -74.9‰ for $\delta^{2}H$. The isotopic composition of canal water is depleted in comparison to Ghaggar River and local precipitation. Since, the source of canal water is Bhakara dam, which is on Satluj River.

The spatial variation of $\delta^{18}O$ values of groundwater of shallow depth show that $\delta^{18}O$ varying between -4‰ and -12‰. The enriched $\delta^{18}O$ values are found in the upper part of the catchment while depleted values in the middle and lower part of the catchment. The depleted isotopic signature of groundwater in the middle and lower part indicates recharge to groundwater from canal water. The environmental tritium activity has been measured for groundwater at different locations and it is found to vary between 0.3 TU and 8 TU. The tritium value of groundwater samples collected from shallow depths near Chandigarh and

Rajpura area are varying from 5.2 TU to 6.1 TU and near Patiala and Samana it is about 4.2 TU.

The electrical conductivity (EC) of Ghaghar river and canal water is found in the range of 400 μS/cm to 450 μS/cm and 200 μS/cm to 220 μS/cm, respectively. The canal and river water samples show low salt values than the desirable value of Indian & WHO Standards (782 μS/cm). EC of groundwater ranges between 230 μS/cm and 10500 μS/cm in shallow aquifer, 260 μS/cm to 3900 μS/cm in middle aquifer and 420 μS/cm to 9500 μS/cm in deep aquifer, respectively. In shallow aquifer, EC ranges 250 μS/cm to 2000 μS/cm in upper reaches of study area, 500 μS/cm to 1000 μS/cm in middle part of study area and 1000 μS/cm to 10500 μS/cm in lower part of study area. The southern part of the basin is more saline. This is reason that groundwater level is raising upwards in southern part of the study area.

There is marked variation in isotopic and chemical composition of groundwater which indicates complex system of recharge.

Future Plan

- Pre-monsoon sampling of groundwater for stable and radio isotope measurements
- Estimation of volume of water withdrawn due to pumping
- Preparation of canal map of the study area
- Sampling for stable isotope for estimation of canal recharge to groundwater

9. PROJECT REFERENCE CODE: NIH/HID/IAEA-2/2012-15

Title of the Study : **Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques**

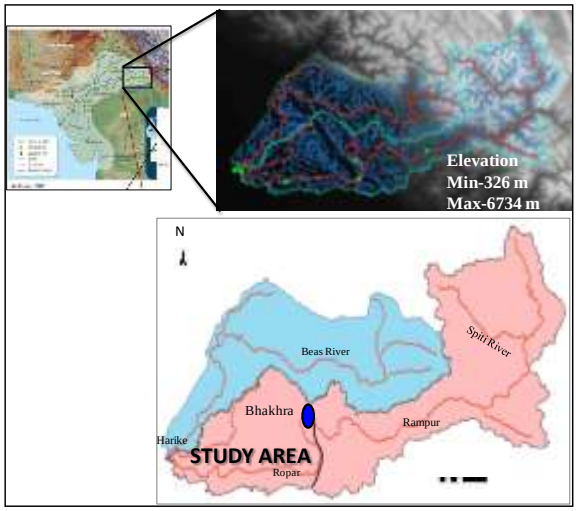
Study Team **:** S. P. Rai (PI), R. V. Kale, M. S. Rao, C. P. Kumar, Sudhir Kumar, V. K. Agarwal, Vishal Gupta, Mohar Singh

Funding Agency : IAEA, Vienna

Budget : 15000 Euro per year

Duration : Three years (October 2012 to September 2015)

Study Area



The study area falls in the Punjab state of India. Groundwater levels in Punjab have reached to most critical condition. As per report of Central Ground Water Board, Government of India (2009), 80% area of Punjab state falls under over-exploited zone. With onset of Green Revolution during 1960s, the state rapidly adopted the green revolution technology and resulted in increased demand for irrigation water. The requirement of irrigation was met through development of irrigation canal network and development of tube wells. Between 1960 and 1999, the food grain production of Punjab increased from 3.16 to 22.22 million tones. During this period, number of tube wells increased from 0.60 million to 1.1 million, leading to over-exploitation of groundwater in most parts of the state. The concentrated pumping has affected the natural groundwater conditions and flow regime.

Study Objectives

1. To develop thematic maps based on isotope and related information relevant to the evaluation and assessment of the quality of surface water
2. Comparative study of recession characteristics of Satluj River with conceptual and isotopic model
3. To assess the potential and limitations of the tracer techniques for routine application in hydrological studies

Statement of the Problem

The importance of Satluj river in Indian context is better understood from the fact that it continues to play a major role in the socio-economic development of north-western part of the country. The dependency of the states of Himachal Pradesh, Punjab, Haryana and

Rajasthan on the resources of Satluj river for the sustenance and growth of agricultural and hydroelectric power sector is ever growing. In addition to several micro and mini projects, several mega projects are under way, particularly in the upper part of Satluj Basin. The runoff of Satluj river receives major contribution from snow/glacier, rainfall-runoff and groundwater/baseflow. The assessment of rainfall derived runoff and snow and glacier melt runoff have been carried out. However, contribution of the baseflow to river flow was overlooked and no major attempt has been made to assess the impact of baseflow contribution on discharge and quality of the river. Therefore, this study will be a first approach to understand the groundwater and river interaction in this part of the Satluj catchment.

Action Plan

Activity Schedule (Quarterwise: 2012-13, 2013-2014 and 2014-2015)

Activity	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**	**11th**	**12th**
Selection of study area			♦									
Literature survey			♦	♦	♦							
Collection of previous years' data				♦	♦							
Identification of data gaps				♦								
Selection of sites for stable isotope (δ^2H and $\delta^{18}O$) analysis					♦	♦	♦	♦				
Selection of sites for radio- isotope (^3H and ^{14}C) analysis			♦	♦	♦	♦	♦	♦	♦	♦		
Site selection and installation of raingauges			♦	♦	♦	♦						
Measurement of δ^2H and $\delta^{18}O$ of rain, river and groundwater				♦	♦	♦	♦	♦	♦	♦		
Measurement of ^3H and ^{14}C activity of groundwater, rain & river				♦	♦	♦	♦	♦	♦	♦		
Preparation of geological & hydro geological maps of the study area				♦	♦	♦	♦	♦				
Preparation of water table and flow direction map				♦	♦	♦						
Interpretation of isotopic data					♦	♦	♦	♦	♦	♦	♦	
Application of conceptual model					♦	♦	♦	♦	♦	♦	♦	
Report Finalisation											♦	♦

Objectives vis-à-vis Achievements

Objectives	**Achievements**
To develop thematic maps based on isotope and related information relevant to the evaluation and assessment of the quality of surface water	Following tasks have been completed 1. Isotopic characterization ($d^{18}O$ and d^2H) of groundwater, stream and rain water 2. Groundwater dating using tritium 3. Delineation of flow direction and recharge zones using water level and tritium data

Comparative study of recession characteristics of Satluj River with conceptual and isotopic model	Isotopic technique has been used to separate out different component of hydrograph Modelling approach has been attempted to separate out the baseflow component of stream discharge Comparison of both study is under progress
To assess the potential and limitations of the tracer techniques for routine application in hydrological studies	Assessment of potential of tracer techniques are under progress

Analysis and Results

Isotopic Composition of Precipitation

The isotopic composition of precipitation in study are varies from -19.4‰ to 9.8‰ for $\delta^{18}O$ and -150.1‰ to 59.1‰ for $\delta^{2}H$. The $\delta^{18}O$- $\delta^{2}H$ bi plot of precipitation in the study area shows similarity with GMWL (Rozanski *et al.* 1993) and Indian Meteoric Water Line for the north region (IMWL- North) (Kumar *et al.* 2010). The slightly lower intercept may be due to local climate.

LMWL: $\delta^{2}H = 7.9 \times \delta^{18}O + 5.4$; $R^2 = 0.97$, n = 119 (eq. 1)

IMWL- North: $\delta^{2}H = 8.15 \times \delta^{18}O + 9.55$; $R^2 = 0.99$ (eq. 2)

GMWL: $\delta^{2}H = 8.17 \times \delta^{18}O + 11.27$; $R^2 = 0.99$ (eq. 3)

Isotopic Composition of River

The $\delta^{18}O$ of Rivers Satluj varies between -12.7‰ to -6.8‰ and $\delta^{2}H$ from -87.9‰ to -48.5‰. The isotopic composition of river gets enriched as water move from Ropar to Harike (downstream). The depleted isotopic composition of Satluj River at Ropar is due to major contribution from the higher Himalayas. As river move downstream, enrichment of $\delta^{18}O$ of river water is observed which may be due to the contribution from groundwater. The regression lines derived for the river water is given below:

$\delta^{2}H = 6.7 \times \delta^{18}O - 3.2$; $R^2 = 0.99$, n = 98 (eq. 4)

Isotopic Composition of Groundwater

The groundwater samples were collected from existing dug well, hand pump and tube wells. The depth of dug well, handpumps and tube wells represents to different depth of water level. The depth of open well, dugwell, hand-pumps and tubewells were collected from the sampling sites. The overall depth data indicate that handpumps are bored up to depth of 80 m and tubwells below the 80 m depth.

Open well and Handpump = <80 m
Tubewell of private farmers and Government = > 100 m

The oxygen isotope ratio ($\delta^{18}O$) of groundwater up to depth of 80 m varied from -12.4‰ (minimum) to -4.7‰ (maximum) and hydrogen isotopic ratio ($\delta^{2}H$) from -85.1‰ (minimum) to -32.4‰ (maximum). The $\delta^{18}O$ of groundwater below the depth of 100 m varied from -11.3‰ (minimum) to -5.4‰ (maximum) and $\delta^{2}H$ -81.6‰ (minimum) to -35.2‰ (maximum).

The $\delta^{18}O$ and $\delta^{2}H$ relationship for groundwater collected upto depth zone of <80 m and >100 m depth has been developed. The regression analysis between $\delta^{18}O$ and $\delta^{2}H$ of the data of different depth gives the best fit line (BFL) as:

$\delta^{2}H = 6.7 * \delta^{18}O - 1.5$ (n = 96, r^2 = 0.98) (< 80 m) (eq. 5)
$\delta^{2}H = 7.6 * \delta^{18}O + 4.9$ (n = 76, r^2 = 0.92) (>100 m) (eq. 6)

Generally, shallow groundwater show enriched $\delta^{18}O$ and $\delta^{2}H$ values in the study area. However at few locations depleted value (more than -9‰) are also found due to possible recharge through river/canal. The deep aquifer shows almost similar isotopic composition throughout the study area which resembles the isotopic composition of precipitation.

In the present study, baseflow separation has been carried out using following non-tracer based methods, (i) Local Minimum Method, (ii) One Parameter Digital Filter, (iii) Eckhardt Digital, and (iv) Modified Eckhardt Digital Filter

The results of baseflow separation hydrograph obtained using filter methods are shown in Figure along with observed discharge hydrograph.

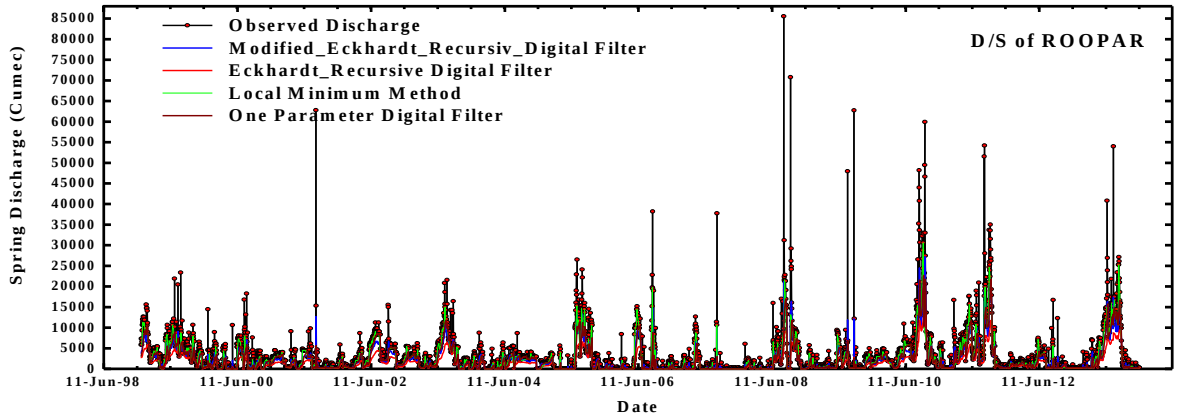


Figure: Estimated vs observed discharge by various separation methods.

The partitioning of stream flow has been carried out using the isotopic modeling techniques. The results as well as their analysis will be presented in more details during WG meeting.

Future Plan

Hydrochemical characteristics of groundwater and river
Identification of groundwater discharge and recharge zones to Satluj river.

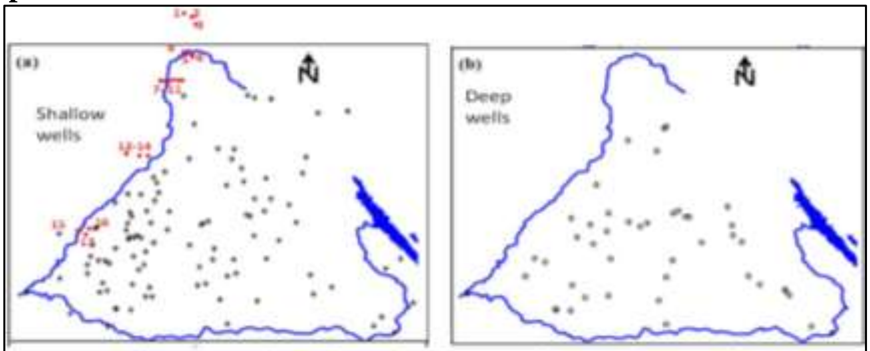
10. PROJECT REFERENCE CODE: NIH/HID/IAEA-1/2012-15

Title of the Study	:	**The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India**
Study Team	:	M. S. Rao (PI), C. P. Kumar and S. P. Rai
Funding Agency	:	IAEA, Vienna
Budget	:	Euros 15,000
Date of Start	:	September 2012
Date of Completion	:	August 2015

Study Objectives

1. Assessment of depleting groundwater conditions in north-eastern parts of Punjab.
2. Identifying the regions where groundwater use has caused changes in chemical, stable isotopic composition and age of groundwater.
3. Identifying the areas where deep aquifers are getting modern recharge through their shallow aquifers.
4. Groundwater recharge/return-flow to the Beas River and Satluj River due to river waterand groundwater interaction.
5. Assessment of artificial recharge measures.

Location Map



Locations	Dhaki	Tangu	Dam-tal	Kath-garh	Mir-thal	Beas near Mirthal	Jagatpur Kalan	Naushera pattan	Kalaut Harsha Leachpur
Loc. No.	1	2	3	4	5	6	7	8	9

Locations	Bahadur pur	Mushaib pur	Ghuman	Machera rai	Hargovind-pur	Fatte-dinga	Amritpur	Mundi Mode
Loc. No.	10	11	12	13	14	15	16	17

Statement of the Problem

As per report of CGWB, 80% area of Punjab falls under over-exploited zone. The concentrated pumping has affected the natural groundwater conditions and flow regime. The falling water table has brought the agricultural productivity and economic conditions of the state to a plateau. Recent isotopic hydrological investigations have provided some clues on recharge conditions of groundwater diminishing zone in Bist doab. However, most of the isotope data in the earlier study was based on top aquifer and few data from a second aquifer, while the wells getting developed for irrigation and drinking needs have been entering into the deeper aquifers. The doab region is underlain by hundreds of meters of thick alluvium.

However, detailed study of groundwater age of deeper aquifer is yet to be mapped using ^{14}C dating. The present study is intended to assess the mid and long term sustainability of groundwater resources, especially in aquifers that have been providing large quantities of water over last few decades. The study region is an extended part of Bist doab region where groundwater is getting over-exploited.

Action Plan

After carefully examining the overall progress report for the period ending in November 2014, IAEA has assigned the following work programme for the remaining period of the project (to be completed before 9th December 2015):

1. Collection of rainwater, groundwater and surface water samples and there analysis for stable isotope, radiometric dating and water quality
2. Data interpretation in terms of recharge characteristic, dynamics of aquifer system and use towards sustainability of aquifers
3. Evaluation of changes in water quality and quantity aspects due to extensive exploitation and identifying the parameters (isotopic, chemical and hydrological) that can be used as indicators for the intensive exploitation for the study area
4. Providing remedial cost effective & environmentally suitable strategies along with a conceptual groundwater model for improving the current groundwater situation.
5. Publications of papers
6. Submission of final report to IAEA as per IAEA's TECDOC format

Work Progress from December 2014 onwards:

During the progress period, as per the objectives assigned by the IAEA, water samples (rainfall, groundwater, river water samples) that were collected in the last quarter of the year 2014 are being analyzed for chemical constituents, tritium dating and stable isotope analysis. A field work is proposed in the month of March for collecting fresh set of water samples from the study region. During the progress period, water level data from 520 villages for the period 1998 to 2011 in the Bist Doab region has been collected. After carefully scrutinizing the data, the data of 520 villages falling in 36 blocks of 5 districts have been separated for trend analysis. Further work is in progress.

Future Plan

- As per the assigned tasks, water samples from the study area will be collected till July 2015.
- The data generated from the analysis of the samples over the 3 years project period will be processed to examine variation in various parameters in response to the over exploitation and from the results indicator for intensive exploitation will be identified.
- Using groundwater age, regions where groundwater surface water interactions is taking place and from the identified effective recharge sources cost effective and environmentally suitable strategies to improve the current groundwater situation will be suggested. A conceptual groundwater model will be provided to explain the observed facts.
- Final report will be submitted and efforts will be put to publish papers in high impact journals.

11. PROJECT REFERENCE CODE: NIH/HID/IAEA-3/2013-15

Title of the Study	**:**	**Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains**
Study Team	**:**	Sudhir Kumar (PI), S. P. Rai, Suhas Khobragade, C. K. Jain, P. K. Garg
Funding Agency	:	IAEA, Vienna
Budget	:	28,500 Euro
Duration	**:**	May 2013 to April, 2015
Location Map	**:**	

Study Objectives: Objectives of the study are

i. To identify the various aquifers present in alluvial tract of the Upper Yamuna Plains.
ii. To identify the source of recharge of different aquifers, and the interaction between various aquifers.
iii. To investigate the continuity of aquifers on both the sides of the river Yamuna,
iv. To determine the groundwater dynamics in different identified aquifers, and
v. To estimate the groundwater velocity and replenishment potential of the deeper aquifers.

Statement of the Problem:

Central Ground Water Board, Government of India has started a program for mapping the aquifers in India. This programme is designed to make a significant step forward in groundwater resource management by identifying and mapping aquifers, quantifying the available groundwater resources potential and proposing plans appropriate to the scale of demand, aquifer characteristics and the institutional arrangements for management. This work will be systematically implemented in the country, by involving organisations / institutions across India.

Alluvial aquifers are primarily composed of thick unconsolidated Quaternary deposits made up of alternating sequences of sand, silt and clay in various proportions. The major part of water demand in these areas is catered from groundwater which is by and large copiously available because of potential nature of aquifers as well as adequate recharge from rainfall. Western part of the Upper Yamuna Plains has a good irrigation canal network of Western Yamuna Canal, which originates from Hathnikund Barrage in Yamunanagar District of Haryana. The unconfined aquifers in the study area are expected to be recharged by the

seepage from canal network and irrigation return flow apart from the rainfall, which is the major source of recharge. The canal water originates at higher altitudes in the Himalayas has different isotopic composition ($\delta^{18}O$ and δD) as compared to the groundwater locally generated in the Upper Yamuna Plains.

Deeper aquifers in the area are supposed to be recharged from the Bhabhar zone, the coarse material deposited as alluvial fans on the margin of Himalayas. Groundwater velocity in the deeper aquifers is expected to be very slow, thus groundwater dating (^{14}C) should give an idea about the groundwater flow direction as well as groundwater velocity in the deeper Aquifers. If there is vertical recharge through the semi-confining layers, the same should be easily detected by Tritium dating.

Thus, isotope based investigations can help understanding the surface water and groundwater interactions, aquifer-aquifer interactions, groundwater dynamics and identification of recharge sources and recharge areas of deeper aquifers for taking better management strategies**.**

Action Plan: The action plan is given below:

Activity	May, 2013 – April,2014				May, 2014 – April,2015			
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Collection of available literature and data from CGWB and State Groundwater Departments	*							
Identification of wells for groundwater sampling	*							
Construction of Aquifer Geometry based on available Data / Information		*						
Collection of groundwater and River /Canal/Rainfall samples for Chemical and Stable isotope analysis		*	*		*			
Chemical and stable Isotopic Analysis of samples		*	*		*	*		
Tritium samples analysis and Dating		*	*	*	*	*		
Collection of Samples for ^{3}H-He dating					*			
^{3}H-He sample analysis at IAEA					*	*		
Collection of Samples for ^{14}C dating		*	*		*			
^{14}C samples analysis at IAEA designated laboratory			*	*	*	*		
Interpretation of Data			*	*	*	*	*	
Interim Report and Discussion of Results during the meeting to be hosted by IAEA				*				
Workshop				*			*	
Final draft report and discussion on outcome during the meeting to be hosted by IAEA + final report submission								*

Objectives vis-à-vis Achievements:

S. No.	Objective	Achievement
1	To identify the various aquifers present in alluvial tract of the Upper Yamuna Plains.	The aquifers have been identified
2	To identify the source of recharge of different aquifers, and the interaction between various aquifers.	Partially achieved

3	To investigate the continuity of aquifers on both the sides of the river Yamuna,	Not yet established
4	To determine the groundwater dynamics in different identified aquifers, and	Partially achieved
5	To estimate the groundwater velocity and replenishment potential of the deeper aquifers.	Not yet established

Present Status

1. Most of the data available with CGWB has been collected.
2. Groundwater sampling from 21 wells ranging in depth from 100-420 m have been collected from UP side. 28 samples from shallow wells tapping the I^{st} aquifer have also been collected.
3. Analysis of groundwater and river/canal/rainfall samples for chemical and stable isotope analysis is under progress.
4. Carbon-14 and carbon-13 analysis of 14 samples has been completed
5. Noble gas analysis for 12 samples has been completed
6. Thirty One samples locations from Haryana have been collected which includes 10 locations for III^{rd} aquifer, 6 locations from II^{nd} aquifer and 15 locations from I^{st} aquifer
7. Construction of aquifer geometry based on available data / information has been completed

The results achieved shall be presented during the working group meeting.

Future Plan

1. Collection of remaining samples from Haryana from the identified locations
2. Analysis of samples for stable isotopes
3. Analysis of physico-chemical parameters
4. Dating of deeper groundwater

ITEM NO. 42.5 PROPOSED WORK PROGRAM OF THE DIVISION FOR THE YEAR 2015-16

As per the approved work program of the Hydrological Investigations Division for the FY 2014-15, 5 Internal studied, 4 sponsored projects and 1 consultancy project shall continue during the FY 2015-16. Moreover, it is proposed to start four new studies (2 internal, 1 sponsored, and 1 consultancy Project) w.e.f 01.04.2015.The proposed work program of the division during FY 2015-16 is given at Annexure-II.

Type of study/Project	*Continuing in Studies*	*New studies proposed*	*Total*
Internal Studies	5	2	7
Sponsored Projects	4	1	5
Consultancy Projects	1	1	2
Total	10	4	14

The details of the proposed new internal studies and the sponsored projects under taken during the FY 2015-16 is given below:

INTERNAL STUDIES:

PROJECT REFERENCE CODE: NIH/HID/INT/2015-16/1

Thrust Area under XII five year Plan

Hydrology of Lakes and other water bodies

Project team:

(a) Project Investigator: **Dr. Suhas Khobragade**
(b) Project Co-Investigator(s): Dr. Sudhir Kumar, Dr. C. K. Jain
Staff: Sh. V. K. Agrawal, and Sh. Satya Prakash

Title of the Project:

Hydrological Aspects of Rewalsar Lake, Himachal Pradesh (Status Report)

Objectives:

(a) To determine the environmental status of the lake
(b) To identify major problems of the lake
(c) To identify major management issues of the lake
(d) To review current research status and research needs for lake
(e) To review the data availability scenario and identify data gaps vis-a-vis identified research needs

Present state-of-art

The Rewalsar Lake is situated at an altitude of 1400 m, 16 km from the city of Mandi in the state Himachal Pradesh. The shallow lake has the maximum depth of 6.5 m. The lake is significant from religious, cultural and tourism purposes.

Water quality degradation has been reported for the lake. Due to pollution the nature of water has turned acidic (Tribune India, May 11, 2010). The poor sewerage system of Rewalsar

town is further increasing the problem as contaminated water directly flows into the lake (Tribune India, May 11, 2010). According to the news published in the Tribune (May 14, 2014), more than 700 fish died during May 2014 at Rewalsar Lake. The death of fish is a regular feature of the lake but no systematic studies have been reported for the lake. However, a few scattered references on the lake are available. Das and Gaye-Haake (2003) studied the geochemistry of Rewalsar Lake sediment and analysed its implications for source-area weathering. Das and Dhiman (2003) studied the chemical characteristics of the lake. Das and Dhiman (2003) also reported the sediment chemistry of the lake. The state Pollution Control Board analysed the dissolved oxygen level in the lake in 2010 and it was found to be low. No hydrological studies have been reported for the lake so far.

Methodology

The envisaged objectives will be achieved through –

a) Collection, processing and analysis of the available data
b) Review of literature
c) Field survey
d) Interaction with management authorities and local people
e) Collection and laboratory analysis for water sample/sediment samples for water quality and isotopic characteristics

Research outcome from the project

The output of the study would be in the form of a comprehensive report wherein all data, maps, information and analysis would be included. The report would also contain major identified problems of the lake, current research status of the lake, identified data gaps. Major management issues related to the lake would be discussed and possible approaches to deal with them would be suggested.

Cost estimate:

a) Total cost of the project: 3.27 Lakhs
b) Source of funding: NIH Budget
c) Sub Head-wise abstract of the cost

Sl. No.	Sub-head	Amount (in Rupees)
1.	Salary	--
2.	Travelling expenditure	**1,10,000**
3.	Infrastructure/Equipment	**1,25,000**
4.	Experimental charges	**52,000**
5.	Misc. expenditure	**40,000**
	Grand Total:	**3,27,000**

d) Justification for Sub-head-wise abstract of the cost

ii) Travelling expenditure: Rs. 1,10,000

a) Vehicle expenses = Rs. 36000
b) TA/DA = Rs. 74000

iii) Infrastructure/Equipment: 1,25,000/-

a) Minor field equipments = Rs. 1,00,000

b) Data = Rs. 25000

iv) Experimental Expenses: Rs. 52,000

a) *Field expenses*: *Rs. 10,000/-*

b) Boating charges for sampling: @ 1000/- per day for two sampling. = 2000

c) Laboratory expendables: Rs. 40000/-

v) Miscellaneous Expenses: Rs. 60000/-

(a) Stationary: Rs. 10,000

(b) Contingency: Rs. 10,000

(c) Report Printing: Rs. 20,000

Quarterly Break up of cost estimates

Year: 1st (2015-16)

Sl. No.	Sub-head	Amount (in Rupees)				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1.	Salary	--	--	--	--	
2.	Travelling expenditure	49,000	35,750	25,250	--	1,10,000
3.	Infrastructure/Equipment	25,000	50,000	50,000	--	1,25,000
4.	Experimental charges	20,000	20,000	12,000		52,000
5.	Misc. expenditure	5,000	10,000	5,000	20,000	40,000
	Total:	99,000	1,15,750	92,250	20,000	3,27,000

Work Schedule:

a) Probable date of commencement of the project: 1st April, 2015

b) Duration of the project: 1 Year

c) Stages of work and milestone:

Sl. No.	Work Element	First quarter	Second quarter	Third quarter	Fourth quarter
	Literature Review	√	√		√
	Collection and compilation of all available data/information	√			
	Purchase of instruments	√			
	Preparation of study area maps		√		
	Procurement of data	√			
	Collection of water samples for water quality analysis	√	√		
	Collection of sediment samples	√			
	Lab. Analysis of water and sediment samples for Water Quality	√			
	Water quality assessment of the lake		√	√	

	Identification major problems, data gaps and research gaps				√
	Preparation of interim report	√	√		
	Preparation of final report				√

1. *PROJECT REFERENCE CODE: NIH/HID/INT/2015-18/1*

Thrust Area under XII five year Plan

Hydrology of Lakes and other water bodies

Project team:

a. Project Investigator: **Dr. Suhas Khobragade**

b. Project Co-Investigator(s): Dr. Sudhir Kumar, Dr. Senthil Kumar, Sh. P Garg,
Staff: Sh. V. K. Agrawal and Sh. Satya Prakash

Title of the Project

Lake-Groundwater Interaction Studies for Sukhna Lake, Chandigarh

Objectives:

(i) To understand lake-ground water interaction regime of the lake and to identify the zones of lake-water interaction

(ii) To determine seepage losses from the lake

(iii) To determine the relative significance of seepage losses in overall water balance of the lake

Present state-of-art

Although an accurate estimate of groundwater and lake water interaction is very significant and fundamental for reliable applications, not many studies have been reported on this aspect. The interaction between lake water and groundwater may be characterized by high degree of variability, and may be difficult to estimate at times, in view of inability of adequate data. However, in the context of lake water budget, it is crucial to understand and quantify exchange processes between groundwater and lake water. In most of the lake water budget studies, the relationship of ground water to lakes has been a minor part of the hydrologic studies, and it remains the least studied and least understood aspect of Lake Hydrology. This may, in many cases, lead to vague and incorrect estimation of actual groundwater proportions of the total water available in the lake.

A number of studies, particularly using the isotopes have been reported for understanding of the lake-groundwater interaction. Nachiappan et al. (2002) estimated subsurface components in the water balance of Lake Nainital using environmental isotopes. The results were verified using the environmental isotope mass balance method and chloride mass balance method. Schuster et al. (2003) studied ground water movement in the littoral zone of Williams Lake using isotope techniques. Temperature measurements can be analyzed for recharge and discharge rates. Anderson (2005) reviewed works related to heat as a groundwater tracer. Kraemer (2005) measured radium isotopes as indicators of inflow and mixing processes in lake and tributary water of Cayuga Lake, New York. Kalbus et al. (2006) provided an overview of the methods for estimating fluxes at the groundwater – surface water interface. As per the conclusions of the review, a multi-scale approach combining multiple measuring methods may considerably constrain estimates of fluxes between groundwater and surface water. Raanan et al. (2009) investigated the Ra isotope quartet in order to quantify the discharge of saline groundwater into a freshwater lake. Kidmose et al. (2010) investigated spatial distribution of seepage for a flow-through lake in western Denmark at multiple scales with an integrated use of; seepage meter, lake- groundwater gradients, stable isotope fractionation ($\delta^{18}O$), CFC apparent ages, land-based and off-shore geophysical surveys, and

lake bed coring. Stets et al. (2010) studied surface water and groundwater flows to open- and closed-basin lakes in a headwaters watershed using a descriptive oxygen stable isotope model. Roningen et al. (2012) studied hydro-geologic control on lake level at Mountain Lake (USA) to understand the hydro-geological factors that influence lake level changes using a daily water balance, electrical resistivity, water sampling and geochemical analysis and well logging.

Sukhna Lake in Chandigarh faces water scarcity problems especially during the deficit rainfall years. No studies on the interaction of the lake with surrounding groundwater have been reported so far except for the preliminary investigations carried out by NIH. Studies on water balance carried out by NIH do indicate that seepage may be a significant factor determining the water availability in the lake. A careful and detailed studies on this aspect is however needed to understand and establish the lake -groundwater interaction and seepage losses from the lake.

Methodology

The envisaged objectives will be achieved through –

a. Collection, processing and analysis of the available hydro-meteorological, ground water and isotopic data
b. Generation of additional hydro-meteorological and groundwater data.
c. Field investigations including, piezometer installation and monitoring, resistivity survey, bathymetric survey and infiltration tests
d. Sample collection and laboratory analysis for isotopic investigations Isotopic investigations of water and soil/sediment samples

Research outcome from the project

The output of the study would be in the form of a comprehensive report. The report would contain all isotopic and ground water data of the lake and surrounding area. It would provide identified of zones of lake-ground water interaction, seepage rates from the lake, its relative contribution in overall water budget of the lake as well as its role in water scarcity problem of the lake.

Cost estimate:

a) Total cost of the project: 59.59 Lakh
b) Source of funding: NIH budget
c) Sub- Head wise abstract of the cost

Sl. No.	Sub-head	Amount (in Rupees)
1.	Salary	15,66,000
2.	Travelling expenditure	6,48,000
3.	Infrastructure/Equipment	29,00,000
4.	Experimental charges	6,75,000
5.	Misc. expenditure	1,70,000
	Grand Total:	59,59,000

d) Justification for Sub-head-wise abstract of the cost

i) Salary:

(a) One JRF is proposed to be engaged @Rs. 25000/- pm for first two years and as SRF @28000/- for the third year.

(b) Five data observers are proposed to be engaged for two and half years @ Rs. 3000/- per observer per month

(c) One daily wage person for office assistance @Rs. 5000/- per month for three years

ii) Travel Expenditure

(a) Vehicle hiring = Rs. 1,40,000

(b) TA/DA = Rs. 5,08,000

iii) Infrastructure/Equipment

a) Data = 1 Lakh

b) ARG with collector (3Nos) @Rs. 40000 each = 1.2 lakh

c) DWLR = (6 nos) @ Rs. 80000 = 4.8 lakh

d) AWS (1 no) @ Rs. 300000 = 3.0 Lakh

e) Thermal Profiler (@10,000 per sensor for 10 sensors) = 1 Lakh

f) Other minor equipment = 2 lakh

g) Installation of AWLR, ARG etc = 1.0 Lakh

h) Construction of piezometers (5 Nos @ 3.0 Lakh each) = 15 Lakh

iv) Experimental Expenses

*(a) **Bathymetric Survey**: 1.0 Lakh*

*(b) **Field expenses**: @ Rs. 20000/- per year for three years. Total 60000.*

*(c) **Security charges for equipment**: For round-the-clock security of AWLR etc three guards per day @10000 per guard per month. Rs. 30000/- per month. 1.2 lakh per year for four monsoon months at a total cost of 3.6 lakhs for three years.*

*(d) **Boating charges for sampling:** @ 1000/- per day for each sampling. Total 20 samplings in three years at a total cost of Rs. 20000/-.*

*(e) **Laboratory expendables***

Chemicals = @25000 per year at a total cost of Rs.75000 for 3 yrs
Glassware, sample bottles & accessories = @20000 per year at total cost of Rs. 60000 for 3 yrs

v) Miscellaneous Expenses

a) Stationary: Rs. 15000 per year at a total cost of 45000 for 3 years

b) Contingency: Rs. 25000 per year at a total cost of 75000 for 3 years

c) Report Printing: Rs. 50000

Quarterly Break up of cost estimate for each year

Year: 1 (FY 2015-16)

Sl.No.	Sub-head	Amount (in Rupees)				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1.	Salary	1,35,000	1,35,000	1,35,000	1,35,000	5,40,000
2.	Travelling expenditure	89,200	52,100	84,200	47,100	2,72,600

3.	Infrastructure/Equipment	1,00,000	1,00,0000	1,50,000	1,50,0000	2,75,0000
4.	Experimental charges	25,000	75,000	50,000	50,000	2,00,000
5.	Misc. expenditure	10,000	10,000	10,000	10,000	40,000
	Sub- Total:	3,59,200	1272100	429200	1742100	3802600
	Grand Total	38,02,600				

Year: 2 (FY 2016-17)

Sl.No.	Sub-head	Amount (in Rupees)				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1.	Salary	1,35,000	1,35,000	1,35,000	1,35,000	5,40,000
2.	Travelling expenditure	49,150	52,100	44,150	47,100	1,92,500
3.	Infrastructure/Equipment	1,00,000	--	50,000	--	1,50,000
4.	Experimental charges	75,000	75,000	75,000	75,000	3,00,000
5.	Misc. expenditure	10,000	10,000	10,000	10,000	40,000
	Sub- Total:	369150	272100	314150	267100	1222500
	Grand Total	12,22,500				

Year: 3 (FY 2017-18)

Sl. No.	Sub-head	Amount (in Rupees)				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1.	Salary	1,44,000	1,44,000	99,000	99,000	4,86,000
2.	Travelling expenditure	57,600	33,850	57,600	33,850	1,82,900
3.	Infrastructure/Equipment	--	--	--	--	0
4.	Experimental charges	40,000	40,000	35,000	60,000	1,75,000
5.	Misc. expenditure	10,000	10,000	10,000	60,000	90,000
	Sub- Total:	2,51,600	2,27,850	2,01,600	2,52,850	9,33,900
	Grand Total	9,33,900				

Work Schedule:

a. Probable date of commencement of the project: **April, 2015.**

b. Duration of the project: **3 years**

c. Stages of work and milestone:

Sl. No.	Work Element	First Year	Second Year	Third Year
1.	Recruitment of project staff	√		
2.	Literature Review	√	√	√
3.	Collection and compilation of all available data/information	√		
4.	Procurement of instruments	√		
5.	Preparation of study area maps	√		
6.	Procurement of data	√		
7.	Identification of locations for installation of piezometers	√		

8.	Installation of piezometers	√		
9.	Collection of water samples for water quality analysis	√	√	√
10.	Collection of water samples for isotope analysis	√	√	√
11.	Infiltration tests to determine Infiltration rates	√		
12.	Measurement/estimation of discharge	√	√	
13.	Bathymetric Survey	√		
14.	Generation of field data such as water levels of lakes & GW, meteorological data etc	√		
15.	Analysis of water samples for Water Quality	√		
16.	Analysis of samples for isotopes	√	√	√
17.	Isotopic characterization of water in and around the lake	√	√	√
18.	Resistivity Survey	√		
19.	Identification of lake-groundwater interaction zones			√
20.	Determination of Seepage rates		√	√
21.	Determination of Water Balance components	√	√	
22.	Preparation of interim report	√	√	
23.	Preparation of final report			√

SPONSORED PROJECT

PROJECT REFERENCE CODE: NIH/HID/SPON/12-15

Title of the Study:	**Understanding of hydrological processes in Upper Ganga basin by using isotopic techniques**
Study Group:	**PI and Co-PI:** Dr. S. P. Rai, Dr. Sudhir Kumar, Rajesh Singh, S. D. Khobragade, Dr. M. Arora, Dr. R. J. Thayyen, and Mr. P. K. Garg
Staff:	Mr. Vipin Agrawal, Rajeev Gupta, Raju Juyal, Mr. Vishal Gupta, Mr. Mohar Singh
Type of Study	**To be s**ponsored from DST, Govt. of India (Under Process)
Nature of Study	Application of isotope to understand hydrological processes of Upper Ganga Basin
Duration:	5 Years
Date of Start:	April 2015
Date of Completion	March 2020

Study Objectives:

- **a)** Isotopic characterisation of precipitation and identification of sources of vapour
- **b)** Runoff generation processes in headwater region of Ganga using isotope and modeling
- **c)** Spatial and temporal variation of snow and glacier melt in Ganga and its major tributaries.
- **d)** Contribution of transient groundwater and its role in sustainable flow of Ganga.
- **e)** Groundwater dynamics in mountainous area including identification of recharge sources and zones of major springs

Statement of the Problem:

The Himalayan mountain system is the source of one of the world's largest supplies of fresh water which is under threat due to serious environmental degradation and climate change. Continuing climate change is predicted to lead to major changes in the strength and timing of the Asian monsoon, inner Asian high pressure systems, and winter westerlies – the main systems affecting the climate of the Himalayan region. The impacts on river flows, groundwater recharge, natural hazards, and the ecosystem, as well as on people and their livelihoods, could be dramatic affected, although not the same in terms of rate, intensity, or direction in all parts of the region. Therefore, a thorough understanding of hydrological processes operating all along the Himalayan region is a fundamental requirement.

Studies conducted worldwide during last few decades have established that stable oxygen and hydrogen isotope ratios provide useful tools for hydrological investigations in mountainous area. Classical approach used to study the hydrological processes can be strengthened through tracing isotopic signature of water molecules. Since, primary input of water on land is precipitation. The isotopic signatures of source and subsequent partitioning into stream

flow, subsurface flow, spring/groundwater recharge processes, etc., though occurring on a local scale and over small time intervals get integrated both temporally and spatially as water from different parts of the catchment originating at different times accumulate and mix through operative hydrological processes, provide valuable information about different hydrological processes. Therefore, isotopes of well-mixed environmental reservoirs, such as the atmosphere, glacial melt, streams and aquifers, often represent an integration of source inputs to the system that extend over large spatial scales. Thus, isotopes indicate, record, integrate and trace water movement and hydrological process from small geographic scales (meters to hectares) and short temporal scales (minutes to hours) to large spatial scales (regions and the globe) and long temporal scales (decades to centuries). The partitioning of the different component of stream runoff can be done. Therefore, isotopic data on water sources at different spatial and temporal scales can be used to calibrate hydrological models, to provide internal quantitative check on the assumptions of various hydrological models.

It can be achieved through investigating stable isotopic composition (oxygen isotopes - ^{16}O and ^{18}O; and hydrogen isotopes-^{1}H and ^{2}H or D) of water molecules in different components of hydrological cycle in conjunction with volume and flux data. Environmental radio tracers (^{3}H, & ^{14}C etc) will be use to trace the residence time, flow velocity and age of the groundwater along with stable isotopes also. Study area for the present study will be upto Rishikesh

Whether Study is a New Study/Extension of Previous Studies: New Study

Study Area: Study area covers upper Ganga basin up to Rishikesh

Methodology:

- Field investigations of the study area
- Hydrogeological investigations of the study area using the past data
- Stable isotopic analysis of precipitation, glacier, river and groundwater
- Tritium and Carbon-14 dating to determine the age of the groundwater
- Delineation of drainage and preparation DEM using remote sensing and GIS
- Application of SNOWMOD and SRM models
- Analysis of the results

Action plan & time line: (Quarter wise, for 2015-2020)

Activities	**1st year**		**2nd year**		**3rd year**		**4th year**		**5th year**	
	I	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**
Appointment of Project staff	√									
Procurement of instruments	√	√								
Literature Collection	√	√	√							
Sample collection and analysis of sample for stable and radio isotope		√	√	√	√	√	√	√		
Compilation of data, interpretation and analysis					√	√	√	√	√	
Organisation of training course and workshop				√		√		√		

Preparation of final report										√

Data requirement & Expected source:
Meteorological data (i.e., rainfall, maximum minimum temperature, sunshine hours, relative humidity, solar radiation etc), Discharge data and hydrogeological data are required. Meteorological data would be purchased from IMD. The geological information's will be collected from the GSI/CGWB and state groundwater cell. The discharge data will be collected from CWC. Isotope and other related data will be generated in the field and lab.

List of deliverables:
Reports and papers will be delivered on following aspects

1. Understanding of Runoff generation processes in head water region of Ganga basin.
2. Assessment and snow/glacier melt contribution in mountainous region of Ganga basin with time and space
3. Role of groundwater contribution in sustaining the discharge of Ganga river and its tributaries.
4. Development of methodology for the sustainable development of springs through understanding the mechanism of recharge and discharge processes of the springs
5. Identification of source of precipitation

IPR potential and issues: NIL

Involvement of End Users/beneficiaries:
The beneficiaries of the study would be the water resource planners and managers of water resources of the study area apart from the academicians.

Specific linkages envisaged with Institutions and/or other NGOs: Sharing of data with central and state government organization and NGOs of the study area

Major items of equipment needed: None

Annexure-II

PROPOSED WORK PROGRAMME OF HYDROLOGICAL INVESTIGATIONS DIVISION FOR THE YEAR 2015 - 16

S. No.	Study	Team	Duration/ Status
INTERNAL STUDIES			
1.	Isotopic Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains	Sudhir Kumar (PI) C. K. Jain S. P. Rai S. D. Khobragade P. K. Garg CGWB, Lucknow CGWB, Chandigarh	**2 years** (07/13-06/15) **Continuing Study**
2.	Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes	S. K. Verma (PI) S. P. Rai (Co-PI) M. S. Rao C. P. Kumar Mohar Singh	**2 years** (10/13-09/15) **Continuing Study**
3.	Interaction between groundwater and seawater along the northern part of east coast of India	M. S. Rao (PI), Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16) **Continuing Study**
4.	Isotopic investigation of benchmark Himalayan glaciers.	M. S. Rao (PI) S.P. Rai, Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16) **Continuing Study**
5.	Assessment of dissolved radon concentration for groundwater investigations in Haridwar district	Pankaj Garg (PI) Sudhir Kumar, M. Someshwar Rao	**1 year** (01/15 – 12/15) **Continuing Study**
6.	Status Report on Rewalsar Lake, Himachal Pradesh	SD Khobragade (PI) Sudhir Kumar, C. K. Jain	**1 year** (04/15 – 03/16) **New Study**
7.	Lake-Groundwater Interaction Studies for Sukhna Lake, Chandigarh	SD Khobragade (PI) Sudhir Kumar, Senthil Kumar, Pankaj Garg	**3 year** (04/15 – 03/18) **New Study**
SPONSORED PROJECTS			
8.	The Structure and Dynamics of Groundwater Systems in Northwestern India under Past, Present and Future Climates	S. P. Rai (PI) M. S. Rao Surjeet Singh S. K. Verma C. P. Kumar Sudhir Kumar V. K. Agarwal Rajeev Gupta S. L. Srivastava Vishal Gupta Mohar Singh	**3 years** (06/12-03/16) **Continuing Study**

S. No.	Study	Team	Duration/ Status
9.	The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India	M. S. Rao (PI) C. P. Kumar S. P. Rai	**3 years** (09/12-08/15) **Continuing Study**
10.	Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques	S. P. Rai (PI) R. V. Kale M. S. Rao C. P. Kumar Sudhir Kumar V. K. Agarwal Vishal Gupta Mohar Singh	**3 years** (10/12-09/15) **Continuing Study**
11.	Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains	Sudhir Kumar (PI) S. P. Rai S. D. Khobragade C. K. Jain P. K. Garg	**2 years** (05/13-04/15) **Continuing Study**
12	Understanding of hydrological processes in Upper Ganga basin by using isotopic techniques	Dr. S. P. Rai (PI) Dr. Sudhir Kumar Rajesh Singh S. D. Khobragade Dr. M. Arora Dr. R. J. Thayyen Sh. P. K. Garg	**5 years** **(4/15 – 3/20)** **New Study**
CONSULTANCY PROJECTS			
13.	Hydrogeological Study for Dewatering of Jhamarkotra Mines, Distt. Udaipur	Sudhir Kumar (PI)	**3 years** (05/13-04/16) **Continuing Study**
14.	Estimation of canal seepage and groundwater recharge using isotopic techniques in the Chajlet block, Moradabad district, Uttar Pradesh	Sudhir Kumar (PI) SP Rai SK Verma	**1 years** (03/15-02/16) **New Study**

SURFACE WATER HYDROLOGY DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr. Rakesh Kumar	Scientist G & Head
2	Dr. J V Tyagi	Scientist G
3	Dr. Avinash Agarwal	Scientist F
4	Dr. S K Singh	Scientist F
5	Dr. R P Pandey	Scientist F
6	Dr. A K Lohani	Scientist F
7	Dr. Senthil Kumar	Scientist E
8	Dr. Sanjay Kumar	Scientist D
9	Smt. Archana Sarkar	Scientist D
10	Dr. Manohar Arora	Scientist D
11	Sri Digambar Singh	Scientist B
12	Sri J P Patra	Scientist B
13	Sri Naresh Kumar	PRA
14	Sri N K Bhatnagar	PRA
15	Sri R K Neema	SRA
16	Sri Hukum Singh	SRA
17	Sri Om Prakash	SRA
18	Sri Jatin Malhotra	SRA
19	Sri T R Sapra	RA

WORK PROGRAMME OF SURFACE WATER HYDROLOGY DIVISION FOR THE YEAR 2014-15

S.No. & Ref. Code	Title	Study Team	Duration
1. NIH/SWD/NIH/ 12-15	Sedimentation Studies for Pong Reservoir, Himachal Pradesh	A. R. Senthil kumar Manohar Arora Suhas D Khobragade Avinash Agarwal Sanjay Jain	3 years (April 2012 to March 2015)
2. NIH/SWD/NIH/ 12-15	Study of Hydro-Meteorological Droughts For Chitrakoot Bundelkhand Region In India	R.P. Pandey Rakesh Kumar	3 years (April 2012 to March 2015)
3. NIH/SWD/NIH/ 13-15	Application of DSS (P) for Integrated Water Resources Development & Management	A.K. Lohani Surjeet Singh Rahul Jaiswal D K Sonkusale Akilesh Verma	2 years (April 2013 to March 2015)
4. NIH/SWD/NIH/ 14-15	Estimation of Water Balance for Integrated Water Resources Management in Yerrakalva Pilot Basin, A.P.	J.V.Tyagi YRS Rao,	1 year (April 2014 to March 2015)
5. NIH/SWD/NIH/ 14-15	Systematic treatment and analytical solutions for surges and bores in rectangular channels (research study)	S.K. Singh	1 year (April 2014 to March 2015)
6. NIH/SWD/NIH/ 14-15	Status Report on "Impact of Anthropogenic and Climate Change on Sediment Load of Rivers"	Archana Sarkar	1 year (April 2014 to March 2015)
7. NIH/SWD/NIH/ 14-16	Study of Rainfall Patterns and Comparison of Rainfall Data from different Sources for Uttarakhand State	Archana Sarkar Vaibhav Garg, Sc C, IIRS, Dehradun Rakesh Kumar N.K. Bhatnagar	2 years (April 2014 to March 2016)
8. NIH/SWD/NIH/ 13-16	Quantitative assessment of uncertainties in river discharge estimation	Sanjay Kumar Sharad Jain	3 years (April 2013 to March 2016)
9. NIH/SWD/NIH/ 13-16	Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills.	Avinash Agarwal Manohar Arora RK Nema	3 years (November 2013 to October 2016)
10. NIH/SWD/NIH/ 14-17	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora Rakesh Kumar	3 years (May 2014 to March 2017)
11. NIH/SWD/NIH/ 14-17	Effect of climate change on evaporation at point scale	Digambar Singh A. R. Senthil kumar Manohar Arora	3 years (June 2014 to March 2017)
12. NIH/SWD/NIH/ 14-17	Hydrological modelling, water availability analysis	J.P.Patra Rakesh Kumar Pankaj Mani	3 years (April 2014 to March 2017)

1. Sedimentation Studies for Pong Reservoir, Himachal Pradesh

1. Title of the study:

Sedimentation Studies for Pong Reservoir, Himachal Pradesh

2. Study Group:

Dr. A. R. Senthil kumar Sc E, SWHD
Dr. Manohar Arora, Sc D, SWHD
Dr. Suhas D Khobragade, Sc E, HID
Dr. Avinash Agarwal, Sc, F, SWHD
Dr. Sanjay Jain, Sc F, WRSD

3. Date of start: 1 April 2012

4. Duration of the study: 3 Years

5. Whether externally funded or not: No

6. OBJECTIVES OF THE STUDY:

i. To develop a sediment yield model for the catchment area
ii. To generate rainfall and runoff series for the future periods
iii. To compute the sediment yield based on the generated rainfall and runoff series
iv. To predict elevation-area-capacity curve

7. BRIEF METHODOLOGY:

Sediment yield model

Multiple Linear regression (MLR) and ANN models are 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

Generation of rainfall and runoff series

The data of rainfall and runoff for future 25, 50, 75 and 100 years are generated by the time series modelling with available data of rainfall and runoff series.

Computation of sediment yield and consolidated sediment volume

The developed sediment yield model is applied to compute the sediment volume for future 25, 50, 75 and 100 years. The unit weight of deposited sediment in the reservoir is 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 are arrived at by empirical equation as well as statistical methods. The consolidated unit weights computed by different methods are 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.

Revision of elevation-area-capacity table

The computed sediment volume for future periods is distributed in the reservoir by empirical area reduction method.

8. Results achieved with progress/present status

The monthly rainfall at Dehra Gopipur, Haripur, Nangal Chowk and Pong dam and monthly flow volume and sediment yield at Jwala Mukhi from 1987 to 2009 are used to develop ANN model to simulate the sediment load. The feed forward ANN is trained with input vector selected from the data as mentioned above. The monthly data from 1987 to 2007 are considered for the training of the model and data from 2008 to 2009 are considered for the validation of the model. The ANN model with input vector of flowvol(t), raindehra(t), rainhari(t), rainnangch(t), rainpondam(t) and the structure of 5-2-1 is the best model among the all. The monthly rainfall at Dehra Gopipur, Haripur, Nangal Chowk and Pong dam and monthly flow volume at Jwala Mukhi for future 25, 50, 75 and 100 years are generated by using time series modelling. The best ANN model is used to simulate the sediment load for future 25, 50, 75 and 100 years using the generated series of rainfall and flow volume. The uncertainty in the simulated series of sediment load is addressed by generating ensembles of input series and determining the sufficient number of parameter sets of the model by boots trap method.

The uncertainty analysis of generated data series of rainfall at Dehra Gopipur, Haripur, Nangal Chowk and Pong dam, flow volume at Jwala Mukhi for future 25, 50, 75 and 100 years is carried out. The uncertainty in the generated data series is determined by finding bandwidth of probable values of a particular series. The 1000 ensembles of rainfall at Dehra Gopipur, Haripur, Nangal Chowk and Pong dam, flow volume at Jwala Mukhi for 25, 50, 75 and 100 years are generated by changing the seed of uniformly distributed random number. The 10, 50 and 90 percent probable generated series of rainfall and flow volume is found from the ensembles of the series. These values address the uncertainty in the generated data. The uncertainty in the model is addressed by developing ANN ensembles by boots trap method. 200 ANN ensembles were generated with available 276 patterns of historical data. The average probable sediment yield from the ANN ensembles were simulated from 10, 50 and 90 percent probable generated series of rainfall and flow volume. The consolidated unit weight of sediment by different methods such as particle size distribution of suspended sediment concentration, hydrographic survey and porosity of uniformly distributed sediment have been computed. The expected life of the reservoir is found to be 340 years from plot of cumulative sediment yield on y-axis and time on x-axis. The consolidated unit weight of sediment by frequency analysis of unit weight of sediment computed from suspended sediment concentration and empirical formula is being done. The estimation of consolidated sediment volume by consolidated unit weight of sediment and estimation of elevation-area-capacity curve for future periods from consolidated sediment volume is being carried out. The simulation of sediment yield from data of each ensemble is being carried out with ANN ensembles.

9. Expected date of completion: 31 March 2015

2. STUDY OF HYDRO-METEOROLOGICAL DROUGHTS FOR CHITRAKOOT BUNDELKHAND REGION IN INDIA

Name of PI: **Dr. R.P. Pandey, Scientist F**; Surface Water Div., NIH Roorkee

Type of study: **Internally Funded**

Project Duration: **3-years**

Date of start: **April 2012**

Scheduled Date of Completion: **March. 2015**

OBJECTIVES OF THE STUDY:

Major objective of the study is to quantify water scarcity during droughts and to identify possible options for augmenting water supply and minimizing crop loss due to droughts. The specific objectives of this project are to:

a) Assessment of drought frequency, duration and severity in Bubdelkhand.
b) Quantification of surface water and groundwater availability.
c) Assessment of total water demands for domestic, industries and agriculture.
d) Assessment of supplemental irrigation to minimize crop loss due to dryspells and droughts.
e) Delineation of zones vulnerable to different degree of drought severity.
f) To suggest an area specific plan for water management in Paisuni Basin,

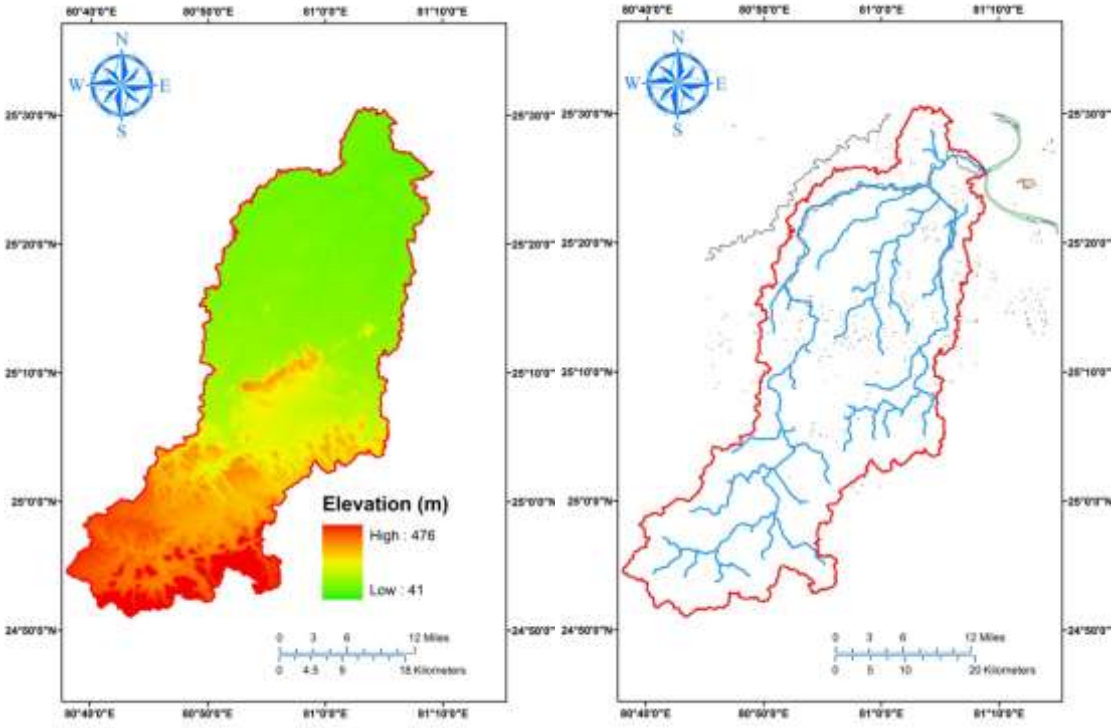
Study Area : Paisuni (Mandakini) Basin in Chitrakoot District

Study area belongs to the part of Bundelkhand region in India (Fig. 1). Mean annual rainfall in the basin is about 1039 mm and mean annual potential evapotranspiration is about 1950 mm. Statement of problems of the study area is as follows:

- Paisuni basin in Chitrakoot faces recurrent droughts of with average frequency of once in five years (greater severity).
- Frequent failures of crops are reported in the basin due to droughts.
- Present sources of drinking water supply are not sufficient to meet the demand during summer. Sever water shortages emerge during drought period
- In recent past during 2004- 2008 and 2010, it experienced acute water scarcity due to persistent drought situation in the basin.
- Ground water availability in Manikpur, Pahari and Chitrakoot blocks are limited and it does not meet the demands. The Manikpur block appears to be more vulnerable to water shortages in summer months.

PROGRESS OF PROPOSED STUDY:

- Collected data/information from various sources and conducted field investigations in the study areas.
- Prepared base maps of drainage, land-use, DEM, ground water aspect map etc. using GIS.
- Analyzed rainfall data to determine frequency and severity of droughts in past decades and their impacts reported in administrative documented.
- Applied and compared SPI and EDI with A New Methodology (named as SDI, simple drought index) to assess attributes of drought events.
- Analyzed critical dry spell fro past 50 year data and estimated supplemental irrigation requirement for crop saving during CDS and drought.
- Prepared map for demarcation water deficit zones in study area in the form of different clusters of villages for water supply planning.



DEM Map Drainage Map

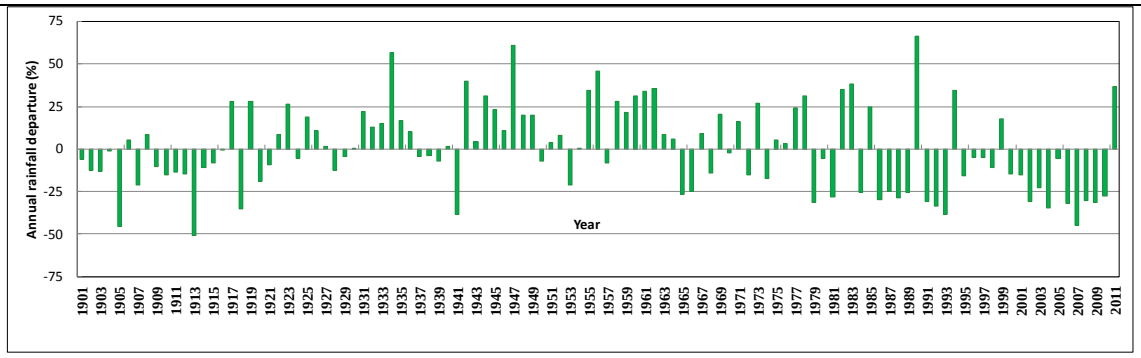


Table : Results of Critical Dry Spell Analysis in Paisuni basin covering Chitrakoot distt. UP and Part of Satna distt. MP

S. No	Station	Ist Critical Dry Spell			IInd Critical Dry Spell			IIIrd Critical Dry Spell			Longest duration of CDS
		Start mean date	End Mean Date	Duration	Start Mean Date	End Mean Date	Duration	Start Mean Date	End Mean Date	duration	
	1	2	3		4	5		6	7		8
1	Mau	17 July	3 Aug	18	12 Aug	23 Aug	11	5 Sep	21 Sep	17	45 (1983)
2	Karwi	18 July	2 Aug	16	9 Aug	26 Aug	18	-	-		28 (2002)
3	Satna	22 July	4 Aug	17	4 Aug	19 Aug	16	27 Aug	7 Sep	11	26 (1974)

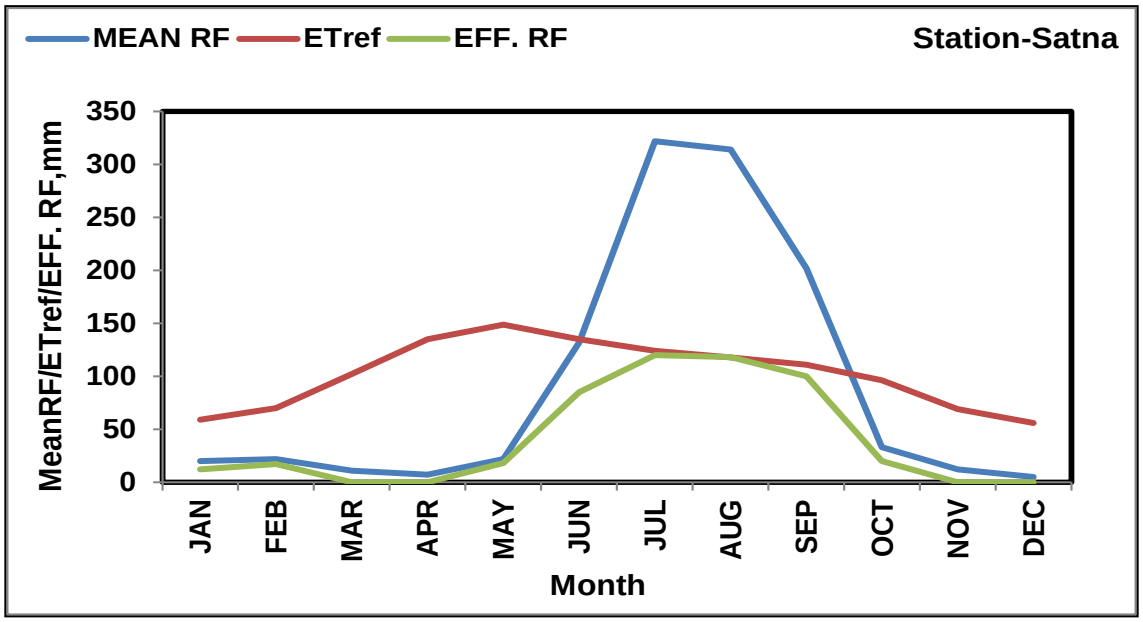


Fig: Distribution of monthly rainfall and Evapotranspiration

Table :Estimation of Crop Water Requirement

S. No.	Name of crop	Crop duration	Sowing time	Total Crop Water requirement (mm)
	1	2	3	4
1	Paddy (Kharif)	97 days	1-Jul	487
2	Soybean (Kharif)	110 days	30-Jun	411
3	Maize (Kharif)	110days	1-Jul	348
4	Wheat (Rabi)	120days	5-Nov	342

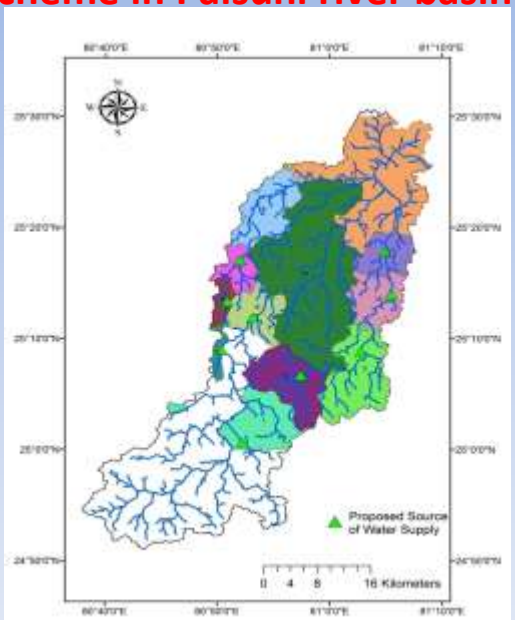
Table: Comparison of results of SDI with SPI and EDI

Year	Month	Rainfall	Monthly Av. RF	SDI-Identification	Weighted Departure	SPI 3 Month	EDI Monthly
2006	Jan	0	20	Drought-50	-2.13	-1.99	0.57
2006	Feb	20	22	Drought-2m	-0.21	-0.43	0.48
2006	Mar	34.2	11	1	2.47	0.31	0.85
2006	Apr	23.8	7	1	1.79	1.17	1.18
2006	May	25	22	1	0.32	1.19	0.62
2006	Jun	42.5	132	Drought-50	-9.54	-0.4	-0.69
2006	Jul	435.6	322	1	12.11	0.27	0.37
2006	Aug	171.5	314	1	-15.19	-0.39	-0.63
2006	Sep	44.9	202	Drought-50	-16.75	-0.64	-1.29
2006	Oct	11.5	33	Drought-50	-2.29	-1.57	-1.31
2006	Nov	0.6	12	Drought-2m	-1.22	-1.71	-1.46
2006	Dec	0	5	Drought-2m	-0.53	-0.86	-1.44
2007	Jan	0	20	Drought-50	-2.13	-1.74	-1.78
2007	Feb	71.2	22	1	5.25	0.75	-0.67
2007	Mar	25	11	1	1.49	1.04	-0.5
2007	Apr	1.8	7	1	-0.55	1.52	-0.67
2007	May	2.9	22	Drought-50	-2.04	0.08	-0.87

Map showing the clusters of villages for water supply scheme in Paisuni river basin

Based on following

- Topography
- Water Demand
- GW availability/potential
- SW storage potential



SUMMARY OF WORKS COMPLETED

- **Analyzed long term (111 years) rainfall data for Assessment of regional drought frequency, magnitude of deficit and drought persistence.**
- **Analyzed daily RF records (1950-2011) for assessment of dry spells and supplemental irrigation requirements.**
- **Preparation of Base maps comprising spatial information on land use, soil, topography, GW prospect, SW availability, water demand.**
- **Proposed a new index for near real time drought monitoring**
- **Assessment of GW recharge/ utilizable ground water resources.**
- **Demarcation of zones vulnerable to water shortages and quantification of total water deficiency.**
- **Field visits for preliminary verification of results.**
- Quantification of storage requirements to meet various demands including identification of suitable sites for storages.
- **Identification of suitable sites to augment surface water resources to meet deficit of water demands.**
- **Report writing--- under progress**

The study is expected to be completed by March 31st 2015.

3. APPLICATION OF DSS (P) FOR INTEGRATED WATER RESOURCES DEVELOPMENT AND MANAGEMENT

1. **Title of the Project:** Application of DSS (P) for Integrated Water Resources Development and Management

2. **Study Group:**
   Dr. A.K. Lohani, Scientist 'F' Surface Water Hydrology Division, PI
   Data Collection, Data Processing, Data Analysis, Simulation, Interpretation of results etc.
   Dr. Surjeet , Scientist 'D', Ground Water Hydrology Division, Co-PI
   Data Collection, Data Processing, Simulation
   Rahul Jaiswal, Scientist 'C' & Ganga Plains Regional Centre, Bhopal, Co-PI
   Data Collection, Data Processing, Simulation
   Officers from Water Resources Department, Chhattisgarh
   ***D. K. Sonkusale,** Water Resources Department, Raipur- Data Collection*
   ***Akilesh Verma**, Water Resources Department, Raipur- Data Collection*

3. **Type of study: Internal**
4. **Date of Start: April 1, 2013**
5. **Date of Completion: March 31, 2015**
6. **Type of Study: Internal**
7. **Statement of Problem**

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. Better and useful information needs to be made available to a larger number of participants in more open and participatory decision making and this information is to be effectively integrated into decision making processes. It is a challenge to integrate new information technologies with traditional methods of analysis and to put these tools to work in practice. 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.

7**. Objectives:**

- To collect and process hydrological time series data and spatial data
- To carry out rainfall-runoff modelling using NAM
- To implement Mike basin in the study area
- To generate scenarios for integrated water resources management

8. **The Study Area**

The Seonath River Originates near village Panabaras in the Rajnandgaon District. The Basin is located between latitude 20^0 16' N to 22^0 41' N and Longitude 80^0 25' E to $82^0$35' E. 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.

9. Analysis and Results:

Converted the MIKE-11 data files for Mike Hydro software. Using the NAM model rainfall runoff modeling of Arpa basin has been carried out. Figure 1 indicates that the observed and simulated values of the runoff and it shows a good match.

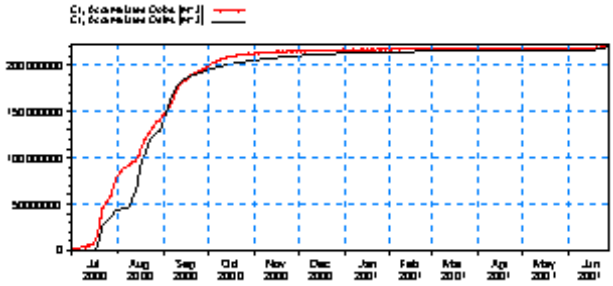


Figure 1: Observed and simulated accumulated runoff: Calibration results of NAM-MIKE-11 Model (2000-2001)

Furthermore, a model for Arpa basin has been setup in Mike Hydro software. Some of the data required to fine tuning of the model parameters for calibration are required. We have requested the Officers of the Water Resources Department, Chhattisgarh progress (Figure 3).

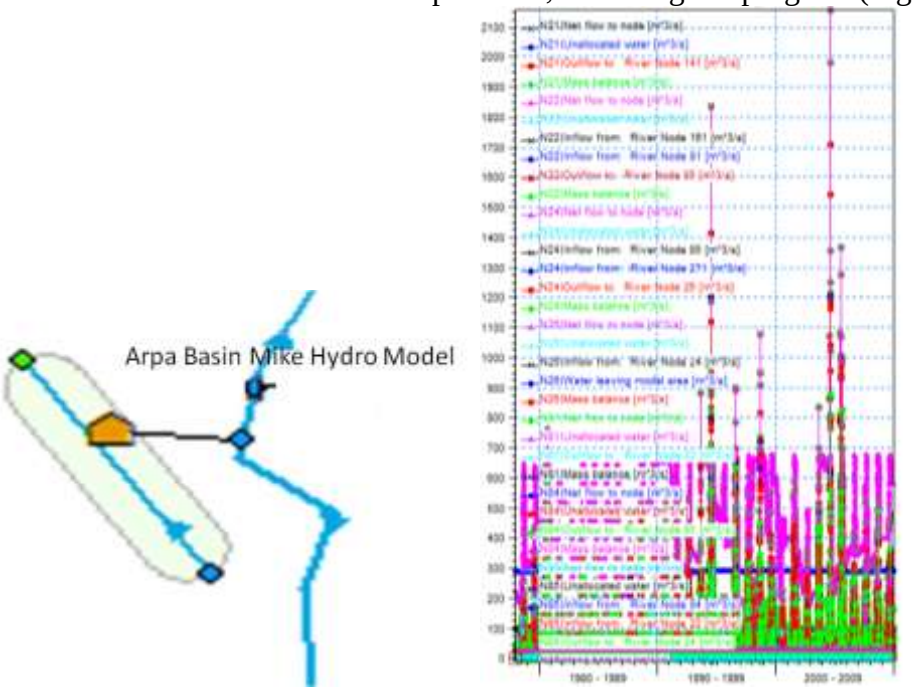


Figure 3: Mike Hydro Model setup for Arpa Basin

10. Action Plan

Task	Apr. -Sep. 2013	Oct.-Mar. 2013	Apr.-Sep. 2014	Oct. 2013-Mar. 2014	Status
Identification of the study basin					**Identifying the basin in consultation with**

					Chhattisgarh WRD
Data Collection & Processing					**Completed**
Rainfall-Runoff Modelling using NAM					**Completed**
Implementation of Mike Basin					**In progress**
Scenario generation using DSS(P)					**In progress**

10. Deliverables

Reports and research papers

4. ESTIMATION OF WATER BALANCES FOR INTEGRATED WATER RESOURCES MANAGEMENT IN YERRAKALVA PILOT BASIN, A.P.

1. Title of the Project: **Estimation of Water Balance for Integrated Water Resources Management in Yerrakalva Pilot Basin, A.P.**

2. Thrust Area under XII five year Plan: Integrated Water Resources Development & Management

3. Project Team: Dr. J.V.Tyagi, Sc 'G', SWH Div. (PI)
Dr. YRS Rao, Sc 'F', DRC, Kakinada (Co-PI)

4. Objectives of the study:

(i) To calibrate and validate SWAT model on Yerrakalva pilot basin
(ii) To compute water balance components of the hydrologic cycle for the basin

5. Statement of the problem:

Under 12th five-year plan program, NIH has taken up Pilot Basin Studies (PBS) for Integrated Water Resources Management (IWRM) in Yerrakalva river basin in coastal Andhra Pradesh. The program involves detailed studies on various components of the hydrologic cycle including water balance study of the basin. A water balance study quantifies the components of the hydrologic cycle at the catchment scale. The components of water balance of a basin are influenced by climate, the physical characteristics of the watershed such as morphology, land use and soil. Therefore, understanding the relationship between these physical parameters and hydrological components are very essential for integrated water resources management. This provides the most fundamental information about the hydrology of a watershed and is necessary to assess the importance of climate and land cover in determining water availability. In addition to providing a baseline understanding of the hydrologic processes occurring within a catchment, the water balance components can be compared over long periods of time to track the hydrologic response of a catchment to climatic and land cover variability. Therefore, the present study has been taken up for estimation of water balance and water yield in Yerrakalva river catchment which is critical to long term sustainable management of water resources in the basin.

6. Study area:

The Yerrakalva river rises in the eastern slopes of the eastern ghats at the boarder of West Godavari and Khammam districts. It enters into West Godavari district after 6.4 km run in Khammam district and runs in West Godavari district for about 180 km and joins the Upputeru river, which takes off from the Kolleru lake and falls into Bay of Bengal. Yerrakalva enters the Godavari western delta near Nandamuru aquiduct of Tadepalligudem Mandal. The catchment area of the river is 2725.03 Sq km of which 2330.10 Sq km spreads in upland and 394.93 Sq km in delta (Fig. 1). The study area gets rain during both Southwest and Northeast monsoons. The annual normal rainfall in the basin is around 1078mm.

7. Present state of art:

Major hydrological processes can be quantified with the help of water balance equations. Since the hydrologic processes are very complex, watershed models are widely used for proper comprehension of water balance components. The models based on explicit catchment water balance modelling are numbered in the hundreds and new models are still being presented. The watershed models partition rainfall into various hydrological processes such as surface runoff, evapotranspiration, percolation, lateral flow and base flow etc. with

the constraint to account for all water entering, leaving and being stored in a catchment. This adaptation of the principle of conservation of mass constrains the potential for error.

Fig. 1: study area

8. Methodology

SWAT, one of the most recent models developed by the USDA, will be used to analyse and quantify the water balance of the Yerrakalva river basin. The model has been chosen as SWAT is an integrated river basin scale, physically based, continuous-time, long-term simulation, distributed watershed model. Also, its suitability to different parts of the world has been well established. The SWAT model uses physically based inputs such as weather variables, soil properties, topography, land use characteristics and land-management practices occurring in the catchment. In SWAT, a basin is delineated into sub-basins, which are then further subdivided into HRUs based on the homogeneous land use, soil types and topographical characteristics. The major components of SWAT can be grouped into two categories (i) land phase of the hydrologic cycle that controls the amount of water, sediment, nutrient and pesticide loadings to the main channel in each sub-basin, and (ii) routing phase of the hydrologic cycle that defines the movement of water, sediments, etc. through the channel network of the watershed to the outlet. The physical processes associated with water flow, sediment transport, crop growth, nutrient cycling, etc. are directly modelled by SWAT. The hydrologic cycle as simulated by SWAT is based on the water balance equation. Model outputs all water balance components (surface runoff, evaporation, lateral flow, recharge, percolation, sediment yield, etc.) at the level of each watershed and are available at daily, monthly or annual time steps.

9. Work schedule:

(a) Date of commencement of the project: April 2014
(b) Duration of the project: One year (Extension for six months i.e. up to Sept. 2015 is required).
(c) Stages of work and milestone:

S. No.	Work Element	1st Qtr 2014	2nd Qtr 2014	3rd Qtr 2014	4th Qtr 2014	Status
1.	Collection of daily hydro-meteorological data & Processing					Completed
2.	Field experiments, collection of soil samples and lab analysis					Completed
3.	Preparation of spatial data base for SWAT viz. DEM, soil map and land use map					Completed
4.	Preparation of attribute data base					Completed
5.	Setting up of SWAT model					Completed
6.	Calibration and validation of model					To be done
7.	Analysis of model output and water balance					To be done
8.	Report preparation					To be done

Progress

The daily rainfall data of the study area have been collected. Soil samples have been collected from the field and are analyzed in the lab for determination of soil texture. Spatial maps viz. DEM, soil map and land use map have been prepared for the study area. Preparation of attribute data for the SWAT model is completed. Model has been set up on the study basin. However, the hydrologic design details of Yerrakalva reservoir and other data such as elevation-area-capacity curve, reservoir outflows etc. are yet to be obtained from the reservoir authorities that are required for calibration and validation of the model. The working Group may consider for extension of study period for six months i.e. up to September 2015.

10. Cost estimates

(a) Total cost of the project: Rs. 1,50,000/-
(b) Source of funding: Internal (Plan funds)
(c) Subhead-wise abstract of the cost:

S. No.	Sub-head	Amount (Rupees)
1.	Salary	-
2.	Travelling expenditure	1,00,000/-
3.	Infrastructure/equipment	-
4.	Experimental charges	25,000/-
5.	Misc. Expenditure	25,000/-
	Grand Total	**1,50,000/-**

(d) Justification for the subhead-wise abstract of the cost: Travelling expenditure of Rs. 1,00,000/- is required for field visits of PI, Co-PI and staff of DRC Kakinada to the study area and for data collection from the field departments. Also, some field experiments and collection of soil samples will be carried out for determination of model parameter values.

11. Research Outcome from the project:

(i) Quantification of water balance components of the catchment
(ii) Long term average estimates of catchment water yield
(iii) Technical publications in the form of report and research paper

6. PROJECT REFERENCE CODE: NIH/SWD/NIH/14-15

Title of the Study: Status Report on "Impact of Anthropogenic and Climate Change on Sediment Load of Rivers"

Name of the PI Dr Archana Sarkar, Sc C, SWHD

Type of Study : Internal

Date of Start : 1 April 2014

Scheduled Date of Completion: 31 March 2015

Study Objectives

1. Literature review
2. Preparation of status report

Statement of the Problem

The sediment load of a river represents a key component of its hydrology, and in turn exerts an important influence on its aquatic ecology, its morphology and the exploitation of its water resources. Changes in the sediment loads of rivers can therefore have wide-ranging environmental and social and economic implications. There is growing evidence (reported by various authors for different rivers of the world) that the sediment loads of many rivers of the world, especially Asian rivers have changed significantly in recent years due to many reasons, including anthropogenic as well as climate change impact). Therefore, it is required to carry out a comprehensive up to date review of all such studies and prepare a status report.

APPROVED ACTION PLAN AND TIMELINE

Year	April - June	July-Sept	Oct-Dec	Jan-March
2014-15	Literature Review	Literature Review	Literature Review	Preparation of status report

PROGRESS

Objectives	Achievements
April 2014- October 2014	
1 Literature Review	Completed
Nov2014- March 2015	
1 Literature Review	Completed
2 Preparation of Final Report	In Progess (to be completed by end of March, 2015)

RECOMMENDATIONS/suggestions in previous meetings of Working Group/TAC/GB
Refer a status report on Sediment Erosion completed by the division earlier.

ANALYSIS AND RESULTS

Extensive review of literature from research papers, reports and books. Preparation of status report is in progress.

EXPECTED ADOPTERS
State Water Resources Dept and other agencies.

DELIVERABLES
Status report

7. PROJECT REFERENCE CODE: NIH/SWD/NIH/14-16

Thrust Area under XII five year Plan

1. Project team:

a. Project Investigator: **Dr ARCHANA SARKAR, Sc 'D', SWHD**
b. Project Co-Investigator(s):
Dr Rakesh Kumar, Sc G & Head, SWHD
Dr. Vaibhav Garg, Sc C, IIRS, Dehradun

Staff: Sh. N.K. Bhatnagar, PRA, SWHD

2. Title of the Project

Study of Rainfall Patterns and Comparison of Rainfall Data from different Sources for Uttarakhand State

3. Objectives:

i. Procurement of additional rainfall data of the available rain gauge stations in Uttarakhand State from various agencies and processing of rainfall data.
ii. Spatio-temporal trend analysis of historical rainfall data.
iii. Downloading and processing of rainfall data (same location as that of rain gauge stations) from TRMM satellite data as well as high resolution gridded re-analysis rainfall data from APHRODITE.
iv. Comparison of rainfall data from various sources.

4. Present state-of-art

Uttarakhand is a state in the northern part of India. It is often referred to as the "Land of the Gods" due to the many holy Hindu temples and pilgrimage centres found throughout the state. Uttarakhand is known for its natural beauty of the Himalayas, the Bhabhar and theTerai. It borders the Tibet Autonomous Region on the north; the Mahakali Zone of the Far-Western Region, Nepal on the east; and the Indian states of Uttar Pradesh to the south and Himachal Pradesh to the northwest. The state is divided into two divisions, Garhwal and Kumaon, with a total of 13 districts. Two of the most important rivers in Hinduism originate in the region, the Ganga at Gangotri and the Yamuna at Yamunotri. Uttarakhand has a total area of 53,484 km², of which 93% is mountainous and 65% is covered by forest. Most of the northern part of the state is covered by high Himalayan peaks and glaciers. Uttarakhand lies on the southern slope of the Himalaya range, and the climate and vegetation vary greatly with elevation, from glaciers at the highest elevations to subtropical forests at the lower elevations.

Study of rainfall based on an integrated perspective of its attributes like spatio-temporal variation, persistence, trends, periodicities etc is very essential for understanding the nature of weather and climate patterns. A good knowledge of local rainfall-regime is crucial for planning and management of domestic, urban as well as industrial water use, irrigation and crop practices besides forecasting and management of extreme events like floods and droughts. In view of the recent flood disaster in the

Uttarakhand state, it becomes all the more important to carry out a scientific analysis of the rainfall regime of the region.

Rainfall observations are an essential element of studies related to hydrological processes. They are utilized both for a better understanding of these processes and as input in hydrological simulation models indispensable to a correct territorial planning and to an adequate management of water resources system. Rain gauges, radars, satellite sensors, forecasts from high resolution numerical weather prediction models and high resolution gridded re-analysis rainfall data are a part of precipitation monitoring networks/data sources. These data sources provide rainfall data that are further provided to hydrological models to produce forecasts, therefore, their comparative accuracy assessment is of prime importance.

Methodology

Trend analysis of historical rainfall data

The objective of a trend analysis is to find out whether a given time series shows an increasing or decreasing tendency over a given period of observation. Confirmatory method of data analysis detects the trends present in a time series and also estimates the rate of the identified trends. Both parametric and non-parametric methods of statistical trend analysis have been extensively used for detection of linear trends in climatic data series. However, form of test and the underlying sample distribution assumptions vary according to the objective of trend analysis. In the present study, linear trends will be estimated using the three methods: linear regression, Mann-Kendall test and Sen's slope estimator considering the advantages and disadvantages of the three methods.

Comparison of rainfall data from different sources

Comparison of rainfall data from two different sources, viz TRMM satellite data products and APHRODITE high resolution gridded re-analysis data will be carried out considering observed rain gauge data as base data.

5. Research outcome from the project

The output of the study would be in the form of a comprehensive report. It is envisaged that the information generated out of this study will add substantially towards better planning, design, development and management of water resources of the basin. It will be useful for the Water Resources Department in particular and people at large in general.

6. Cost estimate:

(i) Total cost of the project: 7.10 Lakh

(ii) Source of funding: NIH budget

i) Sub- Head wise abstract of the cost

Sl.No.	Sub-head	Amount (in Rupees)
1.	Salary	**4,50,000**
2.	Travelling expenditure	**1,50,000**
3.	Infrastructure/Equipment	**40,000**
4.	Experimental charges	**30,000**
5.	Misc. expenditure	**40,000**
	Grand Total:	**7,10,000**

j) Justification for Sub-head-wise abstract of the cost

i) Salary:

(a) Technical services of Sc 'G', Sc 'D' and one PRA will be utilized for achieving the targets.

ii) Travel Expenditure:

Travels would be essential for data collection from various agencies and ground truth survey in the study area.

iii) Infrastructure/Equipment:

Rainfall data will be obtained/procured from the agencies that are operating in the area and also from IMD and other agencies.

iv) Experimental Expenses

Field expenses: @ Rs. 20,000/- per year for one and a half years. Total Rs.30,000/-.

v) Miscellaneous Expenses

Stationary, Contingency, Report Printing, etc

8. **Quarterly Break up of cost estimate for each year**

Year: 2 (2015-16)

Sl.No.	Sub-head	Amount (in Rupees)				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1	Salary	75,000	75,000	75,000	75,000	3,00,000
2	Travelling expenditure	25,000	25,000	25,000	25,000	1,00,000
3	Infrastructure/Equipment	-	20,000	20,000	-	40,000
4	Experimental charges	5,000	5,000	5,000	5,000	20,000
5	Misc. expenditure	5,000	5,000	5,000	10,000	25,000
	Sub- Total:	1,10,000	1,30,000	1,30,000	1,15,000	4,85,000
	Grand Total	**4,85,000/-**				

Year: 3 (2016-17)

Sl.No.	Sub-head	Amount (in Rupees)		
		1st Quarter	2nd Quarter	Total
1	Salary	75,000	75,000	1,50,000
2	Travelling expenditure	25,000	25,000	50,000
3	Infrastructure/Equipment	-	-	
4	Experimental charges	5,000	5,000	10,000

5	Misc. expenditure	5,000	10,000	15,000
	Sub- Total:	1,10,000	1,15,000	2,25,000
	Grand Total	**2,25,000/-**		

Note:

(i) The above table has to be prepared for each year of the project period

(ii) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

9. **Work Schedule:**

a. Probable date of commencement of the project: **April 1, 2014.**

b. Duration of the project: **2.5 years**

c. Stages of work and milestone:

S. No.	Work Element	First Year				Second Year				Third Year	
		Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2
1	Additional rainfall data procurement, data processing										
2	Trend Analysis of historical rainfall data (Annual and seasonal)										
3	Downloading of APHRODITE daily rainfall data, its processing and trend analysis (Annual and seasonal)										
4	**Interpretation of Results, Preparation & Submission of Interim Report-I**										
5	Trend Analysis of historical rainfall data (different rainfall intensity series)										
6	Downloading of TRMM satellite data and processing of the downloaded data										
7	Analysis and comparison of rainfall data from different sources using statistical parameters										
8	Preparation & Submission of **Interim Report-II**										
9	comparison of rainfall data from different sources using a hydrological model										
10	Preparation & Submission of **Final Report**										

Progress (2014-15)

- Procurement of additional rainfall data, processing of missing data and annual and seasonal rainfall series generation
- Downloading of APHRODITE daily rainfall data and its processing
- Trend Analysis of historical rainfall data (annual and seasonal)

Preparation of Interim report (under progress)

8. PROJECT REFERENCE CODE : NIH/SWD/NIH/13-16

1. **Thrust Area under XII five year Plan**: Water Resources Development and Management
2. **Title of Study:** Quantitative assessment of uncertainties in river discharge estimation.
3. **Study Group :** Sanjay Kumar, Sc-D, PI
   Sharad Jain, Sc-F, Co-PI
4. **Objectives of the study:**

The objectives of the study are:

1. To estimate uncertainty in river discharge observations.
2. To estimate uncertainty in the stage-discharge (rating) relationship.
3. To estimate uncertainty in stage- discharge relationship using slope as a parameter (back water effects).

5. **Statement of the problem:**

The uncertainty in the river discharge measurement and estimation is caused by different sources of errors. These mainly includes uncertainty in (a) observations of river stage and discharge used to parameterize the rating curve, (b) presence of unsteady flow conditions, and (c) interpolation and extrapolation errors of the rating curves. The study will provide a framework for analyzing and quantifying the uncertainty in the (i) river flow data (ii) stage-discharge relationship and (iii) stage-slope-discharge relations (for backwater effects) based on the ISO documents GUM (Guides to the expression of Uncertainty in Measurement), HUG (Hydrometric Uncertainty Guidance), ISO 773, 5168, 7066 and 768. The study will also examine various hydraulic factors controlling the flow at a cross section in the river and provides an understanding of independent variables that describes relations among stage, discharge and other parameters specifically discharge measurement under back water effects.

6. **Methodology:**

Statistical methods/tools and the procedures described in various ISO documents (GUM, HUG) will be used for the estimation of river discharge uncertainties. The uncertainty in discharge measurement (assuming velocity area method) will be quantified as per the ISO 748 which provides the magnitude of these errors at 95% confidence level. The GUM defines the law of propagation of errors for combining uncertainties from several sources and HUG described it for different types of mathematical expressions generally used in hydrometry. This is illustrated by considering the quantity Q as a function of several measured quantities x, y, z . The error δQ in Q due to errors δx, δy, δz…. in x, y, z…., respectively, is given by

$$\delta Q = \frac{\partial Q}{\partial x}\delta x + \frac{\partial Q}{\partial y}\delta y + \frac{\partial Q}{\partial z}\delta z + \cdots$$

The uncertainty of a discharge measurement determined from a stage-fall-discharge rating function (as opposed to a gauged discharge which is determined from a current meter) shall be evaluated using statistical equations based on law of propagation of errors described

above. Let X_{rd} be the uncertainty in the recorded discharge, the above error equation is then modified for uncertainty in discharge compution using stage-fall-discharge relationship as

$X_{rd}=\pm(X_{\alpha}{}^{2} + \beta^{2}X^{2} h_{u/s\text{-}h0} + \gamma^{2}X^{2}_{hu/s\text{-}hd/s})^{1/2}$

In practice, X_{α} is the standard error of the mean relation ($S_{mr).}$ $Xh_{u/s\text{-}h0}$ is the standard error of upstream gauge and $X_{h\ u/s\text{-}h\ d/s}$ is the standard error of fall between the u/s and d/s gauges.

7. Deliverables: Revised ISO document**,** Research papers and Report

8. Cost estimate for the FY 2015-16 (continuing)

a. Total cost of the project:

b. Source of funding: Internal

c. Sub head-wise abstract of the cost

S.N.	**Sub-head**	**Amount (in Rupees)**
1.	Salary	24,60,000.00
2.	Travelling expenditure (domestic/international)	100,000.00
3.	Infrastructure/Equipment	100,000.00
4.	Experimental charges	00.00
5.	Misc. expenditure	50,000.00
	Grand Total:	27,10,000.00

d. Justification for Sub-head-wise abstract of the cost

In the year (2015- 16), technical services of Sc'G' and Sc 'D' will be utilized for the achieving the targets. Domestic and international travel for attending various meeting of OSO and BIS related to revising the ISO 9123 document. Availing/procuring computing facilities in the institute and miscellaneous contingencies.

9. Quarterly Break up of cost estimate for each year (FY 2015-16)

S.N.	**Sub-head**	**Amount (in Rupees)**			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	615000.00	615000.00	615000.00	615000.00
2.	Travelling expenditure	25,000.00	50,000.00	25,000.00	00.00
3.	Infrastructure/Equipment	25,000.00	75,000.00	00.00	00.00
4.	Experimental charges	00.00	00.00	00.00	00.00
5.	Misc. expenditure	10,000.00	20,000.00	10,000.00	10,000.00
	Sub- Total:	6,75,000.00	7,60,000.00	6,50,000.00	6,25,000.00
	Grand Total	27,10,000.00			

Note:

(2) The above table has to be prepared for each year of the project period

(3) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

10. Action plan and timeline and progress:

S.N.	Major Activities	1st Year		2nd Year		3rd Year	
1	**Literature review including related various ISO standards**						
2	**Estimation of uncertainty in river discharge measurements (Interim Report-1)**						
3	**Estimation of uncertainty in stage-discharge (rating) relationship using slope as a parameter (back water effects) (Interim Report-2)**						
4	**Estimation of uncertainty in stage-discharge (rating) relationship. (Interim Report-3)**						
5	**Preparation of final report**						

Progress:

(i) As required by ISO/BIS the NWIP and the working draft of the revised ISO 9123 with updated uncertainty clause has been submitted to BIS/ISO for consideration.

(ii) The working draft of the ISO 9123 has been circulated to SC1 members bodies for call of experts.

(iii) The review comments from experts has been resolved.

(iv) The review comments from member bodies has been received and currently being resolved.

9. PROJECT REFERENCE CODE: NIH/SWD/NIH/14-15

Title of the study	Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills.
Name of PI, Co-PI, & their affiliation	Dr. Avinash Agarwal (PI), Dr. Manohar Arora (Co PI), RK Nema (PRA)
Type of study	Internal funded
Date of start	Nov. 2013
Schedule date of completion	Nov. 2013 to Oct. 2016 (3 Years)

Role of team members

Dr. Avinash Agarwal (PI): Field visits, collection of electronic data, processing and plotting of data. Analysis of rainfall, runoff spring flow data. Development of implement-able technology for water availability and transfer. Progress, presentation and final reporting.

Dr. Manohar Arora (Co PI): Field visits. Assessing in collection of electronic data and in development of implement able technology for water availability analysis. Presenting the progress of work when required. Transfer of technology

Sh. R K Nema (PRA): Field visits. Collection of tabulated data. Keeping the record of skilled and unskilled daily wages. Proper running of all field instrument and observatory. Visits of the sites for its proper up date. Assessing in transfer of technology

Location of study area

Study area of this project lies in 'Western Himalaya' agro-ecological region of the Sub-humid ecosystem at elevation of 720 m to 2350 m. Climate in this region is warm with air temperature 3^{o}C to 35^{o}C sub-humid to humid and per-humid with average annual rainfall 900 mm to 1200 mm respectively for Chandrabhaga and Danda watersheds (Uttarakhand). Reliable source of water in the watersheds is only the existing springs in the watersheds.

Objectives of the study:

- Identification and development of river gauging sites. Installation of equipments for long term data base.
- Development of rainfall-runoff-suspended sediment yield model using satellite and general soil information.
- Classification of short and long term springs and development of spring flow model using topographic, hydrologic information such as hydraulic conductivity and effective porosity along with the recession characteristics of fractured soil media.
- Rejuvenation of few selected springs through woven wire check dams/infiltration tanks and to study changes in flow.
- Impact of climatic variability on runoff and spring flows.

Statement of the problem:

The monitoring continued with a network of instrumentation for watersheds (Chandrabhaga, Danda) with Rainfall (08 locations), runoff (3 locations), AWS One location for rainfall, temperature, humidity, wind speed & direction incoming radiation, pan evaporation and soil moisture (different depths), soil temperature (two depths). Daily spring flow of around twenty locations in each watershed is measured. The spring flow models will be developed considering topographic and hydrologic information. A long term spring flow record for

springs is developed for climatic variability of the springs and for evaluation of spring flow with time.

Recommendation and suggestions in previous meeting of working group

Discussions were held with following comment/recommendation.	
▪ It was advised by the group that the tracer technique must be adopted to exactly identify the points/s of recharge to springs before taking any rejuvenation activity. ▪ The impact of rejuvenation must be reported	▪ PI accepted the suggestions and informed that full weight age will be given to suggestions when the rejuvenation activities will be taken up. ▪ The results will be given as suggested.

Analysis of results

(a) Maintenance and up keeping of installed equipments and data collection.

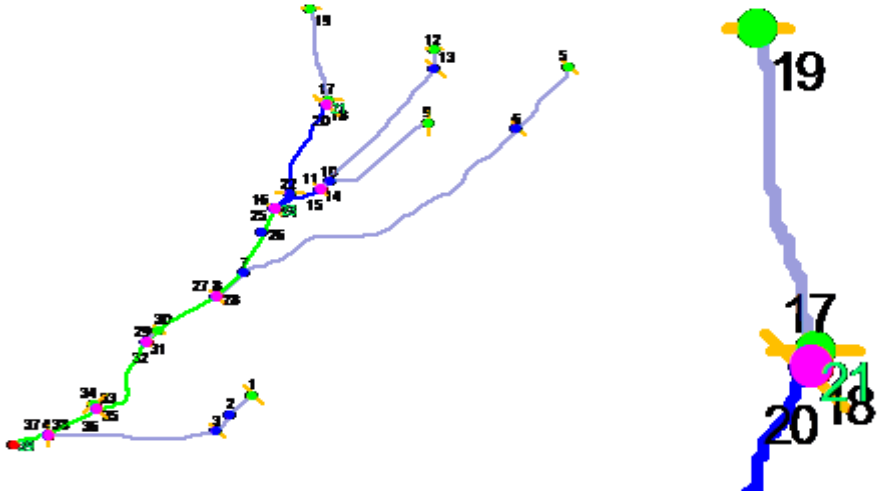
(b) Spring classification on the bases of spring discharge using Meinzer's classification.

(c) 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.

(d) Spring-shed for the springs of watersheds are defined and the spring-shed area has been estimated.

(e) Under Development of runoff, sediment transport model aCCH1D (National Center for Computational Hydro Science and Engineering) flow model is being applied. The input channel geometry, bed sediment, bank sediment, sediment classification are created and given to the model. The river geometry has been defined below as;

Geometry



Results in brief

1. The flow at each input green node is being estimated by SWAT.
2. SWAT inputs files (soil, land use, weather input) have been developed.

List of deliverables	Hydro-meteorological data, papers and report for small watershed of Uttarakhand.
Major items of equipment procured	Nil
Lab facilities used during the study	Nil
Data procured and /or generated	Soil data of UP and Uttarakhand (being

	procured) Spring flow (generated)
Study benefits/impacts	Hill habitat, State Government and other agencies.
Specific linkage with institutions and/or end-users/ beneficiaries	Village wise interactive work shops in the watershed are proposed
Shot comings/ difficulties	Nil
Future plan	Model development

10. PROJECT REFERENCE CODE: NIH/SWD/NIH/14-17

Title of the Study: Monitoring and modelling of streamflow for the Gangotri Glacier

Study Group : Dr Manohar Arora Sc 'C'
Dr Rakesh Kumar Sc 'F'

Role of Team Members:

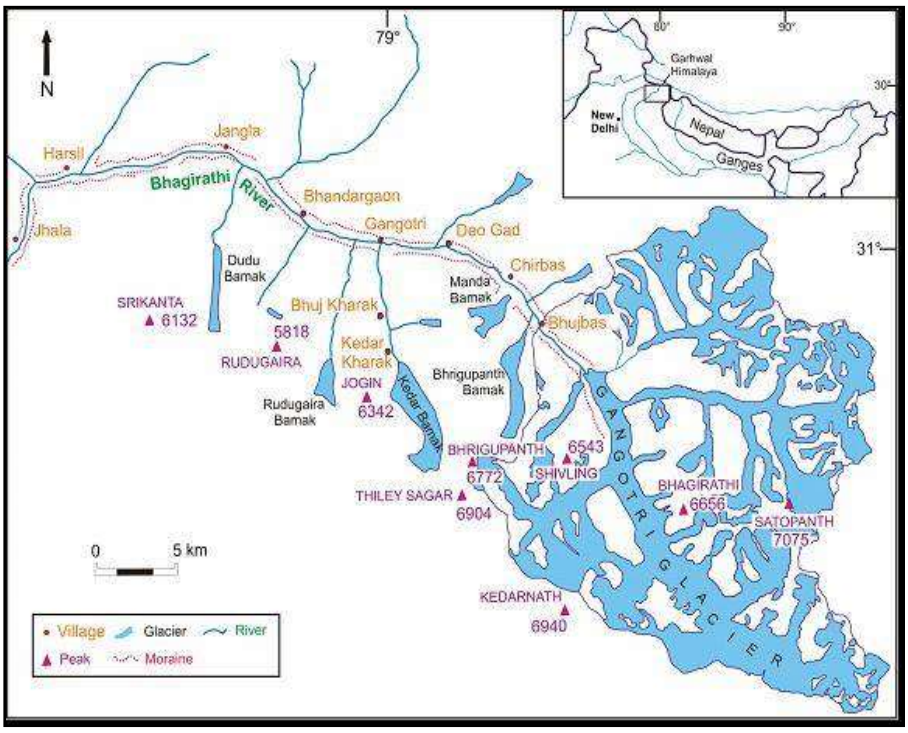
1. **Dr . Manohar Arora, Scientist C& PI:** Conduction field investigations, analyzing data/information, report preparation and overall responsible for the study completion.
2. **Dr Rakesh Kumar, Scientist F &** Co-PI: Guidance in development of methodology, modelling and structuring of report.

Type of Study : Sponsored

Date of start : 01.5. 2014

Scheduled date of completion : 31.03.2017

Location Map:



Objectives: The objective of this study includes:

- Continuous observations of meteorological, hydrological and suspended sediment data for the melt season to determine monthly and seasonal specific water and sediment yield from the study glacier.

- To study the melt water storage and drainage characteristics of the glacier and to simulate daily streamflow using a conceptual hydrological model using observed meteorological and hydrological data.
- Modeling the role of glacier in catchment runoff variation.
- Modeling the catchment runoff variation under different climatic scenarios.

Statement of the problem : The study involves collection and analysis of hydro-meteorological and discharge data of the glacier site. The second step is to develop and apply a snow melt model for streamflow generation and identification of different runoff components. The third step is to model role of glacier in catchment runoff variation and catchment runoff variation under different scenarios.

Approved action plan:

Year	May to October	November to April	Remark
All Years	Field investigations & Data Collection	Data analysis	Report preparation after three years

Objectives vis a vis Achievements:

Objectives	Achivements
Continuous monitoring of meteorological and hydrological data for monthly and seasonal specific water yield and its variability from the year to year	The data collection and field investigations for the summer 2014 have been collected. The team had returned successfully on 17th October 2014
To study the melt water storage and drainage characteristics of the glacier and to simulate daily streamflow using a conceptual hydrological model using observed meteorological and hydrological data.	The data has been analyzed for the ablation season 2014. It is observed that the Maximum Temperature ranged between 21.2°C to 7.1°C. The standard deviation was 2.6. The Minimum Temperature ranged between 13.4°C to -4.3°C. The standard deviation was 3.2. The Mean Temperature varied between 15.1°C to 3.4°C. The standard deviation was 2.4. The total rainfall observed was 193 mm and the maximum rainfall was 28.8mm. The discharge varied between 199 m^3/s to 3.8 m^3/s. The mean suspended sediment concentration was 1265 mg/l and the suspended sediment load was 12421 tonnes. The melt water storage and drainage characteristics for this season is under progress. The estimation of snow cover area for the modeling is also in progress. The climatic scenarios are being generated in collaboration with IIT Delhi.

Recommendations of Working Group/TAC/GB:

The study may be continued for long term to link with climate change.

Analysis and Results:
The Department of Science and Technology has sponsored this study. This is the first year and the investigations were started on 17th May 2014.

Adopters of the results of the study and their feedback:
The study is a sponsored study and the results will be disseminated by DST.

List of deliverables:

Major items of equipment procured: Nil

Lab facilities during the study: Analysis of suspended sediment samples will be carried out in Soil Lab.

Data generated in the study: Meteorological and hydrological data for the Gangotri Glacier.

Study Benefits/Impact: The study is being sponsored by DST. The meteorological and discharge data would be utilised in studying the characteristics of the Gangotri glacier under changing climate.

Specific linkages with Institutions/beneficiaries: The data collected is also being shared with the authorities of Gangotri National Park. The details of sediment concentration are being communicated to the downstream Dam authorities.

Shortcomings/Difficulties: The study involves four months of extensive field work and maintenance of construction site etc. Without the support of project staff it is difficult to manage data collection.

Future Plan: The study will be conducted for long term. The Himalayan glaciers are poorly monitored. There is very little or sparse data of Himalayan Glaciers The collected data will be used for climate change studies.

11. PROJECT REFERENCE CODE: NIH/SWD/NIH/14-17

Title of the study: Effect of climate change on evaporation at point scale

Study Group:

Sh. Digambar Singh, Sc B, SWHD
Dr. A. R. Senthil kumar Sc E, SWHD
Dr. Manohar Arora, Sc D, SWHD

Date of start: 1 June 2014

Duration of the study: 3 Years

Whether externally funded or not: No

Objectives of the study:

v. To develop evaporation model by empirical and soft computing techniques
vi. To downscale the data of temperature, rainfall and humidity from GCM model
vii. To determine the effect of climate variables on evaporation by using the downscaled data

Brief Methodology:

Evaporation model

Multiple Linear regression (MLR) and soft computing techniques would be applied to model the evaporation with rainfall, temperature and humidity as input vectors.

Development of climate scenarios

The prediction of rainfall, minimum and maximum temperature and humidity for future is possible by considering the statistical properties of the time series. The weather generators, considering the future carbon emissions, radiation and effects of green house gases, have been developed to generate the time series by fitting a distribution to the times series and by using the properties of distribution of the times series. The different scenarios of climatic conditions such as A1F1, B1 and baseline can be obtained from SDSM (**Statistical DownScaling Model)** from UK/PRECIS from IITM, Pune. The best models developed by soft computing techniques to simulate the evaporation from historical values of rainfall, maximum and minimum temperature and humidity at the site can be utilized to generate the evaporation from the generated values of rainfall and maximum and minimum temperature and humidity for different climatic scenarios as mentioned above. The falling and rising values of evaporation from the different climate scenarios would give an idea to the official dealing with the planning of cropping pattern.

Results achieved with progress/present status

The literatures related to statistical downscaling from GCM have been reviewed from renowned international journals. The daily data of rainfall, temperature, relative humidity, wind speed and evaporation at NIH observatory are available from 1987 to 2014 and the data

have been analyzed for gaps and errors and the same have been removed. The empirical method, modified Penman method, is used to compute the evaporation from the available data.

Meteorological data have been categorized in five series such as pre monsoon, monsoon, post monsoon, winter and annual. The characteristics of Meteorological data are being studied in detail to finalize the significant independent variables to model the evaporation. ANN model for simulating evaporation has been developed using Meteorological data such as rainfall, maximum temperature, minimum temperature and humidity as input data. Results of the different combinations of ANN model are presented in the following table.

Results of ANN model during calibration and validation

Model No	Input Combination	ANN Structure	Calibration			Validation		
			CORR	RMSE	EFF %	CORR	RMSE	EFF %
ANNEVAP1	R (t-1), maxt(t), mint(t), hum(t-1)	4-1-1	0.8753	1.0462	0.7662	0.8852	1.0245	0.7743
ANNEVAP2	"	4-2-1	0.8792	1.0310	0.7730	0.8883	1.0064	0.7822
ANNEVAP3	"	4-3-1	0.8810	1.0236	0.7762	0.8890	1.0082	0.7814
ANNEVAP4	"	4-4-1	0.8831	1.0151	0.7800	0.8897	1.0045	0.7830
ANNEVAP5	"	4-5-1	0.8829	1.0161	0.7745	0.8888	1.0023	0.7840
ANNEVAP6	"	4-6-1	0.8838	1.0125	0.7811	0.8897	1.0057	0.7825
ANNEVAP7	"	4-7-1	0.8851	1.0070	0.7835	0.8846	1.0051	0.7827
ANNEVAP8	"	4-8-1	0.8843	1.0102	0.7820	0.8903	1.0017	0.7842
ANNEVAP9	"	4-9-1	0.8864	1.0016	0.7857	0.8894	1.0052	0.7827
ANNEVAP10	"	4-10-1	0.8836	1.0134	0.7807	0.8910	0.9976	0.7860

The model ANNEVAP4 with ANN structure 4-4-1 is best among all the structure, because the performance of the structure in terms of all the statistical parameters is best among all ANN structures. Though the performance of ANN structure 4-10-1 is better than other models considered the difference between the results during calibration and validation are negligible. After increasing the number of hidden neurons more than 4 the performance of the model is fluctuating (decreasing and then it is increasing) and it might have led to over fitting of the model parameters and a large ANN structure. Correlation between meteorological and evaporation data is being studied.

12. Cost estimate:

(i) Total cost of the project: 2.35 Lakhs

(ii) Source of funding: NIH budget
(iii)Sub- Head wise abstract of the cost

Sl.No.	Sub-head	Amount (in Rupees)
1.	Travelling expenditure	**1,65,000**
2.	Experimental charges	**10,000**
3.	Misc. expenditure	**60,000**
	Grand Total:	**2,35,000**

Justification for Sub-head-wise abstract of the cost

iv) Travel Expenditure

(a) Vehicle hiring = Rs. 15000/-
(b) TA/DA = Rs 1,50,000/-

v) Experimental Expenses

*(a) **Field expenses**: @ Rs. 5000/- per year for three years. Total 15000 /-*

vii) Miscellaneous Expenses

(a) Stationary: Rs. 5,000/- per year at a total cost of 10,000/- for 2 years
(b) Contingency: Rs. 5,000/- per year at a total cost of 10,000/- for 2 years
(c) Report Printing: Rs. 50,000/-

Quarterly Break up of cost estimate for each year

Year: 2

Sl.No.	Sub-head	Amount (in Rupees)				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1.	Travelling expenditure	-	55,000	-	55,000	1,10,000
2.	Experimental charges	1,000	1000	1,000	2000	5,000
3.	Misc. expenditure	1,000	1,000	2,000	1,000	5,000
	Sub- Total:	2,000	57,000	3,000	58,000	1,20,000
	Grand Total	1,20,000				

Year: 3

Sl.No.	Sub-head	Amount (in Rupees)	

		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1	Travelling expenditure	-	55,000	-		55,000
2	Experimental charges	1,000	1000	1,000	2000	5,000
3	Misc. expenditure	1,000	2,000	2,000	50,000	55,000
	Sub- Total:	2,000	58,000	3,000	52,000	1,15,000
	Grand Total	1,15,000				

Note:

(i) The above table has to be prepared for each year of the project period

(ii) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

14. Action plan and timeline

Year	April - June	July-Sept	Oct-Dec	Jan-March
2014-15	Literature review, Data collection and compilation	Literature review, Data collection, compilation and processing	Development of model for evaporation by empirical and soft computing techniques	Development of model for evaporation by empirical and soft computing techniques
2015-16	Development of model for evaporation by empirical and soft computing techniques	Development of climate scenarios from SDSM/PRECIS	Development of climate scenarios from SDSM/PRECIS	Development of climate scenarios from SDSM/PRECIS
2016-17	Simulation of evaporation by considering the climate scenarios	Simulation of evaporation by considering the climate scenarios	Simulation of evaporation by considering the climate scenarios	Writing of final report

Expected date of completion: 31 March 2017

12. PROJECT REFERENCE CODE: NIH/SWD/NIH/14-17

1. Thrust area under XII five year Plan

Hydrological modelling, water availability analysis

2. Project team:

a. Project Investigator: J.P.Patra, Sc. – B, SWHD

b. Project Co-Investigator (s): Dr. Rakesh Kumar, Sc. – G & Head SWHD
Pankaj Mani, Sc – D, CFMS Patna

3. Title of the Project

Hydrological modelling of Brahmani Baitarani river basin using eWater Source platform.

4. Objectives

a. Statistical and trend analysis of rainfall and river discharge in Brahmani Baitarani river basin.

b. Development of rainfall runoff model for Brahmani Baitarani river basin using eWater source platform.

c. Investigation of implications of different rainfall inputs on rainfall–runoff simulation.

d. Test the applicability of the eWater source modelling platform in Brahmani Baitarani river basin by generating hydrological time series.

5. Present state-of-art

The eWater source is Australia's first national river basin scale water modelling system. The source modelling platform has been developed to take a holistic approach to water management including human and ecological impacts. This includes integrating policy, addressing water savings and sharing for a whole river and connected groundwater systems including cities, agricultural and environmental demands.

In the India-Australia Water Science and Technology Partnership programme, Australia is collaborating with the Ministry of Water Resources to pilot the source river basin modelling platform in India. The MoWR, GOI is planning to develop an Integrated Water Resources Management (IWRM) plan for Brahmani Baitarani basin using the source river basin modelling platform. Hence, the present study has been formulated to develop a rainfall runoff model for Brahmani Baitarani river basin in source platform and test its applicability by generating hydrological time series.

6. Methodology

The Brahmani Baitarni basin (Fig. 1) extends over states of Odisha, Jharkhand and Chhattisgarh with catchment area of about 51,822 km^2. The basin is bounded by the Chhotanagpur Plateau on the north, by the ridge separating it from Mahanadi basin on the west and the south and by the Bay of Bengal on the east. The Brahmani known as South Koel in its upper reaches rises near Nagri village of Jharkhand at an elevation of about 600 m and has length of about 800 km. In its tail reach, the river is known as Maipura. The Baitarni raises near Dumuria village in the hill ranges of Kendujhar district of Odisha at an elevation of about 900 m and has a length of about 355 km.

The river is known as Dhamra in its lower reaches. Brahmani and Baitarni form common delta area before falling into the Bay of Bengal. The lower reaches of the basin near the deltaic area are subject to floods. Moreover Mahanadi, Brahmani and Baitarani are interconnected near their delta, worst flood occur when there is simultaneous heavy rains in all the three catchments. Floods are also caused from cyclonic storms since the coastal areas of the basin are cyclone-prone. The industrial development potential of this basin is very high due to its rich mineral resources (iron ore, copper, bauxite etc.) and power potential (548 MW at 60% load factor). Rourkela is an important industrial centre located in this basin. There various other industries (Iron and steel, Thermal power plant, fertilizers etc) existing the basin and more than 50 small to large industries are planned to set up in the upper and middle reaches of the basin. Hence, in future there will be very high water demands from industrial sectors.

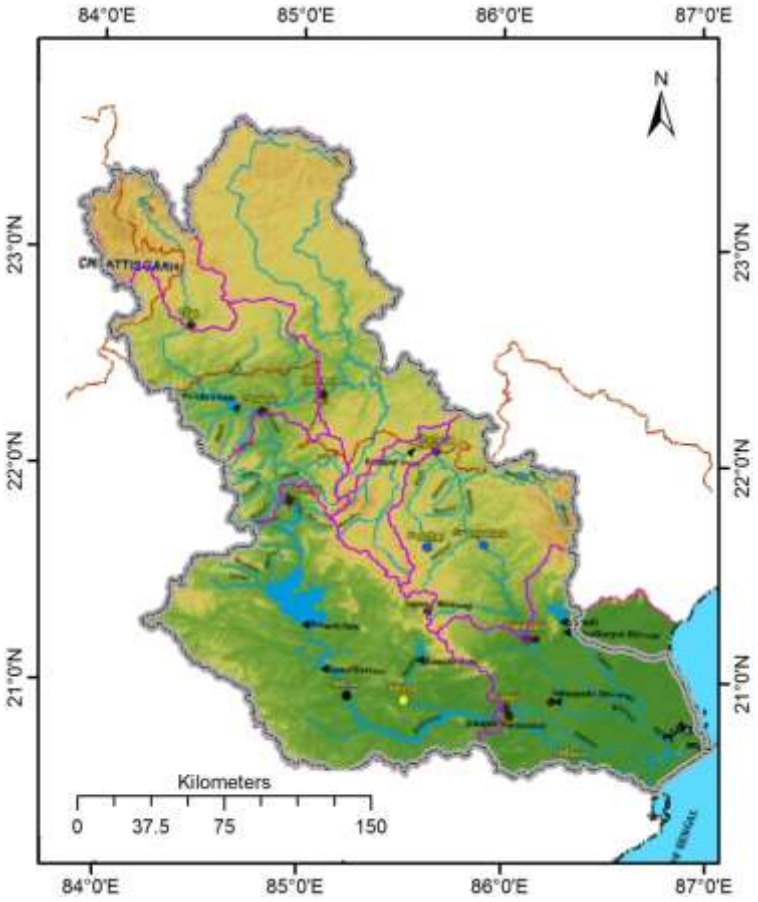


Fig. 1: Index map of study area

Historical rainfall and flow data of the Brahmani Baitarani river basin will be collected and time series of monthly, seasonal and annual values of rainfall and discharge will be analyzed using statistical methods. Trend analysis will be performed to determine whether or not there have been any significant changes in rainfall and discharge over this catchment. The analogue year's plots will be used to identify years with near normal, above normal and below normal conditions, using the long term mean of the variables.

Rainfall runoff models are used to derive runoff for a particular area from inputs of rainfall and potential evapotranspiration. All rainfall runoff models in source are conceptual models that represent catchment hydrological response to rainfall as a series of mathematical relationships. They provide runoff output from each functional unit as total discharge, which is split into quick flow (surface flow) and slow flow (baseflow) proportions. The rainfall-runoff models presently available in source are: Sacramento (sixteen parameters), SIMHYD (7 parameter), SMARG, GR4J (modèle du Génie Rural à 4 paramètres Journalier) (four parameters), IHACRES (six parameters), AWBM (3 parameter), SURM. These models will be configured to run the rainfall-runoff models at the catchment scale.

Different methods are available to obtain the daily rainfall time series for conceptual rainfall–runoff models, depending on data availability, time constraints etc. The implications of different rainfall inputs on the calibration and simulation of rainfall–runoff models will be analysed. First, the simulated runoff resulting from single lumped daily rainfall series for each catchment obtained from three methods: single rainfall station, thiessen average, and average of interpolated rainfall surface will be compared. Secondly, runoff generated from catchment modelling using daily/monthly rainfall series and modelling with smaller functional units within a sub catchment will be compared. The source platform includes set of optimisation tools for calibration of various model parameters. These high-level optimisation features include: Shuffled Complex Evolution (SCE-UA), multi-objective complex evolution (MOCOM-UA), Rosenbrock and other optimisation algorithms; predefined and user defined custom objective functions; option for custom optimisation problems such as regional calibration. Some of these techniques will be applied to calibrate the model. Finally, the calibrated model will be used to simulate hydrological time series for various time periods and will be compared with observed time series to test the applicability of the eWater source modelling platform in Brahmani Baitarani river basin.

7. Research outcome of the project

- Trends of rainfall and stream flow in the Brahmani Baitarani river basin.
- Calibration and validation of various model parameters of eWater source modelling platform for Brahmani Baitarani river basin.
- Water availability at various rivers reaches and sub catchments.
- Quantify rainfall-driven runoff in the catchment under present conditions and alterations made to runoff by climate variability, different land uses etc.
- Applicability of the eWater source modelling platform in Brahmani Baitarani river basin.
- The rainfall runoff modelling setup will help in development of IWRM plan in Brahmani Baitarani river basin.
- Research papers and reports.

8. Cost estimates

a. Total cost of the project: ₹ 25,70,000

b. Source of funding: Internal

c. Sub Head wise abstract of the cost

SI. No.	Sub head	Amount (in Rupees)
1	Salary (PI, Co PI, technical staff)	16,10,000
2	Travelling expenditure	5,10,000
3	Infrastructure/Equipment	1,50,000
4	Experimental charges/ Data	1,50,000
5	Misc. expenditure	1,50,000
	Grand Total:	25,70,000

d. Justification for Sub-head-wise abstract of the cost

Salary: Salary for PI, CoPIs and technical staff are included with respect to man days involved in the study.

Travel Expenditure: Funds would be required towards TA/DA by PI and team members for visits to Brahmani Baitarani river basin and departments maintaining related datasets for discussions, information collection, verification and assessment of data and results. Part of the travel grants will be used to participate in conferences and workshops to disseminate preliminary results of the project, and to obtain critical feedback. Further, travel of the project investigators to CWC, MoWR meetings and relevant training/workshops would also be met from the travel head. Travel expenses for field visits, data collection etc. = ₹ 3,00,000 (6 trips, @ Rs. 50,000 per trip per person); Travel expenses to attend training, conferences/workshop = ₹ 1,80,000 (6 travels, @Rs 30000 per person per trip); Travel expenses for attending meetings at CWC/MoWR = ₹ 30,000 (6 travels, @Rs 5000 per trip).

Infrastructure/Equipment: The source platform requires high end systems to run effectively. Recommended system requirement for the source platform is Windows with 16 GB RAM (Minimum 4 GB) and minimum 10,000 rpm hard drive. One high end desktop is required for this study. External hard disk, UPS, laser printer etc. are also required. Further basic furniture like one computer table, chair and storage are required. 1 High end PC = ₹ 60,000; 1 Laser Printer = ₹ 40,000;

Hard disk, UPS etc. = ₹ 25,000, Furniture (computer table, chair, storage/book case) = ₹ 25,000.

Experimental charges/ Data: The project involves purchase of extensive data (hydro meteorological and satellite images, thematic maps), visits to several government agencies for collection these data. Services of assistants/helpers will be needed during field surveys for ground truth verification and data collection.

Misc. expenditure: Expenses would be incurred for purchase of stationery, cartridges of printer and other consumables, charges towards colour printing of large size maps, preparation of project reports and for meeting expenses of other unforeseen needs of the project.

9. Quarterly Break up of cost estimate for each year

Year: 2014-15

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	1,20,000	1,20,000	1,20,000	1,20,000
2.	Travelling expenditure	-	50,000	35,000	80,000
3.	Infrastructure/Equipment	-	40,000	-	-
4.	Experimental charges	-	25,000	-	25,000
5.	Misc. expenditure	10,000	10,000	10,000	15,000
	Sub- Total:	92,500	2,45,000	1,65,000	2,40,000
	Grand Total	7,80,000			

Year: 2015-16

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	1,47,500	1,47,500	1,47,500	1,47,500
2.	Travelling expenditure	35,000	50,000	55,000	80,000
3.	Infrastructure/Equipment	60,000	50,000	-	-
4.	Experimental charges	25,000	25,000	-	25,000
5.	Misc. expenditure	10,000	15,000	10,000	15,000
	Sub- Total:	2,77,500	2,87,500	2,12,500	2,67,500
	Grand Total	10,45,000			

Year: 2016-17

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	1,35,000	1,35,000	1,35,000	1,35,000
2.	Travelling expenditure	55,000	35,000	5,000	30,000
3.	Infrastructure/Equipment	-	-	-	-
4.	Experimental charges	25,000	-	-	-
5.	Misc. expenditure	10,000	10,000	15,000	20,000
	Sub- Total:	2,25,000	1,80,000	1,55,000	1,85,000
	Grand Total	7,45,000			

Note:

(v) The above table has to be prepared for each year of the project period

(vi) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

10. Work Schedule:

a. Probable date of commencement of the project: April 2014

b. Duration of the project: 3 Years

c. Stages of work and milestone:

SI. No.	Work Element	First Year	Second Year	Third Year
1	Literature Review and detailed formulation of research approach			
2	Collection of hydro meteorological data, satellite images, thematic maps etc.			
3	Compilation, statistical and trend analysis of rainfall and river discharge			
4	Rainfall runoff model set up in eWater Source platform			
5	Implications of different rainfall inputs and sub catchment size			
6	Calibration and parameter estimation			
7	Model performance evaluation with in various time periods			
8	Reporting	1st Interim report	2nd Interim report	Final report

Results achieved with progress/present status

During the past one year the major time was devoted for literature review, collection of hydro meteorological data, satellite images, thematic maps etc. and compilation of rainfall and river discharge data. The details of data collected are given in a separate heading. The rainfall and discharge data are analysed for missing value and various statistical properties are calculated. Both parametric and non parametric trend analysis for some of rainfall and river discharge data has been carried out and the rainfall runoff model setup for Brahmani Baitarani river basin using eWater source platform is under progress.

Action taken on comments of previous working group meeting

There were no specific comments.

New Studies

13. PROJECT REFERENCE CODE: NIH/SWD/NIH/15-18

1. **Thrust Area under XII five year Plan**
   Flood & Sediment Modelling
2. **Project team:**
   i. Project Investigator: Dr. A.K. Lohani
   ii. Project Co-Investigator(s):
3. **Title of the Project: Flood and Sediment studies in Himalayan basin using MIKE-11 Model**
4. **Objectives**
   To model the floods generated due to cloud burst events.
   To develop discharge-sediment relationship.
   To assess sediment dynamics in the river system.
5. **Present state-of-art**
   In upper Himalayan basins, several water resources projects are under operation and many more are coming up to harness the water resources. These projects are of considerable national and local importance in terms of hydropower generation, irrigation, flood control and subsequent socio-economic development of the region. In the recent past various cloud burst events have been observed in the Himalayan region. Therefore, it is important to analyze the cloud burst generated floods in the basin. Furthermore, the Himalayan rivers carry very high sediment load. Therefore, keeping in view the upcoming projects and development in the Himalayan region modeling of the sediment dynamics in a river system is need of the day.
6. **Methodology**
   a) Analysis of available precipitation data for different return period for the identified sub basin.
   b) Historical study of cloud bursts in the Himalayan Region.
   c) Study of phenomenon of cloud bursts
   d) Quantification of cloud burst phenomenon into flood hydrograph at the critical section in the river stream.
   e) Flood routing of cloud burst flood.
   f) Development of MIKE-11 based sediment model to assess the sediment dynamics of the river system.
7. **Research outcome from the project**
   The research outcome will be in the form of technical report, research papers.
   Development of methodology for the cloud burse flood modeling and sediment modeling.
8. **Cost estimate:**
   Total cost of the project
   Source of funding
   Sub Headwise abstract of the cost

Sl. No.	Sub-head	Amount (in Rupees)
1.	Salary	15,00,000
2.	Travelling expenditure	50,000
3.	Infrastructure/Equipment	18,00,000
4.	Experimental charges	-
5.	Misc. expenditure	50,000
	Grand Total:	34,00,000

a. Justification for Sub-head-wise abstract of the cost

Salary: It includes salary of the PI and one resource person.

Travelling expenditure: Expenditure towards the field visits and data collection.

Infrastructure/Equipment: Procurement of Mike-11 Software with sediment module and one workstation.

Misc. expenditure: To meet out unforeseen expenditure.

10. Quarterly Break up of cost estimate for each year

Year:

Sl. No	Sub-head	Amount (in Lakh)											
		2015-16				2016-17				2017-18			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	3.75	1	1	1	1.25	1	1	1	1	1	1	1
2.	Travelling expenditure	0.125		0.125		0.125				0.125			
3.	Infrastructure/Equipment	18..00	-	-	-								
4.	Experimental charges	-	-	-	-								
5.	Misc. expenditure	0.125			0.125			0.125				0.125	
	Sub- Total:	**22.00**	**1**	**1.125**	**1.125**	**1.375**	**1**	**1.125**	**1**	**1.125**	**1**	**1.125**	**1**
	Grand Total	**34,00,000**											

11. Work Schedule:

a. Probable date of commencement of the project
b. Duration of the project
c. Stages of work and milestone:

Sl. No.	**Work Element**	**2015-16**	**2016-17**	**2017-18**
1	Data Collection	✓		
2	Procurement of Mike-11 Software	✓		
3	Analysis of available precipitation data for different return period for the identified sub basin	✓✓✓	✓	
	Historical study of cloud bursts in the Himalayan region.	✓✓✓	✓	
	Study of phenomenon of cloud bursts	✓✓	✓	
	Quantification of cloud burst phenomenon into flood hydrograph at the critical section in the river stream		✓✓	
	Flood routing of cloud burst flood.		✓✓	
	Development of MIKE-11 based sediment model to assess the sediment dynamics of the river system.		✓✓✓✓	✓✓✓✓
	Report writing			✓✓

14. PROJECT REFERENCE CODE: NIH/SWD/NIH/15-18

1. Thrust Area under XII five year Plan

2. Project team:

Project Investigator: **Dr ARCHANA SARKAR, Sc 'D', SWHD**
Project Co-Investigator(s):
Er. T. Thomas, Sc D, Regional Centre, Bhopal
Dr. Vaibhav Garg, Sc C, IIRS, Dehradun

Staff: Sh. N.K. Bhatnagar, PRA, SWHD

3. Title of the Project

Snowmelt Runoff Modelling and Study of the Impact of Climate Change in Sharda River Basin

4. Objectives:

i. Preparation of basin maps including DEM and estimation of snow cover area using remote sensing data
ii. Calibration of conceptual snowmelt runoff models namely, SRM and SNOWMOD for Sharda River basin upto Tanakpur.
iii. Development and training of black-box models (ANN models) for simulation of runoff including snowmelt runoff of the Sharda River basin upto Tanakpur.
iv. Inter-comparison of various models.
v. Investigation of the impact of likely future changes in climate on stream flow using downscaled GCM scenarios in the study area.

5. Present state-of-art

The Sharda Valley in Uttrakhand has a vast potential for Water Resources Development, which was not tapped at all during the initial three decades of planned development. The region is mythological abode of Gods; the pilgrim route to Holy Mansarover passes along the Sarda Valley. The river Sharda (or Kali) form the international boundary between India and Nepal, towards the north, from a point called Bramhadeo, about 5 km upstream of Tanakpur. River Sharda originates in the region of Higher Himalayas, near lndo-Tibetan border, from the Glacier of Zaskara range, at about 5250 M. In the upper reaches, in the hills, it is called Mahakali. The river emerges into plains at Bramhadeo and it is called Sharda. The study area extends between 29°0'–30°38'N and 79°28 – 81°7'E covering an area of about 15280 Sqkm, with elevation ranging from 250 to 7000m above msl. About 1732 Sqkm of the total area of the basin is under glacier landscape. The Main River generally flows in north-south direction and is met with by a number of major tributaries from Indian side, namely, Dhauliganga, Goriganga, Sarju and Ladhia. The major tributary from the Nepal side is Chameliya. The Sharda river finally joins the Ghaghra (Karnali) River as its right-bank tributary in Uttar Pradesh. The Sharda Valley in Uttrakhand has a vast potential for Water Resources Development. The Tanakpur Hydroelectric Project (120MW)

was commissioned in 1992 by the NHPC with a barrage on the Sharda River near the town of Tanakpur in the district of Champawat. Mahakali (Sharda in India) is one of the five major river basins of Nepal which is shared with India and of which about 34 per cent of total basin area lies in Nepal. The hydroelectric potential of the valley on the Indian side of the river as assessed by UP Irrigation Department is over 3000 MW; and the power potential of the main Sharda river is assessed as 2000 MW. Therefore, accurate estimation of the basin runoff (including snowmelt runoff) is of extreme importance.

Rainfall-runoff models are of prime importance in the decision making process of water resources planning, design, development and management activities. Such models are used, for example, in the design and operation of hydraulic structures, for flood forecasting, and for evaluating possible impact of land use land cover changes as well as climate changes over a catchment. However, due to the interrelated character of driving factors, i.e., physiographic and climatic factors, the rainfall-runoff process becomes highly complex to understand and also extremely difficult to model. Further, in Himalayan region, like the Sharda River, snowmelt is a governing factor for runoff generation. So, for snow-fed basins, snowmelt runoff component is also required to be incorporated in the modelling approach. It is, therefore required to apply a suitable methodology for modelling the runoff in the Sharda river basin.

Potential climate change and its unfavourable impacts on hydrologic systems pose a threat to water resources throughout the world. The effect of climate on hydrology in tropical Asia has many facets. The Himalayas, which act as a mountain barrier on the earth, where polar, tropical and Mediterranean influences interact, play an important role in maintaining and controlling the monsoon system over the Asian continent. In the Himalayas, the storage of precipitation in the form of snow and ice (in glaciers) over a long period provides a large water reservoir that regulates annual water distribution. The majority of rivers originating in the Himalayas have their upper catchments in snow covered areas and flow through steep mountains. If there is any climatic variability in the Himalayas, the impacts could be felt in regions downstream. Therefore, besides reasonably accurate estimation of the runoff, there is an imperative need to study the impact of climate change on the runoff regime of the Sharda basin in view of its huge water resources potential including uses for hydropower, irrigation etc.

6. Methodology

Generation of Base Maps and Snow Cover Maps

- The Shuttle Radar Topography Mission (SRTM) elevation data at 90 m resolution (3-arc SRTM) will be used in this study which consists of a specially modified radar system that flew onboard the Space Shuttle Endeavour during an 11-day mission in February of 2000. All SRTM data are freely available at the USGS ftp site: http://seamless.usgs.gov/.
- Snow cover area (SCA) is one of the important input parameters in modelling. In the Himalayan region, due to cloud cover it is very difficult to get cloud free satellite data for most part of the year. Therefore, snow covered area in the basin would be determined from Moderate Resolution Imaging Spectro radiometer (MODIS – a NASA space satellite) in the form of eight day composite snow cover data (MODIS/Terra-MOD10A2 products). The chances of getting cloud-free scenes in case of MODIS are higher due to higher temporal resolution. Besides, MODIS has an automated snow-mapping algorithm, which reduces the time and errors incorporated during processing satellite data manually.

Hydrological Modelling for Simulation Runoff including Snowmelt Runoff and Inter-comparison of Models

Two types of modeling approaches would be applied, viz, conceptual modeling approach and black-box modeling approach with two types of models (SRM & SNOWMOD) in the former approach as explained below:

- SRM is a conceptual, deterministic, degree day hydrologic model used to simulate daily runoff resulting from snowmelt and rainfall in mountainous regions where snowmelt is a major runoff factor. It is the most popular temperature index method developed by Martinec for small European basins originally and has been applied in over 100 basins ranging in surface area from 0.8 Sq.km to 917,444 Sq.km in 29 different countries. SRM requires daily temperature, precipitation and daily snow covered area values as input parameters.
- The snowmelt model (SNOWMOD) is designed to simulate daily stream flow for mountainous basins receiving input from both snowmelt and rainfall. It is a semi-distributed model in which division of the basin is carried out into a number of elevation zones and evaluation of different hydrological processes related to snowmelt and rainfall runoff is done zone-wise. At each time step, the model achieves three operations. The first one is the extrapolation of the available meteorological data at different elevation zones. Thereafter, the rate of snowmelt is calculated at each time step. Finally, the snowmelt runoff generated from SCA is integrated with runoff generated due to rainfall from SFA (snow-free area), and these components are routed separately to the outlet of the basin with proper accounting of base flow. The model optimizes the parameters used in routing of the snowmelt runoff and rainfall runoff.
- Artificial Neural Networks (ANNs) have been proposed as efficient tools in developing nonlinear systems theoretic models of the rainfall-runoff process. In the present study, multi-layer feed forward ANN technique will be applied for developing runoff models for the Sharda basin using available data.
- All the runoff simulation models will be calibrated/trained for the same period and with similar input data so that a comparison can be made.

Impact of Climate Change on Runoff

- Investigation of the impact of likely future changes in climate on stream flow will be carried out using downscaled GCM scenarios.

7. Research outcome from the project

The output of the study would be in the form of a comprehensive report. It is envisaged that the information generated out of this study will add substantially towards better planning, design, development and management of water resources of the basin. The climate impact study aims to provide information for planning of climate change adaptation strategies for the study basin.

Cost estimate:

a) Total cost of the project: **31.00 Lakh**
b) Source of funding: **NIH budget**
c) Sub- Head wise abstract of the cost

Sl.No.	Sub-head	Amount (in Rupees)
1.	Salary	**21,60,000**
2.	Travelling expenditure	**4,80,000**
3.	Infrastructure/Equipment	**2,50,000**
4.	Experimental charges	**90,000**
5.	Misc. expenditure	**1,20,000**
	Grand Total:	**31,00,000**

d) Justification for Sub-head-wise abstract of the cost

i) Salary:

(a) Technical services of two Sc 'D'and one PRA will be utilized for achieving the targets.

(b) One full time RA/SRF/JRF is proposed to be engaged @Rs. 30000/- pm for three years for assistance in the data processing and technical analysis. A qualified person will be recruited as per the guidelines of Ministry of Water Resources on temporary basis.

(c) One daily wage person for office assistance @Rs. 5000/- per month for three years. (**30 percent hiked in view of new pay commission**)

ii) Travel Expenditure:

Travels would be essential for data collection from various agencies and ground truth survey in the study area.

iii) Infrastructure/Equipment:

Rainfall and hydrological data will be obtained/procured from the agencies that are operating in the area. Also the required data will be procured from IMD, CWC, NRSA and other agencies.

iv) Experimental Expenses

Field expenses: @ Rs. 30,000/- per year for three years. Total Rs.90,000/-.

v) Miscellaneous Expenses

Stationary, Contingency, Report Printing, etc @ Rs. 40,000/- per year for three years. Total 1,20,000/-.

11. Quarterly Break up of cost estimate for each year

Year: 1

Sl.No.	Sub-head	Amount (in Rupees)				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1	Salary	1,80,000	1,80,000	1,80,000	1,80,000	7,20,000
2	Travelling expenditure	50,000	30,000	50,000	30,0000	1,60,000
3	Infrastructure/Equipment	25,000	50,000	25,000	25,000	1,25,000
4	Experimental charges	10,000	5,000	10,000	5,000	30,000
5	Misc. expenditure	10,000	10,000	10,000	10,000	40,000
	Sub- Total:	2,75,000	2,75,000	2,75,000	2,50,000	10,75,000
	Grand Total	**10,75,000/-**				

Year: 2

Sl.No.	Sub-head	Amount (in Rupees)				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1	Salary	1,80,000	1,80,000	1,80,000	1,80,000	7,20,000
2	Travelling expenditure	50,000	30,000	50,000	30,0000	1,60,000
3	Infrastructure/Equipment	25,000	-	25,000	-	50,000
4	Experimental charges	10,000	5,000	10,000	5,000	30,000
5	Misc. expenditure	10,000	10,000	10,000	10,000	40,000
	Sub- Total:	2,75,000	2,25,000	2,75,000	2,25,000	10,00,000
	Grand Total	**10,00,000/-**				

Year: 3

Sl.No.	Sub-head	Amount (in Rupees)				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1	Salary	1,80,000	1,80,000	1,80,000	1,80,000	7,20,000
2	Travelling expenditure	50,000	30,000	50,000	30,0000	1,60,000
3	Infrastructure/Equipment	50,000	25,000			75,000
4	Experimental charges	10,000	5,000	10,000	5,000	30,000
5	Misc. expenditure	10,000	10,000	10,000	10,000	40,000
	Sub- Total:	3,00,000	2,50,000	2,50,000	2,25,000	10,25,000
	Grand Total	**10,25,000/-**				

Note:

(i) The above table has to be prepared for each year of the project period

(ii) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

12. Work Schedule:

a) Probable date of commencement of the project: **April 1, 2015.**

b) Duration of the project: **3 years**

c) Stages of work and milestone:

S. No.	Work Element	First Year				Second Year				Third Year			
		Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4
1	Collection of information and Hydro-meteorological Data												
2	Preparation of base maps												
3	Downloading MODerate resolution Image Spectral radiometer (MODIS) snowcover data products for for the study area												

4	Analysis and interpretation of weekly MODIS snowcover data and preparation of snow cover maps												
5	**Preparation & Submission of Interim Report-I**												
6	Input data preparation for SRM Model												
7	Calibration and Validation of SRM Model												
8	Input data preparation for SNOWMOD Model												
9	Calibration and Validation of SNOWMOD Model												
10	Input data preparation for ANN Models												
11	Training and Validation of ANN Models												
12	Preparation & Submission of **Interim Report-II**												
13	Inter-comparison of Models												
14	Downscaling of GCM outputs for the study basin												
15	Preparation of Input data for conceptual model for changed climate scenarios												
16	Simulation of conceptual snowmelt runoff model with changed climate scenarios												
17	Preparation & Submission of Final Report												

15. PROJECT REFERENCE CODE: NIH/SWD/NIH/15-18

1. Thrust Area under XII five year Plan

2. Project team:

a. Project Investigator: **Dr A. R. SENTHIL KUMAR, Sc "E" SWHD**
b. Project Co-Investigator(s):
Dr. J. V. Tyagi, Sc "G", SWHD
Dr Avinash Agarwal, Sc "F", SWHD
Dr. Suhas Khobragade, Sc "E", HID
Dr Manohar Arora, Sc "D", SWHD

Staff: Sh. R. K. Nema, PRA, SWHD and Sh. Omprakash, SRA, SWHD

3. Title of the Project

"Study on effect of climate change on sediment yield to Pong reservoir"

4. Objectives:

a) To model sediment yield at Pong dam.
b) To investigate the impact of likely future changes in climate on sediment yield up to Pong dam using future climatic scenarios.
c) To assess the life of the reservoir for the likely sediment yield under the projected different climatic scenarios.

5. Present state-of-art

The developmental activities in the catchment area contribute high sediment load which affects the expected performance of the reservoir. Increase of anthropogenic emissions of green house gases will aggravate climate change and thus average temperature of atmosphere, no of extreme events of rainfall and intensity will increase. In Himalayan region, the increase in high intensity rainfall will contribute more sediment to the reservoir. It is important to estimate the change in sediment yield under the projected different climatic scenarios to assess the performance of the Pong reservoir.

The sedimentation in the reservoir is a continuous process and it reduces the performance of the reservoir slowly in meeting the demands over the time during the life of the reservoir (Morris and Fan, 1997). Survey of Indian reservoirs shows that sediment yield from the catchment due to unpredicted land use changes has been many fold than the sediment inflow considered during the design of the reservoirs (Tejwani, 1984). Consideration of sediment yield from the catchment area over the life period of the reservoir in view of the high sediment inflow has become important to evolve future operating policy to maximize the benefits from the water releases for various sectors.

The recent IPPC's summary report for policymakers confirms the human interference with the climate system based on the data of anthropogenic emissions of green house gases observed for many decades (IPCC WGII AR5, 2014). Increased level of green house gases in the atmosphere has increased average surface temperature of the earth and it will continue

to increase in the 21st century. Increased average surface temperature results in extreme events and high intensity of precipitation. The high intensity rainfall will dislodge the sediment and generate more sediment from the catchment and the sediment will get deposited in the reservoir in due course. So it is imperative to estimate the sediment yield at the upstream of Pong reservoir under different future climate scenarios considered by the IPCC summary report and the elevation-area-capacity will be revised by considering the increased sediment yield.

6. Methodology

The sediment yield up to Pong reservoir is to be modeled by Soil and Water Assessment Tool (SWAT). SWAT is a physically based semi distributed continuous time model developed by USDA Agricultural Research Centre (ARS) of Texas A&M university, USA to predict the impact of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land use and management conditions over long periods of time (Soil and Water Assessment Tool Theoretical Documentation, 2011). SWAT requires specific information about weather, soil properties, topography, vegetation and land management practices occurring in the watershed. The physical processes associated with water movement, sediment movement, crop growth, nutrient cycling etc. are directly modeled by these inputs. The sediment yield is modeled by modified USLE (universal Soil Loss Equation) (Parajuli et al., 2009).

The different CGMs (Global Climate Models) are available by the research team worldwide based on the reports published by IPCC from time to time. GCMs have been evolved from the Atmospheric General Circulation Models (AGCMs) widely used for daily weather prediction. GCMs have been used for a range of applications, including investigating interactions between processes of the climate system, simulating evolution of the climate system, and providing projections of future climate states under scenarios that might alter the evolution of the climate system. The most widely recognized application is the projection of future climate states under various scenarios of increasing atmospheric carbon dioxide (CO2). The different scenarios of climatic conditions such as RCP2.6 and RCP8.5 are to be obtained from CMIP5 models available from different institutes.

The parameters of the SWAT are to be calibrated using the historical hydro-meteorological data. The future sediment yield are to be simulated using SWAT with the data of different climatic scenarios. The impact of likely future changes in climate on stream sediment yield up to Pong is to be analyzed by the output of SWAT for future climate scenarios. The elevation-area-capacity curve of Pong reservoir will be revised based on the future sediment yield and the life of the reservoir will be projected.

7. Research outcome from the project

The output of the study would be in the form of a comprehensive report. The output of the study will give an idea of increased sediment yield from the future climatic scenarios to the state department officials for managing the various demands based on the available storage in the reservoir on priority basis.

8. Cost estimate:

a. Total cost of the project: **24.16 Lakh**

b. Source of funding: **NIH budget**

c. Sub- Head wise abstract of the cost

Sl.No.	Sub-head	Amount (in Rupees)
1.	Salary	**14,50,800**
2.	Travelling expenditure	**5,35,200**
3.	Infrastructure/Equipment	**2,00,000**
4.	Experimental charges	**60,000**
5.	Misc. expenditure	**1,70,000**
	Grand Total:	**24,16,000**

d) Justification for Sub-head-wise abstract of the cost

i) Salary:

(a) One JRF is proposed to be engaged @Rs. 25000/- pm for first two years and as SRF @28000/- for the third year.
(b) One daily wage person for office assistance @Rs. 5000/- per month for three years

(30 percent hiked in view of new pay commission)

ii) Travel Expenditure

(a) Vehicle hiring = Rs. 72,000/-
(b) TA/DA = Rs. 4,63,200/-

iii) Infrastructure/Equipment

a) Data = 2,00,000/-

iv) Experimental Expenses

*(a) **Field expenses**: @ Rs. 20,000/- per year for three years. Total 60,000.*

v) Miscellaneous Expenses

(c) Stationary: Rs. 15,000/- per year at a total cost of 45,000/- for 3 years
(d) Contingency: Rs. 25,000/- per year at a total cost of 75,000/- for 3 years
(e) Report Printing: Rs. 50,000/-

13. Quarterly Break up of cost estimate for each year

Year: 1

Sl.No.	Sub-head	Amount (in Rupees)				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total

1	Salary	1,17,000	1,17,000	1,17,000	1,17,000	4,68,000
2	Travelling expenditure	62,300	24,000	62,300	24,000	1,72,600
3	Infrastructure/Equipment	-	50,000	-	50,000	1,00,000
4	Experimental charges	10,000	-	10,000	-	20,000
5	Misc. expenditure	10,000	10,000	10,000	10,000	40,000
	Sub- Total:	1,99,300	2,01,000	1,99,300	2,01,000	8,00,600
	Grand Total	8,00,600				

Year: 2

Sl.No.	Sub-head	Amount (in Rupees)				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1	Salary	1,17,000	1,17,000	1,17,000	1,17,000	4,68,000
2	Travelling expenditure	62,300	24,000	62,300	24,000	1,72,600
3	Infrastructure/Equipment	50,000	-	50,000	-	1,00,000
4	Experimental charges	10,000	-	10,000	-	20,000
5	Misc. expenditure	10,000	10,000	10,000	10,000	40,000
	Sub- Total:	2,49,300	1,51,000	2,49,300	1,51,000	8,00,600
	Grand Total	8,00,600				

Year: 3

Sl.No.	Sub-head	Amount (in Rupees)				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
1	Salary	1,28,700	1,28,700	1,28,700	1,28,700	5,14,800
2	Travelling expenditure	65,000	30,000	65,000	30,000	1,90,000
3	Infrastructure/Equipment	-	-	-	-	-
4	Experimental charges	10,000	-	10,000	-	20,000
5	Misc. expenditure	10,000	10,000	10,000	60,000	90,000
	Sub- Total:	2,13,700	1,68,700	2,13,700	2,18,700	8,14,800
	Grand Total	8,14,800				

Note:

(i) The above table has to be prepared for each year of the project period

(ii) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

14. Work Schedule:

a) Probable date of commencement of the project: **April, 2015.**

b) Duration of the project: **3 years**

c) Stages of work and milestone:

Sl. No.	Work Element	First Year	Second Year	Third Year
1	Recruitment of project staff	√		
2	Literature Review	√	√	√
3	Collection and processing of Hydrometeorological data and purchase of satellite imagery and soil maps	√		
4	Data preparation for SWAT	√		
5	Simulation of Sediment yield by SWAT	√	√	
6	Downscaling of data from GCM Models	√	√	
7	Simulation of sediment yield with the data from future climatic scenarios		√	√
8	Revision of elevation-area-capacity table of the reservoir by using the future projected sediment yield		√	√
9	Preparation of interim report	√	√	
10	Preparation of final report			√

References

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3. Parajuli, P. B., Nelson, N. O., Frees, L. D., and Mankin, K. R. (2009). "Comparison of AnnAGNPS and SWAT model simulation results in USDA-CEAP agricultural watersheds in south-central Kansas." *Hydrolog. Precess*. 23(5), 748-763.
4. Soil and Water Assessment Tool Theoretical Documentation, Version 2009. (2011). TR-406, Texas A&M University, USA.
5. Tejwani, K.G. (1984). "Reservoir sedimentation in India-Its causes, Control, and Future course of action." *Water International*, 9, 150-154.

16. PROJECT REFERENCE CODE: NIH/SWD/NIH/15-17

1. Thrust Area under XII five year Plan
   Study of Hydrologic extremes

2. Project team:

b. Project Investigator: Dr. R.P. Pandey, Scientist F
c. Project Co-Investigator(s): Dr. Rakesh Kumar, Scientist G

3. Title of the Project

Study of regional drought characteristics and long term changes in supplemental irrigation water requirement in Seonath Basin in Chhattisgarh

4. Objectives

The main objectives in this study will be as follows:

(1) To analyse long-term rainfall and streamflow data for assessment of regional drought characteristics
(2) To assess the climatic variability in terms of long term trend in climatic variables.
(3) To assess long-term changes in evapotranspiration and sensitivity analysis of ET to different climatic variables.
(4) Estimation of Crop Water Requirement (CWR) and net irrigation requirement (NIR) using suitable method.
(5) To analysis Long Term Trend in NIR to estimate the change in total Irrigation Water Demand (IWD).

5. Present state-of-art

Any change in meteorological variables adversely affects the crop productivity and thereby the regional economy. Thus assessment of the regional level irrigation water demand is necessary for developing strategies for its mitigation. A number of researchers perceive the trend analysis of different climatic variables and parameters which leads to the change in IWD. The literature pertaining to this is given below:

Elgaali et.al, (2007) reported an increase in Irrigation Water Demand for HAD and CCC climate change scenarios for Arkansas River Basin in southeastern Colorado. Elnesr et al. (2010) studied changes in the ETo of 27 weather stations from the period of 1980-2008 in Arabian Peninsula. The increasing trends prevailed during most of the year except in the winter months from October to January. During winter months, significant decreasing trends were observed for only four stations. In general, most of stations showed an increasing trend especially in the Northern parts of KSA (Kingdom of Saudi Arabia).

Liang et al. (2010) analyzed monthly ETo at 15 stations during 1961–2005 in the Taoer River basin in China. The long term persistence of the trends for growing season and annual ETo showed the same spatial patterns, high positive values in the west study area in the upper reach and negative values in the Southeast study area in the lower reach was noticed.

Dinpanshoh et al., (2011) analyzed trend in reference crop ET over Iran. The result showed both statistically significant increasing and decreasing trends in the annual and monthly ETo. The increasing trends in ETo were more pronounced than the decreasing trends. In annual time scale, the strong positive (negative) trend in ETo over Iran of the magnitude of about 186 (-65) mm/year per decade was observed. In monthly time scale there was greater number of increasing trends than that of the decreasing trends in most of

the warm months. The most strong positive (negative) trend magnitude was found in April (July) with Theil–Sen's slope. Wind speed was found to be the most dominant variable influencing ETo in all the months except the winter months in Iran. Shamsuddin Shahid (2011) reported that there will be no appreciable changes in total irrigation water requirement due to climate change in Bangladesh. However, there will be an increase in daily use of water for irrigation. As groundwater is the main source of irrigation in northwest Bangladesh, higher daily pumping rate in dry season may aggravate the situation of groundwater scarcity in the region.

Tabari et al., (2011) analyzed annual, seasonal and monthly trends in the Penman–Monteith ETo at 20 meteorological stations during 1966–2005 in the western half of Iran. The result indicated significant positive trends magnitude in annual ETo varied from 11.28 to 2.30 mm/year. On the seasonal scale, stronger increasing trends were identified in ETo data in winter and summer compared with those in autumn and spring. The highest numbers of stations with significant trends were found in the monthly ETo series in February, while the lowest numbers of stations with significant trends were observed in November. Analysis of the impact of climatic variables on the significant increasing trend in ETo showed that the increasing trend was mainly caused by a significant increase in air temperature during the study period.

Tabari et al., (2011) analyzed the impacts of meteorological variables on the temporal trends of ETo indicated that the increasing trend of ETo was most likely due to a significant increase in minimum air temperature, while decreasing trend of ETo was mainly caused by a significant decrease in wind speed. Tang et al. (2011) analyzed variations in ETo over 58 years (1950–2007) at 34 stations in the Haihe river basin China. The results showed that ETo gradually decreased in the whole basin over the entire study period. On the monthly scale temperature had positive impact on ETo and while solar radiation and wind speed had negative effect on it. Whereas changes in air temperature were found to produce a large increase in derivative of ETo, changes in other key variables each reduced rates, resulting in an overall negative trend in ETo. Wang et al. (2011) studied the spatial and temporal patterns of trends for ETo at 34 meteorological stations during 1957-2007 in the Haihe River basin, China using the Mann-Kendall (MK) test and the Sen's method. The basin is subjected to significant decreasing trend in annual ETo, which is observed at most stations in the eastern and southern areas of the basin.

6. Methodology

For determination in variability of climatic factors and the long term changes in IWD, the methodology would include the following:

- The determination the monotonic linear trends in metrological time series (Temperature, Rainfall, Relative Humidity, Wind Speed and Sunshine Hours) using the Mann Kendall's test.
- Estimation of the slopes of trend lines of metrological variables using the Theil–Sen's slope estimator.
- Determination of the step change/ detect the abrupt changes in the time series using cumulative deviation test and distribution free CUSUM test.
- Determination of the percentage variability of metrological series by Coefficient of Variation (CV) over entire Seonath river basin.
- Estimation of ET using suitable method and the application of the Partial Relative Correlation Method to investigate the correlation between ETo and meteorological variables.

- Estimation of CWR and NIR and subsequently assessment of changes in the total Irrigation Water Demand in different seasons.
- Long term Trend Analysis of Net Irrigation Requirement and determination of trend in ET and NIR using Mann Kendall's test and Thiel's Sen's Slope Estimator will be use to estimate the trend magnitude.
- Thus the study will lead to assess changes in irrigation water demand over past 50-years in the context of long term changes in climatic variables.

Proposed Study Area: The study is proposed to be carried out for the Seonath river basin in Chattisgarh. The Seonath river basin is the longest tributary of the Mahanadi basin draining three districts of Chhattisgarh namely Durg, Rajandgaon and Bilaspur. The Basin is located between latitude $20^0$16' N to 22^0 41' N and Longitude $80^0$25' E to $82^0$35' E. The drainage area of the Seonath river basin is 30,860 Sq km. The mean annual rainfall in the basin varies from 1005 mm to 1255 mm. Seonath river basin comprises 25% of the upper catchment of the Mahanadi basin

1. Research outcome from the project

ii. The study would be able to reveal long term trend and changes in different meteorological variables in the study basin

iii. The long-term changes in CWR and NIR in the study will be estimate and the prediction of changes in total irrigation water demand will be obtained.

iv. The study will lead to assess long-term changes in supplemental water need to save seasonal crops during drought and to enhance crop yield in good years.

This research will provide updated information on the effect of climatic variability on irrigation water in the study area. Such knowledge is vital for proper planning and management of water resources for future use.

2. Cost estimate:

a. Total cost of the project : Rs. 13,05,000/-
b. Source of funding : Internal funding from NIH
c. Sub Headwise abstract of the cost

Sl.No.	Sub-head	Amount (in Rupees)
1.	Salary	2,40,000
2.	Travelling expenditure	2,50,000
3.	Infrastructure/Equipment	75000
4.	Experimental charges	6,00,000
5.	Misc. expenditure	1,40,000
	Grand Total:	**13,05,000**

d. Justification for Sub-head-wise abstract of the cost

Salary: Full time one personnel (RA/SRF/JRF) for the project will be required for assistance in the data processing and technical analysis. A qualified person will ne recruited as per the guidelines of Ministry of Water Resources on temporary basis.

Travel: Travel to study site and the intra basin travels would be essential for data collection, field investigations and data monitoring in the study area. The regular movement/ travel would be required for surveyes and investigation of need information. Data collection and monitoring will require massive field work to achieve the targets.

Infrastructure/Equipment: Rainfall and hydrological information will be ootained/procured from the agencies that are operating in the area . Also the required data will be procured from IMD, CWC, NRSA and other agencies. For timely data processing and downloading and storage of information a dedicated computer will be required to work with the updated versions of latest softwares. A note book computer will be required to work at the the field sites. Therefore, above computing systems and softwaters are necessary for completing the work promptly.

Experimental Charges: Contingent workers would be required hired to perform field investigations. Intra-basin travel to various sites within the basin would be essential to perform investigations at the sites and verify the results with physical ground information during the project period.

3. Quarterly Break up of cost estimate for each year

Year: First Year

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary (RA/SRF/JRF--1)	30000	30000	30000	30000
2.	Travelling expenditure	50000	25000	25000	25000
3.	Infrastructure/Equipment	50000	--	--	--
4.	Experimental charges	150000	50000	50000	50000
5.	Misc. expenditure	35000	15000	15000	15000
	Sub- Total:	**3,90000**	**1,20000**	**1,20000**	**1,20000**
	Grand Total (First Year)	**7,50000/-**			

Year: Second Year

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary (RA/SRF/JRF--1)	30000	30000	30000	30000
2.	Travelling expenditure	50000	25000	25000	25000
3.	Infrastructure/Equipment	25000	--	--	--
4.	Experimental charges	150000	50000	50000	50000
5.	Misc. expenditure	15000	15000	15000	15000
	Sub- Total:	**3,90000**	**1,20000**	**1,20000**	**1,20000**
	Grand Total (First Year)	**7,50000/-**			

Note:

(i) The above table has to be prepared for each year of the project period

(ii) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

4. Work Schedule:

a. Probable date of commencement of the project: **April 1, 2015**
b. Duration of the project : **Two Years**

c. Stages of work and milestone:

Sl. No.	Work Element	First Year				Second Year			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	Collection of information and Hydro-meteorological Data								
2	Preparation of base maps								
3	Analysis of long-term rainfall and stream flow records to assess regional drought characteristics								
4	Analysis of long-term trends of climatic variables and determination of slope of trend lines and step change etc.								
5	**Preparation & Submission of Interim Report-I**								
6	Estimation of ET_o and sensitivity analysis of climatic factor								
7	Estimation of CWR and NIR for various crops in rabi and kharif season								
8	Determination of Critical Dry spells and assessment of water requirement and irrigation water requirement								
9	Determination of long-term changes in Irrigation water requirement								
10	Preparation & Submission of Final Report								

PROPOSED WORK PROGRAMME OF SURFACE WATER HYDROLOGY DIVISION FOR THE YEAR 2015-16

S.No. & Ref. Code	Title	Study Team	Duration
1. NIH/SWD/NIH/ 14-16	Study of Rainfall Patterns and Comparison of Rainfall Data from different Sources for Uttarakhand State	Archana Sarkar Vaibhav Garg, Sc C, IIRS, Dehradun Rakesh Kumar N.K. Bhatnagar	2 years (April 2014 to March 2016)
2. NIH/SWD/NIH/ 13-16	Quantitative assessment of uncertainties in river discharge estimation	Sanjay Kumar Sharad Jain	3 Years (April 2013 to March 2016)
3. NIH/SWD/NIH/ 13-16	Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills.	Avinash Agarwal Manohar Arora RK Nema	3 Years (November 2013 to October 2016)
4. NIH/SWD/NIH/ 14-17	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora Rakesh Kumar	3years (May 2014 to March 2017)
5. NIH/SWD/NIH/ 14-17	Effect of climate change on evaporation at point scale	Digambar Singh A. R. Senthil kumar Manohar Arora	3years (June 2014 to March 2017)
6. NIH/SWD/NIH/ 14-17	Hydrological modelling, water availability analysis	J.P.Patra Dr. Rakesh Kumar Pankaj Mani	3years (April 2014 to March 2017)
NEW STUDIES			
7. NIH/SWD/NIH/ 15-18	Flood and Sediment studies in Himalayan basin using MIKE-11 Model	Dr. A.K. Lohani	3 years (April 2015 to March 2018)
8. NIH/SWD/NIH/ 15-18	Snowmelt Runoff Modelling and Study of the Impact of Climate Change in Sharda River Basin	Dr Achana Sarkar Er. T. Thomas Dr. Vaibhav Garg	3 years (April 2015 to March 2018)
9. NIH/SWD/NIH/ 15-18	Study on effect of climate change on sediment yield to Pong reservoir	Dr A. R. Senthil Kumar Dr. J. V. Tyagi Dr Avinash Agarwal Dr. Suhas Khobragade Dr Manohar Arora	3 years (April 2015 to March 2018)
10. NIH/SWD/NIH/ 15-17	Study of regional drought characteristics and long term changes in supplemental irrigation water requirement in Seonath Basin in Chhattisgarh	Dr. R.P. Pandey Dr. Rakesh Kumar	2 years (April 2015 to March 2017)

WATER RESOURCES SYSTEM DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr. S K Jain	Scientist G & Head
2	Mrs. Deepa Chalisgaonkar	Scientist F
3	Dr. Sanjay K Jain	Scientist F
4	Dr. M K Goel	Scientist F
5	Sri D S Rathore	Scientist F
6	Dr. Renoj Thayyen	Scientist D
7	Sri L N Thakural	Scientist B
8	Sri. Manish Nema	Scientist B
9	Sri P K Mishra	Scientist B
10	Sri Tanvear Ahmed	Scientist B
11	Sri P K Agarwal	Scientist B
12	Sri Yatvear Singh	PRA

WORK PROGRAMME FOR THE YEAR 2014-2015 &2015-16

WORK PROGRAMME FOR THE YEAR 2014-2015				
SN	**Title**	**Study Team**	**Duration**	**Funding (Rs. in Lakhs)**
Completed Internal Studies				
1.	Trend and variability analysis of rainfall and temperature in Himalayan region	L. N. Thakural Sanjay Kumar Sanjay K. Jain Sharad K. Jain Tanvear Ahmed	3 years (10/11-09/14)	NIH
2.	Web GIS based snow cover information system for the Indus Basin	D. S. Rathore Deepa Chalisgaonkar L. N. Thakural Tanvear Ahmed	2 Years (04/13-03/15)	NIH
3.	Assessment of Water Footprint of the National Capital Territory (NCT) of India	Deepa Chalisgaonkar Sharad K. Jain M. K. Nema P. K. Mishra	2 Years (04/13-03/15)	NIH
Ongoing Internal Studies				
1.	NIH_Basin – A WINDOWS based model for water resources assessment in a river basin	M. K. Goel Sharad K. Jain Deepa Chalisgaonkar Prabhash K. Mishra	3 Years (04/13-03/16)	NIH (16)
2.	Assessing climate change impact across KBK region of Odisha	P. K. Mishra Sharad K. Jain Sanjay K. Jain	3 Years (04/13-03/16)	NIH (28)
3.	Glacier change and glacier runoff variation in the upper Satluj river basin	Sanjay K. Jain Sharad K. Jain Renoj J. Thayyen	2.5 Years (10/13-03/16)	NIH (12)
4.	Variability of the Hydro-climatic variables in Punjab Plains of Lower Satluj	M. K. Nema Sharad K. Jain	2 Years (11/13-10/15)	NIH (11.34)
5.	Catchment scale evaluation of cold-arid cryospheric system Hydrology, Ganglass catchment, Ladakh	Renoj J. Thayyen S. P. Rai Sanjay K Jain Sudhir Kumar	3 years (04/14-03/17)	NIH (48)
6.	Hydrologic Modelling of a part of Satluj Basin using SWAT Model	P. K. Agarwal Sharad K. Jain Tanvear Ahmed M. K. Goel Sanjay K. Jain M. K. Nema	2 -3/4 Years (06/14-3/17)	NIH (23)
7.	Decision Support System for Water Resources Planning in Upper Bhima basin, Maharashtra	D. S. Rathore M. K. Goel, R.P. Pandey Sanjay Kumar Surjeet Singh	2 years (07/14-06/16)	NIH (34)
8.	Modeling of Narmada basin by using the GWAVA model	Sanjay K. Jain Sharad K. Jain T. Thomas (RC-Bhopal) P. K. Mishra P. K. Agarwal	2.25 years Dec. 2014 – Mar 2017	NIH

		M. K. Nema		
9.	Runoff modeling of Shyok River, Karakorum Range	Renoj J.Thayyen Sanjay K.Jain	3 years Dec-2014 to Nov.2017	NIH (38)
10.	Hydrological process and characterization of Lesser Himalayan Catchments	M. K. Nema Sharad K. Jain Sanjay K. Jain Renoj J.Thayyen P. K. Mishra P. K. Agarwal	5 Years 12/14-12/19	NIH+
Ongoing Sponsored Studies				
1.	Glaciological studies of Phuche Glacier, Ladakh Range, India	Renoj J. Thayyen M K Goel S P Rai	5 Years 1/10-06/15	DST (56)
2.	Assessment of Environmental flow for Himalayan River	Sharad K. Jain Pradeep Kumar P. K. Agarwal P. K. Mishra	1 Year 07/14-07/15	MOES (8.61)
Proposed New Internal Studies for the year 2015-2016				
1.	Development of Ganga Information Portal	Deepa Chalisgaonkar Sharad K. Jain D. S. Rathore Sanjay K. Jain Sudhir Kumar P. K. Mishra P. K. Agarwal M. K. Nema	3 years (04/15-03/18)	MoWR (107.88)
2.	Integrated approach for hydrological changes in selected catchments for IWRM in view of climate change in India	L. N. Thakural D. S. Rathore Surjeet Singh Tanvear Ahmed Sanjay K. Jain Sharad K. Jain	3 years (04/15-03/18)	MoWR (44.30)

COMPLETED STUDIES

INTERNAL RESEARCH PROJECT: NIH/WRS/2015/01

1. Thrust Area under XII five year Plan

2. Project team:

a. Project Investigator	Mr. L. N. Thakural, Sc-B, PI
b. Co-PIProject Co-Investigator(s)	Dr. Sanjay Kumar, Sc-D,
	Dr. Sanjay Kumar Jain, Sc-F, Co-PI
	Dr. Sharad Kumar Jain, Sc-G, Co-PI
	Mr. Tanveer Ahmed, Sc-B, Co-PI

3. Title of the Project - Trend and variability analysis of Rainfall and Temperature in Himalayan region

4. Objectives-

1. To create database for hydrological parameters (Rainfall and Temperature) for the Himalayan region.
2. To estimate temporal and spatial characteristics of the rainfall and temperature time series.
3. To carry out trend and variability analysis of rainfall and temperature.

5. Present state-of-art

Interest in climate variations has experienced a significant increase in recent years due to the important economic and social consequences connected with extreme weather events. Most of the studies regarding climate change only seek to detect potential trends or fluctuations in the long term mean of climatic signals, but the study of variability changes and extreme event behaviour is also essential. In the present study statistical analysis, trend and climatic variability changes in climatic variables namely temperature and rainfall will be carried out in Himalayan region, India. The parametric and non-parametric approaches will be used to determine the trends in the time series data of these meteorological parameters

6. Methodology

Statistical techniques/tools will be used to evaluate the temporal and spatial characteristics of the rainfall and temperature time series (statistical distribution, temporal correlation, spatial correlations). As meteorological data in the Himalayan region is scarce the rainfall data from APHRODITE would also be used in the study. A comparison of rainfall from APHRODITE with the ground based stations will also be carried out. The trends and variability analysis of rainfall and

temperature time series would be evaluated using the following statistical techniques for various time scales.

1. Parametric approach for trend and variability.
2. Mann-Kendall test and Sens's estimator of slope method (non-parametric) for trend and variability.

7. Research outcome from the project

The changes in temperature, precipitation, and other climatic variables are likely to influence the amount and distribution of runoff in all river systems globally. The detection of trends and magnitude of variations due to climatic changes in hydro climatic data, particularly temperature and precipitation is essential for the assessment of impacts of climate variability and change on the water resources of a region. The results will be useful for the runoff and climate change studies.

8. Cost estimate:

Project to be completed by March 2015

9. Work schedule

Sr. No.	**Major Activities**	**1st Year**	**2nd Year**	**3rd Year**
1	Literature review			
2	Data collection & preparation for analysis			
3	Temporal and Spatial characteristics of the rainfall and temperature time series and their statistical distribution.			
4	Analysis using parametric approach			
5	Analysis using non-parametric approach			
6	Preparation of report**		Part-1 / Part-2 / Part-3	

10. Analysis and Results

HIMALAYAN REGION

The trends for the rainfall data has been carried using the rainfall data derived from the APHRODIE. The location map of stations considered is shown in Figure 1

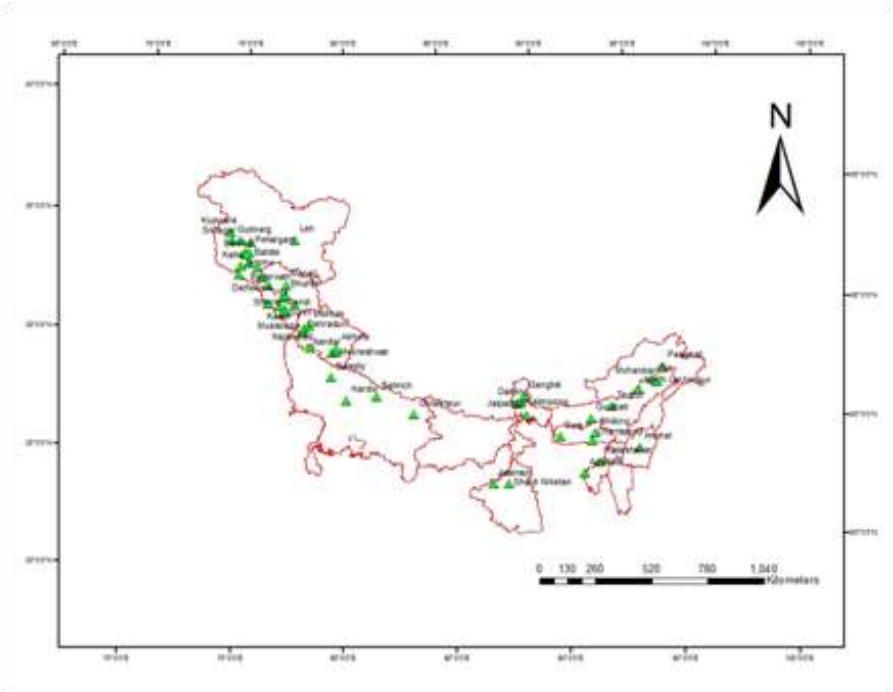


Figure 1: Location map of study area.

Trends in Rainfall

The magnitude of the trends in the annual mean rainfall time series on seasonal and annual time scale is determined using the Sen's slope estimator is given in Table 3. The Man-Kendall test was applied to this time series to ascertain the significance of trends (Table1).

Table 1: Sen's estimator of slope (^{0}C/year) for rainfall

Stations	**pre-monsoon**		**monsoon**		**post-monsoon**		**winter**		**annual**	
	Z statistic	Sen slope	Z statistic	Sen slope	Z statistic	Sen slope	Z statistic	Sen slope	Z statistic	Sen slope
Agartala	**0.23**	0.566	0.78	3.64	1.05	1.11	0	0.184	0.86	6.16
Almora	0.12	0.067	-1.11	-3.93	-0.78	-0.309	0.67	0.599	-0.54	-2.89
Asansol	1.1	0.87	0.78	3.24	0.23	0.42	0.01	0.005	0.75	2.917
Baderwah	**-0.89**	-2.53	-1.62	-6.65	0.78	0.6	-0.26	-0.71	-1.4	-8.03
Bahrich	**1.46**	0.85	-1.21	-4.3	-0.67	-0.26	0.99	0.56	-42	-2.21
Bareilly	**1.27**	0.84	0.5	2.33	-1.16	-0.3	0.97	0.53	0.61	3.15
Batote	**-1.1**	-3.14	-1.05	-2.26	0.26	0.08	-0.67	-1.17	-1.33	-6.32
Bhuntar	**-1.14**	-1.66	0.91	3.29	-0.61	-0.24	-1.73	-2.46	-0.29	-1.06
Bilaspur	**1.1**	0.48	-0.34	-0.69	-0.01	-0.02	0.59	0.24	-0.26	-0.96
Dalhousie	**-1.14**	-1.77	-1.08	-7.73	0.06	0.03	-0.12	-0.23	-0.68	-5.31
Darjeeling	**1.51**	2.68	1.78	8.2	-0.23	-0.41	1.62	0.84	1.31	14.71
Deradun/ Mussorie	**0.18**	0.37	0.4	2.38	-1.48	-0.82	0.07	0.04	0.31	3.87
Dharamsala	**0**	0.01	-0.69	-12.39	-0.78	-0.63	-0.48	-1.01	-0.91	-15.38

Gangtok	**1.08**	4.61	0.85	14.75	0.5	0.55	**2.98**	1.32	1.16	20.38
Gulmarg	**-0.56**	-1.17	-180	-1.17	0.23	0.09	-0.59	-0.98	-1.27	-4.54
Guwahati	**1.76**	3.04	-0.04	-0.26	0.83	0.82	0.03	-0.12	1.73	5.88
Hardoi	**0.74**	0.34	-1.76	-5.1	-0.56	-0.23	1.68	0.66	-1.27	-4.03
Imphal	**1.51**	3.19	-0.18	-0.66	0.23	0.43	0.86	0.53	1.05	4.61
Jalpaiguri	**1.36**	4.68	1.05	6.88	0	0	1.84	0.75	1.21	12.63
Jammu	**-0.74**	-0.17	0.12	0.5	1.29	0.61	0.48	0.62	0.15	0.83
Kaliashahr	**0.07**	0.41	1.45	6.25	-0.42	-0.65	-0.04	-0.02	1.24	7.35
Kasol	**0.48**	0.22	-0.07	-0.12	-0.8	-0.34	0.42	0.76	-0.12	-0.73
Kukernag	**-1.24**	-3.34	-0.59	-1.28	0.64	0.54	-0.62	-0.39	-1.39	-3.42
Kupwara	**-0.53**	-1.53	-1.4	-1.56	-0.1	-0.14	-0.31	-0.86	-1.19	-5.26
Leh	**-0.18**	-0.04	0.31	-0.25	0.45	0.07	**-0.94**	-0.35	0.09	0
Manali	**-2.13**	-4.49	-0.8	-1.81	-1.81	-0.87	-3.18	-8.57	-1.87	-13.13
Mandi	**0.03**	-1.08	0.89	3.8	-0.23	-0.13	-0.31	-0.46	0.23	1.5
Mohanbari	**0.86**	2.85	-0.75	-4.42	-0.4	-0.56	0.86	0.53	-0.12	-0.91
Mukhim	**0.01**	0.12	0.83	5.13	-1.68	-0.63	-0.42	-0.4	0.69	4.46

*Bold indicates statistical significance at 95% confidence level as per with Mann-Kendall test (+ for increasing and – for decreasing)

The rainfall analysis of the stations located in Himalayan region shows a mixed (increasing/decreasing) in the trends both at seasonal and annual scale. Gangtok and Leh are showing the decreasing trend in rainfall during winter season which are statistically significant also.

COMPLETED STUDIES

INTERNAL RESEARCH PROJECT: NIH/WRS/2015/02

1. **Thrust Area under XII five year Plan:** Hydrological information
2. **Project team:**
   a. Project Investigator: D.S. Rathore, Sc F
   b. Project Co-Investigator(s): Deepa Chalisgaonkar, Sc F
      L.N. Thakural, Sc B
      Tanveer Ahmad, Sc B
3. **Title of the Project:** Web GIS based snow cover information system from Indus basin

4. **Objectives:**
   a. To publish snow cover information on web as an OGC web service for Indus basin
5. Present state-of-art

   NSIDC has prepared snow cover maps using MODS bands 2, 4 and 6, cloud mask and temperature screen. The methodology utilizes masking, thresholding and spectral space partitioning techniques with NDSI, NDVI, individual band values to delineate snow in swath product. Multiple temporal and spatial resolution products are generated from swath products. Snow cover maps for Himalaya are also prepared by ICIMOD through post processing of NSIDC snow maps. The maps are also visualized through web GIS application.

6. **Methodology**

   MODIS data mosaicing, subsetting (spectral and spatial), reprojecting and conversion of format for the data was carried out in MODIS Reprojection Tool (MRT). Basins were delineated using SRTM250 data. Indus basin boundary was reshaped based on ICIMOD basin vector data. The basin extent within India was obtained by overlay with Indian geographical extent. Snow was delineated using NDSI and MODIS band-2 reflectance. Snow statistics was computed. Snow raster were polygonized and morphologically cleaned. Snow vector maps were published using Geoserver software as WMS layers. Web application was developed utilizing these maps.

7. **Research outcome from the project**
   a. Sub basin wide snow statistics: Snow cover maps were prepared for years 2007-08, 2010-2012.
   b. Web application for snow cover maps: Web application was prepared for visualization of snow cover maps.

8. **Cost estimate:**

   Project to be completed by March 2015

9. **Quarterly Break up of cost estimate for each year**

   Project to be completed by March 2015

10. **Work Schedule:**

    Project to be completed by March 2015

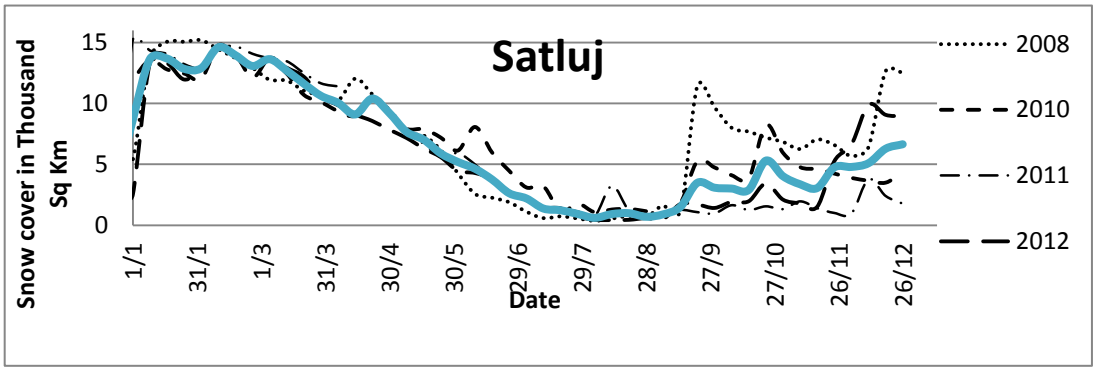


Fig Snow extent for Satluj basin

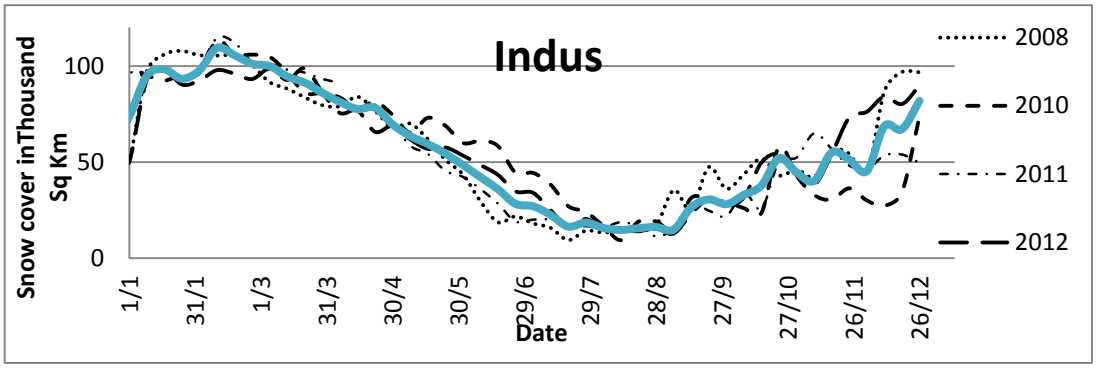


Fig. Snow extent for Indus basin

Fig. Web application for snow cover in Indus basin

COMPLETED STUDIES

INTERNAL RESEARCH PROJECT: NIH/WRS/2015/03

Title of Study	-	**Assessment of Water Footprint of the National Capital Territory (NCT) of India**
Study Group	-	D. Chalisgaonkar Dr. S. K. Jain Manish Nema Prabhash K. Mishra
Type of Study	-	Internal
Start Date	-	April 01, 2013
Target date of completion	-	31st March, 2015

Objectives

The objective of this study is to estimate the water footprints of NCT Delhi from both a supply and consumption perspective by quantifying green, blue and grey water footprints. Additionally, the aim is to understand how the water resources of NCT Delhi are being utilized for water consumption.

Methodology

The methodology used in this study is largely based on earlier studies supported by Water Footprint Network (www.waterfootprint.org). There are three components of water footprint.

Blue Water Footprint:

It is the volume of surface water and groundwater consumed (i.e. evaporated or incorporated into the product) during production processes.

Green Water Footprint

It is the volume of rainwater consumed (i.e. evaporated or incorporated into the product) by the product; and

Grey Water Footprint

It is the amount of freshwater required to mix pollutants and maintain water quality according to agreed water quality standards.

In the present study, the previous methodologies are integrated and upgraded where possible. The main upgrades are the incorporation and assessment of green, blue and grey water resources.

The study of existing water management schemes of water supply and sewage treatment of NCT Delhi reveals the following activities influence the water use within the city boundary:

- Sources of Water in NCT Delhi
- Consumption of water for various purposes
- Processing at a sewage treatment plant

The water footprints thus consist of two components: consumptive water use and wastewater pollution. The impact of water pollution is being assessed by quantifying the dilution water volumes required to dilute waste flows to such extent that the quality of the water remains below agreed water quality standards. The water footprint of NCT Delhi is being assessed for three major sectors i.e. domestic, agriculture and industrial.

The WF of the NCT Delhi is being computed based on the data for the period 2006-2010 collected from various sources, published reports from various departments of government of NCT Delhi and from some other important websites. The virtual water content related data is available at country level not at NCT Delhi level, so it is being used for NCT Delhi as well. The data which was not available has been assumed.

The WF is being computed based on the available data of direct (real) and indirect (virtual) water consumption of NCT Delhi. As the computation of grey water footprint includes the amount of freshwater required for mixing pollutants and maintaining water quality according to agreed water quality standards, the water quality criterion of Central Pollution Control Board ('C' Class water), given below, has been taken as the water quality standards for the computation of dilution water requirement.

'C' CLASS WATER QUALITY NORMS

Drinking water source after conventional treatment and disinfection	• Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less

Progress of the Study:

The assessment of the domestic water footprint has been done as a first step during 2013-14. It has been done by computing the environmental pressure exerted by the population of NCT Delhi in terms of the water it uses directly and indirectly. Presently the assessment of agriculture water footprint and industrial water footprint are being done.

For the computation of crop water requirement, CROPWAT software is being used. It uses precipitation data, crop growth inputs, and soil data to calculate crop water requirements.

After all yields and variables in the CROPWAT program are accounted for, the blue and green water footprints can be determined.

Green water use by crop = min (crop water requirement, effective precipitation)
Blue water use by crop = min (irrigation requirement, effective irrigation)

The grey water component assessment has been done based on the application of nitrogen (N) fertilizer to the crop fields. Only the nitrogen fertilizer use has been incorporated into the grey water footprint, because the grey component is expressed as a dilution water requirement. This means only the most critical pollutant with the greatest application rate need be considered.

Virtual water import component has also being considered for the computation of agriculture water footprint as lot of agriculture related products are brought in Delhi for consumption.

Benefits of the Study:

- Economic benefits: better water management and better water use have positive impacts on water costs;
- Environmental benefits: better water quality and more efficient water consumption have lower impacts on ecosystem;
- Social benefits: better quality of water means better quality of life;
- An Indian approach on water use: definition of common strategies on water footprint will contribute to promote transnational awareness on domestic water management, saving and innovations.

ONGOING STUDIES

INTERNAL RESEARCH PROJECT: NIH/WRS/2015/01

1. Thrust Area under XII five year Plan: Integrated Water Resources Development & Management

2. Project team:

a. Project Investigator:	Dr. M. K. Goel, Sc. "F"
b. Project Co-Investigator(s):	Dr. Sharad K. Jain, Sc. "G" Smt. D. Chalisgaonkar, Sc. "F" Mr. P. K. Mishra, Sc. "B"

3. Title of the Project NIH_Basin – A WINDOWS based model for water resource assessment in a river basin

4. Objectives

Envisaged objective of the study is to develop a WINDOWS interface (named as NIH_Basin – NIH_Basin-Simulation) of a model developed for assessment of water resources in a river basin for easy application by the user groups. It is also proposed to carry out a number of modifications in the model (developed in earlier study) for comprehensive analysis of water resources at basin scale.

5. Present state-of-art

Effective management of water and related environment in a river basin requires an integrated and co-ordinated planning within the basin. In the present approach of water availability estimation in a river basin, it is difficult to account for the effect of various developmental activities and climate sensitive parameters on the water resources scenario in a river basin. Groundwater is not given enough attention in the assessment of total water resources in the basin and the water requirement for different purposes is not precisely estimated. Discharge is considered as the basic unit for water availability estimations which may be affected by a number of basin parameters and developmental activities. A number of basin scale models, like RIBASIM, MIKE BASIN etc. have been reported but there is no Indian model which can cater, particularly, to the Indian conditions. Further, spatial variability of water related variables and parameters are not considered in such models.

With this need in view, a detailed spatially distributed model has been developed to assess various components of the hydrological cycle in a river basin. In this model, focus is given to incorporate spatial variation of land-use, soil type, rainfall, evapo-transpiration, physiographic characteristics, cropping pattern, irrigation development, groundwater conditions, river network and hydraulic structures in a river basin. GIS is employed to link the spatial data with the simulation model and to project the model results in map form for easy visualization. The basin is divided into grids of uniform size (~ 1 km) and model computes various components of hydrologic cycle such as actual evapo-transpiration, overland flow, groundwater recharge, and residual soil water content at monthly time step for each grid. The model brings out total water availability in the basin; water consumed by different uses; and water storage in different hydraulic structures, in soil water zone, and in groundwater aquifer in a river basin. By taking repeated runs of the model for longer time periods, sustainability of various water resources management plans can be examined. The model can be used to: a) visualize the effect of land use change, cropping pattern change,

climate change (in terms of rainfall and its distribution, temperature, humidity etc.), and population and industrial growth on the basin water resources, and b) analyze various management options like inter-basin transfer of water, development of new water resources projects etc.

The model is in continuous phase of development. Some of the present limitations of the model which are planned to be addressed include: i) specification of EAC tables or corresponding relationships for various storage structures, ii) rule-curve based operation of reservoirs so that different operation policies of the system can be simulated, iii) option of hydropower simulation in the basin, iv) continuous long-term simulation, and v) simplified representation of groundwater simulation. It is proposed to prepare input data files through user-interactive forms.

6. Methodology

For approximating the EAC relationships for a reservoir, the approach developed by J. Mohammadzadeh-Habili et. al (2009) has been adopted, avoiding the necessity of specifying EAC tables for various reservoirs in the river basin. The method has been programmed within the FORTRAN code of the model. The previous option of assuming a triangular distribution has also been retained.

Rule-curve based approach has been added in the FORTRAN code for simulating the reservoir operation as per specified operation policy. Earlier, reservoir operation was simulated only with standard linear operation policy (SLOP) only. The option of hydropower simulation of a reservoir has also been added and eight different methods of supply of water through the power plants have been considered. Tail water elevation is also considered as a function of discharge.

Model is planned to work in two modes: a) monthly mode (in which the simulation is carried out at daily time step for a month and then the spatial recharge and discharge pattern are externally used to find the revised water table in the basin with some groundwater simulation model, say Visual MODFLOW, and the revised groundwater table is used for the subsequent month), and b) continuous mode (in which the simulation is carried out at daily time step for the complete period for which hydro-meteorological data are available). In the second mode, grid-wise pumping and recharge estimations are accumulated over each sub-basin and then divided by the S_y of sub-basin to convert water withdrawal/ recharge to corresponding change in groundwater level which can be applied to initial groundwater surface to find the revised surface in the sub-basin, thus avoiding the necessity of detailed groundwater simulation. For each sub-basin, average groundwater depth is computed from data of a large number of observation wells (a procedure, defined by DHI, Denmark has been adopted for converting irregular observations in different wells in a sub-basin) has been programmed and is being added as a module in the software.

In WINDOWS interface of the model, various data input forms are being developed. The layout plan of the software for various activities is shown in Figure - 1. Four important modules of the software include:

a) Database preparation
b) GIS analysis
c) Model execution
d) Analysis of results

Figure – 1: Layout plan of *NIH Basin*

The "Database Preparation" module is planned to include forms for the entry of attribute and temporal data of hydrological variables and model parameters. In the "GIS Analysis" module, it is planned to link the free domain GIS (ILWIS system) for creating and processing geo-spatial data. This module will also contain provisions for converting raster data to ASCII format. In the "Model Execution" module, various sub-models which are run for aggregating spatial information will be provided. In addition, the main Basin model will also be provided in this module. In the "Analysis of Results" module, provision will be made to view spatial and hydrological results of the model.

7. Research outcome from the project

Research outcome from the project is a WINDOWS based spatially distributed river basin planning and management model for integrated water resources assessment and management at basin scale. The study can help water resources departments and river basin authorities in the analysis at river basin scale. It can also help in assessing the impact of various natural and anthropogenic activities on various components of the hydrological cycle at basin scale.

8. Cost estimate:

a. Total cost of the project: Rs. 16.00 lakhs
b. Source of funding: NIH
c. Subhead-wise abstract of the cost

S. No.	Sub-head	Amount (in Rs.)
1.	Salary of Scientists	Rs.15,00,000/-
2.	Travelling expenditure	-
3.	Infrastructure/Equipment	-
4.	Experimental charges	-
5.	Misc. expenditure	Rs.1,00,000/-

	Grand Total	Rs.16,00,000/-

d. Justification for Subhead-wise abstract of the cost

i) Four scientists (@average salary of Rs.1.25 Lakh per month) for 30 months (2.5 years) with an average devoted time of 10%.

ii) Though the WINDOWS based program is being developed with in-house capability of NIH scientists, it is planned to reserve some amount (Rs.1 Lakh only) for professional enhancement and modifications of the software.

9. Quarterly Break up of cost estimate for each year

Year: 2013-14

S. No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	1,50,000/-	1,50,000/-	1,50,000/-	1,50,000/-
2.	Travelling expenditure				
3.	Infrastructure/Equipment				
4.	Experimental charges				
5.	Misc. expenditure				
	Sub Total	1,50,000/-	1,50,000/-	1,50,000/-	1,50,000/-
	Grand Total	Rs.6,00,000/-			

Year: 2014-15

S. No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	1,50,000/-	1,50,000/-	1,50,000/-	1,50,000/-
2.	Travelling expenditure				
3.	Infrastructure/Equipment				
4.	Experimental charges				
5.	Misc. expenditure				
	Sub Total	1,50,000/-	1,50,000/-	1,50,000/-	1,50,000/-
	Grand Total	Rs.6,00,000/-			

Year: 2015-16

S. No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	1,50,000/-	1,50,000/-		
2.	Travelling expenditure				
3.	Infrastructure/Equipment				
4.	Experimental charges				
5.	Misc. expenditure	50,000/-	50,000/-		
	Sub Total	2,00,000/-	2,00,000/-		
	Grand Total	Rs.4,00,000/-			

10. Work Schedule:

a. Probable date of commencement of the project: April 01, 2013

b. Duration of the project: 2.5 years

c. Stages of work and milestone:

S. No.	Work Element	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Year 2013 - 14					
1.	Modification in model methodology and source code				
Year 2014 - 15					
2.	Modification in model methodology and source code				
3.	Development of data forms & WINDOWS interface				
Year 2015 - 16					
4.	Development of data forms & WINDOWS interface				
5.	Model testing and refinement				
6.	Report writing and User Manual preparation				

11. Present Progress:

A number of modifications have been made in the model methodology and the source code for making it more practicable and realistic. Some of these modifications include:

a) Number of landuse classes has been increased from 6 to 60 for more detailed representation.
b) As suggested in last WG, option has been included to consider industrial demands separately (earlier, it was merged with domestic demands) and the same has been linked to city attributes.
c) Date of commissioning of hydraulic structures has been included and in the long-term simulation, their effects are considered only after their commissioning.
d) Now, variable GW development is considered (which was constant initially) by specifying the parameters of a 2nd order equation.
e) Provision of observed EAC table specification for a hydraulic structure has been added.
f) Baseflow computation is now made depending on the actual GW storage in upstream basin above a gauging site.
g) Rather than considering constant population for human and cattle population, population growth is considered as per defined rate and for long-term simulation, revised population is estimated at the beginning of each year.
h) In the command area of hydraulic structures which are commissioned in intermediate stages during long-term simulation, option has been included for considering the revised cropping pattern while computing irrigation demands.

These modification required changes in the input data. Therefore, it was decided to first complete the model modifications and then develop the WINDOWS based forms for database preparation. The program development is nearing completion but interface development needs considerable time. It is suggested to increase the time period of this study by 6 months.

ONGOING STUDIES

INTERNAL RESEARCH PROJECT: NIH/WRS/2015/02

1. Thrust Area under XII five year plan: Impact of climate change on water resources

2. Project team:

a. Project Investigator:	Shri P. K. Mishra, Sc 'B'
b. Project Co-Investigator(s):	Dr. Sharad K. Jain, SC 'G' & Head
	Dr. Sanjay K. Jain, Sc 'F'

3. Title of the Project: Assessing Climate Change Impact across KBK (Kalahandi-Bolangir-Koraput) region of Odisha

4. Objectives:

1. To analyze long-term historical climatic data to determine trend
2. To analyze the future climate in the region based on downscaled GCM data
3. To assess the current potential and utilization gap of water resources in the region to develop management plan

5. Present state-of-art

The proposed study envisages assessing the climate change effects in one of the poorest region in the country (KBK region, Odisha) regularly facing drought, water scarcity, and flood as well. The region is neglected with poor connectivity, resulting in increased Naxalite activities. With large-scale Govt. funding and concerted efforts, KBK region can be developed. Further, climate change and its impact on the water resources is also inevitable. The situation may aggravate in future. Therefore, a timely holistic study considering all the three undivided districts is essential to study the water resources problem in the region considering climate change.

6. Methodology

The study requires creation of a large database collected from primary and secondary sources and generated through Remote sensing and GIS. The study commences with findings standard statistical characteristics for rainfall and temperature such as mean (μ), standard deviation (σ), skewness (Sk), kurtosis (Kk), and coefficient of variation (Cv) for monthly, seasonal and annual temporal scale. The seasonal assessment will include Pre-monsoon (April-May), Monsoon (June-September), Post-Monsoon (October-November) and Winter (December-March) period.

The long-term historic data is analyzed for detecting trend utilizing parametric (5-year moving average) and non-parametric tests (Mann-Kendall test; Sen's slope estimator). Unlike parametric test, the non-parametric tests are robust in nature and do not affected by outliers but certainly by randomness. Hence, the series of data were tried for detecting outliers and randomness before performing any test for trend detection. Standard Normal Homogeneity Test (SNHT) and Pettitt's Test are utilized to find the most probable year where the rainfall and temperature trend has been shifted considerably.

The downloaded large-scale daily predictors of Hadley Center's GCM (HadCM3) for HadCM3 A2 and B2 future scenarios for 139 years (1961–2099) on 3.750 latitude x 3.750 longitude grid-scale (http://www.cics.uvic.ca/scenarios/sdsm/select.cgi) is downscaled using Statistical Downscaling Model (SDSM). The Statistical Downscaling Model (SDSM) is a multiple regression-based tool, introduced by Wilby et al. (2002), for generating future scenarios to assess the impact of climate change. HadCM3 is a coupled atmosphere-ocean GCM developed at the Hadley Centre of the United Kingdom's National Meteorological Service. HadCM3 has been chosen because of its' wider acceptance in many climate change impact studies. Further, it provides daily predictor variables, which can be exclusively used for the SDSM model. Water resources availability and utilization will be made using primary and secondary data collected through field visit and from different multiple sources. It is planned to utilize SWAT model to assess the water resources.

7. Research outcome from the project

a. Long-term trend of climatic variables viz. rainfall, temperature and potential evapotranspiration for the region
b. Future climatic scenario for the region
c. Water availability at present and in the future scenario vis-à-vis its present utilization

8. Cost estimate

a. Total cost of the project: Rs. 28.00 lakhs

b. Source of funding: NIH

c. Sub Headwise abstract of the cost

Sl No.	Sub-head	Amount (Rs.)
1.	Salary	25,80,000.00
2.	Travelling expenditure	1,00,000.00

3.	Infrastructure/ Equipment	0.00
4.	Experimental charges	0.00
5.	Misc. expenditure	1,20,000.00
	Grand Total:	28,00,000.00

d. Justification for Sub-head-wise abstract of the cost

i. Salary head accounts for involvement of 30 man-month (in three years) for the PI and three man-month each for Co-PIs (in three years) and supporting staff.

ii. Travelling expenditure include visit to Bhubaneswar and KBK districts.

iii. Misc. expenditure for an amount of Rs.50000.00 has been considered.

9. Quarterly Break up of cost estimate for each year

Year: 2013-14

Sl. No.	Sub-head	Amount (in Rupees)			
		Q1	Q2	Q3	Q4
1.	Salary	2,37,500/-	2,37,500/-	2,37,500/-	2,37,500/-
2.	Travelling expenditure			50,000/-	
3.	Infrastructure/Equipment				
4.	Experimental charges				
5.	Misc. expenditure	10,000/-	10,000/-	10,000/-	10,000/-
	Sub Total	2,47,500/-	2,47,500/-	2,97,500/-	2,47,500/-
	Grand Total	Rs.10,40,000/-			

Year: 2014-15

Sl. No.	Sub-head	Amount (in Rupees)			
		Q1	Q2	Q3	Q4
1.	Salary	2,37,500/-	2,37,500/-	1,92,500/-	1,92,500/-
2.	Travelling expenditure				
3.	Infrastructure/Equipment				
4.	Experimental charges				
5.	Misc. expenditure	10,000/-	10,000/-	10,000/-	10,000/-
	Sub Total	2,47,500/-	2,47,500/-	2,02,500/-	2,02,500/-
	Grand Total	Rs.9,00,000/-			

Year: 2015-16

Sl. No.	Sub-head	Amount (in Rupees)			
		Q1	Q2	Q3	Q4
1.	Salary	1,92,500/-	1,92,500/-	1,92,500/-	1,92,500/-

2.	Travelling expenditure			50,000/-	
3.	Infrastructure/Equipment				
4.	Experimental charges				
5.	Misc. expenditure	10,000/-	10,000/-	10,000/-	10,000/-
	Sub Total	2,02,500/-	2,02,500/-	2,52,500/-	2,02,500/-
	Grand Total	Rs.8,60,000/-			

Note:

(vii) The above table has to be prepared for each year of the project period

(viii) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

10. Work Schedule

a. Probable date of commencement of the project: April 01, 2013

b. Duration of the project: 3 years

c. Stages of work and milestone:

Sl. No.	Work Element	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Year 2013 - 14					
1.	Data procurement & Review of literature				
2.	Trend analysis				
3.	1st Interim report				
Year 2014 - 15					
4.	Downscaling				
5.	Inputs for SWAT model set-up				
6.	2nd Interim report				
Year 2015 - 16					
7.	Water resources assessment				
8.	Final report				

11. Progress till date:

The study started with three objectives as given in item 4. Already trends in long-term climatic data, i.e., rainfall (110 years), temperature (102years), and potential evapotranspiration (102 years) have been investigated on monthly, seasonal and annual series in eight districts spread over in the KBK region in the western part of Odisha, India. The trends are generated using both parametric (linear regression method) and non-parametric (Mann-Kendall test and Sen's Slope estimates).

As per the second objective of the study i.e. to analyze the future climate in the region based on downscaled GCM data, future rainfall in the KBK region has been downscaled from HadCM3 A2 and HadCM3 B2 GCM data utilizing SDSM model and presented in the 41st Working Group. The study has been carried out using SDSM tool version 4.2.9.

In the present Working Group, future temperature scenario in the KBK region has been downscaled from HadCM3 A2 and HadCM3 B2 GCM data utilizing SDSM model. Further, to assess the water availability and utilization, input data for two basins in the KBK region viz. Tel basin (sub-basin to Mahanadi basin) and Sarbari basin (sub-basin to Godavari basin) is under preparation to run SWAT model. In view of the work volume, it is requested to extend the project period for one year.

ONGOING STUDIES

INTERNAL RESEARCH PROJECT: NIH/WRS/2015/03

1. Thrust Area under XII five year plan: Impact of climate change on water resources

2. Project team:

a. Project Investigator:	Dr. Sanjay K. Jain, Sc "F"
b. Project Co-Investigator(s):	Dr. Sharad K. Jain, Sc 'G' & Head
	Dr. Renoj Theyyan, Sc "D"

3. Title of the Project: Glacier change and glacier runoff variation in the upper Satluj river basin

4. Objectives:

A major goal of the proposed study is to obtain broader understanding of glacier change (spatial and temporal), reasons and their impact on glacier melt runoff. The objectives of the proposed study are as follows:

- Collection and processing of historical data
- Future climate projections will be applied to see the changes in meteorological variables.
- Assessment of changes in glacier cover area using satellite data
- Modelling of glacier melt runoff.
- Glacier mass balance
- Changes in glacier mass balance will be used to investigate glacier melt contributions.

5. Present state-of-art

Glacier runoff contributions to streamflow provide critical water supply in many mountainous regions. These glacier runoff contributions are highly sensitive to changes in temperature. The change in glacier cover area results in significant changes to both total annual and summer streamflow downstream. Warmer temperatures cause increased glacial melt but as glaciers recede; their potential contributions to water supplies are also affected. In Western Himalayan basins, several water resources projects are under operation and many more are coming up in near future to harness the available potential. These projects are of paramount importance in terms of drinking water, irrigation, hydropower generation, flood control and subsequent socio-economic development of the region. The availability of stream flow for glacier melt for these projects throughout the year is very important.

6. Methodology

- Creation of data base of the study area(s)
- Glacier inventory and glacier change occurring in the study area.
- Trend analysis of past and future metrological data
- Glacier mass balance study
- Modeling of glacier melt runoff
- Projection of temperature change
- Assessment of changes in glacier melt runoff vis-à-vis glacier change/change in meteorological inputs

7. Research outcome from the project

The glacier inventory and change in the glacier of the study area. Expected runoff in future and changes in hydropower potential.

8. Cost estimate

a. Total cost of the project: Rs. 12.00 lakhs

b. Source of funding: NIH

c. Sub Headwise abstract of the cost

Sl No.	Sub-head	Amount (in Rupees)
1.	Salary	10,00,000/-
2.	Travelling Expenditure	100,000/-
3.	Infrastructure/Equipment	Nil
4.	Experimental charges	Nil
5.	Misc. expenditure	100,000/-
	Grand total	1200000/-

9. Quarterly Break up of cost estimate for each year

10. Work Schedule

a. Probable date of commencement of the project: October 2013
b. Duration of the project: 3 years
c. Stages of work and milestone:

1st. Interim report	2nd. Interim report	Final report
April 2014	April 2015	March 2016

11. Progress:

In the present study three sub basins of Satluj basin has been taken and they are Baspa, Tirunglhad and Spiti (shown in Figure 1). In these three basins glacier change have been

computed using glacier map obtained from Topographical maps (1966) and satellite data (2000, 2006 and 2011). It was observed that the glacier areas in these basins have been receding. Discharge data of three sites (Sangla, Thangi and Khab), temperature data (Raksham, Kaza, Kalpa) as well as snow water equivalent (SWE) have been collected. The field data have been processed. The correlation of this data with the glacier change obtained using image processing has been investigated.

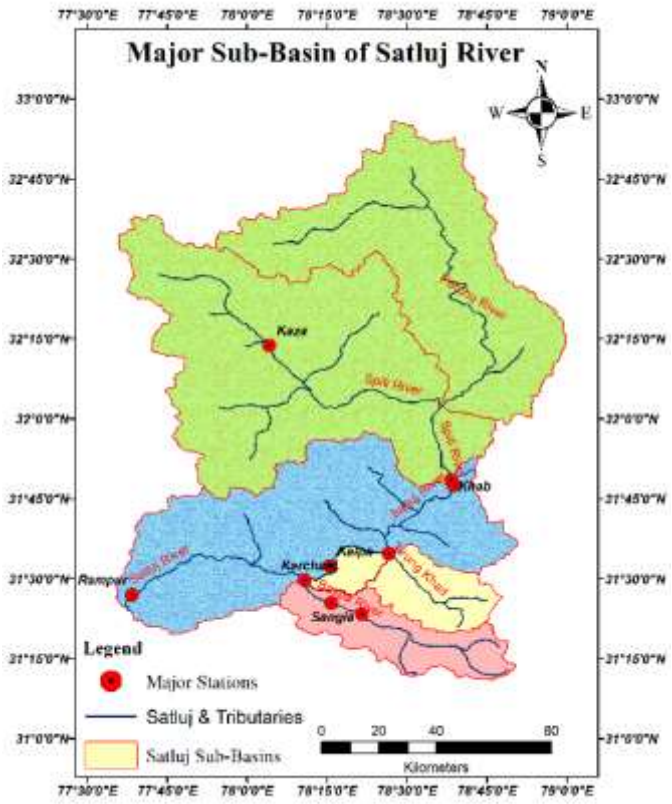


Fig. 1 Study area

Fig. 2 Major sub-basins of Satluj River

ONGOING STUDIES

INTERNAL RESEARCH PROJECT: NIH/WRS/2015/04

1. Thrust Area under XII five year plan: Sustainable water systems management: Adaptation of hydro-system to climate change

2. Project team:

a. Project Investigator: Manish Kumar Nema, Sc 'B'
b. Project Co-Investigator(s): Dr. Sharad K. Jain, Sc 'G' & Head

3. Title of the Project: Variability of the Hydro-climatic variables in Punjab Plains of lower Sutlej

4. Objectives:

a. To collect/procure/computerize long-term hydrological and climatic data of study area
b. To create an integrated hydrological database of lower Sutlej
c. To analyze recorded hydro-climatic data for trends or changes in Punjab Plains of lower Sutlej
d. To evaluate monthly/seasonal/annual hydrology of the region

5. Present state-of-art

The most of the hydrologic and climatic datasets varies with time and space. The assessment of trends in climatology and hydrology still is a matter of debate. Capturing typical properties of time series, like trends, is highly relevant for the discussion of potential impacts of global warming or flood / drought occurrences. The majority of the Indian agriculture is dependent on the southwest monsoon, which brings about 80% of the total precipitation over the country which is critical for the availability of freshwater for drinking and irrigation. Changes in climatic variable over the Indian region, particularly the SW monsoon, would have a significant impact on agricultural production, water resources management and overall economy of the country. A pre-information regarding the changes can be ascertained by the analyzing the trend of these variables. Considering their importance, this study is proposed to understand the variability of the Hydro-climatic variables in Punjab plains of lower Satluj basin by performing standard trend analysis. The Punjab plain of lower Satluj basin up to Harike Barrage has been selected for the study in views of its important contribution in agricultural production for the country. The land surface of Punjab is one of the most fertile plains of India. The Satluj, Ravi and Beas are the major rivers flowing through the Punjab. The Satluj and its tributary Beas enters Punjab near Nangal and Talwara respectively. After moving about 450 km in the plains of Punjab, these two confluences at Harike before crossing over to Pakistan. On micro regional basis the Punjab plains may be divided into the Bari Doab (be-tween the Beas and the Ravi) and the Bist Doab (between the Beas and the Satluj).

6. Methodology

Data Acquisition:

All possible hydro-climatic data and other related information shall be acquired, purchased, collected from various state and central agencies mainly includes Indian Meteorology Department (IMD); Central Water Commission (CWC); Bhakra Beas Management Board (BBMB); Ground Water Department, Govt. of Punjab; etc.

Processing of Acquired Hydrological data:

Integrated hydrological data base will be created in GIS environment after data pre-processing like identification and removal the data gaps, outliers etc.

Linear Regression and Mann–Kendall Test for Trend Analysis:

Prior to perform linear regression test data series shall be standardized by subtracting the mean and diving by their standard deviations. To test for randomness against trend in hydrology and climatology the widely used Kendall's τ statistic will be applied

Magnitude of the Trends: The magnitude of the trend in a time series will be determined using a non-parametric method known as Sen's Slope Estimator.

7. Research outcome from the project

Research Papers and Reports. Comprehensive database of the lower Sutlej in Punjab plains for the end users/beneficiaries from the relevant Sectors

8. Cost estimate

a. Total cost of the project: Rs. 11.34 lakhs

b. Source of funding: NIH

c. Sub Headwise abstract of the cost

S. No.	Sub-head		Amount (in Rupees)
1.	Salary	160 man-days of Sci. – B @ 1600/day	509640
		67 man-days of Sci. – F @ 2740/day	183580
2.	Travelling Expenditure		30000
3.	Infrastructure / Equipment / Data		400000
4.	Experimental charges		0
5.	Misc. expenditure		10000
	Grand Total:		1133220

d. Justification for Sub-head-wise abstract of the cost

Salary is the major comment of the project cost followed by the cost of data to be procured from various data handling agencies. As 70% of the full time of scientist –B and 15 % time of scientist - G is proposed to be devoted due course of accomplishment of the projects.

9. Quarterly Break up of cost estimate for each year

Year: 2013-14

SN	Sub-head	Amount (in Rupees)			
		NDJ (Q1)	FMA (Q2)	MJJ (Q3)	ASO (Q4)
1.	Salary	86652.00	86652.00	86653.00	86653.00
2.	Travelling expenditure	3750.00	3750.00	3750.00	3750.00
3.	Infrastructure/Equipment	50000.00	50000.00	50000.00	50000.00
4.	Experimental charges	0.00	0.00	0.00	0.00
5.	Misc. expenditure	1250.00	1250.00	1250.00	1250.00
	Sub- Total:	141652.00	141652.00	141653.00	141653.00
	Grand Total:				566610.00

Year: 2014-15

SN	Sub-head	Amount (in Rupees)			
		NDJ (Q1)	FMA (Q2)	MJJ (Q3)	ASO (Q4)
1.	Salary	86652.00	86652.00	86653.00	86653.00
2.	Travelling expenditure	3750.00	3750.00	3750.00	3750.00
3.	Infrastructure/Equipment	50000.00	50000.00	50000.00	50000.00
4.	Experimental charges	0.00	0.00	0.00	0.00
5.	Misc. expenditure	1250.00	1250.00	1250.00	1250.00
	Sub- Total:	141652.00	141652.00	141653.00	141653.00
	Grand Total:				566610.00

10. Work Schedule

a. Probable date of commencement of the project: 01/11/2013
b. Duration of the project: 2 years
c. Stages of work and milestone:

SN	Work Element	First Year				Second Year			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1.	Literature survey, Data collection/Monitoring/Field & Lab Investigation	■	■	■	■				
2.	Processing of Acquired Hydrological data			■	■	■			
3.	Linear Regression and Mann–Kendall Test for Trend Analysis and Magnitude of the Trends				■	■	■		
4.	Analysis & Interpretation of data using computer program/model output					■	■	■	■

5.	Preparation of Papers/ Report				■				■

12. Progress till date:

The trend and magnitude of trend analysis has been performed for the monthly rainfall, maximum and minimum temperature data series for the 9 districts which fall under the study area. The results has also been presented in the previous working group meetings. While analyzing the discharge data of the lower Sutlej at Harike and Ropar, it has been observed that most of the discharge is highly regulated and even many a times there are flow breaks in the data. Therefore, it has been felt that the application of MK and Sen's slope may not be very fruitful for understanding the trends. While discussing the issue during the internal review meeting it has been decided to drop the trend component of discharge for the study and also to shorten the period of study from three to two years.

In the last five months the groundwater level data from observation wells and piezometers present in the study area has been collected and being analyzed for identification of trends and their magnitude in the ground water levels using the same methods used in case of rainfall data. The groundwater data has been categorized in to pre-monsoon (i.e. Month of June) and post monsoon (i.e. Month of October) for the available datasets. Average pre-monsoon water table depth of the study area various from 5.32 - 26.87 meters below ground level. The ground water level over the study area are showing a falling trend yet the reason for fall has to be investigated as both groundwater withdrawals are significantly rising in the Punjab and rainfall is also showing decreasing trends.

ONGOING STUDIES

INTERNAL RESEARCH PROJECT: NIH/WRS/2015/05

1. **Thrust Area** **:** Himalayan Cryosphere and Climate Change
2. **Project team** **:** Dr. R.J Thayyen, Dr.S.P Rai, Dr**.** Sanjay Jain, D**r.** Sudhir Kumar
3. **Title of the project** **:** Catchment scale evaluation of cold-arid cryospheric system Hydrology, Ganglass catchment, Ladakh.
4. **Objective**
   1. To improve the understanding of the climate forcing on cold-arid cryospheric system and Hydrology.
   2. To improve the understanding of the melt water generation process and the role of permafrost.
   3. To study the temporal variations in isotopic characteristics of winter base flow and summer flow of the perennial reach and its cryospheric linkages.

5. **Present state of the art:**
   Himalayan and trans- Himalayan regions of the country have many hydrological regimes. Role of the Himalayan cryospheric systems to the downstream river flow varies across these hydrological regimes. However, lack of data and research in these areas limit our understanding of these systems and thereby our ability to manage these system under the changing climate. Cold-arid cryospheric system of the Ladakh is unique hydrological regime of the Himalayan system. The first phase of the project entitled "Cryospheric system studies and runoff modeling of Ganglass catchment, Leh, Ladakh Range" has revealed many unknown facets of the hydrology of the cold-arid cryospheric system such as catchment specific runoff of nival/glacier system, very high temperature lapse rate under cold-arid climate, Low contribution of glacier melt and significant contribution from frozen ground etc. While the earlier project has concentrated on the high altitude Nival/glacier system with catchment outlet at 4700 m a.s.l., the present project (Phase-II) has aimed to expand the research preview to the foothill zones of the mountain to achieve a more comprehensive understanding of the cold-arid system hydrological processes with a view to assist people in managing these scarce resources.

6. **Methodology**

   a) Monitoring of weather parameters by AWS at 3500 m a.s.l., 4700 m a.s.l. and 5600 m a.s.l. for studying the orographic forcing

   b) Monitoring discharge and Electrical conductivity at 4700 m a.s.l & 3500 m a.s.l.

   c) Measuring ground temperature for permafrost studies

   d) Geophysical investigation of potential permafrost zones

e) Isotope studies of stream discharge at 4700m a.s.l. and 3500 m a.s.l.

f) Runoff modeling by SNOWMOD by incorporating the new SELR concept

7. **Research Outcome from the Project:** The project is aimed at quantifying various hydrological components in the catchment and its seasonal responses. Such an understanding is essential for managing the water resources of the region effectively. Better understanding of the lean season winter outflow from the groundwater system is intended to bridge the critical knowledge gap of the mountain groundwater resources and its linkages with the surface water. Understanding of the orographic processes and mountain climate at the nival/glacier systems to decipher the climate change impact on the cold-arid cryospheric system better.

8. **Cost estimate:**

a. Total cost of the project: 48 lakhs

b. Source of funding: NIH

c. Sub Headwise abstract of the cost

S. No.	Sub-head		Amount (in Rupees)
	Salary	Sr. Project Officer	800000
2.	Travelling Expenditure		500000
3.	Infrastructure / Equipment / Data		2500000
4.	Experimental charges		500000
5.	Misc. expenditure		500000
	Grand Total:		4800000.00

9. Work Schedule

S. No.	Work Element	First Year				Second Year				Third Year			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1.	Monitoring weather												
2.	Monitoring Q												
3.	Permafrost temp.												
4.	Geophysics-permafrost												
5.	Isotope studies												

10. Analysis and result

This is a new study initiated in July 2014 in continuation of the studies of past 05 years in the Ladakh region. In view of the expanded research preview, a new discharge and meteorological station are established at 3700 m a.s.l. at Gonpa area. This discharge station at

the perennial stretch of the interrupted stream is established with a view to gather hydrological information throughout the water year, which may provide some insight on surface water – ground water interaction and information of possible permafrost degradation/seasonally frozen ground in the catchment. Discharge measurement at 3700m a.s.l. continued during the reporting period and the samples for isotopic analysis were collected. Meteorological data being generated from 3700, 4700 and 5600 m a..s.l. and analysed. Discharge data from 4700m a.s.l is analysed. This data shows significant snow melt during the July and August months constituting 67% of the catchment discharge in summer. Isotope samples collected during the 2014 summer months is also being analysed.

Figure 1 Study area showing South Pullu and Gonpa discharge stations and weather stations

ONGOING STUDIES

INTERNAL RESEARCH PROJECT: NIH/WRS/2015/06

1. Thrust Area under XII five year plan: Integrated water resources management/ watershed hydrology

2. Project team:

a. Project Investigator: P. K. Agarwal, Sc 'B'
b. Project Co-Investigator(s): Dr Sanjay K. Jain, Scientist 'F'
Shri Tanvear Ahmed, Scientist "B"
Dr. M. K. Goel, Scientist "F"
Dr. Sharad K. Jain, Scientist "G"

3. Title of the Project: Hydrological modeling of a part of Satluj basin using SWAT Model

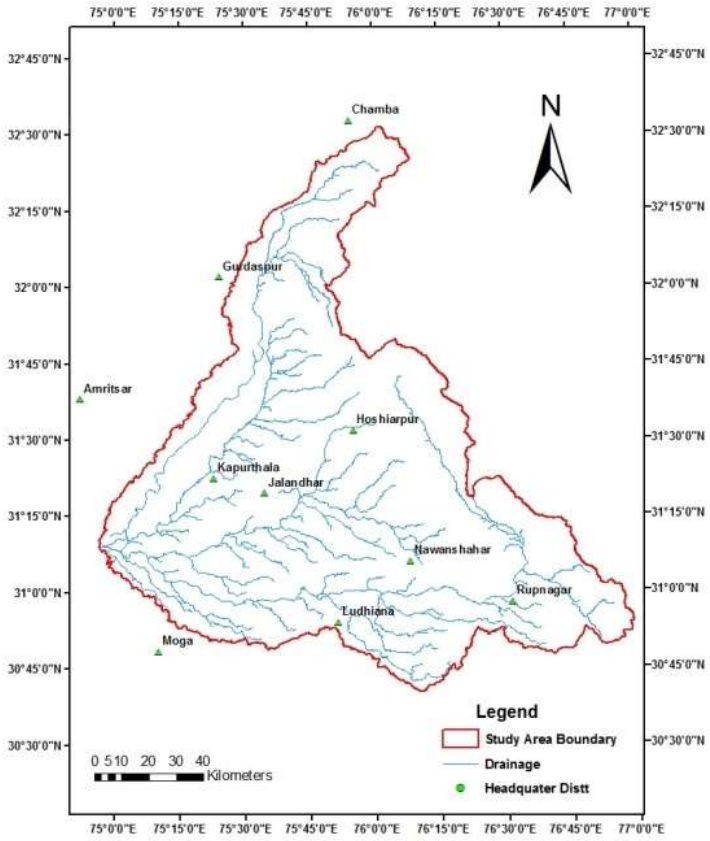
4. Objectives:

i. To develop the data base of a part of Satluj river basin (between Ropar D/s of Bhakra dam to Harike) and
ii. To carry out Hydrological modeling of the basin using ArcSWAT model to find out water balance components e.g. Actual evapo-transpiration etc.

5. Present state-of-art

The Soil and Water Assessment Tool (SWAT) model is a river basin or watershed scale model developed by the USDA Agricultural Research Service. SWAT is a spatially distributed, continuous time model that operates on a daily time step. SWAT was developed to predict the impact of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land use and management conditions over long periods of time. It can incorporate the effects of tanks and the reservoirs/check dams off-stream as well as on-stream. SWAT requires specific input about weather, soil properties, topography, vegetation, and land management practices to model hydrology and water quality in a watershed. The model allows a basin to be subdivided into sub-basins or watersheds which is particularly beneficial when different areas of the macro-watershed are dominated by land uses or soils different enough in properties to have different impacts on the hydrological response. Within SWAT the input information for each watershed is grouped and is called hydrologic response units or HRUs. The major advantage of the model is that unlike the other conventional conceptual simulation models it does not require much calibration and therefore can be used on ungauged watersheds. Model outputs include all water balance components (surface runoff, evaporation, lateral flow, recharge, percolation, sediment yield, etc.) at the level of each watershed and are available at daily, monthly or annual time steps.

Study Area selected Satluj river basin (between Ropar D/s of Bhakra dam to Harike) as given figure



6. Methodology

In the present study, the following methodology will be adopted:

- Data base preparation in ArcGIS (DEM, Land use, soil map)
- Collection of metrological data (rainfall, temperature, wind, solar radiation, humidity)
- Setup of SWAT model using Acr-GIS.
- Calibration and validation of SWAT model
- To carry out the effect of land use & other changes on stream flow.

7. Research Outcome from the Project

- Stream flow from the study area
- Water balance components (runoff, evaporation, lateral flow etc) for the sub-basin.

8. Cost Estimate:

a. Total cost of the Project: Rs. 23.00 lakhs
b. Sources of Funding: NIH
c. Sub head wise Abstract of Cost

S N	Sub Head	Amount (in Rupees)
1	Salary	Rs. 15,00,000.00
2	Travelling Expenditure	Rs. 3,00,000.00
3	Infrastructure/Equipment/Data	Rs. 3,00,000.00
4.	Experimental Charges	-
5.	Misc. Expenditure	Rs. 2,00,000.00
	Total	Rs. 23,00,000.00

9. Quarterly Break up of cost estimate for each year

Year: 2014-15

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	-	100000.00	100000.00	100000.00
2.	Travelling expenditure	-	NIL	NIL	NIL
3.	Infrastructure/Equipment	-	NIL	NIL	NIL
4.	Experimental charges	-	NIL	NIL	NIL
5.	Misc. expenditure	-	NIL	NIL	NIL
	Sub- Total:	-	100000.00	100000.00	100000.00
	Grand Total	Rs. 3,00,000.00			

Year: 2015-16

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	150000.00	150000.00	150000.00	150000.00
2.	Travelling expenditure	40000.00	40000.00	40000.00	40000.00
3.	Infrastructure/Equipment	40000.00	40000.00	40000.00	40000.00
4.	Experimental charges	NIL	NIL	NIL	NIL
5.	Misc. expenditure	20000.00	20000.00	20000.00	20000.00
	Sub- Total:	250000.00	250000.00	250000.00	250000.00
	Grand Total	Rs. 10,00,000.00			

Year: 2016-17

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	150000.00	150000.00	150000.00	150000.00
2.	Travelling expenditure	40000.00	40000.00	40000.00	40000.00
3.	Infrastructure/Equipment	40000.00	40000.00	40000.00	40000.00
4.	Experimental charges	NIL	NIL	NIL	NIL
5.	Misc. expenditure	20000.00	20000.00	20000.00	20000.00
	Sub- Total:	250000.00	250000.00	250000.00	250000.00
	Grand Total	Rs. 10,00,000.00			

d. Justification for sub-head-wise abstract of cost:
Salary may be taken for 15 man months @ 1.00 lacs/man month average
Travelling expenditure for Field visit and collection of data as per requirement
Infrastructure/Equipment/Data charges are required for collection of data/satellite data
Misc. Expenditure: For miscellaneous expenditures lik stationary, printing, etc.

10. Work Schedule

a. Probable date of commencement of work June 2014
b. Duration of Work 2-3/4 Years
c. Stage of work and Milestone

SN	Work Element	**First Year (2014-15)**			**Second Year (2015-16)**				**Third Year (2016-17)**			
		Jun-Sep	Oct-Dec	Jan-mar	April-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jen	Jul-Sep	Oct-Dec	Jan-Mar
1	**Literature Review & Data Collection**	■	■	■								
2	**Development of data base for a river basin for SWAT model**		■	■	■							
3	**Application of SWAT model**				■	■	■	■				
4	**Analysis of Results**							■	■	■		
5	**Preparation of Report**									■	■	■

11. Progress made between Dec 2014-Feb 2015

- SRTM DEM (90 meter) has been downloaded and study area and drainage etc. have been generated.
- Literature review in progress;
- Meteorological data has been collected;
- The preparation of data base required for SWAT is under progress
- Preparation of land use map & Soil map are in the final stage of completion;
- In SWAT HRU analysis work just has been started;

ONGOING STUDIES

INTERNAL RESEARCH PROJECT: NIH/WRS/2015/07

1. Thrust Area under XII five year Plan: Integrated Water Resources Development and Management

2. Project team:

a. **Project Investigator**: D.S. Rathore, Sc F

b. **Project Co-Investigator(s)**: M.K. Goel, Sc F
R.P. Pandey, Sc F
Sanjay Kumar, Sc D
Surjeet Singh, Sc D

3. Title of the Project: Decision support system for water resources planning in Upper Bhima basin, Maharashtra

4. Objectives:

a. Rainfall- runoff modeling and estimation of water availability in the basin
b. Multi-reservoir operation in the basin for project complexes
c. Drought prediction
d. Water quality modeling in the basin
e. Conjunctive use operation in command area
f. Rainfall- runoff modeling and river basin simulation for climatic change scenarios

5. Present state-of-art

A Decision Support System (Planning) has been developed under Hydrology Project - II for State and Central implementing agencies. The project has two components, namely DSS platform and modelling systems. For modelling system, MIKE HYDRO Basin model was chosen in the project. The model is a water allocation model which also has conceptual lumped rainfall- runoff model NAM in built for generation of long term runoff time series. The platform has GIS, spreadsheet, scenario, script, time series and dashboard (for web applications) managers. On the platform, data and model scenarios may be handled. The scenarios are run with available MIKE HYDRO Basin engine.

6. Methodology

MIKE HYDRO Basin will be used and database for the Upper Bhima basin up to Ujjani dam developed in HP-II project will be transferred to the new system. Rainfall-runoff modelling will be done using NAM for finding different hydrological components at sub-basins scale. Rule curves would be developed for various project

complexes and multi reservoir operation would be carried out to optimize the water use in the basin. Meteorological and hydrological drought indices would be computed using rainfall and hydrological data. Conjunctive use scenario in canal command areas will be run. River water quality modelling will be carried out. Web-interfaces through Dashboards would be developed for dissemination of input and results of simulation in DSS (Planning). Downscaling will be done for climatic scenario. Downscaled climate data will be utilized and model runs would be taken to find their impact on the water availability and allocation in the basin.

7. Research outcome from the project

a. Water availability in various sub-basins in present and changed future climate.
b. Reservoir operation rules for existing and future climatic scenarios: Model was set up for reservoir operation and optimization in Khadakwasla complex.
c. Meteorological and hydrological drought indices: Data preparation was done for computing meteorological drought indices.
d. Conjunctive use in canal command areas.
e. River water quality modeling in river reaches and impact of climate change: Water quality model was set up.
f. Interfaces for decision support.

8. Cost estimate:

a. Total cost of the project: Rs.50.10 lakhs
b. Source of funding: NIH
c. Sub Headwise abstract of the cost

Sl.No.	Sub-head	Amount (in Rupees)
1.	Salary	4080000.00
2.	Travelling expenditure	00.00
3.	Infrastructure/Equipment	880000.00
4.	Experimental charges	00.00
5.	Misc. expenditure	50000.00
	Grand Total:	5010000.00

d. Justification for Sub-head-wise abstract of the cost

In the year (2015- 16), 24, 12 and 4 man months will be utilized for Sc F, Sc D and SRA (monthly emoluments are taken as Rs 120000.00, 80000.00 and 60000.00 for sc F, Sc D and SRA respectively). A work station and laptop will be procured at cost of Rs 400000.00 and Rs 80000.00 respectively. MIKE HYDRO Basin software will be procured costing Rs 400000.00.

9. Quarterly Break up of cost estimate for each year

Year: 2015-16

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	1020000.00	1020000.00	1020000.00	1020000.00
2.	Travelling expenditure	00.00	00.00	00.00	00.00
3.	Infrastructure/Equipment	880000.00	00.00	00.00	00.00
4.	Experimental charges	00.00	00.00	00.00	00.00
5.	Misc. expenditure	15000.00	10000.00	15000.00	10000.00
	Sub- Total:	1915000.00	1030000.00	1030000.00	1030000.00
	Grand Total	5010000.00			

Note:

(ix) The above table has to be prepared for each year of the project period

(x) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

10. Work Schedule:

a. Probable date of commencement of the project: Continuing
b. Duration of the project: 2 years
c. Stages of work and milestone:

Sl. No.	Work Element	First	Second	Third
1	Water availability	Data processing	Rainfall- runoff modeling- current	Rainfall- runoff modeling- future
2	Reservoir operation rules	Data preparation, Model set up	Rule curves-current	Rule curves-future
3	Drought indices	Data preparation	Meteorological	Hydrological
4	Conjunctive use	Model set up	Current scenario	Future scenario
5	Water quality modeling	Model set up	Current scenario	Future scenario
6	Interfaces	Application-1	Application-2	Application-3

ONGOING STUDIES

INTERNAL RESEARCH PROJECT: NIH/WRS/2015/08

1. Thrust Area under XII five year plan: Hydrology for sustainability of water resources

2. Project team:

a. Project Investigator:	Dr. Sanjay K. Jain, Sc "F"
b. Project Co-Investigator(s):	Dr. Sharad K. Jain, Sc "G" Er. T. Thomas, Sc 'C' Er. P K Mishra, Sc 'B' Er. Manish Neema, Sc 'B' Er. P.K.Agarwal, Sc 'B'

3. Title of the Project: Modelling of Narmada Basin Using GWAVA Model

4. Objectives:

A major goal of the proposed study is to do hydrologic modeling of the basin. The objectives of the proposed study are as follows:

- Collection and processing of historical data
- Future climate projections will be applied to see the changes in meteorological variables.
- Modelling of rainfall runoff.
- Impact of changes on stream flow in the basin.

5. Present state-of-art

Accurate water resources assessment and re-assessment is need of the hour in view of the altered water demand and utilization scenario world-wide. This requires robust hydrological model to accurately assess the water availability at present and in the future. Narmada basin is one of the highly regulated basins in India. Several water resources projects are being implemented, under construction and proposed in the basin. Since last few decades, urbanization and population growth has also driven additional water requirement in the basin. This requires revisiting water resources assessment in the Narmada basin.

6. Methodology

Study area: Narmada basin up to Hoshangabad including Tawa basin (D/s of confluence with Tawa)

GWAVA is a hydrological model which incorporates additional water resource components such as reservoirs, abstractions, and water transfers that modify water

quantity and flow regime. It was developed with funding from DFID (UK Department for International Development). The model typically operates on 0.5 or 0.1 degree latitude-longitude grid. The choice of grid size is a compromise between that needed to represent spatial variability and the availability of suitable data. The model outputs include simulated monthly flows and a cell-by-cell comparison of water availability. GWAVA can be used to examine scenarios of change, both for climate and water demands.

Inputs for first tier GWAVA application

- Spatially and temporally explicit inputs
    - Rainfall, temperature (at least daily resolution)
    - Potential evapotranspiration or wind speed + relative humidity + solar radiation (at least daily resolution)
    - If the modelled area does not include some upstream areas: River discharges into the modelled area
- Spatially explicit inputs
    - Elevation or flow direction grid
    - Coverage by different irrigated crop types
    - map of rivers and other water bodies
    - Soil texture
    - Land cover
    - Lake, reservoir and wetland parameters (areal cover, maximum water volume, vertical shape, type of reservoir)
    - Urban and rural water demand per capita
    - industrial water demand
    - Rural population
    - Total population
    - Cattle, sheep and goat population
- Temporally explicit inputs
    - Gauged river discharge
- Parameters (constants)
    - Per capita water demand for sheep, goats, and cattle
    - Irrigation efficiency
    - % Leakage from urban and rural water supply systems
    - % return flow
    - Crop characteristics and growth stage durations for individual irrigated crop types, and the start and end of their growing season

Once the database data base of the study area(s) is collected and/or procured, model set up will be done. Then model will be calibrated and validated before going for sensitivity analysis.

7. Research Outcome from the Project

- Stream flow from the study area
- Water balance components (runoff, evaporation, lateral flow etc) for the sub-basin.

8. Work Schedule

a. Probable date of commencement of work November 2014
b. Duration of Work 2-3/4 Years
c. Stage of work and Milestone

1st. Interim report	**2nd. Interim report**	**Final report**
April 2015	April 2016	March 2017

9. Progress

The catchment of the study basin (Narmada) has been created in GIS. The hydromet data of the basin is collected. Processing of the data is in progress. A training course on the application of GWAVA is proposed in the first week of March, 2015. After that model set up for basin will be taken up.

ONGOING STUDIES

INTERNAL RESEARCH PROJECT: NIH/WRS/2015/09

1. **Thrust Area under XII five Year Plan**: Himalayan Cryosphere and Climate Change

2. **Project Team:**

   Project Investigator: Dr. R.J Thayyen, Sci-D

   Project Co-Investigators: Dr. Sanjay Jain, Sci'F'

3. **Title of the Project:** Runoff modelling of Shyok River, Karakorum Range

4. **Objectives:**

1. To generate runoff data at Km 150 for BRO-HIMANK
2. To develop a baseline runoff and meteorological data of Shyok basin
3. Runoff modelling of Shyok River at KM 150 & Shyok village

5. **Present state-of-art**

Shyok Basin lie in the northern most part of our country sharing its boundary with China and Pakistan. The upper Indus basin has the largest glacier reserve in the Himalaya with 5211 glaciers and 29119 km^2 of glacier cover. Within the upper Indus region, the Shyok basin has the largest number of glaciers enumerated at 2454 covering a 10810km^2. Comparing to this, the Indian Himalayan region contributing to Ganga-Brahmaputra river system only have 1578 glaciers covering just 3787km^2 of glacier cover (Data Source Raina& Srivastava,2008 sourced from GSI glacier inventory 2009). However, glaciers and cryospheric system in this region is not received the due attention till date. Discharge of Shyok river is not monitored and its hydrological characteristics and resource potential is not known. The border roads organisation, HIMANK project is in urgent need of discharge data of Shyok river for strategic purpose and the present project is planned to fulfill this requirement for BRO.

Shyok river fed by the glaciers of Karakorum range. It is well accepted that the Karakorum glaciers are gaining mass in the recent past. Long –term monitoring of River Shyok will provide valuable information on river flow response of a glacier fed river under positive mass balance regime. Being a trans-boundary river this information will be very useful different national agencies. The automatic weather station proposed in the study will be the first comprehensive weather station in the region and will provide crucial input to the armed forces and data required for snowmelt runoff model. The ongoing study in the Ladakh range south of the Karakoram in the cold-arid system has shown that the glaciers are losing it mass. The proposed will be provide a interesting comparison between two contrasting glacier systems in the Himalaya.

Head water region of the Shyok river originating from the Remo glacier has couple of surging glaciers such as Chonh Kumdan, Kichik Kumdan and Aktash glacier. Under the mass gain these glaciers are potential to surge. The Kumdan floods during 1929 to 1932 due to bursting of a 16 km long lake formed by blocking of River Shyok by the surging Kumdan glacier was devastated the Shyok basin. Hence monitoring of Shyok river is necessary for

civilian and defense perspective. Hence the proposed study is being taken up by the above objectives.

6. Methodology

1. Monitoring of weather parameters and discharge by AWS at Km 150 (5600 m a.s.l.) for generating climate data for runoff modeling.
2. Generation of snow cover depletion curves through melt season
3. Runoff modeling by SNOWMOD and Win SRM at this two stations

7. Research Outcome from the project: Discharge & Meteorological data, Research papers and project reports and better understanding of the Cryospheric response of the Karakorum mountains.

8. Cost Estimate :

Total cost of the project: Rs. 37.64 lakhs

b. Source of funding: NIH

c. Sub Headwise abstract of the cost

S. No.	Sub-head		Amount (in Lacs)
1.	Salary	Resource person @Rs.22,000/- pm	2.64
2.	Travelling & Fieldwork		3.0
3.	Permanent Equipments (AWS, AWLR etc)		28.0
4.	Contingency		3.0
5.	Misc. expenditure		1.0
	Grand Total:		37.64

9. Work Schedule

S. No.	Work Element	First Year				Second Year				Third Year			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1.	**Monitoring weather**												
2.	**Monitoring Q**												
4.	Runoff modeling												

10. Analysis and result

During the reporting period, a discharge station is set up at km 150 at Durbuk-DBO road axis with the help of Border Road organisation in the month of October 2014 and discharge data is being collected. This data will be downloaded in the month of June/ July months when roads open after the winter.

ONGOING STUDIES

INTERNAL RESEARCH PROJECT: NIH/WRS/2015/10

1. **Thrust Area under XII five Year Plan**: Sustainable water systems management: Adaptation of hydro-system to climate change

2. **Project Team:**
   a. Project Investigator: Manish Kumar Nema, Scientist 'B'
   b. Project Co-Investigators: Dr S. K. Jain, Scientist 'G'/ Head, WRSD,
      Dr Sanjay K Jain, Scientist 'F'
      Dr Renoj J. Thayyen, Scientist 'D' and
      Mr PK Mishra, Scientist 'B'
3. **Title of the Project:** Hydrological Processes and Characterization of Lesser Himalayan Catchments

4. **Objectives:**

   a. To establish an instrumentation and experimental setup to measure various hydrological and meteorological variables in a watershed in the upper Ganga basin within the state of Uttarakhand for better understanding of their behavior and to study the dynamic linkages between the two.
   b. Analysis and comparison of estimated Evapotranspiration (ET) by different methods like RS/SEBAL, FAO56 method and actual field measurements
   c. To study the various water balance components in the watershed

5. **Present state-of-art**

   Watershed is supposed to be the basic unit at which the hydrologic processes are studied and is central to most of the concepts in hydrology. Managing agricultural or forested watersheds for water quality and quantity improvement and productivity requires a detailed understanding of functional linkages between ecohydrological processes and management practices. Various watershed studies are being conducted to understand the fundamental hydrologic and biogeochemical processes and their linkages with soils, vegetation, topography, climate, and management practices worldwide. These studies mainly involve modelling the natural processes but the vibrancy of experimental hydrology broadly across the areas of subsurface and surface hydrology and hydrometeorology still have a unique place of importance and no alternative.

   In view of the state of affairs of existing models and studies addressing the problems of watershed hydrology, the major limitations might be characterized as mainly twofold. First, study basin designs have been limited by the black box concept and many misconceptions (e.g., the linearity, non-heterogeneity, additivity of hydrologic systems etc.). Second, operation has been substantially bounded by the hydraulic conception of these watersheds as isolated hydrological systems (Wei-Zu et al. 2013). Most of the watershed studies monitor only total runoff at the stream-outlet and the subsurface responses of the watershed are only estimated by hydrograph separation, etc. These characteristics undermine the formulation of a unified theory of watershed hydrology (Sivapalan et al. 2005) and the development of watershed models (Kirchner, 2006; Mcdonnell et al., 2007). There is a clear need to move beyond the status quo and expand

from this narrow hydrological perspective to generate hypotheses governing general behavior across places and scales, with the ultimate aim to advance the science of hydrology.

6. Methodology

(A) Study Area:

A small Himalayan hilly watershed Hinval up to Jijli in the upper Ganga basin in the state of Uttarakhand is proposed for the study. This study area is a paired watershed of two kinds. One of them is a forested catchment (undisturbed) and other one is an agricultural watershed with anthropogenic interventions including an urban habitat at Chamba (Uttarakhand). The geographical extent of the study area is from $30^0$17'N–$30^0$26'N latitude and $78^0$16'E–$78^0$25'E longitude. This area is a typical representative of a combination of lesser Himalayan hilly temperate climatic conditions with average annual rainfall range of 1200-1800 mm. The Himalayan subtropical forests yield to a belt of temperate broad leaf and mixed forest mainly comprises of pine forest. The total area under study is of 120 km^2 approximately (20 km^2 forested catchment and 100 km^2 the other one) with an elevation range of 999-2676 m. The location map of the watershed and their digital elevation model from SRTM is given in the figure 1.0 for reference. The stream in the forested sub-catchment is the source of drinking water for 87 nearby villages. This stream is being pumped 24x7 by the state authorities at its outlet at Dev Nagar. A study of the topography and land use of the proposed watershed shows that the watershed is representative of the surrounding areas.

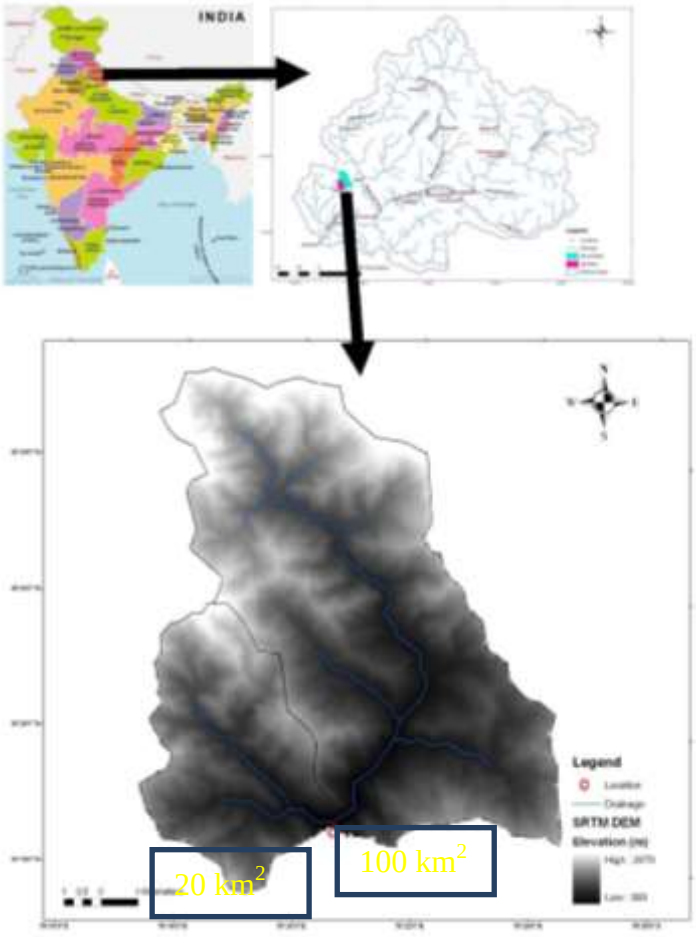


Fig. 1.0 Location of the Hinval watershed up to Jijli within India

(B) Experimental setup

Variables and parameters to be observed: They were organized into four categories, that is, hydrological and ecological variables, atmospheric forcing variables, vegetation parameters, and soil parameters.

(C) Soil Heat Flux

Soil heat flux represents the amount of radiant energy absorbed or released at the soil surface during a given time period. Many field studies in topics such as microclimatology, and hydrology require reliable measurements of the soil surface flux (Payero et al 2005; Oladosu et al 2007). Soil heat flux, as a component of available energy, is a necessary input for many evaporation measurement and prediction techniques. Evaporation measured with the Bowen ratio energy approach is dependent on an accurate value for the available energy (net radiation-heat flux). One of the objective of this study is to estimate soil heat flux using soil temperature collected at various soil depths. It is also intended to study the diurnal variation of soil heat flux in winter, Pre-monsoon, SW monsoon and NE monsoon seasons.

(D) Evapotranspiration (ET)

At the watershed scale, ET represents the largest water flux next to precipitation, but it is the most challenging variable to measure at this scale due to the heterogeneity of the landscape. Accurate estimates of ET are needed for numerous agricultural and natural resource management tasks, hydrological modelling and to project changes in hydrological cycles due to potential climate change. Crop coefficients are developed to determine crop water needs based on the estimated evapotranspiration (ET) of a reference crop under a given set of meteorological conditions as followed in Penman–Monteith equation, as presented in the FAO-56 manual on crop evapotranspiration. Starting in the 1980s, crop coefficients developed through lysimeter studies or set by expert opinion began to be supplemented by remotely sensed vegetation indices (VI) that measured the actual status of the crop on a field-by-field basis. VIs measure the density of green foliage based on the reflectance of visible and near infrared (NIR) light from the canopy, and are highly correlated with plant physiological processes that depend on light absorption by a canopy such as ET and photosynthesis (Glenn et al., 2011). After that many studies have been reported for the estimation of ET and water balance using remote sensing techniques (Senay et al., 2011; Raghuveer et al., 2011; Vinukollu et al., 2011; Elhag et al., 2011; Allen et al. 2011). In the present study, the estimates of ET from various sources will be compared with the actual field observations.

(E) Soil Moisture

Soil moisture in the uppermost 1–2 m of the earth's surface is recognized as a key variable in many environmental studies, including those related to meteorology, hydrology, agriculture and climate change. This thin layer of soil controls the success of agriculture and regulates partitioning of precipitation into runoff and sub-surface water storage. An understanding of the soil moisture variability is necessary to characterize the linkages between a region's hydrology, ecology and physiography (Jackson, 1993). In the changing climate and land use scenario, it is important to evaluate the impacts of these changes on regional hydrology. The proposed objectives under this theme are to understand spatio-temporal variability of soil water potential and soil moisture content under different land covers in the temperate lesser Himalayan region and to evaluate differences, if any in spatial and temporal patterns of soil moisture content as influenced by nature of land cover. We propose to establish sampling points for measuring the soil moisture content under different land covers in selected watersheds. These points shall be spread spatially across the watersheds so as to cover topographic highs and lows. Soil matric potential measurements are proposed using resistance-type probes. At each sampling point, probes will be installed at different depths. A roving instrument (handheld read-out unit) shall be used to record matric potential (kPa). Measurements shall be made at suitable time steps (Venkatesh et al., 2010)

(F) Hydrologic Modelling

Soil and Water Assessment Tool (SWAT) Model

For hydrologic modelling, a robust model, which incorporates most of the study variable sand parameter is needed. The model used at a later stage in the study will be calibrated and validated on the generated data from the experimental setup. For hydrology modelling, SWAT model will be applied. SWAT is a semi-distributed, continuous watershed modelling system, which simulates different hydrologic responses using process- based equations. The model computes the water balance considering a range of

hydrologic processes such as evapotranspiration, snow accumulation, snowmelt, infiltration and generation of surface and subsurface flow components. Spatial variability within a watershed is represented by dividing the area into multiple sub-watersheds, which are further subdivided into hydrologic response units (HRUs) based on soil, land cover and slope characteristics. SWAT uses a temperature-index approach to estimate snow accumulation and melt. Snowmelt is calculated as a linear function of the difference between average snowpack maximum temperature and threshold temperature for snowmelt. Snowmelt is included with rainfall in the calculation of infiltration and runoff. SWAT does not include an explicit module to handle snow melt processes in the frozen soil, but includes a provision for adjusting infiltration and estimating runoff when the soil is frozen (Neitsch et al., 2005). Despite this limitation, SWAT was considered to be the most appropriate integrated model currently available for application in cold regions environment. SWAT computes actual soil water evaporation using an exponential function of soil depth and water content. The model generates surface runoff using a modified Soil Conservation Service (SCS) curve number method based on local land use, soil type, and antecedent moisture conditions. Groundwater flow contribution to total stream flow is simulated by routing the shallow aquifer storage component to the stream. Runoff is routed through the channel network using the variable storage routing method or the Muskingum method (Neitsch et al., 2005). For snowmelt runoff modelling, another model, SNOWMOD model, after proper training and validation, will be forced with climate scenarios to generate future projections of timing and magnitude of snow and glacial melt discharge.

Variable Infiltration Capacity (VIC) Model

The VIC [Liang et al., 1994] model is a macroscale hydrological model that simulates hydrologic fluxes (such as runoff and evapotranspiration) and moisture storage in response to input climate variability. As a semi-distributed macroscale hydrological model, VIC balances both the water and surface energy budgets within the grid cell, and its sub-grid variations are captured statistically. Distinguishing characteristics of the VIC model include: subgrid variability in land surface vegetation classes; subgrid variability in the soil moisture storage capacity; drainage from the lower soil moisture zone (base flow) as a nonlinear recession; inclusion of topography that allows for orographic precipitation and temperature lapse rates resulting in more realistic hydrology in mountainous regions. It is applied to grid cells, with typical spatial dimensions from 1/80 to 20 latitude by longitude. VIC represents multiple vegetation classes as fractions within a grid cell and uses two or more soil layers to calculate the energy and water balance while considering sub grid spatial variability of precipitation and infiltration [Liang et al., 1996]. The upper soil layer represents the dynamic response of soil moisture to rainfall events and the lower layers represent the seasonal soil moisture storage. Most of the applications use three layers (e.g. Bowling et al., 2003a, Maurer et al., 2001, Wood et al., 2002).

The VIC model represents surface runoff processes via the variable infiltration curve. This curve represents the relationship between the fractional area that is assumed to be saturated in any given time step and the infiltration capacity for the remaining unsaturated portion of the grid cell. During rain events, surface runoff is produced from the saturated fraction. The base flow is specified as a function of soil moisture in the lowest soil layer. This relationship is nonlinear at high soil moisture contents thereby producing rapid base flow response in wet conditions. Below a user specified value of soil moisture, the

function becomes linear thereby reducing the responsiveness of base flow in dry conditions. It is proposed to apply above models once sufficient data have been collected.

7. Research Outcome from the project:

Development of a world class field hydrological laboratory in the lesser Himalaya. Development of better understanding of monsoon forcing on regional hydrology under changing climate for the end users/beneficiaries from the relevant Sectors. Research Papers and Reports.

8. Cost estimates:

a. Total cost of the project: ₹ 90, 55, 000. 00
b. Source of funding : NIH
c. Sub-head wise abstract of the cost :

S. No.	Sub-head	**Amount in ₹ (Lac)**
1.	Salaries/ wages	33.60
2.	Travelling Expenditure	10.00
3.	Infrastructure / Equipment / Data	39.45
4.	Experimental charges	7.50
5.	Misc. expenditure	0.00
	Grand Total:	90.55

d. Justification for sub-head wise abstract of the cost: due to lots of instrumentation involve in the project the non-recurring cost is the major component followed by the salary of the project staff.

9. Quarterly Break up of cost estimate for each year

Year: 2015-16

SN	Sub-head	Amount (in Rupees)			
		JFM (Q1)	AMJ (Q2)	JAS (Q3)	OND (Q4)
1.	Salary	168000.00	168000.00	168000.00	168000.00
2.	Travelling expenditure	50000.00	50000.00	50000.00	50000.00
3.	Infrastructure/Equipment	986250.00	986250.00	986250.00	986250.00
4.	Experimental charges	0.00	0.00	0.00	0.00
5.	Misc. expenditure	37500.00	37500.00	37500.00	37500.00
	Sub- Total:	1011800.00	1011800.00	1011800.00	1011800.00
	Grand Total:				4047200.00

10. Work Schedule:

a. Probable date of commencement of the project: 01.01.2015
b. Duration of the project: 5 years
c. Stages of work and milestones:

SNo.	Description of Activity	2015				2016				2017				2018				2019			
		J	**A**	**J**	**O**	**J**	**A**	**J**	**O**	**J**	**A**	**J**	**O**	**J**	**A**	**J**	**O**	**J**	**A**	**J**	**O**
1.	Development of Procedure for scientific work																				
2.	Recruitment and deployment of Project Personnel																				
3.	Purchase of instruments and experimental setup																				
4.	Data generation and acquisition																				
5.	Data analysis and modelli																				
6.	Final Reporting																				

10. Progress till date:

The project has recently started and the study team members has visited the study area on 06.02.2014 and assessment and identification of the discharge gauging sites and location for automatic weather stations has been done. Soon the construction of the gauging structure has to be started and procurement of instruments and man power deployment are the immediate targets of the project.

SPONSORED STUDIES

EXTERNAL RESEARCH PROJECT: NIH/WRS/2015/01

1. **Thrust Area:** Himalayan Cryosphere and Climate Change
2. **Project team:** Dr. R.J Thayyen, Dr. S.P Rai & Dr. M.K Goel
3. **Title of the project:** Glaciological studies of Phuche Glacier, Ladakh Range.
4. **Objectives**
   1. Winter & Summer Mass Balance studies by glaciological method
   2. Runoff measurements
   3. Collection and standardization of meteorological parameters by AWS
   4. Mass Balance & Runoff modeling
   5. To study the composition of stable isotopes $\delta^{18}O/\delta D$ in the winter snow, summer snow/rainfall and separate snow, rain and glacier melt components in the glacier discharge and its temporal and seasonal variations.

6. **Present state of the art**

Most of the glacier mass balance research in the Himalaya is concentrated in the monsoon regimes of Uttarakhand and Himachal Pradesh. Response of small glaciers in the Cold-Arid climate system of the Trans-Himalaya to the prevailing climate is not yet known, leading to a huge knowledge gap in our understanding of factors influencing glacier response to the climate change and its consequences. As people fully depend on glacier streams of the region for their sustenance, as the glacier melt feeds into a dry regime, study of these glaciers have greater societal importance.

7. **Methodology**
   a) Procurement and installation of equipments
   b) Yearly winter and summer mass balance measurement
   c) Glacier runoff measurements
   d) Year round monitoring of meteorological parameters and standardization
   e) Mass balance & runoff modeling
   f) Stable isotope characterization of winter snow pack, summer rain/snow and stream flow
   g) Hydrograph separation by isotope method.

8. **Research outcome:** Glacier mass balance data inclusive of winter and summer mass balance of two glaciers in the Ladakh Himalaya. Assessment of prevailing climate and its orographic controls. Isotope based assessment of stream flow components and its seasonal variations. All these insights will be useful for managing the scarce water reserve of the Ladakh region.

9. Cost estimate :

a. Total cost of the project: Rs. 56 lakhs

b. Source of funding: DST

10. Analysis and Result

Glacier response to prevailing weather is influenced by many factors like regional/local climate, aspect, altitude, Debris cover, dust/soot deposits etc. How to achieve a region specific understanding of glacier response – climate relationship by resolving these various forcing factors is a challenging question. Glacier melt contribution to the catchment runoff across the Himalaya under various glacio-hydrological regimes are also not well understood. This knowledge gap is primarily because of the standard practice in India to estimate only the annual glacier mass balance leaving aside the melting snow accumulated in winter and summer precipitation contributions. Under this project, winter and summer mass balance of Phuche and Khardung glaciers were studied. These wo glaciers are part of Khardung glacier complex in the cold-arid climate and situated just 2.5 Km apart on the Ladakh Range near Leh. These glaciers are being monitored for winter and summer mass balance since 2010 by glaciological method. Both these glaciers have same NE aspect but have different wind regime as the Khardung glacier is situated on the northern slopes of the Ladakh range feeding to the Nubra valley and the Phuche glacier is in the Ganglass valley feeding to the River Indus. During the four years of study (2010-2013), Phuche glacier experienced two slightly positive mass balance years interspersed with two significant negative mass balance years. While Khadung glacier experienced consistent mass loss with a remarkable cumulative mass loss of (-)2690 mm w.e. during these four years. Cumulative mass loss of Phuche glacier was significantly less at (-)670 mm w.e. during the same period. Winter mass balance of Phuche glacier ranged between 660 to 590mm w.e and annual mass exchange from the glacier range between 630 to 835mm w.e. Winter mass balance of Khardung glacier range between 690 to 567mm w.e and annual mass exchange from Khardung glacier ranged between 1140 to 770mm w.e. These values gives the first information on mass exchange on a Himalayan glacier and suggest that the winter snow accumulation on the glacier is many fold than the precipitation monitored at the valley bottom at Leh at 3500m a.s.l. Lack of precipitation data from glacier accumulation area is proved to be one of the key factors restraining our understanding on the glacier contribution to the stream flow and catchment/basin water balance. This study provide a firm basis for a reliable water balance estimate of the headwater catchments of the cold-arid system. This study also provided the first unequivocal evidence of mass loss of Ladakh glaciers in response to prevailing weather and suggests that the southern extent of the 'Karakorum anomaly' did not reach the Ladakh range.

During the reporting period summer mass balance measurements were continued in the Phuche and Khardung glaciers. The weather parameters were monitored and the weather data is being analysed to study the seasonal variations of meteorological variables and resultant glacier melt. Modelling of glacier melt is attempted through the degree-day approach and energy balance components were prepared modelling. Analysis of isotope data is also in progress.

SPONSORED STUDIES

EXTERNAL RESEARCH PROJECT: NIH-E/WRS/2015/02

1. **Thrust Area:**
2. **Project Team:**

   a. Project Investigator: Dr. Sharad K. Jain, Scientist 'G'/ Head, WRSD
   b. Project Co-Investigators: Dr. Pradeep Kumar, Scientist 'B', WHRC
   Shri P. K. Agarwal, Scientist 'B'
   Shri P. K. Mishra, Scientist 'B'

3. **Title of the Project:** Assessment of Environmental flow for Himalayan River
4. **Type of Study** - MOES Sponsored
5. **Amount** - 8.61 Lakhs
6. **Start Date** - Nov., 2014
7. **Scheduled date of completion** - Nov., 2015
8. **Status:**

   A project proposal for carrying out work to create baseline database and estimate environmental flows for a few Himalayan rivers was submitted to the Ministry of Earth Sciences and the same has been approved. Formal orders have been issued and funds have been received recently.

   Two Research Associates have been recruited recently. One is working from WHRC, Jammu and other is posted at HO, Roorkee. In the meantime work has started to collect the data and create the database.

NEW STUDIES

EXTERNAL RESEARCH PROJECT: NIH-E/WRS/2015/01

1. **Thrust Area under XII five year Plan** : Hydrological information

2. **Project team:**

   a. Project Investigator: Deepa Chalisgaonkar, Sc F

   b. Project Co-Investigator(s): Dr. Sharad K. Jain, Sc G
   Sri D. S. Rathore, Sc F
   Dr. Sanjay K. Jain, Sc F
   Dr Sudhir Kumar. Sc 'G'
   Sri P.K. Mishra, Sc B
   Sri P K Agarwal, Sc B
   Sri Manish Nema, Sc 'B'

3. **Title of the Project :** Development of Ganga Information Portal

4. **Objectives**

   Ganga Information Portal is envisaged to provide a unique platform comprising multisource data and information on Ganga basin. The major objective for developing such a portal is:

   - To develop a knowledge/ information e-portal (Ganga Information Portal) with updated information on Ganga basin
   - To provide a world class platform as resource centre for data sharing, retrieving pertaining to Ganga basin
   - To operate and maintain the e-portal on 24x7 basis

5. **Present state-of-art**

   The Ganga is the most sacred as well as one of the most exploited rivers of India. With a vast geographical extent, varied climate, land use land cover, wildlife, demography and socio-economic situation in the entire Ganga Basin, tapping information for resource planning, R&D activities is a difficult task. There are lot of information on Ganga basin collected, collated, and compiled by different institutions/ organizations and agencies of both State and Central Governments. Many NGOs are also involved in different activities related to Ganga basin with possession of valuable information. There are also a number of books, journal papers, reports on Ganga basin. But this information is scattered, fragmented and unavailable on one platform to cater the need of multiple users.

   Recently, the Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR, RD&GR) is emphasizing to restore the rivers into 'Nirmal' and 'Aviral' including Ganga. In addition to this, the government has launched the ambitious 'Namami

Gange' an Integrated Ganga Conservation Mission with activities related with conservation and rejuvenation of the Ganga. Recognizing the multi-sectoral, multi-dimensional and multi-stakeholder nature of information in the Ganga basin, it is need of the hour to develop a web-based platform where different types of data/ information (facts; publications; data; maps; photographs; etc.) related to Ganga basin is available at one place. 'Ganga Information Portal' (GIP) is a step in this direction to develop a web-based information portal where variety of information on Ganga basin will be uploaded and maintained at National Institute of Hydrology, Roorkee.

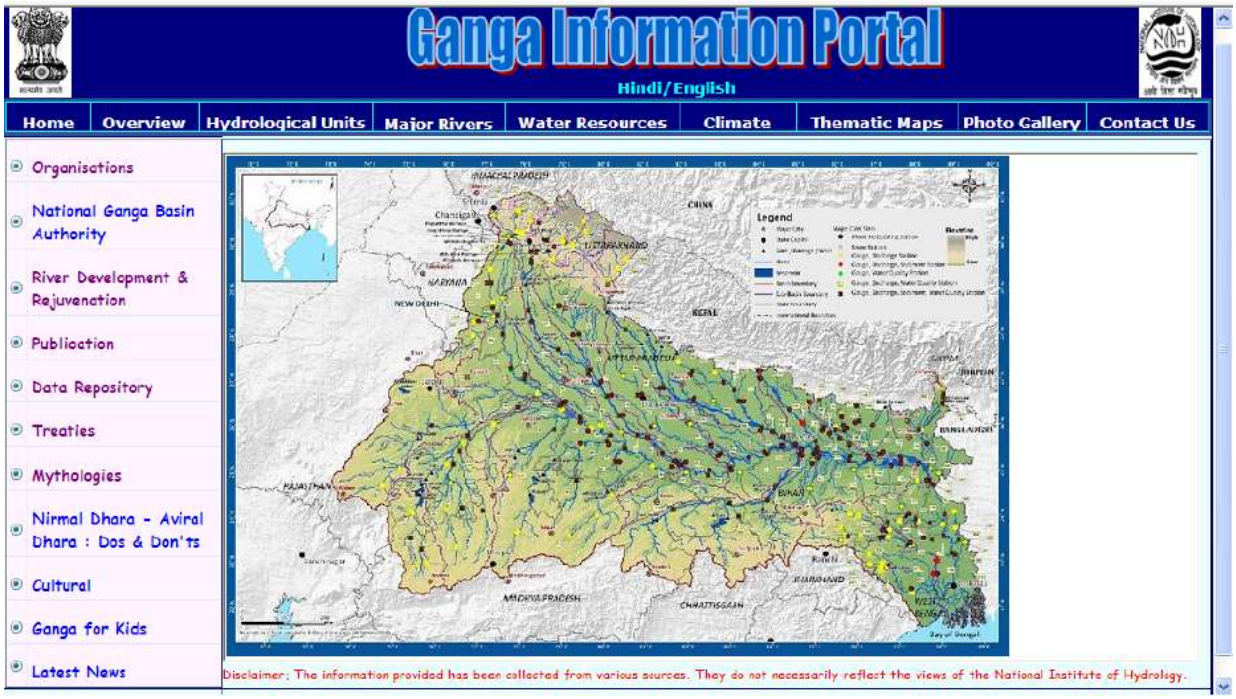
6. Methodology

The GIP will be developed using World Wide Web (*WWW*) technology. The *WWW* technology is based on an open unstructured distributed hypermedia information system. It consists of non-linear, flexibly linked HTML (Hyper Text Media Language) documents, in which different types of *WWW* objects can be embedded. This allows interactive components to be integrated, besides multi-media objects like images, videos and audio sequence. In this way, the *WWW* provides new possibilities and features for information presentation, documentation and exchange and sharing.

The system will be developed in HTML and java script language. Users can use the software with the help of a web browser. The main and drop down menus allow the user to interact with the system very easily. The information relating to the Ganga will be collected from many different sources, agencies and organizations and will be arranged between the time-spaces, and it will be possible to share, to search, to display, and to output (print) it. The main screen of the proposed software is shown in Fig.1. It will use "Point and Click" navigation to navigate around the site. A list of the states is provided for easy geographic access to spatial data.

7. Research outcome from the project

A portal as shown in fig.1 will be developed which will support quick and timely access of the information related to Ganga, anytime and from anywhere in the world.



8. Cost estimate:

a. Total cost of the project : Rs.107.88 lakhs

b. Source of funding : Proposal submitted to MOWR

c. Sub Headwise abstract of the cost

Sl. No.	Item	Nos. required	Duration (Man months)	Unit amount (Rs.)	Amount (Rs.)
A	**Manpower**				
i.	Scientist G and above	3	2	150000.00	900000.00
ii.	Scientist E and F	3	4	100000.00	1200000.00
ii.	Scientist B and above upto D	5	4	75000.00	1500000.00
iii.	IT expert	1	36	50000.00	1800000.00
iv.	JRF	2	36	28000.00	2016000.00
v.	Skilled worker	1	36	10000.00	360000.00
B	**Equipments (Hardware & Software)**				
	Workstations	2		50000.00	100000.00
	Photocopier	1		100000.00	100000.00
	Scanner-A3 & A4	1		55000.00	55000.00
	Printer (multifunctional, duplex)	1		45000.00	45000.00
	UPS – 5KvA	1		500000.00	500000.00
	LAN wire and other accessories	2		6000.00	12000.00
	Web server software; Map info; Photoshop; antivirus, etc.	1		500000.00	500000.00

C	**TA/DA**				
	Travelling by experts & JRFs	LS			1000000.00
D	**Data**				
	Cost towards data collection, procurement and compilation	LS			200000.00
E	Institute overhead and contingency	LS			500000.00
	Total (A+B+C+D+E)				**10788000.00**

d. Justification for Sub-head-wise abstract of the cost

a. Manpower: The manpower will be required for the information collection, development of the software, and management and operation of the portal. The roles of various persons involved has been given in para 8.

b. Equipments: Computer hardware and software will be required for the development, operation and maintenance of the portal. The portal will be operated on the basis on 24 X 7.

c. TA/DA: At present more than 100 organizations are working on Ganga. They include various ministries, river basin organisations, central government organisations and undertakings, IITs, NITs, state government organisations, professional societies, NGOs etc. Some international organisations are also involved. Visits to these organisations may be necessary will be contacted for providing the information for inclusion in the portal.

d. Data: The data related to Ganga basin like hydrolological data, agriculture related data, water availability, demography, publications, climate data, ancient literature, cultural practices, religious scriptures, various maps etc will be collected for putting on portal. If they are not freely available, they will be purchased.

9. Quarterly Break up of cost estimate for each year

2015-2016

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1	Salary	648000.00	648000.00	648000.00	648000.00
2	Traveling expenditure	50000.00	50000.00	50000.00	100000.00
3	Infrastructure/Equipment	300000.00	1012000.00		
4	Experimental charges		20000.00	20000.00	20000.00
5	Misc. expenditure			50000.00	50000.00
	Sub- Total:	998000.00	1730000.00	768000.00	818000.00
	Grand Total				4314000.00

2016-2017

Sl.No.	Sub-head	Amount (in Rupees)

		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1	Salary	648000.00	648000.00	648000.00	648000.00
2	Traveling expenditure	125000.00	125000.00	125000.00	125000.00
3	Infrastructure/Equipment				
4	Experimental charges	20,000.00	20,000.00	20,000.00	20,000.00
5	Misc. expenditure	50,000.00	50,000.00	50,000.00	50,000.00
	Sub- Total:	843000.00	843000.00	843000.00	843000.00
	Grand Total				3372000.00

2017-2018

Sl.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1	Salary	648000.00	648000.00	648000.00	648000.00
2	Traveling expenditure	125000.00	125000.00		
3	Infrastructure/Equipment				
4	Experimental charges	20,000.00	20,000.00	20,000.00	
5	Misc. expenditure	50,000.00	50,000.00	50,000.00	50,000.00
	Sub- Total:	843000.00	843000.00	718000.00	698000.00
	Grand Total				3102000.00

10. Work Schedule:

a. Probable date of commencement of the project : April 1, 2015

b. Duration of the project : 3 years, however, GIP is an integrated information portal which requires continuous efforts in upgradation and maintenance.

c. Stages of work and milestone:

Sl.No	Item/Activity	Timeframe
i.	Creation/ Establishment of Infrastructures	2 months
ii.	Collection and procurement of different types of data/ information from different stakeholders on Ganga basin	3 months & beyond
iii.	Collation and compilation of information before uploading for end users	4 months & beyond
iv.	Portal development and management	4 months & beyond
v.	Launching of portal	
	(i) Initially for limited users for feed-back & comments	6 months
	(ii) Public domain	8 months
vi.	Operation and maintenance of GIP on 24x7 basis	8 months & beyond
vii.	Retrieving critics, comments and feedback from different users	On regular basis

NEW STUDIES

EXTERNAL RESEARCH PROJECT: NIH-E/WRS/2015/02

1. Thrust Area under XII five year Plan

2. Project team:

a. Project Investigator	Mr. L. N. Thakural, Sc-B, PI
b. Co-PI Project Co-Investigator(s)	Mr. D. S. Rathore, Sc-F
	Dr. Surjeet Singh, Sc-D
	Mr. Tanvear Ahmad¸ Sc-B
	Dr. Sanjay Kumar Jain, Sc-F,
	Dr. Sharad Kumar Jain, Sc-G

3. Title of the Project - Integrated approach for hydrological changes in selected catchments for IWRM in view of climate change in India

4. Objectives-

- Development of database related to hydro-meteorological data.
- Long-term spatio-temporal analysis of hydro-meteorological variables.
- Assessment of variation in surface water and groundwater availability.
- Spatial variation of Ground water levels.
- Drought characterization.
- Climate change scenarios/analysis.
- Inter-comparison of water resources variability in selected basins and suggestions for IWRM.

5. Present state-of-art

The climate of earth has never been stable for any extended period but varying naturally on all time scales. Climate change has greatly affected the characteristics of climatic variables globally. These changes are not uniform but vary from place to place or region to region. Probable climate change and its perilous impacts on the hydrologic system pose a threat to global fresh water resources and aquatic ecosystems worldwide. The present study is envisaged in this context to take up the study on the assessment of hydrological changes in different watersheds in India under changing environment.

6. Methodology

- Literature survey on the guidelines and pre-requisites for the selection of watersheds.
- GIS database development.
- Field visits for ground truth and data collection of exiting hydro-meteorological and groundwater related data and processing of data.

- Spatio-temporal analysis of hydro-meteorological data using parametric and non-parametric approaches.
- Application of lumped conceptual rainfall-runoff model (NAM) for assessment of surface and ground water availability.
- Computation of SPI, hydrological drought indices, analysis of change in rainy days.
- Downscaling of meteorological data, generation of climatic scenarios based on IPCC-SRES using actual data
- Impact of climate change on streamflow using statistically downscaled data for each catchment
- Inter-comparison of watersheds and suggestion for irrigation water management.

7. Research outcome from the project

The outcome of the study will help in assessment of water resources availability and impact of climate change at basin scale.

8. Cost estimate:

a. Total cost of the project : Rs. 44.30 Lakh
b. Source of funding : NIH
c. Sub Headwise abstract of the cost

S.No.	Sub-head	Amount (in Rupees)
1.	Salary	9,00,000
2.	Travelling expenditure	20,00,000
3.	Infrastructure/Equipment	30,000
4.	Experimental charges	Nil
5.	Misc. expenditure	15,00,000
	Grand Total:	**44,30,000**

d. Justification for Sub-head-wise abstract of the cost

(1) **Salary** for one JRF @ 25,000 per month to support in various activities (GIS, Creation of data base and analysis).

(2) **Travelling expenditure:** Field visits for data collection from different agencies, ground truth and discussions regarding the study.

(3) **Infrastructure/Equipment:** GPS

(4) **Experimental charges:** Nil

(5) **Misc. expenditure**

- Procurement of satellite data

- Procurement of hydro-meteorological data
- Stationary charges etc.
- Other miscellaneous field expenditure

9. Quarterly Break up of cost estimate for each year

Year: 2015-16

S.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	**Salary**	75,000	75,000	75,000	75,000
2.	**Travelling expenditure**	3,00,000	3,00,000	3,00,000	3,00,000
3.	**Infrastructure/Equipment**	30,000	-		-
4.	**Experimental charges**	-	-	-	-
5.	**Misc. expenditure** Hydro-meteorological Data and Satellite Data Miscellaneous	 - -	 5,00,000 - 1,00,000	 5,00,000 -	 - -
	Sub- Total:	4,05,000	9,75,000	8,75,000	3,75,000
	Grand Total	**26,30,000**			

Year: 2016-17

S.No.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	**Salary**	75,000	75,000	75,000	75,000
2.	**Travelling expenditure**	2,00,000	2,00,000	1,00,000	
3.	**Infrastructure/Equipment**	-	-	-	-
4.	**Experimental charges**	-	-	-	-
5.	**Misc. expenditure** Hydro-meteorological Data and Satellite Data Miscellaneous	 - - 1,00,000	 - - -	 - - 50,000	 - - -
	Sub- Total:	3,75,000	2,75,000	2,25,000	75,000
	Grand Total	**9,50,000**			

Year: 2017-18

S.No.	Sub-head	Amount (in Rupees)

		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	**Salary**	75,000	75,000	75,000	75,000
2.	**Travelling expenditure**	1,50,000	1,50,000	-	-
3.	**Infrastructure/Equipment**	-	-	-	-
4.	**Experimental charges**	-	-	-	-
5.	**Misc. expenditure** Hydro-meteorological Data and Satellite Data Miscellaneous	 - - 2,00,000	 - - 50,000	 - - -	 - - -
	Sub- Total:	4,25,000	2,75,000	75,000	75,000
	Grand Total	**8,50,000**			

Note:

11. The above table has to be prepared for each year of the project period

12. PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

10. Work Schedule:

a. Probable date of commencement of the project: April 2015
b. Duration of the project: 3 Years (April 2015 to March 2018)
c. Stages of work and milestone:

S. No.	Work Element	First Year	Second Year	Third Year
1.	Literature survey and Data collection, selection of watersheds	*		
2.	Processing and analysis of hydrometereological data, GIS database development,	*	*	
3.	Assessment of variation in surface water		*	
4.	Ground water variation, Drought characterization		*	
6.	Climate change, Inter-comparison of water resources variability in selected basins and suggestions for IWRM.		*	*
7.	Preparation of Final report			*

RESEARCH MANAGEMENT AND OUTREACH DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr. V C Goyal	Scientist F & Head
2	Sri Omkar Singh	Scientist E
3	Dr. R V Kale	Scientist B
4	Dr (Mrs) Jyoti Patil	Scientist B
5	Sri Subhash Kichlu	PRA
6	Sri Rajesh Agarwal	SRA

RESEARCH MANAGEMENT AND OUTREACH DIVISION (RMOD)

WORK PROGRAMME FOR YEAR 2014-2015

SN	Title of Project/Study, Study Team	Duration
1.	Pilot Basin Studies (PBS) at six identified sites, jointly with the RCs and CFMSs (**Joint Study)** **NIH HQs:** V C Goyal (Leader), Omkar Singh, R V Kale **NIH RCs/CFMSs:** RC-Belgaum, RC-Jammu, RC-Kakinada, RC-Sagar, CFMS-Guwahati, CFMS-Patna	DOS: Apr 2012 DOC: Mar 2015
2.	Water Conservation and Management in Ibrahimpur Masahi Village of Hardwar District (Uttarakhand) **Team:** Omkar Singh, V.C. Goyal, C.K. Jain, J.V. Tyagi and Sanjay Jain	DOS: Apr 2013 DOC: March 2015
3.	Participatory development of structure for IWRM Framework in identified sub-basins under Pilot Basin Studies (PBS) program **Team:** V C Goyal (PI), Omkar Singh and R V Kale	DOS: July 2014 DOC: June 2015
4.	Customization of WEAP model for application in Ur river watershed in Tikamgarh district of Bundelkhand region. **(Under TIFAC Project)** **Team:** R V Kale (PI), T Thomas- RC Bhopal, Jyoti Patil, Rajesh Agarwal	DOS: Apr 2014 DOC: Sep 2015

Sponsored Projects

1. Integrating hydrology, climate change and IWRM with livelihood issues: Development of methodology and a DSS for water-scarce Bundelkhand region in India, **Funded by TIFAC, Government of India under INDIA-IIASA Programme of TIFAC**
   Period: Aug 2013-Dec 2016 (30 months) Budget: Rs 56.64 lakh
   Team from NIH:
   V C Goyal (PI), T Thomas (Co-PI), R V Kale (Co-PI)
   Nodal Coordinators from other partners:
   Dr (Mrs) K Vijaya Lakshmi, DA, New Delhi
   Dr Sandeep Goyal, MAPCOST, Govt. of MP (India)
   International Collaborators: IIASA, Austria
2. Development of a DSS for Hydrology and Watershed Management in Neeranchal Project, **To be funded by Dept. of Land Resources (GoI) under a World Bank supported project**
   Period: Jun/Jul 2014-May 2019 Budget: Rs 30 Crore approx.
   Partners: NIH; IIT Delhi; WTC Delhi; NRSC Hyderabad

WORK PROGRAMME FOR YEAR 2015-2016

SN	Title of Project/Study, Study Team	Duration
1	Participatory development of structure for IWRM Framework in identified sub-basins under Pilot Basin Studies (PBS) program **Team:** V C Goyal (PI), Omkar Singh and R V Kale	DOS: July 2014 DOC: June 2015 (**Ongoing study)**
2	Customization of WEAP model for application in Ur river watershed in Tikamgarh district of Bundelkhand region. **(Under TIFAC Project)** **Team:** R V Kale (PI), T Thomas- RC Bhopal, Jyoti Patil, Rajesh Agarwal	DOS: Apr 2014 DOC: Sep 2015 (**Ongoing study)**
3	Water Conservation and Management in Ibrahimpur Masahi Village of Hardwar District (Uttarakhand) **Team:** Omkar Singh, V.C. Goyal, C.K. Jain, and Rajesh Singh	DOS: Apr 2013 DOC: March 2016 (**Ongoing study- extension being sought)**
4	WEAP Model set up for four sub-basins under Pilot Basin Studies (PBS) Programme, jointly with the RCs/CFMSs **NIH HQs:** V C Goyal (PBS Leader), Jyoti Patil and R V Kale **Co-investigators from NIH RCs/CFMSs:** Chandramohan T (RC-Belgaum), Y R S Rao (RC-Kakinada), T R Nayak (RC-Bhopal), B Chakravorty (CFMS-Patna)	DOS: Apr 2015 DOC: Mar 2016 (**New study)**

Sponsored Projects

1. Integrating hydrology, climate change and IWRM with livelihood issues: Development of methodology and a DSS for water-scarce Bundelkhand region in India, **Funded by TIFAC, Government of India under INDIA-IIASA Programme of TIFAC**
   Period: Aug 2013-Jan 2016 (30 months) Budget: Rs 56.64 lakh
   Team from NIH:
   V C Goyal (PI), T Thomas (Co-PI), R V Kale (Co-PI)
   Nodal Coordinators from other partners:
   Dr (Mrs) K Vijaya Lakshmi, DA, New Delhi
   Dr Sandeep Goyal, MAPCOST, Govt. of MP (India)
   International Collaborators: IIASA, Austria
2. Development of a DSS for Hydrology and Watershed Management in Neeranchal Project, **To be funded by Dept. of Land Resources (GoI) under a World Bank supported project**
   Period: Apr 2015-May 2020 Budget: Rs 30 Crore approx.
   Partners: NIH; IIT Delhi; WTC Delhi; NRSC Hyderabad

Proposed Technical Transfer & Outreach Activities during 2015-2016

S N	Activity	Estimated Budget (Rs)
1	Outreach activities (IITF-2015, IWW, other exhibitions)	9,00,000
2	5-day Workshop on "Citizen science in hydrology and water resources"	5,50,000
3	Orientation training of newly appointed scientists	85,000
4	Science-Policy interface, IPR issues, and technical meetings	15,80,000
5	Establishment of "Water Activity Centre"	5,00,000
6	Operational expenses of LCU-Delhi	7,00,000
	Total	**43,15,000**

Study- 1 (RMOD/2015-16/TS-1)

1. **Thrust Area under XII five year Plan**: Integrated Water Resources Management (IWRM)- PBS

2. **Project team:**
   a) Project Investigator: Dr V C Goyal, Sc F
   b) Project Co-Investigator(s): Er Omkar Singh, Sc E and Dr R V Kale, Sc B

3. **Title of the Project:** Participatory development of structure for IWRM Framework in identified sub-basins under Pilot Basin Studies (PBS) program

4. **Objectives :**
   The objective of the study is to prepare an IWRM Framework document outlining the availability of water and related natural resources, and the strategy to share, use, manage and protect the basin's resources in an equitable and acceptable way.

5. **Present state-of-art:**

6. **Methodology**
   Through the proposed study, a document will be prepared which will provide the structure of IWRM Framework to be used for each of the six sub-basins of the PBS Program. This document will have sections and reporting formats on the status of the basin, development trends, capacity development needs, and basin development strategy. Consultations will be held with the local stakeholders and the six sites. Professional organizations having specialized knowledge of IWRM issues (e.g. SaciWaters, Hyderabad) will be consulted/involved in preparation of the structure of the IWRM Framework document.

7. **Research outcome from the project:**

Contents of the Draft IWRM Framework Document

1.0 INTRODUCTION • Who is managing the water resources? • Who are water resources users? • Who is developing the water resources? • Water resources management problems and challenges • Why Integrated Water Resources Management (IWRM)?
2.0 WATER RESOURCES ASSESSMENT • Physical Setting and Climate • Surface Water Resources • Ground Water Resources • Water Balance Estimation • Water Quality
3.0 WATER RESOURCES ALLOCATION AND USE
4.0 PILOT BASIN MANAGEMENT PLAN
5.0 CAPACITY BUILDING MECHANISM
6.0 INSTITUTIONAL COORDINATION MECHANISM

8. **Cost estimate:**
   a) Total cost of the project: 75,000/-
   b) Source of funding: Plan funds
   c) Sub Headwise abstract of the cost:

S.N.	Sub-head	Amount (in Rupees)
1.	Salary	
2.	Travelling expenditure	50,000
3.	Infrastructure/Equipment	
4.	Experimental charges	
5.	Misc. expenditure	25,000
	Total	**75,000**

d) Justification for Sub-head-wise abstract of the cost

Travelling expenses of investigating team (NIH) for discussion with the team members at RCs/CFMSs and/or stakeholders at project sites.

Quarterly Break up of cost estimate for each year

Year: 2015-16 (Upto June 2015)

S.N.	Sub-head	Amount (in Rupees)			
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1.	Salary				
2.	Travelling expenditure	50,000			
3.	Infrastructure/Equipment				
4.	Experimental charges				
5.	Misc. expenditure	25,000			
	Sub- Total:	75,000			
	Total				**75,000**

9. Work Schedule:

e) Duration of the project: July 2014- June 2015

f) Stages of work and milestone:

S.N.	**Activity**	**2014-15**				**2015-16**
		Q1	Q2	Q3	Q4	Q1
1.	Compilation of IWRM Framework strategies					
2.	Preparation of draft IWRM Framework document for the PBS Program					
3.	Consultation with stakeholders on the draft document					
4.	Finalization of the IWRM Framework document					

Study- 2 (RMOD/2015-16/TS-2)

1. **Thrust Area under XII five year Plan**: Integrated Water Resources Management-DSS (Planning) Activities

2. **Project team**:
   a. **Project Investigator :** Dr. Ravindra V. Kale, Scientist 'B'
   b. **Project Co-Investigator:** Er. T Thomas (RC Bhopal), Dr. Jyoti Patil
      Staff: Mr. Rajesh Agarwal, SRA

3. **Title of the Project:** Customization of WEAP model for application in Ur river watershed in Tikamgarh district of Bundelkhand region.

4. **Objectives:**
   The main object of the study is the customization of **W**ater **E**valuation **A**nd **P**lanning (WEAP) model for linking the Integrated Water Resource Management (IWRM) in Ur River catchment in Tikamgarh district of Madhya Pradesh (India). This main objective of the study can be accomplished with following sub-objectives:
   1. To prepare the input data structure for WEAP model.
   2. To test the ability of WEAP model to be used as a simulation tool to perform different types of scenario analysis studies

5. **Present State-of-Art:**
   There are various hydrologic modelling tools which are designed to simulate water development and management policies in river basins. These models are applicable to wide variety of specific watershed or river basin conditions, water resource system configurations, institutional conditions, and management issues. Each of these modelling softwares are based on a node-link network representation of the water resource system being simulated. Some of the models include optimization that replaces a more detailed representation of operating policies. All contain menu-driven graphics-based interfaces that facilitate user interaction.

   WEAP is a robust tool for assessment, management and planning of water resources where it simulates hydrologic pattern based on climatic input. WEAP uses precipitation, temperature, humidity, infiltration, and wind speed data to predict the amount of precipitation that falls into a particular area, discharge of streams, recharge of groundwater and/or evapotranspiration through vegetation. It allows to build a futuristic scenarios based on the baseline scenarios along with assumptions towards water demand, infrastructure and regulations. The assessment of the impact of all the anthropogenic activities on water resources management and livelihood issues could be possible in order to predict water shortage and water quality base on a model scenario. This software tool can be used to demonstrate the results of water demand quantity met during a month, the degree of potential water shortage, level of reservoir storage for future use and measurement of water quality. Further, it can be used to assess the adequacy of environmental flows, the level of hydropower generation capacity, the evaluation of soil moisture, evapotranspiration rates, volume of surface runoff, the rate of ground water recharge, agriculture water requirement, possible alternative to adapt cropping pattern to increase water use efficiency and maximize the income. Basically, WEAP has two main functions:

1. Simulation of natural hydrological processes (e.g. evapotranspiration, runoff and infiltration) to enable assessment of the availability of water resources within a catchment; and
2. Simulation of anthropogenic activities superimposed on the natural system to influence water resources and their allocation (e.g. consumptive and non-consumptive water demands) to enable evaluation of the impact of human water use.

This study is undertaken with aim to prepare required input data structure to customize WEAP model for Ur River watershed falling in Tikamgarh district of Madhya Pradesh, India in order evaluate currently available water resources and management of demand and supply requirements of different socio-economic activities. Subsequently, customized WEAP model will be tested to assess its ability to be used as a simulation tool to perform different types of scenario analysis studies.

6. Methodology

This study intended to customize the Water evaluation and Planning (WEAP) model (Fig. 1) by linking the Integrated Water Resource Management (IWRM) and hydrological inputs with livelihood issues in Ur River catchment in Tikamgarh District (M.P.).

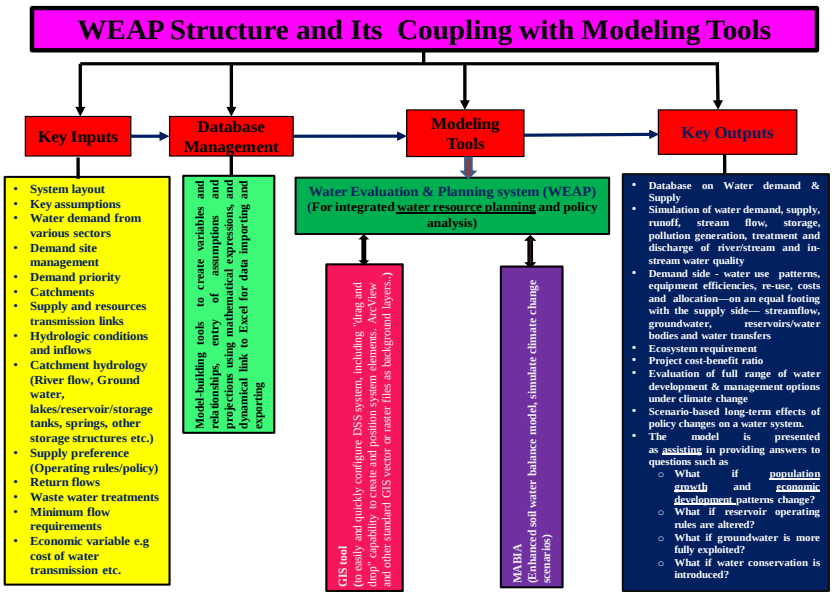


Figure 1. The WEAP model structure along with its coupling with other modeling tools to customize it for the Ur River catchment.

The WEAP model will be customized at sub-catchment scale in order to fulfill the requirements of the proposed DSS and output will be obtained on a daily/monthly scale. Prior to this, the hydrological processes occurring in the Ur River catchment will be modeled and and will be compared with the measured discharge time series. After, the proper calibration of the model, the demand sites will be added into a model framework and different scenarios will be generated to assess the gaps in the water demand and supply and water availability at different locations and at the different period of time.

7. **Research outcome from the project**

WEAP model will be customized for its application in Ur River watershed in Tikamgarh District (M.P.). Such model will be beneficial for the proper management of water resources in Ur River catchment and economic and social up-liftment of the area.

8. **Cost estimate**:

a. **Total cost of the project:**

b. Source of funding: TIFAC sponsored project under INDIA-IIASA program

c. Sub Headwise abstract of the cost

S. N.	Sub-head	I Year	II Year (6 months)	Amount (in Rupees)
1.	Salary			
2.	Travelling expenditure			
3.	Infrastructure/Equipment			
4.	Experimental charges			
5.	Misc. Expenditure			
	Grand Total			

d. Justification for Sub-head-wise abstract of the cost

9. Quarterly Break up of Cost Estimate for Each Year

Year: 2015-16 (April 2015 – Sept. 2015)

S.N.	Sub-head	Amount (in Rupees)	
		1st Quarter	2nd Quarter
1.	Salary		
2.	Travelling expenditure		
3.	Infrastructure/Equipment		
4.	Experimental charges		
5.	Misc. expenditure		
	Sub- Total:		
	Grand Total		

10. **Work Schedule**:

a. Duration of the project: April 2014- Sep 2015

b. Stages of work and milestone

Sl. No.	Work Element	2014-15				2015-16	
		Q1	Q2	Q3	Q4	Q1	Q2
1	Identification of site and Instrumentation at the identified site						
2	Collection of hydro meteorological data, satellite images, thematic maps etc.						
3	Compilation and verification of hydro-meteorological data, baseline survey data, census data and other qualitative data						
4	Preparation of input data for WEAP model						
5	Customization of WEAP for Ur River catchment and validation of model with observed data						
6	Report writing						
	Deliverable	**1st Interim Report**				**Final Report**	

Study- 3 (RMOD/2015-16/TS-3)

1. Thrust Area under XII five year Plan: IWRM- Hydrology for sustainability of water sources

2. Project team:

a. Project Investigator: Omkar Singh
b. Project Co-Investigator(s): V.C. Goyal, C.K. Jain, Rajesh Singh
c. Supporting staff: Subhash Kichlu, Rajesh Agarwal, Rakesh Goyal

3. Title of the Project: Water Conservation And Management In Ibrahimpur Masahi Village Of Haridwar District (Uttarakhand)

4. Objectives :

- Assessment of water demand in the study area
- Assessment of water availability in the study area
- Assessment of water quality status/Eutrophication of Ponds in the study area
- Preparation of water conservation plan for the study area

5. Present state-of-art:

In our country, most of the traditional sources of water in villages are on the verge of disappearing/shrinking due to encroachment, siltation and water quality deterioration and witnessing severe eutrophication. The ponds located in the Haridwar District are also suffering from various hydrological problems and are at the verge of extinction, which require immediate intervention to restore for various uses. Rain water harvesting is a popular technique of developing surface water resources that can be used to provide water for livestock, domestic use and irrigation purposes. The purpose of rain water harvesting is to either augment existing water supplies or to provide water where other sources are not available. It also aims to provide water in sufficient quantity and of suitable quality for the intended use. Therefore, water conservation and its management of village ponds is essential for proper utilizing the water for beneficial use in the society. The water conservation and rain harvesting may be helpful for improving the livelihood of the peoples.

The present study has been taken for Ibrahimpur Masahi revenue village, lying under Shipla Nadi-Halzora Nadi watershed (a tributary of Solani River), District Haridwar (Uttarakhand). The area of Ibrahimpur Masahi revenue village is 14.26 km^2. The Ibrahimpur Masahi revenue village consists of 5 five sub-villages under its jurisdiction, namely- Ibrahimpur, Masahi, Belki, Inayatpur and Halzora.

6. Methodology

- Estimation of Domestic Water Requirement (Human Needs)
- Estimation Livestock Water Requirement
- Estimation Crop Water Requirement
- Probability Analysis of Rainfall Data & Water Availability
- Planning of Rainwater Harvesting in the Village
- Planning for Wastewater Management

The rainwater harvesting potential in the study area would be carried out as below:

- Household Monthly Harvested Rainwater & Balance After Flushing
- Household Monthly Harvested Rainwater & Balance After Flushing & Laundry (combined)
- Rainwater Harvesting Potential of Village Ponds
- Monthly Roof Top Water Harvesting Potential of Schools/Govt. Buildings

7. Research outcome from the project: Reports and papers

8. Cost estimate:

a. Total cost of the project: 25,00,000/-
b. Source of funding: Internal
c. Sub Headwise abstract of the cost:

Sl.No.	Sub-head	Amount (in Rupees)
1.	Salary	1,00,000
2.	Travelling expenditure	1,00,000
3.	Infrastructure/Equipment	20,000,00
4.	Experimental charges	2,00,000
5.	Misc. expenditure	1,00,000
	Total	**25,00,000**

d) Justification for Sub-head-wise abstract of the cost

1. Salary of a skilled casual worker of RMOD.
2. Travelling expenses of investigating team (NIH) for monthly collection of waste water samples and visits of external expert at study site for creation of waste water treatment unit.
3. Charges towards infrastructure includes for establishing a "Constructed Wetland" for wastewater treatment in a selected village,development of pond and purchasing of one Algae Torch (Rs. ~11 lakh) for eutrophication studies.
4. Experimental charges for analysis of monthly waste water samples for various water quality parameters.
5. Misc. expenditure may be required to fulfill needs of the project for satisfactorily operation of wastewater treatment unit and charges towards consultancy fee of the waste water treatment expert.

Quarterly Break up of cost estimate for each year

Year: 2015-16

S.N.	Sub-head	Amount (in Rupees)			
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1.	Salary	25,000	25,000	25,000	25,000
2.	Travelling expenditure	25,000	30,000	30,000	15,000

3.	Infrastructure/Equipment	3,00,000	13,00,000	3,00,000	1,00,000
4.	Experimental charges	50,000	50,000	50,000	50,000
5.	Misc. expenditure	25,000	25,000	25,000	25,000
	Sub- Total:	4,25,000	14,30,00	4,30,000	2,15,000
	Total				**25,00,000**

9. Work Schedule:

a. Probable date of commencement of the project: ongoing
b. Duration of the project: Apr 2013- Mar 2015 (extension being sought for 1 year, i.e. upto Mar 2016)
c. Stages of work and milestone:

S. N.	**Major Activities**	**2013-14**				**2014-15**				**2015-16**			
		1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
1	Review of literature	■											
2	Reconnaissance survey of the study area		■										
3	Procurement/Collection of necessary data for the study		■	■	■								
4	Field investigations (WQ, survey of ponds etc.)			■	■	■	■	■		■	■	■	
5	Analysis of data for assessment of water demand, availability, Water Quality, etc.			■	■	■	■	■	■				
6	Preparation of water conservation plan, in-situ wastewater management, sewage quality parameters & eutrophication of ponds									■	■	■	
7	Report (s) preparation				■				■				■

Study- 4 (RMOD/2015-16/TS-4)

1. Thrust Area under XII five year Plan

Integrated Water Resources Management (IWRM)- PBS

2. Project team:

a. **Project Investigator**: V C Goyal (PBS Leader)

b. **Project Co-Investigator(s):** Jyoti Patil and R V Kale (RMOD); Chandramohan T (RC-Belgaum), Y R S Rao (RC-Kakinada), T R Nayak (RC-Bhopal), B Chakravorty (CFMS-Patna)

3. Title of the Project: WEAP Model set up for four sub-basins under Pilot Basin Studies (PBS) Programme

4. Objectives

The main objective of the study is to set up the WEAP model for 4 sub-basins under the PBS Programme (Bina in MP; Zuari in Goa; Yerakalva in AP and Mahi in Bihar).

5. Present state-of-art

The Water Evaluation and Planning System (WEAP) contains components that allow the appraisal of water management strategies at basin level with economic values. It has been developed by the Stockholm Environmental Institute (SEI) as a decision support tool for water resources management (www.weap21.org). Currently, it is being applied particularly in regions, which are characterized by water scarcity and increasing demands, such as in the Middle East and North Africa. In many basins, the groundwater extractions exceed the natural recharge resulting in a deterioration of the water qualities and worsening the water shortage. The application of integrated water management strategies (IWRM), including water reuse, artificial ground water recharge, use of brackish water, storage of natural and reclaimed water, demand measures and improved water allocation among competing water uses, becomes increasingly necessary.

The economic components of WEAP allow the calculation of costs for demand notes, transmission links, treatment plants and reservoirs. Moreover, the beneficial impacts of increases in water availability for different demand sites can be evaluated in economic terms. By creating suitable indicators the economic losses of unmet demands and the environmental costs of low river flows can be evaluated as well. WEAP offers the possibility to perform cost-benefit analyses of alternative measures to tackle water problems. For instance, the construction of a reservoir or of a new treatment technology at a demand node to mitigate water shortage can be compared in terms of net present values. The economic net benefits of investments on annual basis can be calculated for different demand nodes. These calculations methods serve to find out the most appropriate IWRM strategy at basin level. Furthermore, various financing options under different loan conditions and pricing policies can be considered.

WEAP was applied successfully to model the hydrological features and water management strategies at many basins and it is being developed further. An example is the co-operation between the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD) and the German Federal Institute for Geosciences and Natural Resources (BGR) (www.acsad-bgr.org). A further example is the research project 'Integrated Water Resource Management in the Lower Jordan Rift Valley (SMART)', funded by the German Ministry of Education and Research (BMBF) (www.iwrm-smart.org).

6. Methodology

WEAP is a robust tool for assessment, management and planning of water resources where it simulates hydrologic pattern based on climatic input. WEAP uses precipitation, temperature, humidity, infiltration, and wind speed data to predict the amount of precipitation that falls into a particular area, discharge of streams, recharge of groundwater and/or evapotranspiration through vegetation. It allows to build a futuristic scenarios based on the baseline scenarios along with assumptions towards water demand, infrastructure and regulations. The assessment of the impact of all the anthropogenic activities on water resources management and livelihood issues could be possible in order to predict water shortage and water quality base on a model scenario. This software tool can be used to demonstrate the results of water demand quantity met during a month, the degree of potential water shortage, level of reservoir storage for future use and measurement of water quality. Further, it can be used to assess the adequacy of environmental flows, the level of hydropower generation capacity, the evaluation of soil moisture, evapotranspiration rates, volume of surface runoff, the rate of ground water recharge, agriculture water requirement, possible alternative to adapt cropping pattern to increase water use efficiency and maximize the income.

Customization of the WEAP model will be carried out for the respective sub-basins on a daily/monthly time step. First, a database will be prepared covering the required hydrologic, demographic and socio-cultural data, to be used with the model. Then, a draft schematic of the WEAP model will be prepared defining the demand and supply nodes, etc. The draft WEAP schematic will be discussed with the local stakeholders, and their views will be incorporated in the final model set up. Results from the WEAP model analysis will be used to prepare an integrated water management plan for the 4 sub-basins. Next, the integrated water management plan will be shared with the local stakeholders in the form of a training workshop.

7. Research outcome from the project

WEAP model will be set up for its application in the 4 sub-basins under the PBS Programme. This model will be useful in preparation of integrated water management plans for each sub-basin.

8. Cost estimate:

a. Total cost of the project: Rs 19.0 lakh
b. Source of funding: Plan funds
c. Sub Headwise abstract of the cost:

S.N.	Sub-head	Amount (in Rupees)
1.	Salary (contractual staff)	6,00,000
2.	Travelling expenditure	3,00,000
3.	Infrastructure/Equipment	
4.	Experimental charges	2,00,000
5.	Misc. expenditure (stakeholders meetings/training workshops)	8,00,000
	Total	**19,00,000**

d. Justification for Sub-head-wise abstract of the cost

9. Quarterly Break up of cost estimate for each year

Year: 2015-16

S.N.	Sub-head	Amount (in Rupees)			
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1.	Salary	1,50,000	1,50,000	1,50,000	1,50,000
2.	Travelling expenditure	50,000	50,000	1,00,000	1,00,000
3.	Infrastructure/Equipment				
4.	Experimental charges		1,00,000	1,00,000	
5.	Misc. expenditure (stakeholders meetings/ training workshops at 4 sites)		4,00,000		4,00,000
	Total	2,00,000	7,00,000	3,50,000	6,50,000

Note:

(i) The above table has to be prepared for each year of the project period

(ii) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

10. Work Schedule:

(i) Duration of the project: Apr 2015- Mar 2016

(ii) Stages of work and milestone:

S. N.	Work Element/ Milestone	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	Creation of database	√			
2	Draft WEAP model set up		√		
3	Stakeholders' meeting		√		
4	Finalization of WEAP model set up				√
5	Training workshop				√

TWSSM- 1 (RMOD/2015-16/TWSSM-1)

ORGANISING TRAINING WORKSHOPS/SEMINARS/ SYMPOSIA/MASS AWARENESS PROGRAMME, ETC

1. **Thrust Area under XII five year Plan:** Outreach Activities

2. **Topic of Training Workshops/Seminars/Symposia/Mass Awareness Programmes etc:** IITF-2015, IWW & Any Other Exhibition

3. **Convener:** Dr. V.C. Goyal, Head, RMO Division

4. **Co-ordinator/ Organising Secretary:** Mr. Omkar Singh, Sc E

5. **Co Co-ordinator (S)/ Co-Organising Secretary:** Mr Subhash Kichlu, PRA, Mr Rajesh Agrawal, SRA

6. **Faculty:** Internal Team of Exhibitors

7. **Duration of the programme:** Apr 2015- Mar 2016

8. **Tentative Schedule:** IITF (2 weeks), IWW (1 week), other exhibitions, NIH Foundation Day, World Water Day

9. **Place at which Programme would be organized:** New Delhi/ Roorkee/other places

10. **No of Participants Expected**: NA

11. **Budget Estimate (FY: 2015-16)**

S.N.	Sub-Head	Amount (Rs.)
1.	Inaugural tea	-
2.	Valedictory tea	-
3.	Working lunch, Session tea (Morning and Evening)	-
4.	Registration kits (bag, writing pad, pen and pen drive)	-
5.	Lecture notes	-
6.	Honorarium to faculty (As per Institute's norm)	-
7.	Travel expenditure for Guest Faculty	-
8.	Field trip	-
9.	Miscellaneous	
	Total	9,00,000

12. Justifications for budget estimate (please specify how the amount under different sub- heads at sl. no. 10 are computed):

(A) IITF-2015: Rs 3,00,000

(B) IWW- 2015: Rs 1,00,000

(C) Other exhibitions: Rs 3,00,000

(D) NIH Foundation Day (16 Dec): Rs 1,00,000

(E) World Water Day (22 March): Rs 1,00,000

TOTAL EXPENDITURE = Rs 9,00,000

Stages of Work:

S. N.	Work Element/ Milestone	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	IITF-2015			√	
2	IWW	√			
3	Other exhibitions				
4	NIH Foundation Day			√	
5	World Water Day				√

PROFORMA FOR SUBMITTING PROPOSALS FOR ORGANISING TRAINING WORKSHOPS/SEMINARS/SYMPOSIA/MASS AWARENESS PROGRAMME ETC

1. Thrust Area under XII five year Plan
Technology Transfer and Outreach Activities

2. Topic of Training Workshops/Seminars/Symposia/Mass Awareness Programmes etc
Citizen Science in Hydrology and Water Resources Management

3. Convener: V C Goyal, Head, RMO Division

4. Co-ordinator/ Organising Secretary

5. Co Co-ordinator (S)/ Co-Organising Secretary (ies)

6. Faculty
NIH, CGWB, IMD, ICAR, CSIR
ATREE (Bangaluru), PSI (Dehradun), DA (Delhi), ARGHYAM (Bengaluru), ACWADAM (Pune), INREM (Hyderabad), TERI (Delhi)

7. Duration of the programme
5 days

8. Tentative Schedule
October 2015

- Lectures (1.5 days)
    a. Concepts of hydrologic analysis and data requirement
    b. Instrumentation and field monitoring
    c. Quality control
    d. Monitoring protocols and standards
    e. Database creation and management
- Tutorials (0.5 day)
    a. Preparation of field installation plan
    b. Selection of instrumentation
    c. Participatory water balance estimation
    d. Storage and retrieval of field data
- Field visit (2 days)
    a. Rain gauges
    b. Dug wells and piezometers
    c.Water level in streams, ponds/tanks
    d. Water quality
    e. Soil moisture, soil nutrients, landuse/landcover,
- Synthesis and Recommendations (1 day)
    a. Role and responsibility of actors
    b. Evolving water use plans
    c. Crowdsourcing hydrologic data and meta-data plans
    d. Virtual laboratories

9. Place at which Programme would be organized
Delhi

10. No of Participants Expected

30

11. Budget Estimate

S.N.	Sub-Head	Amount (Rs)
1.	Inaugural tea	50,000
2.	Valedictory tea	
3.	Working lunch, Session tea (Morning and Evening)	
4.	Registration kits (bag, writing pad, pen and pen drive)	50,000
5.	Lecture notes	1,00,000
6.	Honorarium to faculty (As per Institute's norm)	
7.	Travel expenditure for Guest Faculty	2,00,000
8.	Field trip	1,00,000
9.	Miscellaneous	50,000
Total		**5,50,000**

Justifications for budget estimate (please specify how the amount under different sub- heads at sl. no. 10 are computed)

PROFORMA FOR SUBMITTING PROPOSALS FOR ORGANISING TRAINING WORKSHOPS/SEMINARS/SYMPOSIA/MASS AWARENESS PROGRAMME ETC

1. **Thrust Area under XII five year Plan:** Induction Training Activities

2. **Topic of Training Workshops/Seminars/Symposia/Mass Awareness Programmes etc:** Orientation Training of Newly Appointed Scientists/Staff

3. **Convener:** Dr. V.C. Goyal, Head, RMO Division

4. **Co-ordinator/ Organising Secretary:** Mr. Omkar Singh, Sc E

5. **Co Co-ordinator (S)/ Co-Organising Secretary:**

6. **Faculty:** Internal

7. **Duration of the programme:** One week

8. **Tentative Schedule:** To be decided after joining of the new employees

9. **Place at which Programme would be organized:** NIH, Roorkee

10. **No of Participants Expected:** 20

11. **Budget Estimate**

S.N.	Sub-Head	Amount (Rs.)
1.	Inaugural tea	2000
2.	Valedictory tea	2000
3.	Working lunch, Session tea (Morning and Evening)	22000
4.	Registration kits (bag, writing pad, pen and pen drive)	20000
5.	Lecture notes	10000
6.	Honorarium to faculty (As per Institute's norm)	15000
7.	Travel expenditure for Guest Faculty	-
8.	Field trip	10000
9.	Miscellaneous	4000
Total		**85,000**

12. **Justifications for budget estimate (please specify how the amount under different sub- heads at sl. no. 10 are computed):**

- Inaugural Tea & Valedictory tea on first and last day of training, respectively, for the participants and organizing committee & faculty members.

- Working Lunch for five days as per Rate contract
- Registration kit for the participants includes: bag, writing pad, pen and pen drive for providing soft copy of the material.
- Preparation of lecture notes includes expenditure for stationery, printing charges/cartridges, binding, etc.
- Honorarium to the faculty as per approved rate of the institute.
- Field trip will be conducted to the relevant site showing any reservoir, treatment sites/experimental sites. The cost includes towards hiring charges of a vehicle/POL, Lunch & Refreshment for the participants during field visit, etc.
- Miscellaneous: The items as required time to time for the training course.

TWSSM- 4 (RMOD/2015-16/TWSSM-4)

1. Thrust Area under XII five year Plan

Technical Transfer and Outreach Activities

2. Project team:

a. **Project Investigator:** Dr V C Goyal, Head, RMO Division
b. **Project Co-Investigator(s):** Sri Rajesh Agrawal, SRA

3. Title of the Project: Science-Policy Interface, IPR Issues in Hydrology & Water Resources, and Technical Meetings (TAC, WG)

4. Objectives

5. Present state-of-art

6. Methodology

7. Research outcome from the project

8. Cost estimate:

a. Total cost of the project:
b. Source of funding: Plan funds
c. Sub Headwise abstract of the cost:

S.N.	Sub-head	Amount (in Rupees)
1.	Salary (contractual staff)	6,00,000
2.	Travelling expenditure	
	Organization of TAC meeting	2,00,000
	Organization of WG meetings (2)	3,00,000
3.	Infrastructure/Equipment	
4.	Experimental charges	
5.	Misc. expenditure	
	Publication of newsletter “Hydrology for People” (2 issues)	80,000
	ISO surveillance audit	50,000
	ISO-related training course	50,000
	Organization of TAC & WG meetings	3,00,000
	Total	**15,80,000**

d. Justification for Sub-head-wise abstract of the cost

9. Quarterly Break up of cost estimate for each year

Year: 2015-16

S.N.	Sub-head	Amount (in Rupees)			
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1.	Salary (contractual staff)	1,50,000	1,50,000	1,50,000	1,50,000
2.	Travelling expenditure		1,50,000		3,50,000
3.	Infrastructure/Equipment				
4.	Experimental charges				
5.	Misc. expenditure	40,000	1,25,000	90,000	2,25,000
	Total	**1,90,000**	**4,25,000**	**2,40,000**	**7,25,000**

Note:

(i) The above table has to be prepared for each year of the project period

(ii) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

10. Work Schedule:

a. Duration of the project: Apr 2015- Mar 2016

b. Stages of work and milestone:

S. N.	Work Element/ Milestone	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	Science-Policy Interface- Publication of newsletter “Hydrology for People”	√		√	
2	IPR Issues in Hydrology & Water Resources- ISO surveillance audit ISO-related training course for staff		√	√	√
3	Organization of technical meetings		WG		TAC, WG

Annexure-WAC

PROFORMA FOR SUBMITTING INTERNAL RESEARCH PROJECTS

1. Thrust Area under XII five year Plan

Major Facilities to be Created- 'Water Activity Centre'

2. Project team:

a. **Project Investigator**: Dr V C Goyal, Head, RMOD
b. **Project Co-Investigator(s):** Er Omkar Singh, Sc E; Sri Subhash Kichlu, PRA

3. Title of the Project: Establishment of 'Water Activity Centre'

4. Objectives

The Water Activity Centre would be an Information Centre covering various themes of water resources, its conservation and management, and many more. It would be a platform where most of the information on water resources can be gathered in a very interesting manner. Through its various programs, the Centre would attract a lot of visitors who would get informed on the issues and challenges of water resources.

5. Present state-of-art

6. Methodology

Components of Water Activity Centre

1. Live Diorama

This section would house working models on different themes, e.g. Rain Water Harvesting structures, groundwater recharge, Hydrologic Cycle, flood plain zoning, wastewater treatment. Understanding the concept of the working of the displayed models would motivate the visitors.

2. Audio Video Corner

This would be an extensive collection of documentary films made on the issues of water. It would also include the songs and *bhajans* sung on water. This would be an innovative way of teaching the visitors about the importance of water, water conservation, etc. A computer with a nice PA system shall be installed herein where a visitor can watch or listen to the audio video on water.

3. Knowledge Shelf

This would be the corner in the centre enabled with books from national and international publications pertaining to the issues of water and water conservation. This would include books in English and Hindi and would have reference guides, DIY Guides and many more.

4. Water Wall

This would be a room giving an amazing feeling to the visitor about water related issues. On its four walls different paintings denoting different issues would be put up.

5. Water on touch

This would be a Touch Screen portal covering important aspects of water, interactively discussing water-related problems and their solutions. This would establish a relationship of the visitor with water in a way so as to make him/her understand the various facets of water.

7. Research outcome from the project

The visitors visiting the Centre would be more informed on the issues of water resources and water conservation. They would be motivated to contribute considerably towards water conservation.

8. Cost estimate:

a. Total cost of the project: Rs 7,00,000
b. Source of funding: Plan funds of NIH
c. Sub Headwise abstract of the cost

S.N.	Sub-head	Amount (in Rupees)
1.	Salary (contractual staff)	3,00,000
2.	Travelling expenditure	70,000
3.	Infrastructure/Equipment	2,00,000
4.	Experimental charges	80,000
5.	Misc. expenditure	50,000
	Grand Total:	**7,00,000**

d. Justification for Sub-head-wise abstract of the cost

9. Quarterly Break up of cost estimate for each year

Year: 2015-16

S.N.	Sub-head	Amount (in Rupees)			
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1.	Salary				
2.	Travelling expenditure				
3.	Infrastructure/Equipment				
4.	Experimental charges				
5.	Misc. expenditure				
	Sub- Total:				
	Grand Total				

Note:

(i) The above table has to be prepared for each year of the project period
(ii) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

10. Work Schedule:

a. Duration of the project: Apr 2015- Mar 2016
b. Stages of work and milestone:

S. N.	Work Element/ Milestone	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	Live Diorama			√	
2	Audio Video Corner			√	
3	Knowledge Shelf			√	
4	Water Wall				√
5	Water on touch				√

Annexure- LCU

PROFORMA FOR SUBMITTING INTERNAL RESEARCH PROJECTS

1. Thrust Area under XII five year Plan
Major Facilities to be Created- LCU at Delhi

2. Project team:
a. **Project Investigator:** Dr V C Goyal, Head, RMOD
b. **Project Co-Investigator(s):** Dr Jyoti Patil, Sc B (LCU)

3. Title of the Project: Functioning of LCU at Delhi

4. Objectives
The basic intent of setting up a LCU has been to effective liaise and coordinate with the various government and non-government organizations in the NCR region on a regular basis. The LCU is expected to enhance interactions with policy makers, bureaucrats, and industrialists, who normally find it difficult to move out of Delhi.

5. Present state-of-art

6. Methodology

7. Research outcome from the project

8. Cost estimate:
a. Total cost of the project: Rs
b. Source of funding: Plan funds of NIH
c. Sub Headwise abstract of the cost

S.N.	Sub-head	Amount (in Rupees)
1.	Salary (contractual staff)	3,00,000
2.	Travelling expenditure	80,000
3.	Infrastructure/Equipment	2,00,000
4.	Experimental charges	
5.	Misc. expenditure	1,20,000
	Grand Total:	**7,00,000**

d. Justification for Sub-head-wise abstract of the cost

9. Quarterly Break up of cost estimate for each year

Year: 2015-16

S.N.	Sub-head	Amount (in Rupees)			
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1.	Salary				
2.	Travelling expenditure				
3.	Infrastructure/Equipment				
4.	Experimental charges				
5.	Misc. expenditure				
	Sub- Total:				
	Grand Total				

Note:

(i) The above table has to be prepared for each year of the project period

(ii) PI has to submit the revised table to the Finance Officer for the subsequent year (on or before 15th March of current year) considering the actual expenditure incurred during the current year

10. Work Schedule:

a. Duration of the project: Apr 2015- Mar 2016

b. Stages of work and milestone:

S. N.	Work Element/ Milestone	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr