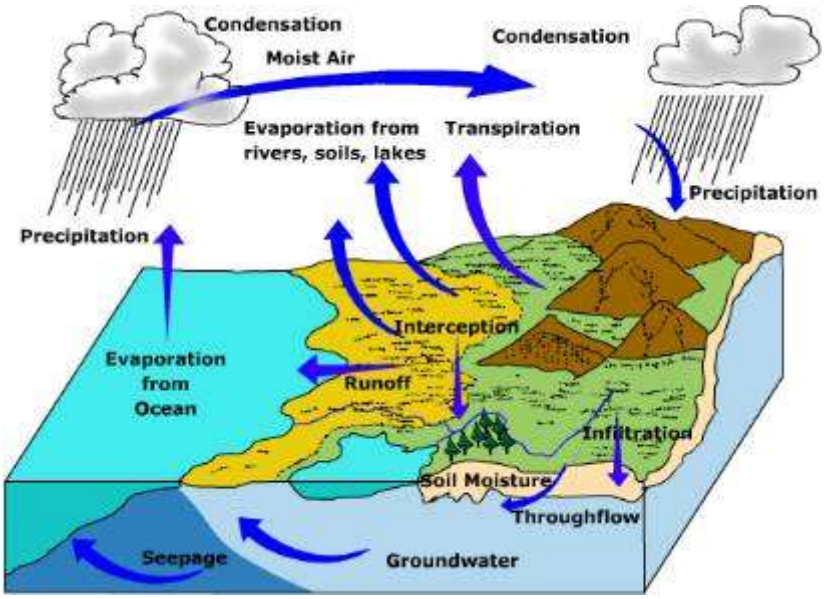
AGENDA AND AGENDA NOTES FOR THE 37th MEETING OF THE WORKING GROUP OF NIH

OCTOBER 29-30, 2012
AT 1100 HRS



NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE-247667

AGENDA AND AGENDA NOTES FOR THE 37th MEETING OF THE WORKING GROUP OF NIH

AGENDA ITEMS

ITEM NO. 37.1 Opening Remarks by the Chairman

ITEM NO. 37.2 Confirmation of the minutes of 36th meeting of the Working Group

The 36th meeting of the Working Group was held during April 3-4, 2012. The minutes of the meeting were circulated to all the members and invitees vide letter No. RCMU/36th WG/NIH/11 dated May 7, 2012. No comments were received on the circulated minutes. A copy of the minutes of the 36th Working Group is given in **Annexure A.**

The Working Group may please confirm the minutes.

ITEM NO. 37.3: Action taken on the decisions/recommendations of the previous Working Group meeting

During the 36th Working Group meeting, the following recommendations/ suggestions had been made by the Working Group members. The actions taken on these recommenadations/ suggestions shall be informed by the respective Divisions during the meeting.

ITEM NO. 37.4: Presentation and discussion on the status and progress of the work programme for the year 2012-2013.

The approved Work Programme of the six Divisions of the Institute for the year 2012-13 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		**03**
Ground Water Hydrology	03	04	**07**
Hydrologic Investigation	05	07	**12**
Surface Water Hydrology	08		**08**
Water Resources System	06	03	**09**
RMOD	03		**03**
Total			**42**

During the present meeting, Division-wise progress and status of the work programme for the year 2012-13 shall be presented in detail. The Working Group may please consider the progress and status of the Work Programme for the year 2012-2013.

ITEM NO. 37.5: Any Other Item with Permission of the Chair.

ANNEXURE – A

MINUTES OF THE 36TH MEETING OF WORKING GROUP

MINUTES OF THE
36TH MEETING OF WORKING GROUP OF NIH
HELD AT NIH, ROORKEE, DURING APRIL 3-4, 2012

The 36th meeting of the Working Group of NIH was held at NIH, Roorkee, during April 3-4, 2012 under the Chairmanship of Director, NIH. The list of the participants of the meeting is given in **Annexure-I**.

ITEM NO. 36.1: OPENING REMARKS BY THE CHAIRMAN

The Chairman, WG welcomed the Working Group members and the Scientists of the Institute. He apprised the members on the organizational structure of NIH, and on the role of Working Group in the technical programme of the Institute. The chairman informed that the Institute is undertaking Pilot Basin Studies (PBS) as an important R&D activity in the XIIth 5-year Plan. Under this program, up gradation and automation of data collection system will be achieved using advanced instrumentation. Also, laboratory and technical up gradation at Headquarter as well at RC's of the Institute will be carried out through DFID funding.

The Chairman then requested the Working Group members to give their general observations, suggestions and remarks on the scientific activities of the Institute. These are summarized below:

S N	Member	Suggestion(s)
1	Dr R C Jain	▪ Studies on the management aspects of water resources. ▪ Studies on the water-energy relationships. ▪ Aquifer demarcation. ▪ CO_2 sequestration in saline aquifers. ▪ Part demand management of aquifers in RBs. ▪ Water balance studies in different aquifers. ▪ Protection and augmentation of ground water in over-exploited areas. ▪ Studies on efficiency of recharge structures. ▪ Studies on operational research models.
2	Dr G P Juyal	▪ Studies on forest hydrology.
3	Dr S K Bartarya	▪ Estimation of hill aquifer parameters. ▪ Study of dying springs. ▪ He suggested the collaborative studies by NIH and WIHG for (i) estimation of aquifer properties in Himalaya, and dating of waters for different aquifers for Himalayan region.
4	Dr R D Deshpande	▪ Three important topics which required to be covered in the new R&D projects during XIIth plan are i. Dew water harvesting: using existing technology

		or developing newer ones ii. Soil Aquifer Treatment (Geo-purification) to reuse the primarily treated waste water iii. Thermal springs and thermal artesian wells in the country in light of geothermal gradient and tectonic framework, and to explore the means of socio-economic benefits. ▪ One of the points in the R&D under National Water Mission refers to "research and studies on all aspects related to impact of climate change on hydrological cycle and water resources". One of the major stumbling block in the global efforts in this direction is the difficulty in differentiating between the hydrological impacts of three drivers namely, (i) engineering intervention; (ii) temperature effects through green house gas and aerosol emissions; and (iii) long-term natural climate variability. It is very important to initiate activities aimed at identifying specific parameters/tracers/ logic which can convincingly delineate the impact of these drivers in any planned hydrological investigations. ▪ The present format of agenda document, which provides a summary of each research project, contains a lot of information about the work done and the results (pattern of data) obtained, but lacks in the inferences drawn from the work already done. The format of agenda document should be improvised by giving much more importance to inferences rather than description of the work done or presentation of data. Such a format will entail greater responsibility on the part of scientists to churn the data more rigorously and drive convincing inferences. ▪ From a critical looks at the reports given in the Agenda document, and the presentations in the meeting, it seems that in case of several studies, much more robust and conclusive inferences could have been drawn. In view of this, it may be useful if thematic group discussions are organized after grouping the projects with similar objectives and/or methodologies. Respective experts may be invited during these group discussions. The discussions in these groups should be more intensive and extensive than those during WG meetings. ▪ Several programmes, though undertaken by different divisions and with different perspectives, have converging and overlapping research interests. Clubbing of the observations from such projects for the purpose of interpretations can results in very significant research papers from NIH. ▪ It will be of great use to society at large and hydrology researchers in particular if the results and inferences derived from various projects undertaken

		by NIH scientists are published in the form of an edited book containing thematic chapters in which results from similar type of projects undertaken by NIH scientists are compiled in a holistic manner.
5	Dr. S N Rai	▪ Emphasis must be given on the sustainability of source, particularly ground water.
6	Er. Ravindra Kumar	▪ Impact of climate change on water resources should be studied in more details. ▪ Study of cropping pattern and land use change under glooming climate change with emphasis on post monsoon scenarios should be under taken.
7	Sh. B.M. Murali Krishna Rao	▪ Impact of sand mining on ground water. ▪ Studies related to declining ground water levels under drought situation. ▪ Prediction of total contribution to ground water. ▪ Ground water modeling. ▪ Preparation of protocol containing methodology and procedure to collect ground water data.
8	Sh. N K Sharma	▪ Studies on the Green House (GH) emission in the hydropower projects.
9	Prof. J S Rawat	▪ Surface water assessment in the Brahmaputra river. ▪ Transfer of water from perennial rivers to non-perennial rivers. ▪ Studies related to drying up of streams, especially non-glacier fed streams.
10	Prof. K.C. Patra	▪ Study of ponds and lakes in coastal areas. ▪ Study on sea water intrusion – temporal dynamics. ▪ Study on minimum environmental flow.
11	Dr. M. Perumal	▪ Studies related to improving yield of springs. ▪ Collaborate with organization (Himolthan work, Dehradun) working for springs.
12	Dr. R C Trivedi	▪ Not only environmental flow but also environmental water need in context of green and blue water and also for ground water required to be properly assessed ▪ He informed that lots of such studies are carried out in the Australia.
13	Dr S S Grewal	▪ Research studies on the ground water in the Himalayan / Arvali region is required to be undertaken. ▪ Problems related to environmental degradation and thickly populated areas required to be addressed. ▪ In reply, Dr N. C. Ghosh informed that NIH has already submitted Indo-US project proposal to MoES to work in hard rock area. Further, Dr. V. C.

		Goyal asked whether there is any proposal to work in co-ordination mode. In reply to this question, Dr. Grewal informed that NGO's and other group have already started the work in this area.
14	Dr Ritesh Arya	▪ Studies on hydro-geology safe habitats. ▪ Hydro-geology of springs. ▪ Hydrology of extremes. ▪ Himalayan hydro-geology for study of ground water aspects and energy generation. ▪ Study of hot water springs.
15	Dr A P Singh	▪ Emphasis must be given on the recycling and reuse of water, water policy, water pricing and water economics by undertaking case studies. ▪ Studies related to ground water contamination and vulnerability should be undertaken.

After taking the views of the members and their self-introduction, the Chairman asked the Member-Secretary to take up the agenda of the meeting.

ITEM No. 36.2: CONFIRMATION OF THE MINUTES OF 35TH MEETING OF THE WORKING GROUP

The 35th meeting of the Working group was held during October 11-12, 2011. The minutes of the meeting were circulated to all the members and invitees vide letter No. NIH/RCMU/35th WG/11 dated February 22, 2012. As no comments were received on the circulated minutes, the minutes were confirmed.

ITEM No. 36.3: 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 35th working group meeting.

ITEM NO. 36.4: ACHIEVEMENTS DURING THE 11TH PLAN PERIOD

The Member-Secretary presented a list of the thrust areas and studies carried out by different divisions during the 11th Plan, as listed below:

Coverage of Thrust Areas & Studies by Divisions during 11th Plan Period

Division → **Theme and Studies ↓**	**EH**	**GWH**	**HI**	**SWH**	**WRS**	**RCMU**

I. Hydrology of Extremes 1. Flood routing 2. Real time flood forecasting 3. Dam break flood wave simulation 4. Flood plain zoning 5. Flash floods studies 6. Flood estimation 7. Integrated drought vulnerability assessment 8. Drought characterization in different climatic regions 9. Regional drought studies				√ √ √ √ × √ √ √ √		
II. Impact of Climate (landuse) Change on Water Resources 1. Impact of urbanization on hydrologic regime 2. Land use changes vis-à-vis hydrological components 3. Sedimentation and soil erosion in lake catchments 4. Forest hydrology and socio-economics	√		√	√	√	
III. Groundwater Modeling and Management 1. Resource estimate and water availability studies 2. Aquifer dynamics and artificial recharge and resource management 3. Inverse modeling for source identification 4. Surface water groundwater interaction 5. Management of groundwater in hard rock formations. 6. Management of coastal aquifers 7. Fresh water saline water interactions 8. Groundwater contamination and remediation 9. Aquifer remediation, wellhead protection and management 10. Impact of climate change on groundwater 11. Groundwater-environment-energy interaction 12. Impact of inter-basin transfer of water on groundwater regime 13. Policy evaluation modeling for groundwater management and its regulation	√ √	√ √ √ √ √ √ √		√		
IV. Sustainable Water Systems Management 1. Risk based management of water systems						

2. Cumulative impact of dams and diversions					√	
3. Adaptation of hydro-systems to climate change				√		
4. Assessment of water demand and availability using spatially distributed modeling						
5. Inter-basin water transfer					√	
6. Conjunctive use of surface water and aquifers		√				
7. Hydro-informatics for water systems management					√	
8. Water, energy and food security nexus						
9. Spatial estimate of AET using RS data						
10. Data driven models for analysis of water systems					√ √	
V. Surface Water Modeling and Regional Hydrology						
1. Prediction of extreme hydrologic events in ungauged catchments				√		
2. Design flood estimation for gauged as well as ungauged catchments				√		
3. Water availability				√		
4. Hydrological modeling				√		
5. Isotopic characterization of water resources on regional scale			√			
VI. Environmental Hydrology						
1. Water quality and human health	√					
2. Natural and organic contaminants	√					
3. Non-point source pollution	√					
4. Assessment of environmental flows	√					
5. River bank filtration for water supply		√				
6. Sediment dynamics						
7. Integrated hydrological studies of lakes	√		√			
8. Low cost treatment/remediation technologies	√					

ITEM NO. 36.5: THRUST AREAS/ACTIVITIES PROPOSED DURING THE 12TH PLAN

The Member-Secretary presented a list of the thrust areas and studies proposed by different divisions during the 12th Plan, as listed below:

Involvement of Divisions in Thrust Areas & Studies during 12th Plan Period

Division → Theme and Studies ↓	**EH**	**GWH**	**HI**	**SWH**	**WRS**	**RCMU**
I. Hydrology of Extremes						
1. Flood management				√		
2. Urban flooding				√		
3. Drought mitigation and management				√		
4. Glacier lakes outburst flood				√		
5. Early warning systems				√		

II. Regional Hydrology		√		√		
III. Environmental Hydrology						
1. Pollution from point and non-point sources	√					
2. Water quality and health	√					
3. Environmental flow in rivers	√					
4. River bank filtration studies		√				
5. Water treatment/ remediation technologies	√					
IV. Integrated Water Resources Management (IWRM)						
1. Hydrology for sustainability of water sources					√	
2. Integrated operation of reservoirs					√	
3. Groundwater management		√				
4. Conjunctive use of surface and Ground Water		√			√	
5. Pilot basin studies	√	√	√	√	√	√
6. DSS (Planning) activities		√		√	√	
7. Hydrological studies in Brahmputra basin	√			√	√	
V. Hydrology for Watershed Management						
1. Forest hydrology				√		
2. Hydrology for springs management		√	√			√
3. Hydrology of lakes and other water bodies	√		√			
4. Water management in mined areas	√		√			
5. Water management in salinity-affected areas	√	√				
6. Water management in coastal and hard rock aquifers		√				
7. Impact assessment studies	√					
VI. R&D Under National Water Mission						
1. Development / implementation of modern technology for measurement of various data						√
2. Research and studies on all aspects related to impact of climate change on hydrologic cycle and water resources, including quality aspects	√	√	√	√	√	√
3. Projection of the impact of climate change on water resources				√	√	
4. Dynamics of deeper aquifers		√				
5. Centre for Climate Change Studies				√		
6. Centre for Snow & Glacier Studies				√		
VII. Technology Transfer and Outreach Activities						
1. Training workshops	√	√	√	√	√	√
2. Seminars/symposia	√	√	√	√	√	√
3. User interaction workshops						√
4. Science-policy interface						√

5. IPR issues in hydrology and water resources 6. PPP linkages					√ √	√ √

ITEM No. 36.6: PRESENTATION AND DISCUSSION ON THE STATUS AND PROGRESS OF THE WORK PROGRAMME FOR THE YEAR 2011-12, AND FINALIZING THE WORK PROGRAMME FOR THE YEAR 2012-13.

The Member-Secretary made a brief presentation outlining progress made under different studies for the work programme of 2011-12 and the proposed studies for the year 2012-13. Division wise details on each study/project presented during the meeting are given below, and the respective work programme recommended for the year 2012-13 are given in **Annexure-II.**

ENVIRONMENTAL HYDROLOGY DIVISION

S. N.	Title of the Project/Study, Study Team, Date of Start and Completion	Status and Recommendation/Suggestion
	Research Studies	
1.	Assessment of Groundwater Quality in Hindon River Basin. Team: M.K. Sharma (PI), V. K. Choubey, Omkar Singh, Rajesh Singh, Babita Sharma, Beena Prasad, Rakesh Goel, Dayanand DOS: 11/2011, DOC: 10/2014	Ongoing study Study was presented by Dr. M.K. Sharma No specific comments/suggestions
2.	Development of low cost media for fluoride removal from drinking water of fluoride affected areas. Team: Rajesh Singh (PI), V. K. Choubey, Omkar Singh, M.K. Sharma, Dayanand DOS: 04/2011, DOC: 03/2013	Ongoing study Study was Presented by Dr. Rajesh Singh Dr. Deshpande suggested use of pottery clay, PVC media, etc. for Fluoride removal. PI informed to comply suggestions in another study.
3.	Water Quality Modeling of Hindon River. Team: Omkar Singh (PI), V. K. Choubey, M.K. Sharma, Rajesh Singh, A.R. Senthil Kumar, Babita Sharma, Beena Prasad, Rakesh Goel, Dayanand DOS: 04/2012, DOC: 03/2015	New study was proposed and presented by Shri Omkar Singh No specific comments/suggestions
4.	Impact of sewage effluent on drinking water sources of Shimla city and suggesting ameliorative measures Team: V.K.Choubey (PI), Omkar Singh, M.K. Sharma, Rajesh Singh and I&PHE Dept. Shimla DOS: 04/2009, DOC: 03/2012	PDS under HP-II. The PDS has been completed and progress was presented by Mr. Omkar Singh on behalf of the PI No specific comments/suggestions The final report would be submitted by 30.4.2012.

GROUND WATER HYDROLOGY DIVISION

Dr. N. C. Ghosh, Scientist-F & Head of the division presented the list of studies carried out and broad areas covered during the 11th Plan period. He also presented the board areas of research to be covered under the 12th Plan period. While presented the technical activities carried out & progress made on different studies during last six months, he gave an account of man-power available at the division and the consultancy projects pursuing by the division. Dr. Ghosh informed that out of 6 R & D studies approved for the year 2011-12, one study is concluded, and 5 research studies are to be continued in the next financial year. The division also proposed to undertake 2 more new studies during the year 2012-13. With

continuation of 5 research studies of the year 2011-12 and proposed 2 new studies, the work programme of the division for the year 2012-13 is given at annexure-1.

It was also informed that under the European Commission funded collaborative R & D project 'Saph Pani', the division organized the 'Saph Pani' project inception workshop during Nov. 3-4, 2011 at India Habitat Centre, New Delhi. In which, all project partners from 8 countries participated and discussed about the project activities and finalized the work programme for the coming one year. Dr. Ghosh also informed that Scientists of the Division have submitted/published a number of research papers in various journals/conferences/symposia during the period and also delivered lectures in various training courses.

Thereafter, PIs of the concerned studies presented the detailed progress of each study. The Study-wise progress reported, and suggestions emerged are given below.

1.0 QUANTIFICATION OF IMPACT OF RAINWATER HARVESTING ON GROUNDWATER AVAILABILITY IN ARAVALLI HILLS – PART II: MATHEMATICAL MODELING

Dr. Anupma Sharma explained about the background and objectives of the study, data monitoring and field investigations carried-out in Savana macro-watershed located in Jaisamand Lake catchment. She also informed that 'Wells for India' (an NGO) and the local villagers are providing support in the data monitoring and field investigations for the study. Due to delay in analysis of soil samples on account of lab renovation work and to carry out some more field tests, an extension of six months was sought from the Working Group members. Dr. Anupma Sharma explained about the use of GIS for identification of potential runoff harvesting sites in Savana watershed. On a query from Dr. S.N. Rai about suitability of sites for artificial recharge to groundwater, it was explained that the proposed sites are only for rainfall-runoff harvesting. Geology and presence of lineaments/ fractures need to be included in the analysis for identification of groundwater recharge sites.

2.0 IMPACT OF CLIMATE CHANGE ON DYNAMIC GROUNDWATER RECHARGE IN A DROUGHT PRONE AREA

Dr. Surjeet Singh presented the results of the completed study. The results reported on the projected were on: rainfall and temperature for the Sonar basin for years 2039, 2069 and 2099 based-upon IPCC SRES scenarios (A1FI and B1), estimation of groundwater recharge at 12 locations using Visual HELP model for future climate scenarios and simulation of groundwater levels in 10 zones of the Sonar basin. Dr. Ritesh Arya enquired about the geological formations and the findings of the study. Mr. C.P. Kumar clarified the queries.

3.0 COASTAL GROUNDWATER DYNAMICS AND MANAGEMENT IN THE SAURASHTRA REGION, GUJARAT.

Dr. Anupma Sharma presented the groundwater salinity issues in Coastal Saurashtra and the various measures taken by the State Dept. to prevent ingress of saline water through creeks and freshwater reservoir schemes. The objectives of the study, details of data collection program undertaken for the Minsar Basin, geology of

Minsar Basin, variations in water table and groundwater salinity along the coast were explained. Details of geophysical surveys, pump tests and analysis carried out in the study area were also presented. On queries from Dr. S.N. Rai and Dr. R. Arya about the geology of the region and weathered zone thickness, it was explained that on moving from coast towards inland areas, the thickness of limestone and Gaj formations reduces. The thickness of weathered zone varies up 31 m in inland areas.

4.0 SAPH PANI - ENHANCEMENT OF NATURAL WATER SYSTEMS AND TREATMENT METHODS FOR SAFE AND SUSTAINABLE WATER SUPPLY IN INDIA

Dr. N. C. Ghosh, Project coordinator of NIH-component presented the activities carried out and initiated under the project. He informed that NIH is involved in four work packages (WP-1 : Riverbank Filtration studies; WP-2: Managed Aquifer Recharge; WP-5 : Modelling and System Design; and WP-7 : Training & Dissemination) of the project along with other partners. As follow up tasks, NIH has taken initiative to carry out R & D programs for the WP1 & WP2, and field visits and data collection efforts are in progress. It was also informed that the 'Saph Pani' project has participated in the India Water Week-2012 as a 'Platinum Sponsor' and is organizing a training workshop under the WP-7entitled "Bank Filtration for sustainable drinking water supply in India" as an add-on to the India Water Week-2012 on 13th April, 2012 at New Delhi.

It was also informed that the first biannual review meeting of the project to take stock of the progress and finalize the activities for future is scheduled to be held at Basel, Switzerland during 9-11 May, 2012.

5.0 MANAGEMENT OF AQUIFER RECHARGE (MAR) AND AQUIFER STORAGE RECOVERY (ASR)

Mr. Sumant Kumar (PI) presented the objectives, statement of the problems, achievements and the future plan of the study. Dr. R.C Jain advised that in case of MAR one should ensure that improved quality of surface water body is recharged to the aquifer. It was suggested that title of the study should be Managed Aquifer Recharge instead of Management of Aquifer Recharge. Some queries about the study area and data collection were also enquired. It was informed that specific study site in the Raipur Municipal area is to yet to be finalized; the data collection activities will be followed thereafter in consultation with the other project partners.

6.0 GROUND WATER FLUORIDE CONTAMINATION IN DIFFERENT PARTS OF INDIA

The progress of the study was presented by Mr. A.K. Dwivedi, PI of the study. Mr. Dwivedi indicated that the status report is yet to be completed. He informed that some geochemistry part are to be included in the report. Dr Desh Pandey, Dr R.C. Trivedi, Dr S.N. Rai and Dr R.C. Jain suggested to include the status of effect of fluoride on human, causing various diseases, in addition to Dental and Skeletal Fluorosis. They also suggested to include latest techniques of defluoridation, ways

and means for supplying fluoride free potable water to the village people at large. PI informed that efforts would be made to include maximum possible information and the report would be completed within in a month or two.

7.0 HYDROLOGICAL INSTRUMENTATION AND DATA MONITORING PLANNING FOR INTEGRATED WATER RESOURCES MANAGEMENT (IWRM) OF THE BINA RIVER PILOT BASIN

Dr. Surjeet Singh presented the objective of the proposed new study on the Bina Pilot basin for developing procedures and guidelines for instrumentation and data monitoring network in the basin. Dr. N.C. Ghosh suggested to include scientists involved from the Regional Centre, Sagar in the Pilot study of Bina basin. Director, NIH suggested to have a P.I. under this study from RC, Sagar for supplying necessary data and Dr. Surjeet Singh shall be the P.I. from HQ for carrying out analysis work under this study.

8.0 FLOW AND CONTAMINANT TRANSPORT MODELING OF RIVERBANK FILTRATION

Mrs. Shashi Poonam Indwar, Scientist-B & PI of the study presented the objectives, statement of the problem, baseline data requirement, methodology, action plan and timeline, list of deliverables etc. She presented the Haridwar riverbank filtration wells network, which would be considered for modeling. It was asked whether 5-10 m distance of well from riverbank is adequate for riverbank filtration. Mrs Shashi informed that all those wells have been constructed long back, and they are being operated as the bank filtrate wells. In the present study, the performance of the wells with regard to the travel time, contaminants' removal efficiency and effectiveness of the wells would be examined and modeled.

HYDROLOGICAL INVESTIGATION DIVISION

S. N.	Title of Project/Study, Study Team, Start and Completion Dates	Status and Recommendations/Suggestions
1.	Surface Water and Groundwater Interaction at Selected Locations along River Yamuna in NCT, Delhi: Phase-II Sudhir Kumar (PI), M. S. Rao and P. K. Garg DOS: 4/2009, DOC: 03/2012	Status: Completed No specific comments/suggestions
2.	Estimation of Snow and Glacier Melt Contribution in Melt Water of Gangotri Glacier at Gaumukh using Isotopic Techniques S. P. Rai (PI), Manohar Arora, Bhishm Kumar, Rakesh Kumar, Naresh Kumar, Vishal Gupta and Jamil	Status: On-going Study Dr. J. S. Rawat asked about the low contribution of rainfall-runoff. It was replied that there were only two rain events of more than 10 mm which contributed significantly to river discharge. On a query from Dr. R. D. Deshpande, Dr.

	Ahmad DOS: 04/2010, DOC: 03/2013	Rai explained about the d-excess of melt water and rainfall.
3.	Identification of Recharge Zones of Some Selected Springs of Uttarakhand using Isotopes S. D. Khobragade (PI), Bhishm Kumar, Sudhir Kumar, S. P. Rai and P. K. Garg DOS: 04/10, DOC: 03/2012	Status: Completed Dr. S. S. Grewal, Chandigarh cautioned that care must be taken before suggesting engineering methods as engineering structures may cause landslides. Mr. Ritesh Arya, Chandigarh indicated that so-called drying springs may actually not be drying at all and it may be due to lowering of water tables only. He further commented that sometimes a pit near the spring can lead to increased discharge in the springs. Dr. Deshpande, PRL, Ahmedabad suggested to analyze the results in light of the isotopic variation obtained in the data. Chairman, Working Group, enquired whether causes of decline of spring discharges are also being investigated. Dr. Khobragade informed that no historical data on spring discharges are available; therefore these are not being investigated in the present study.
4.	Assessment of Radon Concentration in Waters and Identification of Paleo-Groundwater in Punjab State S. K. Verma (PI), Sudhir Kumar, M. S. Rao, Mohar Singh DOS: 04/2011, DOC: 03/2013	Status: On-going Study No specific comments/suggestions
5.	Hydro-geological Assessment of Ghar Area for Artificial Recharge and Water Management Planning P. K. Garg (PI), Sudhir Kumar, V. C.Goyal M. S. Rao, C. P. Kumar, Tanveer Ahmad and Rajesh Agarwal DOS: 04/2011, DOC: 03/2013	Status: On-going Study Mr. Niladari Naha, Ground Water Department, West Bengal suggested to check the EC in terms of dissolved constituents (cation & anion).
6.	Assessment of Sensitivity of Open Water Evaporation to Increase in Temperature for Different Climatic Regions of India S. D. Khobragade (PI), C. P. Kumar,	Status: New Study No specific comments/suggestions

	Manohar Arora and A. R. Senthil Kumar DOS: 04/2012, DOC: 03/2014	
SPONSORED PROJECTS		
7.	National Program on Isotope Fingerprinting of Waters of India (IWIN) M. S. Rao (PI), Bhishm Kumar, Sudhir Kumar, S. P. Rai, S. K. Verma and Pankaj Garg DOS: 07/2007, DPC: 06/2012 (DOC To be extended upto Aug, 2013)	Dr. R. D. Deshpande highly appreciated the experiments and value of the data generated. He provided the following suggestions: 1. To observe the date of first rain at Roorkee along with the depletion in the value of isotope composition of ground level vapour and to find their correlation. 2. To present the data obtained by P&T method also with the condensation method. 3. To look at humidity aspect in presenting the isotopic data.
8.	Groundwater Dynamics of Bist-Doab Area, Punjab Using Isotopes M. S. Rao (PI), Bhishm Kumar, Sudhir Kumar, S. K. Verma, Pankaj Garg and CGWB Officials DOS: 07/2009, DOC: 06/2012	Dr. S. S. Grewal appreciated the work. He suggested to investigate groundwater recharge to deep aquifers near Garhshankar-Hoshiarpur due to Swan river that flows on other side slope of Siwalik hills. Dr. S. N. Rai, NGRI suggested to correlate the isotopic data with the water quality data.
9.	Groundwater Management in Over-Exploited Blocks of Chitradurga and Tumkur Districts of Karnataka Sudhir Kumar (PI), J. V. Tyagi, S. P. Rai, Anupma Sharma, B. K. Purandara and Prof. C. Rangaraj DOS: 07/2009, DOC: 06/2012	Status: On-going The PI emphasized the need to collect the data for atleast one more year to draw some meaningful conclusions. No specific comments/suggestions
10.	Impact Assessment of Landuse on the Hydrologic Regime in the selected Micro-watersheds in Lesser Himalayas, Uttarakahand S. P. Rai (PI), Bhishm Kumar, J. V. Tyagi, M. P. Singh (FRI), Rajeev Tiwari (IGNA), Vishal Gupta, Jamil Ahmad and V. K. Agarwal DOS: 04/2010, DOC: 03/2013	Status: On-going On a query from Dr. J. S. Rawat, Dr. S. P. Rai informed about the rainfall-runoff and sediment yield of both watersheds. Dr. S. N. Rai suggested that infiltration rates should be used to estimate the recharge rates in the watershed. Dr. S. S. Grewal enquired about the impact of landuse on infiltration rates. Dr. Rai informed that higher rates of infiltration in agricultural land and degraded forest indicates the impact of soil depth, fracture density and slope etc.
11	Development of Spring Sanctuaries in	

.	an Urban and a Rural Watershed in District Pauri Garhwal, Uttarakhand S. P. Rai (PI), Bhishm Kumar, Sudhir Kumar, S. D. Khobragade, Pankaj Garg, Jamil Ahmad and Vishal Gupta DOS: 04/2010, DOC: 03/2013	Status: On-going No specific comments/suggestions
CONSULTANCY PROJECTS		
12.	Hydro-geological Studies of Jhamarkotra Mines, Udaipur, Rajasthan Sudhir Kumar (PI), S. K. Verma, P. K. Garg DOS: 07/2010, DOC: 06/2011 Extended upto Dec, 2012	Status: On-going
13.	Assessment of Groundwater Resources & Development Potential of Yamuna Flood Plain, NCT, Delhi Sudhir Kumar (PI), Vijay Kumar, AK Keshari (IIT Delhi), S. Shekhar (Delhi Univ), YB Kaushik (CGWB), PS Datta (ICAR), Executive Engineer (CWC) and AK Gupta (Delhi Jal Board) DOS: 02/2010, DOC: 12/2011	Status: Completed
14.	Hydro-geological Studies and Rainwater Harvesting Technology / Design Report for 4x600 MW Coal Based Thermal Power Plant of Jindal Power Limited, Tamnar, District Raigarh, Chhattisgarh Sudhir Kumar (PI) DOS: 07/2011, DOC: 12/2011	Status: Completed
15.	Impact of Mining on Groundwater Regime in Ghogha-Surka, Khadsaliya-I and Khadsaliya-Ii Lignite Mines, Bhavnagar District, Gujarat Sudhir Kumar (PI) DOS: 08/2011, DOC:12/2011	Status: Completed
16.	Integrated Hydrological Investigations of Sukhna Lake, Chandigarh for its Conservation and Management S. D. Khobragade (PI), C. P. Kumar, R. D. Singh, S. P. Rai and Vipin Agrawal DOS: 07/2011, DOC: 06/2013	Status: On-going Project

SURFACE WATER HYDROLOGY DIVISION

Dr. Avinash Agarwal, Scientist F presented a summary of studies carried out by Surface Water Hydrology Division during 11th Plan period. He also presented the proposed thrust areas for taking up studies during 12th Plan. He then presented the brief details of various studies carried out by the division during 2011-12 along with number of research papers published/accepted for publication/ communicated as well as other research and technical activities and also the proposed studies for the year 2012-13. The progress of studies was then presented by the respective P.I. of the study. The details are as under.

A. PROGRESS OF WORK PROGRAMME FOR THE YEAR 2011-12

1. STUDY ON INTEGRATED WATER RESOURCES MANAGEMENT OF A BASIN TO COPE WITH DROUGHTS

Dr R.P. Pandey, PI of the project presented the study. Dr. Pandey informed that the base maps like soil map, DEM, drainage map, land use map, etc. has been prepared for the study area in Tons basin. He reported that a field visit was carried out during Nov. 2011 to gather information for verification of the results obtained from past meteorological data from 1969 to 2008. Monthly, seasonal and annual rainfall departure analysis indicated that the basin has faced drought events with an average frequency of once in five year. The maximum deficiency in monsoon season rainfall has been observed in the order of about 60% of corresponding mean value. Trend analysis of monthly rainfall and temperature data for annual and monsoon, summer & winter seasons have been carried out and the results were presented before the Working Group. The PI further informed that the discharge data for two sites in Tons basin was obtained from CWC office Varanasi. The results of streamflow data analysis were presented to explain hydrological drought conditions in the basin in past 20 years in the basin. PI reported that the strategic water resources in the basin to be used during the drought situation are inter-basin canal from Bansagar Dam on the Sone river and Govindgarh Tank for parts of Rewa district. For the other parts in the basin (i.e. Nagod, Maihar, Birsingpur, Hanumanaand, and Mauganj blocks), special attention is required to create provisions for storage of monsoon water to moderate the hardships due to drought. The PI informed that the report is under writing and it will be submitted by the end of April 2012. The Chairman asked to prepare a pamphlet incorporating the techniques used and findings of the study in brief.

2. SNOW MELT RUNOFF MODELLING IN SUTLEJ BASIN

Dr. A. R. Senthil Kumar, PI of the project, presented the objectives, methodology, and final results of the study in brief. DR. S. N. Rai inquired about the utilization of the results of the study. The PI of the study informed that the outcome of the study could be used by BBMB Nangal to regulate the reservoir for conservation and flood control purposes. Shri J. S. Rawat queried about the source of the satellite imageries used for snow cover computation. The PI informed that imageries were procured from NRSA Hyderabad..

3. SNOWMELT RUNOFF MODELING AND STUDY OF THE IMPACT OF CLIMATE CHANGE IN PART OF BRAHMAPUTRA RIVER BASIN

Mrs Archana Sarkar, PI of the study presented the statement, objectives, study area, approved action plan, methodology, progress, results and deliverables of the study. Mrs Sarkar informed that the study area is the Subansiri River basin, the biggest northern tributary of Brahmaputra River within India which originates in Tibet, contains snow-fed tributaries and glaciers and has a huge hydropower potential for the country. She informed the house that the first part of the report consisting snow cover mapping which would be an input to the snowmelt runoff model in the second part of the study has been completed. She further informed that the input data for snowmelt runoff model like the precipitation and temperature data for the study area has also been processed elevation band wise. She further presented the preliminary calibration results of the SNOWMOD program runs. Sh. R.D. Despande, Member of the working group enquired about the calibration and validation years. Mrs Sarkar replied that the model is calibrated for three years (2000-03) and would be validated on two years data (2004-05). Sh. S.N. Rai, Member of the working group enquired about the average annual rainfall in the Tibet part. Mrs Sarkar informed that average annual rainfall is about 300-350 mm in the Tibet part. Sh Rai also enquired if the MODIS data gives the depth of snow. Mrs Sarkar informed that MODIS data gives only the areal extent of snow cover.

4. MONITORING AND MODELLING OF STREAMFLOW FOR THE GANGOTRI GLACIER

Dr Arora presented the progress of the study. He informed the house that the data collection for the ablation period of 2011 was started in the month of May. He presented the results of the data collected during the ablation period 2012. He informed the house that the discharge was less in comparison to previous years especially in month of July. The AWs data has also been analysed and the parameters required for modelling were also estimated. The SRM model was applied for the simulation of the flows. Shri N.K. Sharma SE enquired about the estimation of sediment load in Himalayan Rivers. Dr Arora informed that the sediment load from Gangotri glacier is estimated. There were no specific comments from the members.

5. CLIMATIC SCENARIOS GENERATION FOR SATLUJ BASIN USING STATISTICAL DOWNSCALING TECHNIQUES

Dr Arora presented the progress of the study. He presented the results of the AO GCM quantitative evaluation of the downscaled output of the data for precipitation and temperature for the period 1980 to 2000 for the Satluj basin. He outlined the procedure for selecting a particular model output for the basin. Out of 24 GCM's downscaled five have performed better for the Satluj basin. There were no specific comments from the members.

6. CLIMATIC VARIABILITY ANALYSIS AND ITS IMPACT ON HIMALAYAN WATERSHED IN UTTARAKHAND.

Dr. Avinash Agarwal presented the revised objectives in the light of suggestion from previous meeting. Presented study area and methodology in brief. Study progress of last five months was presented with updated data and spring flow lag to rainfall on daily and monthly basis. Climatic variability impacts on stream flow were also presented. Some inquiries were from working group and the same were explained. No specific comment / suggestion were added.

7. IMPACT OF CLIMATE CHANGE ON GLACIERS AND GLACIAL LAKES: CASE STUDY ON GLOF IN TISTA BASIN

The study was presented by Dr. A K Lohani. He explained the objectives of the study alongwith the progress made so far. Dr. Ritesh Arya said that the study is very important and useful. Dr. J S Rawat asked whether any GLOF study has been carried out in past. Dr. Loahni said that a number of studies on GLOF have been carried out for Bhutan, Sikkim and Uttarakhand. Dr. Perumal said that if more vulnerable lakes are in series then which lake has to be considered. Dr. S.K. Jain said that the lake which is near to project site or giving more flood will be considered. If the lake is fragmented then all the lakes will be taken up for the study. Dr. S.N. Rai enquired about the lake shown during presentation. Dr. A K Lohani said that there are number of lakes and some of them are having names. Dr. Jain said that the names are given arbitrarily in clockwise direction.

8. HYDROLOGICAL STUDIES FOR UPPER NARMADA BASIN

Mr. Jagadish Prasad Patra, PI of the study presented the progress during first year of the ongoing three year study scheduled to complete by March 2014. Objectives of the study with brief methodology and data collected for this study were presented. Design floods at Bargi dam estimated using CWC guide line (unit hydrograph approach) were presented. Further, the floods for various return periods estimated by regional flood frequency relationships developed based on the L-moments approach for Upper Narmada and Tapi Subzone 3(c) were also discussed. There were no specific comments from the members.

B. <u>NEW STUDIES FOR 2012-13</u>

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

Dr. R.P. Pandey, PI of the project informed the house that the Bundelkhand region of the country is currently facing water shortages during summer months and this problem became more severe during drought years i.e. 2004-2008. Accordingly, it has been planned to takeup a study in a pilot area in Bundelkhand region with the major objective 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** specific objectives of this project are to: (a) assessment of drought frequency, duration and severity in the selected pilot area in Bubdelkhand region; (b) quantification of surface water and groundwater availability in space and tine; (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, and (e) delineation of zones vulnerable to different degree of drought severity. The PI informed that the study will be useful to devise area specific plan for water management in the study area to deal with the drought situation.

2. SEDIMENTATION STUDIES FOR PONG RESERVOIR, HIMACHAL PRADESH

Dr. A. R. Senthil Kumar, PI of the project, presented the proposed objectives, methodology and expected results of the study in brief. Dr. N. C. Ghosh, suggested to include the effect of the climate change into the sediment yield model to predict the increase or decrease in the storage capacity of the reservoir. The chairman also suggested to do the same analysis as briefed above. Shri S. S. Grewal suggested to prioritize the watershed for computing the sediment yield from the catchment.

WATER RESOURCES SYSTEMS DIVISION

WATER RESOURCES SYSTEM DIVISION		
S. N.	**Title of the Project/Study, Study Team, and Start and Completion Dates**	**Status, and Recommendation/suggestion**
Research studies 2011-12		
1.	Application of a distributed hydrological model for river basin planning and management M. K. Goel (PI), D. S. Rathore, Deepa Chalisgaonkar, and Rama Mehta DOS: 10/2009; DOC: 3/2012	Completed study (Research study) Sh. Ravindra Kumar suggested to use MODIS data for cropping pattern mapping; Sri G. P. Juyal suggested to carry out ground truthing of the remote sensing observations Dr. S. S. Grewal inquired if rainfall variation with time is accounted for in the model. Dr. Goel informed that classified landuse map has been obtained from NRSC. The model runs at daily time step and spatial and temporal variation of rainfall and evapo-transpiration is considered in the model.
2.	Web based information system for major and important lakes in India Deepa Chalisgaonkar (PI), and Suhas Khobragade DOS: 04/2010; DOC: 3/2012	Completed study (Research study) Dr. R. C Trivedi enquired about the size of the water body being considered as lake. Dr. Khobragade informed that the lakes which are significant for water supply for drinking or irrigation, religious significance, recreation, tourism, etc., have been included irrespective of their size, however, the water bodies conventionally designated as lakes in India have been included.
3.	Analysis of water management scenarios in Tapi River basin using MIKE Basin Rama Mehta (PI), M. K. Goel, and D. S. Rathore DOS: 04/2010; DOC: 3/2013	Ongoing study (Research study) Dr. Ravindra Kumar inquired whether the emphasis is on the analysis of water management scenarios or on use of Mike-Basin software. Dr. Rama Mehta clarified that both aspects have been considered, and water management scenarios have been analyzed using the results of Mike-Basin
4.	Development of analytical equation for alternate depths for flow in rectangular channels Sushil K. Singh DOS: 4/2011; DOC: 3/2012	Completed study (Research study) Dr. M. Perumal enquired about the difference between the intended solution and that given in the book by Subhash. Dr. Sushil K. Singh informed that intended solution is generalized one and both alternate depths can be obtained from the known value of the non-dimensional specific energy, while the solution available in books requires one altenate depth and specific energy to be known to compute the other alternate depth. Dr. S. N. Rai suggested and encouraged the possible use of developed solutions in dealing with the surges due to tsunami. Dr. Sushil K. Singh added that such solutions if obtained for

		unsteady flow can more appropriately be useful in dealing with the problems of surges in open channels and rivers due to tide or tsunami. Dr. A. P. Singh opined that the developed solution will also be useful for students and academic organizations. Dr. Sushil K. Singh added that this would make thinner the thin boundary between the research and academic organizations.
5.	A transfer function model for event based runoff Sushil K. Singh DOS: 4/2011; DOC: 3/2012	Completed study (Research study) No specific comment/suggestion.
6.	Trend and variability analysis of Rainfall and Temperature in Himalayan region L. N. Thakural (PI), Sanjay Kumar, Sanjay K. Jani, and Tanveer Ahmed DOS: 10/2011; DOC: 09/2014	Ongoing study (Research study) Dr. V. C. Goyal suggested redefining the objectives of the study to include the innovative aspects. Dr. R. P. Deshpande suggested that the rainfall and temperature data from APHRODITE data may be compared with available ground based observation from state weather observations, IMD or SASE and if ground based observations is not available in study area the nearest locations outside the study area may also be used for this purpose.
7.	Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin Sanjay K. Jain (PI), S. P. Rai, and L. N. Thakural DOS: 04/2009; DOC: 03/2012	Ongoing study (PDS under HP-II) Dr. Deshpande inquired about the possible reasons for the high intercept of Local Meteoric Line presented on the basis of Snow in modeling. Dr. Jain explained that the high intercept of the snow is due to change in source of vapour. Similar slope and intercept in the Local Meteoric Line developed for snow and river reveals that the contribution of snow is dominant in the river discharge. On inquiry from Dr. S. K. Sharma, Dr. Jain informed that the snow samples have been collected for two years 2010-2011. Dr K. C. Patra Observed that the presented scenario for rainfall in Mahanadi are not very good. Dr. Jain said that in this study the precipitation at Bhunter is not projected well (2001-2010) while temperature is giving good results.
8.	Assessment of effects of sedimentation on the capacity/ life of Bhakra Reservoir (Gobind Sagar) on River Satluj and Pong Reservoir on River Beas Sanjay K. Jain (PI), J. V.	Ongoing study (PDS under HP-II) Dr. J. S. Rawat inquired about the frequency of the data collections. Dr. Jain informed that sediment data have been collected from BBMB for 20 years on daily basis. On inquiry from Dr. A. P. Singh about the transfer function used for ANFIS modeling and the period during which the silt variation is more, Dr. Rama

	Tyagi, D. S. Rathore, and Rama Mehta DOS: 04/2009; DOC: 03/2012	Mehta informed that Gausian function has been used, and Dr. Jain said that the silt is maximum in monsoon seasons. Dr. S. N. Rai and Dr. Deshpande asked about the possible reasons for the simulated values being underestimated for some of the years. Dr. J. V. Tyagi said that the unavailability of data in upper part of the catchment results in the poor matching of the peaks and the calibration will be further improved to get better results. Dr. S. N. Rai suggested carrying out sensitivity analysis, which would be helpful in improving the results.
9.	Hydrological assessment of ungauged catchments (small catchment) Pradeep K Bhunya (PI), Rakesh Kumar, D. S. Rathore, Sanjay Kumar, P. C. Nayak DOS: 05/2009; DOC: 05/2012	Completed study (PDS under HP-II) No specific comment/suggestion.
Consultancy projects		
10.	Vetting of water availability studies of the Gulf of Khambhat Development Project (Kalpasar Project) M. K. Goel, P. K. Agarwal, and Yatveer Singh DOS: 04/2011; DOC: 10/2011	Ongoing study
11.	Snowline estimation snowmelt runoff study and Glacial Lake Outburst Flood study for Kuri-Gongri H.E. Project in Bhutan (NHPC, Faridabad) Sanjay K. Jain, A. K. Lohani, Sudhir Kumar, L. N. Thakural, Anju Chaudhary, and Tanveer Ahmed	Completed study
Proposed research studies 2012-13		
12.	Mathematical representation of elevation-area-capacity curves for Indian reservoirs M. K. Goel, Sushil K. Singh, and P. K. Agarwal DOS: 04/2012; DOC: 03/2013	New research study Dr. M. Perumal, and Dr. S. S. Grewal apprehended that since the EAC curves depend on the shape of valley of different projects, unique mathematical equations may not be practicable. Dr. Sushil K. Singh informed that the objective is to mathematically represent these curves (elevation-area, and elevation-capacity) by suitable parameteric and computationally simple functions, which finds application in estimating the reservoir elevation for a known predicted inflow to the reservoir based on real time occurrence of

		rainfall in upstream reaches. Use of a parametric simple functional form would avoid errors due to interpolation from the tabulated values, and subjectivity involved in reading the values from the graph. The possible generalization of these functional approximations for different reservoirs is also intended to be taken up. Members observed if generalized functional forms could be established, these would be of considerable help while dealing with the planning and management studies for reservoir projects.
13	WebGIS based snow cover information system for Himalayas D. S. Rathore, Deepa Chalisgaonkar, L. N. Thakural, and Tanveer Ahmed DOS: 04/2012; DOC: 03/2013	New research study Dr R. D. Deshpande suggested that the scope of the study may include other hydrometeorological data such as temperature, rainfall, relative humidity etc. The data are already being collected in other ongoing studies and may be readily available. Further, information available from Indian satellites may be included. Shri Rathore said that attempt will be made to include other data and snow cover information available from Indian satellites. Dr J. S. Rawat inquired if the ETM+ data could be used and whether information will be accessible to user. Shri Rathore replied that snow cover map based on any satellite may be used.
14.	Software for Frequency Analysis in Hydrology Deepa Chalisgaonkar, Sushil K. Singh, D. S. Rathore, and M. K. Goel DOS: 04/2012; DOC: 03/2013	New research study No specific comment/suggestion.
15.	Event-based rainfall-runoff modelling using soft computing techniques Rama Mehta, Sushil K. Singh, and Yatveer Singh DOS: 04/2012; DOC: 03/2013	New research study Dr. S. S. Grewal suggested that the proposed study should be supported with past experience of used techniques. Dr. Rama Mehta informed that in the present study the event based modeling in intended to be taken up using the past experiences and the results would be compared to those obtained by using the conventional techniques.

RESEARCH COORDINATION & MANAGEMENT UNIT (RCMU)

S. N.	Title of Project/Study, Study Team, Start/Completion Dates	Status and Recommendations/Suggestions
1.	Recession Flow Analysis for Evaluation of Spring Flow in Indian Catchments	Status: Ongoing study

	Team: Ravindra V. Kale (PI), V. C. Goyal DOS: Apr 2011 DOC: March 2013	Dr. S. K. Bartarya suggested that it would be interesting if recession flow analysis may be made according to control/classification of springs such as Fracture joint or Fluvial related spring etc. (as given in Valdiya & Bartarya, 1991) or on types of aquifer. Further, he also suggested that tracers and isotopes may be incorporated as another tool.

The Working Group noted the progress of the studies undertaken and recommended the new studies initiated by different Divisions of the Institute.

The Chairman 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 36th WG meeting

1	Sh. R.D. Singh Director, NIH	**Chairman**
2	Dr. R C Jain, Regional Director, CGWB, Dehradun	Member
3	Sh. R.D. Ram, IMD, New Delhi	Represented DDG (H)
4	Sh. Sanjeev K. Sharma, Geological Survey of India, New Delhi	Member
5	Dr. G.P. Juyal, CSWCRT, Dehradun	Member
6	Dr. S.K. Bartarya, Wadia Institute of Himalayan Geology, DehraDun	Member
7	Dr. R.D. Deshpande, Physical Research Laboratory, Ahmedabad	Member
8	Dr. S. N. Rai, National Geophysical Research Institute, Hyderabad	Member
9	Er. Ravindra Kumar, SWRA, Lucknow	Represented Chief Engineer
10	Sh. Niladri Naha, State Water Investigation Directorate, Kolkata	Member
11	Sh. B.M. M. Krishna Rao, GWD, Hyderabad	Member
12	Sh. N K Sharma, IRI, Roorkee	Member
13	Prof. J.S. Rawat, Kumaun University, Almora	Member
14	Prof. K.C. Patra, NIT Rourkela	Member
15	Prof. Ajit Pratap Singh, BITS, Pilani	Member
16	Dr. G.J. Chakrapani, IIT, Roorkee	Member
17	Dr. M. Perumal, IIT Roorkee	Member
18	Dr. R.C. Trivedi, (Retd), CPCB	Member
19	Dr. S.S. Grewal, Chandigarh	Member
20	Dr. Ritesh Arya, Panchkula, Haryana	Member
21	Dr. Sharad K. Jain, IIT, Roorkee	Invitee
22	Dr. N.C. Ghosh, Sc. F & Head GWH Division, NIH	Member
23	Dr. V.K. Choubey, Sc. F & Head EH Division, NIH	Member
24	Sh. C.P. Kumar, Sc. F & Head HI Division, NIH	Member
25	Dr. S.K. Singh, Sc. F & Head WRS Division, NIH	Member
26	Dr. V. C. Goyal, Sc. F & Head RCMU, NIH	Member-Secretary

Scientists from National Institute of Hydrology, Roorkee

1. Dr. Sanjay Jain, Sc.F
2. Dr. Avinash Agarwal, Sc.F
3. Dr. J.V. Tyagi, Sc.F
4. Dr. Sudhir Kumar, Sc.F
5. Dr. D.S. Rathore, Sc.E2
6. Dr. M.K. Goel, Sc.F
7. Smt. D.Chalosgaonkar, Sc.F
8. Dr. A.K. Lohani, Sc.E2
9. Dr. R.P. Pandey, Sc.E2
10. Dr. Omkar Singh, Sc.E2
11. Sh. Suhas Khobragade, Sc.E1
12. Dr. P.K. Bhunya, Sc.E1
13. Dr. S.P. Rai, Sc.E1
14. Sh.A R Senthil Kumar, Sc.E1
15. Dr. Anupama Sharma, Sc.E1
16. Dr. M.S. Rao, Sc.E1
17. Dr. Sanjay Kumar, Sc.E1
18. Dr. Surjeet Singh, Sc.E1
19. Dr. R.D. Mehta, Sc.C
20. Sh. S.K. Verma, Sc.C
21. Smt. Archana Sarkar, Sc.C
22. Sh. A.K. Dwivedi, Sc.C
23. Dr. Manohar Arora, Sc.C
24. Dr. M.K. Sharma, Sc.C
25. Sh. P.K. Garg, Sc.B
26. Sh.Rajan Vatsa, Sc.B
27. Dr. Ravindra Vittal Kale, Sc.B
28. Sh. J.P. Patra, Sc.B
29. Sh. Sumant Kumar, Sc.B
30. Dr. Rajesh Singh, Sc.B
31. Sh. L.N. Thakural, Sc.B
32. Mrs. Shashi Poonam, Sc.B
33. Sh. Biswajit Chakravorty, Sc.E2,CFMS, Patna
34. Sh. Pradeep Kumar, Sc.B, WHRC, Jammu
35. Sh. Sanjay K. Sharma, Sc.B, CFMS, Guwahati
36. Sh. T. Thomas, sc.C, GPSRC, Sagar
37. Dr. YRS Rao, Sc.E2, DRC, Kakinada
38. Sh. Manish Nema, Sc.B, WHRC, Jammu
39. Dr. Chandramohan T., Sc.E1, HRRC, Belgaum

ANNEXURE-II

Recommended Work Program of Different Divisions for the Year 2012-13

ENVIRONMENTAL HYDROLOGY DIVISION

S.N.	Study	Study Team	Duration
	Internal Studies		
1.	Assessment of Groundwater Quality in Hindon River Basin	M.K. Sharma, V. K. Choubey, Omkar Singh, Rajesh Singh, Babita Sharma, Beena Prasad, Rakesh Goel, Dayanand	3 Years (11/2011-10/2014)
2.	Development of low cost media for fluoride removal from drinking water of fluoride affected areas.	Rajesh Singh, V. K. Choubey, Omkar Singh, M.K. Sharma, Dayanand	2 Years (4/2011-3/2013)
3.	Water Quality Modeling of Hindon River	Omkar Singh, V. K. Choubey, M.K. Sharma, Rajesh Singh, A.R. Senthil Kumar, Babita Sharma, Beena Prasad, Rakesh Goel, Dayanand	3 years (4/2012-3/2015) New Study

GROUND WATER HYDROLOGY DIVISION

S. N.	Study	Study Team	Duration & Status	Funding Source
1.	Quantification of Impact of Rainwater Harvesting on Groundwater Availability in Aravalli Hills – Part II: Mathematical Modeling	**Anupma Sharma (PI);** C.P. Kumar (Co-PI); N.C. Ghosh; Sudhir Kumar; Rajan Vatsa; Sanjay Mittal	2 years (04/10 – 03/12) Extended by 6 months after March, 2012	NIH
2.	Groundwater Fluoride Contamination in different parts of India and study severity of Fluorosis in a Drought prone area	**A.K. Dwivedi (PI);** N.C. Ghosh; Anupma Sharma; Sumant Kumar; Sanjay Mittal; Ram Chandra	3 years (04/11 – 03/14) Position document to be completed by May, 2012	NIH
3.	Coastal Groundwater Dynamics and Management in the Saurashtra Region, Gujarat.	N. C. Ghosh (Coordinator); **Anupma Sharma (PI);** C P Kumar (Co-PI); A.D. Gohil; C.K. Jain; Sudhir Kumar; D.S. Rathore; Surjeet Singh; Rajan Vatsa	3 years (10/09 – 06/12) Continuing study	PDS (HP-II)

4.	Saph Pani - Enhancement of Natural Water Systems and Treatment Methods for Safe and Sustainable Water Supply in India"	Project Director : R. D. Singh; **N. C. Ghosh (Coord.);** V. C. Goyal; C. K. Jain; Sudhir Kumar; B. Chakravorty; A. K. Lohani ; Anupma Sharma; Surjeet Singh ;Sumant Kumar, Shashi Indwar.	36 months (10/11- 9/14)	European Union under 7^{th} - Framework Programme
5.	Managed 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)	Under Work Package-II of 'Saph Pani' Project
6.	Hydrological Instrumentation and Data Monitoring Planning for Integrated Water Resources Management (IWRM) of the Bina River Pilot Basin	**Surjeet Singh (PI-HQ);** Mr. T. Thomas (PI-RC, Sagar) Mr. Tej Ram Nayak(RC-Sagar) N.C. Ghosh R.K. Jaiswal (RC-Sagar)	1 year (4/12 – 3/13) **New study**	NIH
7.	Flow and Contaminant Transport Modeling of Riverbank Filtration	**Shashi Poonam Indwar (PI),** N.C. Ghosh, Anupma Sharma, Rajan Vatsa, Stefanie Fischer - Research Student (Germany) - six months, HTWD Germany, Uttarakhand Jal Sansthan (UJS), Haridwar & Dehradun	30 months (4/12 – 9/14) **New study**	Under the Work Package-I of 'Saph Pani' Project

HYDROLOGICAL INVESTIGATION DIVISION

S. N.	Study	Team	Duration/ Status
INTERNAL STUDIES			
1	Estimation of Snow and Glacier Melt Contribution in Melt Water of Gangotri Glacier at Gaumukh using Isotopic Techniques	S. P. Rai (PI) Manohar Arora Bhishm Kumar Rakesh Kumar Naresh Kumar Jamil Ahmad Vishal Gupta	3 years *(4/10 – 3/13)* ***Continuing Study***
2	Assessment of Radon Concentration in Waters and Identification of Paleo-Groundwater in Punjab State	S. K. Verma (PI) Sudhir Kumar M. S. Rao Mohar Singh	***2 years*** *(04/11-03/13)* ***Continuing***

S. N.	Study	Team	Duration/ Status
			Study
3	Hydro-geological Assessment of Ghar area for Artificial Recharge and Water Management Planning	P. K. Garg (PI) Sudhir Kumar V.C. Goyal M. S. Rao C. P. Kumar Tanveer Ahmad Rajesh Agarwal	***2 years*** *(04/11-03/13)* ***Continuing Study***
4	Assessment of Sensitivity of Open Water Evaporation to Increase in Temperature for Different Climatic Regions of India	S. D. Khobragade (PI) C. P. Kumar Manohar Arora A. R. Senthil Kumar	***2 years*** *(04/12-03/14)* ***New study***
SPONSORED PROJECTS			
5	National Program on Isotope Fingerprinting of Waters of India (IWIN)	M. S. Rao (PI) Bhishm Kumar Sudhir Kumar S. P. Rai S. K. Verma Pankaj Garg	5 years *(07/07–06/12)* *(To be extended upto Aug, 2013)* ***Continuing Study***
6	Groundwater Dynamics of Bist-Doab Area, Punjab Using Isotopes	M. S. Rao (PI) Bhishm Kumar Sudhir Kumar S. K. Verma PankajGarg CGWB Officials	3 years *(07/09-6/12)* ***Continuing Study***
7	Groundwater Management in Over-Exploited Blocks of Chitradurga and Tumkur Districts of Karnataka	Sudhir Kumar (PI) J. V. Tyagi S. P. Rai Anupma Sharma B. K. Purandara Prof. C. Rangaraj	3 years *(07/09-6/12)* ***Continuing study***
8	Impact Assessment of Landuse on the Hydrologic Regime in the selected Micro-watersheds in Lesser Himalayas, Uttarakahand	S. P. Rai (PI) Bhishm Kumar J. V. Tyagi M. P. Singh, FRI Rajeev Tiwari, IGNA Vishal Gupta Jamil Ahmad V. K. Agarwal	5 years *(4/08– 3/13)* ***Continuing Study***
9	Development of Spring Sanctuaries in an Urban and a Rural Watershed in District Pauri Garhwal, Uttarakhand	S. P. Rai (PI) Bhishm Kumar Sudhir Kumar S. D. Khobragade Pankaj Garg Jamil Ahmad Vishal Gupta	3 years *(04/10-03/13)* ***Continuing Study***

S. N.	Study	Team	Duration/ Status
CONSULTANCY PROJECTS			
10	Hydro-geological Studies of Jhamarkotra Mines, Udaipur, Rajasthan	Sudhir Kumar, (PI) S. K. Verma P. K. Garg	1 year (07/10-06/11) Extended upto Dec, 2012 ***Continuing Study***
11	Integrated Hydrological Investigations of Sukhna Lake, Chandigarh for its Conservation and Management	S. D. Khobragade (PI) C. P. Kumar R. D. Singh S. P. Rai Vipin Agrarwal	3 years *(07/11-06/13)* ***Continuing Study***

SURFACE WATER HYDROLOGY DIVISION

S. No. & Ref. Code	Title	Study Team	Duration
Internal Studies			
1. NIH/SWD/NIH/ 10-13	Snowmelt Runoff Modeling and Study of the Impact of Climate Change in part of Brahmaputra River Basin	**Archana Sarkar** R. D. Singh Rakesh Kumar **Sanjay K. Jain**	3 years (April 10-March 13)
2. NIH/SWD/NIH/ 08-	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora Rakesh Kumar	March 08 - To be continued
3. NIH/SWD/NIH/ 10-13	Climatic Scenarios Generation for Satluj Basin using Statistical Downscaling Techniques	Manohar Arora Rakesh Kumar	3 years (April 10 – March 13)
4. NIH/SWD/NIH/ 10-13	Climatic variability analysis and its impact on Himalayan watershed in Uttarakhand	A. Agarwal, Manohar Arora R K Nema	3 years (Nov. 10 – Oct. 13)
5. NIH/SWD/NIH/ 11-13	Impact of Climate Change on Glaciers and Glacial Lakes: Case Study on GLOF in Tista basin	A.K. Lohani Sanjay K. Jain Rakesh Kumar	2 years (April 11 – March13)
6. NIH/SWD/NIH/ 11-14	Hydrological Studies for Upper Narmada Basin.	Jagdish P. Patra Rakesh Kumar Pankaj Mani T R Sapra	3 years (April 11 – March 14)
Proposed new Internal studies			
7. NIH/SWD/NIH/ 12-15	**Study of Hydro-Meteorological Droughts for Bundelkhand Region in India**	R.P. Pandey	3 years (April 12-March 15)

8. NIH/SWD/NIH/ 12-15	**Sedimentation Studies for Pong Reservoir, Himachal Pradesh**	A. R. S. Kumar, Manohar Arora Suhas D Khobragade, A. Agarwal, Sanjay K. Jain	3 years (April 12 – March 15)
Consultancy Projects			
1.	Estimation of Design Basis - flood & safe grade elevation in the Upstream of Bargi Dam at Chutka Nuclear Power Project site, situated in Narmada Valley in Madhya Pradesh (NPCIL)	Rakesh Kumar Pankaj Mani J. P. Patra R. D. Singh T. R. Sapra N.K. Bhatnagar	Under Progress
2.	Site Specific Area Drainage Study for Plant and Ash Dyke for Khargone Super Thermal Power Project (2 x 660 MW) (NTPC)	Rakesh Kumar R.P. Pandey Pankaj Mani J. P. Patra R. D. Singh T. R. Sapra Om Prakash	Under Progress
3.	Area Drainage Study for Plant and Ash Dyke for Gajmara Super Thermal Power Project (4x800 MW)" (NTPC)	Rakesh Kumar Pankaj Mani J. P. Patra Archana Sarkar R. D. Singh T. R. Sapra Hukum Singh	Under Progress
4.	Drainage study for Rourkela Expansion Power Project (1*250 MW) (NTPC)	Rakesh Kumar Pankaj Mani J. P. Patra R. D. Singh A.R. Senthilkumar T. R. Sapra S.P.L. Shrivastava	Under Progress
5.	Carrying Out Dam Break Analysis and Preparation of Emergency Action Plan for Nagarjunasagar Dam	A.K. Lohani Rakesh Kumar S.K. Jain	Under Progress
6.	Study of hydro-meteorological droughts for Bundelkhand region in India	R.P Pandey M.K. Goel D.S. Rathore S.K.Singh	Under Progress

WATER RESOURCES SYSTEMS DIVISION

S.N.	Title	Study Team	Duration	Funding
Internal Studies				
1.	Trend and variability analysis	L.N.Thakural	3 years	NIH

	of rainfall and temperature in Himalayan region	Sanjay Kumar Sanjay K. Jain Tanvear Ahmed	(10/11-09/14) **Continuing study**	
2.	Analysis of water management scenarios in Tapi river basin using MIKE basin	Rama Mehta M.K.Goel D.S.Rathore	3 years (4/10-3/13) **Continuing study**	NIH
Sponsored Studies				
3.	Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin	Sanjay K. Jain S. P. Rai L. N. Thakural	3 years (4/09-3/12) **Continuing study**	PDS (HP-II)
4.	Assessment of effects of sedimentation on the capacity/life of Bhakra reservoir (Gobind sagar) on river Satluj and Pong reservoir on river Beas	Sanjay K. Jain J. V. Tyagi D. S. Rathore Rama Mehta	3 years (4/09-3/12) **Continuing study**	PDS (HP-II)
New Internal Studies				
5.	Mathematical representation of elevation-area-capacity curves for Indian reservoirs	M. K. Goel Sushil K. Singh P. K. Agarwal	1 year (4/12-3/13) **New Study**	NIH
6.	Web GIS based snow cover information system for Himalayas	D. S. Rathore D. Chalisgaonkar L. N. Thakural Tanvear Ahmed	1 year (4/12-3/13) **New Study**	NIH
7.	Software for frequency analysis in Hydrology	D. Chalisgaonkar Sushil K. Singh D. S. Rathore M. K. Goel	1 year (4/12-3/13) **New Study**	NIH
8.	Event-based rainfall runoff modelling using soft computing techniques	Rama Mehta Sushil K. Singh Yatveer Singh	1 year (4/12-3/13) **New Study**	NIH

RESEARCH COORDINATION & MANAGEMENT UNIT (RCMU)

SN	Study	Team	Duration
Internal Studies			
1	Recession Flow Analysis for Evaluation of Spring Flow in Indian Catchments	Ravindra V Kale (PI) V C Goyal	DOS: Apr 2011 DOC: Mar 2013
2	Understanding Water Use Efficiency: A Field Based Research and Documentation of Best Practices on Water Use Efficiency and Conservation	**Joint study** **I. NIH:** V C Goyal (PI) Subhash Kichlu Rajesh Agrawal **II. Indian Environment**	DOS: Apr 2012 DOC: Mar 2013 **(New Study)**

		Law Offices, Gurgaon: Ms Archana Vaidya Ms Shilpa Chohan Mr Shawahiq Siddiqui (PI)	
3	Pilot Basin Studies (PBS) at six identified sites, jointly with the RCs and CFMSs	**Joint study** **NIH HQs:** V C Goyal (Leader) Ravindra V. Kale New Scientist **NIH RCs/CFMSs:** RC-Belgaum RC-Jammu RC-Kakinada RC-Sagar CFMS-Guwahati CFMS-Patna	DOS: Apr 2012 DOC: Mar 2015 **(New Study)**

ANNEXURE – B

Division-wise Work Programme

ENVIRONMENTAL HYDROLOGY DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr C K Jain	Scientist F & Head
2	Sri Omkar Singh	Scientist E2
3	Dr Mukesh Sharma	Scientist C
4	Dr Rajesh Singh	Scientist B
5	Smt Babita Sharma	RA
6	Smt Bina Prasad	RA

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राष्ट्रीय जल विज्ञान संस्थान
आपो हिष्ठा मयोभुव

WORK PROGRAMME FOR THE YEAR 2012-13

S.No.	Study	Study Team	Duration
Internal Studies			
1.	Development of Low Cost Media for Fluoride Removal from Drinking Water of Fluoride Affected Areas	Rajesh Singh (PI), Omkar Singh, M. K. Sharma, Dayanand	**2 Years** **(04/11-03/13)**
2.	Assessment of Ground Water Quality in Hindon River Basin	M. K. Sharma (PI), Omkar Singh, Rajesh Singh, Rakesh Goel, Dayanand	**3 Years** **(11/11-10/14)**
3.	Water Quality Modeling of Hindon River	Omkar Singh (PI), M. K. Sharma, Rajesh Singh, A.R. Senthil Kumar, Beena Prasad, Dayanand	**3 Years** **(04/12-03/15)**

Study – 1

1. Title of the Study: **Development of Low Cost Media for Fluoride Removal from Drinking Water of Fluoride Affected Areas**

2. **Study Group:**

Project Investigator Dr. Rajesh Singh, Sc. 'B'
Co-Investigators Sri. Omkar Singh, Sc. 'E2 Dr. M. K. Sharma, Sc. 'C'
Scientific/Technical Staff Sri. Dayanand, Tech. Gr. II

3. Type of Study: Internal

4. Nature of Study: Technology Development

5. Date of Start: 1.4.2011

6. Scheduled Date of Completion: 31.3.2013

7. Duration of the Study: 2 years

8. Study Objectives:

i) Development of low cost media for removal of fluoride from drinking water.
ii) Establishing the mechanism involved in removal of fluoride.
iii) Establishing the capacity of media for fluoride removal.

9. Statement of the Problem:

Fluoride is an essential element for human being as it helps in normal mineralization of bones and formation of dental enamel. At the same time, it adversely affects the health of human being when their concentration exceeds the limit of 1.5 mg/L. About 96% of the fluoride in the body is found in bone and teeth. Fluoride is a double-edged sword. Ingestion of large amount of fluoride is as harmful as ingestion of its inadequate amount.

In India, more than 76% of the population live in rural areas. The problem of endemic fluorosis occurs with varying intensity in different parts of the country. Out of the 29 countries known to have excess fluoride in drinking water, the number of people suffering from fluorosis in India is the highest in the world, and, with time, the number is increasing rapidly. Excess fluoride ingestion is a major health problem, 20 of the 30 states and Union territories in India being endemic for fluorosis.

Therefore, there is a need for development of low cost treatment and remediation technology for fluoride removal.

10. Approved Action Plan / Methodology:

i) Synthesis of media from baggase fly ash.
ii) Characterization of media using SEM, TEM, XRD and wet analysis.
iii) Sorption studies.
iv) Column studies for application at field scale.
v) Testing of developed media in actual field condition.

11. Timeline:

S.No.	Major Activities	2011-12				2012-13			
		1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
1.	Literature survey								
2.	Development of media								
3.	Characterization								
4.	Adsorption studies/ model evaluation								
5.	Kinetic & thermo-dynamic studies								
6.	Field trials								
7.	Report preparation								

12. Objectives and achievement during last six months:

Objectives	Achievements
Development of media and characterization	Media synthesized from bagasse fly ash. Characterization completed
Adsorption studies	Adsorption studies are under progress

13. Recommendation / Suggestion:

Recommendation / Suggestion	Action Taken
Dr. Deshpande suggested use of pottery clay, PVC media, etc. for fluoride removal.	Suggestions will be complied in another study.

14. Analysis & Results:

i) Literature survey on low cost treatment technologies based on fly ash indicates that most of the research work has been carried out with coal fly ash and bagasse fly ash for contaminant removal. However, attempt to synthesis zeolite based media from bagasse fly ash is limited. Till date, zeolite based media synthesized from bagasse fly ash has not been utilized for fluoride removal.

ii) Fluoride specific zeolite based media synthesized from bagasse fly ash.
iii) Characterization of the synthesized media completed.
iv) Adsorption studies are under progress.

15. End Users / Beneficiaries of the Study: Common people of the affected areas

16. Deliverables: Technical report and 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**
i) Development of new product	In progress
ii) Solution of identified problem	In progress

21. Involvement of end users/beneficiaries: Local people of the affected regions.

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

23. Shortcoming/Difficulties: No

24. Future Plan:

i) Model evaluation
ii) Kinetic and thermodynamic studies
iii) Field trials to see the applicability of the new product at field scale.

Study – 2

1. Title of the Study: **Assessment of Ground Water Quality in Hindon River Basin**

2. **Study Group:**

Project Investigator Dr. M. K. Sharma, Sc. 'C'
Co-Investigators Sri. Omkar Singh, Sc. 'E2 Dr. Rajesh Singh, Sc. 'B'
Scientific/Technical Staff Sri. Rakesh Goyal, Sr. Tech. Sri. Dayanand, Tech. Gr. II

3. Type of Study: Internal

4. Nature of Study: Water Quality and Human Health

5. Date of Start: 1.11.2011

6. Scheduled Date of Completion: 31.10.2014

7. Duration of the Study: 3 years

8. Study Objectives:

i) Monitoring and assessment of water quality of Hindon River
ii) Examining the suitability of ground water in the vicinity of River Hindon for various designated uses
iii) Characterizing different point source contributing River Hindon
iv) Explore possible remedial measures for improvement of river water quality

9. Statement of the Problem:

The River Hindon is subjected to varying degree of pollution caused by numerous untreated and/or partially treated waste inputs of municipal and industrial effluents. The main sources of pollution in River Hindon include municipal and industrial (sugar, pulp and paper, distilleries etc.) wastes from Saharanpur, Muzaffarnagar and Ghaziabad urban areas. The water quality of the River Hindon gets further deteriorated due to confluence of River Kali and River Krishni. The river is highly influenced due to heavy metals, pesticides, which enter the river system, by direct discharges of municipal and industrial effluents and surface runoff. These toxic pollutants will ultimately reach the ground water and will enter in the food chain posing a threat to human health because of their carcinogenic nature. In view of these facts, assessment of the present status of surface and ground water quality in the Hindon River Basin will be carried out.

10. Approved Action Plan / Methodology:

i) Sampling of River Hindon and point sources contributing to river and ground water sources in the vicinity of the river in summer, monsoon and winter seasons.
ii) Analysis of the samples for Physico-chemical parameters, Bacteriological parameters, Toxic (Heavy) Metals and Pesticides.
iii) Processing of data for different seasons as per BIS and WHO standards to examine the suitability of surface water and ground water for drinking purpose and irrigation purpose on the basis of total soluble salts, SAR, RSC.
iv) Classification of water using Piper trilinear diagram, Durov plots, Chadha's diagram, U S Salinity Laboratory Classification and Gupta Classification.
v) Identification of degraded water quality locations using spatial distribution map.
vi) Identification of degraded water quality stretches of the River Hindon using Water Quality Index

11. Timeline:

S.No.	Major Activities	2011-12		2012-13				2013-14				2014-15	
		3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.
1.	Literature survey												
2.	Reconnaissance Survey of the Study Area												
3.	Field visit, sampling and analysis												
4.	Analysis and processing of data												
5.	Report preparation												

12. Objectives and achievement during last six months:

Objectives	Achievements
Field visit and sample collection	A Field visit of Hindon River Basin was carried out during June 2012. Surface and ground water samples were collected
Laboratory analysis	Collected samples have been analysed for physico-chemical and bacteriological parameters, toxic metals and Pesticides

13. Recommendation / Suggestion: None

Recommendation / Suggestion	Action Taken

14. Analysis & Results:

i) A field visit of Hindon River Basin was carried out during June 2012. Water samples were collected from River Hindon, ground water from the vicinity of the river and waste water from the drains. All the samples have been analysed for physico-chemical and bacteriological parameters, toxic metals and pesticides.
ii) Hardness, nitrate and fluoride in few ground water samples exceeded the maximum permissible limit prescribed by BIS for drinking purpose.
iii) Bacteriological contamination was observed in few ground samples of the study area.
iv) Concentration of manganese and chromium in few ground water samples exceeded the maximum permissible limit prescribed by BIS for drinking purpose.
v) Further processing of the data is under progress.

15. End Users / Beneficiaries of the Study: Policy makers and planners of State Government and common people of the affected areas.

16. Deliverables: Technical report and 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
i) Ground water quality and surface water quality data	In progress
ii) Identification and characterization of point sources	In progress

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:

i) Collection and analysis of surface and ground water samples
ii) Identification of degraded water quality zones
iii) Processing of water quality data to examine the suitability of water for different uses.

Study – 3

1. Title of the Study: **Water Quality Modelling of Hindon River**

2. Study Group:

Project Investigator Sri. Omkar Singh, Sc. 'E2'
Co-Investigators Dr. M. K. Sharma, Sc. 'E2' Dr. Rajesh Singh, Sc. 'B' Dr. A. R. Santhil Kumar, Sc. 'E1'
Scientific/Technical Staff Smt. Beena Prasad, RA Sri. Dayanand, Tech. Gr. II

3. Type of Study: Internal

4. Nature of Study: Water Quality and Human Health

5. Date of Start: 1.4.2012

6. Scheduled Date of Completion: 31.3.2015

7. Duration of the Study: 3 years

8. Study Objectives:

i) To estimate rate of re-aeration and de-oxygenation coefficients in different reaches of Hindon River
ii) To estimate downstream DO deficit in different stretches of river using Streeter-Phelps oxygen sag equation
iii) To estimate reduction values of BOD loads of point sources (industrial/municipal wastewater) entering into the Hindon River in order to achieve a desirable level of DO for survival of aquatic fauna of the River

9. Statement of the Problem:

The River Hindon is subjected to varying degree of pollution caused by numerous untreated and/or partially treated waste inputs of municipal and industrial effluents. The amount of dissolved oxygen in water is one of the most commonly used indicators of a river's health. As DO drops below 4 or 5 mg/L, the forms of life that can survive begin to be reduced. In the extreme case, when anaerobic conditions exist, most higher forms of life are killed or driven off. Noxious conditions, including floating sludges, bubbling, odorous gases, and slimy fungal growths, then prevail. Therefore, the water quality modeling is necessary to estimate downstream DO deficit in different stretches. If DO deficit is greater as wells as river water attaining minimum DO level below limit (4.0 mg/l) for survival of aquatic life. Accordingly, it will be necessary to determine the possible reduction in wastewater

BOD load through trial and error process to achieve a more desirable level. In view of above, is proposed to estimate the DO deficit in various stretches of the River Hindon (a tributary of Yamuna River).

10. Approved Action Plan / Methodology:

In this study, it is proposed to apply a model of the oxygen resources in a river having two key processes (i) the removal of oxygen by microorganisms during biodegradation, and (ii) the replenishment of oxygen through re-aeration at the surface of the river. In this connection rate of re-aeration in different stretches of the Hindon River would be determined using equation given by O' Connor and Dobbins (1958) for rate of re-aeration, $Kr= (3.9u^{1/2})/(H^{3/2})$. Where, u is average stream velocity (m/s) and H is average stream depth (m). The de-oxygenation rate constant (Kd) is often assumed to be same as the (temperature adjusted) BOD rate constant (k) obtained in standard laboratory BOD test (typical values for the BOD rate constant k at 20 ^{o}C in accordance with Davis and Cornwell (1985) is $k =k_{20}\theta^{(T-20)}$. Finally, the estimation of downstream DO deficit in different stretches will be carried out using Streeter-Phelps oxygen sag equation (Streeter and Phelps, 1925). The equation is given below:

$$D=(K_dL_0/K_r-K_d)(e^{-kdt}-e^{-krt})+D_0\ e^{-krt}$$

Where, D = dissolved oxygen deficit (DO_s-DO), DO_s= saturated value of dissolved oxygen, DO = actual dissolved oxygen at a given location in the river, K_d= de-oxygenation rate constant (day^{-1}), L_0= initial BOD of the mixture of streamwater and wastewater (mg/l), K_r= re-aeration constant ($time^{-1}$), t = elapsed time between discharge point and distance x downstream (x/u), u= stream speed

11. Timeline:

S.No.	Major Activities	2012-13				2013-14				2014-15			
		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.	Literature survey												
2.	Field investigations												
3.	Estimation of re-aeration and de-oxygenation coefficients												
4.	Development of program for DO deficit based on Streeter & Phelps equation												

5.	Analysis and interpretation of DO-BOD data using program/ model output												
6.	Report preparation												

12. Objectives and achievement during last six months:

Objectives	**Achievements**
Literature survey	Literature survey carried out.
Field investigation / data collection	Field investigations carried out to collect pre-monsoon samples for DO and BOD measurements. X-section and velocity measurements were carried out at sampling location.
Laboratory analysis	Analysis of collected samples carried out.

13. Recommendation / Suggestion: None

Recommendation / Suggestion	**Action Taken**

14. Analysis & Results:

i) Analysis of pre-monsoon samples for DO and BOD was carried out.
ii) The flow (Q, m^3/s) of water/wastewater at different sampling locations in the Hindon River and open drains was computed.
iii) Processing of observed data for estimation of the rate of re-aeration and de-oxygenation coefficients is under progress.

15. End Users / Beneficiaries of the Study: Policy makers, Planners, Implementing Agencies, Industries and Government organizations.

16. Deliverables: Technical report and 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: Water Quality and Discharge Data for River Hindon

20. Study Benefits / Impacts:

Measurable Indicators	**Achievements**

Estimation of rate of re-aeration and de-oxygenation coefficients in different stretches of the Hindon River	In progress
Estimation downstream DO deficit in different stretches	In progress
Estimation of reduction values of BOD loads of point sources (industrial/municipal wastewater) entering into the Hindon River	In progress

21. Involvement of end users/beneficiaries: Local people

22. Specific linkage with Institution and /or end users / beneficiaries: Under identification with the problematic area authorities.

23. Shortcoming/Difficulties: No

24. Future Plan:

i) To intensify the water quality samplings in the Hindon River and open drains

ii) Estimation of the rate of re-aeration and de-oxygenation coefficients and DO deficit in different reaches of the Hindon River and to develop a program for DO Deficit based on Streeter & Phelps Equation.

GROUNDWATER HYDROLOGY DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr N C Ghosh	Scientist F & Head
2	Dr Anupama Sharma	Scientist E1
3	Sri Surjeet Singh	Scientist E1
4	Sri A K Dwivedi	Scientist C
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 Ram Chandra	RA

WORK PROGRAMME FOR THE YEAR 2012-13

S. No. & Reference Code	Project	Project Team	Duration & Status	Funding Source
1. NIH/GWD/ NIH/10-12	Quantification of Impact of Rainwater Harvesting on Groundwater Availability in Aravalli Hills – Part II: Mathematical Modeling	Anupma Sharma (PI) C.P. Kumar N.C. Ghosh Sudhir Kumar Rajan Vatsa Sanjay Mittal	2 years (04/10 – 03/12) **Status**: In progress	NIH
2. NIH/GWD/ NIH/11-14	Groundwater Fluoride Contamination in different parts of India and study severity of Fluorosis in a Drought prone area	A.K. Dwivedi (PI) N.C. Ghosh Anupma Sharma Sumant Kumar Sanjay Mittal Ram Chandra	3 years (04/11 – 03/14) **Status**: Completed	NIH
3. NIH/GWD/ NIH/12-13	Hydrological Instrumentation and Data Monitoring Planning for Integrated Water Resources Management (IWRM) of the Bina River Pilot Basin	Surjeet Singh (PI-HQ) N.C. Ghosh T. Thomas (PI-RCSagar) R.K. Jaiswal T.R. Nayak	1 year (04/12 – 03/13) **Status:** In progress	NIH
Sponsored & PDS (HP-II) Projects				
4. NIH/GWD/ HP-II/10-12	Coastal Groundwater Dynamics and Management in the Saurashtra Region, Gujarat.	N. C. Ghosh (Coordinator) Anupma Sharma (PI) C P Kumar SE (GWRDC, Gujarat) C.K. Jain Sudhir Kumar D.S. Rathore M.S. Rao Surjeet Singh Rajan Vatsa	3 years (10/09 – 06/12) **Status:** In progress	PDS (HP-II)
5. EU-sponsored Project no. 282911	Saph Pani - Enhancement of natural water systems and treatment methods for safe and sustainable water supply in India"	Project Director : R. D. Singh Project Coordinator & P.I. : N. C. Ghosh Other Team Members: V. C. Goyal C. K. Jain Sudhir Kumar B. Chakravorty A. K. Lohani Anupma Sharma Surjeet Singh Sumant Kumar Shashi Poonam Indwar	36 months (October, 2011-September,2014)	European Union under 7th - Framework Programme
6. NIH/GWD/ NIH/11-14	Managed Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR) *(Titled changed as per*	Sumant Kumar (PI) Rajan Vatsa N.C. Ghosh C.P. Kumar Surjeet Singh	3 years (04/11 – 03/14) **Status:** In progress	Saph Pani Project

	suggestion of Working Group)	Sanjay Mittal		
7. EU-sponsored Project no. 282911	Flow and Contaminant Transport Modeling of Riverbank Filtration	Shashi Poonam Indwar (PI) N.C. Ghosh Anupma Sharma Rajan Vatsa Sanjay Mittal Stefanie Fischer Research Student **Support:** Uttarakhand Jal Sansthan (UJS)	2 ½ years (04/12 – 09/14) **Status:** In progress	Saph Pani Project
Consultancy Project				
8.	Drainage Area Mapping and Hydrological Studies in and around Gurha (W) Block in Kolayat Tehsil of Bikaner District, Rajasthan	A.K. Dwivedi (PI) N.C. Ghosh Surjeet Singh Rajan Vatsa Sumant Kumar S.P. Rai	09 months **Status:** In progress	RSMML, Rajasthan

1. PROJECT REFERENCE CODE: NIH/GWD/NIH/10-12

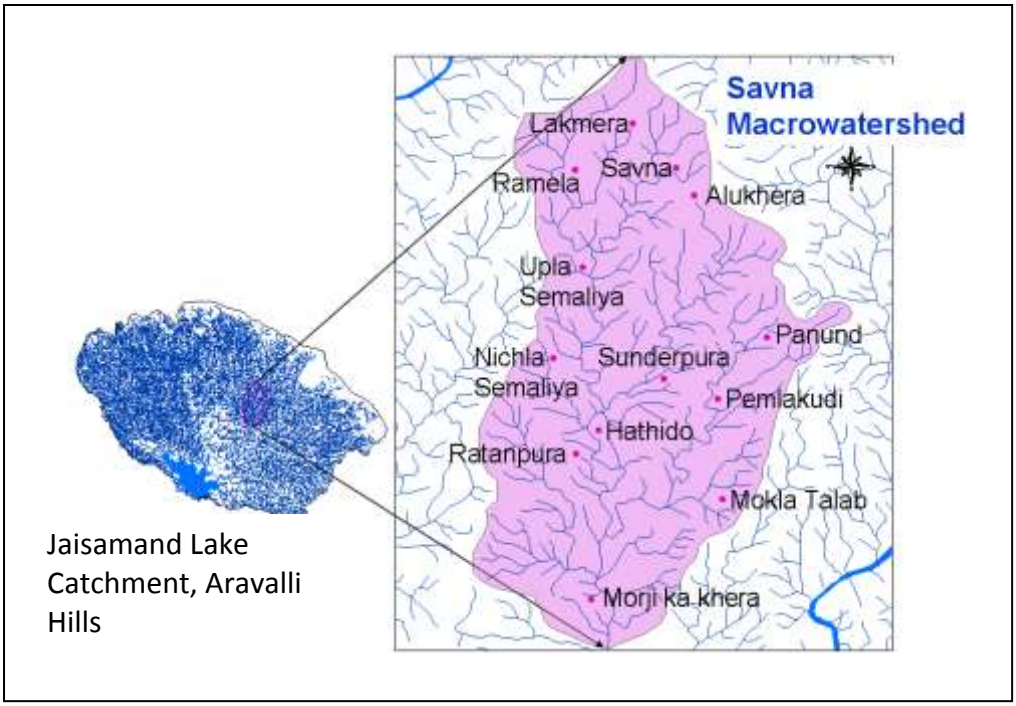
Title of the study: Quantification of Impact of Rainwater Harvesting on Groundwater Availability in Aravalli Hills – Part II: Mathematical Modeling

Type of study (sponsored/consultancy/referred/internal): Internal funding with manpower and logistic support from local non-governmental agencies and beneficiaries of the study.

Date of start: April 1, 2010

Scheduled date of completion: Oct. 2012. Due to renovation of Soil and Water Laboratory, the soil analysis component essential for the study has not been completed till Sept. 2012.

Location map:



Study objectives: To quantify impact of rainwater harvesting schemes on groundwater availability at macrowatershed scale in Aravalli hills using mathematical modeling.

Approved action plan: The action plan of the study comprises the following:

1. Field and lab experiments to determine soil moisture retention characteristics and saturated hydraulic conductivity.
2. Estimation of recharge to groundwater, utilizing the database developed in Part I of study.

3. Mathematical modeling to analyse the hydrological impact of rainwater harvesting schemes on groundwater availability.

Objectives vis-à-vis Achievements:

Objectives	Achievements
Field visits	Two visits undertaken since April 2012.
Data monitoring	Quarterly water level monitoring of 314 wells. For wells located near four anicuts in Nichla Semaliya and Hathido villages in Savna watershed, monitoring on fortnightly basis in monsoon and on monthly basis in non-monsoon.
Field and lab experiments	Pump tests carried out at 3 sites. Collection of 54 soil samples (previously) for analysis in lab. Samples under analysis in laboratory. Soil moisture data monitored at varying depths (10-15 cm interval) at 15 days interval at five different anicut sites. Analysis of water quality samples. Geophysical survey by WFI, Udaipur, in coordination with NIH
Mathematical modeling	Test runs on VS2DT to compute water flux through unsaturated zone. Water balance of Savna watershed on GIS

Analysis and Results

1. Updating of database.
2. Geophysical survey and mapping of weathered zone
3. Test runs on VS2DT to compute water flux through unsaturated zone.
4. Water balance of Savna watershed on GIS

Adopters of the results of the study and their feedback: Groundwater level monitoring work done by villagers in study area

Major items of equipment procured: TDR soil moisture meter

Lab facilities used during the study:

1. Soil and Water Lab, NIH
2. Nuclear Hydrology Lab, NIH

Data procured and/or generated during the study:

Data Generation

1. Hydrogeological database
2. Landuse database
3. Soil database

Study Benefits/Impact (2-column table showing achievements against measurable indicators as mentioned in the approved study document):

Measurable indicators	Achievements
Generation of database on GIS for Savna Macrowatershed	Database pertaining to hydrogeology, landuse and soil
Technology transfer	User interactive training

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

- Logistic support from Udaipur based local non-governmental agency Wells for India.
- End-users/beneficiaries: local villagers

Shortcomings/difficulties, if any: -

Future plan:

Study would be completed on analysis of soil samples that is still pending as on Sept. 2012. Development of mathematical model and report writing under progress.

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

Title of the Study: **Groundwater Fluoride Contamination in different parts of India and study severity of Fluorosis in a Drought prone area**

Date of Start : 1st April, 2011

Scheduled Date of Completion : 31st March, 2014

Objectives: i) Preparation of a position document on Ground Water Fluoride Contamination in India, and
ii) To study variability and severity of fluorosis in a selected region (drought prone area);

Note : WG in its 35th meeting suggested to prepare review/ status report on fluoride contamination including various aspects before working on the second part of the study.

Approved action plan

- Literature Review, Field investigation & data collection, and writing of Status Report
- Draft report.

Objectives & Achievements

To prepare a status report on Groundwater Fluoride Contamination in different parts of India	A draft report is ready for circulation and comments.

Analysis and Results: Completed.

List of deliverables: Report only.

3. PROJECT REFERENCE CODE: NIH/GWD/NIH/12-13

Title of the Study: **Hydrological Instrumentation and Data Monitoring Planning for Integrated Water Resources Management (IWRM) of the Bina River Pilot Basin**

Funding: Internal

Date of Start: April 01, 2012

Scheduled Date of Completion: March 31, 2013

Location Map: Bina river is a major tributary of River Betwa in Bundelkhand region of Madhya Pradesh, which originates from Begumganj block of Raisen district. Total catchment area of the basin is 2,365.50 sq.km.

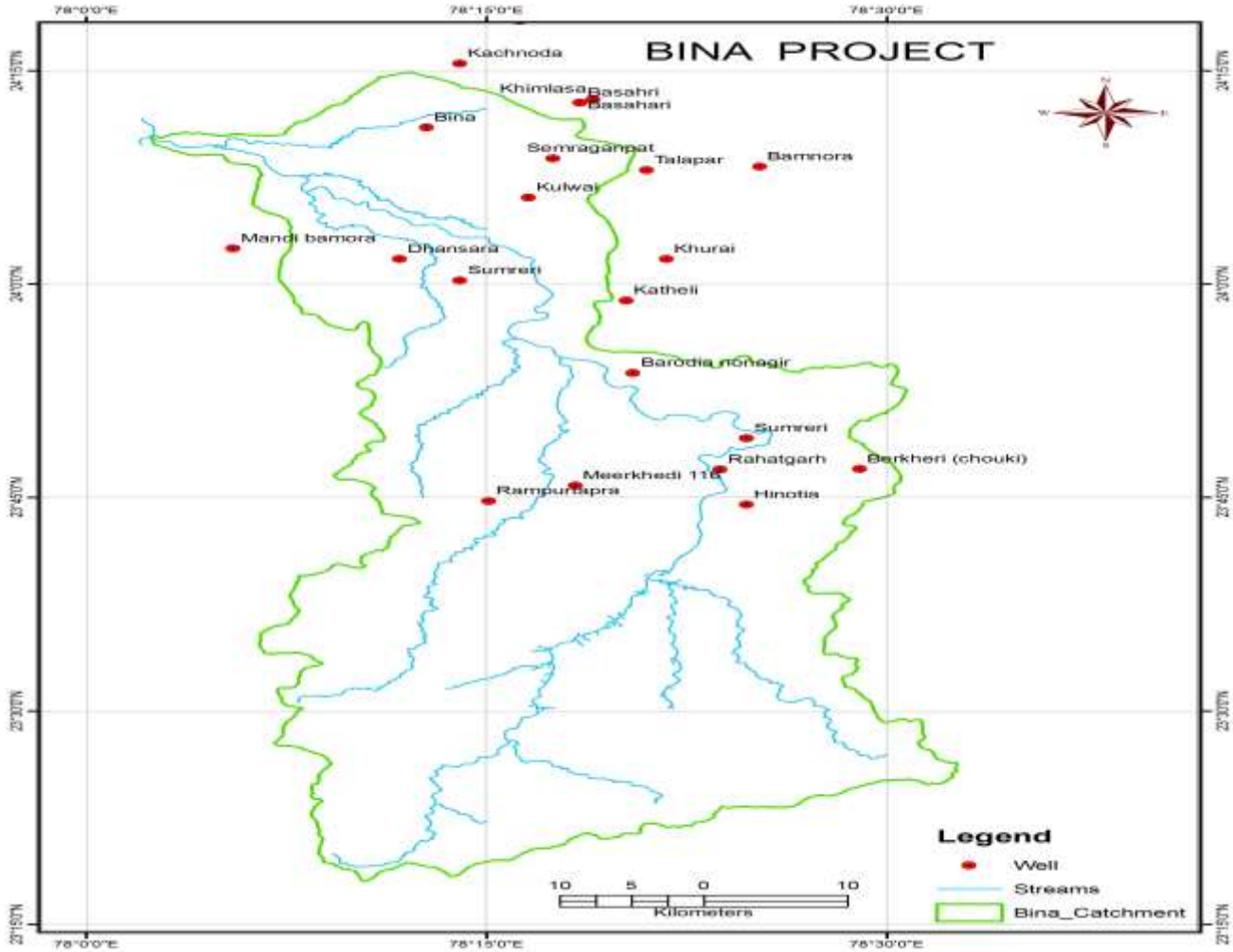


Figure : Bina River Basin showing the location of existing water resources projects

Approved action plan:

- Review of existing and proposed schemes.
- Existing database collection.
- Basic data preparation using GIS.

- Meteorological, hydrological and hydro-geological characterization of the study area.
- Preparation of optimum instrumentation.
- Development of data collection and analysis guidelines for IWRM.
- Preparation of final report.

Timeline and justification for time over runs:

1-3 months: Field visits & data collection.
4-6 months: Assessment of existing & proposed instrumentation.
7-9 months: Development of procedures and guidelines.
10-12 months: Refinements and report writing.

Objectives & Achievements:

To analyze and schematize of the existing and proposed schemes of the water usages pattern in the basin under the GIS framework.	Collection of data and basin information. Review of existing and proposed schemes. Preparation of various GIS layers. Characterization of the study area.
To identify and plan the meteorological/hydrological/hydro-geological data monitoring networks, and devising instrumentation requirement for developing guidelines for the IWRM.	Will be undertaken during Oct. 2012 – Mar. 2013.

Recommendations/suggestions in previous meetings of Working Group/TAC/GB – Nil.

Analysis and Results:

1. GIS database development.
2. Characterization of the study area.

Adopters of the results of the study and their feedback:

- NIH, RC Sagar
- MP State line departments

List of deliverables:

1. Database development.
2. Report.
3. Manual.

Major items of equipment procured: 01 no. Hand Held GPS.

Lab facility used under the study:

Numerical Groundwater Modeling Unit (NGMU) of NIH is used for GIS work.

Data procured and generated:

1. Existing monitoring stations, viz. rain gauge stations, river gauging stations, wells, etc.
2. Existing water resources schemes, viz. dams, reservoirs, canals, etc.
3. GIS Layers, viz. basin and command boundary, drainage network, well network, DEM, existing schemes, proposed schemes, etc.
4. Data: toposheets, geological maps, soil maps, litho logs, rainfall, groundwater levels, etc.

Study Benefits:

The study will be beneficial to develop guideline for planning hydrological instrumentation and data collection procedure to achieve the objectives of IWRM.

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

- End-users/beneficiaries: The study will provide inputs to NIH, RC Sagar, MP State line departments and Local habitants.

Shortcomings/Difficulties, if any:

Data collection process took time to get the data from various State and Central govt. organizations.

Future Plan:

- Submission of final report by 30th April, 2013.

4. PROJECT REFERENCE CODE: NIH/GWD/HP-II/10-12

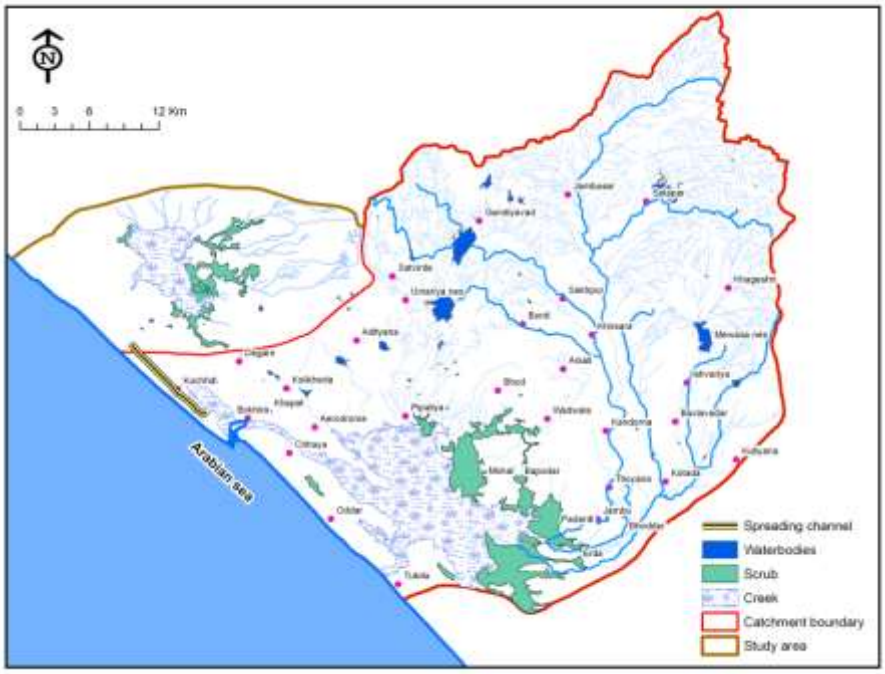
Title of the study: Coastal Groundwater Dynamics and Management in the Saurashtra Region, Gujarat

Type of study (sponsored/consultancy/referred/internal): Sponsored; *Purpose Driven Study* under World Bank funded Hydrology Project Phase-II (HP-II). Study in collaboration with Gujarat Water Resources Development Corporation (GWRDC), Govt. of Gujarat, Gandhinagar

Date of start: Oct. 26, 2009

Scheduled date of completion: Dec. 31, 2013

Location map:



Study Area: Minsar River Basin, Coastal Saurashtra, Gujarat

Study objectives:

1. To characterize the various hydrologic components and establish their quantitative inter-relationships in the coastal aquifer system.
2. To identify causes of increasing groundwater salinity and its far reaching consequences on the coastal aquifer system, and to establish the physico-chemical mechanism of mixing of freshwater-saltwater in the coastal aquifer system of Saurashtra region.
3. To simulate the transport of saltwater in the coastal aquifer system through numerical modeling and study impact of existing aquifer management practices on the groundwater regime.
4. To evaluate the impact of anticipated climate change on groundwater recharge and dynamics of coastal aquifer system and suggest suitable remedial measures.

5. Analysis of effect of water quality degradation due to saltwater intrusion on the socio-economic growth.
6. Rollover of project output to State Departments in Gujarat and concerned users in terms of technology transfer of technical know-how gained during the project for implementation of program for sustainable development of coastal groundwater resources.

Approved Action Plan:

1. Collection and monitoring of data and identification of data gaps.
2. Development of thematic maps using remote sensing and GIS.
3. Isotope analysis and water quality assessment.
4. Field tests and geophysical surveys, hydrogeological surveys in study area.
5. Development of hydrological water balance model.
6. Hydrogeochemical/geophysical surveys for 3D mapping and monitoring of freshwater-saltwater interface.
7. Numerical modeling of saltwater transport in the coastal aquifer system.
8. Field experiments for artificial recharge.
9. Evolve guidelines for optimal design of possible remedial measures in terms of pumping policy and artificial recharge.
10. Evaluation of the impact of anticipated climate change on groundwater recharge and dynamics of coastal aquifer system for different scenarios of sea level rise and rainfall events and suggest suitable remedial measures.
11. Analysis of affect of water quality degradation due to saltwater intrusion on the socio-economic growth.
12. Organization of training courses for state departments.

Objectives vis-à-vis Achievements:

Objectives	Achievements
Literature review	Completed.
Field visits	Three since April 2012.
Data collection	Collection of data about landuse, river stage and water levels in surface water bodies, groundwater draft, spreading channel, irrigation schemes, relevant maps, meteorological data
Data monitoring	Water level and water quality data monitoring of wells every two months, including creeks and reservoir schemes near coast.
Field experiments and Laboratory investigations	- Soil samples in grid pattern collected from Kerly Creek: disturbed & undisturbed; rock samples collected - Installation of data loggers and measurement of groundwater level, temperature and salinity using data loggers at three sites; one data logger relocated in June 2012 - Field tests near river and in river bed at two sites - Samples for water quality and isotope analysis collected - Measurement of salinity profiles through TLC meter - Geochemical analysis of collected samples

Database preparation	DEM of Minsar basin developed, Fence diagram, Land use, Pump test data, Geochemical data, Water elevations, Water balance.
Data analysis	Analysis of satellite data, pump tests, landuse, water table and water quality data. Data analysis for infiltration and saturated hydraulic conductivity. Water balance computations.

Analysis and Results

1. Topography of Minsar River Basin
2. Analysis of soil characteristics
3. Generation of water table and TDS contours
4. Analysis of lithologs; preparation of fence diagram
5. Hydrological water balance
6. Pump test data analysis
7. Geophysical survey data analysis
8. Geochemical analysis of water samples
9. Socio-economic survey in 21 villages

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 – Interim Report
2. Training Programs
3. Research Papers

Major items of equipment procured:

1. Procurement of distometer, bailer sampler (under progress)

Lab facilities used during the study:

1. Soil and Water Lab, NIH
2. Nuclear Hydrology Lab, NIH
3. Water Quality Lab, NIH
4. Water Quality Lab, GWRDC
5. District Laboratory, PHED, Porbandar

Data procured and/or generated during the study:

1. Hydrogeological database
2. Landuse database
3. Soil database

Study Benefits/Impact:

Measurable indicators	**Achievements**
Generation of database on GIS for Minsar River Basin	Database pertaining to hydrogeology, landuse and soil
Hydrological water balance	Computation of water balance components
Technology transfer	Demonstration about usage of

	equipment (aquameter, CTD diver, TLC meter) to GWRDC Officers

Specific linkages with Institutions and/or end-users/beneficiaries:
Study in collaboration with Gujarat Water Resources Development Corporation (GWRDC), Govt. of Gujarat, Gandhinagar

Shortcomings/difficulties, if any: -

Future plan:

1. Data monitoring, field surveys and data analysis to continue.
2. Development of numerical model
3. Organization of training course on 'Groundwater Management in Coastal Aquifers' for Officers of Gujarat State during February 2013 at Rajkot, Gujarat.

5 PROJECT REFERENCE CODE: EU-sponsored Project no. 282911

Project Titled: EU-sponsored Project no. 282911 entitled "Saph Pani - Enhancement of natural water systems and treatment methods for safe and sustainable water supply in India"

i. Total Project cost: Appox. 3.5 million Euros.
ii. NIH's share : 2,42,044 Euros
iii. Duration: 36 months (October, 2011 – September, 2014).

iv. List of Work Packages

LIST OF WORK PACKAGES (WP)			
WP Number [53]	WP Title	Type of activity [54]	Lead beneficiary number [55]
WP 1	Bank filtration in urban areas under varying pollutant loads and flood situations	RTD	16
WP 2	Managed aquifer recharge and soil aquifer treatment	RTD	13
WP 3	Constructed wetlands and other natural treatment systems for wastewater treatment and reuse	RTD	11
WP 4	Post-treatment of water from natural treatment systems for different applications	RTD	17
WP 5	Modeling and system design	RTD	14
WP 6	Integrated sustainability assessment	RTD	15
WP 7	Training and dissemination	RTD	3
WP 8	Management	RTD	1

v. NIH's involvement

- In Work Packages (WP) - WP 1, WP2 , WP 5 and WP7.
- NIH is the Lead agency in WP7.

vi. Targeted Areas for R & D works

For WP 1 : Haridwar, and Baseline data collection from existing RBF sites.
For WP 2 : Raipur Municipal Area.
For WP 5 : Based on the baseline data to be collected from WP1, & WP2.

vii. Progress made so far

(a) **Work Package 1 :** Bank Filtration in Urban areas under varying Pollutant loads and flood situation.

For research, training and demonstration (RTD) purposes, NIH has been entrusted with the Haridwar RBF site for periodic data collection and analysis. In Haridwar site, there are 22 RBF wells in operation. Bimonthly water samples from 22 RBF wells, river water samples from 4 locations, groundwater samples from 2 locations have been collected since June, 2012 to determine the concentration of 21 water quality constituents and isotopic characteristics. Groundwater levels and river

states have also been measured simultaneously. Other auxiliary data for modelling the well fields of the RBF wells such as, meteorological data, borelog data, and aquifer properties have also been collected partially from different organizations, and continuous efforts are in progress to collect other data. The data collected from the field investigation are being used for well field modelling using MODFLOW coupled with MT3D and are also being provided to the WP-1 leader (HTWD) as part of the progress of the project.

With regard to the collection of Baseline data for the existing RBF wells in other part of the country, some preliminary data from Patna have been collected and provided to the WP-1 leader.

Second 6 monthly report of the WP-1 has been submitted to the WP-1 leader.

(b) **Work Package 2 :** Managed Aquifer Recharge and Soil Aquifer Treatment

As part of the first six months deliverable, NIH has significantly contributed to the MAR review report along with other 5 project partners. The preparation of the MAR review report was coordinated by the FHNW, Switzerland. The final report has been completed by the consortium in the mid of September, 2012.

For RTD activities on WP-2, NIH has been entrusted with the Raipur Municipal Area site along with NGRI, RMC, and KWB-Germany. NIH's scientist has visited the site twice and collected some data related to Meteorology, hydrogeology, groundwater level data, etc. Analysis of collected data is in progress. Time to time interaction with other partners also takes place to exchange information and results.

(c) **Work Package 5 :** Modelling and System Design

In this work package, NIH has a secondary role, i.e., data being collected from WPs 1,2,3 & 4 will be used for the activities of WP5. The activities of WP5 will basically start after 1st year of the Project.

(d) **Work Package 7 :** Training & Dissemination

In this Work Package, NIH has the lead role supported by 11 other project partners.

The first training course entitled "Bank Filtration for Sustainable Drinking Water Supply in India" was organized as add on to the "India Water Week-2012" on 13th April, 2012 at New Delhi. In addition to that the 'Saph Pani' project had been participated in the exhibition of the IWW-2012 as a Platinum Sponsor organized in the Pragati Maidan during 10-13 April, 2012.

The first six monthly meeting of the project to review the progress, finalize the activities for future 6 months and for visit of some field sites was held at Basel, Switzerland during 9-16 May, 2012. Four officials from NIH attended the meeting at Basel during 9-16 May, 2012.

The second training program on "Managed Aquifer Recharge: Methods, Assessment, Hydrogeological and Water Quality Considerations" being organized by

NIH and Anna University is scheduled to held during 11-12 December, 2012 at Chennai.

The first annual review meeting of the ‘Saph Pani’ project to review the progress of activities is scheduled to be held during 13-14 December, 2012 at Chennai.

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

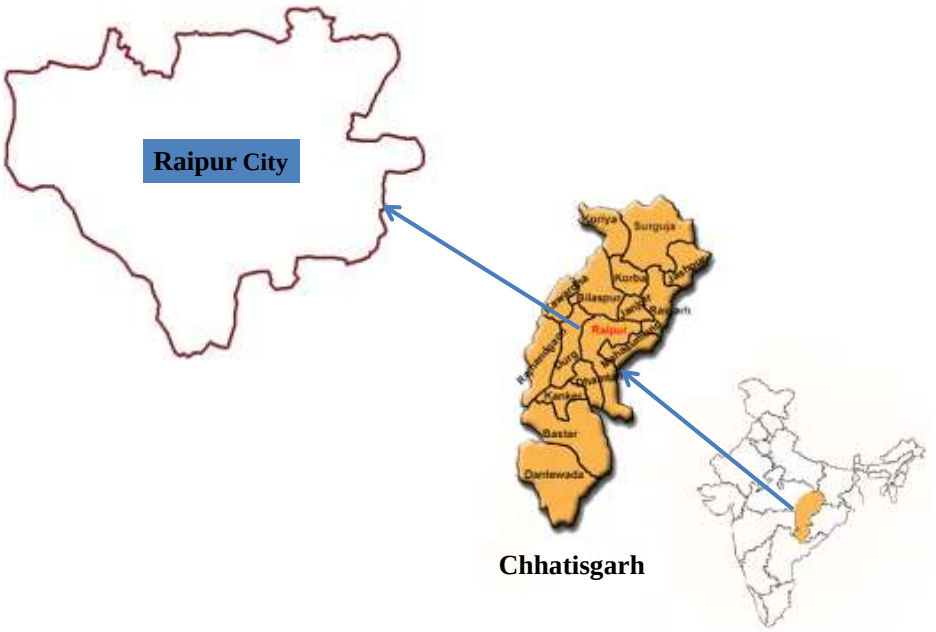
Title of the Study: **Managed Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)**

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

Date of Start : 1st April, 2011

Scheduled Date of Completion : 31st March, 2014

Location Map Study area is Raipur, the capital city of Chhattisgarh lies between 21° 10'and 21° 21' N latitudes and 81° 32' to 81° 44'E longitudes.



Objectives

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

Approved action plan

- Literature Review
- Field Investigation & Data Collection

- Determination of Availability of Surface water & Ground water
- Recharge Site Identification
- Estimation of Groundwater Recharge and Simulation of Aquifer response
- Analysing Water Supply & demand Pattern
- Demand Management

Objectives & Achievements

To identify the potential recharge site for groundwater (GW) augmentation	Literature review has been completed. Consultation with NGRI and RMC for finalization of recharge sites is taking place regularly. Meteorological and GWL data have been collected and other data collection are in progress.
To model & analyze aquifer response due to the recharge from the identified potential recharge site	The modeling task will be taken up after obtaining data and their analysis.
To manage the augmented GW resources for subsequent potential uses	Will be taken up after completion of second objective.

Analysis and Results

To meet the first objective Meteorological data, Topography, Geological formation, Groundwater Table, Hydraulic properties of aquifer, Soil characteristic, Land uses etc. are required. Meteorological data viz. Rainfall, Temperature, R.H and Evaporation are being analyzed, which will help in estimation of Surface water availability. Topographic data are being analyzed and based on the analysis, a Digital Elevation Map (DEM) is developed and delineation of watersheds and development of drainage networks are in progress.GWL data and Geological formation are being analyzed to know the position of Groundwater Table and its direction. GWL contours have been drawn and GW flow directions have been observed along with geological map to identify the recharge sites.

Data Source

Rainfall data - IMD, Pune.
GWL & Geological data - CGWB, Raipur
Meteorological data - Indira Gandhi Viswa vidyalay (IGKV), Raipur
Toposheets - S.O.I, Raipur

7. PROJECT REFERENCE CODE: EU-sponsored Project no. 282911

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

[Under the framework of 'SAPH PANI' Project Work Package – 1(WP-1) – Bank Filtration in Urban Areas under varying Pollutants Loads and Flood situation]

Type of study: Under the Work Package-I of 'Saph Pani' Project

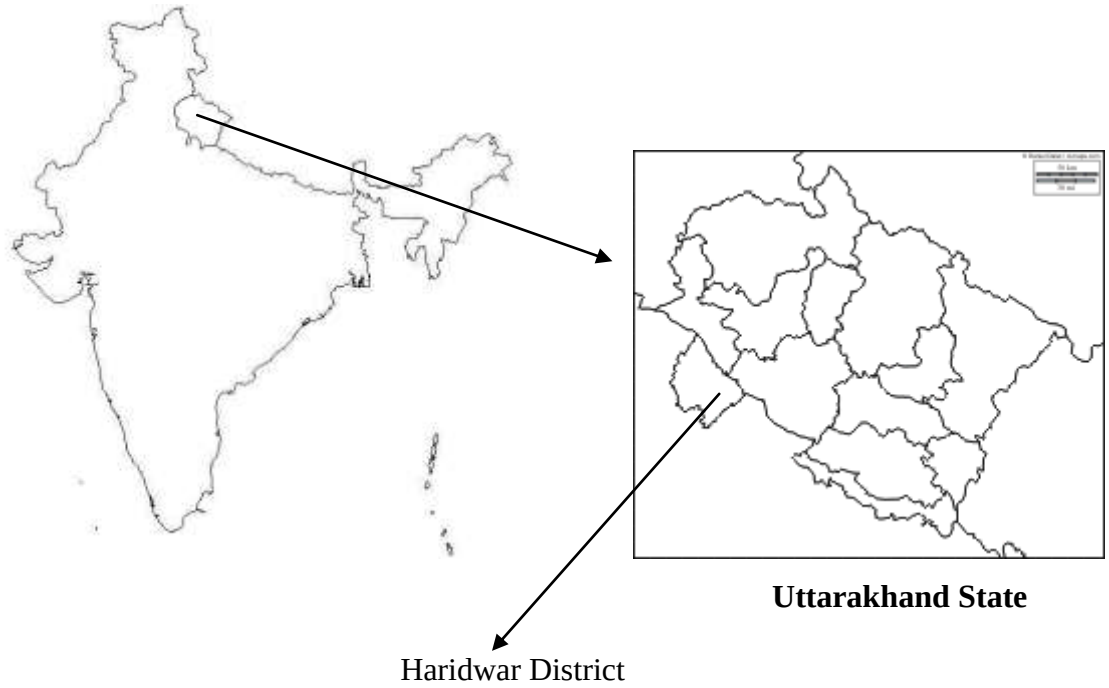
Nature of study: Technology or technique development

Date of start: 1rst April 2012

Scheduled date of completion: October 2014

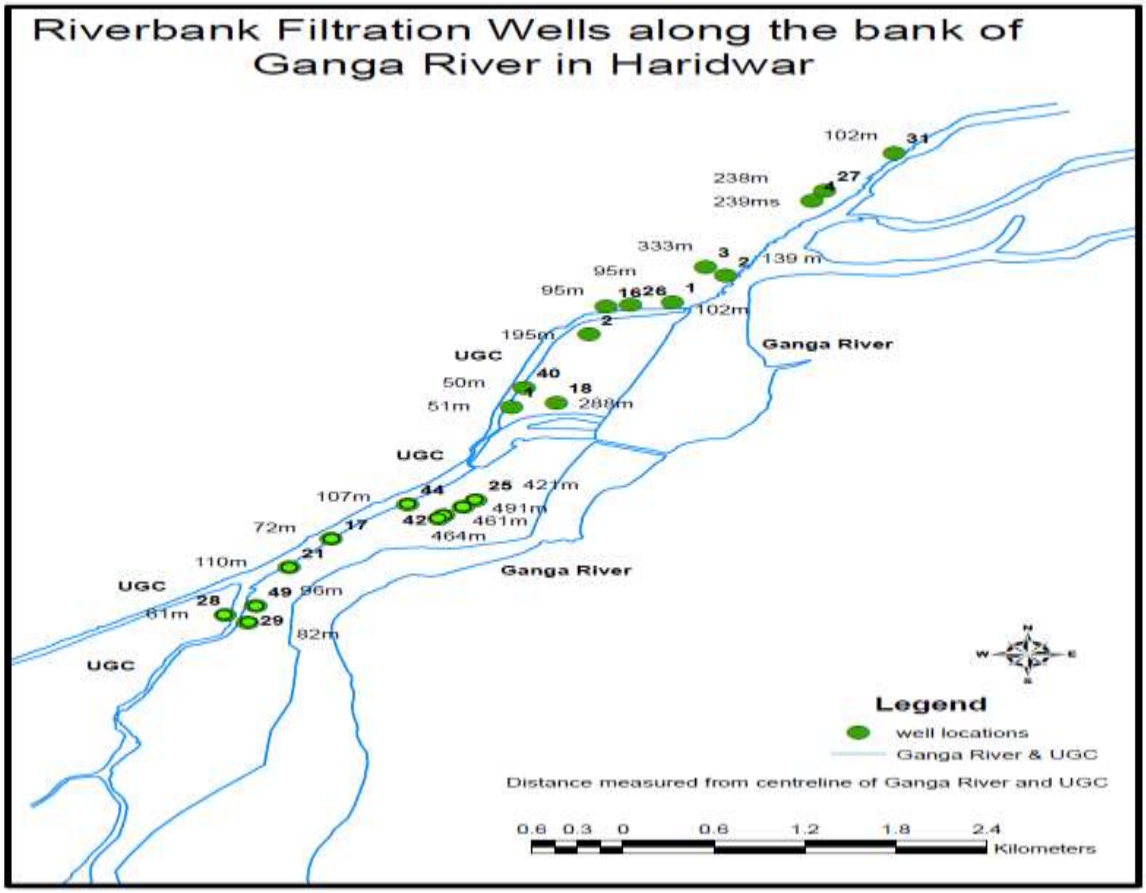
Location map

India



Uttarakhand State

Haridwar District



Riverbank Filtration wells along the river Ganga and Upper Ganga Canal in Haridwar

Study objectives:

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

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

Approved action plan:

- Data collection and base data computerization (6 months)
- Conceptualization of the problem, model setup, model data preparation (6 months)
- Part-I report preparation- Model Calibration, validation and analysis (1 year)
- Contaminant Transport Modeling & analysis etc (9 months)
- Report preparation (3 months)

Action plan for forthcoming one year (2012-2013)

Review Literature	Completed
Reconnaissance Survey of study sites	Completed
Data collection and base data analysis	Under Progress
Analysis of field	Under Progress

data(Conceptualization of the problem, model setup, model data preparation)	

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 the Ganga River in Haridwar.	• The baseline data for flow and contaminant transport modeling has been collected and assimilation of various other data related to flow modelling is under progress. • The Conceptual framework for the flow model has been prepared.
• 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:

Data collection and base data computerization: The baseline data such as groundwater level measurements, river stage at different locations of the River Ganga for flow and contaminant transport modelling are being collected on regular basis. Daily meteorological data for 5 years from 2004 to 2008 have been collected. Bore log data for 4 locations, topographic information through ASTER data, hydraulic conductivity for riverbed of Ganga River, Ganga River and Upper Ganga Canal geometry, stages and discharge data from 2001 till August 2012 have been collected. Groundtruthing of distances of well from river and Upper Ganga Canal is under progress. Periodic collections for 22 RBF wells, 2 Observation wells, and 2 locations of river (upstream and downstream) and 2 locations of Upper Ganga Canal are being collected on regular basis for pre monsoon period and post monsoon period. Water quality analysis to determine 21 water quality parameters (Table1) are being carried out at the Water Quality Lab of NIH. Isotopic analysis for the same samples is also being carried out. Up till now, 5 times sampling of water for water quality analysis, 11 times measurement of flow and groundwater level have been carried out on different dates.

Table1.Water Quality Parameters being analyzed for the RBF sites in Haridwar

S.No	**Water quality parameters**
1	Temperature[°C]
2	pH
3	Electrical conductivity

4	TDS [mg/L]
5	Hardness
6	Turbidity[NTU]
7	Alkalinity
8	Cl-
9	SO_4^{2-}
10	NO_3^-
11	Na^{2+}
12	K+
13	Ca^{2+}
14	Mg^{2+}
15	Fe^+
16	Mn^+,
17	HCO_3^-,
18	Total coliforms [MPN / 100 mL]
19	Fecal coliforms (E. Coli) [MPN / 100 mL]
20	COD
21	BOD

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 under progress and various hydrogeological and hydraulic data for setting up the flow model is under progress.

HYDROLOGICAL INVESTIGATION DIVISION

Scientific Manpower

S N	Name	Designation
1	Sri C P Kumar	Scientist F & Head
2	Dr Sudhir Kumar	Scientist F
3	Dr Suhas Khobragade	Scientist E1
4	Dr S P Rai	Scientist E1
5	Dr M S Rao	Scientist E1
6	Sri S K Varma	Scientist C
7	Sri P K Garg	Scientist B
8	Sri Rajeev Gupta	SRA
9	Sri U K Singh	SRA
10	Sri V K Agarwal	SRA
11	Sri Jameel Ahmed	SRA
12	Sri Vishal Gupta	RA

WORK PROGRAM FOR THE YEAR 2012-2013

(This includes studies which are continuing and 3 new studies which are being proposed in the 37th meeting)

S. No.	Study	Team	Duration/ Status
INTERNAL STUDIES			
1	Estimation of Snow and Glacier Melt Contribution in Melt Water of Gangotri Glacier at Gaumukh using Isotopic Techniques	S. P. Rai (PI) Manohar Arora C. P. Kumar Rakesh Kumar Naresh Kumar Jamil Ahmad Vishal Gupta	**3 years** (4/10 – 3/13) **Continuing Study**
2	Assessment of Radon Concentration in Waters and Identification of Paleo-Groundwater in Punjab State	S. K. Verma (PI) Sudhir Kumar M. S. Rao Mohar Singh	**2 years** (04/11-03/13) **Continuing Study**
3	Hydro-geological Assessment of Ghar Area for Artificial Recharge and Water Management Planning	Pankaj Garg (PI) M. S. Rao Sudhir Kumar C. P. Kumar Tanveer Ahmad Rajesh Agarwal Gopal Krishan	**2 years** (04/11-03/13) **Continuing Study**
4.	Assessment of Sensitivity of Open Water Evaporation to Increase in Temperature for Different Climatic Regions of India	S. D. Khobragade (PI) C. P. Kumar Manohar Arora A. R. Senthil Kumar	**2 years** (04/12-03/14) **Continuing Study**
5.	Water Quality, Hydrogeology and Isotopic Investigations in SW Punjab	M. S. Rao (PI) C. P. Kumar Gopal Krishan	**2 years** (07/12-06/14) **New Study**
SPONSORED PROJECTS			
6	National Program on Isotope Fingerprinting of Waters of India (IWIN)	M. S. Rao (PI) Bhishm Kumar Sudhir Kumar S. P. Rai S. K. Verma Pankaj Garg	**6 years** (07/07–07/13) **Continuing Study**
7	Groundwater Dynamics of Bist-Doab Area, Punjab Using Isotopes	M. S. Rao (PI) Bhishm Kumar Sudhir Kumar S. K. Verma Pankaj Garg CGWB Officials	**4 years 6 months** (07/09-12/13) **Continuing Study**

S. No.	Study	Team	Duration/ Status
8	Groundwater Management in Over-Exploited Blocks of Chitradurga and Tumkur Districts of Karnataka	Sudhir Kumar (PI) J. V. Tyagi S. P. Rai Anupma Sharma B. K.. Purandara C. Rangaraj	**4 years 9 months** (07/09-03/14) **Continuing study**
9	Impact Assessment of Landuse on the Hydrologic Regime in the selected Micro-watersheds in Lesser Himalayas, Uttarakhand	S. P. Rai (PI) J. V. Tyagi M. P. Singh, FRI Rajeev Tiwari, IGNA Vishal Gupta Jamil Ahmad V. K. Agarwal	**5 years** (4/08– 3/13) **Continuing Study**
10	Development of Spring Sanctuaries in an Urban and a Rural Watershed in District Pauri Garhwal, Uttarakhand	S. P. Rai (PI) Sudhir Kumar S. D. Khobragade Pankaj Garg Jamil Ahmad Vishal Gupta	**3 years** (04/10-03/13) **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	**1 Year** (09/12-08/13) **New Study**
12	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 Vipin Agarwal S. L. Srivastava Vishal Gupta Mohar Singh	**3 Years** (06/12-05/15) **New Study**
CONSULTANCY PROJECTS			
13	Hydro-geological Studies of Jhamarkotra Mines, Udaipur, Rajasthan	Sudhir Kumar (PI) S K Verma, Pankaj Garg,	**2 years** (07/10-12/12) **Continuing Study**
14	Integrated Hydrological Investigations of Sukhna Lake, Chandigarh for its Conservation and Management	S. D. Khobragade (PI) C. P. Kumar R. D. Singh S. P. Rai Vipin Agarwal	**3 years** (07/11-06/13) **Continuing Study**

1. *REFERENCE NUMBER: NIH/HID/INT/2010-13*

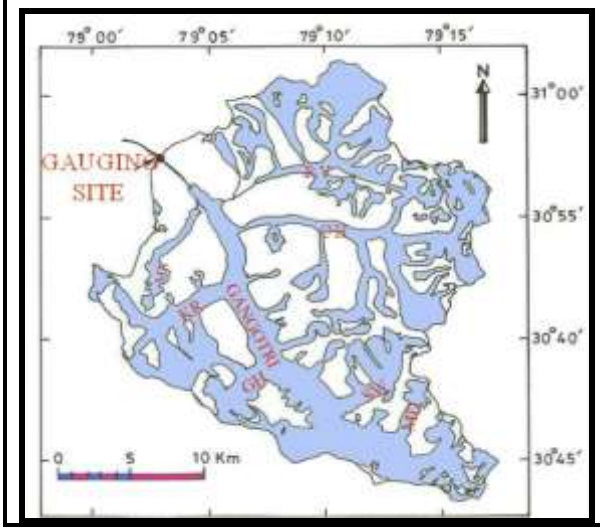
Title of the study : **ESTIMATION OF SNOW AND GLACIER MELT CONTRIBUTION IN MELT WATER OF GANGOTRI GLACIER AT GAUMUKH USING ISOTOPIC TECHNIQUES**

Name of PI, Co-PI, & their affiliations : Dr. S. P. Rai (PI)
Dr. Manohar Arora
Mr. C. P. Kumar
Dr. Rakesh Kumar
Mr. Naresh Kumar
Mr. Jamil Ahmad
Mr. Vishal Gupta

Type of study : Internal

Date of start & scheduled date of completion : April 2010, March 2013

Location map



Glacier Type	Valley
Elevation Range	4000-7000 m
Length	30 km
Width:	~0.2 to 2.35 km
Total Area: Glacierised Area	~556 km^2 ~286 km^2

Study objectives :
- Isotopic characterization of melt water and individual components (snow-glacier melt, groundwater, rainfall-runoff)
- Estimation of snow and glacier melt contribution separately and its variability with time

Statement of the problem : The snow and glacier melt runoff contributes

significantly to all north India Himalayan rivers during summer when demand of water increases for hydropower, drinking and irrigation etc. Due to lack of information on hydrological processes of snow/glacier regime and assured availability of melt water, water resources management policies at lower reaches of the glacier fed rivers are often formulated without considering the impact of snow and glacier on river hydrology.

Himalayan glaciers are sensitive indicator of climate changes as the world's other mountains glaciers. Snow and glacier melt isotopic composition can provide information on atmospheric circulation such as responses to climatic fluctuations, changes in the strength of south-west summer monsoon, and western disturbances.

Therefore, this study has been taken up to study the isotopic composition of snow, rain, ice and melt water which will be useful in separation of various components of stream discharge and in the long term will be useful to understand the source of moisture and impact of climate change on melting pattern.

Approved action plan **:** Please See Annexure 1

Timeline and justification for time over runs **:** March 2013

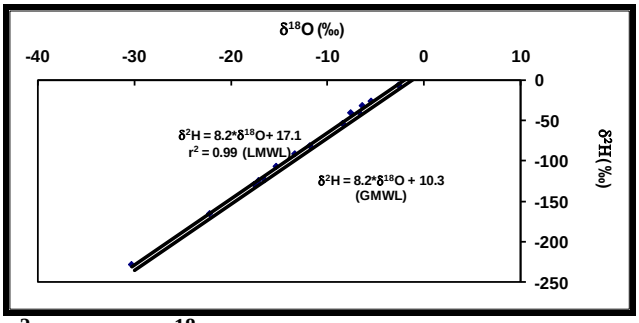
2-column table showing objectives vis-à-vis achievements **:**

Objectives	Achievements
Isotopic characterization of melt water and individual components (snow-glacier melt, groundwater, rainfall-runoff)	Samples were collected for the ablation period 2011 and sampling for 2012 is continued.
Estimation of snow and glacier melt contribution separately and its variability with time	Isotopic characterization of melt water during the ablation period of 2005 to 2011 under progress.

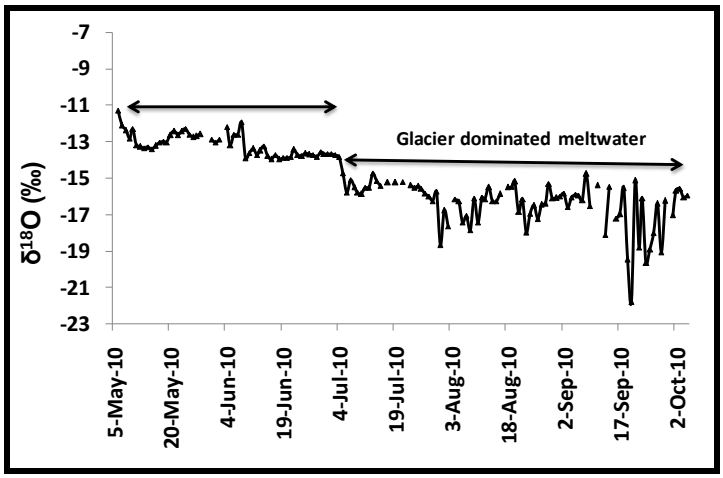
Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken **:** NIL

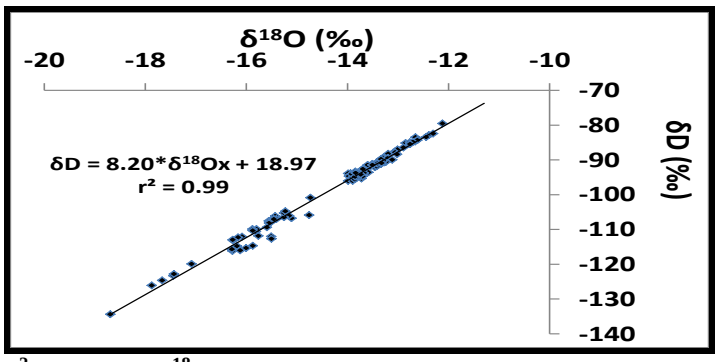
Analysis and Results :

- The plot of δ^2H versus $\delta^{18}O$ has been made for all precipitation samples collected during the ablation period of 2004 and 2008. The Local Meteoric Water Line (LMWL) developed as δ^2H = 8.2 (±0.10) x $\delta^{18}O$ + 17.1 (±1.53) (n = 15, r^2 = 0.99) for the complete ablation period, which is showing higher slope and y intercept in comparison to GMWL.
- It has been observed that the isotopic values of melt water initially follow the average $\delta^{18}O$ values of snow ranged between -12‰ to -13.8‰, which shows the enriched value of snow. It may be due to the sublimation process.
- The abrupt change in $\delta^{18}O$ values during the rainfall reflects the contribution from the rainfall-runoff to the stream.
- δ^2H vs $\delta^{18}O$ plot for the meteoric water line developed for melt water of Gangotri Glacier at Gaumukh site and the best fit line is $\delta^2H=8.2*\delta^{18}O + 18.97$, r^2 = 0.99, n = 110 (2010).
- Attempt has been made to separate the snow and glacier contribution at Gaumukh.
- The details of the results will be presented in the working group meeting.



δ^2H versus $\delta^{18}O$ of precipitation (monthly weighted) during the ablation period 2004 to 2010





δ^2H versus $\delta^{18}O$ of melt water during the ablation period 2010

Adopters of the results of the study and their feedback : R & D organizations

List of deliverables : Paper presented in International Conference at Monaco, organized by IAEA. Accepted for the publication in the proceedings.

Major items of equipment procured : NIL

Lab facilities used during the study : Isotope Laboratory and Hydrological Instrumentation Laboratory

Data procured and/or generated during the study : Isotopic data of melt water and rainfall at an altitude of 3800 m generated

Study Benefits / Impact :

Activity	Status
Selection of sampling site	Completed
Sample collection for 2010	Completed
Sample collection for 2011	Completed
Analysis of stable isotopes (δD and $\delta^{18}O$) of collected samples	Continued
Compilation of results	In progress

Specific linkages with Institutions and/or end-users/beneficiaries : NIL

Shortcomings/difficulties, if any : Collection of samples at high altitude

Future plan : Computation of snow and glacier melt variation with time.

Annexure – 1

ACTIVITY SCHEDULE (QUARTER WISE, FOR 2011-12 AND 2012-2013) FOR ESTIMATION OF SNOW AND GLACIER MELT CONTRIBUTION IN MELT WATER OF GANGOTRI GLACIER AT GAUMUKH USING ISOTOPIC TECHNIQUES

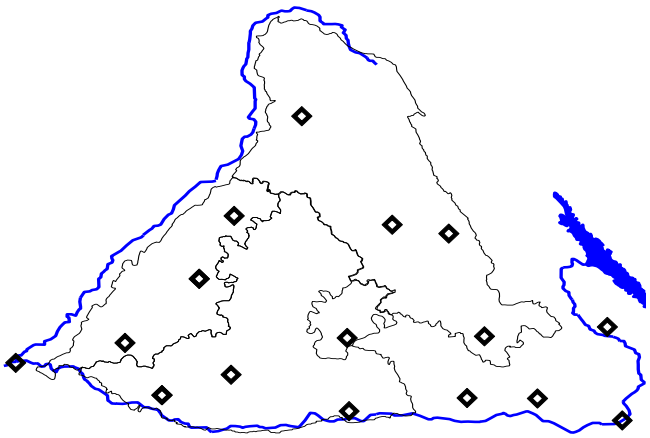
Activity	1st	2nd	3rd	4th	5th	6th	7th	8th
Collection of melt water, precipitation, ice and snow samples for isotopic (δD and $\delta^{18}O$) analysis	♦	♦			♦	♦		
Measurement of δD and $\delta^{18}O$ in laboratory			♦	♦		♦	♦	
Development of meteoric water line for melt water			♦	♦			♦	
Establishment of moisture source				♦	♦		♦	

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th
Analysis of discharge data				♦	♦	♦	♦	
Separation of different components of melt water using the isotope model				♦	♦	♦	♦	
First draft report						♦		
Second draft report							♦	
Final report								♦

2. REFERENCE NO.: NIH/HID/INT/2011-13/1

Title of the study	**:**	**ASSESSMENT OF RADON CONCENTRATION IN WATERS AND IDENTIFICATION OF PALEO-GROUNDWATER IN PUNJAB STATE**
Name of PI, Co-PI, & their affiliations	**:**	Mr. S. K. Verma (PI) Dr. Sudhir Kumar Dr. M. S. Rao Mr. Mohar Singh
Type of study	**:**	Internal
Date of start, Scheduled date of completion	**:**	April 2011, March 2013

Location map (wherever applicable):



Map of Study area

Study objectives **:** To measure radon concentration in waters
To identify paleo-groundwater in deep aquifers

Statement of the problem **:**

Radon (^{222}Rn) is a radioactive, colorless, odorless, tasteless noble gas, occurring naturally as the decay product of Uranium. It has a half-life of 3.8 days. Radon gas is considered to be a health hazard due to its radioactivity. It can cause serious diseases like lung cancer if it exceeds certain limit. It has been found that in a country like USA, more than 30,000 deaths occur every year due to high radon concentration in water as well as in air. High concentrations of Radon have been observed in certain parts of India also during preliminary studies carried out by various investigators. Therefore, a National Working Group has been constituted by the Govt. of India to study the radon concentration in different materials. NIH has been entrusted to study the radon concentration in waters. Keeping in view the facts mentioned above, this study is proposed to be carried out in Punjab state to meet out first objective of the study.

Paleo-groundwaters are those groundwaters which are thousands years old. People are drawing groundwater from deeper aquifers without the knowledge of their dynamics. Some of the deeper aquifers may have paleo water which may not serve the needs for water supply for longer time. However, such sources can be used to fulfill some specific needs. Therefore, there is a need to map the paleo-waters to avoid huge investments on other industrial and/or urbanizational developments in such areas. Keeping this in view, the mapping of paleo-groundwater is proposed in the Punjab state where tapping of deeper aquifers has started at large scale.

Approved action plan **:** Annexure 2

Timeline and justification for time over runs **:** March 2013

:

2-column table showing objectives vis-à-vis achievements

S. No.	Objective	Achievement
1.	To measure radon concentration in waters	Achieved
2.	To identify paleo-groundwater in deep aquifers	In progress

Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken **:** N.A.

Analysis and results **:**

- The analysis of environmental tritium has been carried for the 16 nos. of water samples collected from different locations and sources from three districts namely Ropar, Nawanshahar & Hoshiarpur.

- It is found that the tritium unit in water samples varies from 2.62 TU to 7.73 TU in district Ropar, 0.99 TU to 6.94 TU in district Nawanshahar and 1.84 TU to 7.40 TU in district Hoshiarpur.

- In addition to above, a total of 17 groundwater samples were collected from shallow hand pumps/tubewells from 17 sites located in the study area. These samples have been analysed for stable isotopes (δD and $\delta^{18}O$) using Isotope Ratio Mass Spectrometer available in Isotope laboratory. It has been found that the value of $\delta^{18}O$ varies from -9.81‰ at Sangowal site to -4.58‰ at Fattu Dhingra site and the value of δD varies from -68.6‰ at Sangowal site to -35.46‰ at Dhilwan site.

- The analysis of environmental tritium for 17 nos. of groundwater samples

collected from district Kapurthala and Jalandhar is under progress in Isotope laboratory.

Adopters of the results of the study and their feedback : CGWB (NWR), Chandigarh; Punjab Water Resources Development & Management; and Punjab Water Resources & Environment Directorate, Chandigarh.

List of deliverables : Papers and reports along with the data on radon concentration and paleo-groundwater.

Major items of equipment procured : Two sets of radon detector with accessories have been procured and installed satisfactorily at Isotope laboratory of the Institute.

Lab facilities used during the study : Tritium and carbon dating facilities are proposed to be used at Isotope laboratory in addition to Radon Detector in laboratory as well as in the field.

Data procured and/or generated during the study : NA

Study Benefits / Impact :

- Data base on radon concentration in waters
- Information and data base about availability of paleo-waters in the study area.

Specific linkages with Institutions and/or end-users/beneficiaries : The work is proposed to be carried out with the support of CGWB, Punjab State Water Resources Department, and Punjab University, Chandigarh.

Shortcomings / difficulties, if any : NA

Future plan : As per activity chart

Annexure - 2

ACTIVITY SCHEDULE FOR ASSESSMENT OF RADON CONCENTRATION IN WATERS AND IDENTIFICATION OF PALEO-GROUNDWATER IN PUNJAB STATE

S. No.	Activity	2011-2012				2012-2013			
		1st Q	2nd Q	3rd Q	4th Q	1st Q	2nd Q	3rd Q	4th Q
1.	Review of literature, collection of hydro-geological data/information for the study area etc.	√	√						

2.	Preparation of index map of study area, selection of locations/sites for experimental works etc.	√	√						
3.	Collection of water samples for radon measurement and tritium analysis, measurement of radon		√	√	√				
4.	Laboratory analysis of water samples for tritium dating			√	√	√			
5.	Collection of water samples for ^{14}C dating					√	√		
6.	Laboratory analysis of water samples for ^{14}C dating						√	√	
7.	Analysis and interpretation of data						√	√	
8.	Preparation of interim report/ Part-1				√				
9.	Writing of report								√

3. ***REFERENCE NUMBER: NIH/HID/INT/2011-13/2***

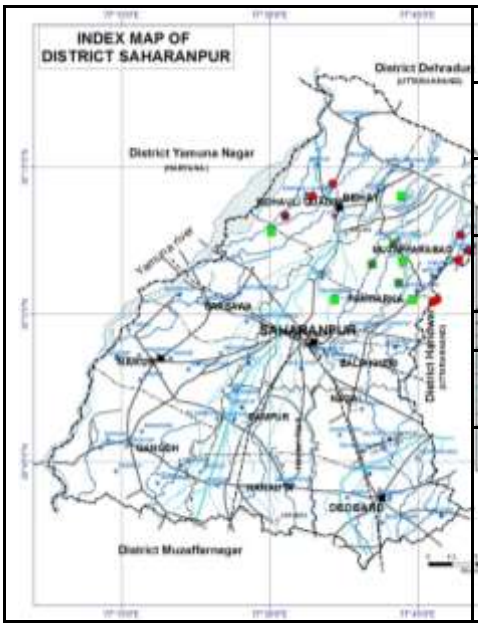
Title of the study : **HYDRO-GEOLOGICAL ASSESSMENT OF GHAR AREA FOR ARTIFICIAL RECHARGE AND WATER MANAGEMENT PLANNING**

Name of PI, Co-PI, & their affiliations: Mr. Pankaj Garg (PI)
Dr. M. S. Rao
Dr. Sudhir Kumar
Mr. C. P. Kumar
Mr. Tanveer Ahmad
Mr. Rajesh Agarwal
Dr. Gopal Krishan

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

Date of start, scheduled date of completion: April 2011- March 2013

Location map (wherever applicable)



MUZZAFFARABAD	**SADHAULI QUADIM**
Study Area - 40621 ha	Study Area - 38767 ha
Govt. Tubewells – 130	Govt. Tube wells – 6
Private Tubewells – 5333	Private Tubewells – 4196
Rainfall – 740 mm	Rainfall – 740 mm
G.W. Utilization - 97.42%	G.W. Utilization - 94.62%
Forested Area – 1910 ha	Forested Area – 1589 ha

Study objectives :

- To identify the groundwater recharge zones and groundwater flow velocity in Ghar area
- To identify sites for water harvesting structures in Ghar area

Statement of the problem:

Two blocks of district Saharanpur (U.P.) which fall in Ghar area namely, Muzaffarabad and Sadhauli Kadim have been taken for this study. The availability of groundwater and surface water is limited in both these blocks which poses problem to meet out the need of

drinking water as well as water for irrigation. As per the data taken from UP Ground Water Deptt., the groundwater utilization in Muzaffarabad is 97.42% while in Sadhauli Kadim 94.62%. Therefore, presently both the blocks fall in dark category and require artificial recharge measures.

Approved action plan: Annexure 3

Timeline and justification for time over runs: NA

2-column table showing objectives vis-à-vis achievements:

Objective	Achievement
• Review and synthesis of literature and purchase of map	• Literature survey completed.
• Data collection and preparation of index maps	• Required data collected and index map prepared. Rainfall trend analysis of the Saharanpur district on the basis of 30 years data (1982-2011) in context of agriculture has been done.
• Analysis of water table data to identify water scarce zones, recharge areas and groundwater safe zones	• On the basis of pre and post monsoon groundwater table data, water scarce zones, recharge areas and groundwater safe zones have been identified.
• Validation of the isotopic based data results	• Isotopic based results have been validated using infiltration tests conducted at 5 locations.

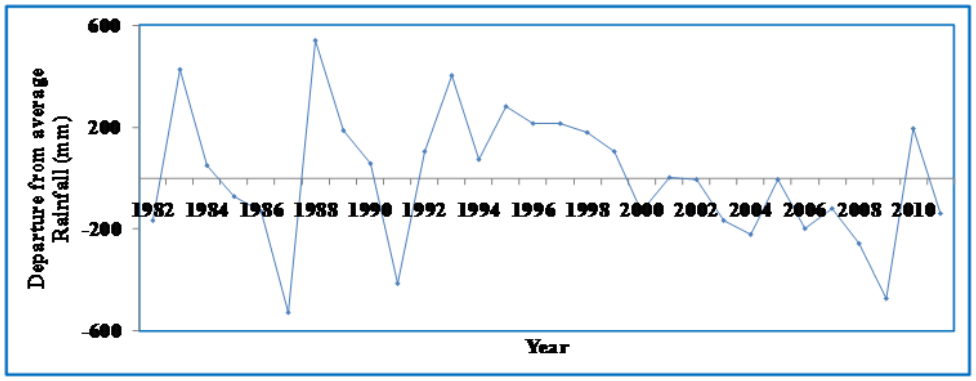
Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken : NIL

Analysis and Results:

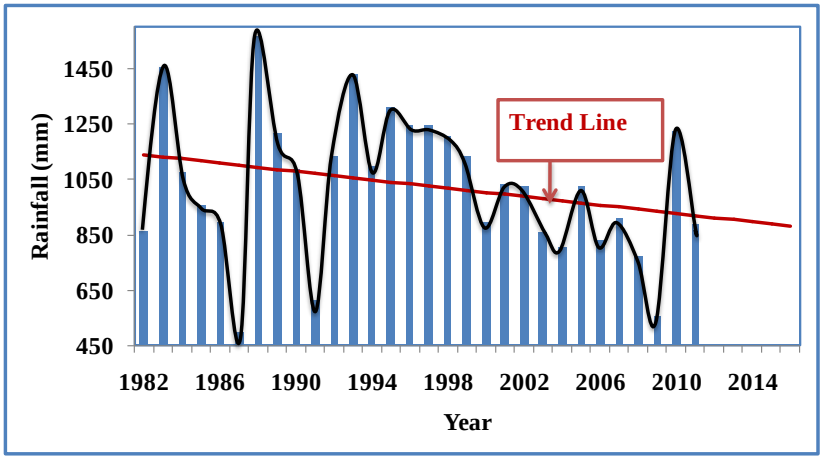
The source of recharging the water table is rain and any declining trend in rainfall can adversely affect the groundwater availability in the study area. Therefore, rainfall trend analysis for Saharanpur has been done for the past 30 years. The variation analysis of rainfall data of Saharanpur reveals a fairly good range of variation indicating a positive trend before 2000 and negative trend from 2000 onwards and that is resulting in depletion of groundwater.

The time series analysis generates valuable information regarding the trend of a series of observations and the trend line is depicted in figure below. It helps to measure the deviation from the trend and also provides information pertaining to the nature of trend. The analysis can be used as a tool to forecast the future behaviour of the parameter. The method of least square fit of straight line has been used for performing the trend analysis of annual rainfall. On this basis, future forecast of rainfall amount for a period of 5 years

from 2012 to 2016 has been made, which shows a negative trend for the coming years.



Departure from average rainfall of Saharanpur for the period 1982-2011



Trend line of rainfall of Saharanpur for the period (for the period 1982-2011)

Adopters of the results of the study and their feedback:

1. UP State Ground Water Department, Saharanpur Division
2. CGWB, Regional Directorate, Lucknow
3. Local NGO's active in the study area
4. Local District Administration

List of deliverables: *Papers accepted/published*

Garg, Pankaj, Krishan, Gopal**,** Rao, M. S., Kumar, C. P. and Agarwal, Rajesh. 2012. Rainfall Trend Analysis in Saharanpur District of Uttar Pradesh - Agricultural Context**.** "28th National Convention of Civil Engineers & National Seminar on Role of Infrastructure on Sustainable Development" during October 12-14, 2012 at IIT-Roorkee. (accepted).

Garg, Pankaj, Rao, M. S., Krishan, Gopal, and Kumar, C. P. 2012. Assessment of Groundwater Recharge Sources in Foothills of North-West UP using Isotopes. In: National Seminar on "Application of Isotopes & Radiation Technology for Societal Benefits (AIRTS-2012)", 21-23 June, 2012 at Bangalore University, India. pp: 45**.**

Major items of equipment procured : NIL

Lab facilities used during the study: Isotope laboratory, Hydrological Instrumentation laboratory, Remote Sensing and GIS laboratory

Data procured and/or generated during the study: Nil

Study Benefits / Impact:

The study will provide suitable sites for artificial recharge in the study area for better water management planning.

Specific linkages with Institutions and/or end-users/beneficiaries: NIL

Shortcomings/difficulties, if any: NIL

Future plan: Identification of suitable sites for artificial measures and preparation of final report

Annexure - 3

ACTIVITY SCHEDULE FOR HYDRO-GEOLOGICAL ASSESSMENT OF GHAR AREA FOR ARTIFICIAL RECHARGE AND WATER MANAGEMENT PLANNING

S. No.	Activity	2011-12				2012-13			
		Ist Q	2nd Q	3rd Q	4th Q	1st Q	2nd Q	3rd Q	4th Q
1.	Review of literature and purchase of map and data etc	√	√						
2.	Collection of hydro-geological data/information for the study area		√	√					
3.	Infiltration tests and collection of samples				√	√	√	√	
4.	Preparation of various maps of the study area				√	√	√	√	
5.	Analysis of isotopic and chemical data				√	√	√	√	
6.	Interpretation of data (recharge zones)				√	√	√	√	
7.	Identification of suitable sites/ management measures							√	
8.	Final report							√	√

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

Title of the Study: **ASSESSMENT OF SENSITIVITY OF OPEN WATER EVAPORATION TO INCREASE IN TEMPERATURE FOR DIFFERENT CLIMATIC REGIONS OF INDIA**

Name of PI, Co-PI, & their affiliations: Dr. S. D. Khobragade (PI)
Mr. C. P. Kumar
Dr. Manohar Arora
Dr. A. R. Senthil Kumar

Type of Study: Internal

Date of start, scheduled date of completion:

Date of Start:	April 2012
Date of Completion	March 2014

Location map (wherever applicable):

Location map of study area

Study Objectives:

(a) To assess the impact of rising temperature on some temperature dependent factors affecting open water evaporation
(b) To assess the impact of rising temperature on open water evaporation in different climatic regions of India using routinely observed data
(c) To compare the variation in impact on open water evaporation under different climatic settings for different scenarios of temperature rise

Statement of the Problem:

A number of studies have been reported in different parts of the world on the assessment of possible impacts of global temperature rise on water resources and hydrologic cycle. However, only a few studies have emphasized the impact primarily on evaporation. Trend analysis of evaporation data shows different trends in different regions, the world over. Although studies using the GCM's are considered as more realistic for global scales, not all the variables required for calculation of more complex evaporation formulae are available from all climate models. Hydrological models are, hence, claimed to be more useful and suitable for regional and local scales, as they have the ability to incorporate projected variations in climatic variables as well as other hydrological parameters. However, contrary to the claim, hydrologic models that use simpler form of evaporation and evapotranspiration formulae, generally do not have scope for assessing the impact of temperature on various atmospheric variables which affect evaporation. As far as evaporation is concerned, changes in atmosphere variables caused by temperature changes could have an important effect on overall changes in evaporation. Thus, for the purpose of studying impact of global warming on a more specific component like evaporation, specific evaporation model such as Penman model which uses as many input parameters as the factors affecting the process, could be preferable because, as pointed out by IPCC (2001), '*equations that do not consider explicitly all meteorological controls may give very misleading estimates of change*'. Moreover, use of GCM's and RCM's, as well as other sophisticated hydrological models, requires technical expertise that may not always be available locally. For such situations, there is a need for development of a simple methodology to assess the sensitivity of local evaporation to rising temperature using routinely observed meteorological data.

Approved action plan: Please see Annexure 4

Timeline and justification for time over runs:

Time line is as per Annexure 4. No time overruns so far.

2-column table showing objectives vis-à-vis achievements:

Objectives	Achievements
To assess the impact of rising temperature on some temperature dependent factors	Analysis has been carried out for Udaipur
To assess the impact of rising temperature on open water evaporation in different climatic regions of India	Analysis has been carried out for Udaipur
To compare the variation in impact on open water evaporation under different climatic settings	To be taken up towards end of the study

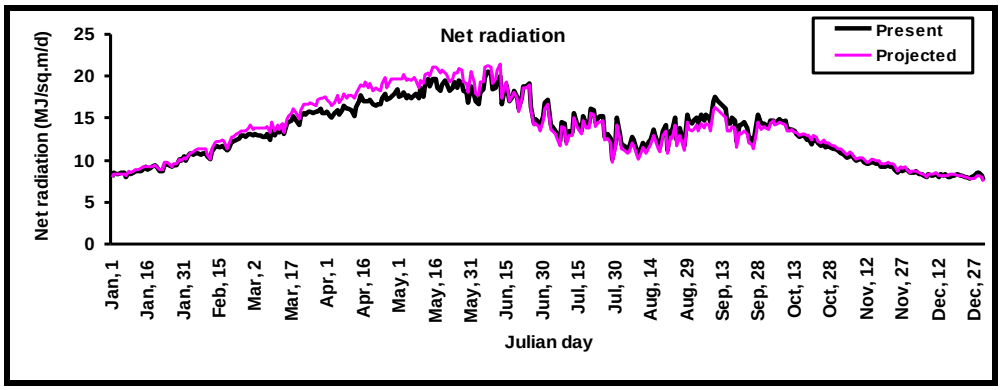
Recommendations/suggestions in previous meetings of Working Group/TAC:

No specific comments were made by either Working Group / TAC.

Analysis and Results

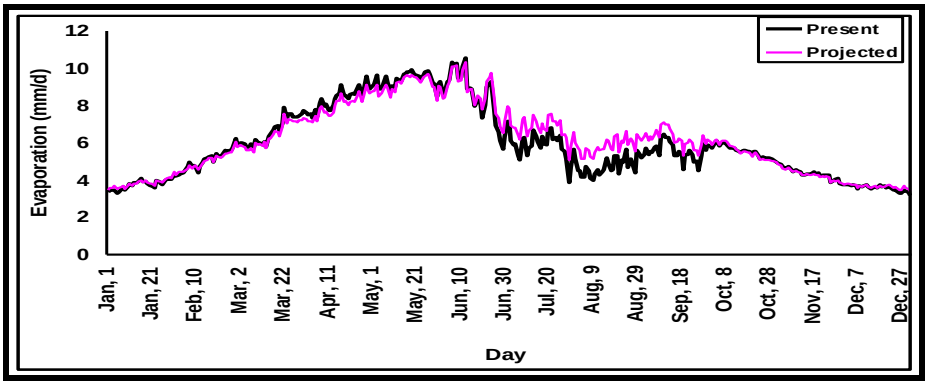
The analysis reveals that an increase in mean temperature would cause significant changes in the regimes of various meteorological parameters. For 1^0C rise in temperature, the mean absolute percent change is expected to be 2.67% for T_{max}, 12.47% for T_{min}, 5.36 % for

saturation vapour pressure. A shift in occurrence of peak of actual vapour pressure (e_a) is also expected. Very high variations in vapour pressure deficit (VPD) are expected during monsoon. Daily values of net long-wave radiation are expected to vary from -36.67% (decrease) to 48.4% (increase). However, the changes in net radiation are not expected to be very profound, except for summer.



Projected variations in radiation parameters

As a result of the projected changes in regimes of various meteorological parameters due to 1^0C hypothetical rise in temperature, daily evaporation rates for the study area are expected to rise significantly (upto 30%) during the monsoon and to some extent (upto 8%) during the winter. However, they are expected to fall by about 5% during the summer. Further, it has been observed that the changes in evaporation regime would be influenced most by the changes in the regime of vapour pressure deficit, followed by T_{max}, R_{nl}, e_s and R_n in that order.



Present versus projected evaporation

Adopters of the results of the study and their feedback:

Water resources managers, as well as researchers working in the area of climate change

List of deliverables:

Projected rates of evaporation for different assumed rise of temperatures for different climatic regions of India, report, papers, methodology

Major items of equipment procured: None

Lab facilities used during the study: None

Data procured and/or generated during the study:

Meteorological data already available for Udaipur station have been used so far. Data for other stations are being procured.

Study Benefits/Impact:

The study would provide projected rates of evaporation for different assumed rise of temperatures for different climatic regions of India

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

The output from the study is expected to assist the water resources planners/managers in planning/managing future demands from open surface water bodies such as lakes and reservoirs by providing them with projected rates of evaporation for the regions.

Shortcomings / difficulties, if any: None so far

Future plan:
The study is to be carried out for few more regions of India.

Annexure - 4

ACTIVITY SCHEDULE FOR ASSESSMENT OF SENSITIVITY OF OPEN WATER EVAPORATION TO INCREASE IN TEMPERATURE FOR DIFFERENT CLIMATIC REGIONS OF INDIA

S. No.	Activities	Quarters							
		1	2	3	4	5	6	7	8
1.0	**PREPARATORY WORK**								
1.1	Selection of study area	√							
1.2	Review of literature	√	√	√	√				
1.3	Identification of data requirement	√							
1.4	Collection and compilation of data	√	√						
2.0	**DATA INTERPRETATION AND ANALYSIS**								
2.1	Impact of temperature rise on various meteorological parameters in different climatic settings			√	√				
2.2	Impact of temperature rise on evaporation in different climatic settings					√	√		
2.3	Comparison of variation in impact of temperature rise on evaporation of different climatic regions						√	√	
3.0	**PROJECT REPORT**								√

5. REFERENCE NUMBER: NIH/HID/DST/2007-13

Title of the study: **NATIONAL PROGRAM ON ISOTOPE FINGERPRINTING OF WATERS OF INDIA (IWIN)**

Name of PI, Co-Pi and his affiliations:
Dr. M. S. Rao (PI)
Dr. Bhishm Kumar
Dr. Sudhir Kumar
Dr. S. P. Rai
Mr. S. K. Verma
Mr. Pankaj Garg

Type of study : Sponsored (funded by DST vide IR/54/ESF/05-2004 dated July17, 2007)

Date of start: July, 2007

Scheduled date of completion: July, 2013

Location map: Samples are collected by NIH from 8 sites (Roorkee, Sagar, Jammu, Kakinada, Tezpur, Kanpur, Manali and Patna) and member organizations collect samples from 85 sites all over India.

NIH-IWIN SAMPLING LOCATIONS MAP

Location	Altitude (m)	Distance from Sea (km)	Starting Date
Roorkee	268	1545	Jul. 2007
Sagar	527	867	Apr. 2008
Jammu	292	1973	Apr. 2010
Kakinada	2	19	May 2010
Tezpur	48	640	May 2011
Kanpur	128	957	Jul. 2011
Manali	3000	1610	Sep.2011
Patna	53	550	Jun. 2012

Study objectives (NIH+IWIN members) :

Identifying regional/local water vapour components in the local atmosphere.

Residence time and exchange estimate of vapour/water in different hydrological units.

Identifying dominant sources of water vapour supply (Arabian sea/ Bay of Bengal/ local and long distant continental sources) during different

seasons, isotopic database development.

Statement of the problem: To identify the source of air moisture during different seasons and isotopic database development. To support the sample analysis of IWIN members.

Approved action plan

Year	October 2012 to June 2013 (Annexure-5)	Remark
Oct. 12 - Jun. 13	**Sampling (from network of stations to achieve the objectives of the project)**: **At Roorkee**: (1) Rain (event based), (2) ground level vapour (GLV) by condensation and P&T methods (daily), (3) groundwater and (4) surface water (river Ganga) **At Sagar**: Items 1-3, as at Roorkee (GLV by cond.) **At Jammu**: Items 1-3, as at Roorkee (GLV by cond.) **At Kakinada**: Items 1-2, as at Roorkee (GLV by cond.) **At Tezpur University**: Item 2, as at Roorkee (GLV by cond.) **At IIT-Kanpur**: Item 2, as at Roorkee (GLV by cond.) **At MMHP, Manali (HP)**: Items 2, as at Roorkee (GLV by cond.) **At Patna**: Items 2, as at Roorkee (GLV by cond.) **Data Collection**: Hydro-meteorological at Roorkee, Sagar, Jammu, Kakinada, Tezpur, Kanpur, Manali and Patna. **Analysis**: Analysis of water samples (Roorkee, Sagar, Jammu, Kakinada, Tezpur, Kanpur, Manali and Patna) and samples provided by participating organizations for δD, $\delta^{18}O$ and ^{3}H. **Data interpretation** **Report writing**	Report preparation as per Annexure-5

Timeline and justification for time over runs: NA (program is going as per schedule)

2-column table showing objectives vis-à-vis Achievements:

Objective	Status	Work Done
Identifying regional/local water vapour components in the local atmosphere	Achieved	Reported in the last Working Group (qualitatively resolved the regional/local water vapour components in the local atmosphere).

Identifying dominant sources of water vapour supply (Arabian sea/ Bay of Bengal/ local and long distant continental sources) during different seasons	In Progress	GLV samples for isotopic analysis from network of stations are being collected. A few samples have been analysed, as the instrument was not functional during most part of the period under reporting.
Isotopic database development	In Progress	Isotopic database has been developed for approximately 22000 samples = 8200 (NIH) + 13800 (PRL)

Recommendations/suggestion in previous meeting of Working Group :

Suggestions by Dr. R. D. Deshpande

1. To record the value of rain along with the depletion of GLV.
2. To present the data obtained by P&T method along with the condensation method

Action Taken

The isotopic value of GLV starts depleting a few days before the arrival of rain (or rain event) and reaches to its saturation during rainy time.

The data obtained by P&T method is plotted along with the condensation method and will be shown during the working group presentation.

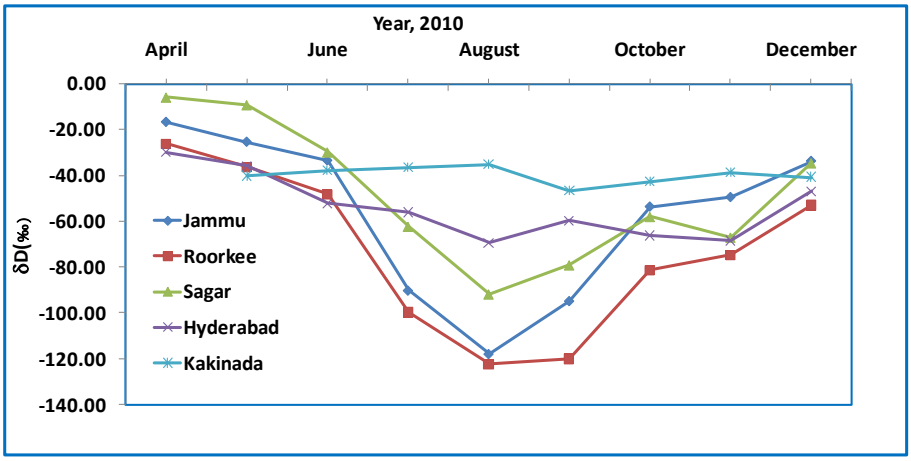
Analysis and Results:

Collected 1123 samples since April 2012. However, only a few of these could be analysed as the system was not functional for most part of this period.

A new station at CFMS, Patna was established in May 2012 for collection of air moisture samples.

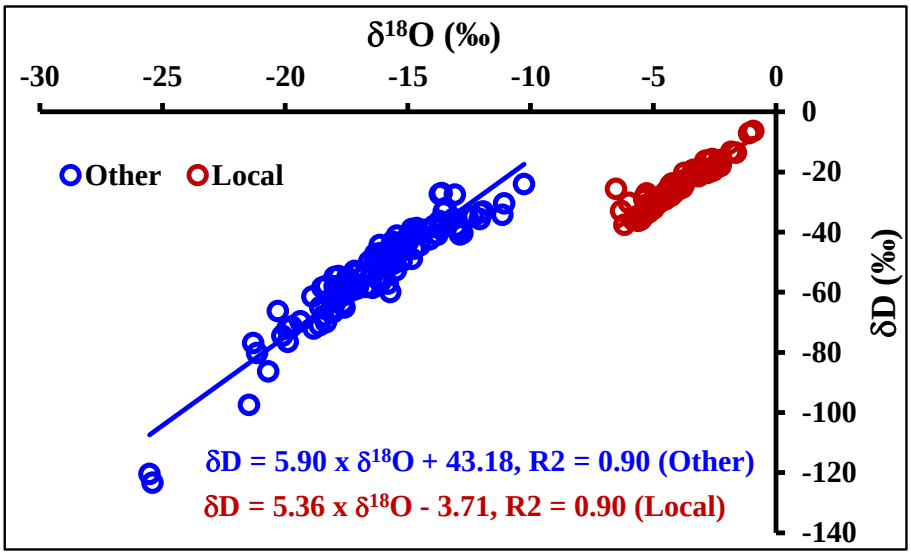
Establishing a new station at Patna for air moisture sampling

- The time variation of atmospheric vapour (δD) in the year 2010 from April to December observed at the stations Roorkee, Sagar, Jammu, Hyderabad and Kakinada shows similar annual cyclic variation of isotopic composition of air moisture at all the stations. The extent of isotopic depletion in GLV increased with increase in distance from the coast.



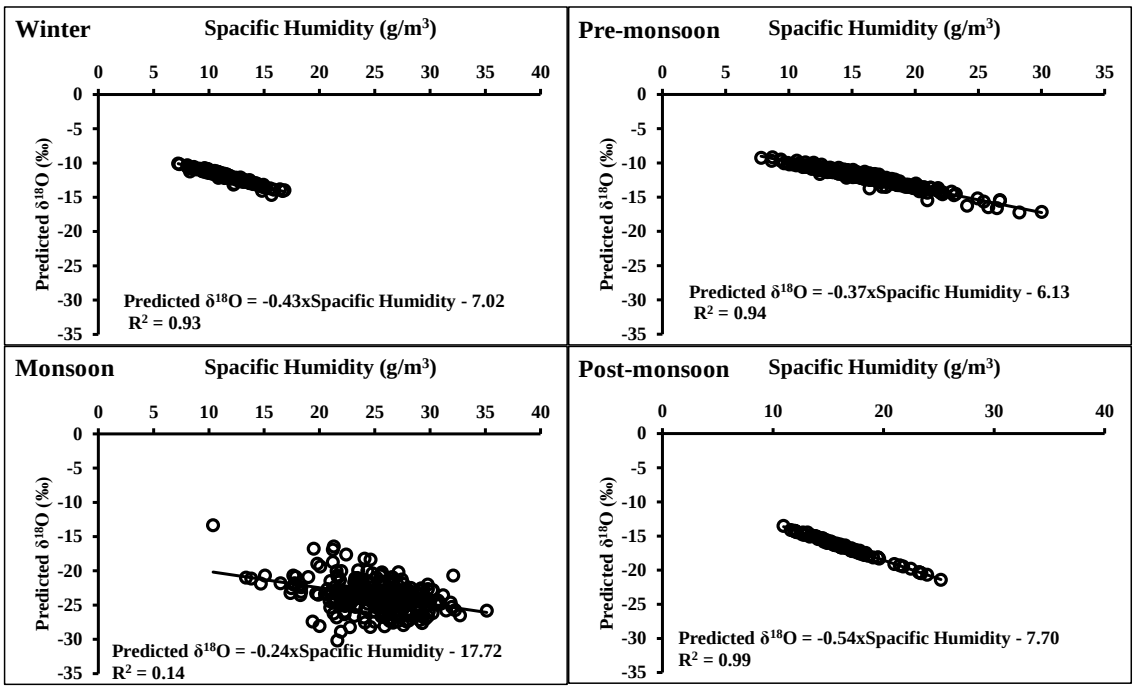
Variation in isotopic composition (δD) at Roorkee, Jammu, Sagar, Hyderabad and Kakinada (2010)

- In Kakinada, two vapour sources (inland and marine) are clearly distinguished, as shown in the figure below throughout the year.



Variation in air moisture sources at Kakinada

A good correlation is observed between specific humidity and $\delta^{18}O$ of $GLV_{cond.}$ throughout the year except during monsoon season (figure below). A reverse of this feature (i.e. a good correlation only during monsoon) is observed between saturation index and $\delta^{18}O$ of $GLV_{cond.}$.



Relationship of isotope with specific humidity

Adopters of the results of the study and their feedback

The IWIN project is a national level program in which various academic institutions, national level organizations including MoWR are participating. A network of stations has been developed and results of the study are commonly getting shared. The program is also generating technical papers in high impact journals and through which the knowledge will be

transpired to various other institutions nationally and globally.

List of deliverables:

Publications:

- Rao, M. S., Krishan, Gopal, Kumar, Bhishm, Anitha, M., Kumar, Kiran B., and Nagabhushanam, P. 2012. Stable isotope systematics of atmospheric vapour at Hyderabad and Roorkee. *International Journal of Earth Sciences and Engineering* (in press).

- Krishan, Gopal, Rao, M. S. and Kumar, Bhishm. 2012. Study of climatological conditions using isotopic signature of air moisture at Roorkee, Uttarakhand, India. In: Proceedings of International Conference "India Water Week 2012 – Water, Energy and Food Security: Call for Solutions" (IWW-2012), 10-14 April 2012, New Delhi, India. pp. 231-232.

- Krishan, Gopal, Rao, M. S., Jaiswal, R. K. and Kumar, Bhishm. 2012. Observation of monsoon dynamics between Roorkee and Sagar using isotopic techniques. In: National Seminar on "Application of isotopes & radiation technology for societal benefits" (AIRTS-2012), 21-23 June 2012, Bangalore University, India, pp. 47.

- Rao, M. S., Krishan, Gopal, Kumar, C. P., Tripathi, Shivam and Kumar, Bhishm. 2012. A pre feasibility study of isotopes for investigation of monsoon dynamics. In: Proceedings of International Symposium on Hydrology and Water Resources (HWRS-2012), 19-22 November 2012, Dockside, Cockle Bay Sydney, NSW, Australia (accepted).

- Krishan, Gopal, Rao, M. S., Garg, Pankaj and Kumar, C. P. 2012. An investigation on continental scales and altitude effect on isotopic composition (δD) of ground level vapour (GLV). In: Proceedings of International Conference of Annual Water Resources Association (AWRA) during 12-15 November, 2012 to be held at Jackson Villa, Florida (accepted).

Reports:

- Submitted annual report of the year 2011-12 to the funding agency (DST-SERC).

Trainings:

25 technical persons have been trained at various stages of the project.

Major items of equipment procured	**:**	Nil
Lab facilities used during the study	**:**	Hydrological Investigations Division
Data generated during the study	**:**	Isotope database for stations at Roorkee, Sagar, Jammu, Kakinada, Kanpur, Tezpur, Manali and Patna

Study Benefits / Impact :

The results of the project may be used in developing a new way to understand Indian meteorology and climate change through isotopes in ground level vapour. The temperature dependant isotopic behavior in the condensation process may provide new insight in basic physics, which were not observed or reported earlier.

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

Participating Organizations: Anna University, BARC, CGWB, CPCB, CWC, CWRDM, IMD, IIT-Kharagpur, NGRI, NIO, NRL-IARI, PRL, CRIDA

Shortcomings / difficulties, if any:

The rate for the sample collection, that was fixed in 2007 and still continuing, needs to be enhanced.

Future plan:

- ❖ The sampling of GLV, rain, river and groundwater will continue in this year.
- ❖ Scientific/technical publication/reporting in consultation with IWIN Secretariat.

Annexure – 5

ACTIVITY SCHEDULE FOR NATIONAL PROGRAM ON ISOTOPE FINGERPRINTING OF WATERS OF INDIA (QUARTER WISE FROM OCTOBER 2012 TO JUNE 2013)

Activity	1st	2nd	3rd
Sampling from all stations (8) of NIH (air moisture, groundwater, precipitation)	♦	♦	
Collection of data from IMD	♦		
Isotopic analysis (δD and $\delta^{18}O$) of samples	♦		
Water quality analysis of SW and GW samples	♦		
Isotopic analysis (δD and $\delta^{18}O$) of SW and GW samples	♦		
First Draft Report	♦		
Second Draft Report	♦	♦	
Final Report	♦	♦	♦

6. ***REFERENCE NUMBER: NIH/HID/HP-II/2009-13***

Title of the study: **GROUNDWATER DYNAMICS OF BIST DOAB AREA,PUNJAB, USING ISOTOPES (PDS UNDER HP-II)**

Name of PI, Co-PI, & their affiliations: Dr. M. S. Rao (PI)
Dr. Bhishm Kumar
Dr. Sudhir Kumar
Mr. S. K. Verma
Mr. Pankaj Garg
CGWB Officials

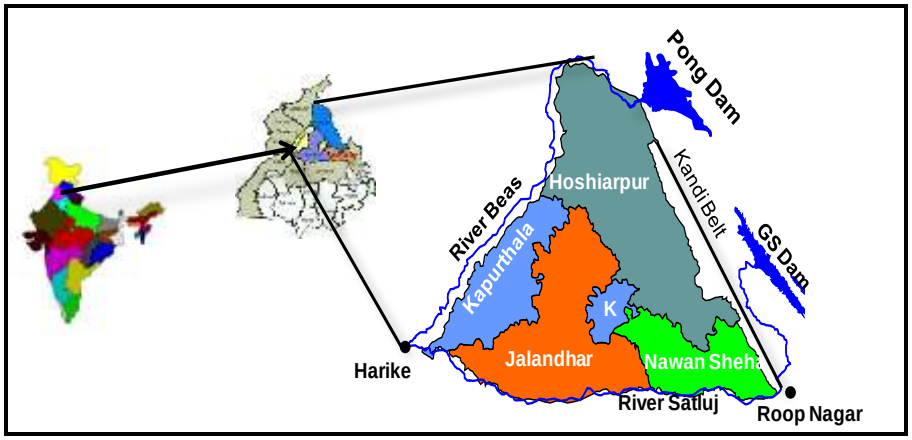
Type of study (sponsored /consultancy /referred /internal): Sponsored (PDS under HP-II)

Date of start: 1st July, 2009

Scheduled date of completion: 31st December, 2013

Location map (wherever applicable):

➢ The Bist Doab is a triangular region and covers an area of 9060 km^2. The area lies between $30^0$51' and $30^0$04' N latitude and $74^0$57' and $76^0$40' E longitude. It comprises the Hoshiarpur, Kapurthala, Jalandhar and Nawanshahar districts and parts of the Roop Nagar district of Punjab State, India. It is bounded by Shiwaliks in the north-east, the river Beas in the north east - south west and the river Satluj in south east - south west. The area is drained by the perennial rivers Satluj and Beas and their tributaries. They coalesce at Harike. The climate of the area is influenced by the Himalayas in the north.



Study objectives:

- Identifying groundwater recharge zones and recharge sources using groundwater dating and stable isotope technique.

Statement of the problem:

The Bist-Doab region, the region between river Satluj and river Beas, experiences high amount of groundwater depletion due to increased agricultural activities. Hence, it is imperative to identify the recharge zones and recharge sources of groundwater.

Approved action plan: See Annexure 6

Timeline and justification for time over runs: NA

2-column table showing objectives vis-à-vis achievements (clearly separate achievements reported in the previous meetings):

Objective	Status	Work Done
Identifying groundwater recharge zones and recharge sources using groundwater dating and stable isotope technique and groundwater modelling	Recharge sources and zones of shallow and deep groundwater have been refined.	704 samples (SW, GW and rain) have been collected after last Working Group meeting making total of 3761 samples collected during the entire study period. Analyses of the collected water samples for isotopic and environmental tritium are in progress. The groundwater samples collected during pre & post monsoon periods of 2011 have been analysed for water quality using Ion Chromatograph, interpretation of data is under progress. The data collected from AWLR for 6 stations have been analysed. On the basis of isotopic and conventional data, physical understanding of groundwater flow conditions has been developed. An interim report has been prepared as a part of the final report. The report discusses the earlier available data in the Bist-Doab region, consisting of detailed summary with 26 figures and 15 tables (88 pages).
	In progress	Analyses of water samples for stable isotopes, environmental tritium and Carbon dating. The data (including AWLR from 6 stations) and phenomenological understanding of groundwater flow will be integrated for hydrological modelling of the study region.

Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken: Nil

Analysis and Results:

Isotopic characterization of sources

- On the basis of water sampled from different types of water sources of the study area, the isotopic characteristic of these sources have been deciphered and given in Table 1. The inferences drawn from these isotopic characteristic equations are:

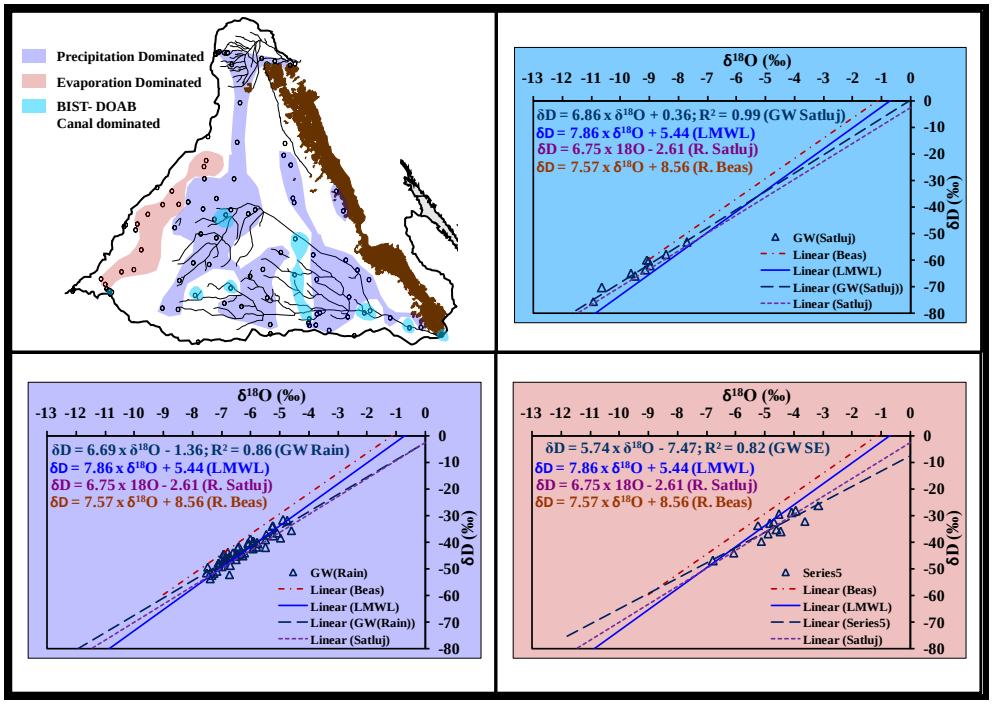
- The deep groundwater gets recharged mainly through Kandi canal which is evidenced from the similar regression equation of precipitation at Kandi region and deep groundwater.

Table - Isotopic characterisation of sampled water

Sampled Water Type	Equation (Refined using the new data set)
Precipitation (All)	$\delta D = 7.86 \times \delta^{18}O + 5.44$; $R^2 = 0.98$
Precipitation (at Kandi)	$\delta D = 7.85 \times \delta^{18}O + 5.82$; $R^2 = 0.98$
Precipitation (at Plain)	$\delta D = 7.87 \times \delta^{18}O + 5.07$; $R^2 = 0.98$
River Beas	$\delta D = 7.57 \times \delta^{18}O + 8.56$; $R^2 = 0.90$
River Satluj	$\delta D = 6.75 \times \delta^{18}O - 2.61$; $R^2 = 0.94$
Shallow Groundwater (Bist-Doab Canal)	**$\delta D = 6.86 \times \delta^{18}O + 0.36$; $R^2 = 0.99$**
Shallow Groundwater (Precipitation)	**$\delta D = 6.69 \times \delta^{18}O - 1.36$; $R^2 = 0.86$**
Shallow Groundwater (Evap. Enrichment)	**$\delta D = 5.74 \times \delta^{18}O - 7.47$; $R^2 = 0.82$**
Deep Groundwater	$\delta D = 7.73 \times \delta^{18}O + 5.63$; $R^2 = 0.95$

(Text in bold are new equations based on recently processed data)

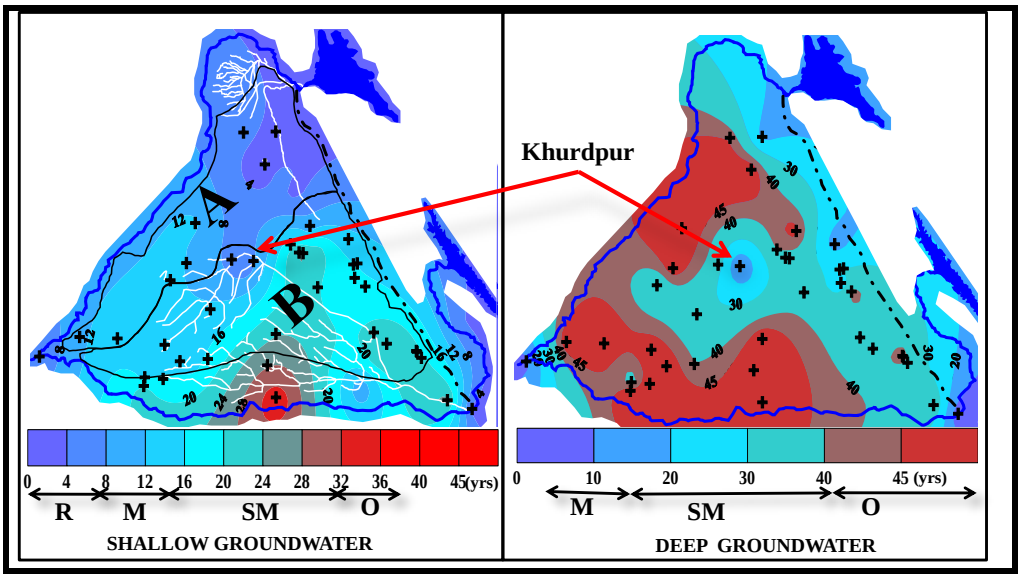
- The shallow groundwater gets recharged (figure below) mainly through precipitation and to minor extent from river Beas, Kandi canal and Bist-Doab canal in the adjoining areas (few hundred metres).



Sources of recharge to shallow groundwater using stable isotopes (included the recently processed data)

Groundwater Age

- The groundwater in shallow aquifer is younger in northern part, in eastern part (at Ropar region) and also at Harike where rivers confluence. Both shallow and deeper aquifers are younger at Kandi region. The shallow aquifer is being recharged by Kandi canal in north and river Satluj at Ropar. The Kali Bein act as a recharge source throughout its course i.e. from northern part of the region to Harike. Bist-Doab canal recharges shallow groundwater at few locations at Nakodar, Nawanshahar and Balachaur region. Older nature of shallow groundwater in central part of southern region is due to the presence of clayey layer.
- The presence of dams in this region act as recharge sources for deeper aquifer. The deeper aquifer in central region of study area is connected with Kandi region.



Spatial distribution of groundwater age in shallow aquifer and deeper aquifer
(A: Kali bein catchment, B: White bein catchment)

Adopters of the results of the study and their feedback:

- CGWB (NWR), Chandigarh; Punjab Water Resources Development & Management; and Punjab Water Resources & Environment Directorate, Chandigarh.

List of deliverables

(i) Mapping the groundwater flow regime in Bist-Doab region, Punjab, India using environmental tritium. National Seminar on Applications of Isotopes and Radiation Technology for Societal Benefits (AIRTS- 2012), 21- 23 June, 2012, Bangalore University, Bangalore

(ii) Assessment of groundwater resources and quality in Bist-Doab region, Punjab, India. International SWAT Conference. 18- 20 July 2012, IIT Delhi, New Delhi

(iii) Hydrochemical characteristics and groundwater quality in Jalandhar and Kapurthala districts, Punjab, India. International Journal of Earth Science & Engineering (accepted)

(iv) Hydrogeochemical and isotopic evidence of groundwater in different aquifers for its evolution and source. Journal of Earth System Sciences (under review)

(v) Organized a training workshop during 27- 30 July 2012.
(vi) Prepared an interim report and will be presented in the working group.

Major items of equipment procured: Nil

Lab facilities used during the study: Laboratory facility at the division has been utilized.

Data procured and/or generated during the study:

- Entire isotopic data has been generated through field sampling and their laboratory analysis. Water level data has been generated through AWLR installed in piezometers at 6 locations in the study area.

Study Benefits / Impact:

- The study is progressing in association with PWR&ED and CGWB. Both the departments will be benefitted through the study results.

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

- CGWB (NWR), Chandigarh; Punjab Water Resources Development & Management; Punjab Water Resources & Environment Directorate, Chandigarh; and Punjab Water Supply and Sanitation Department, Jalandhar.

Shortcomings / difficulties, if any:

- Aquifer specific water sampling from deep piezometers
- Water quality data of the study region (other than southwestern region) is yet to be received from CGWB.

Future plan:

- Analysis of 704 samples, which were collected during March 2012, for stable isotopes
- Analysis of GW, SW samples for environmental tritium and Carbon-14 dating
- Construction of deep piezometers
- Aquifer Disposition Map
- Final report and publication of research articles in Journals and Conferences.

Annexure - 6

ACTIVITY SCHEDULE FOR GROUNDWATER DYNAMICS OF BIST-DOAB AREA, PUNJAB, USING ISOTOPES (PDS UNDER HP-II)

Activity	2012	2013			
Month/Quarter ⟶	Nov.-Dec.	1st	2nd	3rd	4th

Activity	2012	2013			
Month/Quarter ⟶	Nov.-Dec.	1st	2nd	3rd	4th
Sample collection of groundwater, surface water, precipitation	✓	✓	✓		
Surface water and groundwater data processing	✓	✓	✓	✓	
Construction and installation of piezometers at 6 locations (3 in Kandi and 3 in plain region) and water sampling & analysis	✓	✓	✓	✓	
Identification of recharge zones and recharge sources	✓	✓			
Integration of water quality, stable and radioactive isotope data, field data, along with modelling to develop a general scenario for groundwater flow in aquifers			✓	✓	
Publications and reporting in Conferences	✓	✓	✓	✓	✓
Preparation of final report				✓	✓

7. REFERENCE NUMBER: NIH/HID/HP-II/2009-14

Title of the study: **GROUNDWATER MANAGEMENT IN OVER-EXPLOITED BLOCKS OF CHITRADURGA AND TUMKUR DISTRICTS OF KARNATAKA**

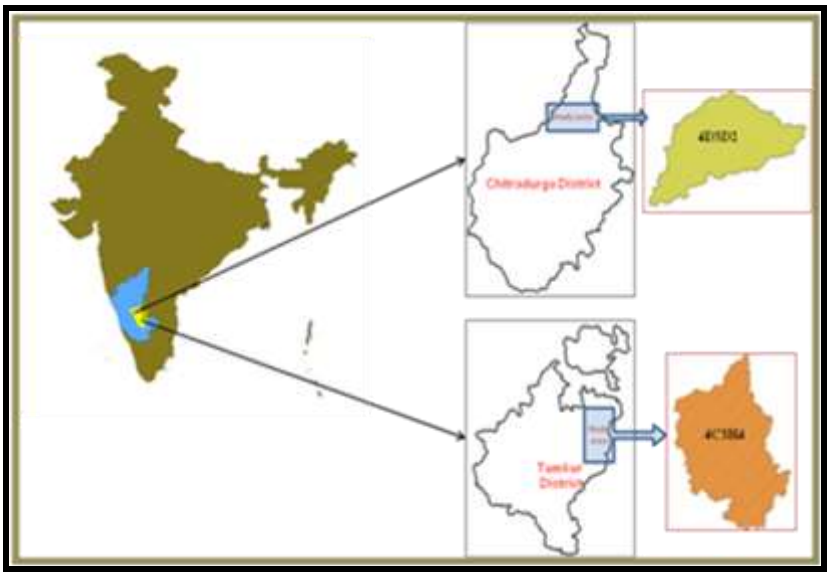
Name of PI, Co-PI, & their affiliations:
Dr. Sudhir Kumar (PI)
Dr. J. V. Tyagi
Dr. S. P. Rai
Dr. Anupma Sharma
Dr. B. K. Purandara (HRRC, Belgaum)
Prof. C. Rangraj (SSIT, Tumkur)

Type of study: Sponsored (PDS under HP-II)

Date of start, scheduled date of completion:

Start Date: 1st July 2009
Expected end date: 31st March 2014

Location map (wherever applicable):



Study objectives:

i) To analyze groundwater productivity at specific study sites including artificial recharge structures and an assessment of potential increases and their contribution to rural livelihood improvement.
ii) To develop integrated understanding of hydrologic, social, economic, and institutional perspectives.
iii) To improve stakeholder engagement and community participation for developing a common vision, goal and partnership for managing basin's groundwater resources.

iv) To identify anthropogenic interventions and evaluate their likely impact for effective groundwater management.
v) To arrive at a model for management and regulation of identified over-exploited blocks on an operational basis.

Statement of the problem:

Today groundwater resources are exploited as a common pool resource in an open access framework by one and all. This has resulted in over exploitation of groundwater resources leading to falling groundwater levels and deterioration of groundwater quality. There is an urgent need for formulations of guidelines for management of groundwater, particularly in hard rock areas, where water table is declining rapidly.

Approved action plan: Please see Annexure 7.

Timeline and justification for time over runs:

The procurement of data and instruments has delayed the work schedule. Non availability of adequate and reliable historical hydrological data has hampered the analysis work.

2-column table showing objectives vis-à-vis achievements (clearly separate achievements reported in the previous meetings):

Objective	Achievement
To analyze groundwater productivity at specific study sites including artificial recharge structures and an assessment of potential increases and their contribution to rural livelihood improvement.	Work in progress
To develop integrated understanding of hydrologic, social, economic, and institutional perspectives.	Work in progress
To improve stakeholder engagement and community participation for developing a common vision, goal and partnership for managing basin's groundwater resources.	Work in progress
To identify anthropogenic interventions and evaluate their likely impact for effective groundwater management.	Work in progress
To arrive at a model for management and regulation of identified over-exploited blocks on an operational basis.	Work in progress

Recommendations/suggestions in previous meetings of Working Group/TAC:

No specific comments were made by either GB / TAC.

Analysis and Results

- Hydrometeorological instruments (evaporation pan, soil moisture sensors and rain gauge) and automatic groundwater level recorders were installed in the field. Evaporation rates vary from 2 mm to 8 mm per day in these watersheds. Rainfall is very erratic, both in space and time.

- GIS database has been prepared for both the watersheds including base map, drainage map, road map and water storage structures maps etc.
- Infiltration tests have been conducted at 16 locations in both the watersheds. Low infiltration rates observed in the bottom of tanks indicate chocking of tank beds. Experiment in one rejuvenated tank is under progress.
- Water level data (depth to water level and reduced water level) and rainfall data have been collected for 14 observation wells in Chitradurga watershed (till 2011) and 15 in Tumkur watershed (upto 2011) and contours prepared. Water table fluctuates with the amount of rainfall.
- About 60 groundwater samples from Chitradurga and Tumkur watershed have been collected and analysed for stable isotopes of hydrogen and oxygen. The results indicate that irrigations tanks are not much recharging the groundwater.
- Resistivity survey has been conducted at 18 sites in both the watersheds. The results indicate availability of water in thin bands.
- Pump tests have been conducted at 4 locations. The results indicate low hydraulic conductivity.
- Socio-economic survey has also been conducted. The results are being analysed. More people are to be surveyed to reach at some conclusion.

Adopters of the results of the study and their feedback: Karnataka Government, the States with hard rock aquifers.

List of deliverables: Report, papers, methodology, brochure and training program.

Major items of equipment procured: Automatic Rain Gauges, Evaporation Pan, Soil Moisture Probes, Automatic Groundwater Level Recorders.

Lab facilities used during the study: Isotope laboratory, Soil Water laboratory and Hydrological Investigations laboratory.

Data procured and/or generated during the study:

Procured: Remote sensing data, geological maps of the area
Generated: Isotopic data and aquifer parameters of the aquifers

Study Benefits/Impact: Some scientific knowledge and data about hydrology of hard rock area, particularly granitic areas of India.

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

The output from the study is expected to provide policy guidelines for developing, managing and regulating groundwater resources on a sustainable basis for over exploited regions.

Shortcomings / difficulties, if any:

Delay in procurement of data and instruments, lack of historical data and reliability of data.

Future plan:

The field activities are to be finished by Dec 2012/Jan 2013. A training course on "Hydrological Investigations and Water Management in Hard Rock areas" shall be organised in Bangalore / Tumkur during November / December 2012.

Annexure - 7

ACTIVITY SCHEDULE (Quarter wise) for GROUNDWATER MANAGEMENT IN OVER-EXPLOITED BLOCKS OF CHITRADURGA AND TUMKUR DISTRICTS OF KARNATAKA

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
Selection of watersheds	♦	♦										
Reconnaissance surveys		♦	♦									
Data collection (Historical)		♦	♦									
Problem conceptualization			♦	♦								
Meetings with participating agencies	♦	♦										
Appointment of project staff	♦	♦	♦									
Procurement of equipment	♦	♦	♦	♦								
Socio-Economic analysis									♦	♦		
Installation of equipment					♦	♦						
Procurement of software				♦	♦	♦						
Database development			♦	♦	♦	♦	♦	♦	♦			
Field interventions to promote artificial recharge								♦	♦	♦	♦	
Development of conceptual model									♦			
Development of groundwater utilization guidelines										♦	♦	
Capacity building and training programs								♦	♦			♦
Report writing											♦	♦

8. PROJECT REFERENCE CODE: NIH/HID/FRI/2008-13

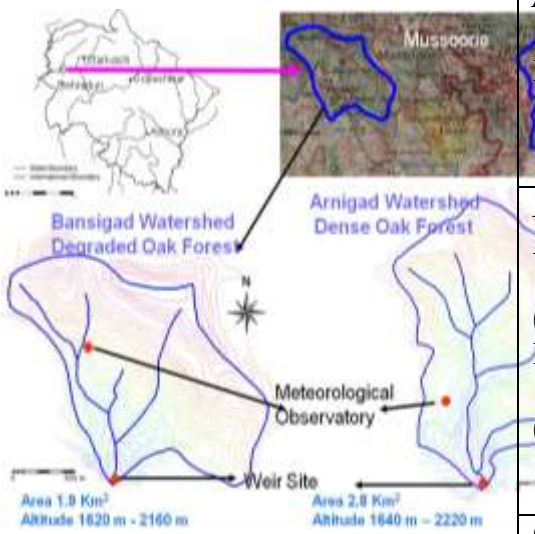
Title of the study : **IMPACT ASSESSMENT OF LANDUSE ON THE HYDROLOGIC REGIME IN THE SELECTED MICRO-WATERSHEDS IN LESSER HIMALAYAS, UTTARAKHAND**

Name of PI, Co-PI, & their affiliations :
Dr. S. P. Rai (PI)
Dr. J. V. Tyagi
Mr. M. P. Singh (FRI)
Mr. Rajeev Tiwari (IGNA)
Mr. Vishal Gupta
Mr. Jamil Ahmad
Mr. V. K. Agarwal

Type of study (sponsored/ consultancy/ referred/ : Collaborative with FRI, Dehradun
Total: Rs. 3 lac (NIH Component)

Date of start, scheduled date of completion : April, 2008 to March 2013

Location map:



Area of watershed Arnigad Bansigad	 ~3 km^2 ~2 km^2
Landuse Arnigad Forest Cover (Dense Oak) Bansigad Forest Cover (Sparsed Mixed)	 86% 65%
Geology of both watersheds	Similar
Geomorphology	Almost similar
Altitude variation Arnigad Bansigad	 1640-2220 m 1620-2160 m

Study objectives

- Impact of forest cover on stream discharge pattern
- To separate surface runoff and groundwater components in the stream discharge using

conventional and isotopic techniques
- Soil erosion under different forest covers
- Identification of recharge zones of streams and springs using isotopic technique

Statement of the problem

Efforts to understand the hydrology of the Himalayan region and impact of forests on watershed level are limited. Studies on the hydrology of the Himalayan mountains have made it clear that the hydrological research conducted in this region so far is inadequate to conclude the impact of forest cover. Because major studies conducted at the experimental plots do not necessarily hold true at the catchment scales. Mainly the studies conducted on plot scale or small catchments of only a few hectares lack continuous data of extreme conditions so that unusual storm events are often not included in the study period. The impact of forests, which cover the head-waters of many of the major river systems of the Indo-Gangetic plains, could not be studied, mainly because of difficult terrain conditions and other logistical problems.

Therefore, to study the impact of forest cover on hydrology of Himalayan watersheds, this study was initiated in collaboration with Forest Research Institute, Dehradun.

Approved action plan **:** Please See Annexure 8

Timeline and justification for time over runs **:** March 2013

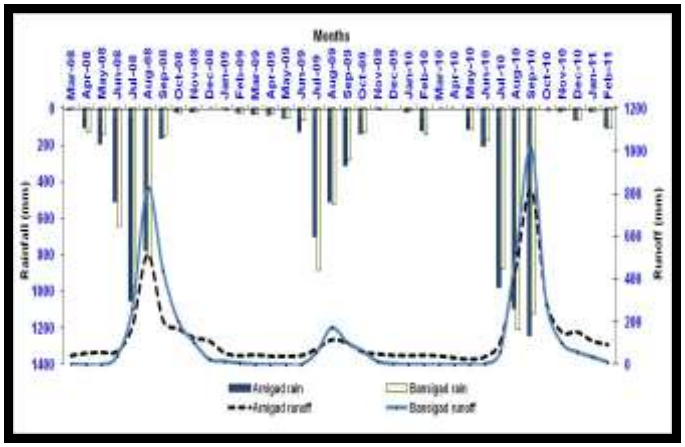
2-column table showing objectives vis-à-vis achievements **:**

Objective	Achievement
Impact of forest cover on stream discharge pattern	Data collection and analysis completed
To separate surface runoff and groundwater components in the stream discharge using conventional and isotopic techniques	Separation of base flow and surface runoff component completed
Soil erosion under different forest covers	Data analysis completed
Identification of recharge zones of streams and springs using isotopic technique	Isotopic technique has been used to identify the recharge zones of streams

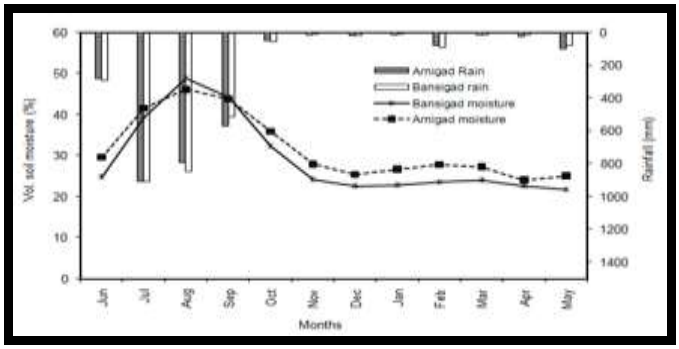
Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken : NIL

Analysis and Results :

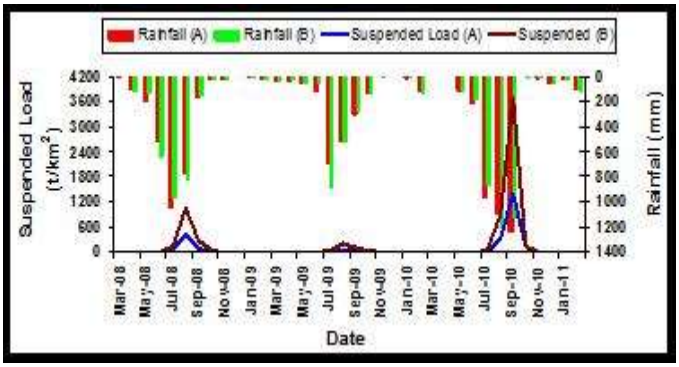
- Data of infiltration tests have been analysed under different landuse conditions.
- Analysis of soil moisture variation has been completed.
- Rainfall and runoff analysis on the monthly basis has been completed. Arnigad watershed discharged approximately 57% of the total runoff during monsoon season while degraded watershed discharged approximately 88% of total discharge. Other details will be presented during the working group.
- Analysis of sediment data is completed. On an average, during the study period 2008-2011, denudation rate is 0.32 mm/year in Arnigad watershed and 0.83 mm in Bansigad watershed.
- Rainfall-Runoff and soil loss modeling using SWAT model is in progress.
- Isotopic characterization of stream, rain and spring water has been completed. Results will be presented in the meeting.



Rainfall-Runoff of both watersheds



Soil moisture variation in degraded and dense forest cover area



Variation of Suspended sediment load with rainfall

Adopters of the results of the study and their feedback : R & D organizations, state forest departments, watershed conservation and management agencies

List of deliverables : Papers

Major items of equipment procured : NIL

Lab facilities used during the study : Isotope Laboratory and Hydrological Instrumentation Laboratory

Data procured and/or generated during the study : Hydrometeorological data and isotopic data generated for both the watersheds

Study Benefits / Impact :

Activity	Status
Selection of two watersheds under different forest covers	Completed
Instrumentation in both the watersheds	Completed
Identification of springs and handpumps	Completed
Geomorphological details	Completed
Geological details	Completed
Infiltration tests	Completed
Collection of SW and GW samples for water isotopic analysis	Completed
Collection of sediment data	Completed
Analysis of stable isotopes (δD and $\delta^{18}O$) of SW and GW samples	Completed
Assessment of impact of forest cover on stream discharge	Completed
Assessment of impact of forest cover on erosion	Completed
Estimation of sediment erosion using the SWAT model	Under progress

Specific linkages with Institutions and/or end-users/beneficiaries : FRI

Shortcomings/difficulties, if any : NIL

Future plan : Preparation of papers from the reports

Annexure – 8

ACTIVITY SCHEDULE (QUARTER WISE, FOR 2011-12 AND 2012-2013) FOR IMPACT ASSESSMENT OF LANDUSE ON THE HYDROLOGIC REGIME IN THE SELECTED MICRO-WATERSHEDS IN LESSER HIMALAYAS, UTTARAKHAND

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th
Collection of discharge data with the help of FRI	♦	♦	♦	♦	♦			
Collection of meteorological data with the help of	♦	♦	♦	♦	♦			

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th
FRI								
Identification of data gaps	♦							
Collection of water samples for isotopic (δD and $\delta^{18}O$) analysis	♦	♦	♦	♦				
Measurement of δD and $\delta^{18}O$	♦	♦	♦	♦	♦	♦		
Rainfall runoff analysis on monthly basis		♦	♦	♦				
Hydrograph separation using the isotopic data			♦	♦	♦	♦		
Establishment of altitude effect		♦	♦	♦				
Identification of recharge zones of springs and streams				♦	♦	♦		
Estimation of natural recharge to groundwater		♦	♦					
Creation of GIS data base for SWAT		♦	♦					
Analysis of data using SWAT			♦	♦				
Development of conceptual model				♦	♦			
Calibration of model					♦	♦		
First draft report						♦		
Second draft report							♦	
Final report								♦

9. REFERENCE NUMBER: NIH/HID/SPON/2010-13

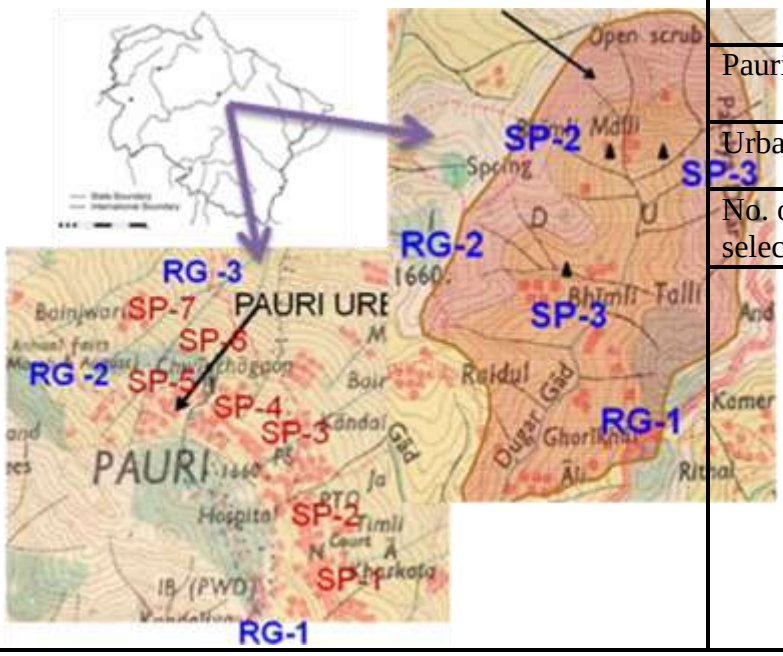
Title of the study : **DEVELOPMENT OF SPRING SANCTUARIES IN AN URBAN AND A RURAL WATERSHED IN DISTRICT PAURI GARHWAL, UTTARAKHAND**

Name of PI, Co-PI, & their affiliations : Dr. S. P. Rai (PI)
Dr. Sudhir Kumar
Dr. S. D. Khobragade
Mr. Pankaj Garg
Mr. Jamil Ahmad
Mr. Vishal Gupta

Type of study : Internal

Date of start, scheduled date of completion : April 2010, March 2013

Location map:

<table>
<tr><td rowspan="4"> 
</td><td colspan="2">Study Area</td></tr>
<tr><td>Pauri Town</td><td>Dugargad Watershed</td></tr>
<tr><td>Urban Area</td><td>Rural Area</td></tr>
<tr><td>No. of springs selected = 7</td><td>No. of springs selected = 3</td></tr>
</table>

Study objectives :

- To decipher the recharge zones of springs falling in the study area
- To analyse the relationship between rainfall, evaporation, landuse/land cover and ecological factors with spring discharge (GBPIHED, Srinagar)
- Formulation of strategies to implement spring

sanctuary strategy in the identified recharge areas in order to enhance the discharge

Statement of the problem : Groundwater flows in the form of springs and seepages in the hilly terrain. Springs are the major source of drinking and other household activities in the hilly terrain. The dwindling discharges of springs and spring fed streams in the populated Lesser Himalayan terrain of Western Himalayas has become a matter of serious concern. In this connection, Jal Sansthan Uttarakhand approached NIH for identification of recharge zones. GBPIHED, Srinagar Unit also approached NIH for collaborative study of recharge zones identification and implementation of recharge techniques. The fundamental question related to springs are:

- ❖ Where does the water originate?
- ❖ How fast is the water moving?
- ❖ How much water is flowing?
- ❖ Is discharge declining?
- ❖ How can we rejuvenate drying springs?

Approved action plan : Please See Annexure 9

Timeline and justification for time over runs : March 2013

2-column table showing objectives vis-à-vis achievements :

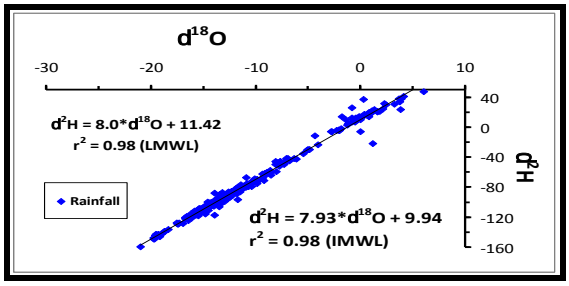
Objectives	Achievements
To decipher the recharge zones of springs falling in the study area	Springs have been selected from different parts of Pauri and Dugargad watershed. Hydrogeological map has been prepared.
To analyse the relationship between rainfall, evaporation, landuse/land cover and ecological factors with spring discharge	Rainfall and other data collected.
To implement spring sanctuary strategy in the identified recharge areas in order to enhance the discharge	Interpretation of results under progress for identification of recharge zones.

Recommendations/suggestions in previous meetings of Working Group/TAC/GB : NIL

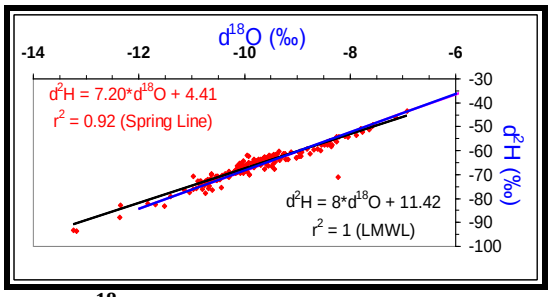
should be mentioned along with the action taken

Analysis and Results :

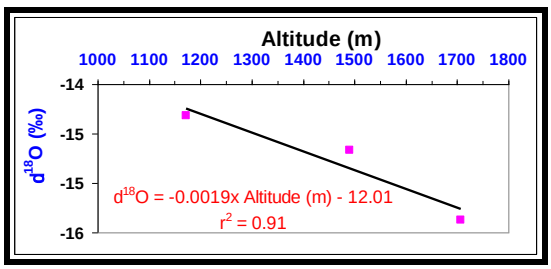
- The plot of δ^2H versus $\delta^{18}O$ for rainfall samples collected during June to September 2010 show the Meteoric Water Line (spring) as $\delta^2H = 8.0 \times \delta^{18}O + 11.4$, which is similar to IMWL .
- The plot of δ^2H versus $\delta^{18}O$ for all springs samples collected during June to September 2010 show the Meteoric Water Line (spring) as $\delta^2H = 7.20 \times \delta^{18}O + 4.41$, which is very close to LMWL
- Temporal variation of isotopic data of springs of Dugargad watershed shows depletion after the July. Maximum depletion is in the month of September. It indicates quick response of recharge in the springs.
- Similarly, springs samples collected from Pauri city show depletion after July and maximum depletion in the month of September.
- These results indicate that source of these springs is local precipitation.
- Altitude effect has been developed and determination of recharge zones of springs is under progress.
- The details of the study will be presented in the working group meeting.



Isotopic composition of rainfall in study area



δ^2H versus $\delta^{18}O$ of springs and rainfall in study area.



Altitude effect in study area

Adopters of the results of the study and their feedback : Jal Sansthan, Uttarakhand

List of deliverables : Papers

Major items of equipment procured : NIL

Lab facilities used during the study : Isotope Laboratory and Hydrological Instrumentation Laboratory

Data procured and/or generated during the study : Isotopic data of the springs and rainfall of study area

Study Benefits / Impact :

Activity	Status
Selection of sampling sites	Completed
Sample collection started since June 2010	Continued
Analysis of stable isotopes (δD and $\delta^{18}O$) of collected samples	Continued
Compilation of the results	In progress

Specific linkages with Institutions and/or end-users/ beneficiaries : NIL

Shortcomings/difficulties, if any : NIL

Future plan : To implement the findings in the study area

Annexure - 9

ACTIVITY SCHEDULE (QUARTER WISE, FOR 2011-12 AND 2012-2013) FOR DEVELOPMENT OF SPRING SANCTUARIES IN AN URBAN AND A RURAL WATERSHED IN DISTRICT PAURI GARHWAL, UTTARAKHAND

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th
Collection of spring, rainfall and stream samples for isotopic (δD and $\delta^{18}O$) analysis with the help of GBPIHED, Srinagar unit	♦	♦	♦	♦	♦	♦		
Measurement of δD and $\delta^{18}O$ in laboratory	♦	♦	♦	♦	♦	♦	♦	
Development of meteoric water line for spring, rainfall etc.			♦	♦		♦	♦	
Establishment of altitude effect				♦	♦			
Analysis of discharge data of springs and its relationship with isotope data			♦	♦		♦	♦	
Estimation of recharge zones					♦	♦		

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th
of springs								
Formulation of strategies for development of spring sanctuaries						♦	♦	
First draft report						♦		
Second draft report							♦	
Final report								♦

NEW STUDIES

10. ***REFERENCE NUMBER: NIH/HID/INT/2012-14/2***

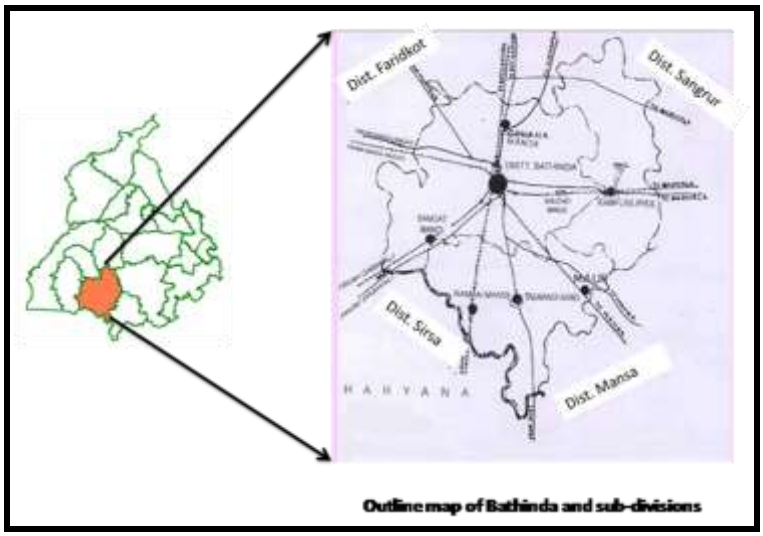
Title of the study : **WATER QUALITY, HYDROGEOLOGY AND ISOTOPIC INVESTIGATIONS IN SW PUNJAB**

Name of PI, Co-PI and their affiliations: Dr. M. S. Rao (PI)
Mr. C. P. Kumar
Dr. Gopal Krishan

Type of study: Internal

Date of start, **Scheduled date of completion:** July 2012, June 2014

Location map:



Outline map of Bathinda and sub-divisions

Study objectives:

i) To investigate the water quality in multi-aquifer system of Bhatinda and neighbouring area
ii) To map the groundwater age distribution and recharge zones
iii) Evaluation of groundwater quality in accordance with its source of origin and age
iv) To suggest the remedial measures to improve the groundwater conditions

Statement of the problem:

Electrical conductivity (EC) of groundwater in the district ranges from 312 to 5800 µS at 25^0C. Around 60% of the district area falls with EC value exceeding 2000 µS, whereas 20% of the district area falls with EC exceeding 3000 µS at 25^oC. The fluoride (F) values in some areas exceed values higher than 6 mg/l. Origin of high salinity and high fluoride in groundwater and its distribution in space is not well understood. In the present study, these aspects will be examined in detail for better prospects of groundwater utilization and future development.

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

Methodology:

In order to investigate the changing groundwater conditions (quality and quantity), water and soil samples will be collected and analysed for salinity, alkalinity and major anions - F, Cl, NO_3 and cations - Ca, Mg, Na. K using Ion Chromatograph. Stable isotopes and radiometric dating (tritium) of groundwater will be carried out to investigate the groundwater dynamics. Aquifer geometry, water quality, water table and isotopic details will be integrated to interpret the changing groundwater conditions and quality. The results will be provided in thematic maps for the user organizations for suitable management practices to overcome the deteriorating quality and improving the sustainability.

The area will be mapped geologically and based on the hydrogeological map, samples will be collected for isotopic and chemical analysis for pre and post monsoon seasons to identify monsoon effect on the groundwater conditions.

Action plan:

Year	**July 2012 to June 2014** (Annexure 10)	Remark
July 2012 to June 2014	Literature survey Groundwater inventory Identifying the sampling sites for isotopic and water quality analysis Data collection Water sampling, analysis and data interpretation Report writing	Report preparation as per Annexure 10

Study Benefits / Impact:

The work will be useful to the state water resource department and academic organizations, district administration etc.

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

Department of Geology, Punjab University, Chandigarh

Data requirement & expected source:

Hydro-meteorological data will be taken from the state departments.

IPR potential and issues: NIL

Major items of equipment needed: None

Annexure – 10

ACTIVITY SCHEDULE FOR WATER QUALITY, HYDROGEOLOGY AND ISOTOPIC INVESTIGATIONS IN SW PUNJAB (QUARTER WISE FROM JULY 2012 TO JUNE 2014)

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th
Sampling (groundwater, surface water, precipitation)		♦		♦		♦		
Collection of data	♦	♦	♦	♦				
Isotopic analysis (δD and $\delta^{18}O$) of samples			♦	♦	♦	♦		
Water quality analysis of surface water and groundwater samples			♦	♦	♦	♦		
Annual report					♦	♦		
Interim report						♦	♦	
Publications and reporting in conferences						♦	♦	♦
Final report							♦	♦

REFERENCE NUMBER: NIH/HID/IAEA/2012-13

Title of the study : THE USE OF ENVIRONMENTAL ISOTOPES TO ASSESS SUSTAINABILITY OF INTENSIVELY EXPLOITED AQUIFER SYSTEMS IN NORTH EASTERN PARTS OF PUNJAB, INDIA

Name of PI and members: Dr. M. S. Rao (PI)
Mr. C. P. Kumar
Dr. S. P. Rai

Type of study: Sponsored by IAEA, Vienna

Date of start, **Scheduled date of completion:** September 2012, August 2013

Location map:

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 areas where deep aquifers are getting modern recharge through their shallow aquifers.
4. Groundwater recharge/return-flow to the river Beas and river Satluj due to river water and groundwater interaction.
5. Assessment of artificial recharge measures.

Statement of the problem:

As per the report of CGWB, 80% area of Punjab falls under over-exploited zone. The concentrated pumping 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 isotope 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 thick alluvium and 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 the last decades. The study region will be an extended part of Bist Doab region where groundwater is getting over-exploited.

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

Methodology:

In this study, groundwater samples will be collected from the deeper aquifers (piezometers and groundwater wells) and will be analysed for water quality through Ion Chromatograph,

the samples will also be analysed for stable isotopes. The groundwater dating investigations will be done to determine the age of water. On the basis of interpretation of results, suitable management measures will be suggested to improve the groundwater conditions in the study area.

Action plan:

Year	**Sept. 2012 to Aug. 2013** (Annexure 11)	Remark
Sept. 2012 to Aug. 2013	Review and synthesis of the groundwater data, isotope data and hydro-chemical data Water sampling, analysis and data interpretation Report writing	Report preparation as per Annexure 11

Study Benefits /Impact:

The work will be useful to the region of Punjab where groundwater is in over-exploited condition.

Specific linkages with Institutions: IAEA, Vienna

Annexure - 11

ACTIVITY SCHEDULE FOR THE USE OF ENVIRONMENTAL ISOTOPES TO ASSESS SUSTAINABILITY OF INTENSIVELY EXPLOITED AQUIFER SYSTEMS IN NORTH EASTERN PARTS OF PUNJAB, INDIA (QUARTER WISE FROM SEPT. 2012 TO AUG. 2013)

Activity	1st	2nd	3rd	4th
Review and synthesis of the groundwater data, isotope data and hydro-chemical data, as on date	♦	♦		
Water sampling from piezometers and deep wells for water quality and stable isotope analysis		♦	♦	
Groundwater age dating investigations			♦	♦
Suggesting management measures to improve groundwater conditions in the region			♦	♦
Interim report				♦

Data requirement & Expected source:

Hydro-meteorological data will be taken from the state departments.

IPR potential and issues: NIL

Major items of equipment needed: None

12. ***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 Group:	Dr. S. P. Rai (PI) Dr. M. S. Rao Dr. Surjeet Singh Mr. S. K. Verma Mr. C.P. Kumar Dr. Sudhir Kumar Mr. Vipin Agarwal Mr. S. L. Srivastava Mr. Vishal Gupta Mr. Mohar Singh
Type of Study	Sponsored from the MOES, Govt. of India, New Delhi, in collaboration with IIT-Kanpur, Delhi University and Durham University (U.K.)
Nature of Study	To study the groundwater dynamics in the catchment of Ghaghar river basin; to identify the recharge sources and zones; to assess the impact of climate change on groundwater.
Duration:	3 Years
Date of Start:	June 2012
Date of Completion	May 2015

Study Objectives:

(a) Isotopic Characterization ($\delta^{18}O$ and $\delta^{2}H$) of groundwater, stream and rain water.
(b) Groundwater dating using the tritium and Carbon-14.
(c) Measurement of Radon in groundwater.
(d) Delineation of flow direction and recharge zones.
(e) To study the impact of climate change on groundwater recharge.
(f) Identification of recharge sources 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 is under vulnerable condition and became a hotspot for groundwater management. The groundwater depletion rates in the states of northwestern India have been reported as highest in the world. This unmanaged use of groundwater becomes more challenging due to increasing impacts from population and

industrial developments under the climate change scenario. There is a major task to replenish the groundwater depletion through recharge. Therefore, this study has been proposed to assess the groundwater dynamics in the region under past, present and future climates.

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

Study Area: Study area covers the parts of Punjab and Ghaghar river basin.

Methodology:

- Hydrogeological investigations of the study area using the past data of CGWB and state groundwater cell
- Stable isotopic analysis of rain water, river water and groundwater
- Tritium and Carbon-14 dating to determine the age of groundwater
- Estimation of groundwater recharge using the Visual HELP model

Action plan & time line: Please see Annexure 12

Data requirement & Expected source:

Meteorological data (rainfall, maximum and minimum temperature, sunshine hours, relative humidity, solar radiation etc.), water level data and hydrogeological data are required. Meteorological data would be purchased from IMD. The water level and geological information will be collected from CGWB and state groundwater cell. Soil data would be collected from agriculture department.

List of deliverables:

Groundwater dynamics within the Ghaghar river basin.
Identification of recharge sources and zones.
Assessment of the impact of climate change on groundwater.

IPR potential and issues: NIL

Involvement of End Users/beneficiaries:

The beneficiaries of the study would be the water resource planners and managers of the study area.

Specific linkages envisaged with Institutions and/or other NGOs: Sharing of data with state groundwater cell, CGWB etc.

Major items of equipment needed: None

Annexure - 12

ACTIVITY SCHEDULE FOR THE STRUCTURE AND DYNAMICS OF GROUNDWATER SYSTEMS IN NORTHWESTERN INDIA UNDER PAST, PRESENT AND FUTURE CLIMATES (QUARTER WISE, FOR 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 water, river water and groundwater		♦	♦	♦	♦	♦	♦	♦	♦	♦		
Measurement of ^3H and ^{14}C activity of groundwater, rain water and river water		♦	♦	♦	♦	♦	♦	♦	♦	♦		
Measurement of radon in groundwater		♦	♦	♦	♦	♦	♦	♦	♦	♦		
Preparation of geological and hydrogeological maps of the study area				♦	♦	♦	♦	♦				
Preparation of water table and flow direction map on the basis of previous years data		♦	♦	♦	♦	♦						
Interpretation of isotopic data					♦	♦	♦	♦	♦	♦	♦	
Estimation of natural recharge to groundwater									♦	♦	♦	
Impact of climate			♦	♦	♦	♦	♦	♦	♦	♦	♦	

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
change on groundwater												
Identification of recharge zones									♦	♦	♦	
First draft report										♦		
Second draft report											♦	
Final report												♦

SURFACE WATER HYDROLOGY DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr Rakesh Kumar	Scientist F & Head
2	Dr J V Tyagi	Scientist F
3	Dr Avinash Agarwal	Scientist F
4	Dr R P Pandey	Scientist E2
5	Dr A K Lohani	Scientist E2
6	Dr Senthil Kumar	Scientist E2
7	Dr Sanjay Kumar	Scientist E1
8	Smt Archana Sarkar	Scientist C
9	Dr Manohar Arora	Scientist C
10	Sri Digambar Singh	Scientist B
11	Sri J P Patra	Scientist B
12	Sri Naresh Kumar	PRA
13	Sri N K Bhatnagar	PRA
14	Sri R K Neema	SRA
15	Sri Hukum Singh	SRA
16	Sri OM Prakash	SRA
17	Sri S L Srivastava	SRA
18	Sri T R Sapra	RA

WORK PROGRAMME FOR THE YEAR 2012-13

S. No. & Ref. Code	Title	Study Team	Duration
Internal Studies			
1. NIH/SWD/NIH /10-13	Snowmelt Runoff Modeling and Study of the Impact of Climate Change in part of Brahmaputra River Basin	Archana Sarkar R.D. Singh Rakesh Kumar Sanjay K. Jain	3 years (April 10-March 13)
2. NIH/SWD/NIH /08-	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora Rakesh Kumar	March 08 -To be continued
3. NIH/SWD/NIH /10-13	Climatic Scenarios Generation for Satluj Basin using Statistical Downscaling Techniques	Manohar Arora Rakesh Kumar	3 years (April 10 – March 13)
4. NIH/SWD/NIH /10-13	Climatic variability analysis and its impact on Himalayan watershed in Uttarakhand	Avinash Agarwal, Manohar Arora R K Nema	3 years (Nov. 10 – Oct. 13)
5. NIH/SWD/NIH /11-13	Impact of Climate Change on Glaciers and Glacial Lakes: Case Study on GLOF in Tista basin	A.K. Lohani Sanjay K. Jain Rakesh Kumar	2 years (April 11 – March13)
6. NIH/SWD/NIH /11-14	Hydrological Studies for Upper Narmada Basin.	Jagdish P. Patra Rakesh Kumar Pankaj Mani T R Sapra	3 years (April 11 – March 14)
7. NIH/SWD/NIH /12-15	Study of Hydro-Meteorological Droughts for Bundelkhand Region in India	R.P. Pandey	3 years (April 12-March 15)
8. NIH/SWD/NIH /12-15	Sedimentation Studies for Pong Reservoir, Himachal Pradesh	A. R. S. Kumar, Manohar Arora Suhas D Khobragade, Avinash Agarwal, Sanjay K. Jain	3 years (April 12 – March 15)

1. PROJECT REFERENCE CODE: NIH/SWD/NIH/10-13

a) Title of study: **Snowmelt Runoff Modeling and Study of the Impact of Climate Change in part of Brahmaputra River Basin**

b) Study group: Archana Sarkar (PI), Sc 'C', SWH Div.
R.D. Singh, Director
Rakesh Kumar, Head & Sc. 'F', SWH Div.
Sanjay K. Jain, Sc. 'F', WRS Div.

c) Type of study: Internal

d) Date of start: April 1, 2010

e) Scheduled date of completion: March 31, 2013

f) Study Area:

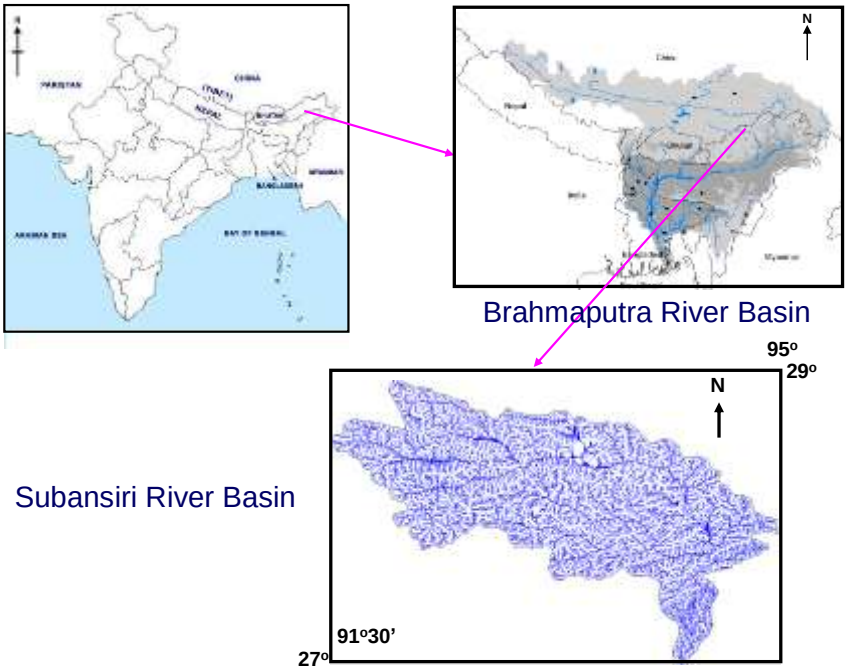


Fig. 1: Study Area

g) Objectives of the study:

1. To estimate snow cover area using remote sensing data
2. To estimate snow melt runoff in Subansiri River basin at Choulduaghat site.
3. To study trend of precipitation and temperature using parametric and non parametric approaches, and
4. To investigate the impact of likely future changes in climate on stream flow using precipitation and temperature scenarios in the study area.

h) Statement of the problem:

Prime Minister's Council on Climate Change, in its first meeting decided that MoWR should initiate studies for major rivers whose waters come from snow

melt. Accordingly, MoWR chalked out an Action Plan to take up related studies on Indus, Ganges and Brahmaputra River basins through CWC, NIH and Brahmaputra Board. The present study has been taken up with this background.

i) Approved action plan:

Activities	I Year	II Year	III Year
To estimate snow cover area and its temporal variation in study basin	⟷		
Preparation of a technical report on "Snow Cover estimation and its temporal variation in a part of Brahmaputra River basin"	⟷		
To estimate stream flow (including snowmelt runoff) in Subansiri River at Choulduaghat site through calibration and validation of hydrological model.		⟷	
To simulate stream flow for the study basin in present climatic conditions using long term records		⟷	
Preparation of a technical report on "Snowmelt Runoff Modelling in a part of Brahmaputra River basin"		⟷	
To study trend of precipitation and temperature using parametric and non parametric approaches			⟷
To simulate stream flow for the basin considering various scenarios of climate (temperature and precipitation) variables and evaluate the impact of changes in climatic variables on stream flow			⟷
Compilation of results and preparation of final technical report			⟷

j) Role and Responsibility of Team Members:

Team Member	**Role and Responsibility**
Archana Sarkar, Scientist C (PI)	Overall responsibility: Procurement of Data, analyzing data/information, calibration & Validation of SNOWMOD program, statistical trend analysis and report writing
R.D. Singh, Director	Advisory: Data analysis and results interpretations
Rakesh Kumar, Scientist F & Head	Advisory: Data procurement, data processing and statistical data analysis
Sanjay K. Jain, Scientist F	Advisory: Snow Cover data analysis, calibration & validation of SNOWMOD program and results interpretations

k) Progress:

Objectives	Achievements
April 2010- March 2011	
1. Literature collection for the technical report on "Snowmelt Runoff Modelling and Study of the Impact of Climate Change in part of Brahmaputra River basin"	Completed
2. Downloading MODerate resolution Image Spectral radiometer (MODIS) snowcover data products for part of Brahmaputra River Basin from the internet for the years 2000-2009.	Completed
3. Analysis and interpretation of weekly MODIS snowcover data collected for the period of 2000-2009 for Subansiri River Basin.	Completed
4. Preparation of technical report on "Snow Cover estimation and its temporal variation in Subansiri River basin".	Completed
April 2011- Sept 2011	
1. Procurement and processing of daily Rainfall data	Completed
2. Procurement and processing of daily Temperature data	Completed
October 2011 – March 2012	
1. Test run of Snowmelt runoff model, SNOWMOD	Completed
2. To simulate stream flow for the study basin in present climatic conditions using long term records	Completed
3. Preparation of a technical report on "Snowmelt Runoff Modelling in a part of Brahmaputra River basin"	Completed
April 2012-Sept 2012	
1. Study of trend of precipitation and temperature using parametric (regression) and non parametric (Man-Kendall) approaches	Completed

l) Recommendations/suggestions in previous meetings of Working Group/TAC/GB: Nil

m) Analysis and Results:

Data Used

- Daily gridded rainfall data 0.25º×0.25º resolution from APHRODITE at five grid points within the Subansiri basin covering different climatic regions for a period of 37 years (1970-2007)
- Daily gridded Temperature (Max, Min and Mean) data at at 1º×1º resolution from IMD at three grid points within and close to Subansiri basin for a period of 36 years (1969-2005)

Results

Historical trends (annual and seasonal) in daily rainfall as well as maximum, minimum and mean temperature (daily) have been examined using regression

analysis and Mann-Kendall (MK) statistics. The non parametric MK statistical test has been widely applied to asses the significance of trends in hydrological time series. On the basis of regression and MK test, rising and falling trend in rainfall and temperature at various grid points have been analysed (Table 1 and 2 below). The result shows that many of these variables demonstrate statistically significant changes occurred in last three decades. However, there is no systematic trend of rainfall in the basin. The temperature trend analysis shows that minimum temperature in general is increasing at all of the grid points considered for analysis, however, maximum temperature shows no trend. The mean temperature shows no significant trend in annual, pre-monsoon and post-on seasons, however there is rising trend in monsoon and winter seasons.

Table 1: Trend in different Season for Temperature Data

	Grid	Dominant trend (Max Temp)	Dominant trend (Mean Temp)	Dominant trend (Min Temp)
ANNUAL	T1	No Trend	No Trend	Increasing
	T2	No Trend	No Trend	No Trend
	T3	No Trend	No Trend	No Trend
WINTER (Dec to Feb)	T1	No Trend	No Trend	Increasing
	T2	No Trend	No Trend	Increasing
	T3	No Trend	No Trend	No Trend
PRE MON (March to May)	T1	Decreasing	No Trend	No Trend
	T2	Decreasing	No Trend	No Trend
	T3	Decreasing	No Trend	No Trend
MON (Jun to Sept)	T1	No Trend	No Trend	No Trend
	T2	No Trend	No Trend	No Trend
	T3	No Trend	No Trend	No Trend
POST MON (Oct to Nov)	T1	No Trend	No Trend	No Trend
	T2	No Trend	No Trend	No Trend
	T3	No Trend	No Trend	No Trend

Table 2: Trend in different Season for Rainfall Data

	Grid	Mann-Kendall test statistic Z	Dominant trend
ANNUAL	R1	-1.28	No Trend
	R2	0.98	No Trend
	R3	-1.06	No Trend
	R4	1.68	No Trend
	R5	3.19	Increasing
WINTER (December to February)	R1	-0.8	No Trend
	R2	0.8	No Trend
	R3	-0.38	No Trend
	R4	1.27	No Trend
	R5	1.18	No Trend
PRE MO	R1	-0.53	No Trend

	R2	1.84	No Trend
	R3	1.58	No Trend
	R4	1.92	No Trend
	R5	2.87	Increasing
MONSOON (June to September)	R1	-1.11	No Trend
	R2	0.15	No Trend
	R3	-0.68	No Trend
	R4	-0.03	No Trend
	R5	1.87	No Trend
POST MONSOON (October to November)	R1	-0.68	No Trend
	R2	1.08	No Trend
	R3	-0.4	No Trend
	R4	1.31	No Trend
	R5	1.06	No Trend

n) Expected adopters:

State Water Resources Dept and other agencies dealing with Hydropower projects.

o) Deliverables:

Research paper would be prepared after completion of the report.

p) Data procured and/generated during the study:

- MODerate resolution Image Spectral radiometer (MODIS) snowcover data products (MOD10A2 8-day composite) for Subansiri River Basin for the years 2000-2009.
- SRTM DEM
- Daily rainfall data at few raingauges in the Indian part of Subansiri basin (2000-07)
- Daily rainfall data at 0.5 deg grid from APHRODITE for whole of the Subansiri basin (2000-07)
- Daily Temperature data at 1 deg grid from IMD for whole of Subansiri basin (1969-2005)
- Daily Temperature data at three stations in Indian part of Subansiri basin (2000-08)

q) Future plan:

As per the approved action plan.

2. PROJECT REFERENCE CODE: NIH/SWD/NIH08-

a) Title of study: **Monitoring and Modelling of Streamflow for the Gangotri Glacier**

b) Study group: Manohar Arora Sc 'C', SWH Div.

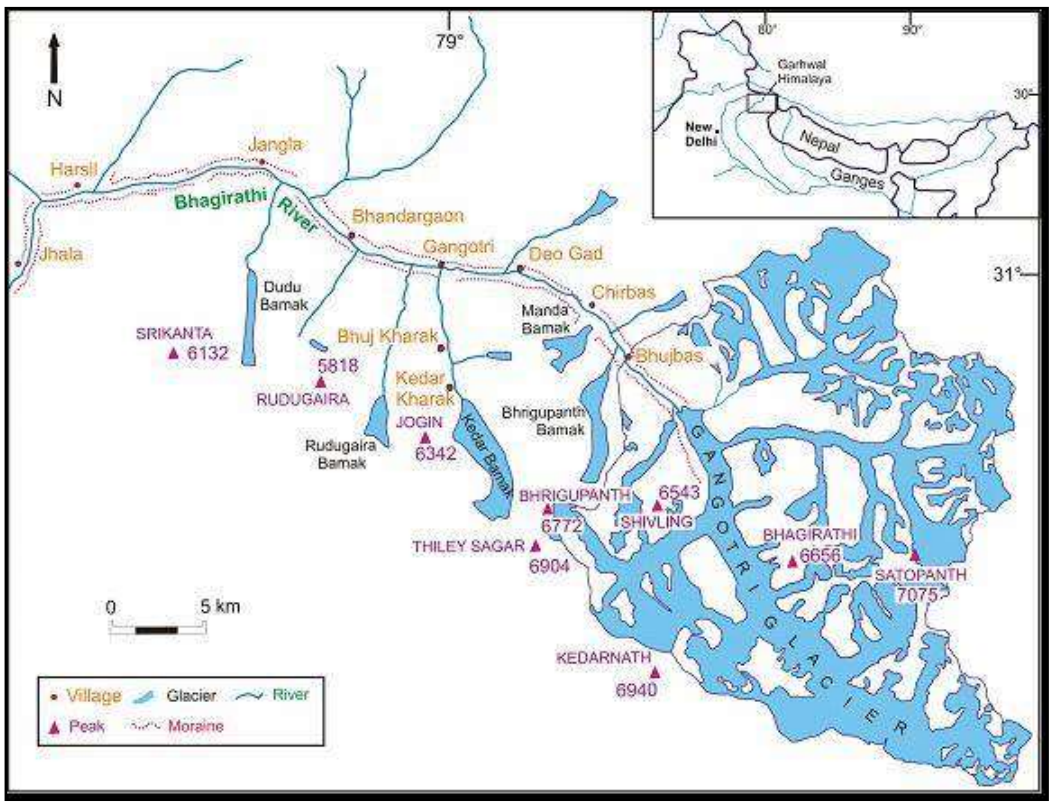
Rakesh Kumar Sc 'F', SWH Div.

c) Type of study: Internal

d) Date of start: 01.04. 2008

e) Scheduled date of completion: Long term study

f) Location map:



g) Objectives of the project:

The objective of this study includes:

i. Continuous monitoring of meteorological and hydrological data for monthly and seasonal specific water yield and its variability from the year to year

ii. To improve the hydrological model for simulating daily streamflow

h) 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.

i) Approved action plan:

Year	May to October	Nov. to April	Remark
All Years	Field investigations & Data Collection	Data analysis	Report preparation after three years

j) Role and Responsibility of Team Members:

i. **Dr . Manohar Arora, Scientist C& PI:** Conduction field investigations, analyzing data/information, report preparation and overall responsible for the study completion.
ii. **Dr Rakesh Kumar, Scientist F & Co-PI:** Guidance in development of methodology, modelling and structuring of report.

k) 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 2011 were completed. The analysis has been completed on collected data.
To improve the hydrological model for simulating daily streamflow	The simulation of flow will be carried out after collection of three years of data.

l) Recommendations of Working Group/TAC/GB:

The study may be continued for long term to link with climate change.

m) Analysis and Results:

The hydro meteorological data collected for the winter 2011 have been processed and analysed. The collection of summer data from May 2012 to October 2012 was started in the month of May 2012 and would continue upto 8th October 2012. The minimum temperature was -19.8°C on 10th February 2012 and Maximum temperature was 16.1°C on 12th October 2012. The discharge during winter was between 3 cumecs to 21 cumecs. The suspended sediment data collected from 2008 to 2011 was analysed and it was found that Mean monthly suspended sediment concentrations, for May, June, July, August and September during the study period were 1011, 1384, 1916, 1675 and 567 ppm, respectively, indicating highest suspended sediment concentration in July, followed by August. For the entire melt season, the mean daily suspended sediment concentration was estimated to be 1320 ppm. Similar trends were also found for the sediment load and about 67% of the total suspended sediment load of the melt period was transported during the months of July and August. Sediment yield for the study basin was computed to be about 2,863 tonnes km^{-2} yr^{-1}. For the entire ablation period, the erosion from the Gangotri Glacier basin is estimated to be about 1.0 mm. There was a poor relationship between

suspended sediment concentration and discharge and hysteresis effect was prominent in the melt stream. The average percentages of clay, silt and sand were found to be 3, 67 and 30%, respectively, which suggest maximum content of silt followed by sand.

n) Adopters of the results of the study and their feedback:

The study is a part of long term action plan on climate change by the Institute.

o) List of deliverables:

1. The report for 2011 – 2014 will be prepared after completion of three years of investigations.
2. Research papers are being brought out.

p) Major items of equipment procured: Nil

q) Lab facilities during the study: Analysis of suspended sediment samples in Soil Lab.

r) Data generated in the study: Meteorological and hydrological data for the Gangotri Glacier.

s) Study Benefits/Impact: The study is being conducted under the long term action plan on climate change as per instructions of MOWR. The meteorological and discharge data would be utilised in studying the characteristics of the Gangotri glacier under changing climate.

t) 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.

u) 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.

v) 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.

3. PROJECT REFERENCE CODE: NIH/SWD/NIH/10-13

a) Title of the Study : **Climatic Scenarios Generation for Satluj Basin using Statistical Downscaling Techniques**

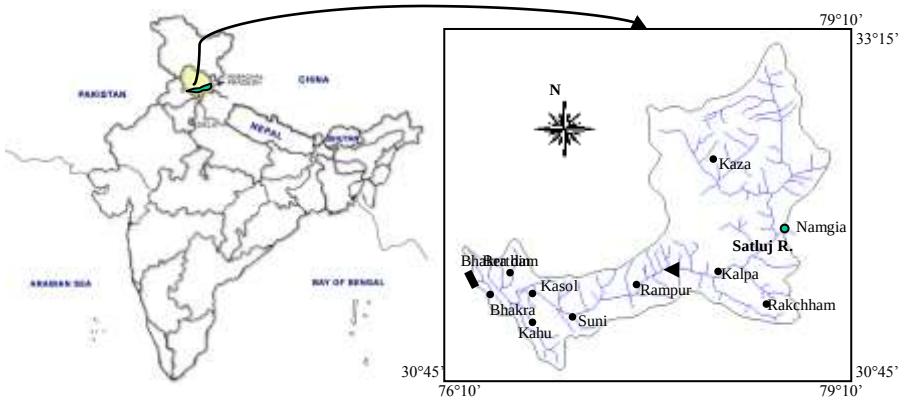
b) Study Group: Manohar Arora Sc 'C', SWH Div.
Rakesh Kumar Sc 'F', SWH Div.

c) Type of study: Internal

d) Date of Start: 1.04.2010

e) Scheduled date of completion: 31.03.2013

f) Location map:



g) Objectives: The objectives of the study are:

i. To Downscale the GCM Output of CMIP3 models.

ii. To predict future climatic scenarios for Satluj basin.

h) Statement of the problem:

For studying the impact of climate change the future climatic scenarios are needed. These scenarios will be downscaled for the Satluj basin using statistical downscaling technique.

i) Approved action plan:

Year	April - June	July-Sept	Oct-Dec	Jan-March
2010	Literature Survey	Literature Survey	Dev. of Methodology	Development of Methodology & Data Collection
2011	Data Processing	Data Processing	Downloading of GCM output	Preliminary processing of GCM
2012	Analysis of data	Analysis of data	Preparation of report	Preparation of report

j) Role and Responsibility of Team Members:

i. **Dr. Manohar Arora, PI:** Conduction field investigations, analyzing data/information, report preparation and overall responsible for the study completion.
ii. **Dr Rakesh Kumar, Co-PI**: Guidance in development of methodology, modelling and structuring of report.

k) Objectives vis a vis achievement:

Development of Methodology & Data Collection	The tentative methodology has been developed. The data has been collected.

l) Recommendation/Suggestion of Working Group:

No specific recommendation

m) Analysis & Results:

The data has been downloaded and the procedure for AO quantitative evaluation has been finalized. The quantitative evaluation has been carried out for the CMIP 3 models and it has been found that nearly 5 models out of 24 models are performing better for the region. The future scenarios will be determined.

n) Adopters of the results of the study and their feedback:

The study will benefit the departments like SJVNL and BBMB.

o) List of deliverables:

1. Case study in the form of report
2. Papers will be outcome of the study**.**

p) Major items of equipment procured: Nil

q) Lab facilities during the study: Desktop study.

r) Data generated in the study: Data will be downloaded from NOAA site.

s) Study Benefits/Impact: The study will develop the capabilities to downscale future climatic scenarios at basin scale. This scenarios generated may be used to assess the impact of climate change

t) Specific linkages with Institutions/beneficiaries: The results will be shared with BBMB and SJVNL.

u) Shortcomings/Difficulties: This is the first study of this kind being taken up. As more and more downscaling at basin scale is done the methodology will become robust.

v) Future Plan: The climatic scenarios generated will be used for assessment of impact of climate change on runoff.

4. PROJECT REFERENCE CODE: NIH/SWD/NIH/10-13

a) Title of the study: **Climatic variability analysis and its impact on Himalayan watershed in Uttarakhand.**

b) Study Group: Avinash Agarwal, Sc F & P.I., SWH Div.
Manohar Arora Sc C & Co.P.I., SWH Div.
R K Nema, SRA, SWH Div.

c) Type of study: Internal

d) Date of start: Nov. 2010

e) Scheduled date of completion: Oct. 2013

f) Location map / 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.

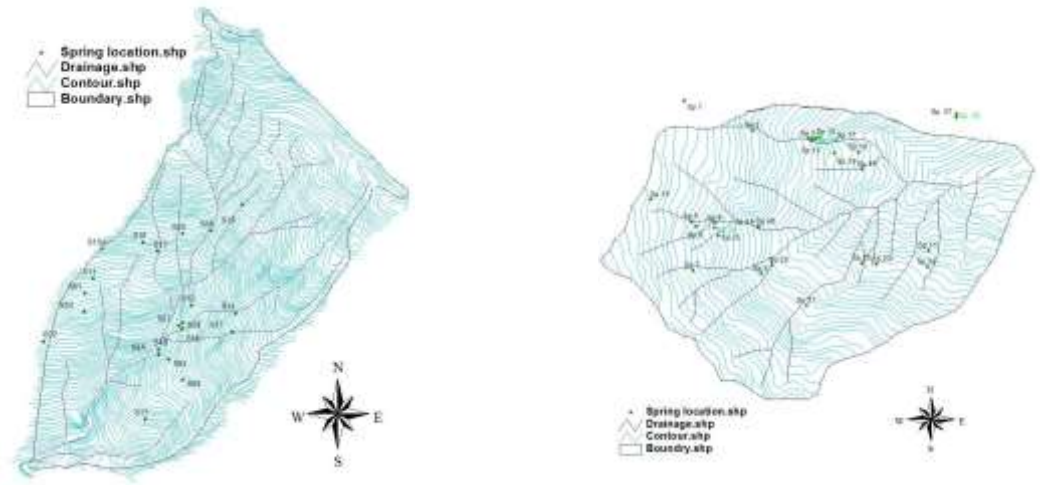


Figure 1: Chandrabhaga and Danda watersheds and location of springs.

g) Objectives of the study:

i. Development of rainfall-runoff, rainfall-spring flow relationships and assessment of climatic variability.

ii. Estimation of impact of climatic variability on runoff and spring flow.

iii. Detailed hydrological monitoring, collection of data at watershed scale and creation of a centralized database for watershed for the benefit of the users.

iv. Development of implement able technology for water availability and transfer of developed technology to users.

h) 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

i) Approved action plan:

Year	1st quarter (A M J))	2nd quarter (J A S)	3rd quarter (O N D)	4th quarter (J F M)
2010			Maintenance and up keeping of installed equipments	Processing and analysis of data collected during 2010
2011	Interactive workshop	Literature review and development of model	Interpretation of results	Processing and analysis of data collected during 2011
2012	Development of appropriate model	Interactive workshop	Interpretation of results	Processing and analysis of data collected during 2012
2013	Analysis of current data with historical data	Interactive workshop	Preparation of report	

j) Role and Responsibility 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 implementable 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 implementable technology for water availability analysis. Presenting the progress of work when required. Transfer of technology

R K Nema (Sc. Asstt.): 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

k) Recommendation and suggestions in previous meeting of working group:

No specific comments/ recommendation.

l) Analysis of results:

i. Maintenance and up keeping of installed equipments.
ii. The collected data for the year is under processing.
iii. Rainfall, runoff and spring flow data has been analyzed for different relationships and for climatic variability assessment.

m) Results in brief:

- **Maintenance and up keeping of installed equipments.**
- **Rainfall runoff and spring Flow analysis.**
  Monthly rainfall runoff relationships are developed for monsoon, non-monsoon and total period. Monthly cumulative rainfall and spring flow indicated a high correlation for all springs in both the watersheds. Total rainfall and spring flow is also highly correlated. The recession of the springs can be given with polynomial, power and log relationship. Generalized relationships are developed for both watersheds. Rain to spring lag on daily and monthly basis is identified. Spring flow variability is related with spring lag.
- **Processing and analysis of data collected up to Sept. 2012.**
  The data collected till Sept. 2012 is under processing.

n) List of deliverables: Hydro-meteorological data, papers and report for small watershed of Uttarakhand.

o) Major items of equipment procured: Nil

p) Lab facilities used during the study: Nil

q) Data procured and /or generated: The data hub for the watersheds has been updated

r) Study benefits/impacts: Hill habitat and State Government and other agencies.

s) Specific linkage with institutions and/or end-users/ beneficiaries: Village wise interactive work shops in the watershed are proposed

t) Shot comings/ difficulties: Nil

u) Future plan: As proposed in the action plan.

5. PROJECT REFERENCE CODE: NIH/SWD/NIH/11-13

a) Title of study: **Impact of Climate Change on Glaciers and Glacial Lakes: Case Study on GLOF in Tista basin**

b) Study group: A.K. Lohani, Sc. 'E2' SWH Div., PI
Sanjay K. Jain, Sc. 'F', WRS Div., Co-PI
Rakesh Kumar, Sc. 'F' & Head SWH Div., Co-PI

c) Type of Study: Internal

d) Date of start: April 1, 2011

e) Scheduled date of completion: March 31, 2013

f) Statement of the problem:

In Himalayan region, several water resources projects are under operation and many more are coming up to harness these 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. Proper planning and management of these projects depends on correct assessment of basin yield. The widespread glacial retreat in the Himalayas has resulted in the formation of many glacial lakes. Due to the recession of glaciers, a number of catastrophic affects such as glacial lake outburst floods (GLOF), water scarcity in the upper Himalayan villages and adverse effects on the flow of Himalayan rivers have been reported. For water resources planning and management, it is therefore essential to study and monitor the Himalayan glaciers and glacial lakes including GLOF. The study stresses the importance of methodologies used to assess impact of climate change on glacial lakes and the impact of glacial lake outburst floods (GLOFs) in Tista basin.

g) Objectives:

1. To prepare inventory of glaciers and glacial lakes using remote sensing data
2. To estimate flood hazard potential of most vulnerable lake glacial lake i.e. estimating the volume of water, peak discharge and corresponding flood hydrograph generated due to outburst of potential glacial lake.
3. To discuss GLOF Mitigation measures and early warning systems.

h) Study Area:

River Teesta or Tista is said to be the lifeline of the state of Sikkim, flowing for almost the entire length of the state and carving out verdant Himalayan temperate and tropical river valleys. The emerald-coloured river then forms the border between Sikkim and West Bengal before joining the Brahmaputra as a tributary in Bangladesh. The total length of the river is 315 km (196 mi).

The river Teesta originates from Cholamo Lake in North Sikkim at an elevation of 5,330 m (17,487 ft) above sea level in the Himalayas. This lake lies to the north of the Donkia pass near Shetschen, where the summit of the pass is about eight kilometres north-east of Darjeeling.

The Teesta River is then fed by rivulets which arise in the Thangu, Yumthang and Donkia-La ranges. The river then flows past the town of Rangpo where it forms the border between Sikkim and West Bengal up to Teesta Bazaar. The Teesta River has preserved good imprints of climatic and tectonics along its valleys and catchments. There are a number of glaciers are present in the Teesta basin. This covers an area of 440.300 sq.km. A number of hydropower projects are proposed within the Teesta river basin. It is estimated that it would produce some 50,000 MW of electricity within the next 10 years. Keeping in view the ongoing development activities in the Tista basin, preparation of inventory of glaciers and glacial lakes, glacial lake outburst flood study are very much important for flood estimation and management.

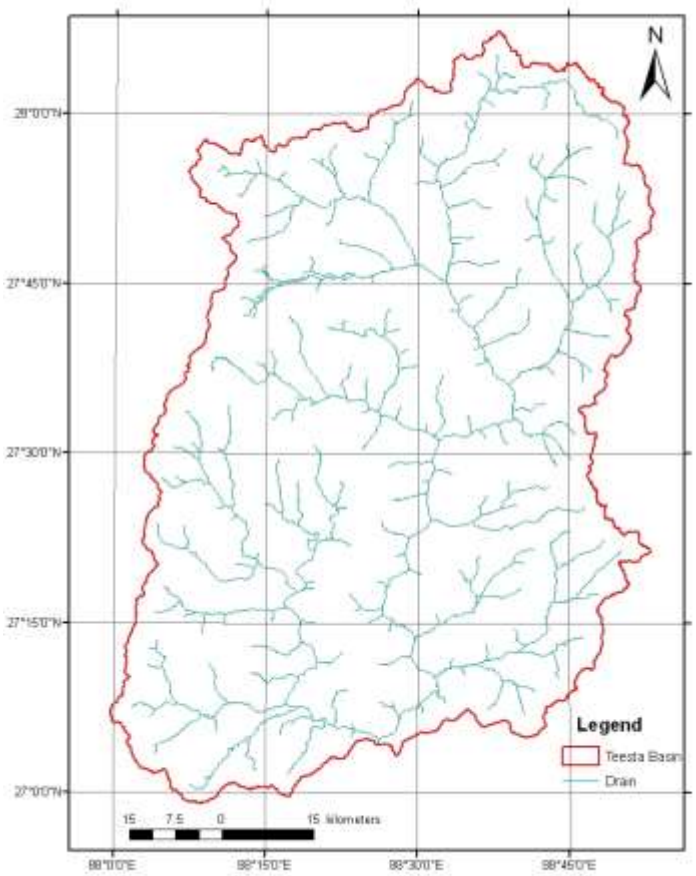


Fig. 1: Basin map of the study area

i) Role and Responsibility of Team Members:

Dr. A.K. Lohani, Scientist 'E2': Data Collection, Data Processing, Simulation of glacial lake outburst using MIKE 11

Dr. Sanjay Kumar Jain, Scientist 'F': Data Collection, Data Processing, Preparation of data base, inventory of glaciers & lakes etc.

Dr. Rakesh Kumar, Scientist 'F': Data Processing, Data Analysis, Interpretation of results etc.

j) Approved action plan :

Task	Apr. - Sep. 2011	Oct. 2011-Mar. 2012	Apr. - Sep. 2012	Oct. 2012-Mar. 2013	Status
Data Collection & Processing					Completed
Preparation of inventory of glaciers and glacial lakes using remote sensing data, Glacial Lake Outburst flood modelling					Completed
Glacial Lake Outburst flood modelling					**In progress**
GLOF Mitigation measures and early warning systems Report writing					

k) Achievements

Year	Objectives (for the period April 2011 to September 2011)	Achievements
October, 2011 to March 2012	1. Creation of Basin map 2. Creation of data base in GIS 3. Classification of data for lake inventory 4. Identification of glaciers and lakes 5. Methodology for GLOF 6. Glacial Lake Outburst flood modelling	Completed Completed Completed Completed Finalized In progress

l) Recommendation / suggestions in previous meetings of Working group / TAC / GB

There was no specific recommendation pertaining to the study.

m) Analysis and results:

The basin map of the study area has been prepared. Further, DEM of the study area has been created in order to analyse the topography for identification of river cross sections. Remote sensing data of Landsat TM have been downloaded from Internet. Using conventional and SVM techniques, classification of this data has been carried out for identification of glaciers and glacial lakes. From the classified

remote sensing data preparation of glacial lakes inventory is in progress. In order to simulate GLOF, methodology has been finalisied using sample data sets. Further, glacial lakes and potentially dangerous lakes have been identified. Glacial Lake outburst flood modeling has been carried out using Mike11 model for the selected lake (Figure 2).

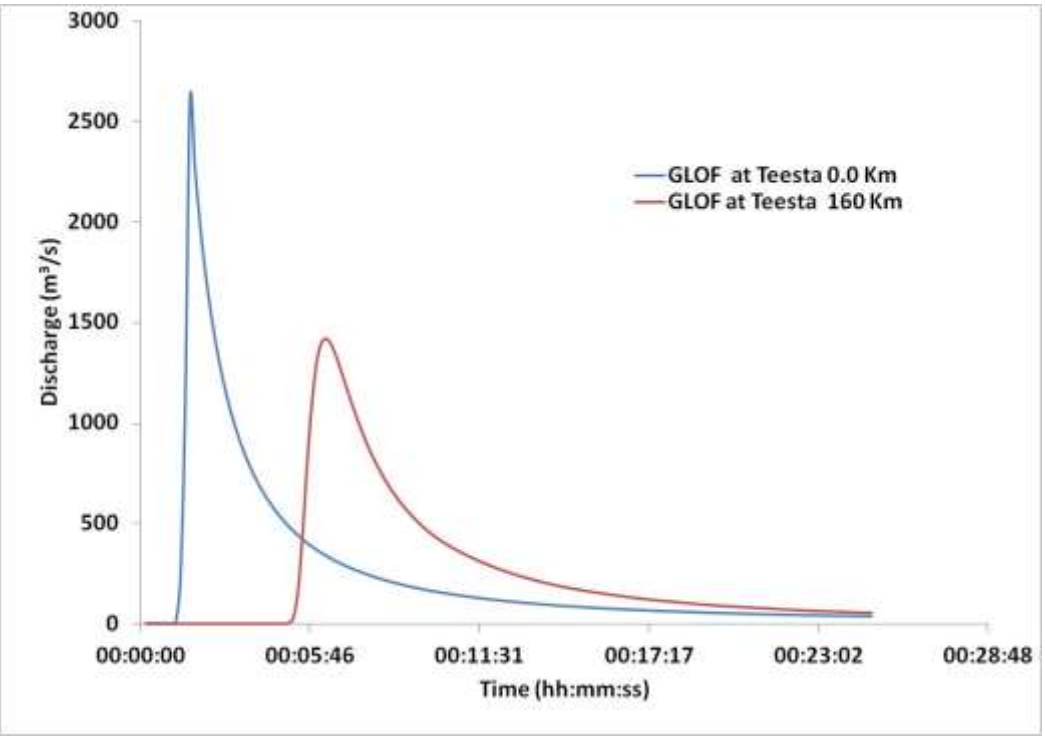


Figure 2: Glacial Lake out burst flood at lake and selected project site

n) Deliverables:

Reports and research papers

o) Data generated in the study:

Inventory of glacial lakes, vulnerable lakes and simulation of vulnerable lakes

6. PROJECT REFERENCE CODE: NIH/SWD/NIH/11-14

a) Title of study: **Hydrological Studies for Upper Narmada Basin.**

b) Study group: Jagdish Prasad Patra, Sc. 'B' SWH Div., PI
Rakesh Kumar, Sc. 'F' & Head SWH Div., Co-PI
Pankaj Mani, Sc 'E1', CFMS, Patna
T R Sapra, R.A.

c) Type of Study: Internal

d) Date of start: April, 2011

e) Scheduled date of completion: March, 2014

f) Location map:

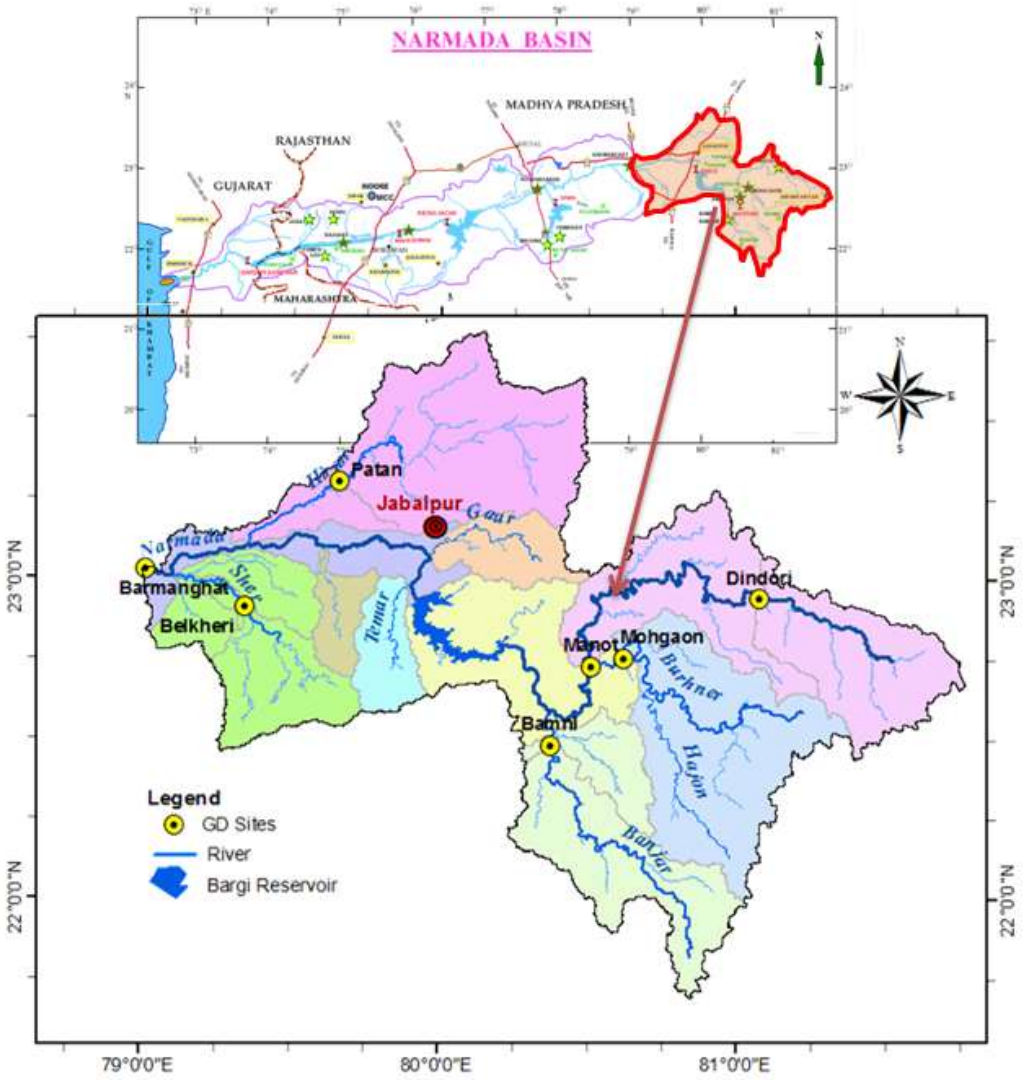


Fig. 1: Location map of study area.

g) Study objectives:

(i) Estimation of dependable flows for some of the gauging sites.

(ii) Rainfall runoff modelling.

(iii) Estimation of floods for various return periods using L-moment for gauged and ungauged catchments.

(iv) Estimation of Standard Project Flood (SPF) and Probable Maximum Flood (PMF) for Bargi dam.

(v) Dam break flood wave simulation.

(vi) Preparation of flood inundation maps for various dam break scenarios.

h) Statement of the problem:

The Narmada is the largest west flowing and seventh largest river of India. The basin, edging between Vindya and Satpuda ranges, extends over an area of 98,796 km^2. The Narmada rises from a Kund at an elevation of 1057m from Amarkantak in the Maikal hill in Shahdol district of Madhya Pradesh. Bargi Dam is one of the first completed Dam out of the chain of 30 major dams to be constructed on Narmada River in Madhya Pradesh. The dam construction work started in 1974 and was completed in 1990 when the dam was filled to its complete capacity. The height of the dam is 69 m and length 5.4 km. The reservoir is about 75 km in length and 4.5 km width, spreading over 267.97 km^2 area.

Though probability of dam failure extremely low, its occurrences can imply catastrophic consequences in downstream, including loss of human lives, properties, natural resources and so on. Therefore, significant predictive data on hypothetical flood events such as flood flows, flow velocities, depths and flood wave arrival times at specific locations downstream of the dam become some the most important pieces of information for disaster preparedness. Moreover, the National Water Policy, 2002 recognized the unavailability of Emergency Action Plans (EAP) for majors dams and stressed upon preparation of EAP for all large dams. Dam break analysis plays a major role in preparing EAP. The preset study focus on dam break analysis of Bargi dam and resulting flood inundation mapping up to barmangath with a drainage area of 26, 453 km^2.

i) Approved action plan and timeline:

Action	Time (month)						Status
	1-6	7-12	13-18	19-24	25-30	31-36	
Literature review Data collection							Under Progress
Processing and analysis of data							Under Progress
Modelling work							Under Progress
Reporting / Assessment of progress							
Preparation final report							

j) Role and Responsibility of Team Members:

Sl No	Role / Action	Member/(s)
1	Data collection	JPP,TRS
2	Estimation of river flows of various dependability	RK
3	Estimation of basin parameters	JPP,PM
4	Estimation of floods for various return periods and PMF	RK, JPP
5	Hydrological modelling using HEC-HMS	JPP,RK
6	Dam Break analysis. Flood wave routing using MIKE-Flood and danger reach mapping	PM,JPP
7	Prepare flood inundation maps using ArcGIS	JPP,RK,PM

JPP = J. P. Patra; RK = Dr. Rakesh Kumar; PM = Pankaj Mani; TRS =T. R. Sapra

k) Brief methodology:

The river flow for some of the gauging sites for the upper Narmada river and its tributaries for various dependability will be estimated. HEC-HMS model will be used for rainfall runoff modelling. The model will be calibrated and validated with available historical events at some of the gauging sites. For estimating design floods the total basin area will be divided into smaller size (Area < 5,000 km^2) sub-basins in order to apply unit hydrograph (UH) techniques. In this study different UH techniques such as in CWC-flood estimation report and Clark's UH method will be used. HEC-GeoHMS software will be used for the delineation of basins, estimation of basin parameters then project will be exported to HEC-HMS for rainfall-runoff modelling of various critical sequences of the rainfall depths. Floods for various return periods will be estimated using L-moments approach for gauged and ungauged catchments. In addition PMF and SPF will be estimated for Bargi dam. The runoff generated at outlet of each sub basin will be routed to dam. Dam break analysis of Bargi dam for various failure scenarios will be simulated using MIKE Flood and flood propagation along river, relationship between peak discharge with distance and its effects in the downstream will be analyzed. Further, the model output will be used to prepare flood inundation maps.

l) Results achieved with progress/ present status:

During past six months the rainfall data collected were analysed for rainfall of various return periods using L-moments based rainfall frequency analysis. Further during field visit some additional cross-section was measured in Narmada River downstream of Bargi dam. The initial model setup with Mike-11 (Fig. 2) is prepared and calibration is in progress. The simulated water surface profile is shown in figure 3.

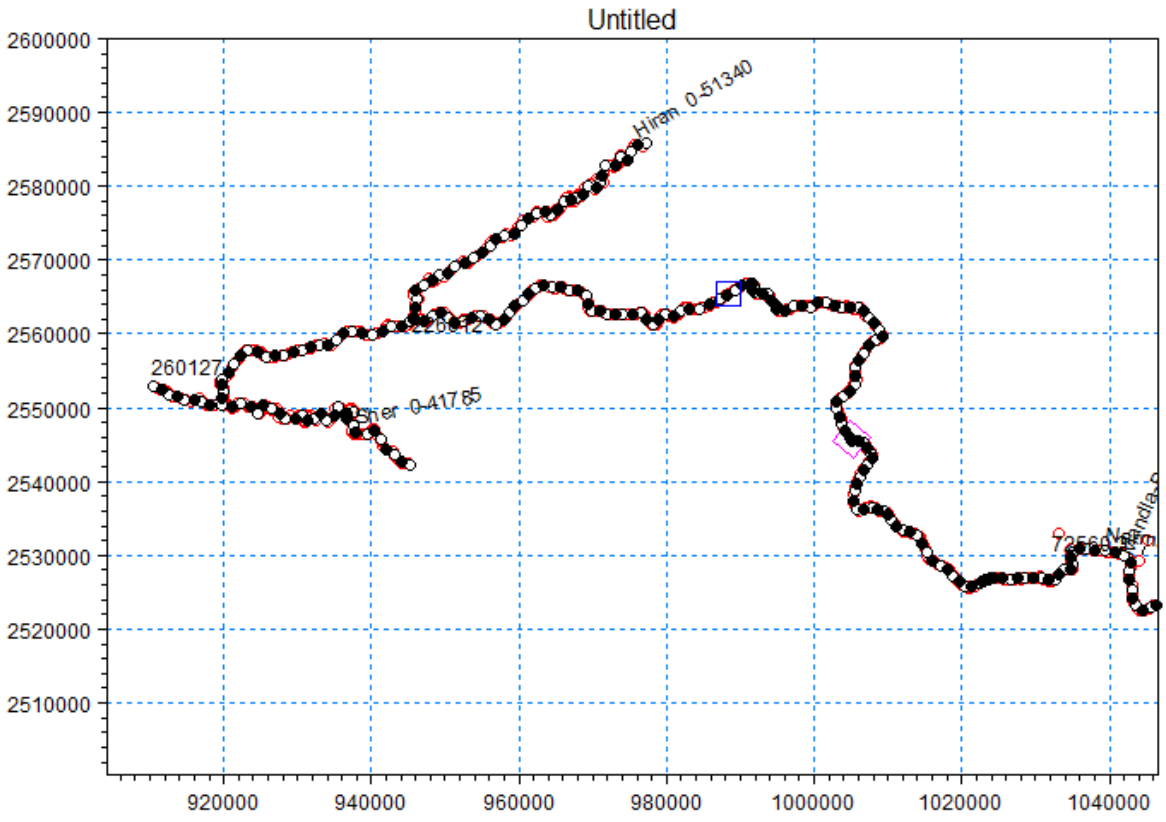


Fig. 2: River network with structures in Mike-11.

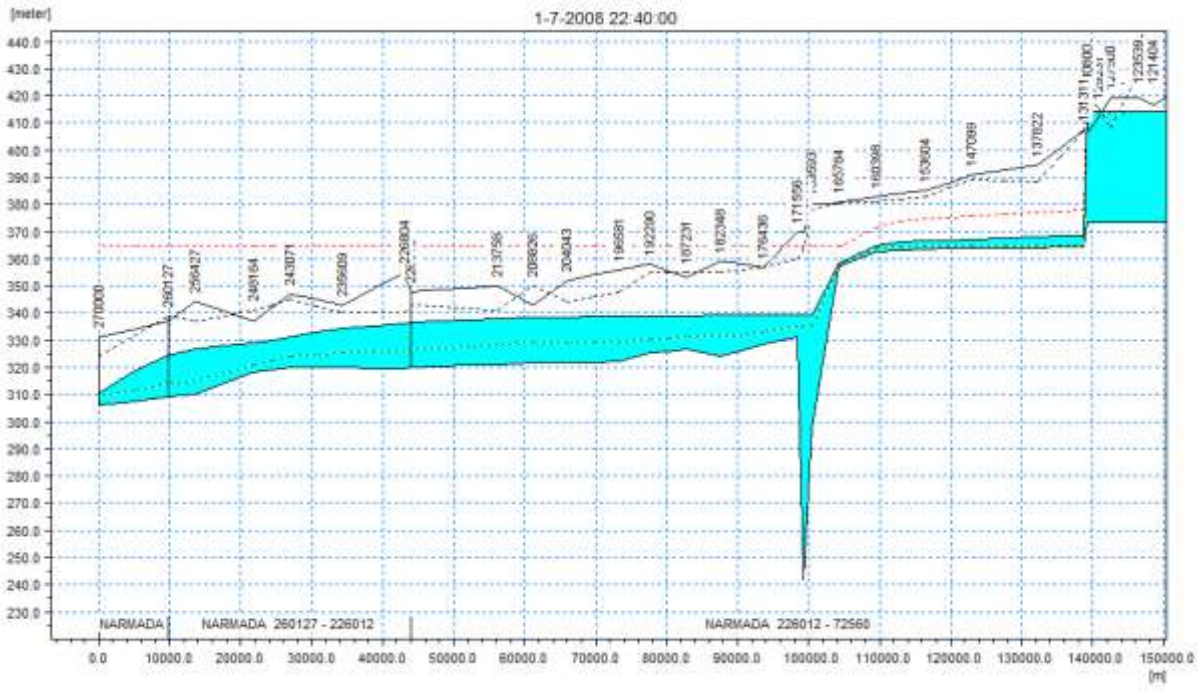


Fig. 3: Water surface profile simulated in Mike-11.

m) **Action taken on comments of previous working group meeting**

There were no specific comments

n) List of deliverables:

Papers and reports.

o) Data collected/generated:

- DEM of the study area is generated from SRTM.
- Land use and land cover map is generated by classifying LANDSAT image.
- Daily rainfall for six raingauge stations i.e., Jabalpur, Mandla, Umaria, Balaghat, Narsinghpur and Seoni for the year 1970 to 2007 are collected from IMD. However the data set is having missing values at some stations.
- Stage and discharge at eight gaugiging sites namely, Bamni, Barmanghat, Belkhedi, Bijora, Dindori, Manot, Mohgaon and Patan for the period of 2000 to 2010 from CWC.
- River cross-sections at above gauging sites are also collected from CWC.
- Measured some river cross-sections during field survey.
- Salient features of dam such as height, length, top-width, elevation of river bed etc, spillway characteristics, and elevation of uncontrolled spillway crest with discharge coefficients are collected from office of Chief Engineer (Bargi), Rani Avantibai Pariyojana, NVDA, Jabalpur (MP)
- Elevation capacity and area capacity curve of the reservoir, Inflow and outflow data from 1990 to 2010 are also collected from office of Chief Engineer (Bargi), Rani Avantibai Pariyojana, NVDA, Jabalpur (MP).

p) Involvement of end users / beneficiaries:

There has been discussion with the officials of Chief Engineer (Bargi), Rani Avantibai Pariyojana, NVDA, Bargi Hills, Jabalpur (M.P.) regarding need of this type of study.

7. PROJECT REFERENCE CODE: NIH/SWD/NIH/12-15

a) Title of the study: **Study of Hydro-Meteorological Droughts for Chitrakoot Bundelkhand Region in India**

b) Study group: R.P.Pandey**,** Sc E2 & P.I., SWH Div.

c) Type of study: Internal

d) Date of start: April 2012

e) Scheduled date of completion: March, 2015

f) Location map / 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 recurrence of droughts of 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, 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.

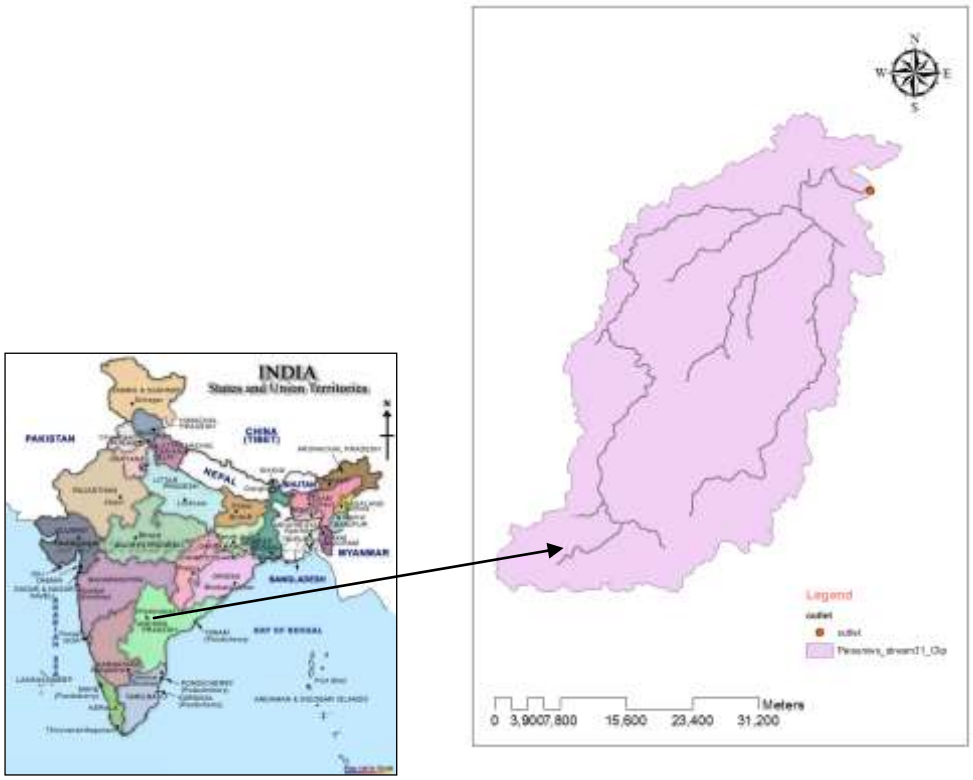


Fig. 1: Location Map of Paisuni Basin

Aview of local topography in study area

g) 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:

(i) Assessment of drought frequency, duration and severity in Bubdelkhand.
(ii) Quantification of surface water and groundwater availability.
(iii) Assessment of total water demands for domestic, industries and agriculture.
(iv) Assessment of supplemental irrigation to minimize crop loss due to dryspells and droughts.
(v) Delineation of zones vulnerable to different degree of drought severity.
(vi) To suggest an area specific plan for water management in Paisuni Basin,

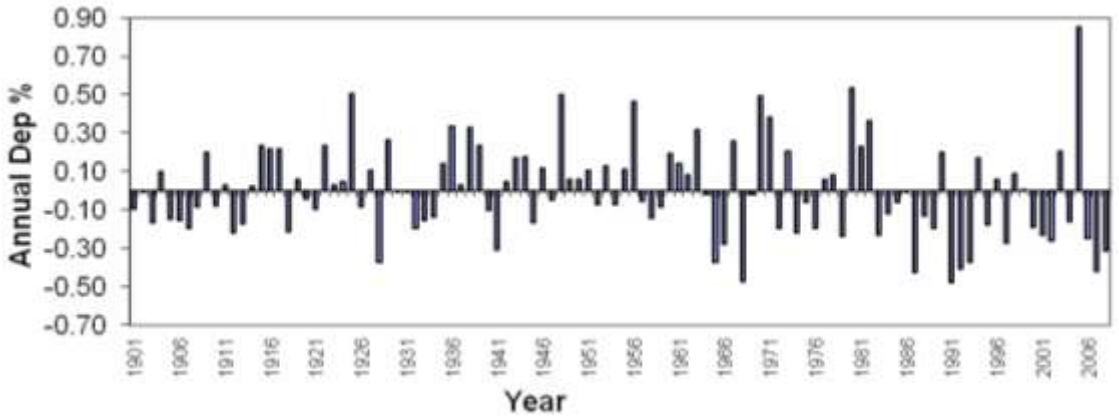
h) Time schedule:

Item of work plan	**Time Schedule**
Field survey & data collection from study area	April-June, 2012
Procurement of meteorological data and stream flow data from IMD and CWC respectively..	April –Sept. 2012
Preparation of base maps	June –December 2012
Mid-term field investigations and crop survey	September 2012 – January 3013
Analysis of Rainfall Temperature, evaporation records	June 2012 –March 2013
Analysis of dry spells & regional drought characteristics	April 2013-Dec 2013
Preparation of drought vulnerability maps	January 2014- June 2014
Assessment of surface and groundwater	April 2014 -Dec 2014

availability and total demand	
Preparation of plan for water augmentation and storage requirements	January –February 2014
Preparation of report	January- March 2015

i) Progress of proposed study:

- Conducted field visit for collection of data/information collection from various sources in the proposed study areas.
- Procured GIS data in soft copy from Remote Sensing Application Centre, UP and collected daily rainfall data from district office.
- Prepared some of base maps of drainage, land-use, DEM, maps etc. using GIS.
- Procured various maps and Gazetteer and gathered other local information to prepare Inventory of past drought events in the study areas
- Analyzed rainfall data to determine frequency and severity of droughts in past decades.



j) Proposed work plan for remaining part of the current year 2012-13

- Classification of zones vulnerable to drought and water scarcity (preparation of vulnerability maps and their physical verification with ground truth).
- Assessment of surface water (Streanflow & Storages) and groundwater availability, (recharge/aquifer storages) at monthly time step.
- Assessment of water demand for domestic, industry and agriculture at monthly time step.
- Assessment of life saving supplemental irrigation requirement for crops to meet dryspell demand.

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

(i) Final report of the study is to be prepared by March 2015.

(ii) This study will yield suitable approach to quantify drought attributes, area specific water availability, demand and magnitude of deficit in the Bundelkhand.

(iii) Two training courses each for one week duration will be organized to disseminate the knowledge and output of the study during 2013-14 and 2014-15.

8. PROJECT REFERENCE CODE: NIH/SWD/NIH/12-15

a) Title of the study: **Sedimentation Studies for Pong Reservoir, Himachal Pradesh**

b) Study group: A. R. Senthil kumar Sc E1 & P.I., SWH Div.
Manohar Arora, Sc C, SWH Div.
Suhas D Khobragade, Sc E1, HID
Avinash Agarwal, Sc F, SWH Div.
Sanjay K. Jain, Sc F, WRS Div.

c) Type of study: Internal

d) Date of start: 1 April 2012

e) Scheduled date of completion: March 31, 2015

f) Study objectives:

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

g) 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

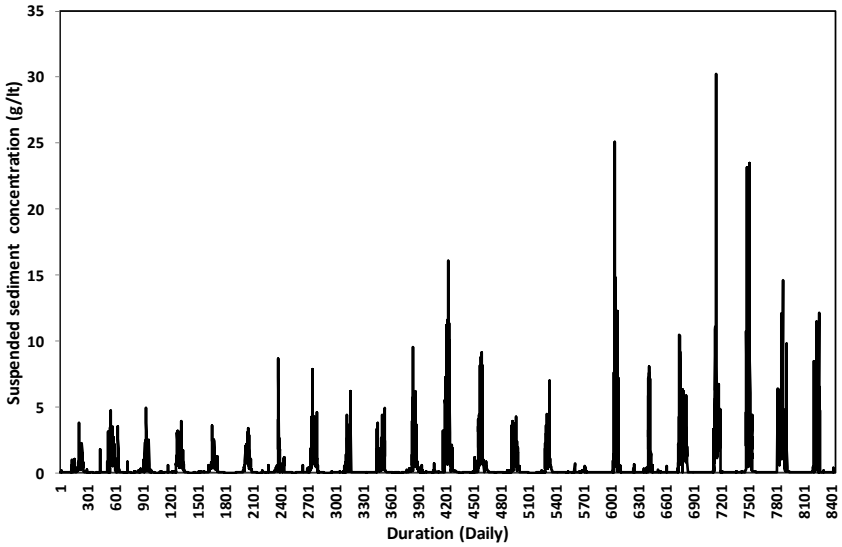
The computed sediment volume for future periods is distributed in the reservoir by empirical area reduction method.

h) Results achieved with progress/present status

The literatures on the modelling of sediment yield have been reviewed from International Journals. The suspended sediment concentration, rainfall for the upstream stations and streamflow series at the entry of the reservoir have been collected and analyzed for errors. The following is the status of data availability.

Sl.No.	Name of the station	Suspended sediment concentration	streamflow series	Rainfall data
1	Haripur	1987-2009	1987-2009	1985-2010
2	Jawali	1987-2010	1987-2010	
3	Jwalamukhi	1987-2010	1987-2010	
4	Nagrota	1987-2010	1987-2010	
5	Pong Dam	1987-2010	1987-2010	1987-2010
6	Dehra Gopipur			1979-2010
7	Nangal Chowk			1985-2010

The gauging station, Jwalamukhi is located on main river, Beas, where suspended sediment concentration and streamflow are measured. The other gauging stations are located on tributaries which contribute less sediment to the reservoir in comparison to main river. The daily suspended sediment concentration at Jwalamukhi is given as follows:



The maximum suspended sediment concentration observed on 11.08.2006 is 30.19 gm/lt

i) Expected date of completion: 31 March 2015

WATER RESOURCES SYSTEM DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr S K Jain	Scientist F & Head
2	Dr S K Singh	Scientist F
3	Mrs Deepa Chalisgaonkar	Scientist F
4	Dr Sanjay K Jain	Scientist F
5	Dr M K Goel	Scientist F
6	Sri D S Rathore	Scientist E2
7	Dr P K Bhunya	Scientist E1
8	Dr (Mrs) Rama Mehta	Scientist C
9	Sri L N Thakural	Scientist B
10	Sri Tanvear Ahmed	PRA
11	Sri P K Agarwal	PRA
12	Sri Yatvear Singh	SRA
13	Mrs Anju Chowdhary	SRA

WORK PROGRAM FOR THE YEAR 2012-2013

S.N.	Title	Study Team	Duration	Funding
1.	Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin	Sanjay K. Jain Sharad K. Jain S. P. Rai L. N. Thakural	3 years (4/09-3/12) (Ext.upto12/13) **Continuing study**	PDS (HP-II)
2.	Assessment of effects of sedimentation on the capacity/life of Bhakra reservoir (Gobind sagar) on river Satluj and Pong reservoir on river Beas	Sanjay K. Jain J. V. Tyagi Rama Mehta	3 years (4/09-3/12) (Ext. upto12/13) **Continuing study**	PDS (HP-II)
3.	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) **Continuing study**	NIH
4.	Analysis of water management scenarios in Tapi river basin using MIKE basin software	Rama Mehta M.K.Goel D.S.Rathore	3 years (4/10-3/13) **Continuing study**	NIH
5.	Mathematical representation of elevation-area-capacity curves for Indian reservoirs	M. K. Goel Sushil K. Singh P. K. Agarwal	1 year (4/12-3/13) **New Study**	NIH
6.	Web GIS based snow cover information system for Himalayas	D. S. Rathore D. Chalisgaonkar L. N. Thakural Tanvear Ahmed	1 year (4/12-3/13) **New Study**	NIH
7.	Software for frequency analysis in Hydrology	D. Chalisgaonkar Sushil K. Singh D. S. Rathore M. K. Goel	1 year (4/12-3/13) **New Study**	NIH
8.	Event-based rainfall runoff modelling using soft computing techniques	Rama Mehta Sushil K. Singh Yatveer Singh	1 year (4/12-3/13) **New Study**	NIH
9.	Hydrological assessment of ungauged catchments (small catchments)	P.K. Bhunya Rakesh Kumar D.S. Rathore Sanjay Kumar P.C. Nayak P.K. Agrawal Tanveer Ahmed Yatveer Singh N.K. Bhatnagar Anju Choudhary U V N Rao	4 years (5/09-3/13)	PDS (HP-II)

Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin

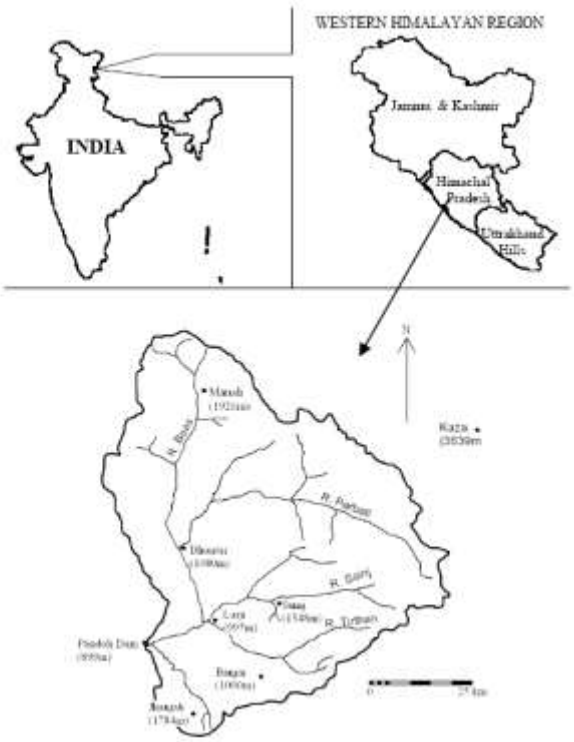
a) Study Group : Dr. Sanjay K. Jain, Dr. Sharad K. Jain, Dr. S. P. Rai, Mr. L N Thakural

b) Date of Start :1st April 2009

c) Schedule date of completion : March 2012 (Extension up to December 2013)

d) Type of study : PDS under HP II

e) **Location map / Study area**



f) Objectives:

1. To create spatial data (consisting of snow cover area and DEM) and meteorological/hydrological data base for the study area
2. To estimate snow cover area and its temporal variation using remote sensing data.
3. To estimate snow melt runoff in Beas River at Pandoh dam.
4. To study the composition of stable isotopes $\delta^{18}O/\delta D$ in the winter snow, summer rainfall, ice core and meltwater and separate snow, rain and glacier melt components in the river flow.
5. To study trend of precipitation, temperature and stream flow in Beas basin using parametric and non parametric approaches, and

6. To investigate the impact of likely future changes in climate on stream flow in the study area using GCM/RCM based scenarios.

g) Statement of the problem:

This study is being carried out under HPII. The simulation of snowmelt runoff will be carried out using remote sensing data and hydrological model. The field samples will be analysed in Nuclear Hydrology Lab. For separation of runoff into snow/glacier melt runoff. Impact of climate change on stream flow will be studied with the help of future scenarios.

h) Approved action plan: Work plan approved for four year is as follows:

Activity	Year 1	Year 2	Year 3	Year 4
Reconnaissance surveys, Data collection				
Problem conceptualization				
Meetings with participating agency				
Appointment of project staff				
Procurement of data, equipment, software, consultancy				
Database development				
Field visits for sample collection				
Applications of conceptual model				
Model calibration & Validation				
Development of climate change scenarios and impact studies				
Report writing				

i) Achievements

Year	**Objectives (for the period April 2010 - March 2011)**	**Achievements**
2010-11	i) Analysis of data and trend analysis	Achieved
	ii) Creation of data base in GIS	Achieved
	iii) Simulation of snowmelt runoff model	Achieved
	iv) Generation of climate change scenarios	Achieved

	v) Samples collection from the field vi) Analysis of samples vii) Simulation under changed scenarios	Achieved Under progress Under progress

j) Recommendation / suggestions in previous meetings of Working group / TAC / GB

There were no specific/major recommendations pertaining to the study.

k) Analysis and Results:

Trend analysis of rainfall, runoff and temperature has been carried out using regression analysis, ManKendall and Sen's Slope. As per this analysis, temperature at Bhunter and Largi is showing increasing trend and rainfall at all the station except one shows decreasing trend. The snows cover area for the years 2000-2009 have been prepared from MODIS data. IRS WiFS and AWiFS data have been collected from NRSC, Hyderabad and snow cover maps have prepared. The model is applied at two more sites i.e. at Manali and Bhunter. Simulation of stream flow has been carried out at three stations i.e. Manali, Bhunter and Pandoh. To see the impact of climate change, hypothetical scenarios were applied earlier. The work of generation of future of climate scenarios (consultancy work) was awarded to IISc, Bangalore. The report has been received from IIsc, Bangalore and results have been discussed during the visit made in June 2012. The simulation under future scenarios is under progress.

For carrying out isotopic analysis, samples have been collected from a number of sites. Weekly samples have been collected from all the sites for the period April 2011 to October 2011 and collection of samples of the year 2012 is under progress. A field visit has been made during July 2012. Analysis of these samples is under progress and results will be presented during the meeting.

l) Adopters of the results of the study and their feedback

Bhakra Beas Management Board

m) Deliverables

Reports and research papers

n) Data generated in the study

Snow cover maps from satellite data. Samples collected from the field, stream flow hydrographs etc.

Assessment of Effects of Sedimentation on the Capacity/ Life of Bhakra Reservoir (Gobind Sagar) on River Satluj and Pong Reservoir on River Beas

a) Study Group : Dr. Sanjay K. Jain,
Dr. J.V. Tyagi,
Dr. Rama Mehta

b) Date of Start : 1st April 2009

c) Schedule date of completion: March 2012 (Extension up to December 2013)

d) Type of study : PDS under HP II

e) **Location map / Study area**

f) Objectives:

The objectives of the study are as follows:

- Collection and development of data for the catchment and the reservoir by latest techniques.
- Analysis of existing sediment data at various locations in the catchments of river Satluj and Beas.
- Soil erosion modelling for both the catchments
- Development of mathematical model for instant study of Sedimentation to assess life of reservoirs.

- Dissemination of knowledge, findings and applications of the developed models to field Engineers through preparation of manual, leaflets & by organizing workshop & seminars.

g) Statement of the problem:

This Purpose Driven Study (PDS) has been taken up by BBMB. They have requested NIH for collaboration in this study. Therefore this study has been proposed under the work program of the division. BBMB has already informed about the approval of chairman, BBMB for partnership of NIH in the study.

h) Approved action plan

Creation of database

- Topographical maps of catchments of Satluj and Beas preferably the scale of 1:250000/1:50000 for drainage, contour etc. BBMB
- Conversion of catchments map into Digital map. NIH
- Landuse map using Remote Sensing data. NIH
- Soil map of the catchments. BBMB
- Digital Elevation Model (DEM) of the catchments. NIH
- Pre – impoundment and the latest observed cross- sections of Bhakra and Pong reservoir etc. BBMB
- Database comprising of rain-fall, discharge, sediments analysis for various existing sites located in Bhakra & Pong Catchments. BBMB

Assessment of sedimenation rate

- Sedimentation assessment by remote sensing
  NIH
- Sedimentation assessment by hydrographic survey
  BBMB

Modelling of soil erosion/sediment yield

- Sediment discharge relationship
  NIH/BBMB
- Modelling of soil erosion/sediment yield
  NIH

i) Achievements

Year	Objectives (for the period April 2010 - March 2011)	Achievements
2010-	i) Analysis of data and sediment rating curves	Achieved

11	ii) Creation of data base in GIS	Achieved
	iii) Processing of satellite data	Achieved
	iv) Assessment of sediment rate	Achieved
	v) Modeling of sediment yield	Under progress

j) Recommendation / suggestions in previous meetings of Working group / TAC / GB

There were no specific/major recommendations pertaining to the study.

k) Analysis and Results:

Processing of satellite data has been completed. Sedimentation rate using remote sensing data have been completed. Sediment discharge relationships for Satluj basin on the basis of regression analysis, sediment transport models and soft computing techniques like ANFIS and ANN have been deployed. Discharge data are used as input data and sediment yield as output data for entire study. Reservoir sedimentation study for both the reservoirs using remote sensing has been completed.

Land use map, soil map and DEM etc. of both the catchments have been converted into Arc SWAT format for sediment yield modeling. Simulation using ArcSWAT have been carried out for Satluj basin. The results of ArcSWAT have been obtained for Satluj basin. The progress will be presented in the meeting. The simulation for Beas basin is under progress. The report writing is under progress.

l) Adopters of the results of the study and their feedback

Bhakra Beas Management Board

m) Deliverables

Reports and research papers

n) Data generated in the study

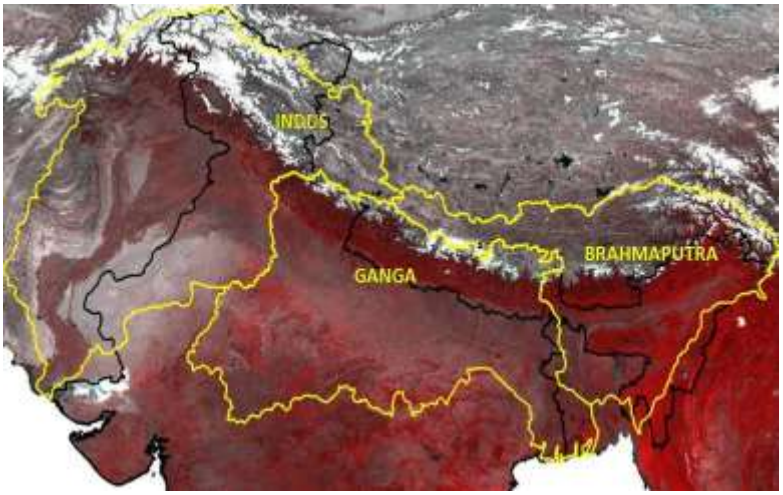
Landuse, DEM, soil etc. maps from satellite data/ancillary data, sedimentation rate from two reservoirs, and sediment yield map from two catchments.

Title of Study - Trend and variability analysis of Rainfall and Temperature in Himalayan region

Study Group	-	Mr. L. N. Thakural, Sc-B, PI Dr. Sanjay Kumar, Sc-E1, Co-PI Dr. Sanjay Kumar Jain, Sc-F, Co-PI Dr. Sharad Kumar Jain, Sc-F, Co-PI Mr. Tanveer Ahmed, PRA, Co-PI
Type of Study	-	Internal
Start Date	-	October 01, 2011
Scheduled date of completion	-	September 30, 2014

Location/Study area

The study is a case study and is a step to understand the behaviour of climate in Himalayan region covering western, central and eastern Himalayas. The Himalayas, which means the storehouse of snow and ice, is the world's youngest, highest, most rugged, sensitive and extensive mountain system having 14 peaks over 8000m and hundreds over 7000m and 530 peaks above 6000m.



Objectives of the study:

The objectives of the study are:

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.

Statement of the problem:

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

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.

Approved action plan and timeline:

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

Achievements

Year	Objectives (period April-October 2012)	Achievements
2011-12	i. Data collection	i. Temperature and Rainfall time series data for various ground stations for N.E & Western Himalayan region have been collected. Data from IMD is in process. Available APHRODITE data for rainfall from website is also downloaded.
	ii. Process and preparation of data	ii. The available raw data of rainfall and temperature have been processed and prepared for analysis. Rainfall data from APHRODITE is under process.
	iii. Creation of data base in GIS	iii. Basin maps of the study area prepared.

Recommendations / suggestions in previous WG

Recommendations	Action Taken
1. Dr. V. C. Goyal suggested redefining the objectives of the study to include innovative aspects.	1. As suggested, the objectives have been redefined.
2. Dr. R.D. Deshpande suggested that the rainfall and temperature data from APHRODITE data may be compared with available ground based observations, IMD or SASE and if ground based observations is not available in study area the nearest locations outside the study area may also be used for this purpose	2. Suggestion incorporated, comparison of rainfall from APHRODITE with the ground based stations will also be carried out and nearest locations outside the study area will be used.

Adopters of the results of the study

Mountainous basin is highly sensitive to climate change, any change in temperature and rainfall highly influences stream flow downstream. The trend describes the long smooth movement of the variable lasting over the span of observations, ignoring the short term fluctuations. The study is a step to understand the behavior of climate in Himalayan terrain of India which can be utilized for proper planning and management.

Deliverables:

Research papers and reports

Major items of equipments procured: Nil.

Lab facilities used during the study

GIS software, ERDAS Imagine and ARCGIS and Microsoft office.

Data procured and generated during the study:

Rainfall and Temperature data collected from various sources.

- Rainfall data from APHRODITE downloaded (0.5 deg. 1957-2007)
- Ground based observations of temperature and rainfall (North-East, Western Himalayan regions).
- GIS map prepared for the study area.

Study benefits/impacts

The study will evaluate the temporal and spatial characteristics and trends in temperature and rainfall time series in the Himalayan region essential for the assessment of impacts of climate variability and change on the water resources of a region.

Analysis of water management scenarios in Tapi River basin using MIKE Basin Software

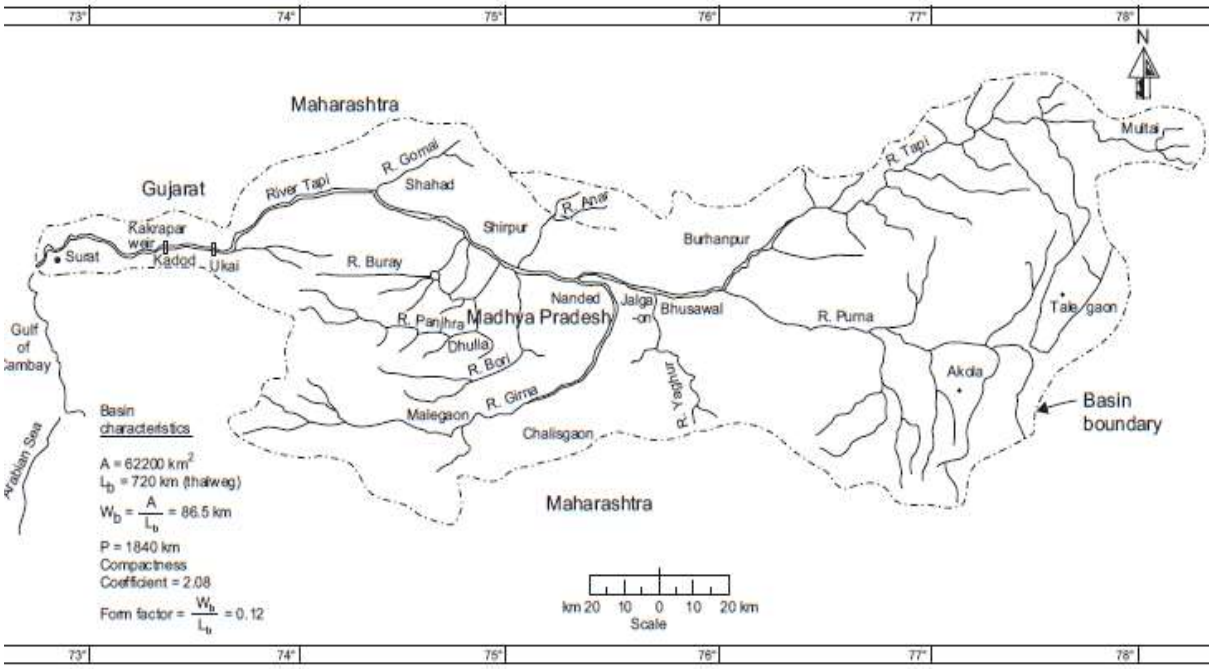
a) **Study group:** PI : Rama Mehta
Co-PI : M.K. Goel, & D.S. Rathore

b) **Date of Start:** April, 2010

c) **Date of completion:** **March, 2013**

d) **Funded:** Internally

- Tapi basin map



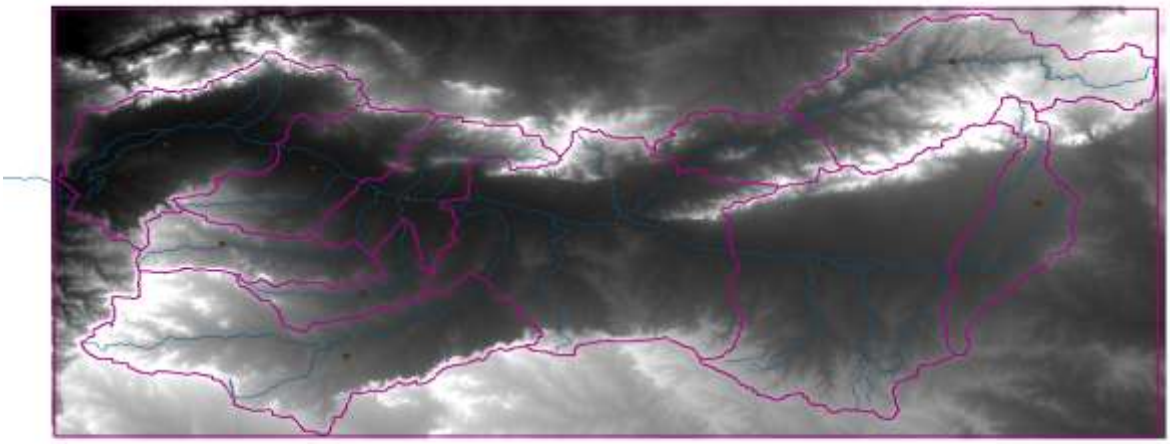
e) Objectives

1. Identification of water resources issues in the study area.
2. Model setup for Tapi river basin up to Sarangkheda using Mike basin software.
3. Analysis of different water management scenarios.

f) Statement of the problem

To develop the model for Tapi river basin for its better water management using Mike Basin Software.

DEM of Tapi basin



Action Plan

Work	First year	Second year	Third year
1. Identification of water resources issues and other information in the study area. 2. Collection of hydrological and meteorological data for all sub-basins from concern states/ NTBO, 3. Study of model and its Input data files formats.	<…>		
1. Visit to NTBO office ,Surat to collect relative data for study. 2. Data files preparation (dfso input files) for all sub-basins in Tapi basin according to the Mike basin requirement. 3. Rainfall runoff modeling for each sub-basin using NAM model.		<……>	
1. Modeling for Tapi basin with all sub-basins outputs. 2. Analysis of different water management scenarios 3. report writing and paper publication			<…>

Action Taken:

Objectives (for the period April 2010-March 2011)	Achievements
1. Identification of water resources issues and other information in the study area.	1 Discharge up to Sarangkheda with outflow of large dams existing in Tapi basin is a big issue as there is a big flood in its

2. Collection of data for 11 sub-basins in whole Tapi basin from concern states/ NTBO. 3. Study of the model for its input data.	downstream. 2 Rainfall, discharge (for few sites), water level, and other hydrological information w.e.f. 1990 to 2009 for some areas as Dedtalai, Burhanpur, Lakhpuri, Yerli & Dapori etc. have been collected with concerned agencies. For other sites, only rainfall data is available. Data for any reservoir is not received within the basin yet. 3a. Input data as Dfso files for each sub-basin is required for MIKE BASIN software. 3b. Collected data has been analyzed and used to prepare the input files as Dfso files to run the software.

Objectives (for the period April 2011-March 2012)	**Achievements**
1. Rainfall runoff modeling for each sub-basin using NAM model. 2. Specific runoff of upstream and intermediate catchments. 3. Monthly demands. 4. Routing of the intermediate catchments	1. To complete the discharge series from rainfall data for few sites (where discharge was not available), Rainfall-Runoff modeling using NAM model has been done. 2. Specific runoff series of upstream and intermediate catchments have been obtained for further analysis. 3. Averaged Monthly demands for all sub-basins have been computed from previous study and used for naturalized flow in sub-basins. 4a. Routing models have been prepared for intermediate catchments- ❖ Dedtalai & Burhanpur…..Burhanpur ❖ Lekhpuri & Yerli …. Yerli ❖ Burhanpur, Yerli & Dapuri .. Savkheda ❖ Morane, Malkheda & Savkheda… Sarangkheda ❖ Sarangkheda . … Ukai 4b.Routed flow series have been obtained with specific runoff.

Objectives (for the period April 2012- March 2013)	Achievements
1. Analysis for different water management scenarios	➢ Two sub-basins have been formed for two projects i.e. Hatnur dam and Girna dam in Tapi basin. ➢ Demands (irrigation and domestic) for projected future population (2050) have been considered. ➢ Reservoir operation models have been

2. Report writing and paper publication	run with inflow and evaporation series for Hatnur and Girna reservoirs. ➢ Outflow from all sub-basins i.e. Burhanpur, Yerli, & Savkheda up to Sarankheda has been computed. In progress...

m). Adopters of the results of the study and their feedback:

- NTBO, State Agencies: Maharashtra, Gujarat, & Madhya Pradesh

n). Deliverables:

- Research papers and technical report.

o). **Data generated in the study:**

- The hydrological and meteorological data has been collected from the concerned divisions of NTBO offices in M.P., Gujarat and Maharashtra. Data has been analysed and converted into Dfso files for MIKE BASIN software.

p). Study benefits / Impacts:

- The results of this study will lead to better Management of water resources of Tapi River Basin.

q). **Future Plan:**

- This study can be extended up to Ukai dam in future.
- Knowledge of Mike basin software and its applications for Tapi basin for water management can be used for other river basins in India.

Title of the Study: Mathematical representation of Elevation-Area-Capacity Curves for Indian reservoirs

Study Group	**-**	M. K. Goel, Sc. "F" Sushil K. Singh, Sc. "F" P. K. Agarwal, PRA
Type of Study	**-**	Internal
Start Date	**-**	April 04, 2012
Scheduled date of completion	**-**	31st March, 2013

Objective of the study:

The envisaged objective of the study is to develop mathematical relationships for characterizing elevation – area and elevation – capacity curves for Indian reservoirs.

Proposed Methodology:

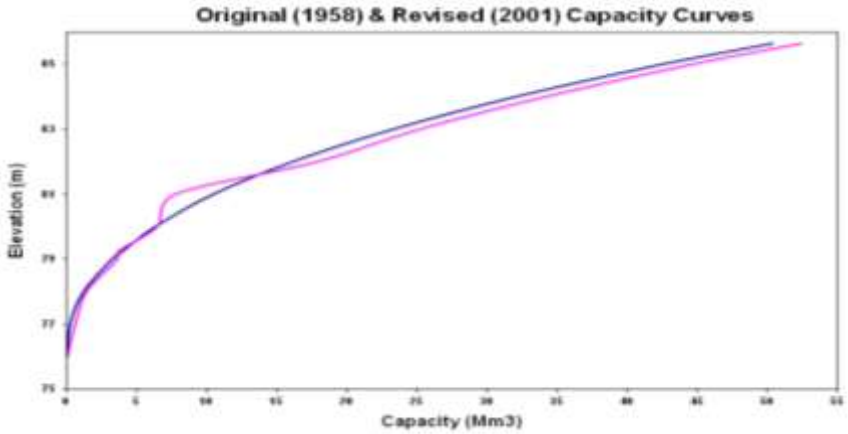
Elevation – Area and Elevation – Capacity curves for a number of Indian reservoirs are available. It is proposed to divide the reservoirs in four different types according to the shape of the gorge and characteristics of submergence area (Gorge, hill, foothill, and plain etc.) and to analyze these curves for various reservoir types for developing mathematical relationships. If suitable relationships could be established, then it would be easier to use such relationships in various simulation studies.

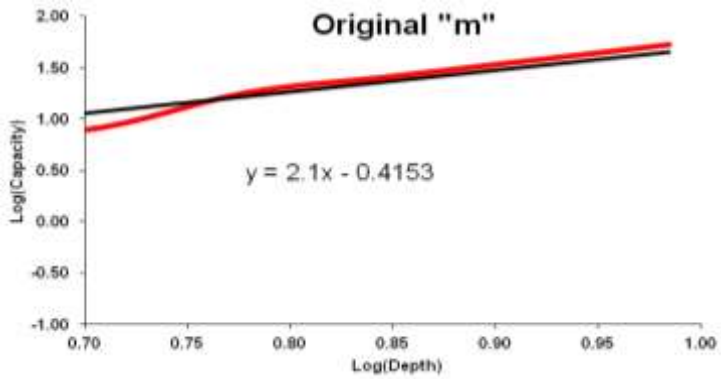
Achievement

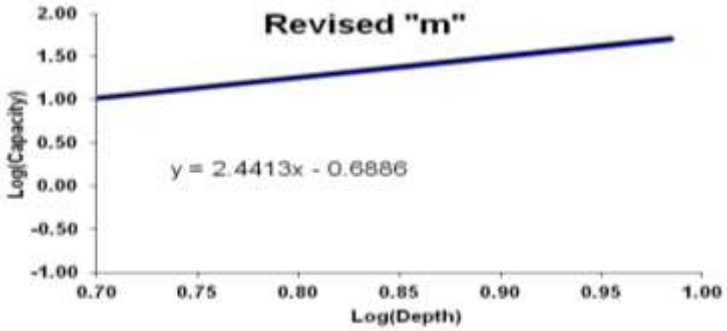
Objectives (April 2012 – till date)	Achievements
1. Development of methodology in MS-EXCEL 2. Application of methodology to known EACs of some reservoirs.	1. The methodology has been developed in MS-EXCEL as follows: a) Original and revised (if any) E-A-C table of the reservoir is tabulated. b) E-A and E-C curves, on normal and log scales, are plotted. c) The type of reservoir, depending on the value of 'm', is determined. d) Separate sheets are prepared for analysis of E-A curves and E-C curves. e) In these sheets, relative depths and relative areas/capacities are determined and plotted on normal and log scales. f) The best fit trend line equation and r^2 are determined. g) The summary is maintained in a separate file.

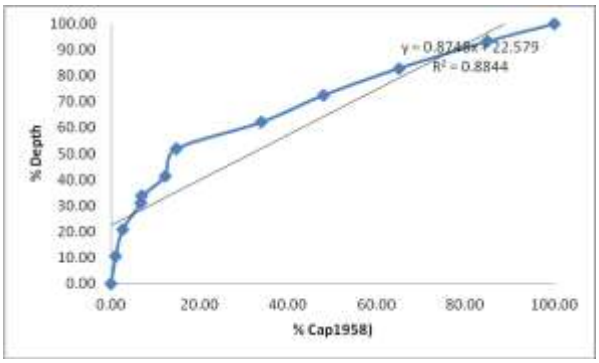
Analysis & results

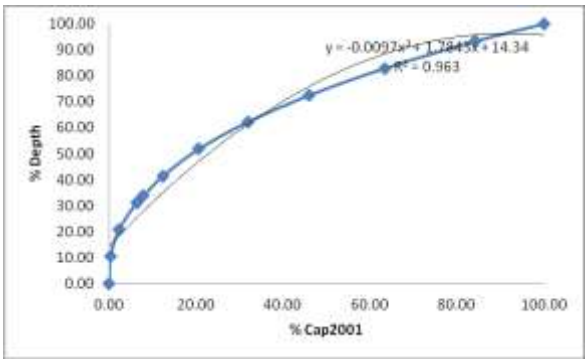
The developed approach is presented in table above. It is planned to combine the E-A and E-C curves of different reservoirs (but of the same type) in a single graph and estimate the mathematical function best representing the available graphs. In case of deviation of representations for different reservoirs, it is also possible to use the value of 'm' in the relationships. Such graphs for a reservoir are presented here for Araniar reservoir in A.P.

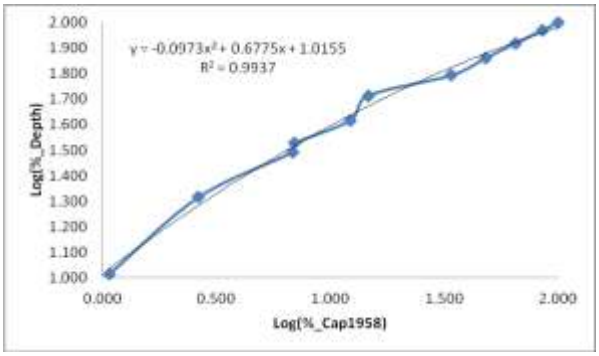


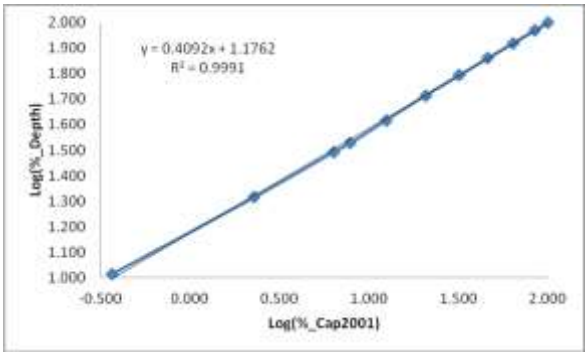












Adopters of the study and study benefits:

This study can be used by the dam authorities and water resources departments for hydrological modeling for river basin planning.

Deliverables:

Research papers and reports.

Data generated in the study

No data is being generated in this study. Rather, this study utilizes the known data of E-A-C table of a large number of Indian reservoirs.

Study benefits/impacts

The study can help in various simulation studies and in planning and management studies for reservoir projects.

Title of the Study - **Web GIS based Snow Cover Information System for Himalayas**

Study group - D. S. Rathore, Sc E2
Deepa Chalisgaonkar, Sc F
L.N. Thakural, Sc B
Tanvear Ahmad, PRA

Type of study - Internal

Date of start - April 01, 2012

Duration and Scheduled date of completion - 1 year**,** 31st March 2013

Objective:
The objective of the study is to publish snow cover information on web/ intranet using GIS server for Himalaya.

Statement of the problem
The information on snow cover, elevation, rainfall etc. is available over web. Snow cover maps of MODIS sensor and AWiFS data are available. For rainfall, APHRODITE data are available. Point temperature data are also available. These data may be processed and made available for hydrological applications as web services. Snow cover information may be disseminated sub basin/ elevation zone wise wise. Data will be downloaded, mosaiced and processed in desktop GIS. The data will be disseminated as web services using Web GIS.

Location map/study area
Himalaya range is selected for the study.

Approved action plan and timeline:

1st quarter	2nd quarter	3rd quarter	4th quarter
Download of data	Processing of the data	Preparation of WebGIS application	Writing of report

Recommendations / suggestions in previous WG

Recommendations	Action Taken
1. Dr. R.D. Deshpande suggested that the scope of the study may include other hydro meteorological data such as temperature and rainfall, relative Humidity etc. The data are already being collected in other ongoing studies and may be readily available. Further, information available from Indian satellites may be included.	Hydrometeorological data namely rainfall, temperature are included in the study. AWiFS data are included in study for part of the area.

Achievements

Year	Objectives (for the period April-October 2012)	Achievements
2012	1. Download of data	AWiFS, MODIS, GLOBE (DEM) data were downloaded. Temperature, APHRODITE data collected in other on- going study were made available. AWiFS data were for part of the area. Data for year 2009 were collected/ will be utilized.
	2. Processing of the data Metrological Data collection	Data were processed to obtain raster thematic, mosaiced data for Himalaya/ part of it.

Deliverables:

Web service for snow cover and hydrometeorology for Himalaya for year 2009.

Data procured and generated during the study:

Satellite data downloaded/ available

- Awif (March and Novemember 2009, 2 scenes each for Uttarakhand)
- MODIS/Aqua Snow Cover, 8 day composite (2009, 500 m)
- APHRODITE (daily, 0.5 deg. 1957 onwards)
- Temperature (point data, monthly, North- East, Satluj, Beas)
- GLOBE DEM

Data generated

Snow cover (AWiFS), Snow cover mosaic (Himalaya), Temperature interpolated raster, elevation zones and sub basins.

Users/ beneficiaries of the study -Policy makers and planners, line departments

Title of the Study: Software for Frequency Analysis in Hydrology

Project Team Deepa Chalisgaonkar
D S Rathore
S K Singh
M K Goel

Date of Start **:** April 1, 2012

Duration **:** 1 year

Funding **:** Internal

Objective :
The envisaged objective is to develop a menu driven, interactive software for frequency analysis of hydrological data using different distributions.

Methodology :
A menu driven, user-friendly software is being developed in Visual Basic language to carry out frequency analysis with different types of information. The software will provide a user-friendly and efficient environment that will be easy to use by water managers. Furthermore, the software will be built with a graphical user interface that requires little training for using it. The software will use a multitude of algorithms for data import, validation and analysis. It allows the handling of a multiple site project and the comparison of quantile estimates with or without historical information.

This software will help to calculate probability plotting positions, estimate the parameters of the various statistical distributions, evaluate the fit of these distributions, estimate flood quantiles, and compare estimates obtained with and without use of historical information. The software will compute the maximum likelihood estimates of probability distribution parameters for several statistical distributions used in flood frequency analysis.

It will be a user friendly tool that can be used by practitioners for solving frequency analysis problems in the field of hydrology.

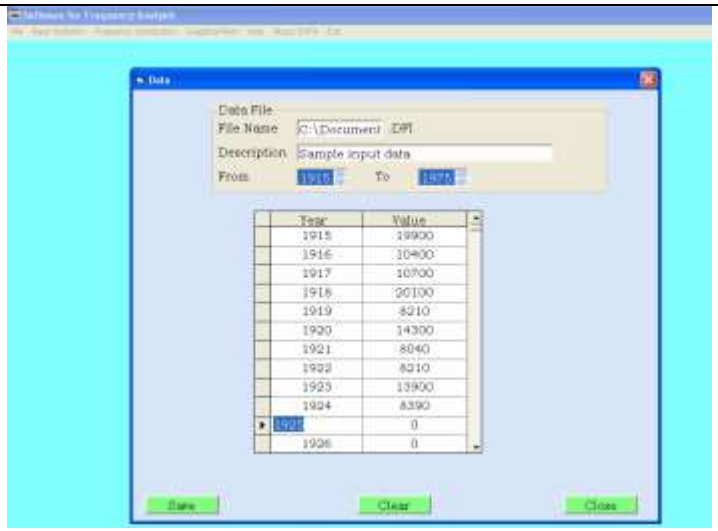
Achievement

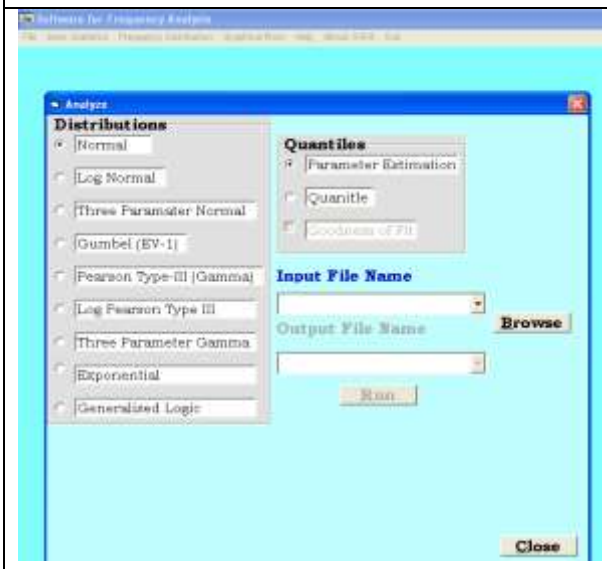
Objectives (April 2012 – till date)	Achievements
1. Review of existing softwares	1. Downloaded software from frequency analysis of hydrological data like Hyfran, HEC-SSP, Rainbow etc were downloaded and their features were explored.
2. Design and Development of the framework of the software	2. Done
3. Development of module for data entry and updation.	3. Done
4 Development of module for graphical representation	4. Done alone with option for copy and printing of graph
5. Development o 'Help' module	5. The coding has been done but final editing is still required.

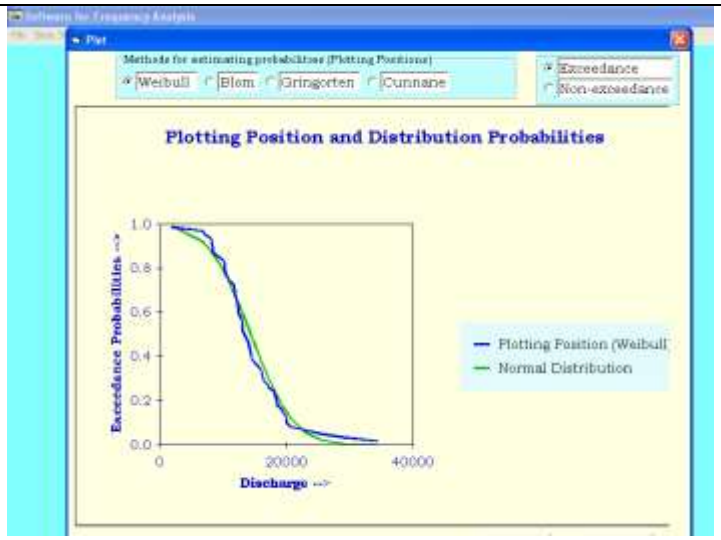
6. Development of one option for frequency analysis.	6. The option 'Normal Distribution' has been completed.

Results

Some of the screens shots for frequency analysis using 'Normal Distribution' are shown below:







The software will be developed on the similar lines for other distributions.

Data generated in the study

This work is related to software development. Hence no data is being generated.

Adopters of the study and study benefits:

It will be a user friendly tool that can be used by practitioners for solving frequency analysis problems in the field of hydrology.

Deliverables:
Research papers and reports.

Title of the Study: Event Based Rainfall Runoff Modelling Using Soft Computing Techniques.

Study group: Scientists - Rama Mehta & Sushil K. Singh
Scientific staff - Yatveer Singh

Date of start of study: April, 2012

Date of completion of study; March, 2013

Type of study; Internal

Objectives of study:
To model the event-based rainfall-runoff using soft-computing techniques, viz., ANN and ANFIS, considering the basin-wise multi-storm data.

Statement of problem and brief methodology
Modeling of rainfall-runoff plays an important role in the design and operation of hydraulic systems. Unit response of catchment can be obtained using traditional approaches such as linear programming and least square methods. A lot of information can be obtained during the event because the system is under greater excitation during storms. Scarcity of hydrological data poses practical problems for the application of more complex models (either conceptual or physically-based) for runoff modeling. In such cases, system based approach is another alternative for modeling. During last decade, there has been an increased interest in applying new emerging techniques as Fuzzy Inference System (FIS) and Artificial Neural Network (ANN) for solving hydrological problems.

With consideration of event based rainfall –runoff, unit response of the system is intended to be developed with ANN and ANFIS techniques. The proposed model is intended to be developed and tested with published event based data of different catchments. It is intended to apply this technique also to a specific Indian basin.

This study explores the application of neuro-fuzzy inference systems for event-based rainfall-runoff modeling. These models intend to describe the non-linear relationship between input/antecedent and output/consequence to the real system. Models are developed by Artificial Neural Fuzzy Inference System (ANFIS) - grid and cluster techniques, which identified suitable numbers of fuzzy if-then rules through proper

partition of the input space. Three variables as rainfall, temperature and evaporation are considered as antecedent and runoff as consequence of the model. The input variables are fuzzified with trapmf, gbellmf or guassmf membership functions (Jang et al, 1997) to develop the fuzzy rules. The consequent function is chosen to be linear or constant in their parameters, and a standard least square error method is employed for parameter estimation. The first stage in the inference process of a TS fuzzy model is the calculation of the degree of fulfillment (DOF) of each rule. The output of each rule is obtained by the evaluation of the membership values. Finally the overall fuzzy model response is obtained as the weighted average of the individual rule response.

To evaluate the performance of developed model, different evaluation criteria will be considered while comparing the observed and simulated runoff hydrographs. These criteria include the root mean square error (RMSE), standard error of estimate (SEE), Nash and Sutcliffe (1970) criterion, a recently proposed criterion considering the multiple isolated storm.

Action plan

Activity	I-Quarter	II-Quarter	III-Quarter	IV-Quarter
Review of literature and collection of data				
Development and application of soft computing methods for rainfall-runoff modelling				
Testing, evaluation, and comparison with different methods				
Writing of report				

Action Taken:

Review of literature and collection of data - Literature review for the present study has been completed. Data has been collected from three published papers (Bree_1978; Diskin and Boneh _1975 and Gupta)

Apart from other UH and IUH methods, the soft computing techniques have been used for future forecast. 22storms data have been collected from Bree (1978) paper.

Analysis for Bree data have been completed and analysed with different sets of data input using ANFIS- Grid Partitioning and Subtractive Partitioning methods. Optimum results have been obtained with different sets of Membership functions in terms of types and numbers. Outputs from all developed models have been plotted with observed values. Potential of the Results have been observed with performance indices.

Model development with other data by; Diskin and Boneh _1975 and Gupta is under process.

SPONSORED PROJECT (HP-2) REFERENCE CODE: **12/94/2005-B & B/VOL-V/922-953 dated 3/9/2008.**

(a) TITLE OF THE PROJECT: HYDROLOGICAL ASSESSMENT OF UNGAUGED CATCHMENTS (SMALL CATCHMENT)

(b) STUDY GROUP:

Principal Investigator (PI):		Dr. Pradeep Kumar Bhunya, Sc. E1
Co-PI	:	Dr. Rakesh Kumar, Sc. F & Head (SW Div.)
Investigators :	(i)	Mr. D S Rathore, Sc. E2, WRS Div.
	(ii)	Dr. Sanjay Kumar, Sc. E1, SW Div.
	(iii)	Dr. P.C.Nayak, Sc. C, RC Kakinada
Project Staffs:	(i)	Mr. P.K.Agarwal, PRA, WRS Div.,
	(ii)	Mr.Tanveer Ahmed, PRA, WRS Div.,
	(iii)	Mr.Yatveer Singh, SRA, WRS Div.,
	(iv)	Mr.N.K.Bhatnagar,SRA.,SWDiv.,
	(v)	Mrs. Anju Choudhary, SRA, WRS Div.,
	(vi)	Mr. U V N Rao, SRA, RC Kakinada

Nodal Officers Representing From Govt. Of Orissa (vide letter No- Dir-Hyd-HP II-PDS 24/7-617 dated 6/8/2007): (i) Director (Hydrology and W.R. Planning-I), Govt. Of Orissa,

(ii) Er. S K Malik (Deputy Director) and (iii)Er. S B Mohanty (Assistant Director) at Director of Hydrometry, Govt. Of Orissa.

(c) TYPE OF STUDY: PDS (Under Hydrology project-II), Funded externally under HP II, vide Letter No. 12/94/2005-B & B/VOL-V/922-953 dated 3/9/2008.

(d) DATE OF START: May, 2009

(e) DURATION OF THE STUDY AND SCHEDULED DATE OF COMPLETION: Duration of four years (2009-2013), and expected date of completion is March, 2013 (revised scheduled approved by the Ministry).

(f) OBJECTIVES OF THE STUDY:

1. To calibrate and validate an event based model employing unit hydrograph approach to the available data of flood events for the gauged catchments in the region.
2. To identify few robust flood frequency distributions that may be used for the computation of return period flood for the gauged catchments in the region, and to develop regional flood formulae using statistical correlation of the observed peak characteristics with important catchment and storm

characteristics, for the estimation of the peak, and time to peak for the ungauged catchments in the region.

3. To develop regional unit hydrograph, and regional flood frequency analysis procedures utilizing the available data and methodologies.
4. To develop methodology for the regionalization of the hydrological parameters for the computation of the water availability for the ungauged catchments in the region.

(g) STUDY AREA AND LOCATION MAP

The Ministry has recommended small catchments in Mahanadi basin as a study area for this project (ref: Letter No. 12/94/2005-B & B/VOL-V/922-953 dated 3/9/2008). Since the basins of Rushukulya and Brahmani are near Mahanadi and has a confluence at *Puri* and *Cuttack* districts, a few selected small catchments from these two basins are envisaged to be included in this project so as to make the results refined.

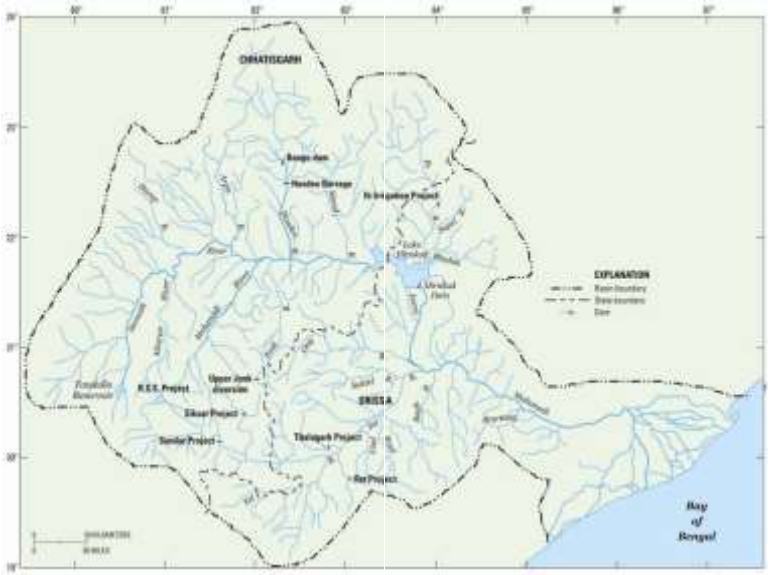


Figure: Mahanadi basin in *Orissa* and *Chatisgarh* states.

(h) STATEMENT OF THE PROBLEM AND BRIEF METHODOLOGY

Briefly the following steps are followed for this study:

(i) Testing few homogeneity tests. (ii) Regionalize the pdf parameters used for transmuting the UH using available UH for a region., (iii) Regional formulae for peak flow and time to peak of UH for the region on basis of geomorphological characteristics of the basins using new methods like ANN, Fuzzy and non-linear regression model, (iv) Explore the potentiality of new synthetic unit hydrograph methods (gamma, beta, Weibull) and identify the best method for the region, (v) Regionalization of parameters of the robust AMS model, (vi) Deriving regional formulae, (vii) Regional formulae for q (T) using regression techniques, (viii) Peak over threshold methods, (ix) Regionalization of flow duration curves using available data, (x)Uncertainty and risk factor analysis

(i) APPROVED ACTION PLAN AND EXPECTED OUTCOME

On basis of the detailed study and analyzing the results of other organizations working on this area in the region, a standardized design practice is to be developed for the ungauged catchments in the region. The following are the expected outcome from the project.

1. Regional unit hydrograph relationships for the region are to be developed. Knowing the catchment characteristics for an ungauged catchment in the region from the available topographical sheet and climatological data, the UH for that catchment can be derived for the region. This shall provide the user to opt among five methods (Snyder, SCS, Gamma, Beta and Weibull method) and the methods to estimate UH parameters like time to peak and peak flow form geo morphological data.
2. Recommend a standard statistical distribution procedure for homogeneity tests.
3. Regional formulae to be used for ungauged catchment in the region to estimate peak flood and time to peak for different storms. The formulae shall be derived with latest data and shall also provide the uncertainty (with risk and reliability degree).
4. Recommend a standard flood frequency models with robust (and least biased) distributions for the different regions in Mahanadi zone. This may be recommended for at-site analysis for return period floods.
5. Recommend a regional flood formulae for the different small catchments (and 13 catchments with records as outflow in CWC gauge sites) and regions in Mahanadi zone.
6. Recommend a standard POT method for return period flood computation when the annual maximum series is short. Regional flow duration curve to estimate the dependable flows for the ungauged catchment.

The following bar chart depicts the scheduled action and time frame that is being followed, and has to be pursued during last phase :

Sl	Technical Component	Technical Activity	11-12		12-13	
			1	2	1	2
1	Analysis of GIS data	Checking up the geomorphology data (including land use) with procured satellite imageries and available toposheets (SOI) in the region (PKB, DSR)				

		Digitization of data, analysis, interpretation for land use and geomorphological data with change interpretation, and reporting of results, modifying/updating the RC chapter and chapter- Fundamentals of Remote Sensing & its Application in Hydrology (PKB, DSR)				
2	Model application (Flood frequency analysis, Regional flood, Regional Unit hydrograph, Rating curve and Regional flow duration formulae)	Application of available models to storm and flood data (PKB, RK, SK, PCN and project staffs)				
		Model application (HEC1 and Fortran programs/Matlab/Systat) using the processed storm and flood data for the ungauged /partially data catchments in the study area. (PKB, RK, SK, PCN and project staffs)				
		Interpretation & reporting of results in the chapters:- Flood frequency/regional flood formulae/UH ,regional UH and design storm chapters(PKB, RK, SK, PCN)				
3	Model development (Extrapolation, pruning, network size and generalization)	Application of available models, and using other software like Mat lab, Mathematica, Systat etc. to combine them and use. (PKB, RK, DSR, SK, PCN)				
		Processing of storm/flood (daily/hourly time period scales) for concurrent periods(PKB, RK, SK, PCN and project staffs)				
		Analysis, interpretation & reporting of results(PKB, RK, DSR, SK, PCN)				
4	Application of recent SUH models	Model application and report of results in systematic table (with reference) in the on-going chapter (PKB)				
5	Application of allied hydrological models.	Model development (PKB, RK, SK)				
		Programming & model application (e.g. parameter optimization, regionalize of independent parameters in zone etc.) (PKB)				
		Analysis, interpretation & reporting of results(PKB, RK, DSR, SK, PCN)				
6	Final report	Summarization of all the above results & reporting (PKB, RK, DSR, SK, PCN)				
7	Dissemination of outcome	Three training courses have been organized and one is proposed at Bhubaneswar during May 2012 (PKB, RK, DSR, SK, PCN and project staffs)				

Completed	
To be done	

1-April to October; **2-**Novemberl-March

RK: Rakesh Kumar, Sc-F; DSR: D S Rathore, Sc-E2;SK: Sanjay Kumar, Sc-E1; PKB: P K Bhunya, Sc-E1; PCN: P C Nayak, Sc-C.

(j) ACHIEVEMENTS IN THE LAST WG MEETING

Achievements are given point-wise at sl. (l), and the training course under the project is (both conducted earlier and to be organized shortly) as follows:

Three training courses have been organized under India-Hydrology Project Phase-II. The last course was organized during July 25-29, 2011. The participants were from different states (coming under HP2), e.g. Orissa, AP, HP, Chatisgarh, Karnataka, Maharashtra, and Gujarat. As per the participants requests a training course on such allied topics has been proposed during October 15-19, 2012 at Roorkee and the invitations to the respective states under have been sent by the HP2 office.

(k) Recommendations : There was no such critical suggestions and recommendations from the working group

(l) RESULTS ACHIEVED DURING THIS PERIOD (MARCH, 2012- OCT, 2012)

Six major objectives have been stressed during this period, and they are summarized as follows:

1. Refined the results of regional flood formulae for Mahanadi small catchments in reference to CWC report, in addition to above three distributions were used i.e. Wakeby, PT3 and Gumbel.
2. Updated the morphological parameters (data), and their variations (regional) for the Mahanadi small catchments from imagery and respective toposheet. It was for twenty-six (26) small bridge catchments. These have been tabled in Chapter- Processing and Analysis of Hydro-Meteorological Data. Using these results three chapters were completed i.e. Study Area and Stream Morphology, Processing and Analysis of Hydro-Meteorological Data and Fundamentals of Remote Sensing & its Application in Hydrology.
3. Table the short-term flood events for use in hydrograph derivation and SUH development, along with the UH parameters in regional scale. Completed the *hydrograph derivation* and *SUH development*, along with the *UH parameters in regional scale*, using available short-term flood events. Three more pdfs were used for SUH derivation.
4. Developed the rating curves regional flow duration curves with the recently procured data. This was for thirteen CWC sites and 23 small catchments (taken from earlier 3d report). The chapter in regards to RC is completed.

5. *AMS and POT methods* have been used *testing robustness*. This is *for the available flood data* in the region, and two separate chapters has been started.

   Since this activity has been planned for the last phase in the project period, and the project report has to be submitted by March 2013, some salient works has to be done in priority, and they area as follows: (i) encamping sub-programs (sub-computation) dealing vitally for some salient calculations are to be assembled in an Annexure and a few references has to be added which points a few allied works being done in India and abroad. (ii) Out of the results obtained so far, some technical papers have been submitted for review, so that the methods and approach might be examined and be fruitful in technical aspects, (iii) As per the requests of some of the participants, a training course on such allied topics had been discussed with Director (Hydrometry), Bhubaneswar and had been proposed this year in Orissa, however, as per their convenient this may be arranged mutually before March 2013 .

(m) ADOPTERS OF THE RESULTS OF THE STUDY AND THEIR FEEDBACK

Ministry of Water Resources under Govt. Of Orissa, and CWC, New Delhi.

(n) DELIVERABLES:

Research papers, user friendly menu and catalogue with focus on a real problem, that of estimating design flood magnitude at sites with either short records, or no flow data at all.

(o) STUDY BENEFITS/IMPACTS:

The study shall give as an user friendly menu and catalogue with focus on a real problem, that of estimating design flood magnitude at sites with either short records, or no flow data at all. This shall focus on two types of flood analysis i.e. with short-term data and daily or annual maximum data base. It would be useful for the Hydrological Design Aids project under HP-II.

(p) FUTURE PLAN:

In future, it is envisaged to add a few more physiographic parameters using remote sensing imageries and GIS, which are sometime difficult to interpret from the Survey of India toposheets or might have changed due to natural and human activities in the region. CWC has already stipulated design return periods for different schemes depending on their size (small, medium, and large) along with the specification for using either PMF or SMF for design

flood computation. Therefore, it is envisaged to analyses various distributions and recommends a standard statistical distribution for flood frequency analysis in the region. This shall include also the uncertainty bands and the robustness of used models for these cases. The theoretical analysis shall include all the recent developments in the topic and the latest available data of the region. For future scope, a margin has to be kept for climate change scenario, and its effect on flood impacts in river regions.

RESEARCH MANAGEMENT AND OUTREACH DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr V C Goyal	Scientist F & Head
2	Dr R V Kale	Scientist B
3	Sri Subhash Kichlu	PRA
4	Sri Rajesh Agarwal	RA

WORK PROGRAMME FOR THE YEAR 2011-2012

SN	Study	Team	Duration
Internal Studies			
1	Recession Flow Analysis for Evaluation of Spring Flow in Indian Catchments	Ravindra V Kale (PI) V C Goyal	DOS: Apr 2011 DOC: Mar 2013

PROPOSED WORK PROGRAMME FOR THE YEAR 2012-2013

SN	Study	Team	Duration
Internal Studies			
1	Recession Flow Analysis for Evaluation of Spring Flow in Indian Catchments	Ravindra V Kale (PI) V C Goyal	DOS: Apr 2011 DOC: Mar 2013
2	Understanding Water Use Efficiency: A Field Based Research and Documentation of Best Practices on Water Use Efficiency and Conservation	**Joint study** **III. NIH:** V C Goyal (PI) Subhash Kichlu Rajesh Agrawal **IV. Indian Environment Law Offices, Gurgaon:** Ms Archana Vaidya Ms Shilpa Chohan Mr Shawahiq Siddiqui (PI)	DOS: Apr 2012 DOC: Mar 2013 **(New Study)**
3	Pilot Basin Studies (PBS) at six identified sites, jointly with the RCs and CFMSs	**Joint study** **NIH HQs:** V C Goyal (Leader) Ravindra V. Kale New Scientist **NIH RCs/CFMSs:** RC-Belgaum RC-Jammu RC-Kakinada RC-Sagar CFMS-Guwahati CFMS-Patna	DOS: Apr 2012 DOC: Mar 2015 **(New Study)**

Annexure-1

Manual of Good Practices on Water Use Efficiency

Table of Contents (Indicative)

4.8 Water Treatment

4.9 Boiler and Steam Systems

4.10 Refrigeration (including Chilled Water)

4.11 Once-Through Cooling

4.12 Management and Employee Awareness Programs on water use efficiency

4.13 Industrial Site Specific Conservation

4.14 Cost-Benefit Analysis of effectiveness for Industrial Water efficient use practices

4.15 Incentives and award

5.0 Agricultural Water Use Efficiency

5.1 Good practices in Agricultural Irrigation Water Use and management

5.2 Irrigation Scheduling

5.3 Volumetric Measurement of Irrigation Water Use by designated government agencies at the state level

5.4 Efficient Management of Irrigation Canals

5.5 Drip/Micro-Irrigation System

5.6 Low Pressure Sprinkler Irrigation Systems

5.7 Linear Move Sprinkler Irrigation Systems

5.8 Tail-water Recovery and Reuse System

5.9 Traditional methods of water conservation, harvesting and farming

5.10 Traditional knowledge in water recharge and storage for irrigation

5.11 Cost benefit analysis in water efficiency in irrigation and role of government agencies involved

5.12 Incentives and award