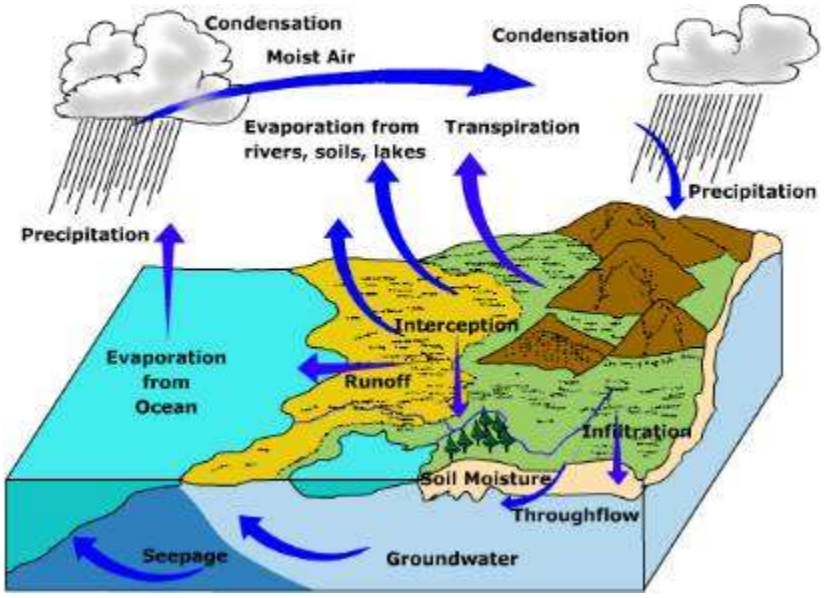
AGENDA AND AGENDA NOTES FOR THE 35th MEETING OF THE WORKING GROUP OF NIH

OCTOBER 11-12, 2011
AT 1100 HRS.



NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE-247667

AGENDA AND AGENDA NOTES FOR THE 35th MEETING OF THE WORKING GROUP OF NIH

AGENDA ITEMS

ITEM NO. 35.1 OPENING REMARKS BY THE CHAIRMAN

ITEM NO. 35.2 Confirmation of the minutes of 34th meeting of the Working Group

The 34th meeting of the Working Group was held during April 7-8, 2011. The minutes of the meeting were circulated to all the members and invitees vide letter No. NIH/RCMU/34th WG/11 dated May10, 2011. No comments were received on the circulated minutes. A copy of the minutes of the 34th Working Group is given in **Annexure A.**

The Working Group may please confirm the minutes.

ITEM NO. 35.3: Action taken on the decisions/recommendations of the previous Working Group meeting

During the 34th Working Group meeting, following recommendations/ suggestions had been made by the Working Group members. The actions taken on the recommendations/ suggestions are as follows:

Item	Recommendations/suggestions	Action Taken
EH Division WP 2011-12 Item#3	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 • Dr N C Ghosh advised to publish the research papers after obtaining the patent of the developed media for removal of fluoride from drinkinh water. • Dr V C goyal suggested referring "Terafil" water filter developed by IMMT-Bhubneshwar.	
GWH Division WP 2011-12 Item#3	Groundwater Flouride Contamination in different parts of India and study severity of Flourosis in a drought prone area Team: A K dwivedi (PI), Shobha	

	Ram, N C Ghosh, Anupma Sharma, Sumant Kumar, Sanjay Mittal, Ramchandra • Sri Dwivedi informed that the study will have two components: (i) preparation of a position document on groundwater fluoride contamination in India (2011-12), and (ii) to study variability and severity of fluorosis in a selected region (grought prone area) (2012-13). • DR V C goyal suggested that contents of the position document should be prepared and sent to the members for their comments. • Also, it was suggested that presence of Boron, which is found where fluoride is in excess, should be studies for any possible relationship.	
SWHD WP 2010-11 Item#4	Snow melt Runoff Modelling in Sultej Basin Team: AR Senthil Kumar, Monohar Arora, A Agarwal, D S Rathore, Digamber Singh • Dr. V V S gurunadha Rao suggested to predict one period value of streamfloe and check it with BBMB.	

ITEM NO. 35.4: Presentation and discussion on the status and progress of the work programme for the year 2011-2012.

The approved Work Programme of the Five Divisions of the Institute for the year 2011-12 has been given in the **Annexure B** in the following order**:**

1. Environmental Hydrology Division 33
2. Ground Water Hydrology Division 51
3. Hydrological Investigation Division 72
4. Surface Water Hydrology Division 135
5. Water Resources System Division 176
6. Research Coordination & Management Unit (RCMU) 208

The division-wise work programme has been categorized into three groups: (a) Internally funded studies, (b) Sponsored studies, and (c) Purpose Driven Studies under HP-II. The numbers of projects being handled by each division under different categories are given below:

Division	**New**		**Ongoing**		**Total**
	Internally funded	Sponsored (including HP-II)	Internally funded	Sponsored (including HP-II)	
Environmental Hydrology	01	0	02	02	**05**
Ground Water Hydrology	00	01	04	01	**06**
Hydrologic Investigation	02	01	03	07	**13**
Surface Water Hydrology	0	0	09	0	**09**
Water Resources System	01	0	05	04	**10**
RCMU			01		**01**
Total	**04**	**02**	**24**	**14**	**44**

During the present meeting, Division-wise progress and status of the work programme for the year 2011-12 shall be presented in detail. The Working Group may please consider the progress and status of the Work Programme for the year 2011-2012.

ITEM NO. 34.5 : ANY OTHER ITEM WITH THE PERMISSION OF THE CHAIR.

ANNEXURE – A

MINUTES OF THE
34TH MEETING OF WORKING GROUP OF NIH
HELD AT NIH, ROORKEE, DURING APRIL 7-8, 2011

The 34th meeting of the Working Group of NIH was held at NIH, Roorkee, during April 7-8, 2011 under the Chairmanship of Director, NIH. The list of the participants of the meeting is given in **Annexure-I**.

ITEM NO. 34.1: OPENING REMARKS BY THE CHAIRMAN

The Chairman, WG welcomed the Working Group members and the Scientists of the Institute. At the outset he welcomed Dr V C Goyal as the new Member-Secretary and thanked Dr N C Ghosh for ably conducting the meetings during the past few years. The Chairman then mentioned about the new tools of performance evaluation, such as Result Framework Document (RFD), which require strict discipline among the government organizations, including NIH.

The Chairman stated that 2011-12 will be the last year of the XIth 5-year Plan. He informed that the Institute is expected to take a leading role in carrying out various R&D studies under the 'National Water Mission' launched by the Ministry of Water Resources, Govt. of India. Thereafter, the Chairman 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	Er Rishi Srivastava	Integrated water management studies for large basin (say larger than 1000 km^2) by accounting for climate change impact
2	Er N.N. Rai	▪ Ungauged catchment hydrology studies ▪ Water availability studies for small hydro power projects with specific emphasis to North-East region ▪ Integrated hydrological modeling approach in estimation of design flood ▪ Research studies on sediment yield analysis including field measurements Er Rai agreed to provide a note on his suggestions.
3	Prof. B.P. Singh	• Project on impact of nuclear waste on the surface and ground water quality • Possible impact studies for Narora Power Plant • Need to provide more emphasis on the fundamental research • Heat effect on isotope studies
4	Sh S.K. Mittal	• Emphasized on Society based research • Need to preserve and protect ground water resources • Possible research areas: impact of climate change studies, geothermal studies, ground water quality, surface water quality and sustainable water resources

		management
5	Dr. S.K. Gupta	▪ Good blend of basic and applied research should be carried out ▪ Research projects on water quality issue need to be undertaken ▪ Need to focus on the water productivity
6	Dr. V.V.S. Gurunadha Rao	• Need to utilize the results of the research studies for welfare of society • Aquifer mapping • Need to follow innovative way for acquisition of data, mapping and their dissemination
7	Dr. M.M. Kimothi	• Need of efficient mechanism to transfer technology to common users and stakeholders • Linkage between line departments and NIH to identify the needs • Effective dissemination of results of ongoing studies
8	Prof. K.V. Jayakumar	• Expressed reservation on NIH deviation from research oriented studies to more implementation based studies • Need to focus research studies on urban water management and climate change impact
9	Dr. R.P. Singh	• Planning and management of surface and ground water resources should be at basin scale • Study for deeper aquifer • Thrust should be on management of aquifer • Methodologies to recharge deeper (confined) aquifer
10	Er N K Sharma	• Seek international funding- e.g. IHP programme does not have a single station in South Asia region, and NIH should work in this direction • Harnessing of tidal energy
11	Sri N Y Apte	• NIH should bring out documentation of international quality (e.g. WMO) • Data from different studies/projects should be entered in a single database (e.g. SWDES, HYMOS)

The Chairman informed that the composition of the Working Group has been revised by the Chairman, GB, and now there will be a single Working Group for the Institute. He mentioned that in the new composition, members have been drawn to cover the various fields of expertise, including members from nongovernmental organizations and independent experts. He further informed that composition of the nominated members in the TAC has also been revised.

After introduction by the members and the invitees, the Chairman asked the Member-Secretary to take up the agenda items.

ITEM NO. 34.2: CONFIRMATION OF THE MINUTES OF THE 33rd MEETING OF THE WORKING GROUP

The 33rd meeting of the Working Group was held during October 7-8, 2010. The minutes of the meeting were circulated to all the members and invitees vide letter No. NIH/GWD/WG/10 dated November 12, 2010. No comments were received on the circulated minutes. As no comments were received from any member, the minutes were confirmed.

ITEM NO. 34.3: 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 33rd working group meeting.

ITEM NO. 34.4: PRESENTATION AND DISCUSSION ON THE STATUS AND PROGRESS OF THE WORK PROGRAMME FOR THE YEAR 2010-2011

The Member-Secretary made a brief presentation outlining account of the previous year work programme (2010-11) including number of studies completed and ongoing concluded during the year, and also the proposed work programme for the year 2011-12 under two categories: (i) internally funded projects, and (ii) sponsored/consultancy projects, including purpose driven projects under HP-II.

Division-wise summary of the studies undertaken at the Institute during 2010-11 is given below:

Division	**Completed**		**Ongoing**		**Total**
	Internally funded	Sponsored (including HP-II)	Internally funded	Sponsored (including HP-II)	
Environmental Hydrology	02	01	02	01	**06**
Ground Water Hydrology	0	01	02	01	**04**
Hydrological Investigations	0	0	03	07	**10**
Surface Water Hydrology	01	01	08	0	**10**
Water Resources System	05	0	03	03	**11**
Total	**08**	**03**	**18**	**12**	**41**

ITEM NO. 34.5: PRESENTATION AND FINALIZATION OF THE WORK PROGRAMME FOR THE YEAR 2011-12

Division-wise summary of the studies proposed at the Institute during 2011-12 is given below:

Division	New		Ongoing		Total
	Internally funded	Sponsored (including HP-II)	Internally funded	Sponsored (including HP-II)	
Environmental Hydrology	01	0	02	01	**04**
Ground Water Hydrology	02	0	02	01	**05**
Hydrological Investigations	02	0	03	07	**12**
Surface Water Hydrology	02	0	07*	0	**09**
Water Resources System	02	01	03	03	**09**
RCMU	01	0	0	0	**01**
Total	**10**	**01**	**17**	**12**	**40**

*One study was dropped from the previous year's programme.

Approved work programme of different Divisions for the years 2010-11 and 2011-12, as recommended by the Working Group, is given in the next section. Suggestions/comments of the members on each study/project presented are indicated against respective item in the tables.

ENVIRONMENTAL HYDROLOGY DIVISION

Work Programme for 2010-11

SN	Title of the Project/Study	Recommendations/suggestions
1	Modelling of Pesticide Transport in Ground Water – a case study of Metropolitan City – Vadodara Team: M.K. Sharma, V.K. Choubey, A.K. Keshari, (IIT-D) DOS: Oct 2007 DOC: Mar 31, 2011	Completed study.
2	Impact of Kumbha Mela 2010 on water quality of surface water and ground water resources in and around Hardwar City Team: V K Choubey, M K Sharma, Omkar Singh, D.G. Durbude DOS: Jan 2010 DOC: Mar 31, 2011	Completed study. In absence of the PI, Dr M K Sharma briefed about the study.
3	Spatial Variability of Ground Water Quality in Kandi, Sirowal and Shiwalik Belts of Jammu Region, J&K (India) Team: Omkar Singh, V K Choubey, D.G. Durbude, M K Sharma DOS: Apr 2010 DOC: Mar 2011	Scheduled date of completion was 31-3-11. On request of the PI, extension of 6 months was granted. The revised DOC for this study would be Sep 2011.
4	Environmental Flow Requirement of a River: A case study of Hemavathi River Team: Dilip G. Durbude, V.K. Choubey, Omkar Singh, M.K. Sharma DOS: Oct 2009 DOC: Sep 2012	
	Sponsored/Consultancy Projects	
5	Assessment of Ground Water Quality in 25 Class I Cities of India – Phase II (Chandigarh, Panjim, Gandhinagar, Shrinagar, Ranchi, Thiruvananthapuram, Imphal, Pondicherry, Kavaratti, Daman, Silvassa, Ratlam, Bilaspur) Team: V.K. Choubey, M.K. Sharma DOS: Oct 2008 (Ph-I), Apr 2010 (Ph-II) DOC: Mar 31, 2011	Completed study. In absence of the PI, Dr M K Sharma presented the study.
6	Impact of sewage effluent on drinking water sources of Shimla city and suggesting ameliorative measures Team: V.K. Choubey, R.P. Pandey, Omkar Singh, D.G. Durbude, M.K. Sharma, Rajesh Singh DOS: Apr 2009 DOC: Mar 2012	Ongoing PDS under HP-II. In absence of the PI, Sri Omkar presented the study.

Work Programme for 2011-12

SN	Title of the Project/Study	Recommendations/suggestions
1	Spatial Variability of Ground Water Quality in Kandi, Sirowal and Shiwalik Belts of Jammu Region, J&K (India) Team: Omkar Singh (PI), V K Choubey, D.G. Durbude, M K Sharma DOS: Apr 2010; DOC: Mar 2011 Revised DOC: Sep 2011	Continuing study.
2	Environmental Flow Requirement of a River: A case study of Hemavathi River Team: Dilip G. Durbude (PI), V.K. Choubey, Omkar Singh, M.K. Sharma DOS: Oct 2009 DOC: Sep 2012	Continuing study.
3	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 DOS: Apr 2011 DOC: Mar 2013	New study. ▪ Dr. N.C. Ghosh advised to publish the research papers after obtaining the patent of the developed media for removal of fluoride from drinking water. ▪ Dr. V. C. Goyal suggested referring 'Terafil' water filter developed by IMMT-Bhubaneswar.
	Sponsored/Consultancy Projects	
4	Impact of sewage effluent on drinking water sources of Shimla city and suggesting ameliorative measures Team: V.K. Choubey (PI), R.P. Pandey, Omkar Singh, D.G. Durbude, M.K. Sharma, Rajesh Singh DOS: Apr 2009 DOC: Mar 2012	Continuing PDS under HP-II. In absence of the PI, Sri Omkar presented the study.

Division's Scientists Involvement Chart for 2011-12

S N	Scientist	S-1	S-2	S-3	P-4
1	V K Choubey	√ CPI	√ CPI	√ CPI	√ PI
2	Omkar Singh	√ PI	√	√	√
3	D G Durbude	√	√ PI		√
4	M K Sharma	√	√	√	√
5	Rajesh Singh			√ PI	√
	Other Division's/ RCs scientists				RPP (CPI)

RPP- Dr R P Pandey, SWH

GROUND WATER HYDROLOGY DIVISION

Work Programme for 2010-11

SN	Title of the Project/Study, Study Team & Duration	Recommendations/suggestions
1	Impact of Climate Change on Dynamic Groundwater System in a Drought Prone area Team: Surjeet Singh (P.I.), C. P. Kumar Anupma Sharma, Rajan Vatsa DOS: Apr 2009; DOC: Mar 2012	Ongoing study.
2	Quantification of impact of rainwater harvesting on groundwater availability in Aravalli Hills- Part II: Mathematical Modelling Team: Anupma Sharma (P.I.), C P Kumar, N C Ghosh, Sudhir Kumar, Rajan Vatsa, Shobha Ram, Sanjay Mittal DOS: Apr 2010; DOC: Mar 2012	Ongoing study. ▪ Members enquired about the fluctuations in groundwater levels during pre- and post-monsoon period. It was informed that the maximum groundwater level fluctuation is about 6-7 m. ▪ Dr Deepak Kashyap enquired about the values of parameters assigned in the model for computing water flux through unsaturated zone. It was informed that presently, only test runs with typical range of parameter values have been taken. Mr. C. P. Kumar added that model runs with field values would be taken after getting the results of soil samples tests from the laboratory analysis.
	Sponsored/Consultancy Projects	
3	Study of Rising Ground Water Table in Jodhpur City, and to Evolve a Management Plan to contain the Rising Trend Team: N.C. Ghosh (PI), C.P. Kumar, Sudhir Kumar, Anupma Sharma, Surjeet Singh, Rajan Vatsa 1yr 6m (9/2009-3/2011)	Completed project. ▪ Dr. Ghosh informed that all scientific analysis except groundwater modeling and remedial options scenarios have been completed, and that the report will contain 14 sections covering various hydrological and hydro-geological analyses. ▪ Dr. Ghosh further informed that a time extension up to May 15, 2011 for submission of the final report has been sought.
4	Coastal Groundwater Dynamics and Management in the Saurashtra Region, Gujarat Team: N.C. Ghosh (Co-ordinator), Anupma Sharma (P.I.), C P Kumar, A.D. Gohil, C.K. Jain, Sudhir Kumar, D.S. Rathore, Surjeet Singh, Rajan Vatsa 2 years 8 m (10/2009 – 06/2012)	Ongoing project. Dr. B. P. Singh enquired about the coastal erosion in the study area. It was informed that at present, coastal erosion in Minsar Basin is not being investigated, but such a study may be taken up in future.

Work Programme for 2011-12

SN	Title of the Project/Study, Study Team & Duration	Recommendations/suggestions
1	Impact of Climate Change on Dynamic Groundwater System in a Drought Prone area Team: Surjeet Singh (P.I.), C. P. Kumar Anupma Sharma, Rajan Vatsa DOS: Apr 2009; DOC: Mar 2012	Continuing study.
2	Quantification of impact of rainwater harvesting on groundwater availability in Aravalli Hills- Part II: Mathematical Modelling Team: Anupma Sharma (P.I.), C P Kumar, N C Ghosh, Sudhir Kumar, Rajan Vatsa, Shobha Ram, Sanjay Mittal DOS: Apr 2010; DOC: Mar 2012	Continuing study.
3	Groundwater Flouride Contamination in different parts of India and study severity of Fluorosis in a drought prone area Team: A.K. Dwivedi (P.I.), Shobha Ram N C Ghosh, Anupma Sharma, Sumant Kumar, Sanjay Mittal, Ramachandra DOS: Apr 2011 DOC: Mar 2014	New study. ▪ In response to a query, Sri Dwivedi informed that the study will have two components: (i) preparation of a position document on groundwater fluoride contamination in India (2011-12), and (ii) to study variability and severity of fluorosis in a selected region (drought prone area) (2012-13). ▪ Dr V C Goyal suggested that contents of the position document should be prepared and sent to the members for their comments. ▪ Also, it was suggested that presence of Boron, which is found where fluoride is in excess, should be studied for any possible relationship.
4	Management of Aquifer Recharge (MAR) and Aquifer Storage Recovery (SAR) Team: Sumant Kumar (PI), Rajan Vatsa, N.C. Ghosh, C P Kumar, Surjeet Singh, Sanjay Mittal DOS: Apr 2011; DOC: Mar 2014	New study. In response to a query, Dr N C Ghosh informed that the Institute is expecting a sponsored R & D project to be funded by European Research Institute, in which MAR will be targeted for specific study areas.
	Sponsored/Consultancy Projects	
5	Coastal Groundwater Dynamics and Management in the Saurashtra Region, Gujarat Team: N.C. Ghosh (Coordinator), Anupma Sharma (P.I.), C P Kumar, A.D. Gohil, C.K. Jain, Sudhir Kumar, D.S. Rathore, Surjeet Singh, Rajan Vatsa 2 years 8 m (10/2009 – 06/2012)	Continuing PDS under HP-II.

Division's Scientists Involvement Chart for 2011-12

S N	Scientist	S-1	S-2	S-3	S-4	P-5
1	N C Ghosh		√	√	√	√
2	C P Kumar	√ CPI	√ CPI		√	√ CPI
3	Anupama Sharma	√	√ PI	√		√ PI
4	Surjeet Singh	√ PI			√	√
5	A K Dwivedi			√ PI		
6	Rajan Vatsa	√	√		√ CPI	√
7	Sumant Kumar			√	√ PI	
	Other Division's/ RCs scientists		SK			CKJ SK DSR

CKJ- Dr C K Jain, CFMS-Guwahati

SK- Dr Sudhir Kumar, HI

DSR- Sri D S Rathore, WRS

HYDROLOGICAL INVESTIGATIONS DIVISION

Work Programme for 2010-11

SN	Title of the Project/Study, Study Team & Duration	Recommendations/suggestions
1	SW and GW Interaction at Selected Locations Along River Yamuna in NCT, Delhi: Phase-II Team: Sudhir Kumar (PI), M. S. Rao, P. K. Garg DOS: *4/2009;* DOC: *3/2012*	Ongoing study. Dr Sudhir Kumar informed that a mathematical model for estimating the induced recharge shall be developed during the year 2011-12.
2	Study of Variability of Snow and Glacier Contribution in Melt Water of Gangotri Glacier at Goumukh using Isotopic Techniques Team: S.P. Rai (PI), Manohar Arora, Bhishm Kumar, Rakesh Kumar and Naresh Kumar DOS: *4/2010;* DOC: *3/2013*	Ongoing study.
3	Identification of Recharge Zones of Some Selected Springs of Uttarakhand Using Isotopes Team: S. D. Khobragade (PI), Bhishm Kumar Sudhir Kumar, S. P. Rai, Pankaj Garg, Uttarakhand Jalsansthan DOS: *04/2010;* DOC: *03/2012*	Ongoing study. ▪ Dr. Gurunadha Rao suggested that hydro-geological aspects, such as groundwater availability, should be considered for selecting the recharge area. ▪ Dr. P. R. Ojswii enquired if it was possible to determine the residence time of the water using the isotope method. He also enquired how the size of the recharge area would be decided. ▪ Dr. G.C. Mishra opined that the depletion time of springs should be taken into account for the calculation of recharge area.
	Sponsored/Consultancy Projects	
4	National programme on isotope fingerprinting of waters of India (IWIN) Team: M.S. Rao (PI), B. Kumar, Sudhir Kumar, S.P. Rai, S.K. Verma, Pankaj Garg + other 13 organizations DOS: *07/2007;* DOC: *06/2012*	Ongoing project. Sh. N. Y. Apte suggested to analyze correlation between meteorological data at Jammu and other stations with isotopic data.
5	Impact Assessment of Landuse on the Hydrologic Regime in the selected Micro-watersheds in Lesser Himalayas, Uttarakahand Team: S.P. Rai (PI), Bhishm Kumar, J.V. Tyagi DOS: *04/2008;* DOC: *03/2013*	Ongoing project.
6	Development of Spring Sanctuaries in an Urban and Rural Watershed in District Pauri Garhwal, Uttarakhand Team: Dr. S.P. Rai (PI), Bhishm Kumar, Sudhir Kumar, Suhas Khobragade, Pankaj Garg DOS: *04/2010;* DOC: *03/2013*	Ongoing project.

7	Assessment of Groundwater Resources & Development Potential of Yamuna Flood Plain, NCT, Delhi Team: Sudhir Kumar (PI), Vijay Kumar + IITD,DU,CGWB, IARI, CWC,DJB DOS: *02/2010;* DOC: *01/2011*	Ongoing consultancy project. The PI informed that survey for groundwater draft was conducted in the month of June 2010. A conceptual model has been prepared and steady state simulations are being carried out to calibrate the model.
8	Hydrogeological studies of Jhamarkotra Mines, Udaipur, Rajasthan Team: Sudhir Kumar (PI), M.S.Rao, S.K. Verma, Pankaj Garg DOS: *07/2010;* DOC: *12/2011*	Ongoing consultancy project.
9	Groundwater Dynamics of Bist-Doab Area, Punjab Using Isotopes Team: M.S. Rao (PI), Bhishm Kumar, Sudhir Kumar, S.K. Verma, PankajGarg+CGWB Officials DOS: *07/2009;* DOC: *6/2012*	Ongoing PDS under HP-II. Dr. Gurunadha Rao suggested that the water quality data should also be presented in conventional graphical forms. He also informed that NGRI has placed large amount of data and maps on website, which can also be used in the present study.
10	Groundwater Management in Over- Exploited Blocks of Chitradurga and Tumkur Districts of Karnataka Team: Sudhir Kumar (PI), J.V. Tyagi, Vijay Kumar, B.K. Purandara, S.P. Rai, M.S. Rao + DMG, Karnataka DOS: *07/2009;* DOC: *6/2012*	Ongoing PDS under HP-II. 16 infiltration tests indicated that the infiltration rates are high in the catchment (sandy soils, infiltration rate 10-15 mm/hr) and low in the tank bed (clayey soil, Infiltration rate=1-2 mm/hr)

Work Programme for 2011-12

SN	Title of the Project/Study, Study Team & Duration	Recommendations/suggestions
1	SW and GW Interaction at Selected Locations Along River Yamuna in NCT, Delhi: Phase-II Team: Sudhir Kumar (PI), M. S. Rao, P. K. Garg DOS: *4/2009;* DOC: *3/2012*	Continuing study.
2	Study of Variability of Snow and Glacier Contribution in Melt Water of Gangotri Glacier at Goumukh using Isotopic Techniques Team: S.P. Rai (PI), Manohar Arora, Bhishm Kumar, Rakesh Kumar and Naresh Kumar DOS: *4/2010;* DOC: *3/2013*	Continuing study.
3	Identification of Recharge Zones of Some Selected Springs of Uttarakhand Using Isotopes Team: S. D. Khobragade (PI), Bhishm Kumar Sudhir Kumar, S. P. Rai, Pankaj Garg, Uttarakhand Jalsansthan DOS: *04/2010;* DOC: *03/2012*	Continuing study.

4	Hydrological Assessment for Artificial Recharge and Water Management in Ghar Area, Saharanpur District, U.P. Team: P.K.Garg (PI), Sudhir Kumar, Tanveer Ahmad, Rajesh Agarwal, V C Goyal, Bhishm kumar DOS: *04/2011;* DOC: *03/2013*	New study. Dr R P Singh enquired whether the study area lies in the Kandi Belt to which Dr Bhishm Kumar replied in confirmation.
5	Assessment of Radon Concentration & Identification of Paleo Groundwater in Punjab State Team: S K Verma (PI), Sudhir Kumar, M S Rao, Bhishm Kumar DOS: *04/2011;* DOC: *03/2013*	New study. ▪ Dr. Gurunadha Rao suggested that title of the study should be modified as "Assessment of Radon Concentration in Waters and Identification of Paleo-groundwater in Punjab State". ▪ Dr. Rao also suggested that the area near Narora Power Plant may also be investigated for radon concentrations in groundwater, river water etc.
	Sponsored/Consultancy Projects	
6	National programme on isotope fingerprinting of waters of India (IWIN) Team: M.S. Rao (PI), B. Kumar, Sudhir Kumar, S.P. Rai, S.K. Verma, Pankaj Garg + other 13 organizations DOS: *07/2007;* DOC: *06/2012*	Continuing project.
7	Impact Assessment of Landuse on the Hydrologic Regime in the selected Micro-watersheds in Lesser Himalayas, Uttarakahand Team: S.P. Rai (PI), Bhishm Kumar, J.V. Tyagi DOS: *04/2008;* DOC: *03/2013*	Continuing project.
8	Development of Spring Sanctuaries in an Urban and Rural Watershed in District Pauri Garhwal, Uttarakhand Team: Dr. S.P. Rai (PI), Bhishm Kumar, Sudhir Kumar, Suhas Khobragade, Pankaj Garg DOS: *04/2010;* DOC: *03/2013*	Continuing project.
9	Assessment of Groundwater Resources & Development Potential of Yamuna Flood Plain, NCT, Delhi Team: Sudhir Kumar (PI), Vijay Kumar +IITD,DU,CGWB, IARI, CWC,DJB DOS: *02/2010;* DOC: *01/2011*	Continuing consultancy project.
10	Hydrogeological studies of Jhamarkotra Mines, Udaipur, Rajasthan Team: Sudhir Kumar (PI), M.S.Rao, S.K. Verma, Pankaj Garg DOS: *07/2010;* DOC: *12/2011*	Continuing consultancy project.
11	Groundwater Dynamics of Bist-Doab Area, Punjab Using Isotopes Team: M.S. Rao (PI), Bhishm Kumar, Sudhir Kumar, S.K. Verma, Pankaj Garg +CGWB	Continuing PDS under HP-II.

	Officials DOS: *07/2009;* DOC: *6/2012*	
12	Groundwater Management in Over- Exploited Blocks of Chitradurga and Tumkur Districts of Karnataka Team: Sudhir Kumar (PI), J.V. Tyagi, Vijay Kumar, B.K. Purandara, S.P. Rai, M.S. Rao + DMG, Karnataka DOS: *07/2009;* DOC: *6/2012*	Continuing PDS under HP-II.

Division's Scientists Involvement Chart for 2011-12

SN	**Scientist**	**S-1**	**S-2**	**S-3**	**S-4**	**S-5**	**P-6**	**P-7**	**P-8**	**P-9**	**P-10**	**P-11**	**P-12**
1	Bhishm Kumar		√	√ CPI	√	√	√ CPI	√ CPI	√ CPI			√ CPI	
2	Sudhir Kumar	√ PI		√	√ CPI	√ CPI	√		√	√ PI	√ PI	√	√ PI
3	S P Rai		√ PI	√			√	√ PI	√ PI				√
4	Suhas Khobragade			√ PI					√				
5	M S Rao	√ CPI				√	√ PI				√ CPI	√ PI	
6	S K Verma					√ PI	√				√	√	
7	Pankaj Garg	√		√	√ PI		√		√		√	√	
	Other Division's/ RCs scientists		MA (CPI) RK		VCG			JVT		VK (CPI)			JVT (CPI) VK BKP

MA- Dr M Arora, SWH; RK- Rakesh Kumar, SWH; VCG- Dr VCGoya, RCMU; VK- Dr Vijay Kumar, WRS; JVT- Dr J V Tyagi, SWH; BKP- Dr B K Purendra, RC Belgaum

SURFACE WATER HYDROLOGY DIVISION

Work Programme for 2010-11

SN	Title of the Project/Study, Study Team & Duration	Recommendations/suggestions
1	Snow Melt Runoff Modeling Using Fuzzy Logic Team: A.K. Lohani (PI), Sanjay K. Jain, Rakesh Kumar DOS: Apr 2009 DOC: Mar 2011	Completed study. ▪ Dr. K.V. Jayakumar enquired about the computational efficiency and requirements of the model. The PI informed that the performance of the fuzzy based models for snow melt runoff modelling is better than the conceptual snow melt model. ▪ Dr S K Mittal mentioned the possibility of comparing the results with the SASE's model.
2	Data book - hydro-meteorological observatory 2001-2008 Team: Digambar Singh (PI), A. R. S. Kumar, Manohar Arora DOS: Apr 2009 ; DOC: Mar 2011 Revised DOC : Sep 2011	▪ Dr V V S Gurunadha Rao and Mr. N. Y. Apte suggested to carry out basic statistical analysis after the entry of the data. ▪ Dr. Rakesh Kumar suggested use of HYMOS for correcting and analyzing the data. Members suggested preparation of format for the data-book. ▪ The PI requested for extension of the study by 6 months, which was granted. The revised DOC would be Sep 2011.
3	Study on integrated water resources management of sub-basin to cope with droughts Team: R.P. Pandey (PI), Ravi V. Galkate, Surjeet Singh, L.N. Thakaral DOS: Dec 2008 DOC: Dec 2012	Ongoing study. ▪ PI reported that the strategic water resources in the basin are being demarcated for their utilization during drought. ▪ Dr. K.V. Jayakumar suggested exploring the use of 'IWRM Tool Box', which is available on the internet.
4	Snow Melt Runoff Modelling in Sultej Basin Team: A.R. S. Kumar (PI), Manohar Arora, A. Agarwal, D.S.Rathore, Digambar Singh DOS: Apr 2009 DOC: Mar 2012	Ongoing study. ▪ Dr V V S Gurunadha Rao suggested to predict one period value of streamflow and check it with BBMB. ▪ Dr. Jayakumar suggested to remove the outliers and run the ANN models again.
5	Snowmelt Runoff Modeling and Study of the Impact of Climate Change in part of Brahmaputra River Basin Team: Archana Sarkar (PI), R.D. Singh, Rakesh Kumar, Sanjay K. Jain DOS: Apr 2010 DOC: Mar 2013	Ongoing study. ▪ Sh. N.Y. Apte enquired whether the MODIS data gives depth of snow. Mrs Sarkar informed that the MODIS data gives only the areal extent of snow cover and not the depth of snow. ▪ Sh R.D. Singh suggested use of GCM output instead of hypothetical scenarios to study the impact of climate change, to be carried out in the third year of the study.

6	Monitoring and modelling of streamflow for the Gangotri Glacier Team: Manohar Arora (PI), Rakesh Kumar DOS: Apr 2008; DOC: Long-term study	Ongoing study. The PI informed the house that the data collected for the ablation period of 2008 to 2010 has been analysed and the report has been submitted.
7	Climatic Scenarios Generation for Satluj Basin using Statistical Downscaling Techniques Team: Manohar Arora (PI), Rakesh Kumar DOS: Apr 2010; DOC: Mar 2013	Ongoing study. The PI informed that statistical downscaling will be performed and an inter-comparison of the downscaled output will be done on the basis of scoring.
8	Climatic variability analysis and its impact on Himalayan watershed in Uttarakhand Team: A Agarwal (PI), Manohar Arora R K Nema DOS: Nov 2010 DOC: Oct 2013	Ongoing study. Dr V C Goyal pointed out that the objectives of the study and statement of the problem do not corroborate the title of the study, and should be revised keeping in view the emphasis on 'climatic variability analysis'. The methodology and results of 'climatic variability analysis' may be presented in the next meeting.
9	Impact of climatic change on evaporation Team: N.K. Bhatnagar (PI), A. Agarwal DOS: Oct 2009 DOC: Sep 2011	On request of the Div. Head, the study was dropped.
	Sponsored/Consultancy Projects	
10	Integrated Hydrological Study for Sustainable Development of two Hilly Watersheds in Uttaranchal Team: A. Agarwal (PI), R.K.Nema DOS: Jul 2005 DOC: Jun 2010 (extended upto Dec 2010)	Completed project. ▪ Corrections were suggested on rainfall-runoff relationships derived and on the values plotted on the graphs; to be suitably incorporated before finalization of the report. ▪ Director, NIH, stated that he will discuss the draft report with the PI.

Work Programme for 2011-12

SN	Title of the Project/Study, Study Team & Duration	Recommendations/suggestions
1	Data book - hydro-meteorological observatory 2001-2008 Team: Digambar Singh (PI), A. R. S. Kumar, Manohar Arora DOS: Apr 2009 ; DOC: Mar 2011 Revised DOC : Sep 2011	Continuing study.
2	Study on integrated water resources management of sub-basin to cope with droughts Team: R.P. Pandey (PI), Ravi V. Galkate, Surjeet Singh, L.N. Thakaral DOS: Dec 2008; DOC: Dec 2012	Continuing study.
3	Snow Melt Runoff Modelling in Sultej Basin Team: A.R. S. Kumar (PI), Manohar Arora, A. Agarwal, D.S.Rathore, Digambar Singh DOS: Apr 2009; DOC: Mar 2012	Continuing study.

4	Snowmelt Runoff Modeling and Study of the Impact of Climate Change in part of Brahmaputra River Basin Team: Archana Sarkar (PI), R.D. Singh, Rakesh Kumar, Sanjay K. Jain DOS: Apr 2010; DOC: Mar 2013	Continuing study.
5	Monitoring and modelling of streamflow for the Gangotri Glacier Team: Manohar Arora (PI), Rakesh Kumar DOS: Apr 2008; DOC: Long-term study	Continuing study.
6	Climatic Scenarios Generation for Satluj Basin using Statistical Downscaling Techniques Team: Manohar Arora (PI), Rakesh Kumar, Naresh Kumar DOS: Apr 2010; DOC: Mar 2013	Continuing study.
7	Climatic variability analysis and its impact on Himalayan watershed in Uttarakhand Team: A Agarwal (PI), Manohar Arora, R K Nema DOS: Nov 2010; DOC: Oct 2013	Continuing study.
8	Impact of Climate Change on Glaciers and Glacial Lakes: Case Study on GLOF in Tista basin Team: A.K. Lohani (PI), Sanjay K. Jain, Rakesh Kumar DOS: Apr 2011; DOC: Mar 2013	New study. ▪ The study stresses on the impact of climate change on glacial lakes and the impact of glacial lake outburst floods (GLOFs) in Tista basin. ▪ The members appreciated the proposed study in view of its usefulness for the upcoming projects.
9	Hydrological Studies for Upper Narmada Basin Team: Jagdish P. Patra (PI), Rakesh Kumar, Pankaj Mani, T R Sapra DOS: Apr 2011; DOC: Mar 2014	New study. ▪ The 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. ▪ Title of the study seems to be too general, and may be suitably modified keeping in view the statement of the problem and objectives. ▪ Dr. N. C. Gosh suggested to refer previous studies of NIH on Narmada basin, and to check availability of data from previous studies. Dr. N.Y. Apte raised concern about implication of results of this study particularly the dam break flooding.

Division's Scientists Involvement Chart for 2011-12

S N	Scientist	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9
1	Rakesh Kumar				√	√ CPI	√ CPI		√	√ CPI
2	A Agarwal			√				√ PI		
3	J V Tyagi									
4	A K Lohani								√ PI	
5	R P Pandey		√ PI							
6	A R S Kumar	√ CPI		√ PI						
7	Sanjay Kumar									
8	Archana Sarkar				√ PI					
9	M Arora	√		√ CPI		√ PI	√ PI	√ CPI		
10	D Singh	√ PI		√						
11	J P Patra									√ PI
	Other Division's/ RCs scientists		RVG (CPI) SS LNT	DSR	RDS (CPI) SKJ				SKJ (CPI)	PM

RVG- Sri R V Galkate, RC-Sagar; SS- Dr Surjeet Singh, GWH; LNT- Sri L N Thakral, WRS; DSR- Sri D S Rathore, WRS; RDS- Sri R D Singh, Director;
SKJ- Dr S K Jain, WRS; PM- Sri Pankaj Mani, CFMS-Patna

WATER RESOURCES SYSTEM DIVISION

Work Programme for 2010-11

SN	Title of the Project/Study, Study Team & Duration	Recommendations/suggestions
1	NIH_ReSyp-A software for Reservoir Analysis (Ver.-I) Team: M.K. Goel (PI), D. Chalisgaonkar DOS: 4/2010; DOC: 3/2011	Completed study. ▪ In response to a query from Mr. NN Rai, the PI informed that spillway rating curve is used in the analysis which is performed for ungated spillways only. A separate module is being added in the software to account for variable spillway release capacity at different reservoir levels. ▪ Mr. O. P. Gupta and Mr. R. R. Yadav asked about the procedure to find the inflow series for a reservoir. MKG explained that inflow series is generally input to the software. Mr Yadav also enquired if the losses are considered in the software. ▪ On query from the Chairman, the PI informed that user manual for the first version of the software will be completed by the end of April, 2011. He informed that newer modules for spillway gate regulation and reservoir sedimentation analysis will be added after completion of the basic development of the software. ▪ A training programme will be organized for field engineers in Nov 2011.
2	Prediction of dispersion coefficient of Streams using Kriging technique Team: Vijay Kumar (PI), S.K. Singh DOS: 4/2010; DOC: 3/2011	Completed study. Dr Jaykumar suggested reference of an IHP report on the Krigging method.
3	GIS based dams and drought information system Team: D.S. Rathore (PI), Deepa Chalisgaonkar, R.P. Pandey, Yatveer Singh, Tanvear Ahmad DOS: 10/2009; DOC: 3/2011	Completed study. In absence of the PI, Mrs Deepa Chalisgaonkar presented the study. ▪ Many members opined that the study team should discuss with dam organizations in the States. ▪ Drought indices at district level should be carefully checked before uploading on web.
4	Computationally simple functions for approximating normal and log-normal distributions Team: S K Singh DOS: Apr 2010; DOC: Mar 2011	Completed study. Sri RR Yadav and Sri O. P. Gupta suggested that the proposed method and its practical utilities need to be disseminated to field engineers.
5	A simple IUH model for runoff modeling Team: S K Singh DOS: Apr 2010; DOC: Mar 2011	Completed study. Sri S. K. Mittal suggested organizing training for field engineers on the proposed method and its practical utilities.
6	Application of a distributed hydrological model for river basin planning and	Ongoing study. ▪ Dr. M. M. Kimothi suggested that higher

	management Team: M.K. Goel (PI), Vijay Kumar, D.S. Rathore, D. Chalisgaonkar, Rama Mehta DOS: 10/2009; DOC: 3/2012	resolution data can be used in the analysis. MKG opined that analysis for a river basin involves very large area and a higher resolution grid size will multiply the dimensions of the analysis manifold. ▪ Dr. Jaya Kumar suggested comparing the results with a lumped model. MKG opined that a number of models have already been planned for application and additional model applications will be taken up depending on the availability of time for the study.
7	Web based Information System for Major and important Lakes in India Team: D. Chalisgaonkar (PI), Suhas Khobragade DOS: 4/2010; DOC: 3/2012	Ongoing study. ▪ Dr Kimothi informed that MOEF has prepared a comprehensive inventory of wetlands. ▪ Dr Kimothi suggested that major hydrological problems of the lakes should be included in the information system. Dr Khobragade informed that it is not possible or practical to physically visit the lakes and find out the problems, but available information will definitely be incorporated. ▪ Dr. Gurunadha Rao opined that information about the lake catchment, such as catchment map, should also be included in the system. ▪ Dr. Jayakumar informed that a lot of information has been compiled for seven lakes of Kerela by the CWRDM, Kozhikode. The PI was asked to contact CWRDM. ▪ Sri N Y Apte suggested providing metadata information in the system.
8	Analysis of water management scenarios in Tapi River basin using MIKE Basin Team: Rama Mehta (PI), M.K. Goel, Vijay Kumar, D.S. Rathore DOS: 4/2010; DOC: 3/2013	Ongoing study. The PI informed that hydrological data for Tapi basin has been received from NTBO, Surat, and a request for reservoir (existing in this basin) details and working tables is in progress with concerning agencies in Maharashtra and Gujarat.
	Sponsored/Consultancy Projects	
9	Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin Team: Sanjay K. Jain (PI), Bhishm Kumar Vijay Kumar, S.P. Rai, Renoj Theyyan DOS: 4/2009 ; DOC: 3/2012	Ongoing PDS under HP-II.
10	Assessment of Effects of Sedimentation on the capacity / Life of Bhakra Reservoir (Gobind Sagar) on River Satluj and Pong Reservoir on River Beas Team: Sanjay K. Jain (PI), S.K. Jain, Vijay Kumar, J.V. Tyagi, Rama Mehta DOS: 4/2009; DOC: 3/2012	Ongoing PDS under HP-II. Mr. N.N. Rai said that MIKE 11 model can also be used for sedimentation rate in the reservoir. Mr. B.P. Singh enquired about the capacity of the Bhakra reservoir.
11	Hydrological Assessment of Ungauged Catchments (Small Catchment)	Ongoing PDS under HP-II.

	Team: P.K.Bhunya (PI), Rakesh Kumar, Vijay Kumar, D.S. Rathod, Sanjay Kumar, P.C. Nayak, Y.R.S. Rao DOS: May 2009; DOC: May 2012	

Work Programme for 2011-12

SN	Title of the Project/Study, Study Team & Duration	Recommendations/suggestions
1	Application of a distributed hydrological model for river basin planning and management Team: M.K. Goel (PI), Vijay Kumar, D.S. Rathore, D. Chalisgaonkar, Rama Mehta DOS: 10/2009; DOC: 3/2012	Continuing study.
2	Web based Information System for Major and important Lakes in India Team: D. Chalisgaonkar (PI), Suhas Khobragade DOS: 4/2011; DOC: 3/2012	Continuing study.
3	Analysis of water management scenarios in Tapi River basin using MIKE Basin Team: Rama Mehta (PI), M.K. Goel, Vijay Kumar, D.S. Rathore DOS: 4/2010; DOC: 3/2013	Continuing study.
4	Development of analytical equation for alternate depths for flow in rectangular channels Team: S K Singh DOS: Apr 2011; DOC: Mar 2012	New study.
5	A transfer function model for event based runoff Team: S K Singh DOS: Apr 2011; DOC: Mar 2012	New study.
	Sponsored/Consultancy Projects	
6	Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin Team: Sanjay K. Jain (PI), Bhishm Kumar Vijay Kumar, S.P. Rai, Renoj Theyyan DOS: 4/2009 ; DOC: 3/2012	Continuing PDS under HP-II.
7	Assessment of Effects of Sedimentation on the capacity / Life of Bhakra Reservoir (Gobind Sagar) on River Satluj and Pong Reservoir on River Beas Team: Sanjay K. Jain (PI), S.K. Jain, Vijay Kumar, J.V. Tyagi, Rama Mehta DOS: 4/2009; DOC: 3/2012	Continuing PDS under HP-II.

8	Hydrological Assessment of Ungauged Catchments (Small Catchment) Team: P.K.Bhunya (PI), Rakesh Kumar, Vijay Kumar, D.S. Rathod, Sanjay Kumar, P.C. Nayak, Y.R.S. Rao DOS: May 2009; DOC: May 2012	Continuing PDS under HP-II.
9	Vetting of Water Availability studies of the Gulf of Khambhat Development Projects (Kalpasar Project) Team: M.K. Goel (PI), Vijay Kumar DOS: 4/2011; DOC: 10/2011	New consultancy project. ▪ Mr. N. N. Rai informed that vertical resolution of SRTM data is better than the ASTER data and same may be utilized in the study. ▪ The PI was advised to consult IMD for PMP. ▪ Dr Gurunadha Rao suggested for ascertaining creek water availability.

Division's Scientists Involvement Chart for 2011-12

SN	**Scientist**	**S-1**	**S-2**	**S-3**	**S-4**	**S-5**	**P-6**	**P-7**	**P-8**	**P-9**
1	S K Singh				√ PI	√ PI				
2	Sanjay Jain						√ PI	√ PI		
3	D S Rathore	√		√					√	
4	M K Goel	√ PI		√ CPI						√ PI
5	Deepa Chalisgaonkar	√	√ PI							
6	Vijay Kumar	√ CPI		√			√	√	√	√ CPI
7	P K Bhunya								√ PI	
8	R D Mehta	√		√ PI				√		
9	L N Thakral									
	Other Division's/ RCs scientists		SKh (CPI)				BK (CPI) SPR RT	SKJ (CPI) JVT	RK (CPI) SanK PCN YRSR	

SKh- Dr Suhas Khobragade, HI; BK- Dr Bhishm Kumar, HI; SPR- Dr S P Rai, HI; RT- Dr Renoj Theyyan, RC-Jammu; SKJ- Prof S K Jain, IIT-Roorkee; JVT- Dr J V Tyagi, SWH; RK- Dr Rakesh Kumar, SWH; SanK- Dr Sanjay Kumar, SWH; PCN- Dr P C Nayak, RC-Kakinada; YRSR- Dr Y R S Rao, RC-Kakinada

RESEARCH COORDINATION & MANAGEMENT UNIT (RCMU)

Work Programme for 2011-12

SN	Title of the Project/Study, Study Team & Duration	Recommendations/suggestions
1	Recession Flow Analysis for Evaluation of Spring Flow in Indian Catchments Team : Ravindra V. Kale (PI), V. C. Goyal DOS: Apr 2011 DOC: Mar 2013	▪ Dr N C Ghosh suggested element of innovation in carrying out the study. ▪ Dr V C Goyal clarified that the study essentially aims at developing a generic technique for assessing the reliability of spring flow by analyzing the flow characteristics.

ITEM NO. 34.6: ANY OTHER ITEM WITH PERMISSION OF THE CHAIR

While concluding the two-day deliberations, the Chairman informed that the next meeting of the TAC is scheduled shortly and the Divisional Heads should expedite sending the draft minutes of their respective divisions to the Member-Secretary. He made the following observations for compliance by the scientists and staff of NIH:

1. The PI should take care that salient details of the study (e.g. title, study team, date of start and completion, objectives, action plan) do not change from those provided in the previous meetings. No deviations are acceptable except when decided (and recorded in the minutes) of the Working Group and/or TAC.
2. Study team as mentioned in the agenda and as shown in the presentation is many times different. The PI should take care of this.
3. The PI (or the Co-PI, if the PI is not present) should present the study.
4. Long study teams should be avoided. The role of each member of the team should be defined in the study writeup in form of an activity chart, and provided in the agenda.
5. Final draft report for completed studies/projects and interim (part) report for ongoing studies should be submitted by April 30, 2011.

The Chairman thanked the members for their valuable contributions during deliberations in the Working Group meetings in the last few years.

The meeting ended with vote of thanks to the Chair.

ANNEXURE-I

List of participants of the 34th Working Group Meeting:

1	Shri R.D. Singh Director, NIH	**Chairman**
2	Prof. G. C. Mishra WRDM, IIT Roorkee	Member
3	Prof. D. Kashyap Deptt. of Civil Engg., IIT Roorkee	Member
4	Prof. K.V. Jayakumar ED, CWDRM, Kerala	Member
5	Prof. B.P. Singh, Gurgoan	Member
6	Dr. M.M. Kimothi, Director, USAC, Dehradun	Member
7	Dr. V.V.S. Gurunadha Rao Scientist G, NGRI, Hyderabad	Member
8	Dr. S.K.Mittal Scientist G, C.S.I.O, Chandigrah	Member
9	Dr. R.P. Singh RD I/C, CGWB, Dehradun	Member
10	Dr. S.K. Gupta Project Coordinator, CSSRI, Karnal	Member
11	Shri N.Y. Apte DDGM(H), IMD, New Delhi	Member
12	Dr. P.R. Ojasvi CSWCRTI, Dehradun	Member
13	Er Rishi Srivastava Director (RO), CWC, New Delhi	Member
14	Er N.N. Rai Director (HSO), CWC, New Delhi	Member
15	Er. M.Sampathkumar, Chief Engineer, PWD, Chennai	Member
16	Er. G. Dhanaraju, Supdt. Engineer, PWD, Chennai	Invitee
17	Sh. R.R.Yadav, Director, Dam ID & R, Jaipur	Member
18	Sh. O.P. Gupta Dam ID & R, Jaipur	Invitee
19	Er N.K. Sharma S.E., IRI, Roorkee	Member
20	Shri Vinod Kumar Research Officer (Basic Res. Div.),UPIRI, Roorkee	Member
21	Dr. Pratibha Naithani Project Specialist, USAC, Dehradun	Invitee
22	Dr. V. C. Goyal Scientist F & Head, RCMU, NIH	Member-Secretary

Scientists from National Institute of Hydrology, Roorkee

1. Dr. Bhishm Kumar, Sc.F & Head, HI Division
2. Dr. V K Choubey, Sc.F & Head, EH Division
3. Dr. N.C. Ghosh, Sc.F & Head, GWH Division
4. Dr. Rakesh Kumar, Sc.F & Head, SWH Division
5. Dr. S.K. Singh, Sc.F
6. Shri C.P. Kumar, Sc. 'F'
7. Dr. Sanjay Kr. Jain, Sc.E2
8. Dr. Avinash Agarwal, Sc.E2
9. Dr. J.V. Tyagi, Sc.E2
10. Dr. Sudhir Kumar, Sc.E2
11. Dr. M.K. Goel, Sc. E2
12. Smt. Deepa Chalisgaonkar, Sc.E1
13. Dr. A K Lohani, Sc.E1
14. Dr. Vijay Kumar, Sc.E1
15. Dr. R P Pandey, Sc.E1
16. Shri Omkar Singh, Sc.E1
17. Shri S.D. Khobragade, Sc.E1
18. Dr. P K Bhunya, Sc.E1
19. Dr. S.P. Rai, Sc.E1
20. Shri A R Senthil Kumar, Sc.E1
21. Dr. M.S. Rao, Sc.C
22. Shri S K Verma, Sc. C
23. Dr. Rama Mehta, Sc.C
24. Dr. Anupama Sharma, Sc.C
25. Dr. Surjeet Singh, Sc. C
26. Shri D. G. Durbude, Sc. C
27. Smt. Archana Sarkar, Sc.C
28. Shri A K Dwivedi, Sc. C
29. Dr. Manohar Arora, Sc.C
30. Dr. M.K. Sharma, Sc.C
31. Shri Pankaj K. Garg, Sc.B
32. Shri Rajan Vatsa, Sc.B
33. Shri Digambar Singh, Sc.B
34. Dr Ravindra Kale, Sc. B
35. Shri J P Patra, Sc. B
36. Shri Sumant Kumar, Sc. B
37. Dr Rajesh Singh, Sc. B
38. Shri L N Thakral, Sc. B

ANNEXURE – B

ENVIRONMENTAL HYDROLOGY DIVISION

NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE – 247 667

WORK PROGRAMME FOR THE YEAR 2011-2012

S.No.	Title of the Project/Study	Study Team	Duration	Funding Agency
1.	Assessment of Ground Water Quality in 25 Class I Cities of India – Phase II (Chandigarh, Panjim, Gandhinagar, Shrinagar, Ranchi, Thiruvananthapuram, Imphal, Pondicherry, Kavaratti, Daman, Silvassa, Ratlam, Bilaspur)	Dr. V.K. Choubey; Sc. F Dr. M.K. Sharma, Sc. C	2 years	CPCB New Delhi
2.	Impact of sewage effluent on drinking water sources of Shimla city and suggesting ameliorative measures	Dr. V.K. Choubey; Sc. F Dr. R.P. Pandey, Sc. E2 Shri Omkar Singh, Sc. E2 Dr. M.K. Sharma, Sc. C Dr. Rajesh Singh, Sc. B	3 years	HP-II
3.	Spatial Variability of Ground Water Quality in Kandi, Sirowal and Shiwalik Belts of Jammu Region, J&K (India)	Shri Omkar Singh, Sc.' E2' Dr. V K Choubey, Sc. 'F' Dr. M K Sharma, Sc. 'C'	1.5 years	NIH
4.	Development of low cost media for fluoride removal from drinking water of fluoride affected areas.	Dr. Rajesh Singh, Sc. 'B' Dr. V. K. Choubey, Sc. 'F' Shri Omkar Singh, Sc. 'E Dr. M.K. Sharma, Sc. 'C'	2 Years	NIH
NEW PROPOSAL				
1.	Assessment of Groundwater Quality in Hindon River Basin	Dr. M.K. Sharma, Sc. 'C' Dr. V. K. Choubey, Sc. 'F' Shri Omkar Singh, Sc. 'E2 Dr. Rajesh Singh, Sc. "B"	3 Years	NIH

Study - 1

1. Title of the Study: Assessment of Ground Water Quality in 25 Class I Cities of India (Guwahati, Raipur, Shimla, Jammu, Shillong, Aizawal, Kohima, Bhubneshwar, Agartala, Dehradun, Itanagar, Gangtok Chandigarh, Panjim, Gandhinagar, Gautambudh Nagar, Ranchi, Thiruvananthapuram, Imphal, Pondicherry, Kavaratti, Daman, Silvassa, Ratlam, Bilaspur)

2. Name of PI & Co-PI:

- V K Choubey, Scientist 'F', National Institute of Hydrology, Roorkee (PI)
- M K Sharma, Scientist' C', National Institute of Hydrology, Roorkee (Co-PI)

3. Type of study: Sponsored project by CPCB, Delhi

4. Date of start: Phase I **(**October, 2008), Phase-II (April, 2010)

5. Scheduled date of completion: 31.10.2011

6. Study objectives:

i) To examine the suitability of ground water for various designated uses
ii) To identify degraded water quality zones and possible sources of pollution and specific parameters not conforming to water quality standards

7. Statement of the problem:

The ground water quality of urban areas of the country is mainly affected domestic and sewage waste produced by the increasing population of the country and industrial effluent generated by different industrial activities. Therefore regular monitoring of ground water sources is essential to see the effect of these on their quality. In view of these facts, a project titled "Assessment of Ground Water Quality in 25 Class I Cities of India" was awarded to NIH by CPCB, Delhi

8. Approved Action Plan: To carry out the above said study, an MOU was signed between NIH and CPCB, Delhi with following components:

- Identification of industrial areas, residential areas, petrol pumps and bulk storage of petroleum production, municipal solid waste disposal (land fill) areas
- Identification of (about 30) locations covering shallow and deep aquifer regions.
- Sampling of ground water in pre- and post-monsoon seasons
- Physico-chemical parameters: pH, EC, TDS, Alkalinity, Hardness, COD, BOD, Major Cations (Na, K, Ca, Mg), Major Anions (HCO_3, Cl, SO_4, NO_3), Minor Ions (F, PO_4, B).
- Bacteriological Parameters: Total and Faecal Coliform

- Toxic (Heavy) Metals: As, Cd, Cr, Pb, Hg, Cu, Ni, Fe, Zn, Mn
- Pesticides: DDT, Total BHC, Endosulphan, Lindane, Aldrin, Deildrin, Carbamat, 2,4 D, Malathion, Parathion, Pyriphos, Chloropyriphos
- Polynuclear Aromatic Hydrocarbon (P AH): location-specific
- Data for pre- and post-monsoon seasons will be processed as per BIS and WHO standards to examine the suitability of ground water for drinking purpose, ionic relationships will be developed and water types will be identified. Spatial distribution map will be prepared in the form of contour diagrams to identify degraded water quality zones. Suitability of ground water for irrigation purpose will be assessed on the basis of total soluble salts, SAR, RSC and boron content. Classification of water will be made using Piper trilinear diagram, Durov plots, Chadha's diagram,U S Salinity Laboratory Classification and Gupta Classification.
-

9. Timeline and justification for time over runs: The expected date of completion of the above study was 31.3.2011, but due to pending analysis of pesticides and inclusion of Gautambudh Nagar in place of Srinagar, the study period was extended upto 31.10.2011 and approval for the same was taken from sponsored agency CPCB.

10. Objectives vis-à-vis achievements:

Objectives	Achievements
i) To examine the suitability of ground water for various designated uses ii) To identify degraded water quality zones and possible sources of pollution and specific parameters not conforming to water quality standards	Out of 25 Class I Cities, 24 Class I Cities were covered during 2009-10 2010-11 and 25th city Gautambudh Nagar was covered during April-October 2011. **35th Working Group Meeting** • Pre- and Post-monsoon sampling of new class I city Gautambudh Nagar has been completed • Physico-chemical, bacteriological and metal analysis of Pre-monsoon sampling of Gautambudh Nagar completed. • Processing of data has been completed as per BIS standards. • Pesticide analysis is in progress. • Writeup of the report is in progress

11. Recommendations/Suggestions in previous meetings of WG/TAC/GB along with action taken: None

12. Analysis and Results: The following analysis of data of 12 Class I Cities have been

carried out:

- Spatial distribution map is prepared in the form of contour diagrams to identify degraded water quality zones.
- Classification of water is done using Piper trilinear diagram, Durov plots, Chadha's diagram,U S Salinity Laboratory Classification and Gupta Classification.
- Quantification of pesticides from chromatograph is under progress.

13. Adopters of the results of the study & their feedback: The said study was sponsored by CPCB, Delhi and the detailed report containing results and recommendations will be submitted to CPCB, Delhi.

14. List of deliverables: The deliverables of this study would be final report.

15. Major items of equipment procured: None

16. Lab facilities used during the study: Water Quality Laboratory

17. Data procured and/or generated during study: Baseline data of ground water Quality of Class I Cities

18. Study Benefits/ Impact: Identification of degraded water quality zones and possible sources of pollution and specific parameters not conforming to water quality standards

19. Specific linkages with institutions and/or end-user/beneficiaries: CPCB, Delhi

20. Shortcomings/difficulties, if any: None.

21. Future plan: Nil

Study-2

1. Title of the Study: Impact of sewage effluent on drinking water sources of Shimla city and suggesting ameliorative measures

2. Study Group:

Project Investigator Dr V K Choubey, Scientist 'F' & Head (EHD), NIH	
Co-Investigators	
Dr. R.P. Pandey, Scientist 'E2' Shri Omkar Singh, Scientist 'E2'	I & PHE Dept., Shimla (H.P.)
Dr. M.K. Sharma, Scientist 'C' Dr. Rajesh Singh, Scientist 'B'	NICD, New Delhi

3. Type of Study: Sponsored

4. Date of start: 1.4.2009

5. Scheduled date of completion: 31.3.2012

6. Duration of the Study: 3 years

7. Study Objectives:

- Analysis of Eco-hydrological, water quality and basin characteristics of Shimla town. Assessment of water quality variable in drinking water sources and sewage effluent.
- Analysis of pollutant / source identification (location) of sewage effluent influx in drinking water.
- Impact assessment of sewage effluent in drinking water sources and suggesting possible remedial measures for its removal.
- Dissemination of knowledge and findings to field engineers and common people through preparation of manual, leaflets, booklets and by organizing workshops/training.

8. Statement of problem:

- Himachal Pradesh is one of the States which is included in the HP Phase II.
- Mass levels Jaundice have been reported due to influx of pollutants/bacteria in the drinking water in Shimla Town during 2007.

- After discussions with the officials of Himachal Pradesh, it is found that the assessment of impact of sewage effluent on drinking water sources of Shimla city is the real problem and needs to be assessed scientifically.

9. Approved action Plan:

- Analysis of hydro-meteorological and basin characteristics of Shimla City using SWDES and ERDAS/ILWIS.
- Assessment of water quality parameters in drinking water sources and sewage effluent.
- Monitoring & evaluation of water quality parameters, essential for drinking water, from different drinking water sources and sewage effluent on quarterly basis using standard methods (APHA, 1995).
- Microbiological/virological investigations of water/waste water through NICD, New Delhi.
- Study of existing sewerage network efficacy using SEWERCAD in problem zone of Shimla, and source identification (location) of sewage effluent influx in drinking water.

10. Timeline:

Sr. No.	Major Activities	1st Year	2nd Year	3rd Year
1	Data collection			
2	Literature survey			
3	Staff appointment			
4	Purchase of equipment			
5	Field survey			
6	Generation of Maps, RS & GIS Applications			
7	Analysis and interpretation of WQ data			
8	Sewerage network, Pollution transport mechanism, & Impact assessment			
9	Preparation of Interim report			
10	Training / Workshop			
11	Preparation of Final Report			

11. Achievements

Objective	Achievement
Analysis of eco-hydrology, Hydro-meteorology and basin characteristics of study area	• Digital Elevation Model (DEM) of study area generated. • Watershed Characteristics are evaluated for problematic area of Shimla City lying under Yamuna basin.
Analysis of water quality parameters in drinking water sources and sewage effluent of study area	• Sampling and analysis for various physico chemical and bacteriological parameters (pH, EC, TDS, Ca, Mg, Na, K, HCO_3, Cl, SO_4, NO_3, PO_4, F, BOD, COD, total coliform, fecal coliform, etc.) of problematic area water samples completed on macro scale. Sampling and analysis on micro scale for identification of problematic locations under progress. • Water quality data analyzed
Source Identification of sewerage effluent influx into drinking water	• Digitization/Preparation of Sewer Network map of Study Area (Sanjauli - Maliana Zone) completed. • Verification for efficacy of sewerage network of Sanjauli - Malyana Zone by Bentley SewerCAD software performed.
Dissemination of knowledge	Three days training course on "Water quality and its management" was organized during June 28 – July 01, 2010 and Sept. 12-14, 2011 at HIPA, Shimla for field engineers of I&PH (HP).

12. Recommendation in previous meetings and action taken: Nil

13. Analysis and Results:

- Digital Elevation Model (DEM) of study area generated.
- Watershed Characteristics completed.
- Verification for efficacy of sewerage network of Sanjauli - Malyana Zone by Bentley SewerCAD software performed. Existing sewerage network is sufficient to cater the present load of municipal sewage.
- Out of 19 groundwater sampling locations spread across the study area 4 sites were found contaminated with fecal coliform.

- The groundwater of Shimla city was found to be of Ca-Mg-HCO_3 type having temporary hardness.
- Inlet water to water treatment plants (Dhalli & Ashwani Khud) supplying water to study area was found contaminated with organics (COD: 12-110 mg/L) as well as bacteria.
- Bore wells supplementing water to Ashwani Khud WTP are also contaminated with organics, fecal coliform and nitrate indicating contamination with sewage.

14. Adopters of the results of the study: I & PHE Dept., Shimla (H.P.)

15. Deliverables:

- Training Programme (22 participants were trained during the training course. Field visit to the participant were also organised and trained them for water sampling.
- Reports

16. Equipment Procured/under process: nil

17. Laboratory facilities used

a. Water quality laboratory

18. Data procured and generated: nil

19. Study Benefits:

Measurable indicators	**Achievements**
Identification of Contaminated sites	In progress
Suggestions for remedial measures	In progress

20. Specific linkage with Institution/end user/ beneficiaries:

- I & PHE Dept., Shimla (H.P.)

21. Shortcomings: nil

22. Future Plan:

- Field investigation and analysis
- Preparation of Final Report

Study - 3

1. Title of the Study: Spatial Variability of Ground Water Quality in Kandi, Sirowal and Shiwalik Belts of Jammu Region, J&K (India)

2. Name of PI & Co-PI:

- Omkar Singh, Scientist' E1, National Institute of Hydrology, Roorkee (PI)
- V K Choubey, Scientist 'F', National Institute of Hydrology, Roorkee (Co-PI)
- M K Sharma, Scientist' C', National Institute of Hydrology, Roorkee (Co-PI)

3. Type of study: Internal

4. Date of start: 1.4.2010

5. Scheduled date of completion: 30.9.2011

6. Study objectives:

- Spatial variability analysis of groundwater quality in the study area
- Hydro-chemical classification of ground water quality parameters and their prioritization for regular monitoring in the study area

7. Statement of the problem:

Management of groundwater is very important to meet the increasing demand of water for domestic, agricultural and industrial uses. The ground water quality monitoring is generally carried out by fetching water samples from exiting open wells which gives point information about ground water quality of that particular well. The information on the spatial variability of groundwater quality is useful for proper planning and management of groundwater resources. The knowledge of spatial variability of ground water quality is also essential for making reliable ground water quality interpretations and for making accurate predictions of ground water quality at any particular location in the aquifer. The spatial dependence between observations can be expressed by the semi variance, which is a measure of the average similarity between observations at a given distance apart.

The study area of Jammu, Kathua and Udhampur Districts is subjected to a lot of increasing pressure of anthropogenic activities viz., industrialization and intensive agricultural and horticultural activities. These activities are posing a risk of ground water quality deterioration. The spatial distribution of ground water quality and appropriate monitoring network is very essential for ground water quality management. Therefore, in the present study, it is proposed to study spatial variability of ground water quality in a part of Jammu Region.

8. Action Plan:

- Review of the literature on application of Geo-statistics on ground water quality for variogram analysis.
- Collection, compiling and analysis of ground water quality data of different open wells of the study area.
- Application of Geo-statistics on ground water quality data of the study area for development of variogram and spatial variability maps.
- Prioritization and classification of ground quality
- Suggestion for improvement of ground water quality network
- Report writing.

9. Timeline and justification for time over runs:

Sr. No.	Major Activities	1st half year	2nd half year	3rd half year
1	Literature survey			
2	Collection/Compiling of ground water quality data			
3	Analysis of ground water quality data for development of variogram/spatial variability maps.			
4	Preparation of Report			

10. Objectives vis-à-vis achievements:

	Objectives	**Achievements**
	a)	• Spatial variability analysis (semi-variogram) of existing ground water quality data of the study area been completed. • Spatial variability analysis (semi-variogram) of recently obtained ground water quality data from CGWB, Jammu is under progress and will be completed shortly.
	b)	• Hydro-chemical classification of ground water quality parameters and their prioritization for regular monitoring in the study area has also been carried out.

11. Recommendations/Suggestions in previous meetings of WG/TAC/GB along with action taken: Nil

12. Analysis and Results:

In the present study, spatial variability analysis (semi-variogram and contour maps) of existing ground water quality data of the study area for various parameters such as., pH, EC, total hardness, alkalinity, chloride, nitrate, sulphate, calcium, magnesium, sodium, potassium, phosphate, etc. has been completed using Surfer. The prioritization of ground water quality parameters has been carried using PCA. The classification of ground water quality been carried out using GWW software. The report writing is under progress.

13. Adopters of the results of the study & their feedback:

The present study has been carried out using ground water quality data monitored by the NIH-RC, Jammu and CGWB, Jammu. The report would be sent to the Regional Centre, Jammu for their own as well as other local offices for their reference/use/adoption of the results.

14. List of deliverables: The deliverables of this study would be final report and subsequently preparation of paper.

15. Major items of equipment procured: Nil

16. Lab facilities used during the study: Nil

17. Data procured and/or generated during study: The recent ground water quality data from CGWB, Jammu.

18. Study Benefits/ Impact:

Measurable indicators	**Achievements**
Spatial variability analysis of ground water quality/maps	completed
Prioritization & classification of ground water quality	completed

19. Specific linkages with institutions and/or end-user/beneficiaries: C.G.W.B., Jammu; WHRC, Jammu; J&K Paryavaran Sanstha.

20. Shortcomings/difficulties, if any: Nil

21. Future plan: Nil

Study – 4

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, Scientist 'B', NIH
Co-Investigators
Dr. V. K. Choubey, Scientist 'F' & Head EHD Shri Omkar Singh, Scientist 'E2 Dr. M.K. Sharma, Scientist 'C'

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:**

- Development of low cost media for removal of fluoride from drinking water.
- Establishing the mechanism involved in removal of fluoride.
- Establishing the capacity of media for fluoride removal.

9. **Statement of problem:**

- Drinking (ground water) of Assam, Bihar, U.P, Punjab, Rajasthan, Gujarat etc. is contaminated with fluoride.
- Presence of fluoride in drinking water leads to fluorosis and is a main concern.

10. **Approved Action Plan / Methodology**

- Media will be synthesized from fly ash.
- Characterization of media will be done by SEM, TEM, XRD and wet analysis.

- Sorption study will be done in CSTR to find out sorption mechanism and kinetics of sorption.
- Column study will be done for application in field scale.
- The developed low cost material will be tested in the actual field condition.

11. Timeline:

Sr. No.	Major Activities	1st Year	2nd Year
1	**Literature Survey**		
2	**Development of media**		
3	**Characterization and adsorption study**		
4	**Preparation of Final Report**		

12. Objectives and achievement during last six months

Objectives	Achievements
Literature Survey	Literature survey for research work on coal as well as bagasse fly ash and the available technologies for fluoride removal carried out.

13. Recommendation / Suggestion

Recommendation / Suggestion	Action Taken
Dr. V. C. Goyal (Sc. F) suggested referring Terafil water filter developed by IMMT-CSIR.	The filter is manufactured from pottery clay, sand, and wood saw dust. This is useful for removal of suspended solids and large colloids. The expected lifetime is 5 years.
Dr. N.C. Ghosh (Sc. F) advised to publish the research papers after obtaining the patent	Noted for compliance

14. Analysis & Results

Literature survey for fly ash indicates that most of the research work has been carried out with coal fly ash. Very few researchers had utilized bagasses fly ash for contaminant

removal. Moreover attempt to synthesis media / zeolite from bagasse fly is limited. Till date, media synthesized from fly ash has not been utilized for fluoride removal.

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

16. Deliverables **:** Paper & Report

17. Major items of equipment procured **:** None

18. Lab facilities used during the study **:** None

19. Data procured or generated during the study: None

20. Study Benefits / Impacts

Measurable indicators	Achievements
Solution of identified problem	In progress
New product	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:

- Collection, analysis, & characterization of bagasse fly ash from sugar mill
- Synthesis of fluoride selective media & characterization
- Lab trials followed by field trials

NEW STUDY – 1

1. Title of the Study: Assessment of Groundwater Quality in Hindon River Basin

2. Study Group:

Project Investigator
Dr. M K Sharma, Scientist 'C', NIH
Co-Investigators
Dr. V. K. Choubey, Scientist 'F' & Head EHD Shri Omkar Singh, Scientist 'E2 Dr. Rajesh Singh, Scientist 'B'

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:

- Monitoring and assessment of water quality of Hindon river
- Examine the suitability of ground water in the vicinity of river Hindon for various designated uses
- Characterize different point sources contributing river Hindon
- Explore possible remedial measures for improvement of river water quality

9. Statement of 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 (Sharma, 2001; Ali, 2000).

These toxic pollutants will ultimately reach the groundwater and will enter in the food chain posing a threat to human health because of their carcinogenic nature. In view of these facts, a water quality monitoring study of groundwater sources and surface water sources in river Hindon basin is being proposed to assess the present status of surface and ground water quality in the Hindon river basin.

10. End Users / Beneficiaries of the study: Policy makers and planners of State government and Common people of the affected areas.

11. Whether study is a new study/extension of previous studies: During 1998-99, a study titled 'Hydro-chemical studies of river Hindon' was carried out by the division in which surface water quality of river Hindon was assessed. In the proposed investigation, the impact of pollution in river Hindon on the groundwater quality will be studied.

12. Baseline data/information on the study area and results of previous studies
The information of previous study will be used in the present investigation.

13. 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

14. Timeline: Quarter-wise Work Programme

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
2011-12	-	-	Literature Survey	Reconnaissance Survey of the study area
2012-13	Field visit,	Field visit,	Field visit,	Analysis and

	Sampling & Analysis	Sampling & Analysis	Sampling & Analysis	processing of the data
2013-14	Field visit, Sampling & Analysis	Field visit, Sampling & Analysis	Field visit, Sampling & Analysis	Analysis and processing of the data
2014-15	Analysis and processing of the data	Writing of the Report	-	-

15. Deliverables:

- Paper
- Report

16. Proposed measurable indicator

- Groundwater quality and surface water quality data
- Identification and characterization of point sources

17. Involvement of end users/beneficiaries: Local people

18. Specific linkage with Institution and /or other NGOs: None

19. Major items of equipment needed: WQ Lab facilities of NIH

GROUNDWATER HYDROLOGY DIVISION

NATIONAL INSTITUTE OF HYDROLOGY

ROORKEE – 247 667

WORK PROGRAMME FOR THE YEAR 2011-12

S. No. & Reference Code	Project	Project Team	Duration & Status	Funding Source
1. NIH/GWD/NIH /09-12/	Impact of Climate Change on Dynamic Groundwater Recharge in a Drought Prone Area	Surjeet Singh (PI) C.P. Kumar Anupma Sharma Rajan Vatsa	3 years (04/09 – 03/12) **Status**: In progress	NIH
2. 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
3. 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**: In progress	NIH
4. NIH/GWD/NIH /11-14	Management of Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)	Sumant Kumar (PI) Rajan Vatsa N.C. Ghosh C.P. Kumar Surjeet Singh Sanjay Mittal	3 years (04/11 – 03/14) **Status:** In progress	NIH
Sponsored Project (HP-II)				
5. 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 A.D. Gohil C.K. Jain Sudhir Kumar D.S. Rathore Surjeet Singh Rajan Vatsa	3 years (10/09 – 06/12) **Status:** In progress	PDS (HP-II)
6. 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 *(Tentative)* Bhishm Kumar V. C. Goyal C. K. Jain Sudhir Kumar B. Chakravorty A. K. Lohani Anupma Sharma	36 months (October, 2011-September,2014)	European Union under 7th - Framework Programme

		Surjeet Singh Sumant Kumar		

1. PROJECT REFERENCE CODE: NIH/GWD/NIH/09-12

Title of the Study: **Impact of Climate Change on Dynamic Groundwater System in a Drought Prone Area**

Study Group:

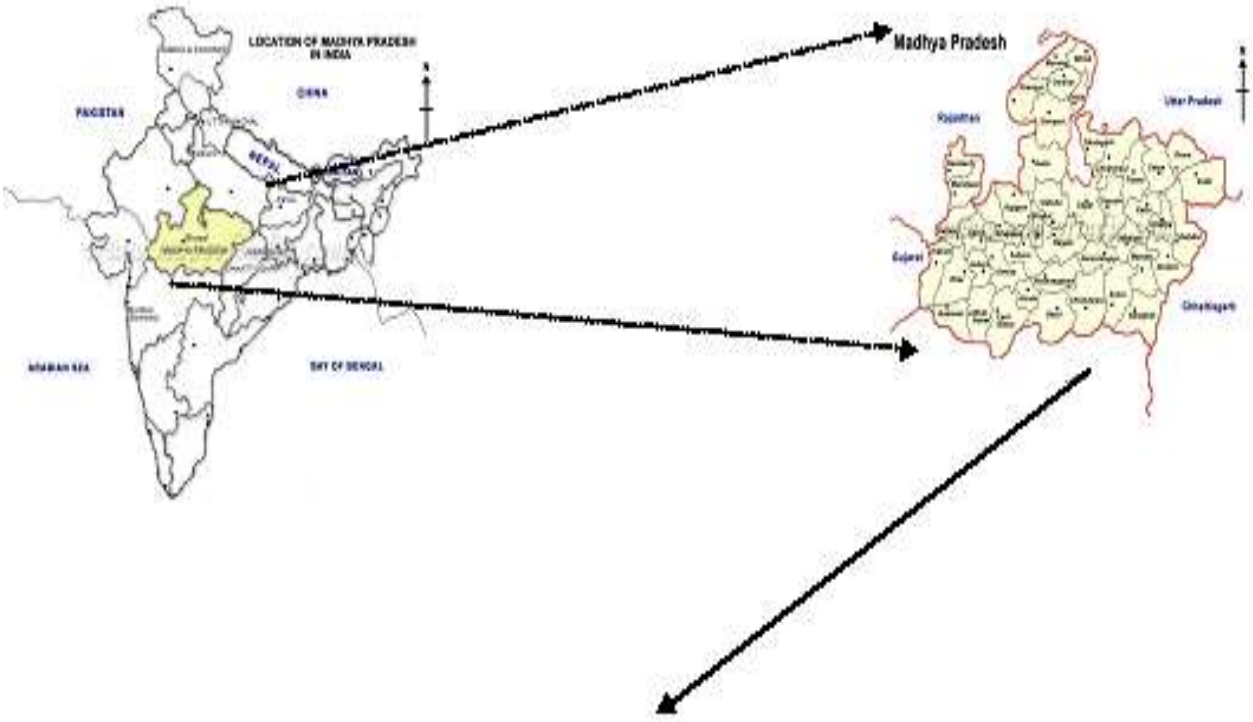
Dr. Surjeet Singh, Sc-E1, GWHD - **PI**
Mr. C. P. Kumar, Sc-F, GWHD – **Co-PI**
Dr. Anupma Sharma, Sc-E1, GWHD
Mr. Rajan Vatsa, Sc-B, GWHD

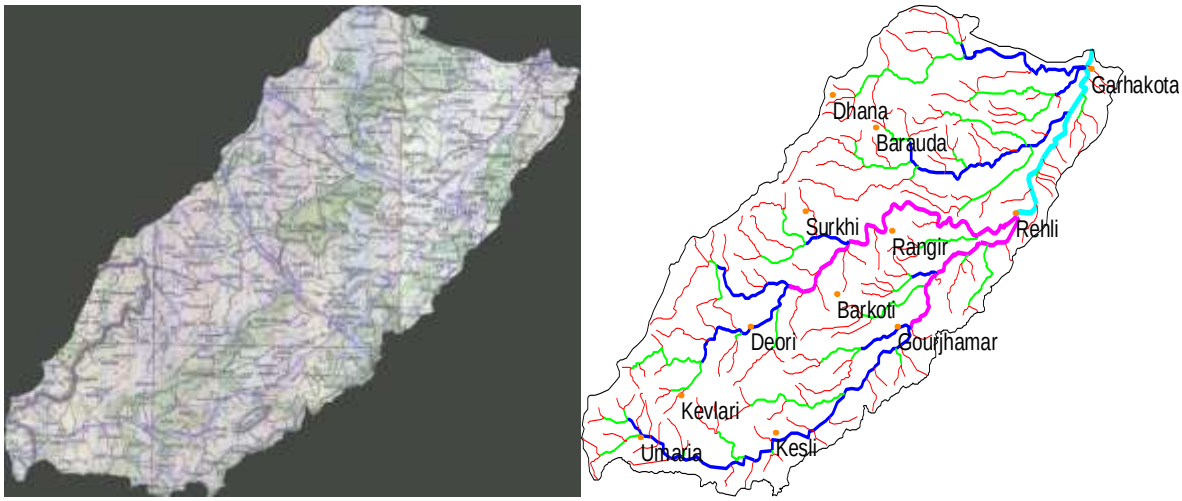
Funding: Internal

Date of Start: April 01, 2009

Scheduled Date of Completion: March, 2012

Location Map:





Statement of the Problem

Climate change is unequivocal. Due to this, there may be change in climatic variables, including rainfall intensity and distribution geographically which will result in change in groundwater recharge. Thus this study focuses impact assessment of climate change on groundwater recharge.

Approved action plan

- Basic data preparation using GIS
- Hydro-geological characterization of the study area
- Synthetic generation of daily values of precipitation, mean temperature, and solar radiation (using a weather generator)
- Estimation of groundwater recharge based on available precipitation and temperature records and anticipated changes to these parameters (using Visual HELP)
- Quantification of the spatially distributed recharge rates using the climate data and spatial soil survey data
- Simulations of groundwater flow using each recharge data set and evaluation of the changes in groundwater flow and levels on time.

Objectives & Achievements

To quantify the impacts of climate change on groundwater recharge in a part of Sonar basin, Madhya Pradesh.	The estimation of groundwater recharge at 12 locations in the basin has been completed. Quantification of change in groundwater recharge in response to climate change is also done.
To simulate the groundwater levels and investigate the temporal response of the aquifer system to historic and future climate	The modeling work for the simulation of groundwater levels in response to the estimated groundwater recharge is under

periods.	progress.

Analysis and Results

1. Development of slope map.
2. Estimation of recharge rates.
3. Quantification of changes in groundwater recharge.

List of deliverables

1. Database.
2. Reports – Part-I
3. Papers.

Lab facility used under the study

1. Soil and Water Laboratory, NIH.
2. Numerical Groundwater Modeling Unit, NIH.

Data procured and generated

1. Meteorological data.
2. Geo-hydrological map.
3. GIS database.
4. Future weather data.
5. Soil database.

Study Benefits

The study will be beneficial to investigate the changes in groundwater recharge in response to the projected climate change and also to predict the groundwater table.

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

- End-users/beneficiaries: Will provide an input to "Climate Change study"

Shortcomings/Difficulties, if any – Nil.

Future Plan

- Simulations of groundwater flow using each recharge data set and evaluation of the changes in groundwater flow and levels on time.

2. 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

Study team:

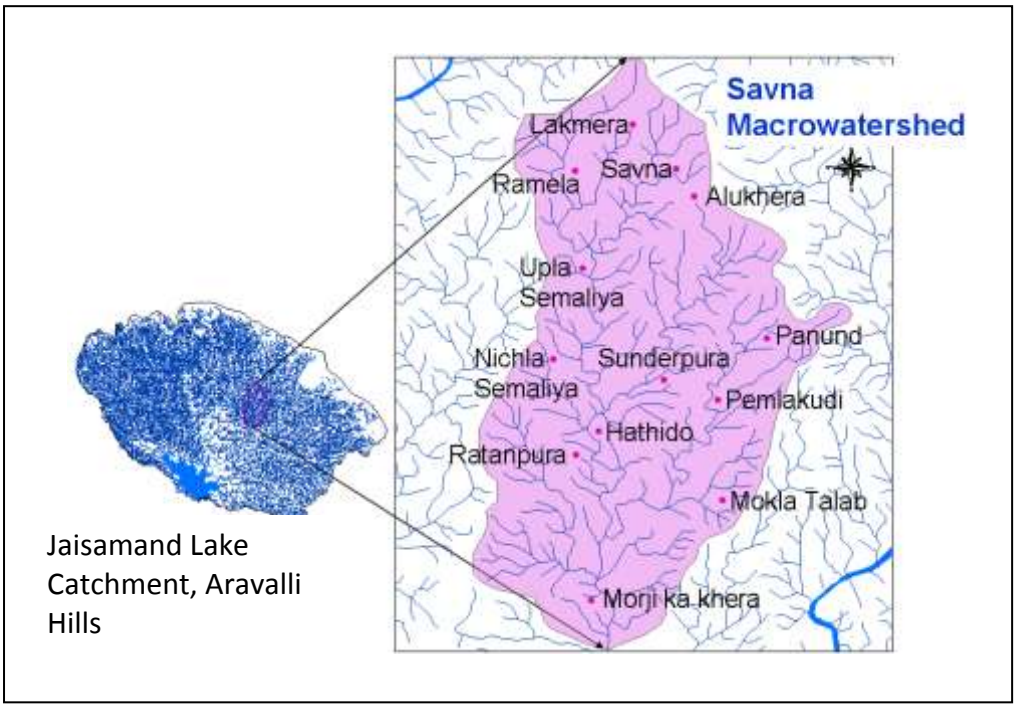
Dr. Anupma Sharma, Sc-E1, GWHD - **PI**
Mr. C P Kumar, Sc-F, GWHD – **Co-PI**
Dr. N.C. Ghosh, Sc-F & Head, GWHD
Dr. Sudhir Kumar, Sc-F, HID
Mr. Rajan Vatsa, Sc-C, GWHD
Mr. Sanjay Mittal, SRA, GWHD

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: March 2012

Location map:



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

Statement of the problem: To study the enhanced groundwater recharge through recharge structures viz. anicuts in the Savna Macrowatershed of Jaismand Lake Catchment in Aravalli Hills.

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	Three visits undertaken since April 2010.
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	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.
Mathematical modeling	Test runs on VS2DT to compute water flux through unsaturated zone.

Analysis and Results

1. Updating of database.
2. Test runs on VS2DT to compute water flux through unsaturated zone.

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

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

1. Reports – Interim Report
2. Papers

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 under progress
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: Will provide an insight to effectiveness of "Artificial Groundwater Recharge".

Shortcomings/difficulties, if any: -

Future plan:

- Development of mathematical model

3. 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

Study Team: Mr. Ashok Kumar Dwivedi, Sc-C, GWHD - **PI**
Dr. N.C Ghosh, Sc-F & Head, GWHD
Dr Anupma Sharma, Sc-E1, GWHD
Mr Sumant Kumar, Sc-B, GWHD
Mr Sanjay Mittal, SRA, GWHD
Mr. Ramchandra, RA, GWHD

Type of study : Internal

Date of Start : 1st April, 2011

Scheduled Date of Completion : 31st March, 2013*

Location Map Identification of the study area will follow after position document on Fluoride is brought out.

Objectives

(i) To prepare a position document on the ever growing problem of fluoride contamination in India
(ii) To study fluorosis – cause and effects in a drought prone area

***Note : 34th WG decided to bring out a position document on Fluoride during 2011-2012. Rest part of the study will follow subsequently.**

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

Excess fluoride in groundwater-based drinking water supply is a growing concern in more than 25 countries of the world. The problem in India is severe. A recent study conducted by the Central Ground Water Board (CGWB), Government of India indicated that more than 16 states of the country are facing the problem of fluorosis- a disease caused due to excessive ingestion of fluoride for a long time. The fluoride affected area goes on increasing and hence the number in states.

In this study, a position document in the form of Status Report for India is envisaged to be prepared first before other part of the study- identification of study area for working on various aspects of spread of fluoride and fluorosis is taken up. In the report, a comprehensive view is thought to be detailed with all possible references and strategy for mitigation and remediation is expected to be incorporated for future to be used by planners, academicians and researchers.

Approved action plan

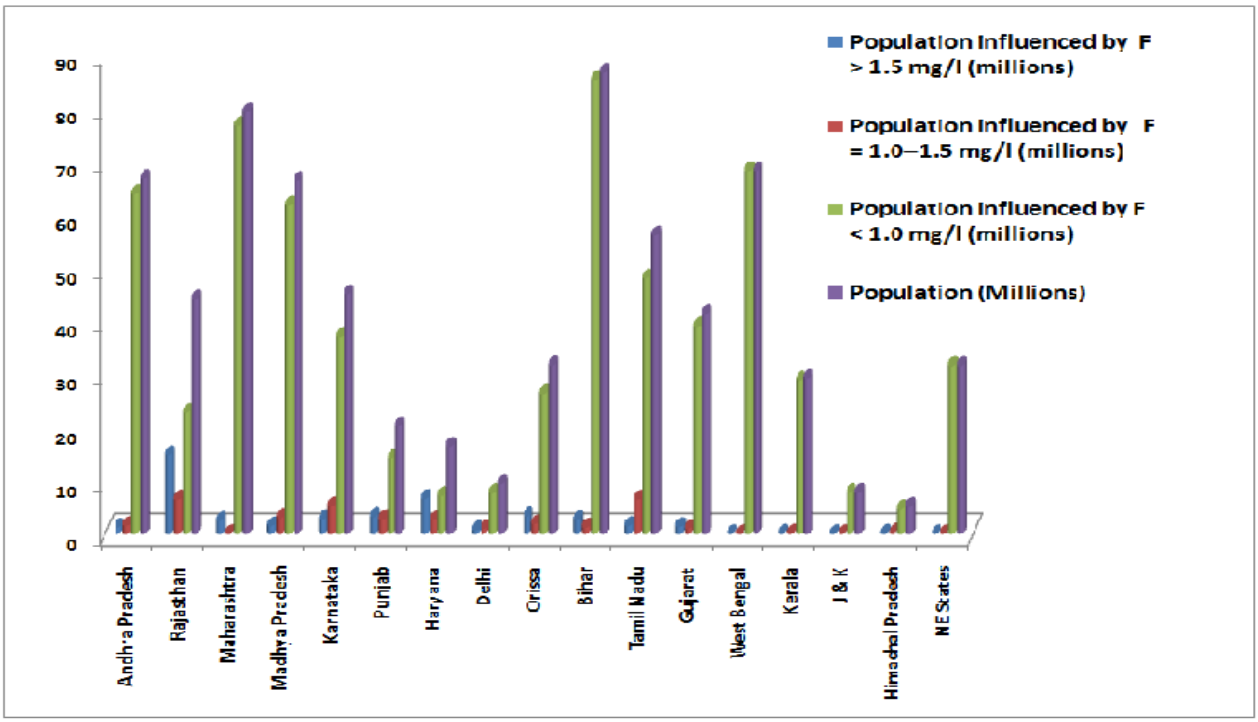
- Literature Review
- Field investigation & data collection.
- Determination of potential affected areas in the country.
- Preparation of Status Report

Note: It is proposed to conduct a national workshop on the fluoride and fluorosis issue, sometimes in the month of January, 2012; if approved by the working group.

Objectives & Achievements

To prepare a position document on the ever growing problem of fluoride contamination in India	Literature review from the published journals, periodicals and other related line literature till 2008 is almost complete. Collection of other literature and data is planned during October and November, 2011. Efforts are being made to get a few chapters of the report written by the experts in the area. A draft report is expected to be tabled by December, 2011.

Analysis and Results



As shown in the graph is as per observations of CGWB, most affected states are Rajasthan, Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra, Madhya Pradesh, Haryana,

Punjab, Orissa & Delhi. Recent investigations show that nearly all states including some districts of Uttar Pradesh are also affected to some extent or more. It is observed that the sampling and testing does not qualify representative sampling of the area, it requires more sampling and testing in those pockets, where it is claimed that F>1.5.

List of deliverables

Report and papers, etc.

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

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

Study Team

Mr. Sumant Kumar, Sc-B, GWHD - **PI**
Mr. Rajan Vatsa, Sc-B, GWHD – **Co-PI**
Dr. N.C Ghosh, Sc-F & Head, GWHD
Mr. C. P Kumar, Sc-F, GWHD
Dr. Surjeet Singh, Sc-E1, GWHD
Mr. Sanjay Mittal, SRA, GWHD

Type of study : Internal

Date of Start : 1st April, 2011

Scheduled Date of Completion : 31st March, 2014

Location Map Catchment area is yet to be finalized as the study is linked to a sponsored project by European Union, which is expected to be launched by the October 2011.

Objectives

1) To identify the potential recharge site for groundwater (GW) augmentation.
2) To manage the augmented GW resources for subsequent potential uses.

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

Growing water demands and increasing climate variability is one of the major concerns for water managers. Integrated management of water resources is required to assure sustainable water availability for various uses. Managed aquifer recharge (MAR) and Aquifer storage recovery (ASR) technology can be used to meet peak demands, emergency supply (strategic storage), drought requirements, and a number of other storage needs.

In this study, catchment area of India would be taken for management of aquifer recharge and aquifer storage recovery. A comprehensive strategy and guidelines will be developed indicating as to how artificial GW recharge is to be managed for augmentation of GW resources & for its subsequent recovery and potential uses. It is expected that the study will

provide a scientific guideline to the policy makers in helping the prospect of existing artificial GW recharge programme.

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 in view of assessing recharge site. The catchment area is yet to be identified as the study has been linked to a sponsored project by European Union which is expected to be launched by the October 2011.
To manage the augmented GW resources for subsequent potential uses	Key components of Managed Aquifer Recharge (MAR) & Aquifer Storage Recovery (ASR) have been elaborated. Components are being studied to derive optimization -simulation model.

Analysis and Results

As the study site is yet to be finalized, hence no specific data could be collected for analysis. However, an ANN based model for computation of GWL has been developed and performances evaluated with the data available from a catchment.

List of deliverables

Reports and papers, etc.

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

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

Study team:

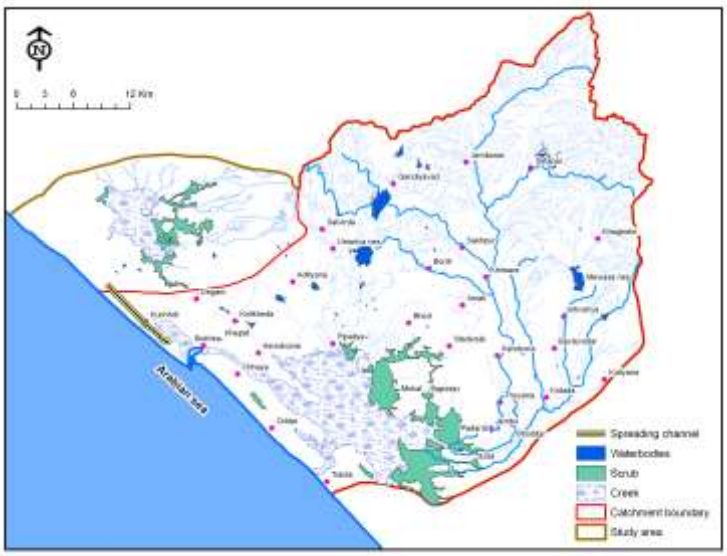
- Study Coordinator : Dr N C Ghosh, NIH
- PI : Dr. Anupma Sharma, NIH
- Co-PI : Mr. C P Kumar, NIH
  Mr. A D Gohil, GWRDC, Gandhinagar
- Co-investigators : NIH - Dr. C.K. Jain; Dr. Sudhir Kumar;
  Mr. D.S. Rathore; Dr. Surjeet Singh; Mr Rajan Vatsa
  GWRDC - Research Officer, Gandhinagar; Geologist, Gandhinagar; Geohydrologist, Rajkot; Geophysicist, Porbandar; Geologist, Porbandar

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: June 31, 2012

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.

Statement of the problem:

To investigate the coastal groundwater dynamics and saltwater intrusion phenomenon in the Porbandar District of Coastal Saurashtra.

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	Five since April 2010.
Data collection	Collection of lithologs, geological maps, pump tests, groundwater draft, reservoirs, check dams, spreading channel, land use, irrigation schemes, relevant reports and maps
Procurement of data	Meteorological data from IMD and satellite data from NRSC
Data monitoring	Water level and water quality data monitoring on quarterly basis in 40 wells and on monthly basis in 26 wells, including creeks and reservoir schemes near coast.
Installation of piezometers	Total 16 piezometers drilled in the study area by GWRDC.

Field experiments and Laboratory investigations	Experiments using double ring infiltrometer: 23 sites Guelph permeameter: 22 sites Soil samples collected from field: 31 disturbed and 19 undisturbed Soil samples analyzed in laboratory for soil moisture characteristics Water samples for isotope analyses: 20 water samples Carbon dating: samples collected from three sites Pump test conducted: One Installation of salinity data loggers Measurement of salinity profiles through TLC meter Geophysical Surveys (VES) at five locations
Database preparation	Digitization of drainage network and other water bodies, marshy areas, water supply and irrigations schemes, administrative boundaries, and elevation contours completed. DEM of Minsar basin developed.
Data analysis	Analysis of satellite data, pump tests, landuse, lithologs, water table and water quality data. Analysis of soil samples and data for infiltration and saturated hydraulic conductivity.
Organization of training course	One training course on 'Coastal Groundwater Modeling and Management' organized for Officers of State Departments from Coastal HP-II States, during Nov. 22-26, 2010 at WALMI, Anand, Gujarat.

Analysis and Results

1. Topography of Minsar River Basin
2. Analysis of soil characteristics (infiltration rate, hydraulic conductivity, retention curve)
3. Generation of water table and TDS contours
4. Analysis of lithologs
5. Hydrological water balance (under progress)
6. Socio-economic survey in 15 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 programmes, users interaction workshops)

1. Reports – Interim Report
2. Training Programs

Major items of equipment procured:

1. GPS, salinity data logger, geophysical resistivity meter and TLC meter procured
2. Procurement of other equipment under progress

Lab facilities used during the study:

1. Soil and Water Lab, NIH
2. Nuclear Hydrology Lab, NIH
3. Water Quality Lab, GWRDC

Data procured and/or generated during the study:

Data Procurement

1. Meteorological data from IMD, Pune
2. Satellite data from NRSC, Hyderabad

Data Generation

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	Few water balance components have been computed
Technology transfer	One training course on 'Coastal Groundwater Modeling and Management' organized for Officers of State Departments from Coastal HP-II States, during Nov. 22-26, 2010 at WALMI, Anand, Gujarat.

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

6. PROJECT REFERENCE CODE : EU-Project no. 282911

i. EU Sponsored multi-stakeholders Collaborative R & D Project entitled:

"Saph Pani - Enhancement of natural water systems and treatment methods for safe and sustainable water supply in India"

ii. Total Project cost: Appox. 3.5 million Euros.

iii. NIH's share : 2,42,044 Euros

iv. Duration: 36 months (October, 2011 – September, 2014).

v. Stake-holders : 20 organizations (11 Indian; 9 Foreign)

Project Number [1]	282911	Project Acronym [2]	Saph Pani

List of Beneficiaries

No	Name	Short name	Country	Project entry month[10]	Project exit month
1	FACHHOCHSCHULE NORDWESTSCHWEIZ	FHNW	Switzerland	1	36
2	Uttarakhand Jal Sansthan	UJS	India	1	36
3	NATIONAL INSTITUTE OF HYDROLOGY	NIH	India	1	36
4	INDIAN INSTITUTE OF TECHNOLOGY ROORKEE	IITR	India	1	36
5	VEOLIA WATER (INDIA) PVT LTD	VEOLIA	India	1	36
6	ANNA UNIVERSITY CHENNAI	ANNA	India	1	36
7	SPT CONSULTANCY SERVICES PARTNERSHIP	SPT	India	1	36
8	MUNICIPAL CORPORATION OF RAIPUR	RMC	India	1	36
9	ARUN GULATI	AJD	India	1	36
10	COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH	NGRI	India	1	36
11	INDIAN INSTITUTE OF TECHNOLOGY BOMBAY	IITB	India	1	36
12	DHI - (INDIA) WATER & ENVIRONMENT PVT LTD	DHI	India	1	36
13	KOMPENTENTZZENTRUM WASSER BERLIN GEMEINNUTZIGE GMBH	KWB	Germany	1	36
14	BUREAU DE RECHERCHES GEOLOGIQUES ET MINIERES	BRGM	France	1	36
15	Zentrum fur Umweltmanagement und Entscheidungstheorie	CEMDS	Austria	1	36
16	Hochschule fuer Technik und Wirtschaft Dresden	HTWD	Germany	1	36
17	UNESCO-IHE INSTITUTE FOR WATER EDUCATION	IHE	Netherlands	1	36
18	INTERNATIONAL WATER MANAGEMENT INSTITUTE IWMI	IWMI	Sri Lanka	1	36
19	COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION	CSIRO	Australia	1	36
20	FREIE UNIVERSITAET BERLIN	FUB	Germany	1	36

vi. Project's Abstract

Abstract [9]
Saph Pani addresses the improvement of natural water treatment systems such as river bank filtration (RBF), managed aquifer recharge (MAR) and wetlands in India building on a combination of local and international expertise. The project aims at enhancing water resources and water supply particularly in water stressed urban and peri-urban areas in different parts of the sub-continent. The objective is to strengthen the scientific understanding of the performance-determining processes occurring in the root, soil and aquifer zones of the relevant processes considering the removal and fate of important water quality parameters such as pathogenic microorganisms and respective indicators, organic substances and metals. Moreover the hydrologic characteristics (infiltration and storage capacity) and the eco-system function will be investigated along with the integral importance in the local or regional water resources management concept (e.g. by providing underground buffering of seasonal variations in supply and demand). The socio-economic value of the enhanced utilisation of the attenuation and storage capacity will be evaluated taking into account long-term sustainability issues and a comprehensive risk management. The project focuses on a set of case study areas in India covering various regional, climatic, and hydrogeological conditions as well as different treatment technologies. The site investigations will include hydrological and geochemical characterisation and, depending on the degree of site development, water quality monitoring or pre-feasibility studies for new treatment schemes. Besides the actual natural treatment component the investigation may encompass also appropriate pre- and post treatment steps to potabilise the water or avoid clogging of the sub-surface structures. The experimental and conceptual studies will be complemented by modelling activities which help to support the transferability of results.

vii. 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

viii. NIH's involvement

In Work Packages (WP) - WP 1, WP2 and WP7.

ix. Targeted Areas for R & D works

For WP 1 : Hardwar, Srinagar, Nainital, and NCT Delhi.
For WP 2 : Municipal area Raipur, Maheshwaram (Warangle, Andra Pradesh).

x. Objectives

For WP 1:

- To analyse the performance of existing bank filtration (BF) schemes in urban areas in India
- To determine/ evaluate the removal of organic pollutants, coliform bacteria and other pathogens for BF schemes located by surface waterswater having varying pollution loads (high – limited – poor source water quality)
- BF risk evaluation with special focus on sustainable operation during floods and addressing the removal/ breakthrough of hygienically relevant bacteria during floods (in cooperation with WP6)
- To develop cost efficient technical elements for the improvement of flood-protection for BF schemes
- To develop remediation concepts for BF in aquifers contaminated with inorganic nitrogen species
- To determine the economic viability of BF including post-treatment (in cooperation with WP4)

For WP 2

- To determine the quantitative and qualitative effects of monsoon water recharge of an overexploited urban aquifer through existing ponds and lakes
- To assess the impact of existing measures for monsoon water infiltration on counteracting seawater intrusion into a coastal aquifer used for urban drinking water production and develop an alternative low-cost and low-tech measure
- To evaluate the impact of MAR through percolation tanks on groundwater recharge and quality in a peri-urban over-exploited hard-rock aquifer
- To derive general recommendations for the implementation of MAR under the specific conditions met in India.

For WP 7

- To transfer knowledge through existing education and training networks to ensure that the knowledge and skills generated during the project are shared with the wider network of end-users and finally implemented.
- To offer specific oversight training courses targeting different stakeholders involved in natural systems for water treatment in India, in close collaboration with related WP leaders, participating academic/training and research institutes and water utilities in India.
- To disseminate information on project research activities, progress and outputs through project website, newsletters, publications in international peer reviewed journals and presentations in different scientific meetings, IWA conferences and other water events in India and aboard.
- To organize a final scientific conference to disseminate the main results and key achievements of the project.

xi. NIH's Study Team

Project Director : R. D. Singh, Director, NIH
Project Co-coordinator & P. I. : N. C. Ghosh

Tentative study Team:
Bhishm Kumar ; V. C. Goyal; C. K. Jain; Sudhir Kumar; B. Chakravorty; A. K. Lohani ; Anupma Sharma; Surjeet Singh; Sumant Kumar

HYDROLOGICAL INVESTIGATION DIVISION

NATIONAL INSTITUTE OF HYDROLOGY

ROORKEE – 247 667

WORK PROGRAMME OF THE 2011-2012

A. INTERNALLY FUNDED STUDIES

Reference Code	Project	Project Team	Duration/ Status	Funding
NIH/HID/INT/09-12	SW and GW Interaction at Selected Locations Along River Yamuna in NCT, Delhi: Phase-II	Sudhir Kumar (PI) M. S. Rao P. K. Garg	3 years *(4/09 – 3/12)* ***Continuing study***	NIH
NIH/HID/INT/10-13	Study of Variability of Snow and Glacier Contribution in Melt Water of Gangotri Glacier at Goumukh using Isotopic Techniques	S.P. Rai (PI) Manohar Arora, Bhishm Kumar, Rakesh Kumar and Naresh Kumar	3 years *(4/10 – 3/13)* ***Continuing study***	NIH
NIH/HID/INT/10-12	Identification of Recharge Zones of Some Selected Springs of Uttarakhand Using Isotopes	S. D. Khobragade (PI) Bhishm Kumar Sudheer Kumar S. P. Rai Pankaj Garg	***2 years*** *(04/10-03/12)* ***Continuing study***	NIH
NIH/HID/INT/11-13/1	Assessment of Radon Cocentration in Waters and Identification of Paleo-groundwater in Punjab State	S. K. Verma (PI) Sudhir Kumar M. S. Rao Bhishm Kumar	***2 years*** *(04/11-03/13)* ***New study***	NIH
NIH/HID/INT/11-13/2	Hydro-geological assessment of Ghar area for artificial recharge and water management planning	Pankaj Garg (PI) Sudhir Kumar Tanveer Ahmad Rajesh Agarwal V.C. Goyal Bhishm Kumar	***2 years*** *(04/11-03/13)* ***New study***	NIH

B. SPONSORED STUDIES/CONSULTANCY STUDIES

NIH/HID/DST /07-12	National programme on isotope fingerprinting of waters of India (IWIN)	M.S. Rao (PI) B. Kumar, Sudhir Kumar S.P. Rai S.K. Verma Pankaj Garg	5 years *(07/07–06/12)* ***Continuing study***	DST
NIH/HID/FRI/ 08-13	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	5 years *(04/08– 03/13)* ***Continuing study***	FRI Deharadun
NIH/HID/DJB /10-11	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 AK Gupta, Delhi Jal Board	1 year *(02/10-01/11)* *To be extended upto12/11* ***Continuing study***	Delhi Jal Board

NIH/HID/GBPIHED/10-13	Development of Spring Sanctuaries in an Urban and Rural Watershed in District Pauri Garhwal, Uttarakhand	S.P. Rai (PI) Bhishm Kumar Sudhir Kumar Suhas Khobragade Pankaj Garg	3 years *(04/10-03/13)* ***Continuing study***	GBPIHED
NIH/HID/RSMML/2010-11	Hydrogeological Studies Of Jhamarkotra Mines, Udaipur, Rajasthan	Sudhir Kumar (PI) S K Verma, Pankaj Garg	1 year (07/10-06/11) ***Continuing study***	RSMML Udaipur
NIH/HID/CONS/11-13	Integrated Hydrological Investigations of Sukhna Lake, Chandigarh for its Conservation and Management	S. D. Khobragade (PI) S. P. Rai Bhishm Kumar Vipin Agrawal, SRA	2 years (07/11-06/13) **New study**	Forest dept., Chandigarh

C. PURPOSE DRIVEN STUDIES UNDER HP-II

NIH/HID/HP-II/09-12	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***	HP-II
NIH/HID/HP-II/09-12	Groundwater Management in Over- Exploited Blocks of Chitradurga and Tumkur Districts of Karnataka	Sudhir Kumar (PI) J.V. Tyagi Vijay Kumar B.K. Purandara S.P. Rai M.S. Rao	3 years *(07/09-6/12)* ***Continuing study***	HP-II

HYDROLOGICAL INVESTIGATIONS DIVISION

ITEM NO. 35.2 ACTIONS TAKEN ON THE ADVICE / DECISIONS OF THE 34th MEETING

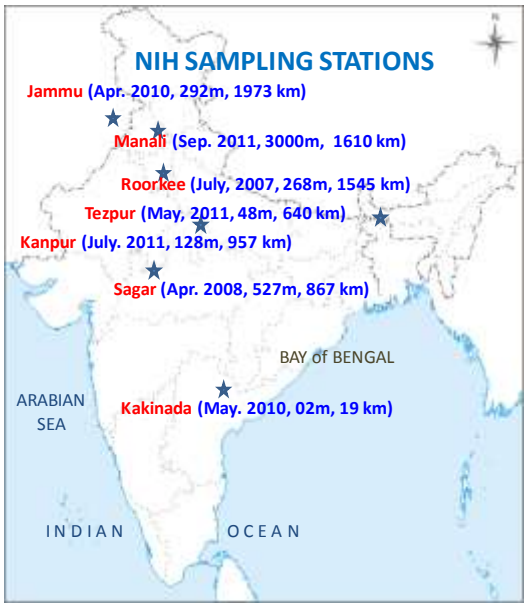
Actions taken pertaining to individual studies, if any, are discussed separately for each study under the Item No. 35.3.

ITEM NO. 35.3: PROGRESS OF THE WORK PROGRAMME OF THE DIVISION FOR THE YEAR 2011-12

1. REFERENCE NUMBER: NIH/HID/DST/07-12

1	Title of the study	:	NATIONAL PROGRAMME ON ISOTOPE FINGERPRINTING OF WATERS OF INDIA (IWIN)
2	Name of PI, Co-PI, & their affiliations	:	Bhishm Kumar, Scientist F & Head HID (PI-national), M S Rao, Scientist E1 (PI-Internal)
3	Type of study (sponsored /consultancy /referred /internal). If referred, mention the reference	:	Sponsored (Funded by DST vide IR/54/ESF/05-2004 dated July17, 2007)
4	Date of start, Scheduled date of completion	:	September, 2007 August, 2012
5	Location map (wherever applicable)	:	Samples are collected by NIH from 7 sites (Roorkee, Sagar, Jammu, Kakinada, Tezpur, Kanpur and Manali) and member organizations collect samples from 85 sites all over India.

NIH-IWIN SAMPLING LOCATIONS MAP



Other participating Organizations: A.U., CGWB, CPCB, CRIDA, CWR DM, IIT-Kharagpur, IMD, NGRI, NIO, NRL-IARI, PRL

Total sampling Locations : 92

6	Study objectives	:	1. Identifying regional/local water vapour components in the local atmosphere. 2. Residence time and exchange estimate of vapour/water in different hydrological units. 3. Identifying dominant sources of water vapour

supply (Arabian sea/ Bay of Bengal/local and long distant continental sources) during different seasons.

4. Isotopic database development.

7 Statement of the problem : To identify the source of air moisture during different seasons

8 Approved action plan : Appendix-1

Year	October, 2011 to August, 2012 (Appendix I)	Remark
Oct, 11-Aug, 12	**Sampling**: 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: Items 2 as at Roorkee (GLV by cond.) At IIT-Kanpur: Items 2 as at Roorkee (GLV by cond.) At MMHP, Manali(HP): Items 2 as at Roorkee (GLV by cond.) **Data Collection**: Hydro-meteorological at Roorkee, Sagar, Jammu, Kakinada, Tezpur, Kanpur and Manali. **Analysis**: Analysis of water samples (NIH, Sagar, Jammu, Kakinada, Tezpur, Kanpur & Manali) and samples provided by participating organizations for δD, $\delta^{18}O$ and ^{3}H. **Data interpretation** **Report writing**	Report preparation as per the Appendix I

9 Timeline and justification for time over runs : NA as the programme is going as per the schedule

10 2-column table showing objectives vis-à-vis achievements (clearly separate achievements reported in the previous meetings) :

Objective	Status	Work Done
Identifying regional/local water vapour components in the local atmosphere	Achieved	• Qualitatively resolved the regional/local water vapour components in the local atmosphere and identified through correlation of isotopic data with wind trajectory
Identifying dominant sources of water vapour supply (Arabian sea/ Bay of Bengal/local and long distant continental sources) during different seasons	Achieved	

Isotopic database development	Achieved	Isotopic database has been developed for approximately 20000 samples =6500 (NIH) + 13500 (PRL)

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

- **Suggestion:** Sh. N. Y. Apte, DDGM, IMD suggested to analyze correlation between meteorological data at Jammu and other stations with isotopic data.
- **Action Taken:** The auto-correlogram for meteorological data at Roorkee and Sagar has been analysed and for other stations the data procurement and analysis work is in progress.

12 Analysis and Results Progress **:**

- Established three air-moisture sample collection units for North-east region at Tezpur University, Assam; IIT-Kanpur and a high altitude station at MMHRP, Manali, HP

- Collected 1021 samples since April, 2011 and out of which 650 samples have been measured

(a) (b) (c)

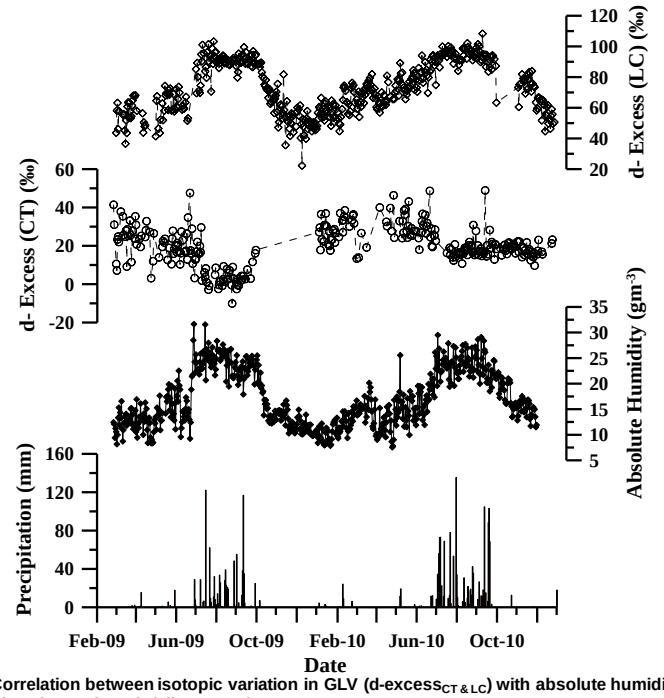
Installation of air-moisture sampling units:
(a) Tezpur University, Assam (b) IIT-Kanpur, UP (c) MMHRP, Manali, HP

Results

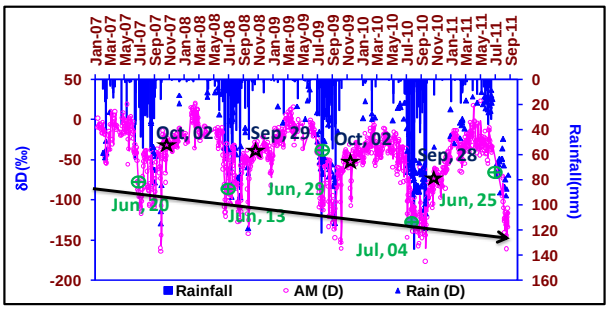
- Analysed & compared variation in isotopes ($\delta^{18}O$, δD) of GLV collected by two methods (liquid condensation and cryogenic trapping) with absolute humidity (derived from temperature and relative humidity) and precipitation. The opposite trend is observed between the two methods (liquid condensation and cryogenic trapping) during the monsoon season indicating temperature dependant fractionation occurring during the condensation, which needs to be investigated to understand

the process.

- ❖ During monsoon, absolute humidity and d-excess$_{LC}$ (=δD - 8* $\delta^{18}O$) is observed to be very high with respect to other seasons. The difference between minimum and maximum in d-excess time series is 60‰ and 38‰ for liquid condensation and cryogenic trapping, respectively. This relates to difference of 20g/cc in the time spectrum of absolute humidity.
- ❖ Analysed & interpreted Isotopic components (δD_{GLV} and $\delta D_{Rainfall}$) and the rainfall amount for onset and withdrawal of monsoon and change in monsoon pattern at Roorkee for 2007-11. The isotopic trend for 5 years indicates a systematic depletion in isotopic minimum with a total depletion by approximately 40‰ which may indicate changing climate. This may require further investigation and data collection will be continued towards this.
- ❖



Correlation between isotopic variation in GLV (d-excess$_{CT\&LC}$) with absolute humidity . Also shown the rainfall pattern for 2009-10.



Actual Date of Monsoon Onset (⊕) & Withdrawal (★) (as per IMD)

Variation in Isotopic components (δD_{GLV}, $\delta D_{Rainfall}$) and the Rainfall Amount for onset and withdrawal of monsoon and change in monsoon pattern at Roorkee for 2007-11

13 Adopters of the results of the study and their feedback : The IWIN project is a National level programme and in which various academic institutions, national level organizations including MoWR are participating. The results of the study are commonly getting shared. The final report will be submitted to DST for further necessary action. The programme is also generating papers in high impact journals and through which the knowledge will be transpired to various other institutions nationally & globally.

14 List of deliverables (e.g. equipment, papers, reports, software, manuals, brochures, flyers, training programmes, users interaction workshops) : Publications

- ➢ Gopal Krishan, M.S. Rao and Bhishm Kumar. 2011. Instruments for measurements for isotopic composition of air moisture. (accepted for oral presentation at NSI-36 symposium to

be held at Invertis University, Bereilly during October 20-22, 2011.

- P. Purushotaman, Pooja Devi, M.S. Rao, B. Kumar, G. Krishan and Y.S. Rawat. 2011. Comparison of two methods for ground level vapour sampling and influence of meteorological parameters on stable isotopic composition. Submitted to *Hydrological Processes* (Under review).

Reports

- Submitted annual report to Project Review Committee and funding agency (DST-SERC)
- Prepared an interim report

Trainings

- 20 technical persons have been trained at various stages of the project
- Under this project a training workshop will be organized during December 19-24, 2011 at NIH, Roorkee

15	Major items of equipment procured	:	NIL
16	Lab facilities used during the study	:	Hydrological Investigations Division
17	Data procured and/or generated during the study	:	
18	Study Benefits / Impact (2-column table showing achievements against measurable indicators as mentioned in the approved study document)	:	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.
19	Specific linkages with Institutions and/or end-users/beneficiaries	:	Participating Organization: AnnaUniversity, BARC, CGWB, CPCB, CWC, CWRDM, IMD, IIT-Kharagpur, NGRI, NIO, NRL-IARI, PRL
20	Shortcomings / difficulties, if any	:	The present sampling is getting done at ground level whereas meteorology includes high altitude atmospheric dynamics. Therefore, sample needs to be collected at various altitudes from ground to cloud level. Technology towards collection of samples from various altitudes will be developed in due course of time.
21	Future plan	:	➢ A training workshop sponsored by DST-SERC will be organized during December 19-24, 2011 at NIH, Roorkee ❖ The sampling of GLV, rain, river and groundwater will continue in this year.

- ❖ Scientific/technical publication/reporting in consultation with IWIN Secretariat.

Appendix – 1

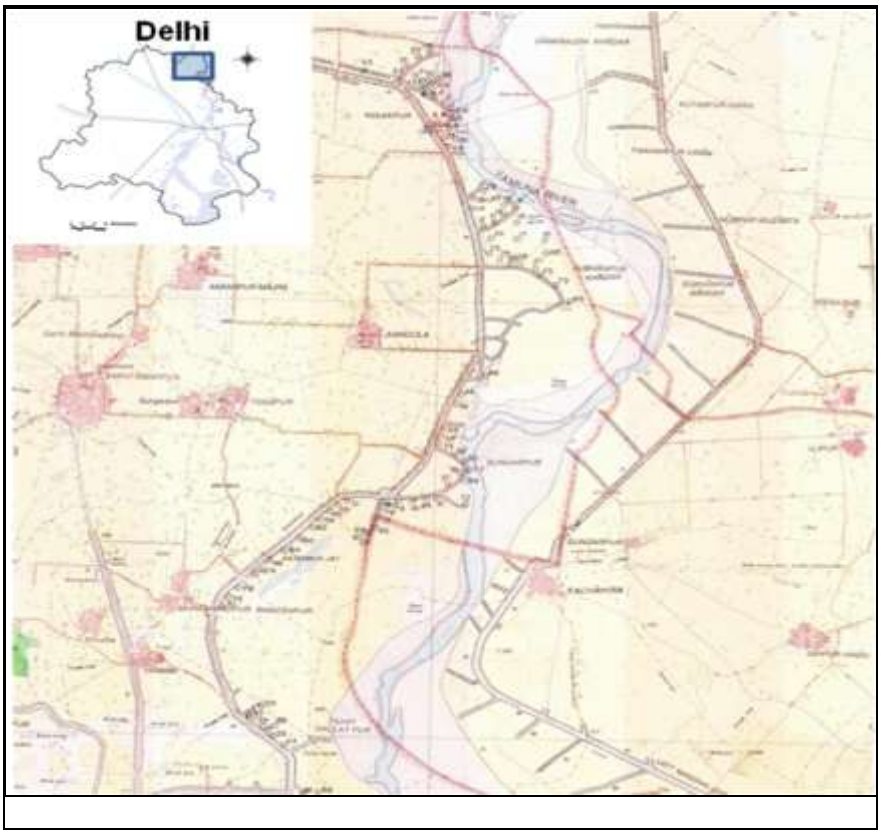
NATIONAL PROGRAMME ON ISOTOPE FINGERPRINTING OF WATERS OF INDIA

ACTIVITY SCHEDULE (Quarter wise from October 2011 to August 2012)

Activity	1st	2nd	3rd	4th
Sampling from all stations (7) 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				♦

2. REFERENCE NUMBER: NIH/HID/INT/2009-12

1	Title of the study	:	SURFACE WATER AND GROUNDWATER INTERACTION AT SELECTED LOCATIONS ALONG RIVER YAMUNA IN NCT, DELHI (*Phase-II*)
2	Name of PI, Co-PI, & their affiliations	:	Sudhir Kumar, Scientist F (PI) MS Rao, Scientist E1 Pankaj Garg, Scientist B
3	Type of study (sponsored /consultancy /referred /internal). If referred, mention the reference	:	Internal (Refinement of Phase-I study)
4	Date of start, Scheduled date of completion	:	1st April, 2009 31st March, 2012
5	Location map (wherever applicable)	:	Study area lies in NCT Delhi near the border of Haryana and Uttar Pradesh. The floodplain is 1.2 – 1.5 km wide and is constrained by embankments on both the sides.



6	Study objectives (not more than 4)	:	5. To study the surface water and groundwater interaction along river Yamuna in National Capital Territory of Delhi. 6. To determine the extent of surface water

groundwater interaction.

7 Statement of the problem : Delhi has constructed 90 tube wells in the floodplains of the river Yamuna to extract groundwater. Haryana has an apprehension that these wells are inducing recharge from the river and thus they have to release more amount of water to maintain the ponding level at Wazirabad.

8 Approved action plan :

Year	**April to March**	**Remark**
All Years	Field investigations, Data Collection and Data analysis, Mathematical Modelling based on Isotopic results	Report preparation after three years

9 Timeline and justification for time over runs : NA

10 2-column table showing objectives vis-à-vis achievements (clearly separate achievements reported in the previous meetings)**:**

Objective	Status	Work Done
To study the surface water and groundwater interaction along river Yamuna in NCT, Delhi.	Achieved	Sampling of samples for isotopic analysis and water level monitoring completed. Mathematical modelling in progress.
To determine the extent of surface water groundwater interaction.	Achieved	

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

12 Analysis and Results :

i) Water level monitoring indicated the recharge in the floodplain 3.52 meters.
ii) Isotopic variation in piezometers along section-II indicates that river usually interacts only upto piezometer no 1. After this the interaction of river is not significant.
iii) Vertical recharge in the floodplains takes place only for 15-20 days in a year

The other details along with interpretation of the data will be presented during the meeting.

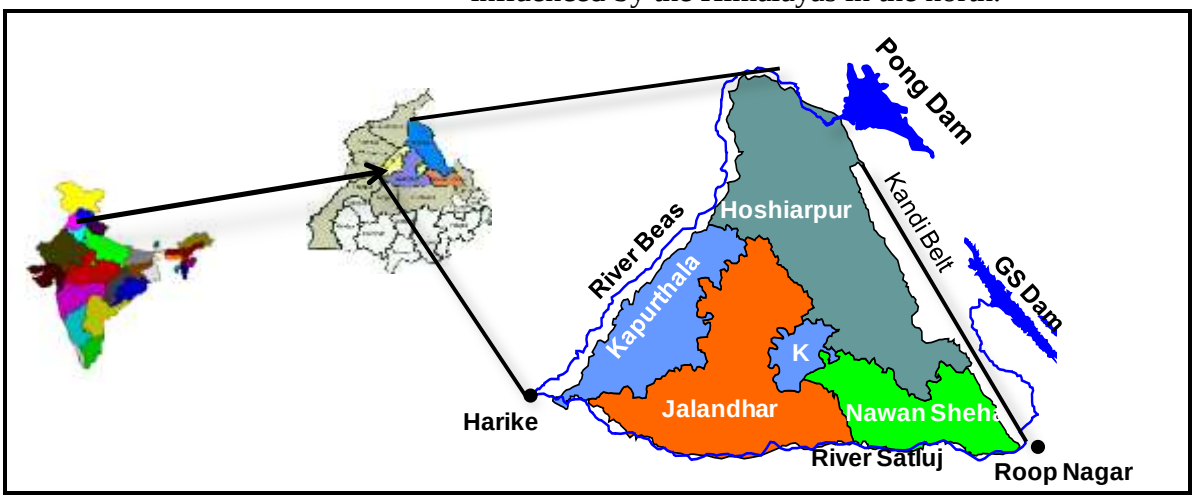
13 Adopters of the results of the study and their feedback : Delhi Jal Board and Upper Yamuna River Board

14 List of deliverables (e.g. equipment, papers, reports, software, manuals, brochures, flyers, training programmes, users interaction workshops) : Report & Paper

15	Major items of equipment procured	:	NIL
16	Lab facilities used during the study	:	Isotope Ratio Mass Spectrometer
17	Data procured and/or generated during the study	:	Isotopic Data and water level data at 13 locations within the Yamuna Floodplain in Palla area
18	Study Benefits / Impact (2-column table showing achievements against measurable indicators as mentioned in the approved study document)	:	Quantification of the groundwater recharge from Yamuna river
19	Specific linkages with Institutions and/or end-users/beneficiaries	:	Upper Yamuna River Board and Delhi Jal Board
20	Shortcomings / difficulties, if any	:	NIL
21	Future plan	:	The project shall be closed in March 2012

3. REFERENCE NUMBER: NIH/HID/HP-II/09-12

1	Title of the study	:	GROUNDWATER DYNAMICS OF BIST DOAB AREA, PUNJAB, USING ISOTOPES (PDS UNDER HP-II)
2	Name of PI, Co-PI, & their affiliations	:	BHISHM KUMAR (PL) M.S. RAO (PI)
3	Type of study (sponsored /consultancy /referred /internal). If referred, mention the reference	:	Sponsored, PDS under HP-II
4	Date of start, Scheduled date of completion	:	1st July, 2009 30th June, 2012
5	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 districts Hoshiarpur, Kapurthala, Jalandhar and Nawanshahar districts and parts of the districts Roop Nagar 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 the Harike. The climate of the area is influenced by the Himalayas in the north.



6	Study objectives	:	Identifying groundwater recharge zone and recharge sources using groundwater dating and stable isotope technique Groundwater modelling
7	Statement of the problem	:	The BIST- DOAB region, region between R. Satluj and R. Beas, experiences high amount of groundwater depletion due to increased agricultural activities. Hence, it is imperative to identify the recharge zones

and recharge source of groundwater.

8 Approved action plan : Appendix-3

9 Timeline and justification for time over runs : NA

10 2-column table showing objectives vis-à-vis achievements (clearly separate achievements reported in the previous meetings) :

Objective	Status	Work Done
Identifying groundwater recharge zone and recharge sources using groundwater dating and stable isotope technique	In Progress	2230 samples (SW, GW & Rain) have been collected and analysed. Recharge source of deep aquifer is identified and in shallow aquifer is broadly demarcated. Sample collection is in progress and will be analysed for getting finer details about the recharge source of shallow aquifer. Installation of AWLR (6 nos.) in selected piezometers in consultation with CGWB, NWR, Chd.
Groundwater Modelling	In Progress	Required data has been collected i.e. Landuse, landform, water body, strata chart, long term rainfall data and groundwater level data.

11 Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken : **<u>Suggestion</u>**: Dr. V.V.S. Gurunadha Rao, NGRI, Hyderabad suggested that the water quality data should also be presented in conventional graphical forms.
<u>Action</u>: The groundwater chemistry for the Jalandhar and Kapurthala districts has been studied and will be presented in this WG meeting.

12 Analysis and Results : Isotopic characterization of recharge sources have been determined form the observed data.

Precipitation Study area

$\delta D = 8.13 \times \delta^{18}O + 7.63$

$R^2 = 0.96$; n= 69

Precipitation Kandi region

$\delta D = 7.93 \times \delta^{18}O + 6.84$;

$R^2 = 0.96$; n= 44

Precipitation Plain region

$\delta D = 8.91 \times \delta^{18}O + 12.26$;

$R^2 = 0.96$; n= 25

River Satluj

$\delta D = 7.05 \times \delta^{18}O + 0.51$;

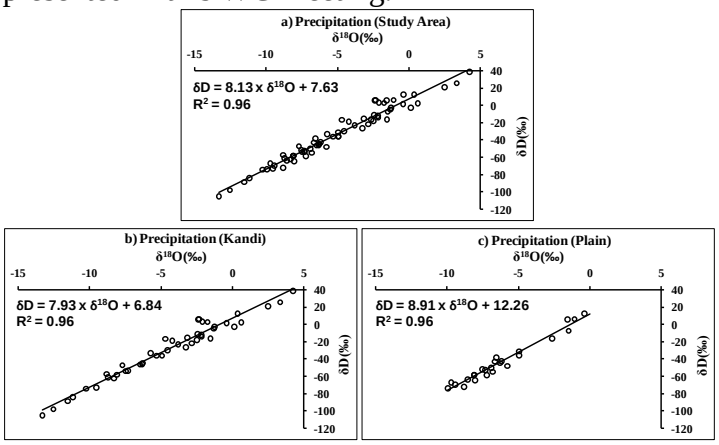


Fig 1. Isotopic characterization of precipitation

R^2 = 0.92; n= 57

River Beas

$\delta D = 7.44 \times \delta^{18}O + 7.53$;

R^2 = 0.93; n= 40

The shallow aquifer has multiple recharge sources. The contribution of various sources for recharge is in the order: Precipitation> Bist- Doab canal> R. Beas (Fig. 3).

Shallow GW

$\delta D = 6.83 \times \delta^{18}O - 0.91$;

R^2 = 0.90; n= 99

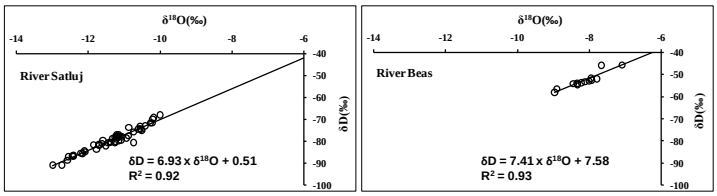


Fig 2. Isotopic characterization of Rivers

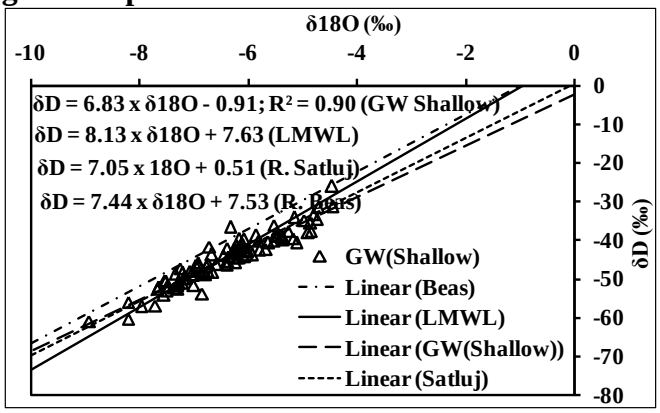


Fig 3. Isotopic characterization in deep aquifer.

The isotopic characteristic of deeper aquifer pattern follows the isotopic characteristic of precipitation at Kandi region, indicating precipitation at Kandi region as its principal recharge source (Fig. 4).

Deep GW

$\delta D = 7.97 \times \delta^{18}O + 7.1$;

R^2 = 0.96; n= 45

Groundwater in the shallow aquifer (Fig. 5) is modern in the northern part and Kandi region while the groundwater is older in the southern part. Groundwater in deep aquifer (Fig. 5) is sub-modern in the Kandi region & at the confluence of rivers Satluj and Beas while old in the central part.

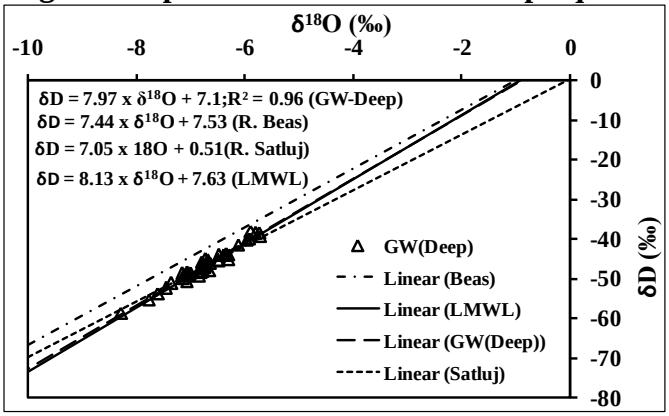


Fig 4. Isotopic characterization in shallow aquifer.

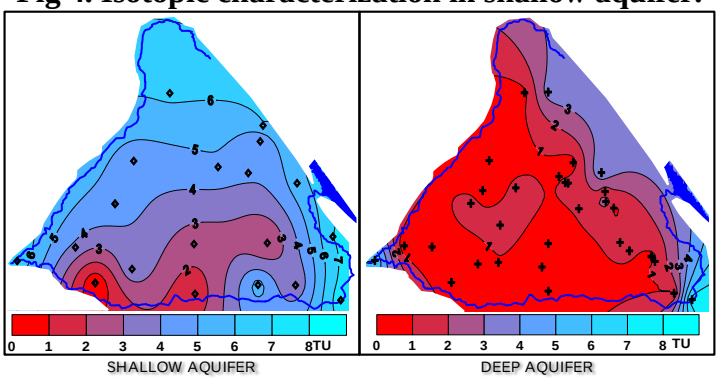


Fig 5. Variation of TU in shallow and deep aquifer.

13 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

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

- Stable isotopic characterisation of groundwaters in Bist- Doab region, Punjab. *Accepted in National conference in advanced techniques in civil engineering, B.H.U, India*
- Hydrochemical characteristics and groundwater

quality in Jalandhar and Kapurthala districts, Punjab, India. *Submitted in Hydrology Journal*

- Hydrogeochemical and isotopic evidence of groundwater in different aquifers for its evolution and source. *Submitted in Current Science*

15	Major items of equipment procured	:	6 no.s of AWLR have been procured and installed in piezometers.
16	Lab facilities used during the study	:	Lab facility at the division has been utilized.
17	Data procured and/or generated during the study	:	Entire isotopic data has been generated through field sampling and their lab analysis.
18	Study Benefits / Impact (2-column table showing achievements against measurable indicators as mentioned in the approved study document)	:	The study is getting progress in association with PWR&ED and CGWB. Both the department will be benefitted through the study results.
19	Specific linkages with Institutions and/or end-users/beneficiaries	:	CGWB (NWR), Chandigarh; Punjab Water Resources Development & Management and Punjab Water Resources & Environment Directorate, Chandigarh; Punjab Water Supply and Sanitation Department, Jalandhar
20	Shortcomings / difficulties, if any	:	Aquifer specific Water sampling from deep piezometers, Additional fund for installation of deep piezometers are awaited, Water quality data of the study region (other than southwestern region) is yet to be received from CGWB.
21	Future plan	:	• Construction of deep peizometers • Aquifer Disposition Map • Groundwater Modeling. • Final Report

Appendix 3

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

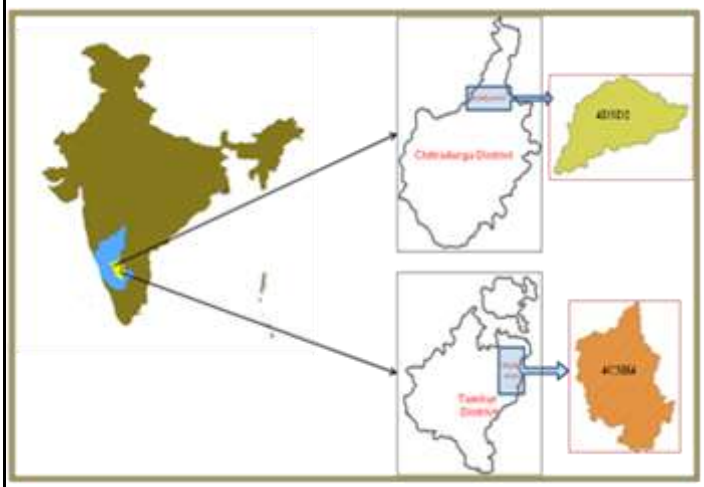
Action Plan

Activity	**Oct.2011- Jun. 2012**		
	1st	**2nd**	**3rd**
Collection of field related data (Rainfall and groundwater level)	✓		
Sample collection of groundwater, surface water & precipitation	✓	✓	✓
Surface water and groundwater data processing	✓	✓	
Procurement of software		✓	
Construction and installation of piezometers at crucial locations, if required		✓	

Activity	Oct.2011- Jun. 2012		
	1st	2nd	3rd
Collection of field related data (Rainfall and groundwater level)	✓		
Mathematical modelling for groundwater potential, optimum pumping, conjunctive use and watershed management.		✓	✓
GIS and remote sensing based analysis of irrigation water management and conjunctive use based data analysis for groundwater flow pattern and velocity.		✓	✓
Identification of recharge zones and recharge sources.	✓	✓	
Integration of water quality, stable & radioactive isotope data and field data along with modelling to develop a general scenario for groundwater flow in aquifers.	✓	✓	
Preparation of final report and publications		✓	✓

4. ***REFERENCE NUMBER: NIH/HID/HP-II(PDS)/Kar/2009-12***

1	Title of the study	:	GROUNDWATER MANAGEMENT IN OVER-EXPLOITED BLOCKS OF CHITRADURGA AND TUMKUR DISTRICTS OF KARNATAKA
2	Name of PI, Co-PI, & their affiliations	:	Sudhir Kumar (PI), NIH Jaivir Tyagi, NIH S P Rai, NIH Anupama Sharma, NIH B K Purandra, NIH, HRRC, Belgaum C, Rangraj, SSIT, Tumkur
3	Type of study (sponsored/consultancy/referred/internal). If referred, mention the reference	:	Sponsored, PDS under HP-II
4	Date of start, scheduled date of completion	:	1st July 2009 31st March 2012
5	Location map (wherever applicable)	:	



District	Tumkur	Chitradurga
Talus	Kortagere (80%) Tumkur (20%)	Challakere (93%) Molakalmuru (7%)
Watershed	4C3H4	4D3D2
Latitude	$13^0 14' - 13^0 44' N$	$14^0 17' - 14^0 34' N$
Longitude	$77^0 02' - 77^0 28' E$	$76^0 22' - 76^0 49' E$
Area	89846 ha	64843 ha
Elevation	618-1261 m	461-902 m
Basin	Pennar Basin	Lower Tungbhadra
Main Stream	Suvarnamukhi	Garani Halla
Geology	Granitic Gneiss	Gneiss, Schi t
Stage of GW development	233 %	140%
Command / Non Command	Non Command	Non Command
Agroclima	Central and	Central dry

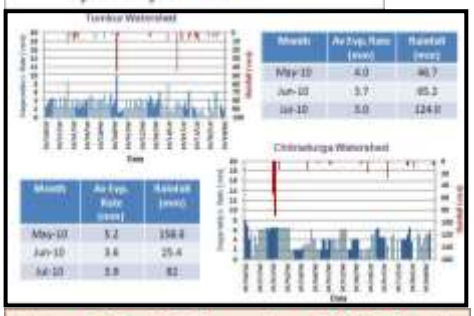
	tic zone	Eastern dry zone	zone
	Soils	Red sandy soil and Red loamy soil	Red loamy soil

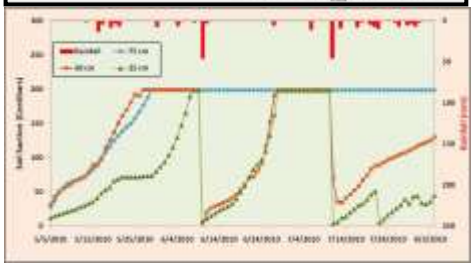
6	Study objectives (not more than 4)	:	i) To analyze groundwater productivity at specific study sites including artificial recharge structures and an assessment of potential increases and their contribution to rural livelihood improvement. ii) To develop integrated understanding of hydrologic, social, 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.
7	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. Therefore there is a growing realization among hydrologists, hydro-geologists and socio-economic scientists that groundwater development and its management is key to poverty alleviation in developing countries, wherein large sections of rural population are illiterate and their livelihood support depends on low productive agriculture.
8	Approved action plan	:	Appendix-4
9	Timeline and justification for time over runs	:	The procurement of data and instruments has delayed the work schedule
10	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

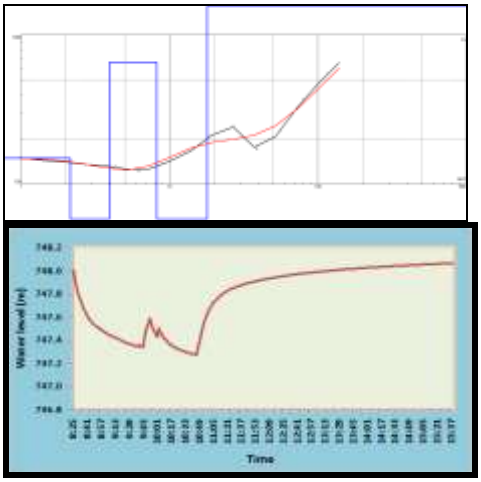
11 Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken : No specific comments were made.

12 Analysis and Results :





- In both the identified in the Tumkur and Chitradurga districts, hydrometeorological Instruments (Evaporation pan, Soil moisture sensors and Rain gauge)and automatic groundwater level recorders have been installed in the field.
- GIS Database has been prepared for both the watersheds including Base map, Drainage map, Road map and Water storage structures maps etc.
- Infiltration tests conducted at 16 locations in both the watersheds.
- Water level data (Depth to water level and reduced water level) have been collected for about 14 observation wells in Chitradurga watershed (only for 2009) and 15 in Tumkur watershed (from 1971 to 2010) and contours prepared.
- Rainfall data of 8 rain gauge stations for Chitradurga watershed (from 2004 to 2010) and 16 rain gauge stations for Tumkur watershed (from 1971 to 2010) is being analyzed.
- Litholog data has been analysed, lithological



sections of both the watersheds prepared.

- About 35 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.
- Pump tests at 4 locations. The results are being analysed.
- Socio-economic survey has also been conducted.

13	Adopters of the results of the study and their feedback	:	Karnataka Government, the States with hard rock aquifers
14	List of deliverables (e.g. equipment, papers, reports, software, manuals, brochures, flyers, training programmes, users interaction workshops)	:	Report, papers, methodology, brochure and training program
15	Major items of equipment procured	:	Automatic Rain Gauges, Automatic Groundwater Level Recorders
16	Lab facilities used during the study	:	Isotope lab, Soil water lab and Hydrological Investigations lab
17	Data procured and/or generated during the study	:	Remote Sensing data
18	Study Benefits/Impact (2-column table showing achievements against measurable indicators as mentioned in the approved study document)	:	
19	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.
20	Shortcomings / difficulties, if any	:	Delay in procurement of data and instruments Lack of historical data and reliability of data.
21	Future plan	:	As per activity chart

Appendix – 4

GROUNDWATER MANAGEMENT IN OVER - EXPLOITED BLOCKS OF CHITRADURGA AND TUMKUR DISTRICTS OF KARNATAKA

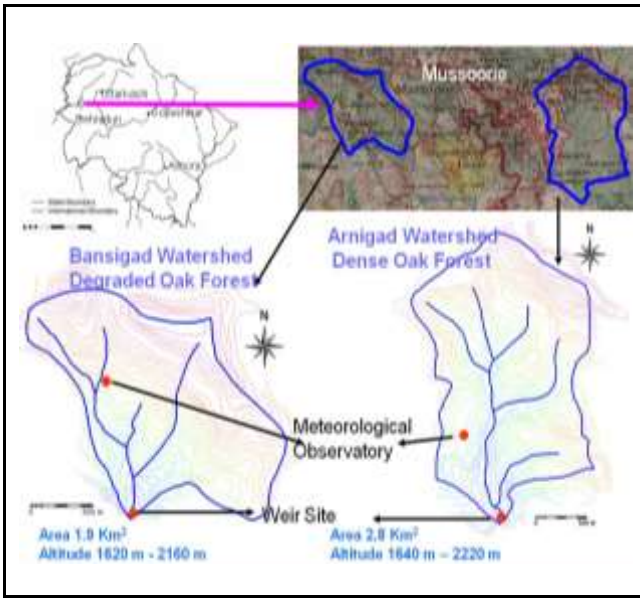
ACTIVITY SCHEDULE (Quarter wise)

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
Selection of watersheds	♦	♦										
Reconnaissance surveys		♦	♦									

Activity	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**	**11th**	**12th**
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 GW utilization guidelines										♦	♦	
Capacity building and training programs								♦	♦			♦
Report writing											♦	♦

5. *REFERENCE NUMBER:* NIH/HID/FRI/08-13

1	Title of the study	:	IMPACT ASSESSMENT OF LANDUSE ON THE HYDROLOGIC REGIME IN THE SELECTED MICRO-WATERSHEDS IN LESSER HIMALAYAS, UTTARAKHAND
2	Name of PI, Co-PI, & their affiliations	:	S. P Rai, Sc. 'E1'(PI), Bhishm Kumar Sc. 'F' and J.V. Tyagi Sc' F'from NIH with Rajeev Tiwari, IFS, FRI
3	Type of study (sponsored/ consultancy/ referred/ internal). If referred, mention the reference	:	Collaborative with FRI, Dehradun Total: Rs. 3 lac (NIH Component)
4	Date of start, scheduled date of completion	:	April, 2008 to March 2013
5	Location map (wherever applicable)		



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 watershed	Similar
Geomorphology	Almost similar
Altitude variation Arnigad Bansigad	 1640-2220 m 1620-2160 m

6	Study objectives	:	• Impact of forest cover on stream discharge pattern • To separate surface runoff & ground water components in the stream discharge using conventional and isotopic technique. • Soil erosion under different forest cover • Identification of recharge zone of stream & springs using isotopic technique.
7	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 have been conducted at the experimental plot do not necessarily hold true at the catchments scale Mainly the

studies conducted on plot scale or small catchments of only a few hectares lacks the continuous data of all 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 started in collaboration of Forest Research Institute, Dehradun.

8 Approved action plan : Appendix-5

9 Timeline and justification for time over runs : March 2013

10 2-column table showing objectives vis-à-vis achievements (clearly separate achievements reported in the previous meetings) :

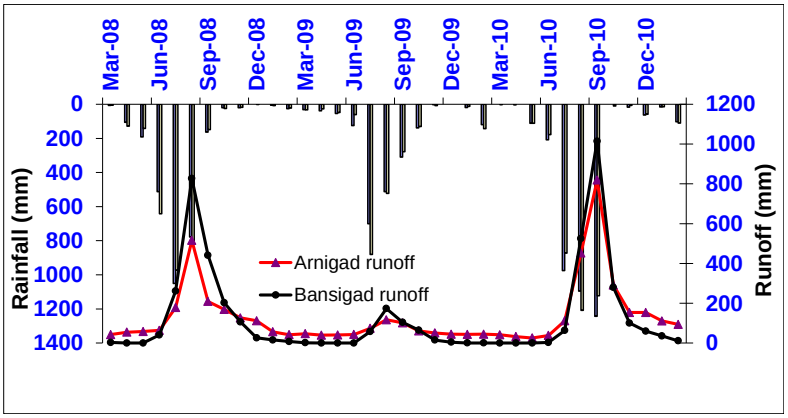
Objective	Achievement
Impact of forest cover on stream discharge pattern	Data collection completed and analysis under progress.
To separate surface runoff & ground water components in the stream discharge using conventional and isotopic technique	Using conventional technique surface runoff and groundwater component is computed for last two years and for third year under progress
Soil erosion under different forest cover.	Monitoring of soil erosion data completed and data under analysis
Identification of recharge zone of stream & springs using isotopic technique	Isotope technique has been used to identify the recharge zones of springs and streams

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

12 Analysis and Results :

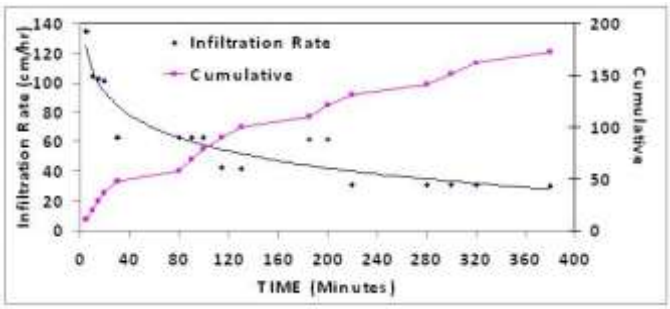
- Hydrometeorological data collection of the both watersheds is completed.
- The continuous data have been recorded from June 2008 to Feb. 2011.

- Samples of streams, springs and handpump have been collected for isotopic analysis and details will be presented in the working group.
- Data of infiltration tests have been analysed under different landuse conditions.
- Analysis of soil moisture variation has been completed.
- Analysis of sediment data is in progress.
- Rainfall and runoff on the monthly basis has been analysed.
- Recharge to groundwater in both watershed has computed.
- Rainfall-Runoff and soil loss modeling using SWAT model is in progress.
- The analysis of soil moisture data revealed large variations in soil moisture storage at different sites and depths and also during different seasons in each of the study watersheds.
- The profile analysis indicated highest soil moisture content in shallow profile which decreased with depth in both the watersheds. A high positive correlation was found between tree density and soil moisture content.

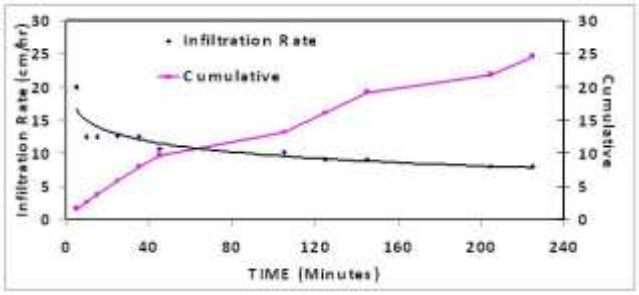


Rainfall-Runoff of both watershed

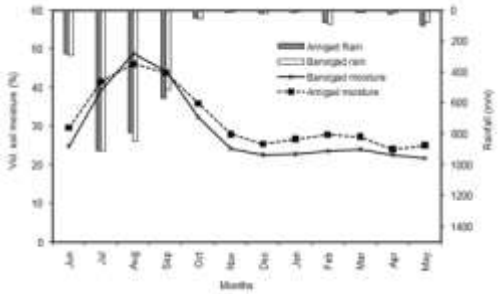
Seasonal variation of runoff in both the watersheds



Infiltration rate in dense forest cover



Infiltration rate in degraded land



Soil moisture variation in degraded and dense forest cover area

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

14 List of deliverables (e.g. equipment, papers, reports, : Papers

softwares, manuals, brochures, flyers, training programmes, users interaction workshops)

15 Major items of equipment procured : NIL

16 Lab facilities used during the study : Isotope and Hydrological Investigations Laboratory

17 Data procured and/or generated during the study : Hydrometeorological data and Isotopic data generated of both the watersheds

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

Activity	Status
Selection of two watershed under under different forest cover	Completed
Instrumentation in both the watershed	Completed
Identification of Springs and handpump completed	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
Development of Aquifer geometry in and around YFP	Completed
Analysis of stable isotopes (δD and $\delta^{18}O$) of SW and GW samples	Under progress
Assessment of impact of forest cover on stream discharge	Under progress
Assessment of impact of forest cover on erosion	Under progress
Estimation of sediment ersosion using the SWAT model	Work started

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

20 Shortcomings/difficulties, if any : Working as project partner

21 Future plan : Preparation of papers from the reports

Appendix–5

Impact Assessment of Landuse on the Hydrologic Regime in the Selected Micro-Watersheds in Lesser Himalayas, Uttarakhand

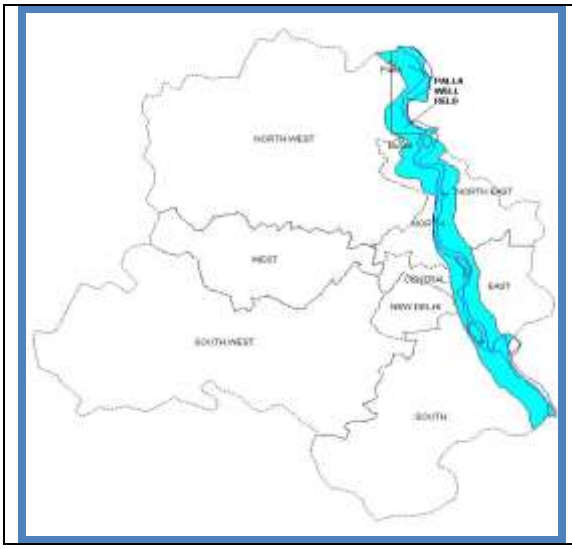
ACTIVITY SCHEDULE (Quarter wise)

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

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

6. ***REFERENCE NUMBER: NIH/HID/DJB/2010-11***

1	Title of the study	:	ASSESSMENT OF GROUNDWATER RESOURCES & DEVELOPMENT POTENTIAL OF YAMUNA FLOOD PLAIN, NCT DELHI
2	Name of PI, Co-PI, & their affiliations	:	Sudhir Kumar, NIH (PI) with investigators from CGWB, CWC IIT Delhi, DU, NRL, and DJB
3	Type of study (sponsored/ consultancy/ referred/ internal). If referred, mention the reference	:	Consultancy Delhi Jal Board Total: Rs.36.267 lac (NIH Component: Rs.26.594 lac)
4	Date of start, scheduled date of completion	:	Start date: 1st April, 2010 End date: Dec. 2011
5	Location map (wherever applicable)		



Area of NCT Delhi	≈ 1483 Km^2
Area of Yamuna FP in Delhi	≈ 97 Km^2 (7%)
Stretch of Yamuna in Delhi	≈ 35 Km
Curved length of river	≈ 50 Km
Area of FP under water during lean season	≈ 16.5 km^2 (17%)
Average slope of river bed	≈ 0.4 m/km
Width of Yamuna FP	1.5 to 3 km
Floodplain ground levels	216m to 193 m (MSL)

6 Study objectives (not more than 4) :

- Estimation of groundwater resources in the Yamuna floodplains.
- Estimation of groundwater development potential in space and time through ground water simulation studies.
- Assessment of the impact of groundwater extraction from floodplains on hydrological regime.
- Assessment of groundwater quality vis-a-vis availability of drinking water.

7 Statement of the problem : Water from River Yamuna and its canal systems, Ganga and Satluj from BBMB are the main sources of water supply to Delhi and about 15 % requirements of Delhi are met from groundwater. Still there is a deficit of about 20 % of

requirement.
In addition to the direct rainfall recharge in the alluvial flood plains, the floods during monsoon period also recharge the adjacent riverbanks. Groundwater abstraction from production wells along the banks may help in meeting the demand during the non-monsoon season on a sustainable basis.
Therefore, the study is aimed at finding the groundwater potential of the Yamuna floodplain falling within the Delhi territory.

8 Approved action plan : Appendix-6

9 Timeline and justification for time over runs : The project shall be completed by December, 2011.

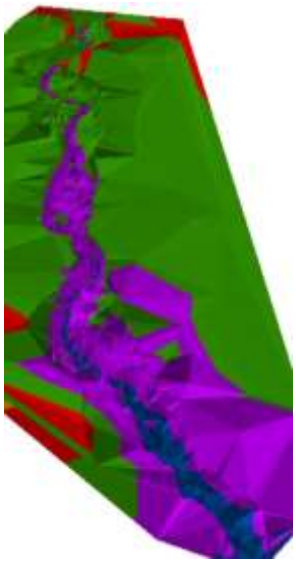
10 2-column table showing objectives vis-à-vis achievements (clearly separate achievements reported in the previous meetings) :

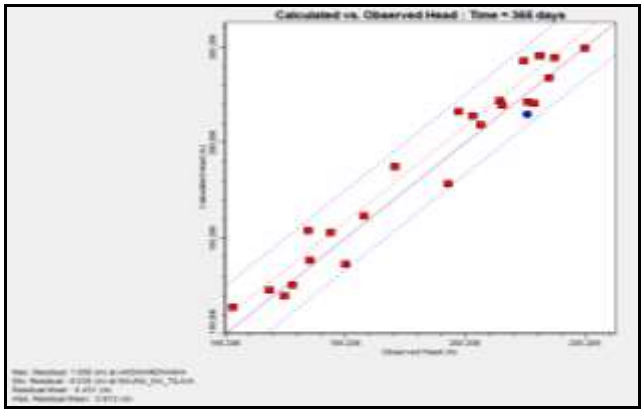
Objective	Achievement
Estimation of groundwater resources in the Yamuna floodplains.	Groundwater draft from the YFP has been estimated
Estimation of groundwater development potential in space and time through ground water simulation studies.	Discharge data of Yamuna has been collected from CWC
Assessment of the impact of groundwater extraction from floodplains on hydrological regime.	Model has been calibrated with year data, is being further refined with 3 year data
Assessment of groundwater quality vis-a-vis availability of drinking water.	Can be achieved after the results of water quality are made available by Prof AK Keshari, IITD

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

12 Analysis and Results :

- All available data with CGWB has been collected regarding lithologs, pump tests and water levels.
- Samples for groundwater quality and isotopic analysis collected and analysed.
- Infiltration tests conducted in the Yamuna flood plain
- Litholog data has been analysed and aquifer geometry of the YFP finalised
- Survey to determine groundwater draft / any other relevant information from floodplain has been completed
- Groundwater flow direction with reference to river Yamuna has been established
- Creation of GIS data base for GW modelling completed
- Development of Conceptual model completed
- River Cross-sections have been incorporated within the model
- Calibration of model with 1 yr data completed





13 Adopters of the results of the study and their feedback : Delhi Jal Board

14 List of deliverables (e.g. equipment, papers, reports, softwares, manuals, brochures, flyers, training programmes, users interaction workshops) : Report and Papers

15 Major items of equipment procured : NIL

16 Lab facilities used during the study : Isotope & Hydrological Investigations Laboratory

17 Data procured and/or generated during the study : Isotopic data of the Yamuna floodplain
Aquifer geometry of the Yamuna floodplain

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

Activity	Status
Collection and Compilation of existing hydrogeological data	Completed
Identification of wells for water level monitoring	Completed
Infiltration tests / Groundwater level monitoring	Completed
Pump Tests to determine Sp. Yield and hyd. Con / Transmissivity	Old data used

Collection and analysis of SW and GW samples for water quality and/or isotopic analysis	Completed
Survey to determine groundwater draft/ any other relevant information from FP	Completed
Development of Aquifer geometry in and around YFP	Completed
Assessment of GW resources of the Yamuna FP in NCT Delhi	Continued
Estimation of Natural Recharge to groundwater	Continued
Determination of groundwater flow direction in reference to river Yamuna	Completed
Delineation of groundwater contaminated areas with in Floodplain	In progress
Identification of areas suitable for GW abstraction w.r.t. WQ	In Progress
Creation of GIS data base for GW modelling	Completed
Development of Conceptual model	Completed
Calibration of Model	In progress
Development of GW extraction scenarios	Not Started
Simulation of impact of GW abstraction on SW and GW resources	Not Started
Simulation of groundwater recharge in the Yamuna FP from Monsoon Floods	Not Started
Report finalisation	Not Started

19 Specific linkages with Institutions and/or end-users/beneficiaries : Delhi Jal Board

20 Shortcomings/difficulties, if any : Bringing together the various partners and work as a cohesive team

21 Future plan : The water quality work is to be started and modeling exercise to be completed

Appendix –6

ASSESSMENT OF GROUNDWATER RESOURCES & DEVELOPMENT POTENTIAL OF YAMUNA FLOOD PLAIN, NCT DELHI

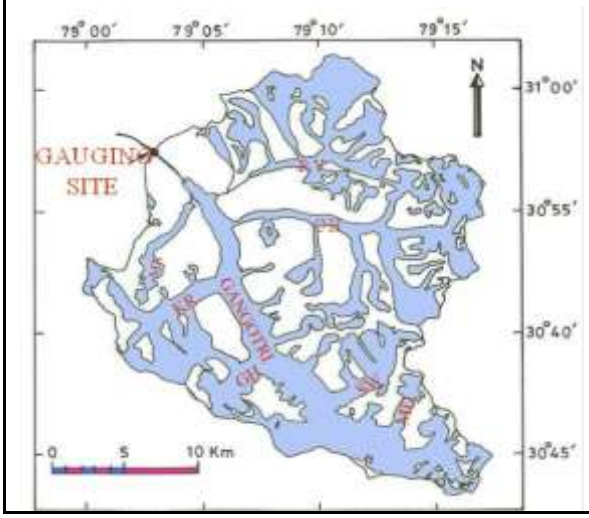
ACTIVITY SCHEDULE (Quarter wise)

Activity	1st	2nd	3rd	4th	Primary Responsibility
Collection of all required data	♦				DJB / CGWB
Compilation of existing hydrogeological data	♦				DU / CGWB
Identification of Data Gaps	♦				NIH+ others
Identification of wells for water level monitoring	♦				CGWB
Establishment of field stations, if required	♦	♦			CGWB
Infiltration tests	♦				NIH / IITD
Identification of wells for WQ monitoring	♦				IITD
RL Survey of GW wells	♦				CGWB
Groundwater level monitoring	♦	♦	♦		CGWB
Pump Tests to determine Sp. Yield and hyd. Con / Transmissivity		♦			CGWB
Collection of SW and GW samples for water quality and/or isotopic analysis		♦	♦		CGWB / IITD / NRL

Activity	1st	2nd	3rd	4th	Primary Responsibility
Survey to determine groundwater draft/ any other relevant information from FP		♦	♦		CGWB
Development of Aquifer geometry in and around YFP			♦		DU / CGWB
Analysis of Water Quality of SW and GW samples		♦	♦		DPCC / CPCB
Analysis of stable isotopes (δD and $\delta^{18}O$) of SW and GW samples		♦	♦		NIH
Assessment of GW resources of the Yamuna FP in NCT Delhi			♦		CGWB / NIH
Estimation of Natural Recharge to groundwater			♦		CGWB / NIH
Determination of groundwater flow direction in reference to river Yamuna			♦		NIH
Delineation of groundwater contaminated areas with in Floodplain			♦		IITD
Identification of areas suitable for GW abstraction w.r.t. WQ			♦		IITD
Creation of GIS data base for GW modelling					NIH
Development of Conceptual model			♦		All
Calibration of Model			♦		All
Development of GW extraction scenarios			♦		NRL / IITD
Simulation of impact of GW abstraction on SW and GW resources			♦		NIH / IITD
Simulation of groundwater recharge in the Yamuna FP from Monsoon Floods				♦	NIH / CGWB
Report finalisation				♦	All

7. REFERENCE NUMBER: NIH/HID/GAUMUKH/09-10

1	Title of the study	:	ESTIMATION OF SNOW AND GLACIER MELT CONTRIBUTION IN MELT WATER OF GANGOTRI GLACIER AT GAUMUKH USING ISOTOPIC TECHNIQUES
2	Name of PI, Co-PI, & their affiliations	:	S.P. Rai Sc 'E1', Manohar Arora Sc. 'C', Bhishm Kumar Sc 'F', Rakesh Kumar Sc. 'F'and Naresh Kumar, PRA
3	Type of study (sponsored/ consultancy/ referred/ internal). If referred, mention the reference	:	Internal
4	Date of start, scheduled date of completion	:	April, 2010 to Mach 2013
5	Location map (wherever applicable)		



Glacier Type	Valley
Elevation Range	4000-7000 m
Length	30 km
Width:	~0.2 to2.35 km
Total Area: Glacerised Area	~556 km^2: ~286 km^2

6 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

7 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 worlds other mountains glacier. 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 to study the isotopic composition of snow, rain, ice and meltwater which will be useful in separation of various component of stream discharge and in long term will be useful to understand the source of moisture and impact of climate change on melting patter.

8 Approved action plan : Appendix-7

9 Timeline and justification for time over runs : March 2013

10 2-column table showing objectives vis-à-vis achievements (clearly separate achievements reported in the previous meetings) :

Objective	Achievement
Isotopic Characterization of Melt Water and individual components (Snow- Glacier melt, groundwater, rainfall-runoff).	Samples are collected for the ablation period 2010 and sampling for 2011 continued.
Estimation of Snow and Glacier melt contribution separately and its variability with time	Isotopic characterization of rainwater has been carried out. Isotopic characterization of snow and glacier under progress. Isotopic characterization of meltwater under progress.

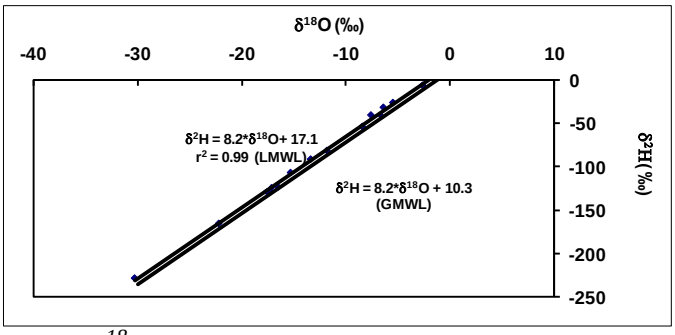
11 Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken : NIL

12 Analysis and Results :

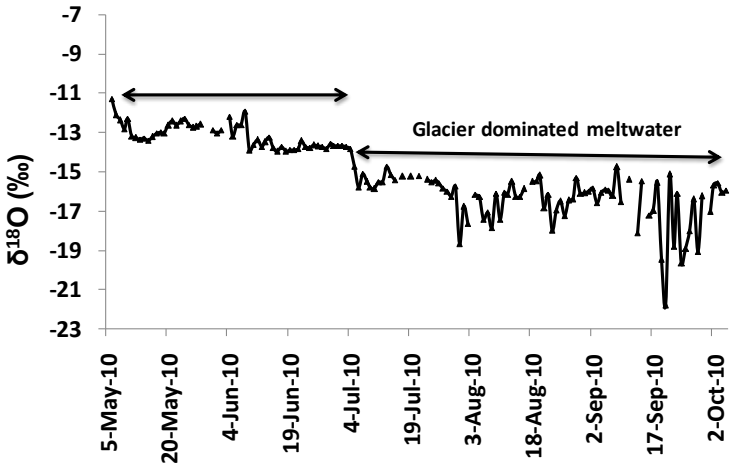
- The plot of $\delta^{2}H$ versus $\delta^{18}O$ for all precipitation samples collected during the ablation period of 2004 and 2008. The Local Meteoric Water

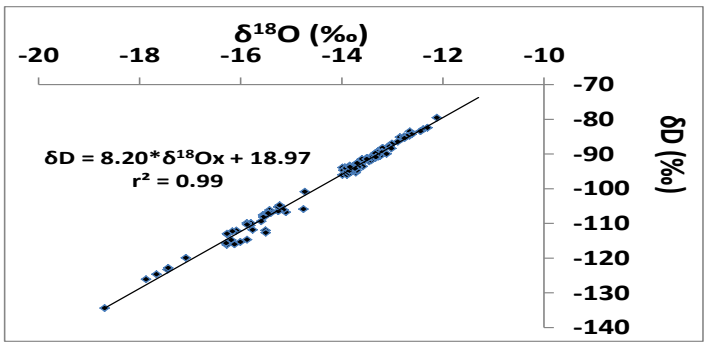
Line (LMWL) developed as δ^2H = 8.2 (±0.10) x $\delta^{18}O$ + 17.1 (±1.53) (n = 15, r2 = 0.99) for a complete ablation period which is showing higher slope and y intercept in comparison to from the GMWL ..

- The isotopic signature of the fresh snow and surface ice of different altitudes in the accumulation and ablation zones of the Western Himalayan reported by various workers and found under the present are between -4.5‰ and -14‰ for snow and -13‰ to -25‰ for glacier.
- It has been observed that the isotopic values of melt initially follow the average $\delta^{18}O$ values of snow ranged between -12‰ to -13.8‰.
- 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 Gomukh site and the best fit line is $\delta^2H=8.2*\delta^{18}O$ + 18.97 r^2 = 0.99, n = 110 (2010).
- The détails 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 meltwater during the ablation period 2010

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

14 List of deliverables (e.g. equipment, papers, reports, softwares, manuals, brochures, flyers, training programmes, users interaction workshops) : Paper presented in International conference at Monaco, organized by IAEA.

15 Major items of equipment procured : NIL

16 Lab facilities used during the study : Isotope and Hydrological Investigations Laboratory

17 Data procured and/or generated during the study : Isotopic data of the snow, ice, meltwater and rainfall at the altitude of 3800 m.

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

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

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

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

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

Appendix -7

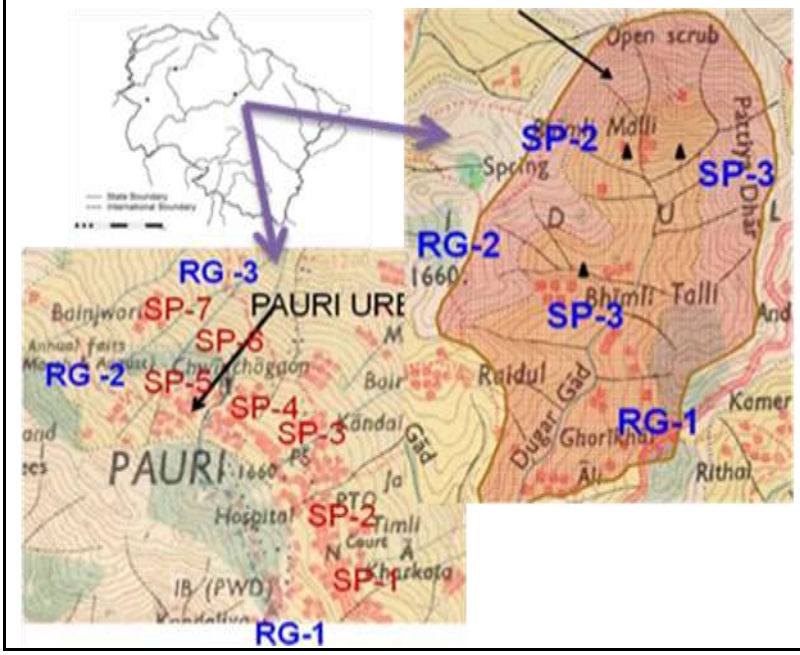
Estimation of Snow and Glacier Melt Contribution in Melt Water of Gangotri Glacier at Gaumukh Using Isotopic Techniques

ACTIVITY SCHEDULE (Quarter wise)

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				♦	♦		♦	
Analysis of discharge data				♦	♦	♦	♦	
Separation of different component of meltwater using the isotope model				♦	♦	♦	♦	
First Draft Report						♦		
Second Draft Report							♦	
Final Report								♦

8. REFERENCE NUMBER: NIH/HID/PAURI /09-10

1	Title of the study	:	DEVELOPMENT OF SPRING SANCTUARIES IN AN URBAN AND A RURAL WATERSHEDS IN DISTRICT PAURI GARHWAL, UTTARAKHAND
2	Name of PI, Co-PI, & their affiliations	:	S.P. Rai Sc 'E1', Bhishm Kumar Sc 'F', Sudhir kumar, Sc 'F', Suhas Khobragade Sc. 'E1'and Pankaj Garg Sc. 'B'
3	Type of study (sponsored/ consultancy/ referred/ internal). If referred, mention the reference	:	Internal
4	Date of start, scheduled date of completion	:	April, 2010 to March 2013
5	Location map (wherever applicable)		



Study Area	
Pauri Town	Dugar Watershed
Urban Area	Rural Area
No. of springs selected 7	No. of springs selected 3

6	Study objectives	:	● To decipher the recharge zone of springs falling in the study area. ● To analyze 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 area in order to enhance the discharge
7	Statement of the problem	:	Ground water flow 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 of 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 has approached to NIH for identification of recharge zone. GBPIHED, Srinagar Unit has approached to NIH for collaborative study of recharge zone identification and implementation of recharge techniques. The fundamental question related to Springs are:

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

8 Approved action plan : Appendix-8

9 Timeline and justification for time over runs : March 2013

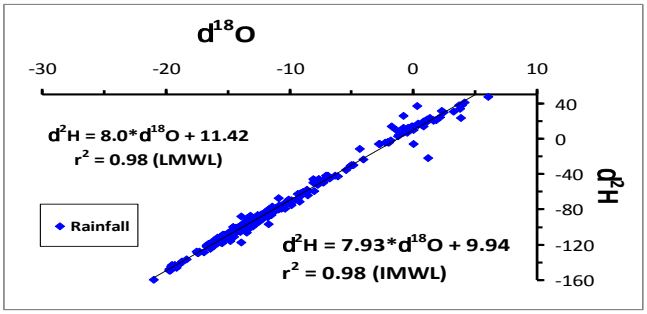
10 2-column table showing objectives vis-à-vis achievements (clearly separate achievements reported in the previous meetings) :

Objective	Achievement
To decipher the recharge zone of springs falling in the study area	Springs have been selected from the different parts of Pauri and Dugargad watershed. Preparation of Hydrogeological mapping under progress.
To analyze the relationship between rainfall, evaporation, landuse/land cover and ecological factors with spring discharge	Raingauges and evaporation pans have been installed
To implement spring sanctuary strategy in the identified recharge area in order to enhance the discharge	Interpretation of results under progress for identification of recharge zones

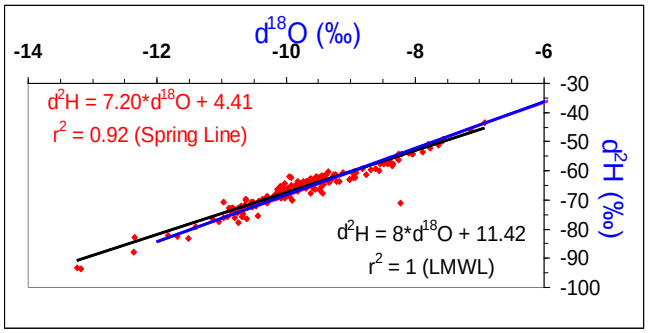
11 Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken : NIL

12 Analysis and Results :

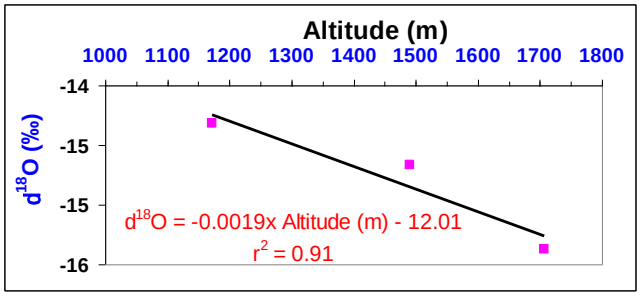
- The plot of δ^2H versus $\delta^{18}O$ for rainfall samples collected during June to September 2010 show the Meteoric Water Line (spring) as δ^2H = 8.0 x $\delta^{18}O$ + 11.4 which is similar to IMWL .
- The plot of δ^2H versus $\delta^{18}O$ for all springs samples collected during June to September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



Altitude effect in the area

13 Adopters of the results of the study and their feedback : Jalsansthan Uttarakhand

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

15 Major items of equipment procured : NIL

16 Lab facilities used during the : Isotope and Hydrological Investigations Laboratory

study

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

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

Activity	Status
Selection of sampling site	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

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

20 Shortcomings/difficulties, if any :

21 Future plan : .

Appendix –8

Development of Spring Sanctuaries in an Urban and a Rural Watersheds in District Pauri Garhwal, Uttarakhand

ACTIVITY SCHEDULE (Quarter wise)

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 Altitude effect				♦	♦			
Analysis of discharge data of spring and its relationship with isotope data			♦	♦		♦	♦	
Estimation of recharge zones of spring					♦	♦		
Formulation of strategies for development of spring sanctuaries						♦	♦	
First Draft Report						♦		
Second Draft Report							♦	
Final Report								♦

9. REFERENCE NUMBER: NIH/HID/INT /10-12

1. Title of the study : IDENTIFICATION OF RECHARGE ZONES OF SOME SELECTED SPRINGS OF UTTARAKHAND USING ISOTOPES

2. **Study Team:** : S. D. Khobragade, Sc-E1, (PI); Bhishm Kumar, Sc-F; Sudhir Kumar, Sc-F; S. P. Rai, Sc-E1 and Sh. Pankaj Garg, Sc-B

3. **Type of study** : Referred (The study has been taken up on the request of Uttarakhand Jalsansthan, Dehradun .

4. (i) Date of start **:** April, 2010
(ii) Scheduled date of completion **:** March, 2012.

4. Study area:
5.

Four springs namely Ratoli, Moli, Gothiyara and Kandha Dhangi, located in the Chandrabhaga Watershed in Jakhanidhar Block, Devprayag in Tehri Garhwal district of Utarakhand in the catchment of river Bhagirathi have been selected for study. The springs have been suggested by the Uttarakhand Jal Sansthan Authorities, Dehradun. The discharge of the springs is known to have reduced considerably over the past few years. The terrain of the study area is highly rugged and hilly with steep slopes. The altitude varies from 800-2300 m. The Ratoli spring is located at 2140 m, Moli Spring at 1942 m, Gothoyara Spring at 1872 m and the Kandha Dhangi spring at 1005 m altitude. The geological formation of the study area consists of greenish grey slaty and schistose phyllite inter-bedded with quartzite. The soils are generally shallow, varying in texture and depth.

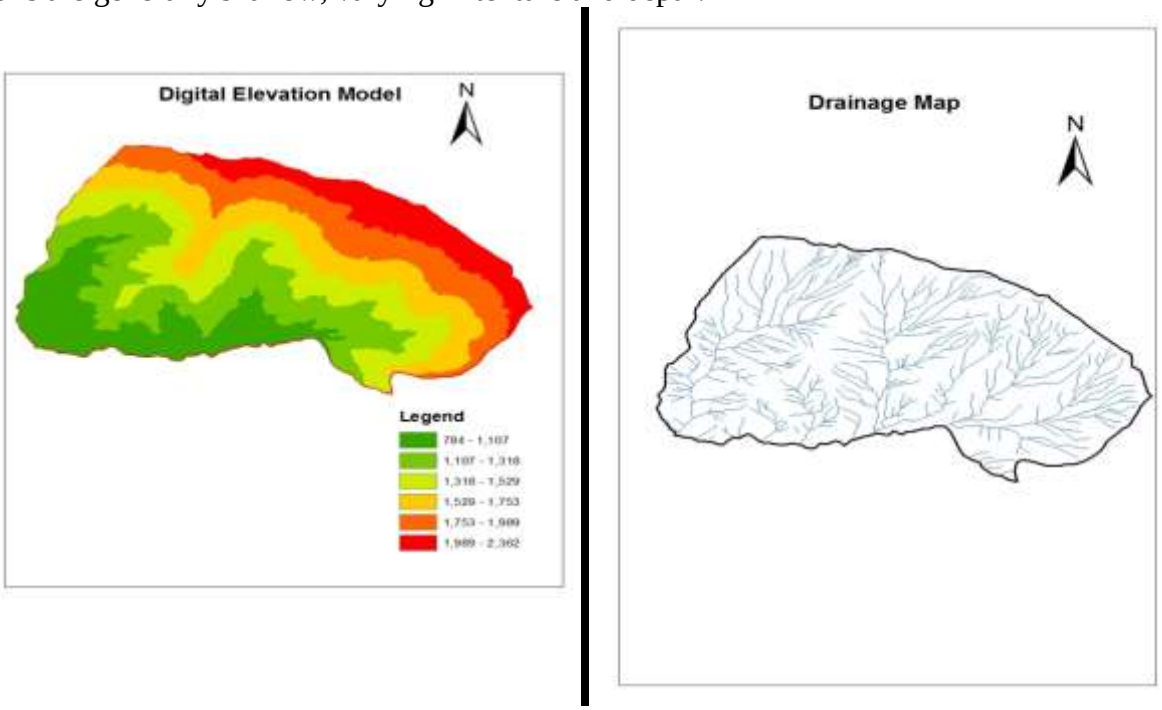


Fig. 1: Study area

6. Study objectives

- To identify the recharge areas of some selected springs of Uttarakhand, and
- To suggest remedial measures for the rejuvenation of these springs

7. Statement of the problem

There are a number of springs in Uttarakhand which are facing problem of reduction in discharges over the years. A request has been received from Uttarakhand Jalsansthan, Dehradun to study the springs of about 10 districts which are the only sources of water in their respective regions, so that conservation and management measures can be suggested for these springs based on scientific investigations. However, keeping in view the feasibility, only a few springs (four from Tehri Garhwal district) have been taken up in the first phase for investigations related to identification of the recharge areas and to suggest remedial measures for their rejuvenation.

8. Approved action plan: Appendix-9

9. Achievements vis-à-vis objectives:

Objective	Achievement
i) Collection of rainfall and discharge data	Monitoring of daily rainfall data at seven locations and stream discharge data of four springs at fortnightly interval previously and weekly interval from June, 2011 has been carried out from June, 2010 to September, 2011.
ii) Collection and laboratory analysis of water samples from rain, springs and hand pump	About 900 water samples have been collected for rain water, spring water and hand pump at different intervals for the period June, 2010 to September, 2011. Laboratory analysis of 500 samples has been completed in last 6 months. Analysis of del O-18 has been completed and del D is under progress.
iii) Analysis of response of spring to rainfall	Response of the springs to rainfall both in terms of discharge and isotopic signatures has been analyzed.
v) Establishment of altitude effect for the study area	Additional required data of rainfall have been generated in the recent monsoon from four additional locations established during May, 2011. The rain samples have been analysed for δ-O 18. Altitude effect for δ-O

	18 has been established. Accordingly the identification of recharge altitudes of different springs is under progress.

11. Recommendations/suggestions in previous meetings of Working Group/TAC/GB along with the action taken:

None Specific

12. Analysis and Results

- Discharge data for the four springs have been monitored at a 15 days interval during 1 June, 2010 to 15 June, 2011 and at weekly interval since June, 2011. The discharge data of the springs indicates that the Moli spring is the only sustainable of all the four study springs. Although its discharge reduces significantly during February to July, it still has a minimum discharge within a range of 0.5 to 1.0 lps during this period also. The Kandhadhangi spring on the other hand exhibits the lowest discharge among all the four study springs. This spring goes completely dry during March to June. The Ratoli and Gothiyara springs also exhibit low discharges for most months except for July to November.

- Rainfall has been collected at three locations on daily basis since 1st June, 2010. Additional four raingauges have been established during May, 2011. Rain data are thus being collected from seven locations at different altitudes since June, 2011. Analysis of the variation of rainfall versus-spring discharge indicates a delayed response of the springs to the rainfall as far as discharge is concerned. However, the response time of different springs vary.

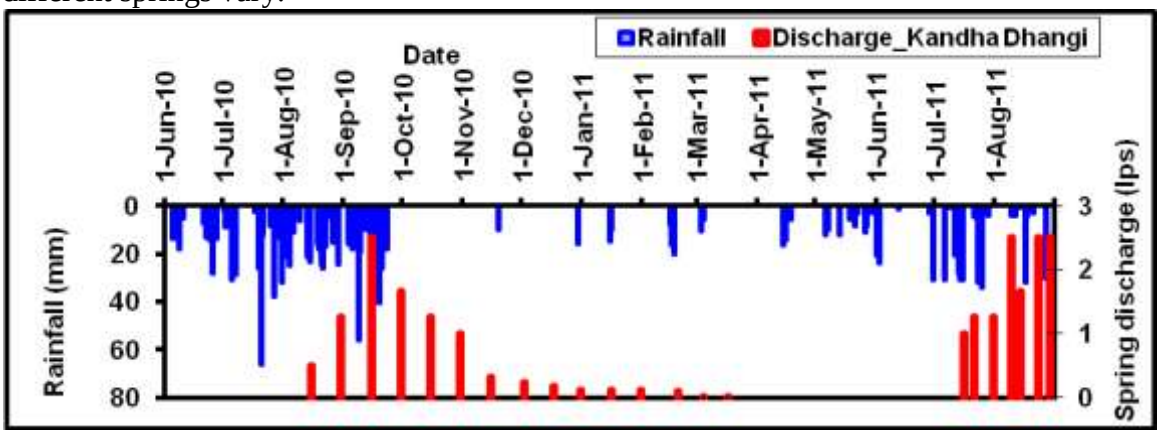


Fig. 2 Variation of spring discharge with rainfall for Kandha Dhangi Spring

- More than 500 water samples from rain, spring and ground water have been collected and analyzed for δ-O18 and δ-D during the last six months. Analysis of the δ-O18 data of the three locations indicate that the area receives some local rainfall during October to mid July and the isotopic signatures are enriched. The enrichment is especially more during the summer months of April to June, indicating effect of evaporation. However, heavier rainfall received thereafter during the monsoon causes depleted isotopic signatures.

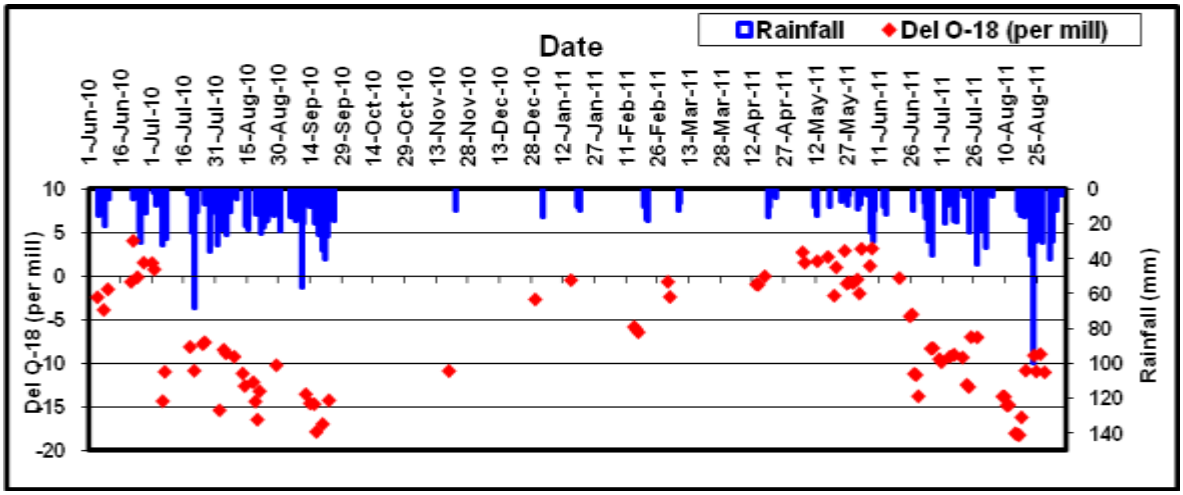


Fig. 3 Variation of del O-18 of precipitation data for Anjanisain

- Altitude effect has been established in isotopic composition ($\partial^{18}O$) of precipitation. Following equation has been obtained:

$\partial^{18}O‰ = -0.00227x(\text{altitude in m}) - 6.3365$ ($R^2 = 0.83$). The variation in $\partial^{18}O$ values comes out to be -0.27 per 100 m. Using this equation, the recharge altitudes for various study springs would be established. The work is under progress and more details will be presented during the Working Group Meeting.

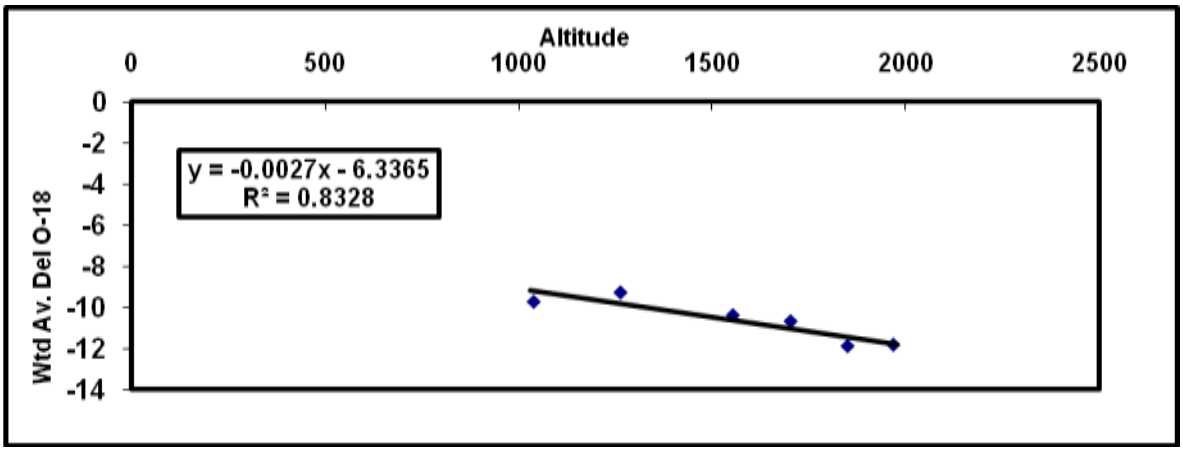


Fig. 4 Altitude effect in $\partial^{18}O$

13. Adopters of the results of the study and their feedback

The main adopter of the results of the study would be Uttarakhand Jalsansthan, Dehradun. Feedback will be received after the final results are communicated to them.

14. List of deliverables:

i) Report with recommendations for increasing discharge/rejuvenation of springs
ii) Rainfall, spring discharge and isotopic data
iii) Research papers
iv) Interaction workshop with Jalsansthan Authorities

15. Major items of equipment procured

None. Minor equipment like raingauges, temperature meter, humidity meter, etc have been procured

16. Lab facilities used during the study

Nuclear Hydrology Lab and Remote sensing Lab

17. Data procured and/or generated during the study

i) Rainfall data
ii) Spring discharge data
iii) Isotopic data for rainfall, springs and ground water

18. Study Benefits / Impact (Showing achievements against measurable indicators):

Indicator	Achievements
Selection of 4 springs for the study	Completed
Installation of raingauges at 7 sites	Completed
Hydro-geological details of study area	Some information collected
Lat., long and altitude of Springs, raingauge and handpump sites	Completed
Collection of rainfall data at different altitudes	Completed for June 2010 to September, 2011 for seven altitudes
Collection of discharge data of spring	Completed for June 2010 to September, 2011
Collection of spring water, ground water and rain water samples for isotopic analysis	Completed/(To Continue till December, 2011)
Laboratory analyses of the collected water samples	Completed
Interpretation of collected data	Completed/To continue
Development of local meteoric line	Previously developed meteoric line is being revisited in light of the additional isotopic data of precipitation samples
Establishment of altitude effect	Altitude effect has been established for del O-18 and is under progress for δD.
Identification of recharge altitudes for different springs	Under Progress.

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

The study has been taken up on the request of the Uttarakhand Jalsansthan, Deharadun.

20. Shortcomings/difficulties, if any:

i) The study area terrain is very difficult for field work as it is located in the high hills without roads and is having forest with a threat of wild animals as well as slip
iii) I am still to develop detailed and adequate understanding of the science of isotope hydrology.
iii) Not much information is available on the hydro-geology of the study area.

21. Future plan:

Identification of recharge zones of the springs, detailed study of topography and hydrogeology of the recharge zones and interaction with the Uttarakhand Jalsasthan authorities for taking measures for increasing discharge of springs by constructing the suitable recharge structures.

Appendix-9

IDENTIFICATION OF RECHARGE ZONES OF SOME SELECTED SPRINGS OF UTTARAKHAND USING ISOTOPES

Action plan

Activity	Q-1	Q-2	Q-3	Q-4	Q-5	Q-6	Q-7	Q-8
Finalization of Springs	♦							
Procurement of equipment like raingauge, temp. meter, humidity meter etc	♦							
Installation of raingauges	♦							
Engaging data observers for collection of raingall, discharge, temperature data etc	♦							
Collection of water samples from spring, rainfall and handpumps for isotopic (δD and $\delta^{18}O$)	♦	♦	♦	♦	♦	♦		
Collection of available data/review of literature/preparation of maps etc	♦	♦	♦	♦	♦	♦		
Laboratory analysis of water samples for δD and $\delta^{18}O$	♦	♦	♦	♦	♦	♦	♦	
Development of meteoric water line for spring, rainfall etc			♦	♦		♦	♦	
Establishment Altitude effect				♦	♦	♦		
Analysis of discharge data of spring and its relationship with isotope data				♦	♦	♦	♦	
Identification of recharge zones of spring						♦		

Activity	**Q-1**	**Q-2**	**Q-3**	**Q-4**	**Q-5**	**Q-6**	**Q-7**	**Q-8**
Formulation of strategies for development of spring						♦	♦	
Interim Report				♦				
Draft Report							♦	
Final Report								♦

10. REFERENCE NUMBER: NIH/HID/RSMML/2010-11

1	Title of the study	HYDROGEOLOGICAL STUDIES OF JHAMARKOTRA MINES, UDAIPUR, RAJASTHAN
2	Name of PI, Co-PI, & their affiliations	Sudhir Kumar, Scientist F (PI) S K Verma, Scientist C Pankaj Garg, Scientist B
3	Type of study (sponsored/ consultancy/ referred/internal). If referred, mention the reference	Consultancy RSMML, Udaipur. Amount: 13.17 Lakh
4	Date of start, scheduled date of completion	1st July 2010 Dec. 2011
5	Location map (wherever applicable)	

6	**Study objectives (not more than 4)**	• To Identify the source of groundwater in blocks D & E of Jhamarkotra mines through stable isotopic and groundwater dating techniques • To suggest complete future dewatering scheme to achieve desirable drawdown (10-12 meters) in the D and E blocks of Jhamarkotra mines • To explore the feasibility of dewatering of monsoon water from the pit in shortest possible time • To suggest measures for protection of groundwater quality in nearby wells • To ensure sustainability of groundwater supply to Udaipur city

7 **Statement of the problem** :

Jhamarkotra Phosphate Mine is the largest and fully mechanised rockphosphate mine of India.

The geometry of the ore body (i.e. thin and steeply dipping) had resulted in long and narrow pits with great depth extension, which involves very high stripping ratio with high lead and lift for waste and mineral. Mining is further complicated by the presence of an estimated 35 MCM of static water in an underground aquifer in the mine area. The working levels are kept dry by continuous pumping of ground water through tube-wells constructed on periphery of the pit limit. The top surface level in the mine area was about 600 m above mean sea level (MSL) and mine working has gone to a depth of up to 405 m and 425 m above MSL in D & E block respectively. Further, RSMM Ltd. plans to excavate the deposit up to 320 m above MSL. Groundwater level contours indicate that present water level in the mining area is about 402 m and 421m above MSL (for D & E block respectively) and the groundwater flow direction is from NW to SE. As the water level is very near to the bottom of the mining pit, it is not possible to excavate to further depth unless the water table is lowered. Under the present condition of water level the mine is facing the threat of closure.

8 Approved action plan — Appendix-10

9 Timeline and justification for time over runs

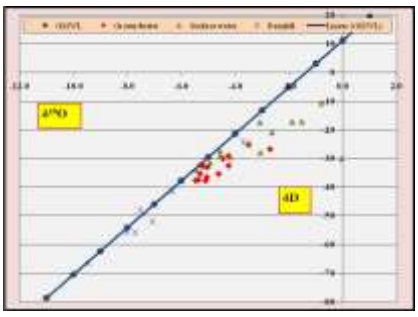
10 2-column table showing objectives vis-à-vis achievements (clearly separate achievements reported in the previous meetings)

OBJECTIVE	STATUS
To Identify the source of groundwater in blocks D & E of Jhamarkotra mines through stable isotopic and groundwater dating techniques	In Progress
To suggest complete future dewatering scheme to achieve desirable drawdown (10-12 meters) in the D and E blocks of Jhamarkotra mines	In Progress
To explore the feasibility of dewatering of monsoon water from the pit in shortest possible time	In Progress
To suggest measures for protection of GW quality in nearby wells	In Progress
To ensure sustainability of groundwater supply to Udaipur city	In Progress

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

Regarding dewatering of the mine pit, Dr Gurunadha Rao suggested that a garland canal type of structure can be suggested so that all water entering into the mining pit can be arrested and pumped out.

12 Analysis and Results



- Creation of GIS database is in progress.
- Drainage and lithological maps in and around mine area has been prepared.
- Groundwater level data in the mine area has been analysed.
- 45 groundwater samples collected and analysed for isotopic analysis.
- Resistivity survey carried out at 12 locations to find the flow path of groundwater. The survey in E block indicates an increase in the apparent

resistivity which is at maximum below 8-13m and then gradually decreases to infinity. The curve shows two layered structure having higher resistivity below 13m indicating hard base layer. However no water sign is found.

- In D block, constant low resistivity has been observed up to 5m and then gradually increases, which indicates thin water zone at a depth of around 3-5m below present ground surface.

13	Adopters of the results of the study and their feedback	Rajasthan State Mines and Mineral Limited
14	List of deliverables (e.g. equipment, papers, reports, software, manuals, brochures, flyers, training programmes, users interaction workshops)	Report & Papers
15	Major items of equipment procured	NIL
16	Lab facilities used during the study	Instruments in Nuclear Hydrology Lab and Hydrological Investigations Lab.
17	Data procured and/or generated during the study	Isotopic data of the mine area
18	Study Benefits / Impact (2-column table showing achievements against measurable indicators as mentioned in the approved study document)	The status of various activities is given below. Other activities have not yet been started.

ACTIVITY	STATUS
Collection and supply of all required data by RSMML	Completed
Compilation of existing hydrogeological data	Completed
Identification of wells for water sampling	Completed
Establishment of raingauge station	Completed
Collection of SW and GW samples for WQ and isotopic analysis	Completed
Collection of samples for groundwater dating	Completed
Groundwater level monitoring in and around mine area	In progress
Creation of GIS data base for GW modelling	Completed
Water Quality analysis of SW and GW samples	In progress
Isotopic analysis (δD and $\delta^{18}O$) of SW and GW samples	In progress
Determination of roundwater flow direction	In Progress

19	Specific linkages with Institutions and/or end-users/beneficiaries	The dewatering plan will be provided to the Mine authority for implementation
20	Shortcomings / difficulties, if any	No difficulty till now
21	Future plan	As per activity chart

Appendix –10

HYDROGEOLOGICAL STUDIES OF JHAMARKOTRA MINES, UDAIPUR, RAJASTHAN

ACTIVITY SCHEDULE (Quarter wise)

Activity	1st	2nd	3rd	4th	5th	6th
Collection and supply of all required data by RSMML	♦					
Compilation of existing hydrogeological data	♦					
Identification of Data Gaps	♦					
Identification of wells for water sampling		♦				
Establishment of raingauge station		♦				
Collection of SW and GW samples for water quality and isotopic analysis		♦	♦	♦		
Collection of samples for groundwater dating		♦		♦		
Infiltration tests			♦			
Groundwater level monitoring in and around mine area		♦	♦	♦	♦	
Pump Tests to determine Sp. yield and Hyd. Cond. (by RSMML)				♦		
Estimation of groundwater draft			♦	♦		
Creation of GIS data base for GW modelling			♦			
Analysis of Lithologs and development of Aquifer Geometry			♦			
Water Quality analysis of SW and GW samples			♦		♦	
Isotopic analysis (δD and $\delta^{18}O$) of SW and GW samples		♦	♦	♦	♦	
Estimation of Natural Recharge to groundwater				♦		
Feasibility of dewatering of monsoon water from the pit in shortest possible time				♦		
Determination of groundwater flow direction				♦		
Identification of the source of groundwater in blocks D & E of Jhamarkotra mines				♦		
Measures for protection of GW quality in nearby wells					♦	
Development of Conceptual model				♦		
Calibration of Model					♦	
Development of mine dewatering Plan						♦
Assessment of availability of GW for Udaipur city						♦
First Draft Report				♦		
Second Draft Report					♦	
Final Report						♦

11. Reference no.: NIH/HID/INT/11-13/1:

1	Title of the study	:	ASSESSMENT OF RADON CONCENTRATION IN WATERS AND IDENTIFICATION OF PALEO-GROUNDWATER IN PUNJAB STATE.
2	Name of PI, Co-PI, & their affiliations	:	S K Verma, Sc. C (P.I.); Sudhir Kumar, Sc. F; M.S. Rao, Sc. E1; Bhishm Kumar, Sc. F
3	Type of study (sponsored /consultancy /referred /internal). If referred, mention the reference	:	Internal
4	Date of start, Scheduled date of completion	:	April , 2011, March 2013
5	Location map (wherever applicable):		

Fig.: Map of Punjab State

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

7 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.

8 Approved action plan : Appendix-11

9 Timeline and justification for time over runs : NA

10 2-column table showing objectives vis-à-vis achievements (clearly separate achievements reported in the previous meetings) :

Sr. No.	Objective	Achievement
1.	To measure radon concentration in waters	A field visit has been planned to collect water samples and measure radon concentration in water during last week of Sept. 2011.
2.	To identify paleo-groundwater in deep aquifers	Dating of water will start in 3rd Quarter (Oct. 2011 on ward).

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

Sr. No.	Recommendations/suggestions	Action taken
1.	Dr. Gurunadha Rao, NGRI, Hyderabad suggested minor modification in the title of the study. According to him, the title of the study should be **"Assessment of Radon Concentration in Waters and Identification of Paleo-groundwater in Punjab State"** in place of "Assessment of Radon Contamination in Waters and Identification of Paleo Groundwater in Punjab State".	The title of the study has been modified as suggested by Dr. Gurunadha Rao.
2.	Dr. Gurunadha Rao also suggested that in order to develop technical background and expertise in this new field at NIH, the area near Narora Power Plant may also be investigated for radon concentrations in groundwater, river water etc.	A field visit has been planned during the last week of Sept. 2011 to fulfill the suggestion.

13 Adopters of the results of the : CGWB (NWR), Chandigarh; Punjab Water Resources

	study and their feedback		Development & Management and Punjab Water Resources & Environment Directorate, Chandigarh.
14	List of deliverables (e.g. equipment, papers, reports, software, manuals, brochures, flyers, training programmes, users interaction workshops)	:	Papers and reports along with the data on radon concentration and paleo-groundwater.
15	Major items of equipment procured	:	Two sets of radon detector with accessories have been procured and installed satisfactorily at Nuclear Hydrology laboratory of the Institute during the month of Aug. 2011.
16	Lab facilities used during the study	:	Tritium and Carbon dating facilities are proposed to be used at Nuclear Hydrology lab in addition to Radon Detector in lab as well as in the field.
17	Data procured and/or generated during the study	:	Nil
18	Study Benefits / Impact (2-column table showing achievements against measurable indicators as mentioned in the approved study document)	:	Data base on radon concentration in waters Information and data base about availability of paleo-waters in the study area.
19	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 Dept. and Punjab University, Chandigarh.
20	Shortcomings / difficulties, if any	:	Nil
21	Future plan	:	As per activity chart

Appendix-11

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

Action plan

Sr. 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 & tritium analysis, measurement of radon								
4.	Lab. analysis of water samples for tritium dating			√	√	√			
5.	Collection of water samples for ^{14}C dating					√	√		
6.	Lab. 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								√

12. REFERENCE NUMBER: NIH/HID/INT/11-13/2

1	Title of the study	:	HYDROLOGICAL ASSESSMENT FOR ARTIFICIAL RECHARGE AND WATER MANAGEMENT IN GHAR AREA, SHARANPUR DISTRICT, U.P.
2	Name of PI, Co-PI, & their affiliations	:	Pankaj Garg, Sc.B (PI) Sudhir Kumar, Sc.E2 Tanveer Ahmad, PRA, WRS Div. Rajesh Agarwal, RA, RCMU V.C. Goyal., Sc.F, RCMU Bhishm Kumar, Sc.F
3	Type of study (sponsored/ consultancy/ referred/ internal). If referred, mention the reference	:	Internal
4	Date of start, scheduled date of completion	:	April, 2011- March 2013
5	Location map (wherever applicable)		

MUZZAFFARABAD	SADHAULI KALIM
Study Area - 40621 ha	Study Area - 38767 ha
Govt. Tube well – 130	Govt. Tube well – 6
Private Tube Well – 5333	Private Tube Well –4196
R.F. – 740 mm	R.F. – 740 mm
G.W. Utilization - 97.42%	G.W. Utilization - 94.62%
Forested Area – 1910 ha	Forested Area – 1589 ha

6	Study objectives	:	• To identify the groundwater recharge zones and groundwater flow velocity for Ghar area • To identify sites for water harvesting structures

for Ghar area

7	Statement of the problem	:	Two blocks of district Saharanpur which fall in Ghar area namely, Muzaffarabad and Sadhauli Kadim has been taken for this study. The availability of groundwater and surface water is limited in these both 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 the both blocks fall in dark category and require artificial recharge measures.
8	Approved action plan	:	Appendix-12
9	Timeline and justification for time over runs	:	NA
10	2-column table showing objectives vis-à-vis achievements (clearly separate achievements reported in the previous meetings)	:	

Objective	Achievement
Review of literature and purchase of map	• Reviewed past work carried out in blocks Muzaffarabad and Sadhuli Kalim • Soil Map of study area • Drainage map • Topographical Contour Map • Land Use Map
Data	• Pre and Post Monsoon G.W. Table data (1998-09) • Monthly R.F. Data of 9 years (2001-09) • G.W. Data • Isotopic analysis of G.W. sample

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

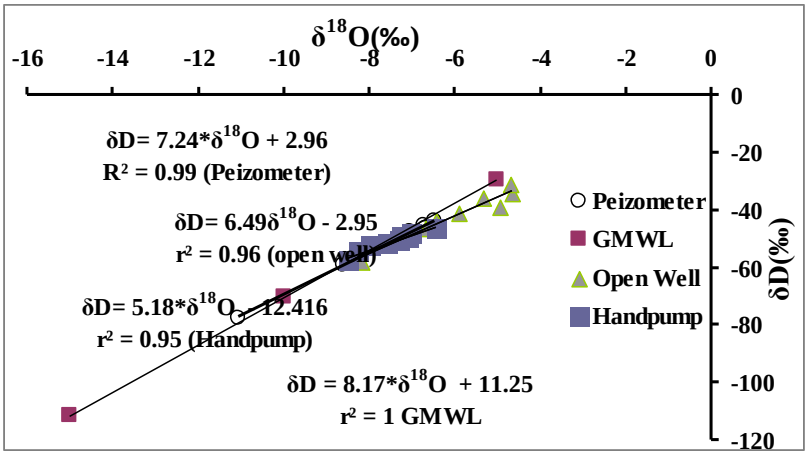
12. Analysis and Results :

12(a) Field work carried out

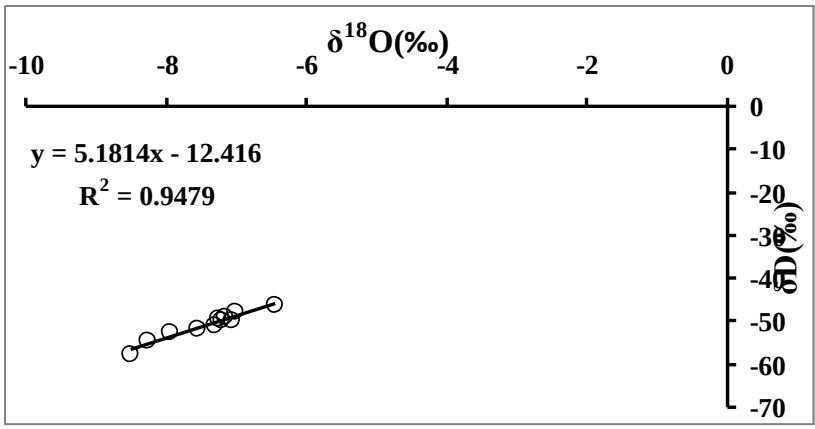
1. Water samples were collected from 34 sites for water chemistry and isotopic analysis
2. Finalized 16 sites for further collection of samples
3. Analyzed all the samples for δD and $\delta^{18}O$

12(b)

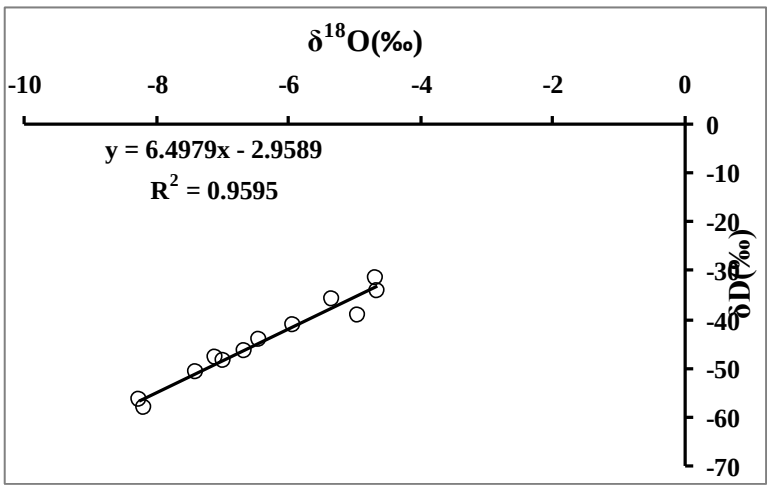
- Isotopic signatures of all the GW samples indicate that the source of ground water recharge is precipitation. However, the open well and piezometer samples show enrichment due to evaporation. The GW lines for sample collected from Piezometer, Handpump and Open well are shown in the figure. A precipitation sample collection station has been established at Muzaffarabad. A field visit proposed in the first week of October to collect precipitation, groundwater and other sources samples. The further interpretation of the the hydrological and isotopic data is in progress. Therefore, more details will be presented during the Working Group Meeting.



.



GW-HP Data Graph



GW-Open Well

13 Adopters of the results of the study and their feedback : 1. UP State Ground Water Deptt., Saharanpur Division
2. CGWB, Regional Directorate, Lucknow
3. Local NGO's active in the study area
4. Local District Administration

14 List of deliverables (e.g. equipment, papers, reports, softwares, manuals, brochures, : Reports & Papers

	flyers, training programmes, users interaction workshops)		
15	Major items of equipment procured	:	NIL
16	Lab facilities used during the study	:	Isotope and Hydrological Investigations Laboratory/RS Lab.
17	Data procured and/or generated during the study	:	
18	Study Benefits / Impact (2-column table showing achievements against measurable indicators as mentioned in the approved study document)	:	i) Selection of study site – site has been selected ii) Collection of literature – some literature collected iii) Collection of water samples – 34 samples collected iv) Installation of Rain Gauge - Completed
19	Specific linkages with Institutions and/or end-users/beneficiaries	:	NIL
20	Shortcomings/difficulties, if any	:	NIL
21	Future plan	:	NIL

Appendix-12

HYDROLOGICAL ASSESSMENT FOR ARTIFICIAL RECHARGE AND WATER MANAGEMENT IN GHAR AREA, SAHARANPUR DISTRICT, U.P.

Action plan & time line

S. N.	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 & data etc	√	√						
2.	Collection of hydro-geological data/informations for the study area		√	√					
3.	Infiltration test & collection of samples	√		√	√	√	√	√	
4.	Preparation of various maps of the study area				√	√	√	√	
5.	Analysis of data in Lab				√	√	√	√	
6.	Interpretation of data (Recharge zone)				√	√	√	√	
7.	Mass Awareness programme							√	
8.	Writing of report (Interim/Final)				√				√

NEW STUDY

13. REFERENCE NUMBER: NIH/HID/CONS/11-13

Title of the Study:	Integrated Hydrological Investigations of Sukhna Lake, Chandigarh for its Conservation and Management
Study Group:	S. D. Khobragade Sc-E1, S. P. Rai, Sc-E1, Bhishm Kumar, Sc-F, Vipin Agrawal, SRA
Type of Study:	Consultancy Project, sponsored by Forest Dept., Chandigarh Administration
Nature of Study:	Data generation and technology adaptation including Promotion of citizen and state action for water conservation, augmentation and prevention: a goal under National Water Mission.
Duration:	**2 Years**
Date of Start:	**July, 2011**
Date of Completion	**June, 2013**

Objectives:

(a) To estimate water availability in the lake through systematic assessment of the water balance components of the lake
(b) To estimate sedimentation rate and expected life of the lake
(c) To study the water quality of the lake
(d) To suggest measures for conservation and management of the lake

Statement of the Problem:

Sukhna Lake is a very significant lake of Chandigarh because of its being an important tourist attraction and centre of recreation. As such, the lake also contributes significantly to the economy of the region. The lake is reported to be facing a serious threat of sedimentation. Its capacity has been reported to have decreased significantly in the past few decades. At the time of its construction its storage capacity was 10.74 MCM. It has now been reported that more that 60% of the original storage capacity has been lost and that about 40 % reduction in the water spread area of the lake has taken place within the first three decades after its construction due to heavy siltation. Moreover, water levels in the lake have been observed to go down considerably in some of the recent years. Also, presence of underground weeds is being observed in the lake in recent years which needs to be curbed before becoming a menace. As such, it is very important to conserve the lake for future. Although some scattered studies have been reported on the assessment of sedimentation in the lake, no systematic scientific investigations on the various hydrological processes and hydrological behaviour of the lake have been reported. Since the various processes occurring in any lake ecosystem are directly or/and indirectly interrelated with the various hydrological processes, it is essential to understand the various hydrological processes of the lake ecosystem, so that systematic and scientific conservation and management measures can be taken up for the lake. Integrated hydrological investigations are hence significant and essential for the Sukhna Lake. The study has been taken up on the request of the Chandigarh Administration through the Conservator of Forests, Chandigarh.

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

Study Area:

Sukhna lake is located in the Union Territory of Chandigarh at 32^0 42' N Lat. and 76^0 54' E Long. in the foothills of Siwalik Hills. It is a manmade lake constructed in the year 1958 as part of the plan prepared by the French architect Le-Corbusier. It was constructed by

constructing a 12.8 m high rockfill earth dam across the Sukhna choe, which is a seasonal stream flowing down from the Shivalik hills. The lake is reported to be 1.52 km long and 1.49 km wide. The maximum water spread area of the lake is reported to be 2.28 sq. km. The lake has a catchment area of 42.07 Sq. Km. of which 29.08 Sq. Km. falls in the Union Territory of Chandigarh, 10.22 Sq. Km. in Haryana and 2.77 Sq. Km. in Punjab. The major land uses in the catchment area are forest and agriculture. Out of the 42.07 Sq. Km. catchment area, about 34 sq. km is forest and 8 sq. km is agriculture. The catchment area has a rugged terrain with steep slopes. The soils are predominantly alluvial sandy embedded with layers of clay and are highly susceptible to soil erosion. The water table is reported to be very deep.Sukhna Lake serves as a sanctuary for a large number of birds. So far, about 150 different species of birds have been reported for the lake. It is an important source of recreation and tourism for the people of the region. Aquaculture is another important economic activity associated with the lake.

Methodology:

The envisaged objectives will be achieved through:

1. Collection, processing and analysis of the available data
2. Generation of additional hydro-meteorological and isotope data
3. Field investigations
4. Sample collection and laboratory analysis for water quality investigations
5. Isotopic investigations of water and soil samples

For the assessment of the availability of the water in lake, its water balance would be carried out. Different components of the water balance are inflow to lake, outflow from the lake, storage in the lake, evaporation from the lake and the ground water inflow/outflow. These components would be determined. The inflow and outflows would be monitored. Lake evaporation would be estimated. Groundwater-lake interaction will be studied using isotope technique. Water levels in the lake would be monitored. Lake sedimentation would be studied using radiometric dating techniques. Sediment cores from the lake would be analyzed in the laboratory for radioactivity. The analysis would be carried out for Cs-137 as well as for Pb-210. Life of the lake would be determined from the sedimentation rates in different parts of the lake using the bathymetric map of the lake. It has been informed by the authorities of the Chandigarh U. T. that the depth area capacity curve (bathymetric map) for the lake is available. It would be collected from them. The radioactivity would be measured at the NIH laboratory. Water quality status of the lake would be assessed from the water quality data of the lake. Water samples from the lake would be collected and would be analyzed in the laboratory.

Action plan & time line:

S.N.	Activities	QUARTERS							
		1	2	3	4	5	6	7	8
1.0	**PREPARATORY WORK**								
1.1	Recruitment of project staff	√							
1.2	Collection and compilation of all available data/information; and identification of Data gaps	√	√						
1.5	Procurement of instruments	√							
1.6	Preparation of maps	√	√						

2.0	**FIELD WORK**								
2.1	Collection of hydro-meteorological and related data	√	√	√	√	√	√		
2.2	Identification of location for installation of equipment/ collecting samples etc	√							
2.3	Installation of equipment	√	√						
2.4	Collection of water samples for water quality analysis	√			√				
2.5	Collection of water samples for isotope analysis	√	√	√	√	√	√		
2.6	Collection of sediment samples	√							
2.7	Infiltration tests to determine Infiltration rates	√			√				
2.8	Measurement of inflow velocities	√	√						
2.9	Cross section of inflow channel	√							
2.10	Discharge measurements	√	√	√	√	√	√		
3.0	**LABORATORY ANALYSIS**								
3.1	Analysis of samples for Water Quality		√	√					
3.2	Analysis of stable isotopes (δD and $\delta^{18}O$) of SW and GW samples	√	√	√	√	√	√		
3.3	Analysis of sediment samples for Cs-137 and Pb-201	√	√	√	√				
3.4	Analysis of water samples for tritium		√						
4.0	**DATA INTERPRETATION AND ANALYSIS**								
4.1	Water availability in lake					√	√	√	
4.2	Siltation rate in lakes and expected life of the lake					√	√		
4.3	Water quality of the lake			√			√		
4.4	Measures for conservation and management of lake								
5.0	**PROJECT REPORT**								√

Data requirement & Expected source:

Most of the data required for the study such as water level data of lakes, rainfall data, water quality data, isotope data of precipitation, ground water, lake water etc, are not available and would be generated. Available data, if any would be collected from the Engineering department, Chandigarh Administration, CGWB, Chandigarh etc.

List of deliverables:

The output of the study would be in the form of a comprehensive report wherein all data, maps, information, analysis and results pertaining to water balance, sedimentation rate, expected useful life and water quality status would be included. The report would also contain recommendations for the conservation and management of the lake based on the analysis carried out. The Final Report would be compiled in the last quarter of the second year. Interim report would be submitted at the end of the first year. It is also proposed to publish research papers based on the investigations.

IPR potential and issues: NIL

Involvement of End Users/beneficiaries:
Administration of Union Territory of Chandigarh

Specific linkages envisaged with Institutions and/or other NGOs:
1. Sharing of Data
2. Assistance in field work
3. The output in the form of recommendations for conservation and management of the lake would be communicated to the Chandigarh Union Territory Administration.

Major items of equipment needed: Bathymetry Survey Profiler, Chlorophyll torch, AWLR.

SURFACE WATER HYDROLOGY DIVISION

NATIONAL INSTITUTE OF HYDROLOGY

ROORKEE – 247 667

WORK PROGRAMME FOR THE YEAR 2011-12

S. No. & Ref. Code	Title	Study Team	Duration	Funding Source
1. NIH/SWD/NIH/08-12	Study on integrated water resources management of sub-basin to cope with droughts	R.P. Pandey Ravi V. Galkate Surjeet Singh L.N. Thakaral	4 years	NIH
2. NIH/SWD/NIH/09-12	Snow Melt Runoff Modelling in Sultej Basin	A.R. S. Kumar Manohar Arora A. Agarwal D.S.Rathore Digambar Singh	3 years	NIH
3. 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	NIH
4. NIH/SWD/NIH/08-	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora Rakesh Kumar	To be continued	NIH
5. NIH/SWD/NIH/10-13	Climatic Scenarios Generation for Satluj Basin using Statistical Downscaling Techniques	Manohar Arora Rakesh Kumar	3 years	NIH
6. NIH/SWD/NIH/09-11	Data book - hydro-meteorological observatory 2001-2008	Digambar Singh A. R. S. kumar Manohar Arora	2 years (up to Sept. 2011)	NIH
7. 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	NIH
8. 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. JainRakesh Kumar	2 years	NIH
9. NIH/SWD/NIH/11-14	Hydrological Studies for Upper Narmada Basin.	Jagdish P. Patra Rakesh Kumar Pankaj Mani T R Sapra	3 years	NIH

1. PROJECT REFERENCE CODE: NIH/SWD/NIH/08-12

a) Title of study: **Study on Integrated Water Resources Management of Sub-Basin to Cope with Droughts**

b) Study group: R.P. Pandey, Sc. E1 & P.I., SWH Div.
Ravi V. Galkate, Sc. C & Co-P.I., RC Sagar
Surjeet Singh, Sc. C, GW Div.
L.N. Thakaral, Sc. B, WRS Div.

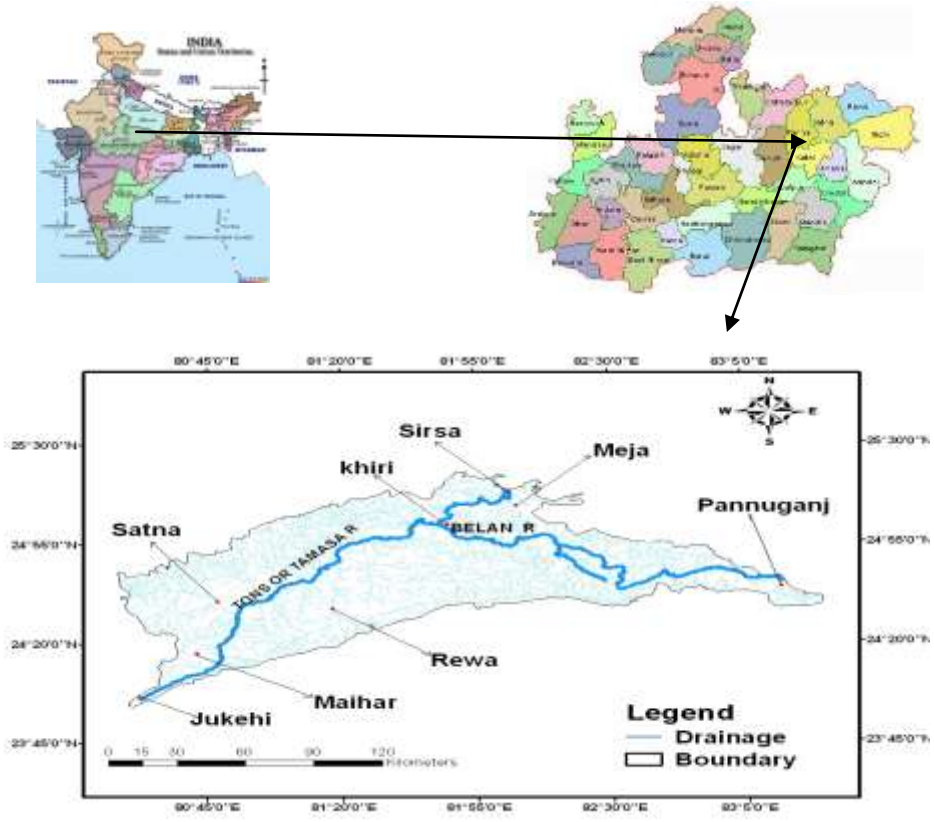
c) Type of study: Internal

d) Date of start: Dec. 2008

e) Scheduled date of completion: Dec. 2012

f) Location map / study area:

Tons Basin



g) Objectives:

Major objective of the study is to devise an integrated water management plan for minimizing water stress during drought situation. The specific objectives of this project are to:

i. Developing inventory of drought events and water resources in study sub-basin.
ii. Identification of strategic surface and groundwater resources to be used in drought situations.
iii. Study of alternative means for minimizing adverse impacts of droughts.

iv. Characterization of drought based on hydro-meteorological, environmental, and socio-economic aspects in the selected basin(s).
v. Delineation of zones vulnerable to drought in the study sub-basin(s).
vi. Devise integrated water management plan to cope with drought.

h) Statement of the problem:

i. Area experiences recurrence of drought
ii. Unprecedented economic losses and great suffering to the affected areas.
iii. Reduced agricultural production and famine threat.
iv. Limited and scarce water resources and demand is very high for agriculture.
v. Year 2007 experienced the acute drought situation in this area.
vi. Limited and scarce water resources. Demand is increasing at a rapid rate due to demographic shifts and lifestyle changes.
vii. Area urgently needs attention and an integrated water resources management approach which includes drought management as a important component.

i) Approved action plan / Proposed work plan for the project:

- Reconnaissance survey, subsequent field visits and liasoning with the concerned departments/offices etc. in the proposed study areas.
- Procurement/Collection of maps and topo-sheets, long term hydro-meteorological and other relevant data/records.
- Digitization of maps, topo-sheets, preparation of maps of drainage, land-use, cropping system, DEM, water availability maps (SW & GW), irrigation maps etc. using GIS.
- Developing inventory of drought events, their impact and Identification of indigenous knowledge (ITKs) on drought mitigation in the study areas
- Analysis of meteorological, hydrological data and agricultural records for establishing regional drought indicators/indices.
- Classification of zones vulnerable to drought and water scarcity (preparation of vulnerability maps and their physical verification with ground truth).
- Random sampling and collection/investigation of socio-economic and environmental information.

j) Achievements:

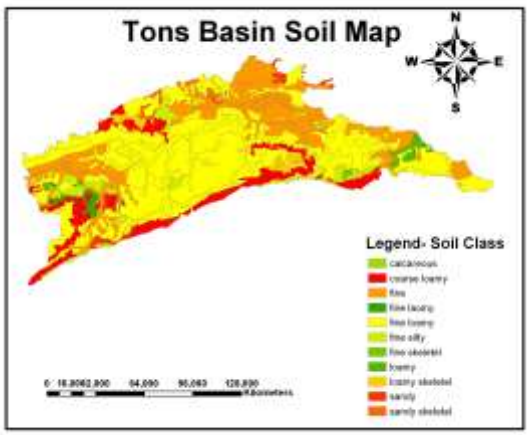
Objectives	Achivements
Field survey & data collection	Preliminary data collection Completed
Inventory of Water resources, drought events etc. in the study sites.	To be completed by March 2011
Preparation of base maps	Completed
Collection of rainfall data, and stream flow data from CWC	Completed
Collection of ground water level from CGWB / state departments, and Temperature, evaporation from IMD	Partially Completed
Crop type and area, Socio-economic Profile & Drought event related information	Partially Completed

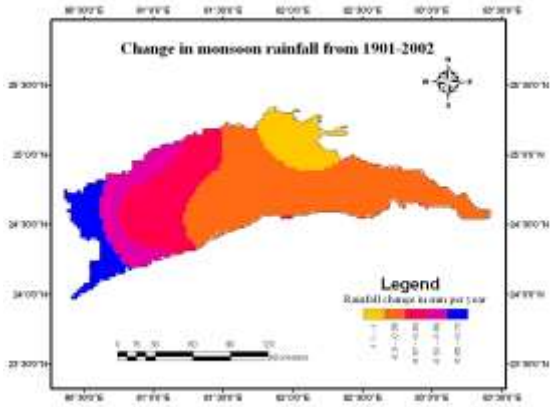
k) Recommendations / suggestions in previous meetings of Working Group/TAC/GB

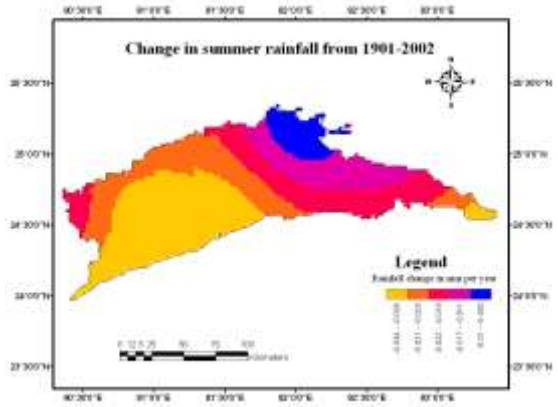
Recommendations / suggestions	Action Taken
Dr. K.V. Jayakumar suggested to refer	Available literature on IWRM has been

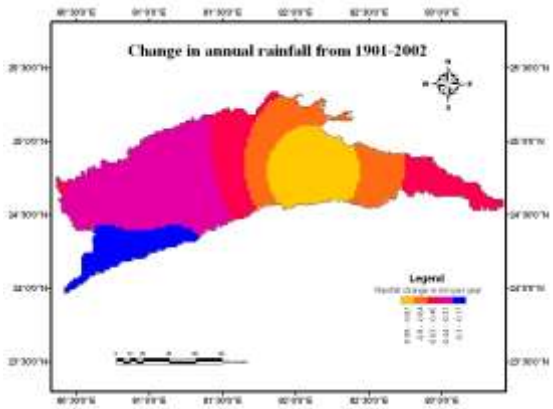
information available in internet on IWRM for identifying the strategic water resources.	referred suitably and the suggestion has been complied.

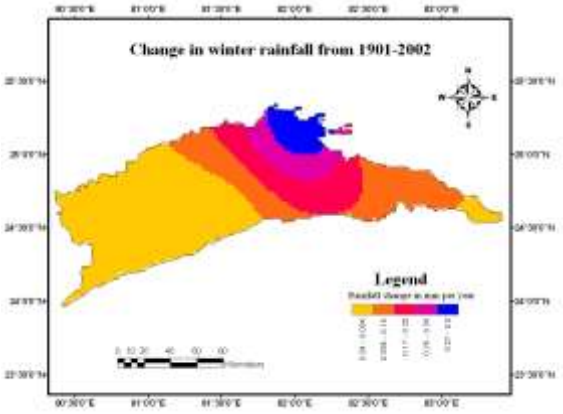
l) Analysis and results

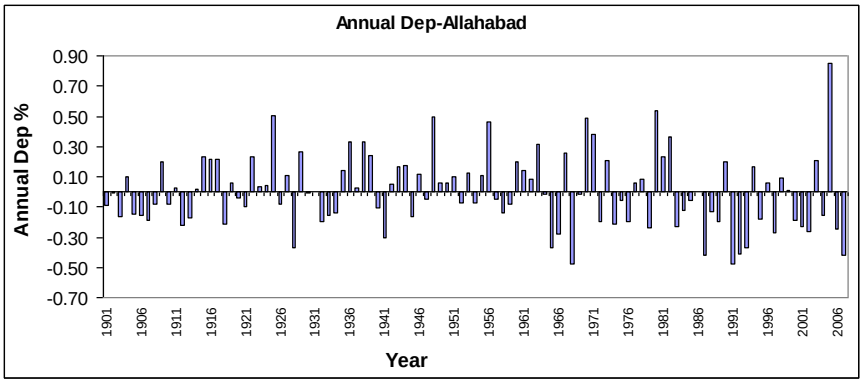


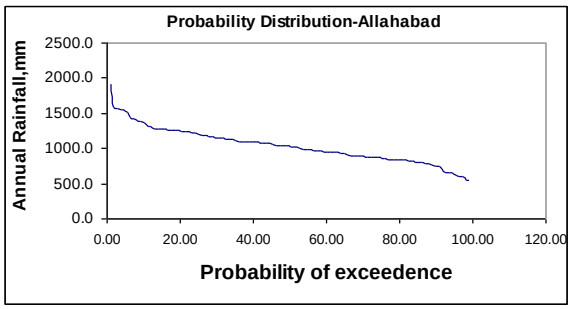


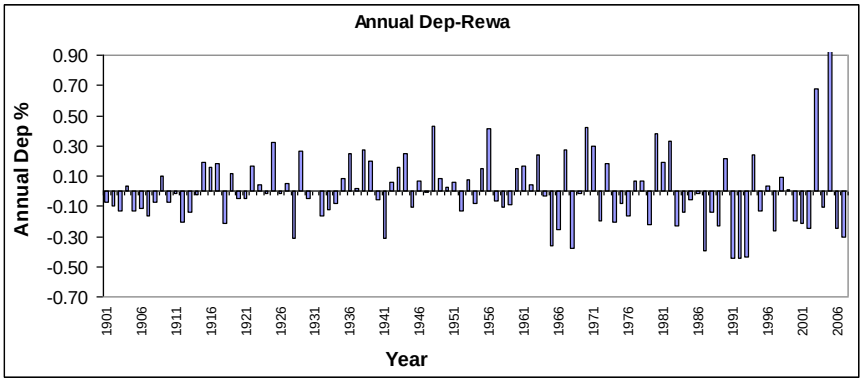


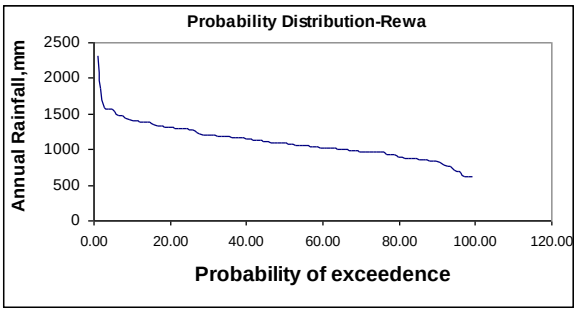





Annual Dep-Allahabad
Annual Dep %
0.90
0.70
0.50
0.30
0.10
-0.10
-0.30
-0.50
-0.70
1901
1906
1911
1916
1921
1926
1931
1936
1941
1946
1951
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
Year


Probability Distribution-Allahabad
Annual Rainfall,mm
2500.0
2000.0
1500.0
1000.0
500.0
0.0
0.00
20.00
40.00
60.00
80.00
100.00
120.00
Probability of exceedence


Annual Dep-Rewa
Annual Dep %
0.90
0.70
0.50
0.30
0.10
-0.10
-0.30
-0.50
-0.70
1901
1906
1911
1916
1921
1926
1931
1936
1941
1946
1951
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
Year


Probability Distribution-Rewa
Annual Rainfall,mm
2500
2000
1500
1000
500
0
0.00
20.00
40.00
60.00
80.00
100.00
120.00
Probability of exceedence

Results of Mann Kendall test for temperature series
(A: annual, W: winter, S: summer, M: monsoon)

	Tmax				Tmin				Tmean			
	A	W	S	M	A	W	S	M	A	W	S	M
Allahabad	▲	▲	+	-	▲	▲	+	+	▲	▲	+	-
Katni	▲	▲	+	+	▲	▲	+	+	▲	▲	+	+
Rewa	▲	▲	+	-	▲	▲	+	-	▲	▲	+	-
Satna	▲	▲	+	-	▲	▲	+	-	▲	▲	+	-
Panna	▲	▲	+	+	▲	▲	+	+	▲	▲	+	+

▲&▲▲: Significant increasing at 5% &10%, ▼&▼▼: Significant decreasing at 5%&10%, +&-: non- significant increasing & decreasing trend.

m) Progress of work

Discharge data from CWC has been collected for two sites namely Meja-Road and Satna. Analysis of stream flow data is completed.

Data procurement from IMD is completed. Interim report progress of the study was submitted in April 2011. Required maps of the study area like drainage map, DEM, and soil map have been prepared. Inventory of problems in the study area has been prepared. Trend analysis of monthly, seasonal and annual rainfall has been carried out for basin. A visit for field investigations was taken up in Septrmbet 2011.

A summary of the analysis inferred so far is as follows.

i. Area experiences recurrence of drought at an average frequency of once in 5 years.
ii. Water storages schemes in Nagod, Maihar and Ram nagar Blocks of the Satna district and Mauganj, Hanumana, and Sirmaur blochs of Rewa district are very few and the areas face frequent and unprecedented economic losses and great suffering due water stress during drought. Reduced agricultural production, mass migration and famine threat are major concern in these areas..
iii. Western part of the basin has observed falling trends of monsoon rainfall during past 102 years
iv. Limited and scarce water resources and demand is very high for agriculture.
v. Year 2007 experienced the acute drought situation in this area and caused 50-60% agricultural production losses.
vi. Limited and scarce water resources. Demand increasing at a rapid rate due to demographic shifts and lifestyle changes.
vii. Area needs attention and an integrated water resources management approach which includes drought management as an important component.

n) List of deliverables:

i. Final report of the study is to be prepared by March 2012.
ii. This study is finally expected to evolve a methodology to deal with drought situation for minimizing crop losses and water stress in semiarid and dry sub humid areas
iii. A training course for one week duration is scheduled to be held on drought mitigation and management in Apri/May 2011

o) Major items of equipment procured: Nil

p) Lab facilities during the study: Nil

q) Data procured / generated in the study: 10-daily Stream flow data for Tons River

r) Future plan of work under this project

Activity (months)	1 to 6	7 to 12	13 to 18	19 to 24	25 to 30	31 to 36	37 to 42	42 to 48
Studying events and inferrencing of results	xxx	xxx	xxx	xxx	xxx	xxx	xxx	
Identification and evaluation of critical parameters that influences drought situations.	xxx	xxx	xxx	xxx	xxx	xxx	xxx	
Devising a Mechanism for assessment & reporting of drought progression/ warning / alert System for water management actions.	xxx	xxx	xxx	xxx	xxx	xxx	xxx	
Knowledge dissemination	xxx	xxx	xxx	xxx	xxx	xxx	xxx	
Final Report Submission	xxx	xxx	xxx	xxx	xxx	xxx	xxx	

s) Role and Responsibilities of Team Members

1. **Dr . R.P. Pandey, Scientist E2 & PI:** Conduction field investigations, analyzing data/information, report preparation and overall responsible for the study completion.
2. **Sh. Ravi Galkate, Scientist E1 & Co-PI:** Assisting in field investigations, part of data analysis and results interpretations.
3. **Dr. Surjeet Singh, Scientist E1 & Co-PI:** Assisting in part of data analysis and interpretations of groundwater component**.**
4. **Sh. L.N. thakural, Scientist B & Co-PI:** Assisting in part of map preparation, GIS related component of the study.

2. PROJECT REFERENCE CODE: NIH/SWD/NIH/09-12

a) Title of the study: **Snow Melt Runoff Modelling in Sultej Basin**

b) Study group: A. R. Senthil kumar Sc E1 & P.I., SWH Div.
Manohar Arora, Sc C & Co-P.I., SWH Div.
Avinash Agarwal, Sc F, SWH Div.
D. S. Rathore, Sc E2, WRS Div.
D. Singh, Sc B, SWH Div.

c) Type of study: Internal

d) Date of start: 1 April 2009

e) Scheduled date of completion: March 31, 2012

f) Location map / study area:

The catchment of Sutlej river up to Rampur has been considered for the analysis. The catchment area up to Rampur is 50298 sq.km. The location of the study area is presented in Figure 1. For the development of the model, the daily rainfall values at Rampur, Kalpa, Rakccham, Kaza and Namagai, snowfall values at Kalpa, Rakccham, Kaza and Namgia, maximum temperature values at Rampur, Kalpa, Rakccham, Kaza and Namagia, minimum temperature values at Rampur, Kalpa, Rakccham, Kaza and Namagia are available from 1987 to 2000. The discharge values at Rampur for the same period are also available.

Fig. 1: Index map of Sutlej basin

g) Objectives of the study:

(i) To simulate snow melt runoff using conceptual models SRM and SNOWMOD
(ii) To develop an ANN model to simulate the snow melt runoff

(iii)To compare the results of conceptual models with ANN model

h) Statement of the problem:

This study focuses on the development and evaluation of ANN models for the simulation of streamflow at Rampur in Sutlej River and the results of ANN models are to be compared with the results of conceptual models such as SNOWMOD and SRM

i) Approved action plan:

Year	April - June	July-Sept	Oct-Dec	Jan-March
2009-10	Literature review, Data collection and processing	Literature review, Data collection and processing, Development of ANN model for snow melt runoff considering the continuous data of streamflow	Development of ANN model for snow melt runoff considering the continuous data of streamflow, Development of ANN models for low, medium and high streamflow	Development of ANN models for low, medium and high streamflow
2010-11	Computation of snow covered area from satellite imageries	Computation of snow covered area from satellite imageries	Simulation of stream flow components by calibrating the parameters of SNOWMOD	Simulation of streamflow components by calibrating the parameters of SNOWMOD
2011-12	Simulation of streamflow by ANN model by considering the snow covered area, Simulation of streamflow components by calibrating the parameters of SRM	Simulation of streamflow by ANN model by considering the snow covered area, Simulation of streamflow components by calibrating the parameters of SRM	Simulation of streamflow components by calibrating the parameters of SRM, Comparison of the simulation results of stream flow by ANN, SNOW-MOD and SRM	Preparation of report

j) Role and Responsibility of Team Members:

i. **Dr. A. R. Senthil kumar, Sc. E1 & PI:** Collection of data and processing, development and application of the models, analyzing the results, report preparation and overall responsible for the study completion.
ii. **Dr. Manohar Arora, Sc. C & Co-PI:** Application of conceptual models and analysis of the results.
iii. **Dr. Avinash Agarwal, Sc. F & Co-PI:** Assisting in the development of models and analysis of the results**.**
iv. **Sh. D. S. Rathore, Sc. E2 & Co-PI:** Assisting in the computation of snow covered area from imageries.

v. **Sh. Digambar Singh, Sc. B & Co-PI:** Assisting in entry and processing of data.

k) Achievements:

Objectives (for the period April 2011- Sep. 2011)	**Achievements**
1. Simulation of streamflow component by calibrating the parameters of SRM	Under progress
2. Rerun of the ANN model with updated data	Under progress

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

Recommendation/suggestion	**Action taken**
1. Dr VVS Gurunadha Rao suggested to predict one period value of streamflow and check it with BBMB, Nangal.	It will be done after the rerun of ANN model with updated data
2. Dr. Jayakumar suggested to remove the outliers and run the ANN models again.	It is considered in the rerun of the ANN model
3. Dr. V. C. Goyal asked to update the database and run the model with the updated data.	The data is updated according to the input data of SNOWMOD and SRM

m) Analysis and Results:

SNOWMOD and SRM

SNOWMOD and SRM are conceptual models and the degree-day approach is adopted in the computation of snow melt runoff. The runoff contribution from snow covered area and snow free area are computed by standard formulae.

ANN Model

Three layered feed forward structure is selected for the ANN model. The training of the model is done by back propagation algorithm. The performance of the model is evaluated by coefficient of correlation, root mean squared error, model efficiency and percentage error in peak flow estimation.

Results

During the first year of the study, ANN models for simulating the streamflow at Rampur considering the continuous data of rainfall, snowfall, minimum temperature, maximum temperature and streamflow at Rampur have been developed. As per the suggestion of the working group members, the development of ANN model for simulating the streamflow at Bhakra Reservoir with updated data is under progress.

During the second year of the study, the stream flow at Bhakra reservoir have been simulated using the conceptual model SNOWMOD considering the snow cover area and other hydrological and meteorological parameters for the years 1999-2003. The data of 1999 to 2002 are considered for the calibration of parameters in SNOWMOD.

During last six months, the stream flow at Bhakra reservoir have been simulated using the conceptual model SRM considering the snow cover area and other hydrological and meteorological parameters for the years 1999-2003. Snowmelt-Runoff Model (SRM) is a conceptual model designed to simulate and forecast daily stream flow in mountain basins where snowmelt is a major runoff factor. The model has been used to simulate the snowmelt runoff in a well distributed area in which the parameters used are to be set different for each sub-area. The results obtained for various years are given below:

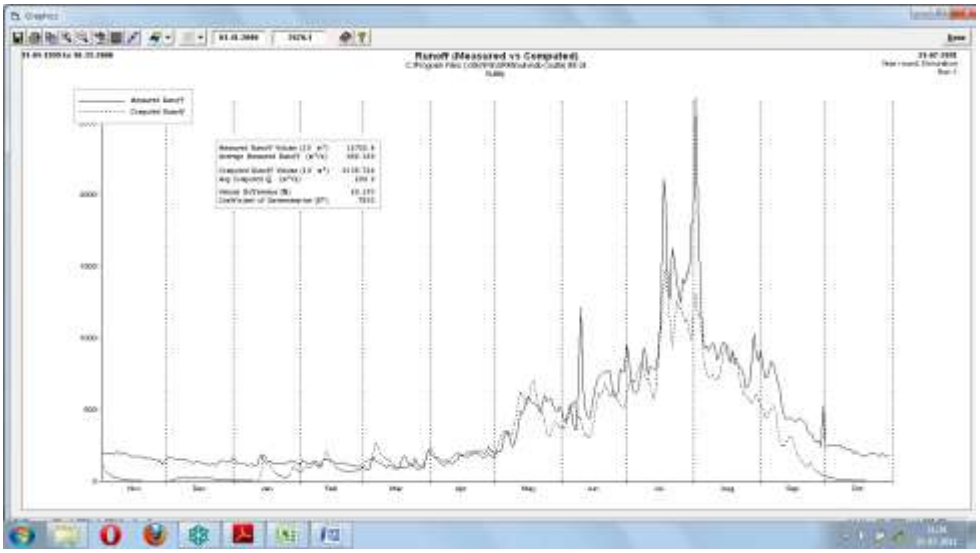


Fig 2. Simulation for the calibration year 1999-2000

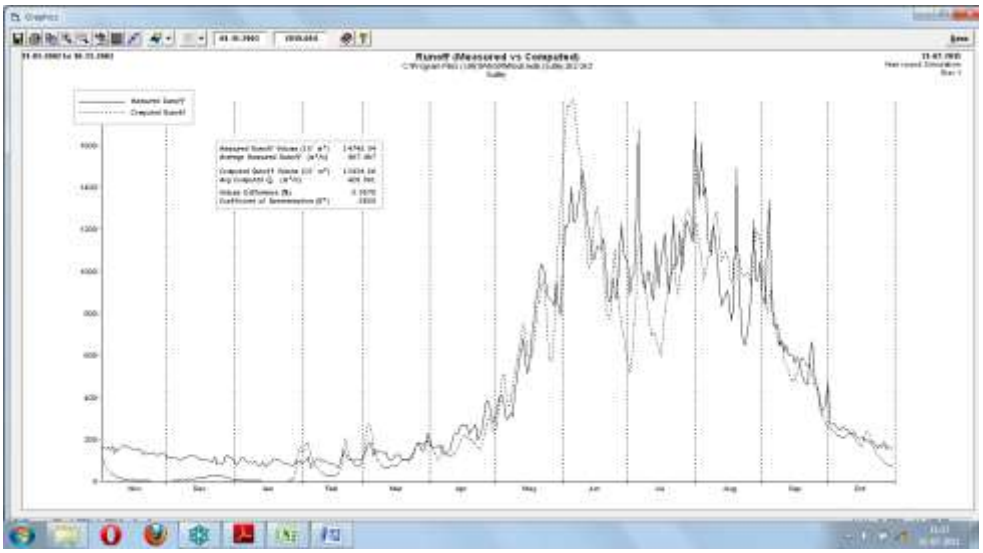


Fig. 3 Simulation for the validation year 2002-2003

Year	Measured Runoff (m^3)	Computed runoff (m^3)	R^2
1999-2000	12722.6	9135.72	0.759
2000-2001	10907.04	9104.054	0.823
2001-2002	13577.34	12491.62	0.818
2002-2003	14742.04	13436.26	0.858
2003-2004	8711.09	8233.09	0.658

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

Water Regulation Division, BBMB, Nangal.

m) Deliverables:

Research papers and reports

n) Data generated in the study:

The hydrological and meteorological data have been collected from the concerned divisions of BBMB, Nangal, The snow covered area for the different zones have been computed from the satellite imageries of different scenarios.

o) Study benefits/impacts:

The study will suggest a better model to simulate the streamflow at Bhakra reservoir by considering the data of rainfall, snowfall, minimum temperature, maximum temperature and streamflow at Bhakra reservoir and the simulation of streamflow at Bhakra reservoir by the better model may be used to regulate the flow at Bhakra Dam by the operating authority.

p) Future plan:

The performance of ANN, SNOWMOD and SRM models will be compared with each other and conclusion will be drawn based on the performance of the models.

3. 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:

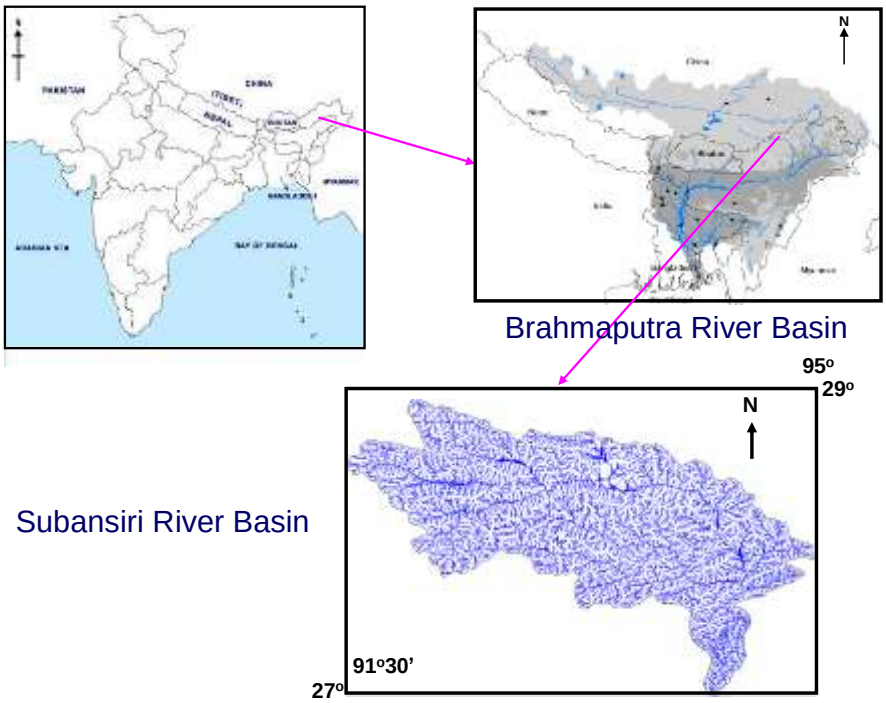


Fig. 1: Study Area

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 part of Brahmaputra River Basin.	Completed
4. Preparation of technical report on "Snow Cover estimation and its temporal variation in a part of Brahmaputra 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

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

Suggestions	Action Taken
1. The chairman suggested use of GCM output instead of hypothetical scenarios to study the impact of climate change, to be carried out in the third year of the study.	This would be taken up as an independent study after the completion of present study

m) Analysis and Results:

Data Used

- 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 (1996-2007)
- Daily Temperature (Max and Min) data at three stations in Indian part of Subansiri basin (2000-08)

Results

- The grid wise computed average annual rainfall is shown in Figure 2. The daily rainfall data is now being processed to write in the input format of SNOWMOD

program.

- The daily average temperature at the Station Gerukamukh (elevation 94m) for a period of 2000-08 is shown in Figure 3. The daily average temperature data is now being processed to write in the input format of SNOWMOD program. This temperature data would be used for various elevation bands after applying temperature lapse rate.

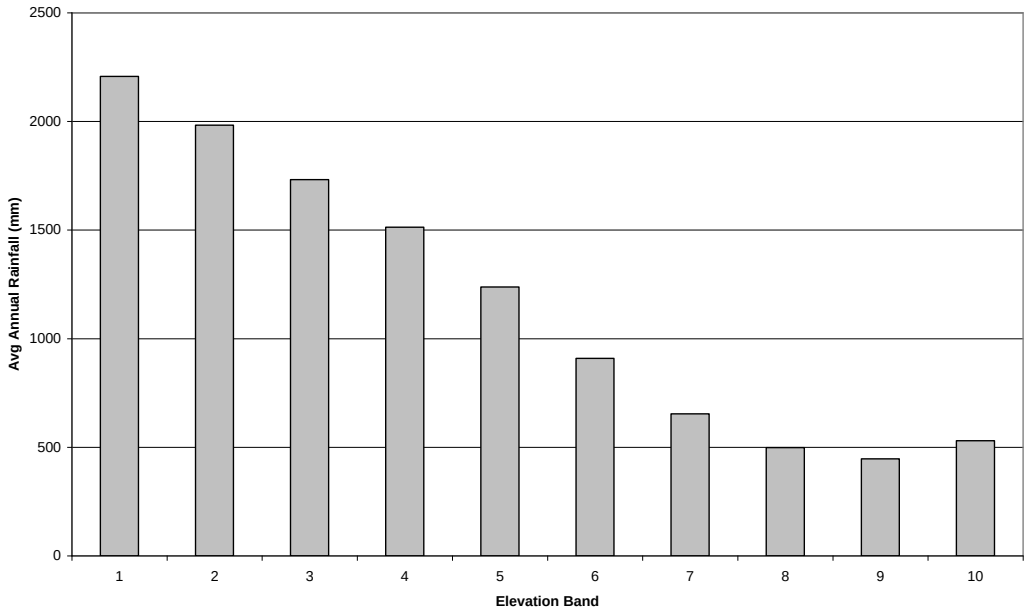


Fig 2: Average Annual Rainfall in Subansiri Basin (1996-2007)

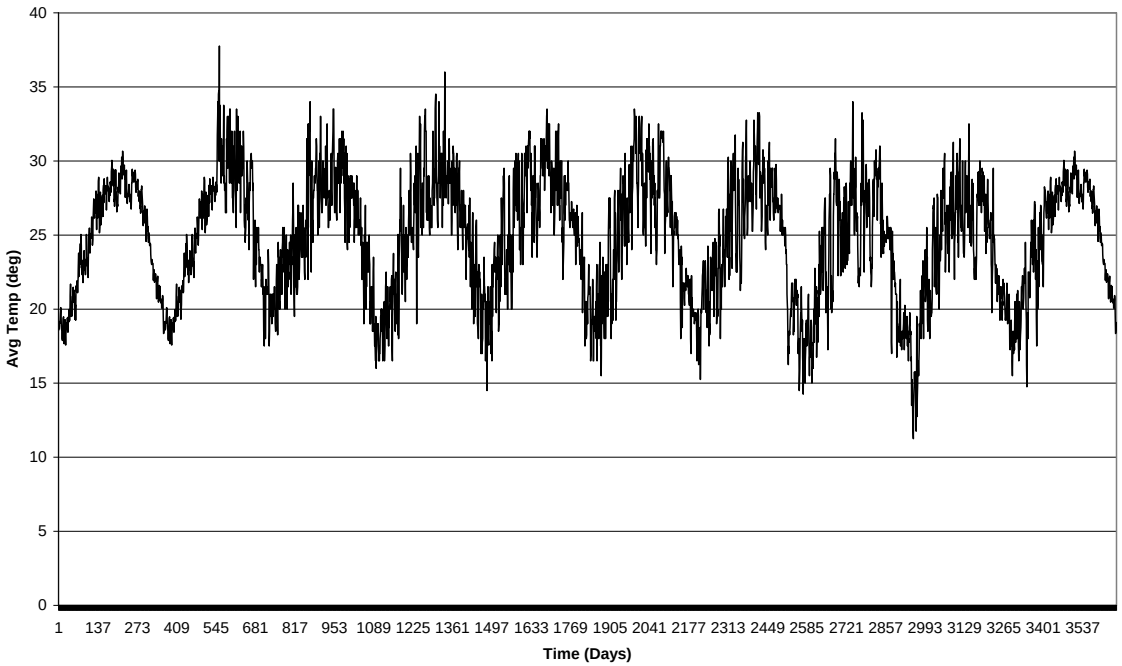


Fig 3: Average Daily Temperature at Gerukamukh (2000-2008)

n) Expected adopters:

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

o) Deliverables:

Research paper would be prepared after completion of Part-II 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 three stations in Indian part of Subansiri basin (2000-08)

q) Future plan:

As per the approved action plan.

4. ROJECT 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.

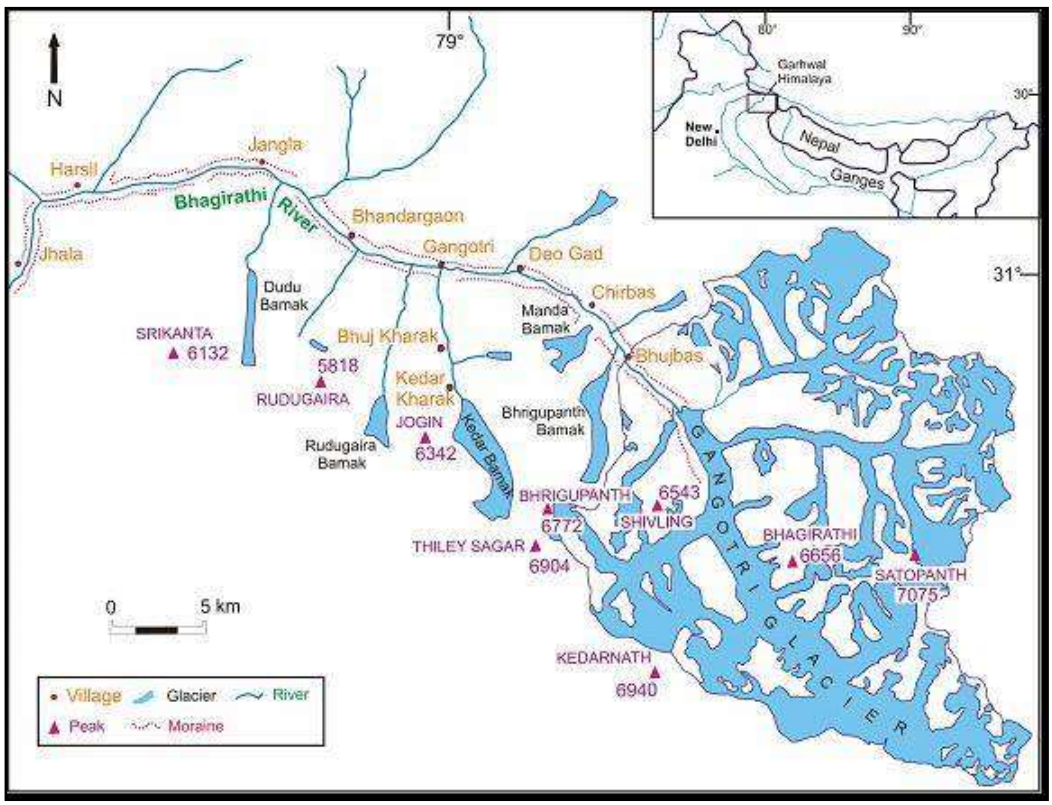
Rakesh Kumar Sc 'F', SWH Div.

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:

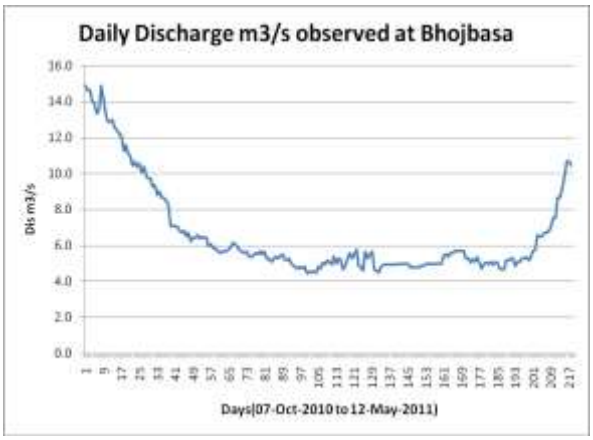
Objectives	Achivements
Continuous monitoring of meteorological and hydrological data for monthly and seasonal specific water yield and its variability from the year to year	The data collection and field investigations for the year 2011 have been started in the month of May 2011
To improve the hydrological 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 three ablation seasons during 2008 to 2010 was analysed and the draft report has been submitted. The winter data from October 2010 to May 2011 has been analysed. The maximum temperature varied between 16.3°C to -6.3°C whereas the minimum temperatures varied between 3.1°C to -17.8°C. The mean temperature was in the range of 8.3°C to -11.6°C. The relative humidity varied between 2 to 100%. The sunshine hours were also recorded for the winter season. It was observed that the maximum sunshine hours were of 8.5 hours. The discharge was observed for the winter season first time and it has been observed that the discharge varied between 4.4 to 14.9 m^3/s.



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.

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

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

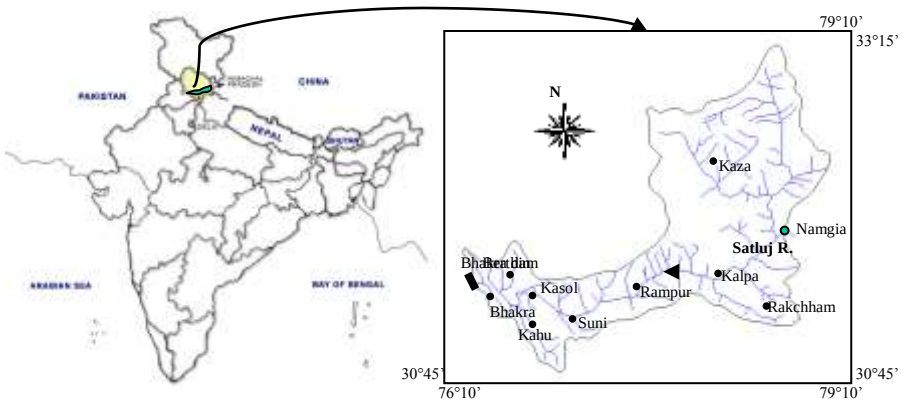
b) Study Group: Manohar Arora Sc 'C', SWH Div.
Rakesh Kumar Sc 'F', SWH Div.

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 NIES and NCEP Re-analysis data.

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	Downloading of NCEP/ NCAR data
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.

j) Objectives vis a vis achievement:

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

k) Recommendation/Suggestion of Working Group:

No specific recommendation

l) Analysis & Results:

The data required for the study has been obtained and the preliminary processing of the data has been carried out. The steps for downloading the different GCM outputs have been identified and after downloading these outputs a comparative analysis with the observed data will be done. A methodology for the comparative analysis is being developed.

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

The study will benefit the departments like SJVNL and BBMB.

n) List of deliverables:

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

o) Major items of equipment procured: Nil

p) Lab facilities during the study: Desktop study.

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

r) 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

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

t) 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.

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

6. PROJECT REFERENCE CODE: NIH/SWD/NIH/09-11

a) Title of the study: **Data Book- Hydro-Meteorological Observatory 2001-2008**

b) Study group: Digambar Singh, Sc B & P.I., SWH Div.
A. R. Senthil kumar Sc E1, SWH Div.
Manohar Arora, Sc C, SWH Div.

c) Type of study: Internal

d) Date of start: 1 April 2009

e) Scheduled date of completion: March 31, 2011 (Revised DOC: Sep 2011)

f) Location map / study area: NIH campus

g) Objectives of the study:

(i) To bring out the data book for NIH hydro meteorological observatory for the years 2001-2008

h) Statement of the problem:

The data of rainfall, relative humidity, maximum and minimum temperature, evaporation, and wind speed and wind direction have been collected since 1985. It is proposed to bring out a data book for the period from 2001to 2008 having the data in tabular form and with some basic statistics.

i) Approved action plan

Year	April - June	July-Sept	Oct-Dec	Jan-March
2009-10	Entry of hourly rainfall data from hyetograph, Entry of hourly humidity data from hygrograph	Entry of hourly rainfall data from hyetograph, Entry of hourly humidity data from hygrograph	Entry of hourly rainfall data from hyetograph, Entry of hourly humidity data from hygrograph	Entry of hourly rainfall data from hyetograph, Entry of hourly humidity data from hygrograph
2010-11	Entry of hourly temperature from thermograph	Entry of hourly temperature from thermograph	Entry of evaporation, wind speed and wind direction	Entry of evaporation, wind speed and wind direction
2011-12	Entry of hourly rainfall, temperature and humidity data	Entry of hourly rainfall, temperature and humidity data	Analysis of the data	Writing of the report

j) Role and Responsibility of Team Members:

i. **Sh. Digambar Singh, Scientist B & PI**: Entry of data and processing, statistical analysis, report preparation and overall responsible for the study completion.
ii. **Dr. A. R. Senthil kumar, Scientist E1 & Co-PI:** Assisting in the entry and processing of the data and statistical analysis.
iii. **Dr. Manohar Arora, Scientist C & Co-PI:** Assisting in the entry and processing of the data and statistical analysis.

k) Achievements

Objectives (for the period April 2011- September 2011)	**Achievements**
Entry of hourly rainfall data from hyetograph Entry of hourly humidity data from hygrograph Entry of hourly temperature from thermograph	Completed Completed up to 2009 Completed up to 2009

l) Recommendation/Suggestion of previous meetings of WG/ TAC/GB: Nil

Recommendation/suggestion	**Action taken**
1. Dr VVS Gurunadha Rao and Mr. N. Y. Apte suggested to carry out basic statistical analysis after the entry of the data.	It will be done after the entry of the data
2. Dr. Rakesh Kumar suggested to use HYMOS for correcting and analyzing the data.	The software HYMOS will be used after the entry of data

m) Analysis and Results

Brief methodology

Hydro-meteorological data is an initial and foremost requirement for the planning and execution of any water resources projects. National Institute of Hydrology commissioned a hydro-meteorological observatory in its campus in the year 1985. Observations of maximum temperature, minimum temperature, relative humidity, pan evaporation, rainfall, wind speed, wind direction are made on daily basis. The request for the data from other organizations is considerably more. So it is appropriate to bring out the data book in regular intervals. It is planned to enter the data in SWDES software and the related statistics of the data will be brought out in tabular forms.

Results

The hourly data of rainfall, relative humidity, temperature up to 2009 have been entered in SWDES. The data entry for 2010 is under progress.

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

Research students from IIT Roorkee, scientist from the Institute and filed engineers from state government departments.

o) **Deliverables:** A report containing data in tabular form with basic statistics.

p) **Data generated in the study:** Data in tabular form with basic statistics.

q) **Study benefits/impacts:** The compiled data may be used for field and research purposes

r) **Future plan:** The statistical analysis of the data will be done.

7. 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). The source of water in the watersheds is only the existing springs in the watersheds.

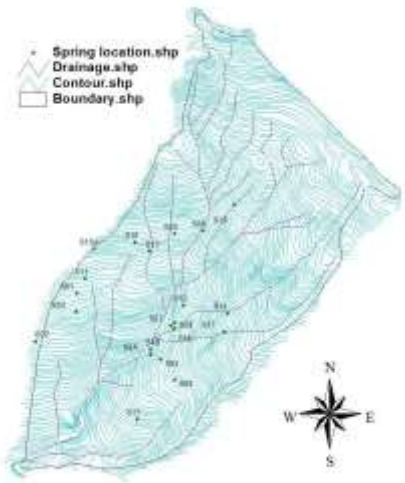


Figure 1: Location of Chandrabhaga springs.

Figure 2: Location of Danda springs.

g) Objectives of the study:

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

ii. Development of implementable technology for water availability analysis.

iii. Interaction and transfer of developed implementable technology to users.

h) Statement of the problem:

A net work of instrumentation of previous project is continued as a pilot monitoring system in middle Himalayan region (Uttarakhand). This net work of instrumentation and data collected will be used to obtain the objective of the project. The monitoring continued for watersheds (Chandrabhaga, Danda) for 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). Spring flow 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 Interactive workshop
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. Development of implement able technology for water availability analysis (analysis and model development). Presentation of progress and final reporting.

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

i. Maintenance and up keeping of installed equipments. Two rain gauges in

Chandrabhaga watershed have gone out of order as being very old and required to be replaced by new ones.

ii. Spring flow data has been analyzed for its lag with rainfall on daily and monthly basis and for spring flow variability.

iii. The collected data has been processed for daily and hourly and the record has been updated.

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

Working group suggested that the objectives may be modified as; ▪ Detailed hydrological monitoring, collection of data at watershed scale and creation of a centralized database for watershed for the benefit of the users. ▪ Development of implement able technology for water availability analysis ▪ Interaction and transfer of developed implementable technology to users.	Modified as suggested

m) Results:

- **Maintenance and up keeping of installed equipments.**
- **Spring Flow analysis.**

Measured springs of the watersheds have been classified in to three groups (perennial, non-perennial and dead springs) based on the flow availability and the record through out years. The springs with continuous availability of water were considered as perennial, the springs with one or more nil flow periods in a year as non-perennial and springs never regained after a specific time as dead. Analysis was performed for rain to spring lag on daily and monthly basis. Springs of Chandrabhaga resulted a lag of 9 to 30 days and on monthly basis as zero to one month. Springs of Danda resulted a lag of 1 to 29 days and on monthly basis as zero to two months.

Relationships were developed between normalized rainfall of the year versus average spring flow for all the springs in each watershed. In general the correlation was high for interrupted spring compared to the perennial spring.

A low correlation between normalized rainfall and average spring flow for respective, suggests that watershed characteristics are dominant on spring flow yield compared to rainfall characteristic.

The spring flow has not indicated any relation ship with number of rainy days and number of rainy hours on yearly basis.

- **Processing and analysis of data collected up to July 2011.**

The data collected till July 2011 has been processed for daily and hourly basis and the record has been updated. The record updating till Sept. 2011 is in the process. The soil moisture at different depths and soil temperature record that could not be collected due to failure of instrument (Water Mark) is being generated by developing the relationships based on the past records and the current values recorded through AWS.

n) List of deliverables: Hydro-meteorological data for small watershed of Uttarakhand.

o) Major items of equipment procured: Require three water level loggers and three ARG. Approximate cost Rs. 3 lacks.

p) Lab facilities used during the study: Nil

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

8. 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) 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.

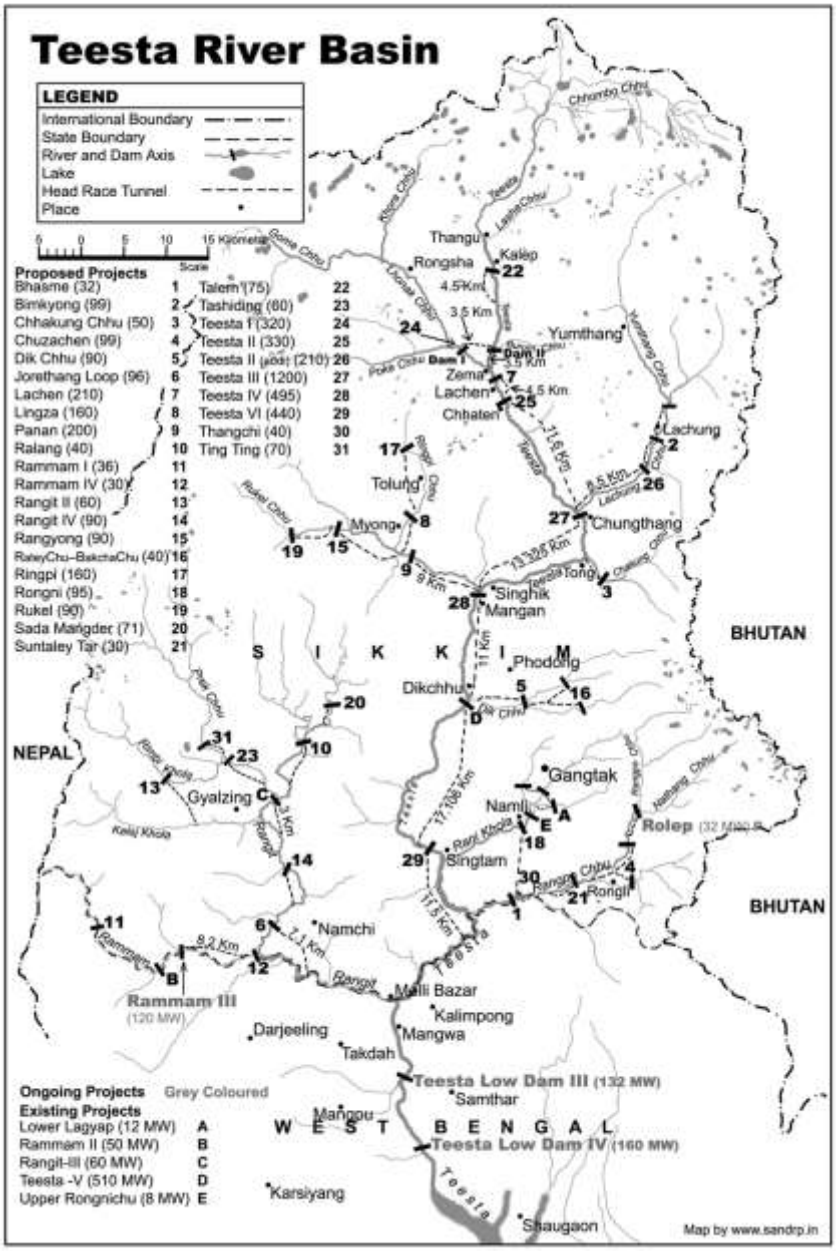


Fig. 1: Teesta (Tista) River Basin

h) 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.

i) Approved action plan :

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

j) 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.

k) Achievements

Year	Objectives (for the period April 2011 to September 2011)	Achievements
2010-11	i) Creation of data base in GIS ii) Classification of data for lake inventory	Partially achieved Partially achieved

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 map of Teesta has been prepared and DEM has been created. Landsat TM data of the basin have been downloaded from Internet. Classification of this data for identification of glaciers and glacial lakes has been carried out using conventional and SVM techniques

have been carried out. On the basis of classification preparation of glacial lakes inventory is in progress.

n) Deliverables:

Reports and research papers

o) Data generated in the study:

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

9. 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 1, 2011

e) Scheduled date of completion: March 31, 2014

f) Location map:

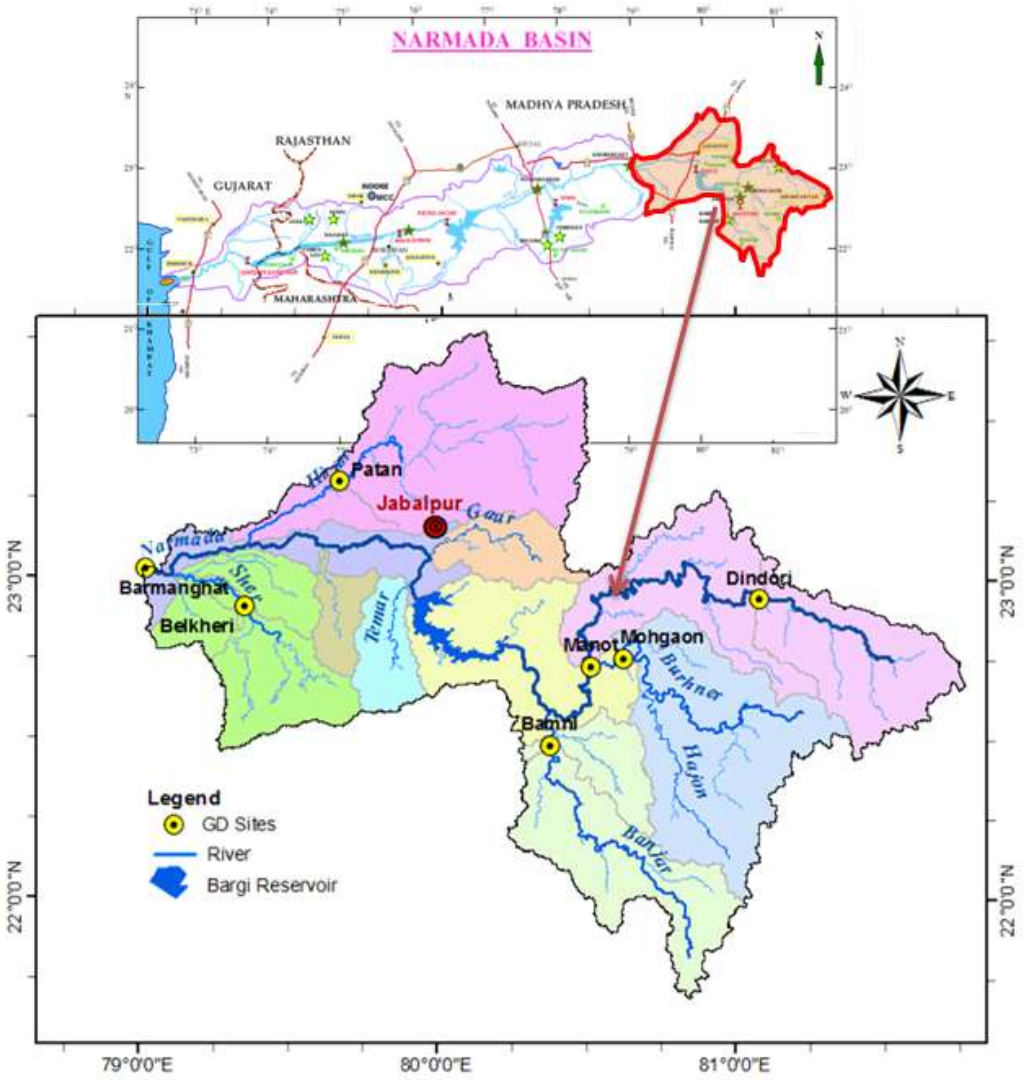


Fig. 1: Location map of study area.

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

S No	Comment/Suggestion	Action taken
1	To refer previous studies on Narmada basin by NIH.	During literature review process previous studies on Narmada river basin have been referred.
2	To check availability of data from previous studies	Efforts have been made to collect data from previous studies and all other possible sources.

m) Results achieved with progress/ present status:

During past six months main focus was on data collection and literature survey as mentioned in the approved action plan. Various previous studies on Narmada basin at NIH are referred along with other published literatures. Rainfall data at six rain-gauge stations are collected from IMD, Pune. Further stage-discharge and river cross-section are collected from CWC. However, some missing values are there in the series and we are planning to collect some addition data and if possible increase the length of time series in future. Reservoir characteristics curve, design dimension, inflow, release etc. are

obtained from office of Chief Engineer (Bargi), Rani Avantibai Pariyojana, NVDA, Jabalpur (MP).

DEM of the study are is prepared from SRTM data and used to delineate sub basins using HEC-GeoHMS. The basin upto bargi dam is divided into 5 sub basins as shown in Fig. 2. The basin characteristics required for generating synthetic unit hydrograph using CWC method is also estimated (Table 1).

Fig. 2: Delineated sub basins.

Table 1: Basin characteristics

Basin No	**A**	**L**	**L_C**	**S**
1	3596.30	170.72	66.86	2.53
2	2612.27	206.88	97.65	2.59
3	2311.98	111.00	55.47	2.77
4	3978.36	173.33	88.83	2.59
5	2533.82	172.60	91.52	1.47

Synthetic Unit Hydrographs

Using the relationships derived in CWC report the SUH parameters are estimated from basin characteristics. The SUH developed using these parameters for delineated five sub basins are shown in Fig. 3.

Estimation of design rainfall

The design 1-day maximum rainfall for 50 and 100 year return periods are taken from the CWC report. Further, design storm duration of each sub basin is estimated and the time distribution of rainfall is made according to CWC report as shown in Fig 4.

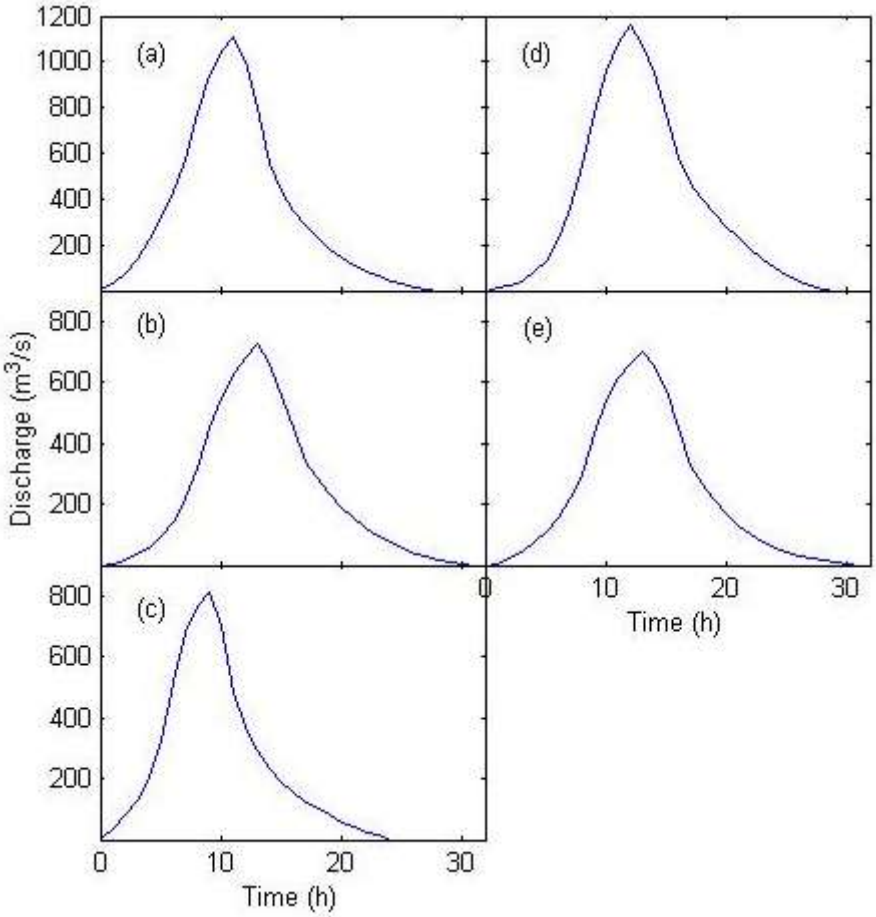


Fig. 3: Estimated SUH for five sub basins.

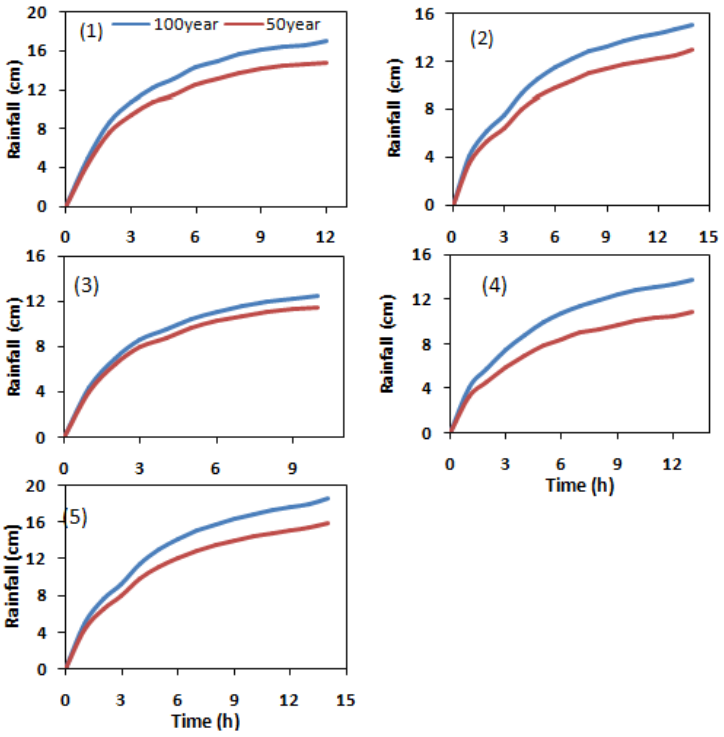


Fig. 4: Time distribution curve of design storm.

Design flood hydrographs

Design loss rate of 0.10 cm/hr is used to obtain effective hourly rainfall. The effective rainfall and constant base flow for each sub basin is provided as input to the HEC-HMS basin model (Fig. 5) to estimate discharge at Bargi dam (junction 3). However, the model has not been calibrated yet. The preliminary result shows the peak flow to Bargi dam is 38,012.2 m^3/s and 45,004.7 m^3/s for 50 and 100 year return period respectively. The flood hydrographs are shown in Fig. 6.

Fig. 5: Basin Model setup in HEC-HMS.

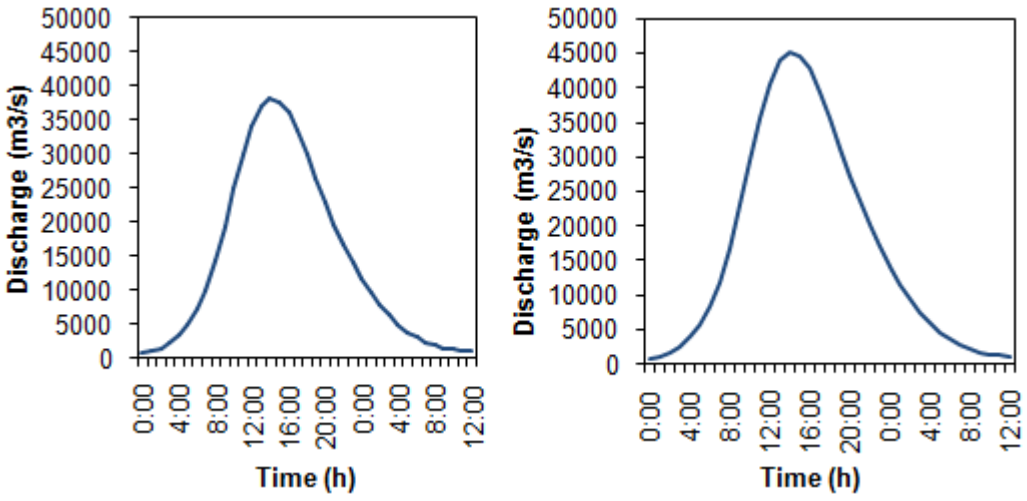


Fig. 6. Design flood hydrographs at Bargi dam for 50 and 100 year return period.

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.
- 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.

WATER RESOURCES SYSTEM DIVISION

NATIONAL INSTITUTE OF HYDROLOGY

ROORKEE – 247 667

WORK PROGRAMME FOR THE YEAR 2011-2012

S.No.	Title	Study Team	Duration	Funding
1.	Application of a distributed hydrological model for river basin planning and management	M.K. Goel Vijay Kumar D.S. Rathore D. Chalisgaonkar Rama Mehta	2 yr 6 month (10/09-3/12)	NIH
2.	Web based Information System for Major and important Lakes in India	D. Chalisgaonkar Suhas Khobragade	1 year (4/10-3/12)	NIH
3.	Analysis of water management scenarios in Tapi River basin using MIKE Basin	Rama Mehta (PI) M.K. Goel Vijay Kumar/ D.S. Rathore	3 years (4/10-3/13)	NIH
4.	Development of analytical equation for alternate depths for flow in rectangular channels	S.K. Singh	1 year (4/11-3/12)	NIH
5.	A transfer function model for event based runoff	S.K. Singh	1 year (4/11-3/12)	NIH
6.	Trend and variability analysis of Rainfall and Temperature in Himalayan region	L.N. Thakural Sanjay Kumar Sanjay Kumar Jain Tanveer Ahmad	3 years (10/11-9/14) **New Study**	NIH
7.	Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin	Sanjay K. Jain Bhishm Kumar Vijay Kumar S.P. Rai Renoj Theyyan	3 Years (4/09 – 3/12)	PDS (HP-II)
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 J.V. Tyagi D.S Rathore L.N. Thakural Rama Mehta	3 Years (4/09-3/12)	PDS (HP-II)
9.	Hydrological Assessment of Ungauged Catchments (Small Catchment)	P.K.Bhunya (PI) Rakesh Kumar D.S. Rathore Sanjay Kumar P.C. Nayak	2 Years (5/09-5/12)	PDS (HP-II)
10.	Vetting of Water Availability studies of the Gulf of Khambhat Development Projects (Kalpasar Project)	M.K. Goel Vijay Kumar	6 Months (4/10-12/11)	Consultancy
11.	Glacier Lake Outburst Flood (GLOF) study for Jelam tamak (THDC India Ltd.)	Sanjay K Jain AK Lohani L N Thakural Anju Chaudhary Tanvear Ahamd		Consultancy
12	Snowline estimation, snowmelt runoff study and Glacial Lake Outburst Flood study for Chamkharchhu H.E. Project in Bhutan (NHPC, Faridabad)	Sanjay K Jain A. K. Lohani L. N. Thakural Anju Chaudhary		Consultancy
13	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 Tanvear Ahamd, PRA		Consultancy

1. Application of a distributed hydrological model for river basin planning and management (Research study)

Study Group	M. K. Goel, Scientist F Vijay Kumar, Scientist E2 (on lien) D. S. Rathore, Scientist E2 Deepa Chalisgaonkar, Scientist F Rama Mehta, Scientist C
Type of study	Internal
Date of start of study	01 October 2009
Duration and scheduled date of completion of study	03 years; 31 March 2012

Objectives of study

The envisaged objectives of the study are:

1. To apply a distributed hydrological model at the scale of a river basin and assess its effectiveness and limitations in light of data availability.
2. To compare the model results with a semi-distributed model for addressing various water related issues at the basin scale.

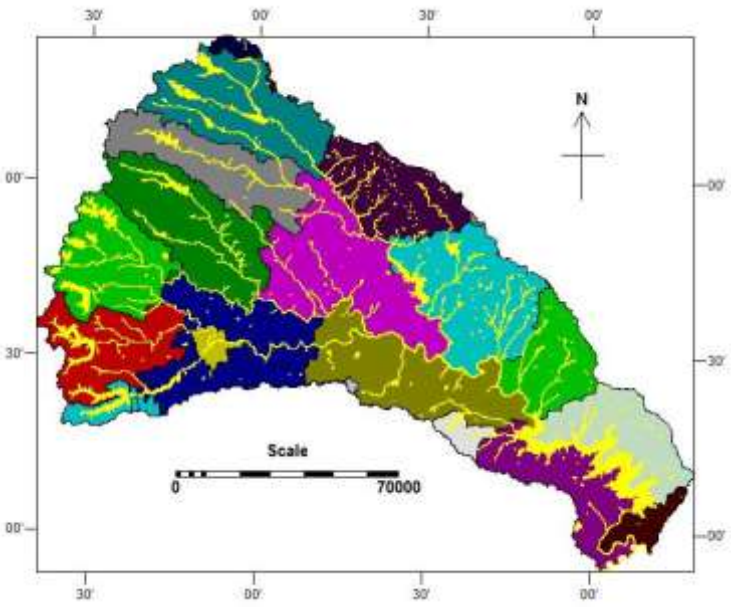
Statement of problem and brief methodology

This study focuses on the application of distributed hydrological models at the scale of a river basin and to assess their effectiveness and limitations in light of data availability in comparison to a semi-distributed model for integrated planning and management of water resources.

Location map/Study Area

The study is being carried out for the upper Bhima basin up to the Ujjani reservoir. It is a multi-purpose multi-reservoir system with catchment area of 14856 sq. km. There are 18 reservoir projects in the basin with total storage of 17.4 MCM and hydropower generation capacity of 318 MW. Major part of the basin is drought prone with GW exploitation. 10% of the basin is forested whereas agriculture is practiced on 76% of the basin of which 64% is irrigated. A map of the basin showing major drainage network, reservoirs, and sub-basins corresponding to different gauging sites is shown below.

Approved action plan



Year	Oct - Dec	Jan - March	April - June	July – Sept
2009-10	1. Database development 2. Download of models	1. Database development 2. Review of models	1. Database development 2. Review of models	1. Database development for Mike Basin 2. Database development for NIH model
2010-11	1. Database development 2. Application of Mike Basin model	1. Database development 2. Application of NIH model	Application of HEC/SWAT/ MODSIM model	Application of HEC/SWAT/ MODSIM model
2011-12	Application of HEC/SWAT/ MODSIM model	Comparison of results	-	-

Recommendations/suggestions in previous WG/TAC/GB meetings:

Recommendations	Action Taken
1. Dr. M. M. Kimothi suggested that higher resolution data can be used in the analysis. 2. Dr. Jaya Kumar suggested comparing the results with a lumped model.	1. Analyses for a river basin involve very large area and a higher resolution grid will multiply the analysis dimensions manifold. 2. Mike Basin is a lumped model at sub-basin scale which is being applied in present analysis. Additional models can be taken up depending on the availability of time for the study.

Achievement

Objectives (April 2011 – till date)	Achievements
1. Database development	1.Nearing completion for some models
2. Application of Mike Basin Model	2. Mike Basin model applied
3. Application of NIH Model	3. NIH model application – In-progress
4. Application of HEC/SWAT models	4. HEC/SWAT model application - In-progress

Analysis & results

The results will be presented in the WG meeting.

Adopters of the results of the study and their feedback

This study will highlight the advantages/limitations of distributed modeling study at the scale of river basin. These results can be utilized for hydrological modeling for river basin planning and management.

Deliverables

Research papers and reports.

Data generated in the study

Distributed hydro-meteorological data has been generated in the study This includes data layers for basin boundary, DEM, drainage, slope, aspect, reservoir locations, land use, crop map, command area map, rainfall stations, river gauge stations, climate stations, sub-basins for different gauging stations, district, Thiessen polygons for rainfall and ET stations etc.

Study benefits/impacts

The study will suggest a better model to integrated river basin planning and management and will bring out the advantages/limitations of distributed models in comparison to the semi-distributed models.

Future plan

Modification in the NIH model to encompass various options of other models for comprehensive river basin planning and management analysis.

2. Web based information system for major and important lakes in India

(Research study)

Study group	Deepa Chalisgaonkar, Scientist F Suhas Khobragade, Scientist E1
Type of study	Internal
Date of start of study	01 April 2010
Duration and scheduled date of completion of study	02 years; 31 March 2012
Study area	India

Objectives of study

1. To develop a framework for web-based information for major and important lakes in India.
2. To compile the information related to major and minor lakes of India.
3. To use web as a platform for the dissemination of this information to the users.

Statement of problem and brief methodology

This study focuses on the development of a web based information system for major and minor lakes of India.

Today internet has been widely accepted as a medium of information exchange. Keeping this in view, the WEBLIS software is being developed on web plateform. The WEBLIS is being developed to provide information regarding the various hydrological and limnological aspects of the lakes of India. All the available information on various lakes are being gathered and provided in the system. The lakes have been arranged state wise, and within a state district wise. Available information related to location (latitude / longitude), morphology and morphometry, water uses, type of origin and historical significance, physical characteristics, biological characteristics, thermal regime, water quality characteristics, thermal regime, sedimentation, water balance, lake dynamics etc would be included. Information on environmental status of the lake and the major problems/environmental threats and conservation measures undertaken/being undertaken to the lakes would also be incorporated.

Action plan

Year	April – Jun	Jul - Sep	Oct - Dec	Jan - Mar
2010-11	Planning the design of the Information system and development of the framework	Preparation of clickable map of India showing different states Review of literature	Preparation of clickable map of Rajasthan showing lakes of Rajasthan Review of	Review and Compilation of information related to 15 lakes of Rajasthan and

	Review of Literature		literature	about 20 other lakes of India
2011-12	Review, compilation and incorporation of the literature/ material to lake hydrology in the system	Preparation of clickable maps of MP, Uttarakhand, J & K, Punjab, Haryana and HP. Review and compilation of literature related to lakes of MP, Uttarakhand, J & K, Punjab, Haryana and HP.	Preparation of clickable maps of AP, Maharashtra, Karnataka, TN, Kerala etc. Review and compilation of literature related to AP, Maharashtra, Karnataka, TN, Kerala etc	Final testing, debugging and installation of Lake Information System

Recommendation/suggestions in previous meetings of Working Group / TAC / GB

S.No	Suggestions of Working group members	Action Taken
1.	Dr Kimothi informed that MOEF has prepared a comprehensive inventory of wetlands	The literature survey was done and it was found that NIH's WEBLIS system is different than the inventory of MOEF as MOEF's system is based on remote sensing and gives only the area covered by the wetlands. It gives very less information about other details of the lakes. Attempts are being made to make WEBLIS as unique system by making it web based / online system. Besides the general and technical information about the lakes, the WEBLIS has been designed to give information about various aspects of limnology, lake hydrology, lake conservation and management. It will provide information about the various organizations working in the area of lake research and conservation, as well as a dictionary about the lake related terms. It also provides information about lake related issues such as the National Lake Conservation Programme of MOEF, RRR programme of MOWR etc.
2.	Dr Gurunad Rao opined that information about lake catchment map should be included in the system	If available, they will also be incorporated in the system
3.	Dr Jaya Kumar informed that a lot of information has been compiled by the CWRDM. The PI was asked to contact CWRDM	CWRDM has been contacted for providing the information. Moreover, information about three lakes of Kerala has been collected from other sources. The entire information will be incorporated into the system.
4.	Sri N Y Apte suggested providing metadata	The metadata information will be provided at proper places

	information in the system.	

Achievements

Year	Objectives (for the period April 2010 - March 2011)	Achievements
2010-11 and 2011-12	1. Planning the design of the Information system and development of the framework	Achieved
	2. Preparation of clickable map of India showing different states	Achieved
	3. Preparation of clickable map of Rajasthan showing lakes of Rajasthan	Achieved
	4. Review and Compilation of information related to 15 lakes of Rajasthan and about 20 other lakes of India	Achieved
	5. Review, compilation and incorporation of the literature/material to lake hydrology in the system	Achieved
	6. Preparation of clickable maps of MP, Uttarakhand, J & K, Punjab, Haryana and HP.	Achieved
	7. Review and compilation of literature related to lakes of MP, Uttarakhand, J & K, Punjab, Haryana and HP	Achieved

Analysis and Results

On similar lines the information is being collected and is being coded.

The web based system intends to provide information regarding the various hydrological and limnological aspects of the lakes of India. Available information related to location (latitude / longitude), morphology and morphometry, water uses, type of origin and historical significance, physical characteristics, biological characteristics, thermal regime, water quality characteristics, thermal regime, sedimentation, water balance, lake dynamics etc are also being included. Information on environmental status of the lake and the major problems/environmental threats and conservation measures undertaken/being undertaken to the lakes are also being incorporated. The main screen of the software is shown in Fig.2.

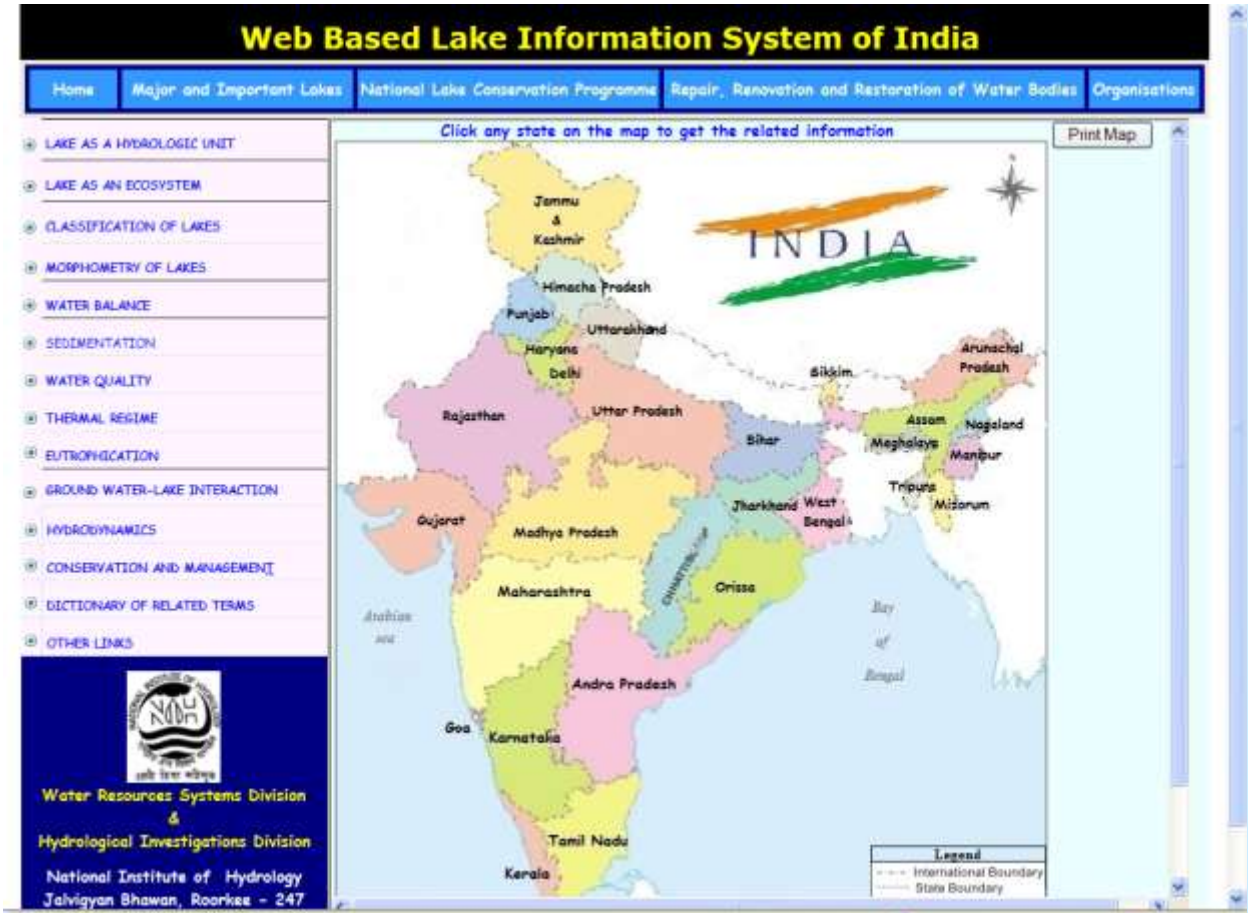


Fig. 2 : Main Screen of WEBLIS

Efforts are also being made to provide information related to the various studies carried out on the lakes so far, bibliography of the research carried out on the lakes till date. List of the various central government, state government, local bodies, academic Institutes and NGO's which are involved in conservation, management or research is also being provided. If needed, external links (if any) for other related information, would be included. It is also planned to include a mini dictionary of the important terms related to Lake Hydrology and Limnology for the ready reference of the users, in the proposed information system.

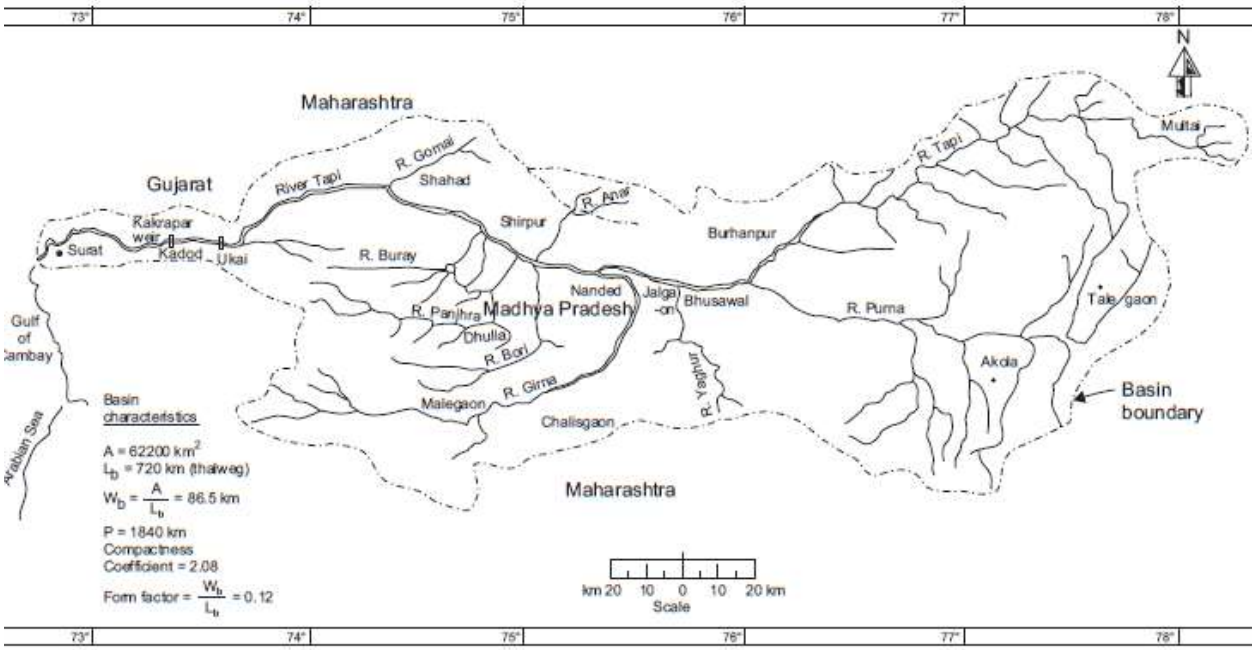
Deliverables

Web-based information system on NIH website
Report and technical papers

3. Analysis of water management scenarios in Tapi River basin using MIKE Basin (Research study)

Study group	Rama Mehta, Scientist C (PI) M. K. Goel, Scientist F (Co-PI) D. S. Rathore, Scientist E2 (Co-PI)
Type of study	Internal
Date of start of study	01 April 2010
Duration and scheduled date of completion of study	03 years; 31 March 2013

Location map/study area:



Objectives of study

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

Statement of problem

Tapi river basin modeling for water management issues using Mike Basin Software.

Approved action plan

Work	First year 2010-11	Second year 2011-12	Third year 2012-13
1. Identification of water resources issues and 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. **4.** Mike basin modeling for Tapi basin with all sub-basins outputs.		<….>	
1. Analysis of different water management scenarios 2. report writing and paper publication			<…>

Recommendation / Suggestions in previous meeting of working group/ TAC/ GB

Recommendation/Suggestion	Action Plan
Mr. Rishi Srivastava, Deputy Director from CWC suggested that there is major problem of flood control in the Surat city which is downstream of Ukai dam. Is it possible to extend this study area upto Surat.	The matter was deliberated at length and it was concluded that flood operation study for Ukai dam cannot be considered as a part of this study because of hourly time step consideration. However if required, this study can be subsequently taken up for flood operation analysis of Ukai dam.

Achievements

Objectives (for the period April 2010- March 2011)	**Achievements**
1. Identification of water resources issues and other information in the study area.	1. There is a great flood problem at downstream of this basin at Ukai dam, so water management through existing reservoirs is a big issue for this basin.
2. Collection of data for sub-basins from concern states/ NTBO.	2. Data collection is in progress
3. Study of the model for its input data.	3. Preparation of input data files (Dfso files) are in progress

Objectives (for the period April 2011-Oct. 2011)	Achievements
4. Collection of relative data for study from NTBO office, Surat.	4. A CD has been received from Surat. It contains Rainfall, discharge (for few sites), water level, and other hydrological information for some areas as Bhusawal, Burhanpur, Chikaldhara, Dahigaon & Dapori etc. For so many sites, rainfall data is available but no discharge data.
5. Data files preparation (dfso input files) for all sub-basins in Tapi basin according to the Mike basin requirement.	5. Data has been analyzed and used to prepare the input files as required by the software.
6. Rainfall runoff modeling for each sub-basin using NAM model.	6. Rainfall-Runoff modeling has been done for the sites where rainfall & discharge is available.
7. Mike basin modeling for Tapi basin with all sub-basins' outputs.	7. In progress.

Analysis & Results

Will be presented in the Working Group meeting.

Adopters of the results of the study and their feedback

NTBO, State Agencies: Maharashtra, Gujarat, Madhya Pradesh

Deliverables:

Research papers and report.

Data generated in the study

The hydrological and meteorological data is to be collect from the concerned divisions of NTBO offices in M.P., Gujarat and Maharashtra. Correspondence is in progress.

Study benefits/Impacts

The Study will give a better idea about Water Management Scenario of Tapi River Basin.

Future Plan

Knowledge of Mike basin software and its applications for Tapi basin for water management can be used for other river basins in India.

Manpower used	Second year
Rama Mehta (PI)	Data collection from NTBO (Gujarat and Maharashtra); Data analysis; Preparation of dfso input files; Model calibration and validation
ManMohan Goel (CO-PI)	Model calibration and validation
D.S. Rathore (CO-PI)	Model calibration and validation

4. Development of analytical equation for alternate depths for flow in rectangular channels (Research study)

Study group Sushil K. Singh**,** Scientist F

Date of start of study 01 April 2011

Duration and scheduled date of completion of study 01 year; 31 March 2012

Type of study Internal

Objectives of study

1. To develop analytical equation/solution for obtaining alternate depths in rectangular open-channels.
2. To illustrate and demonstrate the practical application of the developed analytical equation for solving hydrologic problems.

Statement of problem and brief methodology

Solution to problems concerning transition in the width and bottom of the channels requires computation of alternate depths.

Alternate depths are defined as the depths of flow in open channels for which the specific energy is the same. The objective is intended to be accomplished by analytically solving the relevant equation.

Action plan

Activity	I-Quarter	II-Quarter	III-Quarter	IV-Quarter
Review of literature and identification gaps				
Development of analytical solution/equation				
Application and illustrated examples				
Preparation of report				

Achievement/progress

Expected outcome:

1. A handy and analytical equation for easy and direct computation of the alternate depths.
2. It would be helpful in practical studies dealing with the open-channel flows, especially in the cases of transitions in width and bottom elevation of the channel.

Progress:

1. Review of literature has been completed and gaps have been identified.
2. Development of an analytical equation/solution for alternate depth is in progress.

Analysis and results

To be presented in the Working Group meeting

Adopters of the results of study and their feedback

Practitioners, field engineers, and academic personals.

Deliverables

Research report detailing the developed equation and research papers.

5. A transfer function model for event based runoff (Research study)

Study group Sushil K. Singh, Scientist F

Date of start of study 01 April 2011

Duration and scheduled date of completion of study: 01 year; 31 March 2012

Type of study Internal

Objectives of study

1. To identify the transfer function (TF) for event based runoff modeling.
2. To estimate the event based runoff using the identified TF, and to illustrate and demonstrate its usefulness in solving practical hydrologic problems.

Statement of problem and brief methodology

Event based rainfall runoff modeling has been a concern for practitioners, field engineers, and academicians.

1. A transfer function model is intended to be developed and its parameters are to be estimated. The TF model then would be ready for the estimation of event based runoff.
2. Published authentic field data (multiple-storm data) from different catchments are intended to be used for the illustration and assessment of the performance of the developed model.

Action plan

Activity	I-Quarter	II-Quarter	III-Quarter	IV-Quarter
Review of literature and identification gaps				
Development of transfer function approach and estimation of its parameters				
Application and analysis of results				
Preparation of report				

Achievement/Progress

Expected outcome:

1. A transfer function (TF) model/approach for modeling event based runoff.
2. The developed model would be useful in practical studies dealing with the assessment and prediction of runoff due to a complex or critical rainfall event.

Progress:

1. Review of literature and identification of gaps is complete with z-transform/backward-shift-operator to be used as transfer function modeling of runoff.
2. Identification of the parameters of transfer function using published data is in progress

Analysis and results

To be presented in the Working Group meeting.

Adopters of the results of study and their feedback

Practitioners, field engineers, and academic personals.

Deliverables

Research report detailing the methodology and research papers.

6. Trend and variability analysis of Rainfall and Temperature in Himalayan region (Research Study: New study)

Study Group L. N. Thakural, Sc-B, PI
Sanjay Kumar, Sc-E1, Co-PI
Sanjay Kumar Jain, Sc-F, Co-PI
Tanveer Ahmed, PRA, Co-PI

Type of study Internal

Date of start of study October 2011

Duration and scheduled date of completion of the study 03 years**;** 30 September 2014

Objectives of the study

The objectives of the study are:

1. Database creation for the Himalayan region.
2. Descriptive and inferential statistical analysis of climatic parameters
3. Parametric approach for trend and variability analysis
4. Non-parametric approach trend and variability analysis

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 on monthly, seasonal and annual time scale.

End users/beneficiaries of the study

Academicians, state and central government departments.

Action plan

S. No.	Major Activities	1st Year		2nd Year		3rd Year
1	Literature review					
2	Data collection & preparation for analysis					
3	Descriptive & inferential statistical analysis of time series of rainfall and temperature					

4	Analysis using parametric approach				
5	Analysis using non-parametric approach				
6	Preparation of report**		Part-1	Part-2	Part-3

** Reports: Part-1- Descriptive & inferential statistical analysis of time series of rainfall and temperature
Part-2- Analysis using parametric approach
Part-3- Analysis using non-parametric approach

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. The trends and variability analysis of rainfall and temperature time series would be evaluated using the following statistical techniques for various time scales.

1. Descriptive & inferential statistical analysis of time series rainfall and temperature
2. Parametric approach for trend and variability
3. Mann-Kendall test and Sens's estimator of slope method (non-parametric) for trend and variability.

Data requirement

Daily rainfall and temperature time series. Expected source of data are IMD, BBMB, state departments, websites.

Deliverables:

- Research papers
- Report

7. Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin (PDS under HP-II)

Study group Dr. S. K. Jain, Scientist F
Dr. Bhism Kumar, Scientist F
Dr. S. P. Rai, Scientist E1
Mr. L. N. Thakural, Scientist B

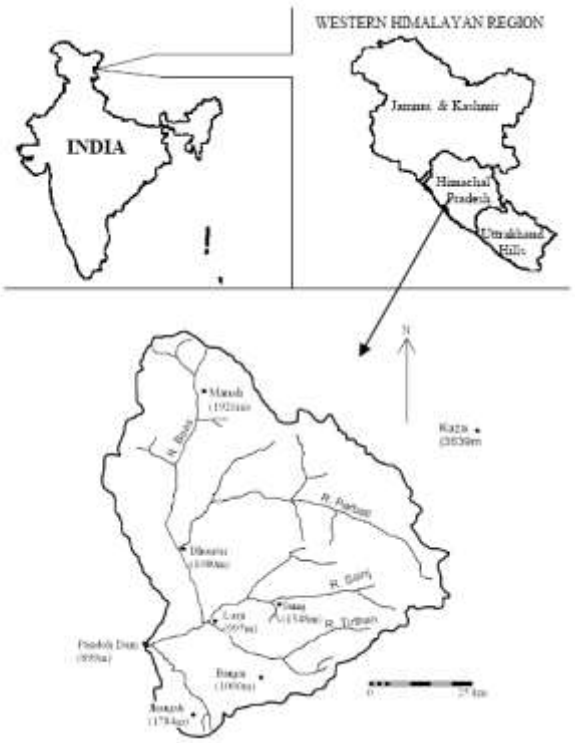
Role & Responsibilities
Snowmelt Runoff Modeling (Dr. S. K. Jain/Mr. L. N. Thakural)
Sampling from the field and Isotopic analysis (Dr. Bhishm Kumar/Dr. S..P.Rai)
Trend Analysis of Temperature/Rainfall/Discharge (Mr. L. N. Thakural/Dr. S. K. Jain)
Generation of GCM/RCM Scenarios for Climate Change Impact Studies (Dr. S.K. Jain/Through Consultant)

Type of study PDS under HP II

Date of Start 01 April 2009

Duration of study and scheduled date of completion 03 years**;** 31 March 2012

Location map / study area



Objectives

To create spatial data (consisting of snow cover area and DEM) and meteorological/hydrological data base for the study area

5. To create spatial data (consisting of snow cover area and DEM) and meteorological/hydrological data base for the study area

6. To estimate snow cover area and its temporal variation using remote sensing data.
7. To estimate snow melt runoff in Beas River at Pandoh dam.
8. 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.
9. To study major ion chemistry (Ca, Mg, K, Na, SO_4, Cl, HCO_3, NO_3,) of winter snow, summer rainfall, ice core and meltwater in the river flows.
10. To study trend of precipitation, temperature and stream flow in Beas basin using parametric and non parametric approaches, and
11. To investigate the impact of likely future changes in climate on stream flow in the study area using GCM/RCM based scenarios.

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.

Approved action plan

Approved work plan is as follows (initially proposed 4-year plan was later rescheduled to 3-year ending in the year 2011-12).

Activity	Year 1	2009-10	2010-2011	2011-12
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	← →			

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

There was no specific recommendation pertaining to the study.

Achievements

Year	Objectives (from April 2011 to September 2011)	Achievements
2010-11 2011-12	i) Analysis of data and trend analysis ii) Creation of data base in GIS iii) Simulation of snowmelt runoff model iv) Generation of climate change scenarios v) Samples collection from the field vi) Analysis of samples	Partially achieved Achieved Achieved Under process Completing by the end of October 2011 Partially achieved

Analysis and Results

Trend analysis of rainfall, runoff and temperature has been carried out using regression analysis, ManKendall and Sen's interpreter. 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 trend analysis have been completed. The simulation of stream flow at three sites in the basins has been completed. In this study, sample collection for river discharge, rain, and snow was started from January 2010 at five sites in 20 ml bottle for carrying out isotope analysis. From April onwards, sample collection has been started on daily basis. Till August 2011, more than thousand samples have been collected on different five sites. Beside these, more than samples in 1 liter bottle at 15 days intervals for each site have also been collected. For carrying out isotopic analysis, samples have been collected from a number of sites. Daily samples have been collected from all the sites for the period April 2011 to August 2011. A number of field visits in the past two years have been made. Analysis of samples in Nuclear Lab. is in progress. Isotopic analysis ($\delta 18O/\delta D$) of rainfall, snow, river water and ground water have been completed. Analysis of Samples collected in the year 2011 is under progress.

The results of the analysis will be presented during the meeting.

Adopters of the results of the study and their feedback

Bhakra Beas Management Board

Deliverables

Reports and research papers

Data generated in the study

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

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

(PDS under HP-II)

Study Group

Dr. Sanjay K. Jain, Scientist F
Dr. J.V.Tyagi, Scientist F
Mr. D S Rathore, Scientist E2
Mr. L N Thakural, Scientist B
Dr. Rama Mehta, Scientist C

Role & Responsibilities

1. Reservoir sedimentation rate in two reservoirs (Dr. S. K. Jain and Mr. D S Rathore)
2. Sediment-Discharge relationships using Rating curves (Dr. S. K. Jain & Dr. J V Tyagi)
3. Sediment-Discharge relationships by soft computing techniques (Dr. Rama D. Mehta)
4. Application of Arc SWAT model for sediment yield assessment (Dr. J. V. Tyagi, Dr. S.K.Jain and Mr. L. N. Thakural)

Type of study PDS under HP II

Date of start of study 01 April 2009

Duration and schedule date of completion 03 years**;** 31 March 2012

Location map / Study area

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.

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.

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

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

There was no specific recommendation pertaining to the study.

Achievements

Year	Objectives (for the period April 2011 – September 2011)	Achievements
2010-11	i) Analysis of data and sediment rating curves	Partially achieved
2011-12	ii) Creation of data base in GIS	Partially achieved
	iii) Processing of satellite data	Landuse maps have been prepared
	iv) Assessment of sediment rate	Achieved
	v) Modeling of sediment yield	Under process

Analysis and results

All the meteorological data have been taken from BBMB. Satellite data for both the catchments i.e. Satluj up to Bhakhra and Beas up to Pong have been procured from NRSC, Hyderabad.

Daily rainfall, temperature, sediment and stream flow data of these two basins have been collected up to December 2009. Sediment discharge relationships for both the basins 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. Processing of satellite data has been completed. Sedimentation rate using remote sensing data have been completed. Land use map have been prepared. Land use map, soil maps, DEM etc. have been converted into Arc SWAT format for sediment yield modeling. A test run for the study has been taken. The progress will be presented in the meeting.

Adopters of the results of the study and their feedback

Bhakra Beas Management Board

Deliverables

Reports and research papers

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.

9. Hydrological assessment of ungauged catchments (small catchment)

(PDS under HP-II)

Study group

Principal Investigator (PI):		Dr. Pradeep Kumar Bhunya, Sc. E1
Co-PIs	:	Dr. Rakesh Kumar, Sc. F & Head (Surface Water Div.)
Investigators :	(i)	Mr. D S Rathore, Sc. E2, WRS Div.
	(ii)	Dr. Sanjay Kumar, Sc. E1, Surface Water 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

Representative Nodal Officer from Govt. Of Orissa :

(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.

Type of study PDS (Under HP-II)

Date of start of study May 2009

Duration of the study and scheduled date of completion 03 years (2009-2012); May 2012

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.

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.

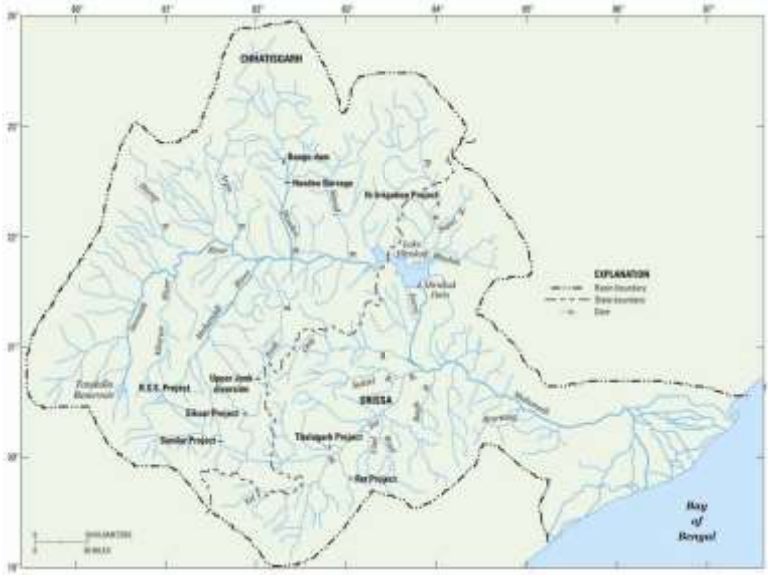


Figure: Mahanadi basin in *Orissa* and *Chatisgarh* states.

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

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.
4. Recommend a standard POT method for return period flood computation when the annual maximum series is short.
5. Regional flow duration curve to estimate the dependable flows for the ungauged catchment.
6. A menu driven software to accomplish the above works.

The bar chart for scheduled action that is being followed is as follows:

Sl	**Technical Component**	**Technical Activity**	**09-10**		**10-11**		**11-12**	
			1	**2**	**1**	**2**	**1**	**2**
1.	Literature survey and watershed identification and data collection.	Literature survey (PKB, RK, DSR)						
		Watershed survey (PKB, Project staffs)						
		Collection of historical data and primary investigation and verification of data (PKB, PCN, and Project staffs)						
2	Analysis of GIS data	Collection of satellite imageries, toposheets (SOI) (PKB, DSR)						
		Digitization of data, analysis, interpretation, and reporting of results (PKB, DSR)						
3	Model application	Processing and application of available models to storm data (PKB, RK, SK, PCN and project staffs)						
		Programming & model application analysis using available storm and flood data. (PKB, RK, SK, PCN and project staffs)						
		Interpretation & reporting of results(PKB, RK, DSR, SK, PCN)						
4	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)						
5	Application of	Available model understanding (PKB, RK)						
		Programming & model application (PKB)						

	recent SUH models	Analysis, interpretation & reporting of results(PKB, RK, SK)							
6	Application of allied hydrological models.	Model development (PKB, RK, SK)							
		Programming & model application (PKB)							
		Analysis, interpretation & reporting of results(PKB, RK, DSR, SK, PCN)							
7	Development of a user interface software (hiring consultancy firms) (PKB, RK)								
8	Final report	Summarization of results & reporting(PKB, RK, DSR, SK, PC and project staffs)							
9	Dissemination of outcome	Three training courses have been organized and one is proposed at Bhubaneswar (PKB, RK, DSR, SK, PC and project staffs)							

Completed

To be done

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.

Recommendations in the last WG meeting

There was no such critical suggestions and recommendations from the working group

Achievements

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. and add some results from Brahmani and Rushukulya basins, which are nearby Mahanadi basin.
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*
3. A detail results regarding the morphological parameters, and their variations (regional) for the Mahanadi small catchments from imageries interpretation has been used for GIUH. Using GIS, and available toposheet, multiple map overlays were prepared for matching the geomorphic and basin characteristics and their corresponding changes. This was in addition to the earlier regions (catchments). In addition, renaissance survey were conducted with field visits. Land-use conditions including change in geomorphology, was studied using a sweep method to view both the imagery and respective toposheet in Arc-GIS.
4. 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.

5. Developed the rating curves regional flow duration curves with the recently procured data. This was for nine GD sites.
6. *AMS and POT methods* have been used *testing robustness*. This is *for the available flood data* in the region.
7. Development of a menu driven software (by consultants) is being initiated for getting it done in the last phase.

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 requests of some of the participants, a training course on such allied topics has been discussed with Director (Hydrometry), Bhubaneswar and proposed during this year in Orissa.

Results achieved during this period (Feb 2011- Oct 2011)

The data length wise runoff (daily, monthly average) in time terms has been added to earlier records that was collected during tours from state hydrometry, and CWC Bhubaneswar. Processing of streamflow and gage data has been completed for twenty two GD sites. Using GIS, and available toposheet, multiple map overlays were prepared for matching the geomorphic and basin characteristics and their land-use conditions including change in geomorphology using a sweep method to view both the imagery and respective toposheet in Arc-GIS. This was done for an additional five small catchments. Two major objectives i.e. rating curves has been completed for additional nine small catchments. This was done using four methods; they are Grigorton, Weibull, Blom's and CWC guidelines that was used earlier in their reports. For the above sites flow duration curves have been completed as per CWC guidelines and regionalized parameters have been evaluated.

With the recently procured data, two works have been completed i.e. (i) to refine the previous results of regional heterogeneity and discordant tests, and (ii) SUH development using short-term flood events for use in hydrograph derivation and, along with the UH parameters in regional scale. A letter for consultancy support under PDS (HP-II) has been submitted earlier, and seven interests of firms /Institutes have been proposed. Since this activity has been planned for the last phase in the project period, the letter of interest for the consultancy support works proposed shall be sent to firms by this year end. This includes encamping sub-programs (sub-computation) dealing vitally for developing a user-friendly tool for the PDS. In addition to these, revised hydrological equipments sanctioned by the Ministry have been received last month, and a tour is being planned shortly for their use for certain events.

Adopters of the results of the study and their feedback

Ministry of Water Resources under Govt. Of Orissa, and CWC, New Delhi.

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.

Data generated in the study

Type of data	Stations / basins	source
Gauge and Discharge data (daily time scale)	23 small catchments on Mahanadi (3d sub-zone) for 34 years (1957-1987) and collected data from 22 sites for the year 1970-2008 viz: *Indupur, Kharaimal, Jenapur, Naraj, Pamposh, Rengali, Talcher, Tikerpada, Akuapada, Alipingal, altuma, Sukma, Champua, Gomlai, jamadarpali, Jharaikela, Kantmal, Keonjhar, Kesinga, Parmanpur, Salebata, Sundergarh*	(i) CWC reports for sub zones, (ii) CWC office, Bhubaneswar, (iii) Directorate (Hydrometry) office, Bhubaneswar
Discharge data (AMS) and G & D data	20 stations on Mahanadi and Brahmani with prominent GD sites are: Tikarpara, Sukuma, Kantamal,Kesing,Pandigaon,Salebhata,Sundergarh	Department of Hydrometry, Govt. of Orissa, and Irrigation department
Discharge data (AMS)	Peak flow data of 3a, 3b, and 3f sub zones	CWC reports for sub zones
Peak hourly - runoff data during floods	23 small catchments on Mahanadi along with 10 other streams	Department of Hydrometry, CWC
Geomorphological data like L, Lc, A and slope	23 small catchments on Mahanadi	(i) CWC reports for sub zones. (ii) SOI toposheets (iii) RS imageries
Rainfall data	Daily maximum and annual for Mahanadi region.	Reports from Department of Hydrometry,

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.

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.

10. Vetting of water availability studies of the gulf of khambhat development project (Kalpasar Project) (Consultancy project)

Study Group	M. K. Goel, Scientist F Vijay Kumar, Scientist E2 (on lien)
Type of study	Consultancy
Start Date	29 April 2010
Scheduled date of completion	31 December 2011.

Location map/study area

The Kalpasar project visualizes a gigantic fresh water lake-dam to be created by closing the Gulf of Khambhat (in the Arabian Sea) and thereby harness the excess water of Narmada, Mahi, Sabarmati, Dhadar rivers and other small rivers for generating tidal power, irrigation, drinking and industrial purposes. A road link will also be set up over dam to reduce the distance between Saurashtra and South Gujarat.

Objectives of the study

The objective of the present study is to review the water availability study of Gulf of Khambhat Development Project carried out by the Central Designs Organisation (CDO), Govt. of Gujarat. The envisaged objectives are:

1. To check the database development for the study.
2. To check the methodology adopted in the study, computational steps, model runs taken, and the results obtained.

11. Glacier Lake Outburst Flood (GLOF) study for Jelam tamak (THDC India Ltd.) (Consultancy project)

Dr. Sanjay K Jain, Sc. F, Dr. AK Lohani, Sc. E2, Mr. L N Thakural, Sc. B, Mrs. Anju Chaudhary, SRA, and Mr. Tanvear Ahamd, PRA.

The present study deals with the estimation of GLOF for Jelam Tamak H.E. Project.

12. Snowline estimation, snowmelt runoff study and Glacial Lake Outburst Flood study for Chamkharchhu H.E. Project in Bhutan (NHPC, Faridabad)

(Consultancy project)

Dr. Sanjay K Jain, Sc. F (PI), Dr. A. K. Lohani, Sc. E2, Mr. L. N. Thakural, Sc. B, Mrs. Anju Chaudhary, SRA

In the present study snow cover area in the basin have been prepared using remote sensing data and snowmelt runoff modeling have been carried out. An inventory of glacier and glacial lakes has been prepared using remote sensing data. Potential dangerous lake has been identified and estimation of GLOF has been carried out.

13. Snowline estimation snowmelt runoff study and Glacial Lake Outburst Flood study for Kuri-Gongri H.E. Project in Bhutan (NHPC, Faridabad)

(Consultancy project)

Dr. Sanjay K Jain, Sc. F (PI), Dr. A K Lohani, Sc. E2, Dr. Sudhir Kumar, Sc. F,

Mr. L N Thakural, Sc.B, Mrs. Anju Chaudhary SRA and Mr. Tanvear Ahamd, PRA.

In the present study snow cover area in the basin have been prepared using remote sensing data and snowmelt runoff modeling have been carried out. An inventory of glacier and glacial lakes has been prepared using remote sensing data. Potential dangerous Lake has been identified and estimation of GLOF has been carried out.

RESEARCH COORDINATION AND MANAGEMENT UNIT

NATIONAL INSTITUTE OF HYDROLOGY

ROORKEE – 247 667

NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE – 247 667

1. **Title of the study:**

   Recession Flow Analysis for Evaluation of Spring Flow in Himalayan Region, India

2. **Name of PI, Co-PI, & their affiliations**

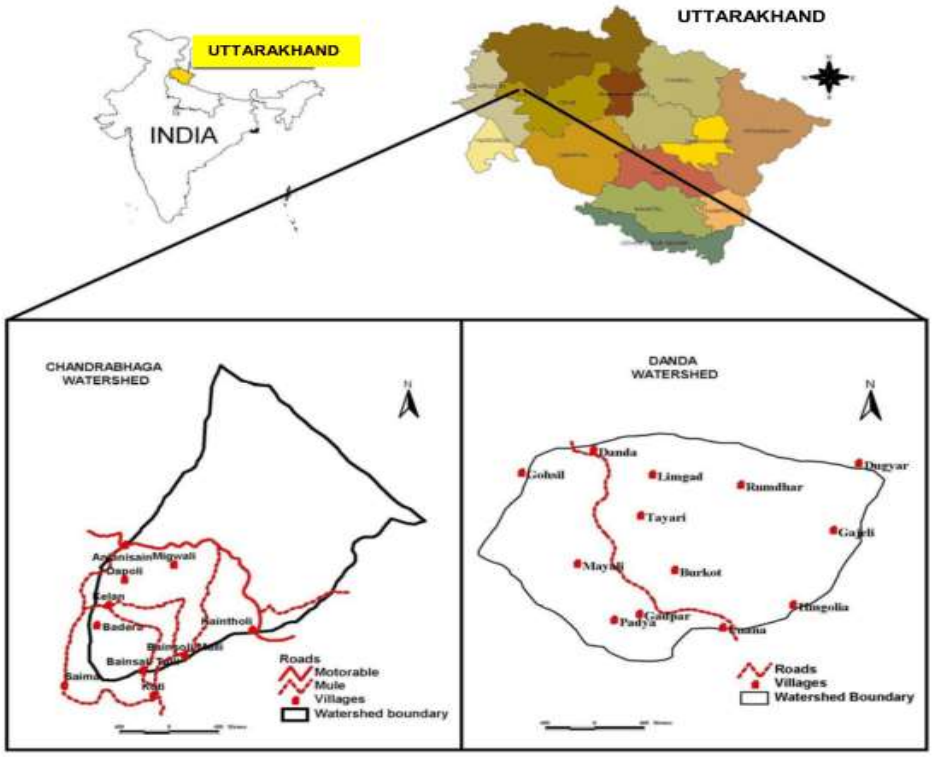
   PI: Dr. R. V. Kale, Sc B, RCMU
   Co-PI : Dr. V. C. Goyal, Sc F and Head, RCMU

3. **Type of study:** Internal (NIH funded)

4. **Date of start:** April 2011

5. **Scheduled date of completion:** March 2013

6. **Location map:** The study is being carried out for two small watersheds in the State of Uttarakhand, India. In these Himalayan watersheds number of springs found which are reliable sources of, clean water supply for drinking and domestic use. The geographical location of these watersheds is shown in following map.



7. **Study objectives**

   I. To develop a technique to assess the reliability of the spring flow as a sustainable source of drinking and domestic water by analyzing the flow

characteristics

II. To assess the potential for springs development as a water source

8. **Statement of the problem**

Springs in the Himalayas, in the Western Ghats and other places in India are the main source of drinking water due to logistical difficulty in creating storage for water. In such areas, majority of spring are of small orders which become dry during summer months. Flow/discharges in such springs vary considerably depending on the catchment characteristics (e.g. area, hydrogeology) and recharge in the catchment. The knowledge about the number of springs as well as their flow characteristics is important in the sustainable development of the water resources of these areas. The study of spring flow analysis has relevance to the water supply to rural areas, specifically hilly areas. As in many locations, rural development agencies would like to develop water resources of the catchment but lack the necessary hydraulic information. Further, the measurement and prediction of spring flows in aquifers are critical to water resources managers to maintain preferred flows based on the effect that current and projected ground water withdrawals have on water levels. Subsequently, the assessment of spring flow using physically based model requires the knowledge of fundamental input parameters such as hydraulic conductivity, specific yield and effective hydraulic conductivity describing the subsurface hydrology which are most problematic to obtain. Since well-drilling to estimate hydraulic parameters is often prohibitively expensive in developing countries, recession flow analysis is a very cost-effective and accurate alternative.

9. **Approved action plan**

Action plan: The collected spring flow and rainfall data will be analyzed for continuity and consistency of the record. In next step, the model will be formulated and will be tested for its accuracy. Then, formulated model will be used for the recession spring flow analysis. The results of the analysis will be produced in the form of research publication, technical report and user manual for field organisations.

Time-line and justification for time over runs:

Period	Task to be completed
April, 2011 – Sep. 2011	Review of literature and collection and preprocessing of data
15th Sep, 2011 – 14th March, 2012	Model formulation and
15th March, 2012 – 15th March, 2013	data analysis Results preparation and report preparation

Role and Responsibility of Team Members:

i. **Dr R Kale, Scientist B & PI**: Model formulation, data processing and analysis, and overall responsibility for the study completion.

ii. **Dr V C Goyal, Scientist F & Co-PI:** Arrangement of data from previous studies, conceptual planning and insights for model evolution.

10. **Objectives vis-à-vis achievements (clearly separate achievements reported in the previous meetings)**

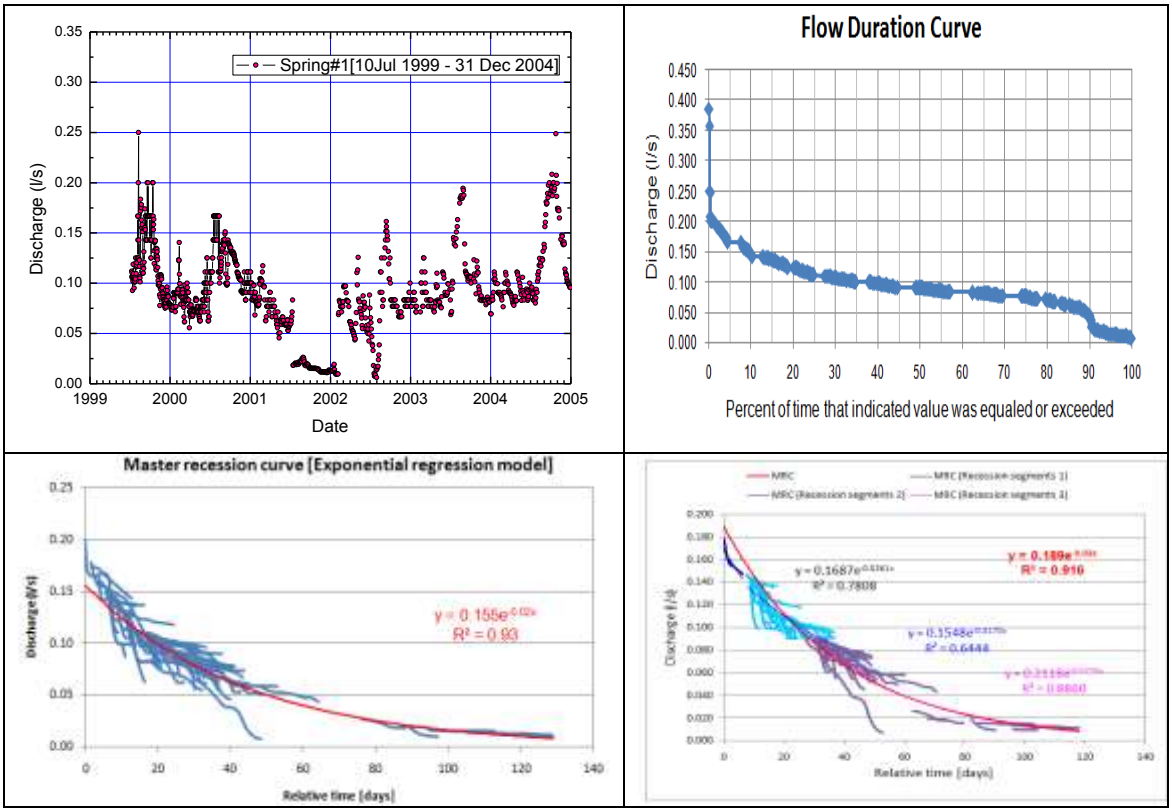
Objectives	**Acheivements**
1. To develop a technique to assess the reliability of the spring flow as a sustainable source of drinking and domestic water by analyzing the flow characteristics	• Review of literature is progress • Collection and preprocessing of required spring flow data and rainfall data • Work on the mentioned objective is in progress
2. To assess the potential for springs development as a water source	• To be undertaken

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

Recommendations/suggestions	**Action taken**
Regarding use of physically based methods for groundwater flow modelling, Dr. N. C. Ghosh suggested the use of Green-Ampt or Richard's equation	The objective of present study is to carry out the recession flow analysis based on the Boussinesq equation. The suggested methods may be tried during later stages of the study.

12. **Analysis and Results**

- The spring flow and rainfall data for 20 springs in Chandrbhaga Watershed and 30 springs in Danda watershed has been obtained from previous studies. These time-series data sets have been checked for consistency and accuracy of the records.
- Time-series spring flow data is available on daily basis from July, 1999 to Feb., 2001 daily while from 20 Feb, 2001 to 31 Dec., 2004 once in two days spring flow data is available.
- The recession flow analysis for these data sets has been carried out using fully automated objective-based method (adapted matching strip method) for Master recession curve separation
- Typical results obtained for one of the spring flow data in Chandrabhaga watershed are shown in following figures.
- The parameters of recession equation obtained through this recession flow analysis will be used to identify the storage and aquifer characteristics during course of the study.
- The other details along with interpretation of the data will be presented during the meeting.



13. **Adopters of the results of the study and their feedback**

    N.A. at present

14. **List of deliverables** (e.g. equipment, papers, reports, softwares, manuals, brochures, flyers, training programmes, users interaction workshops)
    a) Papers
    b) Report

15. Major items of equipment procured : NIL

16. Lab facilities used during the study: NIL

17. Data procured and/or generated during the study

The following are the data requirement for the analysis of spring flow data using recession flow model

a) Daily precipitation and spring flow data
b) Information on catchment characteristics

These informations have been collected from previous study reports by NIH

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

Measurable indicators	Expected achievements
New technologies/processes	This study will provide improved methodology for analysis of spring flow data series in order to analyze the water resources availability in the study region.
Improvement in skill	It is expected

15. **Specific linkages with Institutions and/or end-users/beneficiaries**

NIL

16. **Shortcomings/difficulties, if any**

Nothing specific

17. **Future plan**

To be evolved at later stages of the study.