

**MINUTES OF THE  
35<sup>TH</sup> MEETING OF WORKING GROUP OF NIH  
HELD AT NIH, ROORKEE, DURING OCTOBER 11-12, 2011**

The 35<sup>th</sup> meeting of the Working Group of NIH was held at NIH, Roorkee, during October 11-12, 2011 under the Chairmanship of Director, NIH. The list of the participants of the meeting is given in **Annexure-I**.

**ITEM NO. 35.1: OPENING REMARKS BY THE CHAIRMAN**

The Chairman, WG welcomed the Working Group members and the Scientists of the Institute. He apprised the members on the organizational structure of NIH, and on the role of Working Group in the technical programme of the Institute. The Chairman mentioned that based on the recommendations of the Technical Advisory Committee (TAC), the Working Group composition has been revised, and this is the first meeting of the reconstituted Working Group.

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

<b>S N</b>	<b>Member</b>	<b>Suggestion(s)</b>
1	Sh. R C Jain	<ul style="list-style-type: none"> <li>▪ Emphasized on the need of studies for sustainable aquifer management, in terms of conservation and augmentation of ground water.</li> <li>▪ Assessment of deeper aquifers.</li> <li>▪ Issues related to aquifer pollution and remediation needs to be addressed on priority basis.</li> <li>▪ Involvement of local people as well as civil organization is needed for achievement of sustainable ground water management and accordingly strategies needs to be chalked out.</li> </ul>
2	Sh. R M Bhardwaj	<ul style="list-style-type: none"> <li>▪ Demand driven economic and water consumption pattern are going to change drastically which should be addressed properly with emphasis on water quality aspects.</li> <li>▪ We need a vision document to indicate how to manage water resources as per the need of population in the year 2050.</li> </ul>
3	Dr. Kishore Kumar	<ul style="list-style-type: none"> <li>▪ Creation of reliable database using modern technologies such as ICT.</li> <li>▪ Development of government to community interface.</li> </ul>
4	Dr. R. Krishnan	<ul style="list-style-type: none"> <li>▪ IITM is using high resolution climatic models and the data of these models can be used in river basin simulation modeling to assess the impact on runoff under different climate scenarios. He expressed his</li> </ul>

		<p>desire to collaborate with NIH in these studies.</p> <ul style="list-style-type: none"> <li>▪ He informed that IITM has started training in climatic sciences for B. Tech, M. Tech and PhD students. During these trainings, interested scientists from NIH may also participate.</li> </ul>
5	Dr G P Juyal	<ul style="list-style-type: none"> <li>▪ Mentioned the need of studying hydrology of landuse changes</li> <li>▪ Work for rejuvenation of water sources.</li> </ul>
6	Sh. A K L Asthana	<ul style="list-style-type: none"> <li>▪ Studies on glacier water management and hot water streams in Himalaya need to be undertaken.</li> </ul>
7	Dr. R K Goyal	<ul style="list-style-type: none"> <li>▪ Studies on arid-zone hydrology; flash flood management; and improvement of water quality need to be undertaken.</li> </ul>
8	Dr. M P Singh	<ul style="list-style-type: none"> <li>▪ Need to investigate impact of land use and land cover changes on various hydrological processes.</li> </ul>
9	Dr. V V Rao	<ul style="list-style-type: none"> <li>▪ Emphasized on the need of studies related to urban hydrology.</li> <li>▪ Studies on climate change and required adaptation strategies.</li> <li>▪ Micro-level groundwater studies.</li> <li>▪ Collaborative studies with IITs and other academic institutes needed.</li> <li>▪ Studies should be undertaken on water productivity and water fingerprinting.</li> </ul>
10	Er. Ravindra Kumar	<ul style="list-style-type: none"> <li>▪ Water resources development and management projects should address various environmental concerns.</li> <li>▪ Assessment of irrigation potential for Himalayan regions and reuse of river water should be undertaken.</li> <li>▪ Storm water management should get priority in National Water Mission.</li> <li>▪ Need to give more emphasis to Ganga basin management plan.</li> </ul>
11	Sh. Niladri Naha	<ul style="list-style-type: none"> <li>▪ Studies on drought management and coastal water management need to be undertaken.</li> </ul>
12	Sh. B.M. Murali Krishna Rao	<ul style="list-style-type: none"> <li>▪ He explained about the problem of ground water in hard rock regions such as in Andhra Pradesh.</li> <li>▪ He emphasized on the need of studies on integrated approach in alluvial and hard rock region basins, ground water exploitation, establishment of rainfall and ground water recharge relationships, Water balance, soil and water salinity, pollutant transport etc.</li> <li>▪ Need of guidelines on pumping of ground water quantity to stop sea water intrusion into coastal aquifer.</li> <li>▪ Need to investigate aquifer parameters for deeper aquifers, and studies for establishment of relationships on depth versus storage, and depth</li> </ul>

		<p>versus quality.</p> <ul style="list-style-type: none"> <li>▪ He informed that his department has collected lot of ground water data and they are interested in collaborative studies with NIH.</li> </ul>
13	Prof. J S Rawat	<ul style="list-style-type: none"> <li>▪ Studies on water availability in non-glacial fed rivers in Himalayan region.</li> <li>▪ Hydrological studies in landslide prone areas.</li> <li>▪ Groundwater augmentation and recharge in headwater regions.</li> <li>▪ Hydrological studies in rainfed areas.</li> </ul>
14	Prof. K.C. Patra	<ul style="list-style-type: none"> <li>▪ Advocated the opening of the climate change centre to study impacts of climate change on hydrological processes. Dr V C Goyal informed that a centre already exists at NIH, which will be further strengthened during the 12<sup>th</sup> Plan.</li> <li>▪ He suggested providing a list of scientists under different Divisions along with the agenda item.</li> </ul>
15	Dr. M. Perumal	<ul style="list-style-type: none"> <li>▪ NIH should concentrate more on development of physically based hydrological models.</li> <li>▪ Institute should significantly contribute for the development of hydrological science, and publications in peer-reviewed journals.</li> <li>▪ There is a need for organizing long term training certificate courses at par with IIRS, ISRO etc. for dissemination of knowledge to field organizations.</li> </ul>
16	Dr S S Grewal	<ul style="list-style-type: none"> <li>▪ He argued that there is need to identify end user of the studies.</li> <li>▪ Need of making policy changes based on the results achieved through the research studies. There should be proper link between line departments and R&amp;D institutes to address policy issues properly.</li> <li>▪ Need of studies on changing hydrology in light of interventions due to hydro-electric power projects, widening of roads etc., in Himalaya region.</li> <li>▪ Studies on impact of watershed development on hydrological changes, and the environmental impact assessment in Himalaya region.</li> <li>▪ Integrated water management approach should be addressed in national programs like MGNREGA with the help of rural development departments.</li> <li>▪ Need for development of technology/mechanism for pond water use in irrigation management.</li> </ul>
17	Dr Ritesh Arya	<ul style="list-style-type: none"> <li>▪ Development of model for ground water assessment in Himalayan region.</li> <li>▪ Development of environmental hydrology and protection of water bodies.</li> </ul>
18	Dr A J James	<ul style="list-style-type: none"> <li>▪ There should be role of NIH in policy making as well as in implementation of findings by the Institute in the field.</li> </ul>

		<ul style="list-style-type: none"> <li>▪ Need of carrying out studies on dam operation in view of the climate change.</li> <li>▪ Need for addressing the problem of declining ground water level throughout the country due to over exploitation of ground water.</li> </ul>
19	Dr Ravi Chopra	<ul style="list-style-type: none"> <li>▪ In view of fastest growing urbanization and increased water demands, studies should be undertaken on development and management of urban water systems.</li> <li>▪ Studies on river conservation, especially Himalayan rivers.</li> <li>▪ Studies for flood management and on use of early warning systems.</li> <li>▪ Hydrology of traditional water harvesting systems.</li> </ul>
20	Dr.(Mrs) K Vijaya Lakshmi	<ul style="list-style-type: none"> <li>▪ Studies should be user friendly and end users should be part of the study.</li> <li>▪ Need to enhance outreach and dissemination.</li> <li>▪ Need to undertake more hydrological studies in semi-arid region viz., water budgeting, regional water availability, and economics of water use.</li> <li>▪ Upstream and downstream water sharing issues, ecosystem and sustainability of the hydrological model should be incorporated in the research studies.</li> </ul>
21	Dr A P Singh	<ul style="list-style-type: none"> <li>▪ Develop decision making tools for user community.</li> <li>▪ Study vulnerability of groundwater systems.</li> <li>▪ Studies on non-point source pollution.</li> <li>▪ Studies on water-energy relationships.</li> </ul>
21	Shri Bharat K. Kakade	<ul style="list-style-type: none"> <li>▪ Develop capabilities through training of manpower for watershed management programmes.</li> <li>▪ Studies on productive use of water.</li> <li>▪ Link research findings with livelihood programmes.</li> <li>▪ Need of hydrological studies in coastal areas and desert prone areas e.g. in Maharashtra and Karnataka.</li> <li>▪ Need to develop outreach programmes with project implementing agencies.</li> <li>▪ Utilize efficient hydro-informatics techniques.</li> </ul>

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

#### **ITEM NO. 35.2: CONFIRMATION OF THE MINUTES OF 34<sup>TH</sup> MEETING OF THE WORKING GROUP**

The 34<sup>th</sup> 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/34<sup>th</sup> WG/11 dated May10, 2011. As no comments were received on the circulated minutes, the minutes were confirmed.

### **ITEM NO. 35.3: 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 34<sup>th</sup> working group meeting.

### **ITEM NO. 35.4: PRESENTATION AND DISCUSSION ON THE STATUS AND PROGRESS OF THE WORK PROGRAMME FOR THE YEAR 2011-2012.**

The Member-Secretary made a brief presentation outlining progress made under different studies for the work programme of 2011-12. Division wise progress on each study/project presented during the meeting is given in the next section.

## **ENVIRONMENTAL HYDROLOGY DIVISION**

### **i) Assessment of Ground Water Quality in Class I Cities in India - Phase II (CPCB sponsored project)**

Dr M K Sharma presented the progress of the project and he informed that out of twenty five class I cities, twenty four cities had been already covered during the year 2009-10 and 2010-11. He further informed that twenty fifth Shrinagar was replaced by Gautambudhnagar by CPCB on the request of NIH due to security reasons and an extension of the project upto October 2011 has been given by CPCB. The pre- and post-monsoon sampling of Gautambudhnagar has been completed. About thirty samples were collected from open wells, ring wells, bore wells and handpumps from each of these cities covering residential, industrial, petroleum storage, landfill sites. Collected samples were analysed for various water quality constituents viz; major cations and anions, metal ions, bacteriological parameters and metals. Pesticides residue and PAH analysis were under progress. Dr Sharma presented the results of the study. In a query raised by Dr R C Jain about the presence of nickel in ground water samples of north-eastern cities, Dr Sharma informed that the probable source of presence of nickel in ground water may be wash off from small industrial units of Ni-Cd batteries existing in cities. Dr Bhishm Kumar suggested to present results pin pointing the specific locations in each city. Dr Sharma replied spatial distribution maps have been prepared showing the water quality degraded zones for each city. The report is under writing and will be submitted by 31 October 2011.

### **ii) Impact of sewage effluent on drinking water sources of Shimla city and suggesting ameliorative measures**

Dr. V.K. Choubey, Scientist F & Head/PI given an overview of this study. Thereafter, the detailed progress was presented by Mr. Omkar Singh, Scientist E2 and Dr. Rajesh Singh, Scientist B, respectively. He informed that field investigations have been re-scheduled as per suggestions given by Dr. R.C. Trivedi (TAMC/PCS) and monthly

monitoring of various water quality parameters is in progress. The PI also informed that a 3 days training course on “Water quality & its Management” was organized in collaboration with I&PHE Dept Shimla for their officials at HIPA, Shimla. The final report would be submitted as per given time frame for this PDS under HP-II.

**iii) Spatial Variability of Ground Water Quality in Kandi, Sirowal and Shiwalik Belts of Jammu Region, J&K (India)**

After brief introduction, the study was presented by Shri Omkar Singh, Scientist E1 & PI. He informed that the spatially variability analysis of the groundwater quality data has been completed. The results have been compared with those of the old data sets for various physico-chemical parameters. Accordingly, ground water quality monitoring network in the study area have been proposed. Spatial variability maps of various ground water quality parameters have also been prepared. Shri R K Jain enquired about the field applications of the findings related to spatial variability. PI informed that a report would be sent to the concerned local organizations for possible strengthening of their monitoring programs. The final report is under preparation.

**iv) Development of Low Cost Media for Fluoride Removal from Drinking Water of Fluoride Affected Areas**

Dr. Rajesh Singh, Scientist ‘B’ presented the brief introduction about the objective and progress made in this study. He informed that major review work has been completed so far and a suitable media would be developed by collecting fresh bagasse fly ash from nearby sugar industries. No comments were received.

**v) Assessment of Groundwater Quality in Hindon River Basin**

Dr M K Sharma presented the scope of the study and its brief description. Dr Sharma elaborated the work plan to be carried out for the study. Sri Ritesh Arya suggested to collect ground water samples from different depths in order to have proper picture of the study area. Dr Ravi Chopra suggested to convey the finding/results of the study to the concerned stakeholders by distributing pamphlets or by organizing mass awareness programme.

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**GROUND WATER HYDROLOGY DIVISION**

Dr. N. C. Ghosh, Scientist-F & Head of the division presented an overview of the technical activities carried out by the division & progress made on different studies during last six months. He informed that there are total of 5 research studies approved for the division under the current year, out of which 4 are internally funded, and remaining one is purpose driven study under HP-II. In addition to the 5 research studies, Dr. Ghosh informed that as follow-up of the MOU signed between NIH & HTWD, Germany, NIH has participated in the multi-stakeholders collaborative R & D project sponsored by the European Commission under 7<sup>th</sup> Framework programme entitled “*Saph Pani - Enhancement of natural water systems and treatment methods for safe and sustainable water supply in India*”. The project has seven Work Packages, out of which NIH is

participating in 4 Work Packages with budgetary allocation of 2, 42,044 Euros for the duration of 36 months starting from October, 2011.

He further gave an account of initiatives taken by the division during last six months, and results thereof. Few important initiatives taken up by the division are as follows:

- ❑ A Memorandum of Understanding (MOU) with the University of Applied Sciences Dresden (HTWD), Germany for establishment and cooperation of an “*Indo-German Competence Centre for River Bank Filtration (IGCCRBF)*” at NIH has been signed on 30<sup>th</sup> May, 2011.
- ❑ As follow-up of the Workshop organized by the Ministry of Earth Sciences under the Indo-US bilateral programme, An Indo-US collaborative project entitled “*Modeling Groundwater and Surface Water Availability in an Agricultural Area*” jointly with USGS, ICAR & ISRO has been developed & submitted to the Ministry of Earth Sciences, Govt. of India for evaluation and further necessary action.
- ❑ As follow-up of the MOU with the University of Applied Sciences Dresden, Germany, An Indo-German CLIENT pre-project proposal entitled “*Safe and sustainable drinking water production by coupling natural and innovative techniques in India*” jointly with Germany, NEERI, UJS, IITRoorkee, IIT Madras, Kalyani University has been prepared & submitted to DST, Govt. of India for evaluation and further necessary action.
- ❑ An Indo-Italy collaborative project proposal entitled “*Arsenic affected groundwater and agricultural soils: Integrated assessment of impacts, remediation measures and exploring solutions*” jointly with Italy, and IIT Roorkee has been prepared & submitted to DST for evaluation and further necessary action.

In addition to the above R & D studies, the division is working on one Consultancy Project “*Feasibility study of surface water and groundwater availability including identification of potential groundwater recharge sites in the CIFMR campus, Dhanbad*” of 6 months duration with Rs. 15.07 lakhs supported by the Engineering Projects (India) Ltd. , A Govt. of India Enterprise is in progress since August, 2011. Another consultancy Project entitled “*Drainage Area mapping and hydrological studies in and around Gurha (W) Lignite Block in Kolayat tehsil of Bikaner District, Rajasthan*” of 9 months duration with Rs. 12.5 lakhs from Rajasthan State Mines & Minerals Ltd, - A Govt. of Rajasthan Enterprise is underway.

Dr. Ghosh informed that Scientists of the Division have submitted/published a number of research papers in various journals/conferences/symposia during the period and also delivered lectures in various training courses.

Thereafter, Dr. Ghosh requested the concerned PIs to present the detailed progress of each study. The Study-wise suggestions and discussions emerged are given below.

## **1. QUANTIFICATION OF IMPACT OF RAINWATER HARVESTING ON GROUNDWATER AVAILABILITY IN ARAVALLI HILLS – PART II: MATHEMATICAL MODELING**

Mr. C. P. Kumar explained about the data monitoring and field investigations carried out in Savana macro-watershed including the morphometric analysis, monitoring of soil moisture variation and trial runs using VS2DT model. The role of morphometric analysis in the present study was enquired. It was informed that morphometric analysis is helpful for identifying suitable sites for rainwater harvesting structures. Dr. B. P. Singh suggested to use nuclear techniques for estimating recharge. Mr. Kumar informed that tracer technique using stable isotopes has already been undertaken for the study area. The members opined that such studies need to be undertaken for other areas also.

## **2. IMPACT OF CLIMATE CHANGE ON DYNAMIC GROUNDWATER RECHARGE IN A DROUGHT PRONE AREA**

Mr. C. P. Kumar presented the projected rainfall and temperature for the Sonar basin for years 2039, 2069 and 2099 based-upon IPCC SRES scenarios (A1FI and B1) and estimation of groundwater recharge at 12 locations using Visual HELP model for future climate scenarios. On a query, it was informed that future changes in land-use pattern have not been considered for the present study. It was suggested that in view of uncertainty in GCM predictions and IPCC projections for SRES scenarios, the estimation of recharge and corresponding estimation of groundwater fluctuation should also be worked-out for various other scenarios different from SRES scenarios. Dr. R. Krishnan expressed the desire to take-up collaborative studies between IITM, Pune and NIH for climate change studies.

## **3. COASTAL GROUNDWATER DYNAMICS AND MANAGEMENT IN THE SAURASHTRA REGION, GUJARAT.**

Mr. C. P. Kumar presented the objectives of the study, salient features of the study area, details of data collection program undertaken for the Minsar Basin, geology of Minsar Basin, variations in water table and groundwater salinity along the coast, drilling of piezometers by GWRDC, procurement and use of equipment (salinity data loggers, TLC meter, resistivity meter) and field studies (infiltration and hydraulic conductivity tests) undertaken. On a query, Mr. Kumar informed that impact of spreading channel on groundwater system will be considered in the modeling study. It was enquired if the groundwater salinity at very large depths in inland areas is being studied. Mr. Kumar informed that objective of the present study is mainly inclined towards assessment of seawater intrusion in coastal tracts. On a query from Dr. Bishm Kumar, Mr. Kumar informed that at few localized points, the groundwater table has been found to be below sea level due to heavy groundwater withdrawal near the coast, but in general groundwater outflow to sea occurs.

## **4. MANAGEMENT OF AQUIFER RECHARGE (MAR) AND AQUIFER STORAGE RECOVERY (ASR)**

Mr. Sumant Kumar (PI) presented the objectives, achievements and the future plan for the proposed study. It was informed that MAR schemes have been developed in Maharashtra and PI was advised to go through that particular document. Dr.



Muralikrishnan Rao told that they are having some data which can be useful for the study.

## **5. GROUND WATER FLUORIDE CONTAMINATION IN DIFFERENT PARTS OF INDIA**

As decided in the 34<sup>th</sup> Working Group, the study was reduced to prepare only a Status Report on the problem of ground water fluoride contamination in India. The members, however, suggested that the process should not be stopped as each report would bring out new concepts to fight against the growing problem creating hazard in various pockets of the country. Such efforts would definitely save time for the researchers willing to contribute to this noble cause.

Mr. Dwivedi briefed the outlines and the possible outcomes of the study and sought view of the members to improvise content of the document. Mr Dwivedi informed that the draft copy of the document would be ready by December 2011. He proposed to organize a workshop on the topic sometimes in the end of month of January, 2012 to enrich the content and recommendations before it the document is finalized. The members agreed with the proposal.

## **6. NEW PROJECT: “SAPH PANI - ENHANCEMENT OF NATURAL WATER SYSTEMS AND TREATMENT METHODS FOR SAFE AND SUSTAINABLE WATER SUPPLY IN INDIA”**

Dr. N. C. Ghosh informed that as follow up action of the MOU signed between NIH and Division of Water Sciences, University of Applied Sciences Dresden (HTWD), Germany for establishment and operation of an “*Indo-German Competence Centre for River Bank Filtration (IGCCRBf)*”, NIH and HTWD joining in a consortium of 20 organizations (10 Indian and 10 Foreign) from 8 different countries have developed and submitted a collaborative R & D Project entitled “Saph Pani - Enhancement of natural water systems and treatment methods for safe and sustainable water supply in India” in respect of the call of the European Research Commission 7<sup>th</sup> Framework Program, and qualified to receive grants of about 3.5 million Euros for the project of 36 months duration. The project has been launched from October, 2011.

The Project has seven Work Packages, (i) Bank filtration in urban areas under varying pollutants load and flood situation, (ii) Managed aquifer recharge and soil aquifer treatment, (iii) Constructed wetlands and other natural treatment systems for wastewater treatment and reuse, (iv) Post treatment of water from natural treatment for different applications, (v) Modeling and system design, (vi) Integrated sustainability assessment, and (vii) Training & dissemination. Out of these 7 Work Packages, NIH has participation in WPs( i, ii, v and vii). For WP (vii), NIH is the leader, while for other packages NIH is one of the working partners for specific components.

Dr. Ghosh presented the objectives of different WPs in which NIH is involved, and elaborated the tasks to be carried out by NIH. It was also informed that during 3-4 November, 2011, the inception meeting of the project to be organized by NIH has been

scheduled at New Delhi, in which all partners would be attending to get familiar to each other and the tasks to be carried out in coming one year.

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## **HYDROLOGICAL INVESTIGATIONS DIVISION**

Dr. Bhishm Kumar, Sc. F and Head of the Division presented in brief the various studies being carried out by the Division. He also informed about the number of research papers published/accepted for publication/communicated by the scientists of the Division. Analytical work carried out at the Nuclear Hydrology Laboratory was also presented. He also informed the members about the other activities of the institute in which the scientists of the HI Division are involved.

The progress of studies was presented by the respective P.I. of the study as given under:

**Study No. : NIH/HID/NIH/09-12:                      SURFACE                      WATER                      AND  
GROUNDWATER INTERACTION AT  
SELECTED LOCATIONS ALONG  
RIVER YAMUNA IN NCT, DELHI**

Dr. Sudhir Kumar presented the progress of the study and explained the key findings. Dr. Sudhir Kumar informed that isotopic work for the project has been completed and the 3D mathematical model has been setup. The model is being calibrated. The parameters obtained from the isotopic analysis and the field measurements shall be incorporated in the model. He further informed that isotopic studies have indicated that the vertical recharge from flooding dominates during monsoons. The lateral recharge is slow and the water due to lateral movement of water will take longer time (2-3 years) in reaching the pumping wells, whereas, the water recharged due to flooding reaches within very short time.

**Study No. :NIH/HID/HP-II/09-12:                      GROUNDWATER MANAGEMENT IN  
OVER-EXPLOITED                      BLOCKS                      OF  
CHITRADURGA                      AND                      TUMKUR  
DISTRICTS OF KARNATAKA**

Dr. Sudhir Kumar presented the work done under the project during the last six months. He informed that during this period, pump tests have been conducted in tubewell and dugwells at 4 locations in watershed in Tumkur District. Resistivity surveys were carried out at 16 locations (8 each in Tumkur and Chitradurga Districts). Automatic water level recorders and automatic rain gauges were installed in both the watersheds. It was also informed that in most of the years, the groundwater wells show recuperation after the monsoon and there is no long term decline in water table except during the low rainfall years. He further informed that no outflow has been observed at the outlet of the

watersheds during last 8-10 years and all the precipitation water gets stored in the tanks.

**Study No. : NIH/HID/DST/07-12:**

**NATIONAL PROGRAMME ON  
ISOTOPE FINGERPRINTING OF  
WATERS OF INDIA (IWIN)**

Dr. M. S. Rao presented the progress of the study. He started with the action taken on the comments of the 34<sup>th</sup> Working Group meeting. The isotopic correlation among the IWIN sampling stations Roorkee, Sagar, Jammu and Kakinada were shown with special emphasis on the correlation between Roorkee and Sagar. The progress for the period April, 2011 to September, 2011 was initiated with the establishment of three more sampling stations at Tezpur University, Assam, IIT-Kanpur and Manali for collection of Ground Level Vapour (GLV). A total of 1154 samples were collected from April, 2011 to September, 2011 from Roorkee, Sagar, Kakinada, Jammu, Tezpur, Kakinada, Kanpur and Manali and out of which 650 number of samples have been analysed. These include GLV, rainwater, groundwater and river water. Using GLV – isotopic time series data (2007-11), he has explained the significance of the isotopic composition of GLV in identifying arrival and departure of monsoon and shown its significance in monitoring the climate change which is also reflected in the change in winter temperature and reduction in sustaining the maximum temperature. To extend the objective of study from ground based to vertical profile (500-1000m), balloon based new experiments was also highlighted and work achieved towards this was explained. The invited experts highly appreciated the objectives and achievements of the study due to its national and international importance as it is addressing the onset and withdrawal of monsoon and its regional dynamics.

The comments given by various experts about the study are given below:

1. Er. R.D. Singh suggested to develop isotope based empirical relations for forecasting of monsoon. He also informed that during his meeting with Sh. Ajit Tyagi, DG-IMD who expressed his willingness to collaborate with NIH on monsoon studies. To this Dr. Rao answered: isotope can predict arrival and departure of monsoon vapours and this data can be interlinked with meteorological equations to achieve the objective. He further stated that we need real time isotope data for proper monitoring of the monsoon vapours by using the online vapour analysis.
2. Dr. V.V. Rao and Dr. Kakade emphasized on establishing few more stations for understanding the regional dynamics of vapour. They also suggested to incorporate other meteorological conditions necessary for precipitation; such as cloud cover, integrated vertical moisture content, wind conditions etc. in interpretation of the data towards monsoon prediction.

3. Sh. Ritesh Arya appreciated the study and suggested need of such studies in advance warning of events such as cloud bursts or similar events in high altitudes of Himalayas. He advised to develop a few stations for isotope analysis in high altitude cold deserts or alpine areas like at Leh, where IMD observatory is available.
4. Dr. S.K. Singh, NIH suggested to identify the time required for vapours to travel between two NIH-IWIN stations and to use it in predicting the onset and withdrawal of monsoon.
5. Dr. B.P. Singh suggested to estimate onset and withdrawal dates of monsoon using  $\delta^{18}\text{O}$  and  $\delta\text{D}$  independently and to inter-compare these dates to confirm the validity of technique.

**Study No. :NIH/HID/HP-II/09-12:**

**GROUNDWATER DYNAMICS OF  
BIST-DOAB AREA, PUNJAB USING  
ISOTOPES**

Dr. M. S. Rao presented the progress of the study. He started with the action taken on the comment of the 34<sup>th</sup> working group. The water quality data is presented using conventional methods (Piper, US-salinity, Wilcox, Gibbs and Gailardet et. al.) and explained its suitability for drinking and irrigation purposes. He informed that the sufficient number of stations have been established for isotopic characterization of water resources of the study area. On the basis of analysis of total 2230 samples, the characteristic of groundwater (shallow and deep), rain (plains and Kandi), river water (Beas and Satluj) and canals has been determined. It was also informed recharge to groundwater through seepage from canal is limited to a few tens of meters from the canal reach. A new concept based on environmental isotope (Tritium unit) fence diagram was presented and explained its significance in groundwater resource management. It was also informed that AWLRs (6nos.) were procured and installed in piezometers of Punjab Water Resources & Environment Directorate and the hourly water level data collected for the period of two months (17<sup>th</sup> August to 8<sup>th</sup> October, 2011) was shown during the presentation.

The experts gave the following comments on the study:

1. Dr. S.S. Grewal (Retd. Dir., PAU) informed that in the earlier studies based on Selenium concentration in groundwater it was shown that the canals contribute significantly to groundwater recharge from Balachaur to Nawanshahr and this aspect should be reconfirmed in the present study. In this regard, it was also stated that the canals have been lined recently. He also informed that groundwater is in rising conditions in Kandi area while rapidly declining in the central region of Bist-Doab. He asked to investigate this aspect using isotopic technique.
2. Dr. R.C. Jain, CGWB commented: the isotopic data indicated the deeper aquifers are in confined to sub-confined conditions that need to be substantiated using pump test and hydro-geological conditions.

**Study No. :NIH/HID/FRI/08-13:**

**IMPACT ASSESSMENT OF LANDUSE  
ON THE HYDROLOGIC REGIME IN  
THE SELECTED MICRO-WATERSHED  
IN LESSER HIMALAYAS,  
UTTARAKHAND**

Dr. S. P. Rai presented the progress of the study. He informed that two watersheds namely, Arnigad and Bansigad near Mussoorie have been selected for the study. Arnigad micro-watershed having an area of 3 km<sup>2</sup> is covered with dense oak forest while Bansigad micro-watershed having an area of 2 km<sup>2</sup> is covered with degraded mix forest of oak and pine. Both the watersheds are on the south facing hill slope. Highest and the lowest elevations of both the project area are approximately equal. Other morphometric parameters such as, relief ratio, stream order, form factor, and elongation ratio etc are almost same. Geology of the both the watershed is same and the difference is only in land-cover. Dr. S. P. Rai informed that monthly average discharge in degraded watershed (Bansigad) vary between 0.01m<sup>3</sup>/sec (minimum) in the month of November 1.02 m<sup>3</sup>/sec (maximum) in the month August. The stream flowing through degraded watershed becomes dry during the May and June. However, in forested watershed, it varies between 0.05 m<sup>3</sup>/sec in the month of June and 0.88 m<sup>3</sup>/sec in the month of August. It remains perennial throughout the year. Hydrograph analysis reveals that rainfall response on stream discharge of both watershed is very quick. However, the recession part of hydrograph differs to each other in both watersheds. The discharge decline slowly in Arnigad stream during post monsoon month while it declines at faster rate in Bansigad stream and stream become dry up in summer months. Monthly distributions of runoff in the both the micro watersheds vary significantly. During the monsoon period (June to September) of 2008-2009 and 2009-2010 runoff from the forested watershed is 45 to 60% and about 85% of the total discharge from Arnigad and Bansigad watershed respectively. Due to high runoff during the monsoon period, the Bansigad watershed stream gets dry up during pre-monsoon months. The infiltration test conducted in different landuse condition reveals higher rate of infiltration in the dense oak forest cover. 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 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.

These results indicate that runoff is more uniform in case of dense forests. Runoff in both the catchments is maximum during August and minimum during the May. Total runoff in Bansigad during the month of August is 60% higher than that of Arnigad and from July to September, it is 48% higher than that of Arnigad. Runoff coefficient during the monsoon period, June to September is 0.39 and 0.61 for Arnigad and Bansigad micro watersheds, respectively. During post monsoon months, stream discharge from the degraded watershed reduces drastically. Discharge in Arnigad stream becomes higher than the Bansigad

stream. Total runoff in Arnigad during the nonmonsoon period from October to March is 184mm (50%) more than that of Bansigad.

Dr. Rai also presented the analysis of the isotopic composition of rainfall, stream and springs. He informed that  $\delta^{18}\text{O}$  of rain varies between minimum  $-21.2\text{‰}$  in the month of September and maximum  $+2.6\text{‰}$  in the month of June at Bansigad site and it varies between minimum  $-16.7\text{‰}$  in the month of August and maximum  $+5.7\text{‰}$  in the month of May at Arnigad site. He also presented the relations between  $\delta\text{D}$  and  $\delta^{18}\text{O}$  developed for the study area. He informed that the slope and the intercept of the best fit line of both watershed are close to those of local meteoric water line for the Bhagirathi River basin. Regarding the isotopic composition of the stream water he mentioned that the depleted isotopic signature of stream discharge during the rainy months and enriched values during the pre-monsoon months reveal the seasonal variations due to change in source of contribution. During the monsoon months, stream discharge is dominated by surface runoff while during non rainy months, subsurface flow dominates. Recharge zone of two springs have been estimated using isotopic techniques. He also informed that rainfall-runoff and soil loss modelling will be carried out using SWAT model which is in progress.

**Study No. :NIH/HID/INT/10-13:**

**STUDY OF VARIABILITY OF SNOW AND GLACIER CONTRIBUTION IN MELT WATER OF GANGOTRI GLACIER AT GOUMUKH USING ISOTOPIC TECHNIQUES**

Dr. S. P. Rai presented the progress of the study. He informed that sample collection for the ablation period is continued from 2010 at the site established by NIH, near Gangotri snout. Water sample of river and precipitation (rain/snow) have been collected on daily basis for analysis of stable isotopes ( $\delta\text{D}$  and  $\delta^{18}\text{O}$ ) and tritium. The analyses of the samples are in progress. River, precipitation and few snow and ice samples near Gaumukh snout have been collected during the previous years 2005, 2008 and 2007 and have been analysed for  $\delta\text{D}$  and  $\delta^{18}\text{O}$ .

The isotopic signature of the fresh snow and surface ice samples collected near the snout ranges  $-4\text{‰}$  to  $-13.9\text{‰}$ ; and  $-13.3$  to  $-18.5\text{‰}$  respectively. The snow  $\delta^{18}\text{O}$  values are enriched in comparison to that of glacier. The  $\delta^{18}\text{O}$  values of river water during pre-monsoon (April to June) found between  $-12\text{‰}$  and  $-13\text{‰}$ . The  $\delta^{18}\text{O}$  values further depletes slowly in the month of July. The depleted  $\delta^{18}\text{O}$  signatures continue in the remaining months of August and September with slight enrichment. The abrupt depletion of  $\delta^{18}\text{O}$  in July, August and September is triggered with a heavy rainfall event. It has been observed that the isotopic values of river initially follow the  $\delta^{18}\text{O}$  values of snow which indicate the snowmelt dominates in the river discharge at initial stage (during May and June). While, the depleted value of  $\delta^{18}\text{O}$  in the months of July, August indicated more contribution from ice melt and snow of higher altitude.

The plot of  $\delta^2\text{H}$  versus  $\delta^{18}\text{O}$  for all precipitation samples collected during the ablation period of 2004 and 2008. The Local Meteoric Water Line (LMWL) developed as  $\delta^2\text{H} = 8.2 (\pm 0.10) \times \delta^{18}\text{O} + 17.1 (\pm 1.53)$  ( $n = 15$ ,  $r^2 = 0.99$ ) for a complete ablation period which is showing higher slope and y intercept in comparison to from the GMWL.  $\delta^2\text{H}$  vs  $\delta^{18}\text{O}$  plot for the meteoric water line developed for melt water of Gangotri Glacier at Gomukh site and the best fit line is  $\delta^2\text{H} = 8.2 \times \delta^{18}\text{O} + 18.97$   $r^2 = 0.99$ ,  $n = 110$ .

Dr. Rai informed about the progress made in hydrograph separation of snow and glacial melt contribution. The preliminary results reveal that contribution of snow melt dominates in the total discharge. Contribution of rainfall has been found about 3% of the total discharge during the 2005.

**Study No.: NIH/HID/GBPIHED/10-13: DEVELOPMENT OF SPRING SANCTUARIES IN AN URBAN AND A RURAL WATERSHED IN DISTRICT PAURI GARHWAL, UTTARAKHAND**

Dr. S. P. Rai presented the progress of the study. He informed that two watersheds have been identified for the study of spring sanctuaries which are facing with acute water scarcity. One water shed is in proper Pauri urban area and second one in the rural area i.e. Dugargad watershed. In Pauri watershed eight spring and in Dugargad watershed three spring have selected at different altitude to collect the water samples for stable isotopes ( $\delta\text{D}$  and  $\delta^{18}\text{O}$ ) radioactive isotope ( $^3\text{H}$ ) analysis. Meteorological observatory in both the the watershed has been installed to monitor the variation in meteorological parameters. The discharge of the springs has been measured on the daily basis during the monsoon period. The analysis of  $\delta\text{D}$  and  $\delta^{18}\text{O}$  for collected spring and rainwater samples are in progress. The plot of  $\delta^2\text{H}$  versus  $\delta^{18}\text{O}$  for rainfall samples collected during June to September 2010 show the Meteoric Water Line (spring) as  $\delta^2\text{H} = 8.0 \times \delta^{18}\text{O} + 11.4$  which is similar to IMWL. The plot of  $\delta^2\text{H}$  versus  $\delta^{18}\text{O}$  for all springs samples collected during June to September 2010 show the Meteoric Water Line (spring) as  $\delta^2\text{H} = 7.20 \times \delta^{18}\text{O} + 4.41$  which is very close to LMWL. These results indicate that source of these springs are local precipitation. The springs of Pauri urban area show depletion in the  $\delta\text{D}$  value of July month which indicate that there is quick response of recharge due to rainfall in the month of July. However, the  $\delta\text{D}$  of Dugargad watershed springs show no variation which is indicator of higher residence time of the springs. Dr. Rai informed that altitude effect have been estimated, which will be used to estimate the recharge zones of the spring.

The detailed geological and geomorphological map of the area was presented by Dr. Rai. Recharge zones of the springs have been project using the DEM and lineament details of the study area. The progress of the study was appreciated by Dr. Ritesh Arya and other members.

**Study No.:NIH/HID/INT/10-12:**

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

Dr. Bhisim Kumar, Head, HID initially briefed the members about the study and briefly explained the isotopic techniques which is being followed for the study as methodology. He informed that the study has been referred by the Uttarakhand Jal Sansthan, as these springs have reported a significant reduction in their discharge in recent years. The study was then presented by Dr. S. D. Khobragade. He informed that the study has been taken up with the objectives of identifying the recharge zones of the springs and suggesting the remedial measures for their rejuvenation. Describing the study area, he informed that 4 springs namely Moli, Ratoli, Gothiyara and Kandha Dhangi falling in Chandrabhaga Watershed in Jakhanidhar Block of Tehri Garhwal district are being studied under the present investigations, as suggested by the Uttarakhand Jalsansthan. The study area terrain is highly rugged with steep slopes (elevation range: 800-2300 m). The geological formations are greenish grey slaty and schistose phyllite inter-bedded with quartzite. The soils are shallow and varying in texture and depth.

While discussing the progress of the study, he informed that daily rainfall data have been collected from 1 June-, 2010 and that about 500 water samples of springs, rain and GW have been collected and analyzed for deuterium and O-18. He also informed that spring discharge has been measured at 15 days interval for all the 4 stations since June-2010 and at weekly interval since June, 2011. Further he informed that the response of the springs to rainfall has been analyzed and it has been observed that all the four springs differ in their response which indicates different residence times of water for the various springs. He also informed that that correlation analysis between the spring discharge and lag series of rainfall carried out for Moli spring indicates a significant delay in the response of springs to rainfall. However, he clarified that the rainfall considered for such analysis is that of the nearest station and since the spring may be recharged at a different altitude there may be some degree of error in such an analysis which can be rectified once the recharge altitude of the springs are established using the isotope techniques. He further informed that last year only three rainfall stations were established in the study area but this year four more additional rainfall stations have been established at different altitude to study the altitude effect. He informed that the local meteoric water line for the area has been developed and it has been observed that the local meteoric line falls exactly on the Indian Meteoric Water Line (IMWL). He also informed that the altitude effect for the study area has been studied using O-18 data. He told that using the O-18 data of the springs recharge altitude of Kandhadhangi spring has been estimated and for other springs, it is in progress. Discussing the work plan for the next two quarters he informed that the analysis of the data would be extended to identify the recharge altitude of the remaining springs. Then, based on this altitude as well as after the ground survey of the area, the recharge area



would be identified after considering the hydro-geology and topography of the area. Once the recharge area is identified, recharge structures would be suggested.

Dr. B. P. Singh enquired whether the recharge altitude would be the same if del O-18 or del D data are used, Dr. Bhishm Kumar clarified that although the altitude effect would be different in case of del O-18 and del D, the recharge altitude would come out to be the same.

Mr. Ritesh Arya, Chandigarh asked whether the discharge data and particularly the lean period discharge data, are being monitored or not. To this Dr. Khobragade informed that the discharge data are being continuously monitored for all the four springs at a weekly interval. However, he also clarified, that since no discharge measuring structures are available at these sites, a bucket is being used for the purpose and it has a limitation of recording the maximum discharge.

**Study no. :NIH/HID/INT/11-13/1:**

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

Sh. S.K Verma, the principal investigator of the study, presented the study before the members of the WG meeting. He mentioned about the objectives of the study along with the location of study area, action plan, end users/beneficiaries, equipment procured etc. He also mentioned about the actions taken on the suggestions raised during the last working group meeting.

While discussing the progress of the study, he informed that much progress has not been made during last two quarters because the required instrument i.e. radon detector was supplied and installed by the agency during the month of Aug. 2011. After that rigorous testing of the instrument was carried out in the Nuclear Hydrology laboratory. In the mean time, a lot of literature were collected regarding the radon concentration measured in different parts of India. He also informed that as suggested by one of the honorable members of the last working group, a field trip was organized to collect water samples from different sources from different locations from nearby areas of Narora Atomic Power plant. Accordingly a total of 7 water samples were collected from different sources and different locations near Narora and radon concentration were measured in these samples. In addition to that three water samples were also collected from hand pump, tube well and Ganga canal water from Roorkee. These samples were also analysed for radon concentration. The radon concentrations measured in these samples were within the maximum permissible limit as per the guide lines of WHO.

**Study no. :NIH/HID/INT/11-13/2:**

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

The study was presented by Sh. Pankaj Garg, Scientist B. He informed that this study has been taken up with the objectives to identify the groundwater recharge zones and groundwater flow velocity for Ghar area and to identify sites for water harvesting structures in Ghar area which is water scarce. He further informed that the two blocks of district Saharanpur which fall in Ghar area namely, Muzaffarabad and Sadhauri Kadim have been selected for this study. He said that the availability of groundwater and surface water is limited in both these blocks which poses problem to meet out the need of drinking water as well as water for irrigation. Presently, both the blocks fall in dark category and require artificial recharge measures. Discussing about the study area, he informed that the area of the Muzaffarabad block is 40621 ha and Sadhauri Kalim block is 38767 ha. There are total 130 Govt. tubewells and 5333 private tubewells and pumping sets in Block Muzaffarabad while only 6 Govt tubewells and 4196 private tubewells and pumping sets are available in Block Sadhauri Kadim which draw groundwater for meeting out the drinking and irrigation needs. He further discussed about the progress of the works carried out during the last six months. He informed that water samples were collected from 34 sites for water chemistry and isotope analysis. A total of 16 sites were finalized for further collection of water samples. The isotopic analyses of collected water samples have been completed in the Nuclear Hydrology laboratory. He informed that the further interpretation of the hydrological and isotopic data is in progress.

**Study No. :NIH/HID/CONS/11-13:**

**INTEGRATED HYDROLOGICAL  
INVESTIGATIONS OF SUKHNA  
LAKE, CHANDIGARH FOR ITS  
CONSERVATION AND  
MANAGEMENT**

The study was presented by Dr. S. D. Khobragade, Sc-E1 and PI. He informed that it is a consultancy project given by the Chandigarh Administration through the Conservator of Forests, Chandigarh and has started since July, 2011. Discussing the study area he informed that Sukhna Lake is a very significant lake of Chandigarh because of its being an important tourist attraction and centre of recreation. Discussing the major problems of the lake he informed that 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 than 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. 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. Thus, he stressed the need to

conserve the lake for future. However, he also out that although some scattered studies have been reported on the assessment of sedimentation in the lake, no systematic and scientific hydrological investigations have been reported for the lake. He informed that the major objectives of the study are (i) To estimate water availability in the lake through systematic assessment of the water balance components of the lake, (ii) To estimate sedimentation rate and expected life of the lake, (iii) To study the water quality of the lake and (iv) To suggest measures for conservation and management of the lake, based on the investigations. Discussing the progress of the work carried out in the last three months, he informed that A number of field visits have been made and since no historical data for the lake site are available, instruments such as ordinary raingauges, automatic raingauges, AWLR and AWS have been installed in the study area and data are being collected. He also informed that gauges have been installed in the inflow channel for discharge estimation. He also informed that digital elevation map and drainage map of the study area have been prepared and that samples of rain water, ground water and lake water are being continuously collected for isotopic analysis as well as data on lake water levels and ground water levels are being monitored. He also briefly presented the analysis of the water level data of the lake obtained so far and also discussed the crude estimate of the inflow regime obtained using the collected data and said that from the preliminary analysis it appears that surface abstraction in the catchment appears to be a major reason for the reduced inflow to the lake. However, he said that detailed analysis needs to be carried out before arriving at any conclusions. Dr. Bhishm Kumar informed that a number of earthen and masonry dams have been constructed in the catchment area which are abstracting water in the catchment.

Reacting on the results of the preliminary analysis presented by Dr. Khobragade, Dr. Grewal, SPACE, Chandigarh, said that the present analysis is still very preliminary. He further commented that the role of the check dam should not be viewed separately or only from the angle of their role in surface abstraction but their significant role in controlling the siltation should also be taken into account. Dr. Khobragade clarified that this is just a preliminary analysis carried out to understand the hydrological regime independently and also said that he does agree to the views expressed by Dr. Grewal and informed that integrated role of the check dams would be studied once all the data are available.

## **SURFACE WATER HYDROLOGY DIVISION**

Dr. Jaivir Tyagi, Scientist F, Surface Water Hydrology Division presented brief details of various studies being carried out under the Surface Water Hydrology Division along with number of research papers published/accepted for publication/ communicated as well as other research and technical activities carried out by the division. The progress of studies was then presented by the respective P.I. of the study. The details are as under.

### **1. SNOW MELT RUNOFF MODELLING IN SUTLEJ BASIN**

Dr. A. R. Senthil kumar, PI of the project, presented the objectives, methodology, and results of the study in brief. Dr M Perumal, Professor, DOH, IIT, Roorkee enquired about the input data to the ANN Models and the application of conceptual models in simulating the snow melt runoff. The PI of the study informed about the input data of the ANN model and the application of conceptual models SNOWMOD and SRM for the simulation. Sh Kishore Kumar asked about the length of the data used in the study. The PI informed about that the data up to 2003 was used and the inability of the consideration of the updated data beyond 2003 due to non availability of the snow covered area. The chairman of the working group suggested to present complete work in the next working group meeting.

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

Mrs Archana Sarkar, PI of the study presented the statement, objectives, study area, approved action plan, methodology, progress, results and deliverables of the study. Mrs Sarkar informed that the study area is the Subansiri River basin, the biggest northern tributary of Brahmaputra River within India which originates in Tibet, contains snow-fed tributaries and glaciers and has a huge hydropower potential for the country. She informed the house that the first part of the report consisting snow cover mapping which would be an input to the snowmelt runoff model in the second part of the study has been completed. She further informed that precipitation and temperature data for the study area has also been processed elevation band wise. She further presented the area-elevation relationships prepared from the DEM of the basin and informed that various other input data are being prepared to calibrate the SNOWMOD program which would be completed by end of March 2011 as per the study program. Sh. R.K. Yadav, Member of the working group enquired how impact of climate change would be studied. Mrs Sarkar informed that the snowmelt runoff model, namely, SNOWMOD contains precipitation and temperature as input and once the model is calibrated, various scenarios of precipitation and temperature would be applied to study the impact of climate change on runoff of the basin.

### **3. MONITORING AND MODELLING OF STREAMFLOW FOR THE GANGOTRI GLACIER**

Dr Arora presented the progress of the study. He informed the house that the data collection for the ablation period of 2011 was started in the month of May. He presented the results of the data collected during the winter 2010. 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 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<sup>3</sup>/s. There were no specific comments from the members.

### **4. CLIMATIC SCENARIOS GENERATION FOR SATLUJ BASIN USING STATISTICAL DOWNSCALING TECHNIQUES**

Dr Arora presented the progress of the study. He presented the results of the downscaled output of the data for precipitation for the period 1980 to 2000 for the Satluj

basin. He informed that the data downloaded will be compared with the observed data and the bias correction will be done. The same procedure will be repeated for the temperature. There were no specific comments from the members.

#### **5. CLIMATIC VARIABILITY ANALYSIS AND ITS IMPACT ON HIMALAYAN WATERSHED IN UTTARAKHAND.**

Dr. Manohar Arora presented the objectives of the study and explained the reasons for undertaking the study. Study area, and methodology were presented in brief. Study progress was presented with updated data and spring flow lag to rainfall on daily and monthly basis. The Chairman suggested that one of the objectives must reflect the Climatic variability analysis and its impact on watershed and be amended.

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

The study was presented by Dr. S.K. Jain, Sc. 'F'. He explained the objectives of the study along with the progress made so far. He explained that the procurement of IRS data is in process and data of 2010 and 2011 will be used for identification of glaciers and lakes etc. In the mean time Landsat TM data is being used for identification of lake and glacier. Dr. R K Goyal enquired about the significance of climate change in the study. Dr. Jain replied that there are some glaciers which are retreating due to climate change and that aspect will be studied. Mrs. Vijay Luxmi asked about the technique of glacier mapping and how it is different from technique applied by ICIMOD. Dr. Jain said that the techniques applied by ICIMOD are followed in the present study and also SVM approach will be applied for glacier mapping. Director asked about the design flood/100 return flood. Dr. Jain said that in this study routing of Lake Burst flood will be carried out taking into account 100 year return flood available at the outlet of the basin. Dr. Perumal enquired about the model to be used for GLOF studies. Dr. Jain informed that MIKE 11 will be used for this purpose.

#### **7. HYDROLOGICAL STUDIES FOR UPPER NARMADA BASIN**

Mr. Jagdish Prasad Patra, Sc B presented the study. The objectives of the study with brief methodology and data collected for this study were discussed. Some of the initial results like estimation of design flood were presented. Prof. M. Perumal appreciated the efforts and suggested to try available runoff-volume models in HEC-HMS. Mr. Jagdish Patra informed that the presented results are initial results and the process of carrying out rainfall runoff modelling with the collected data is in progress. Prof. K.C. Patra enquired about possibilities of validating flood inundation maps with remote sensing images.

## WATER RESOURCES SYSTEM DIVISION

S. N.	Title of the Project/Study, Study Team, and Start and Completion Dates	Status, and Recommendation/suggestion
<b>Research studies</b>		
1.	<p>Application of a distributed hydrological model for river basin planning and management</p> <p>M. K. Goel (PI), Vijay Kumar (on lien), D. S. Rathore, Deepa Chalisgaonkar, and Rama Mehta</p> <p>DOS: 10/2009; DOC: 3/2012</p>	<p>Ongoing study (Research study)</p> <p>Dr. M. Perumal suggested that the results of the MIKE Basin will be better than the results of the HEC-HMS model. Mrs. Deepa informed that the results of the NIH model will be compared with other models bringing out the advantages/limitations of distributed models in comparison to the semi-distributed models.</p>
2.	<p>Web based information system for major and important lakes in India</p> <p>Deepa Chalisgaonkar (PI), and Suhas Khobragade</p> <p>DOS: 04/2010; DOC: 3/2012</p>	<p>Ongoing study (Research study)</p> <p>1. On inquiry from Mrs Laxmi Smt. Deepa informed that</p> <ul style="list-style-type: none"> <li>- Reference to source of information is being provided wherever required.</li> <li>- Information is being collected only from documented sources and websites and not from field.</li> <li>- Efforts would be made to update the system from time to time with the availability of new information.</li> </ul> <p>2. Sh. Kishor Kumar suggested</p> <ul style="list-style-type: none"> <li>- to-include/ refer-to the GIGB guidelines given by the Govt for the security of the websites; and</li> <li>- to include/provide in the system the information about RRR and a two-way link to the information and updates from the Ministry's and CWC's sites maintaining such details.</li> </ul> <p>Smt Deepa Chalisgaonkar informed that the Computer Centre of NIH will be maintaining the website, which will be requested for doing the needful regarding the GIGB guidelines once the fully developed system is handed over to the Computer Centre.</p> <p>3. Dr. M. Perumal Perumal suggested considering the information on lakes prepared by Sunita Narayan.</p> <p>4. On inquiry from Sh. M. Krishna Rao it was informed by Smt Chalosgaonkar and Dr. Khobragde that</p> <ul style="list-style-type: none"> <li>-The system is not a GIS based</li> </ul>

		<p>system.</p> <p>-Besides multiple modern dams, other water bodies which are significant and for which information is available are being considered for the system.</p>
3.	<p>Analysis of water management scenarios in Tapi River basin using MIKE Basin</p> <p>Rama Mehta (PI), M. K. Goel, and D. S. Rathore</p> <p>DOS: 04/2010; DOC: 3/2013</p>	<p>Ongoing study (Research study)</p> <p>No specific comment/suggestion.</p>
4.	<p>Development of analytical equation for alternate depths for flow in rectangular channels</p> <p>Sushil K. Singh</p> <p>DOS: 4/2011; DOC: 3/2012</p>	<p>Ongoing study (Research study)</p> <p>Dr. M. Perumal enquired about the difference between the intended solution and that given in the book by Subhash. Dr. S. K. Singh informed that intended solution would be a generalized one and both alternate depths can be obtained from the known value of the specific energy.</p>
5.	<p>A transfer function model for event based runoff</p> <p>Sushil K. Singh</p> <p>DOS: 4/2011; DOC: 3/2012</p>	<p>Ongoing study (Research study)</p> <p>No specific comment/suggestion.</p>
6.	<p>Trend and variability analysis of Rainfall and Temperature in Himalayan region</p> <p>L. N. Thakural (PI), Sanjay Kumar, Sanjay K. Jani, and Tanveer Ahmed</p> <p>DOS: 10/2011; DOC: 09/2014</p>	<p>New study (Research study)</p> <p>No specific comment/suggestion.</p>
7.	<p>Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin</p> <p>Sanjay K. Jain (PI), Bhisim Kumar, S. P. Rai, and L. N. Thakural</p> <p>DOS: 04/2009; DOC: 03/2012</p>	<p>Ongoing study (PDS under HP-II)</p> <p>No specific comment/suggestion.</p>
8.	<p>Assessment of effects of sedimentation on the capacity/ life of Bhakra Reservoir (Gobind Sagar) on River Satluj and Pong Reservoir on River Beas</p> <p>Sanjay K. Jain (PI), J. V. Tyagi, L. N. Thakural, and Rama Mehta</p> <p>DOS: 04/2009; DOC: 03/2012</p>	<p>Ongoing study (PDS under HP-II)</p> <p>On suggestion from Dr. Grewal, Dr. S. K. Jain informed that the work at Lurgi in Beas basin for soil erosion will be consulted for the present study.</p>
9.	<p>Hydrological assessment of ungauged catchments (small catchment)</p> <p>Pradeep K Bhunya (PI), Rakesh Kumar, D. S. Rathore, Sanjay Kumar, P. C. Nayak</p> <p>DOS: 05/2009; DOC: 05/2012</p>	<p>Ongoing study (PDS under HP-II)</p> <p>No specific comment/suggestion.</p>
<b>Consultancy projects</b>		
10.	<p>Vetting of water availability studies of the Gulf of Khambhat Development Project</p>	<p>Ongoing study</p>

	(Kalpasar Project) Goel, Vijay Kumar (on lien) DOS: 04/2011; DOC: 10/2011	M. K.	
11.	Glacier Lake Outburst Flood (GLOF) study for Jelam tamak (THDC India Ltd.) Sanjay K. Jain, A. K. Lohani, L. N. Thakural, Anju Chaudhary, and Tanveer Ahmed		Ongoing study
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, and Anju Chaudhary		Completed
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, and Tanveer Ahmed		Completed

### **RESEARCH COORDINATION & MANAGEMENT UNIT (RCMU)**

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	No specific comment/suggestion.

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

The Chairman thanked the members for their valuable contributions during deliberations in the Working Group meeting.

The meeting ended with vote of thanks to the Chair.

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**ANNEXURE-I****List of participants of the 35<sup>th</sup> Working Group Meeting**

1	Shri R.D. Singh Director, NIH	<b>Chairman</b>
2	Prof. J S Rawat, Kumaon University, Almora	Member
3	Dr R Krishnan, IITM, Pune	Member
4	Shri R C Jain, CGWB, Dehradun	Member
5	Dr M P Singh, FRI, Dehradun	Member
6	Dr Kishore Kumar, NIC, New Delhi	Member
7	Shri A K L Asthana, WIHG, Dehradun	Member
8	Dr M Perumal, IIT Roorkee	Member
9	Dr R K Goyal, CAZRI, Jodhpur	Member
10	Dr V V Rao, NRSC, Hyderabad	Member
11	Er Ravindra Kumar, SWARA, Lucknow	Member
12	Dr G P Juyal, CSWCRTI, Dehradun	Member
13	Shri Niladri Naha, SWID, Kolkata	Member
14	Er D K Singh, UJS, Dehradun	Member
15	Shri B M M Krishna Rao, GWD, Hyderabad	Member
16	Er N K Sharma, IRI, Roorkee	Member
17	Prof K C Patra, NIT Rourkela	Member
18	Dr A P Singh, BITS Pilani	Member
19	Dr S S Grewal, Chandigarh	Member
20	Dr Ritesh Arya, Chandigarh	Member
21	Dr Ravi Chopra, PSI, Dehradun	Member
22	Dr (Mrs) Vijayalakshmi, DA, New Delhi	Member
23	Shri Bharat Kakade, BAIF, Pune	Member
24	Dr A J James, Gurgaon/New Delhi	Member
25	Shri R M Bhardwaj, CPCB, New Delhi	Member
26	Prof. B.P. Singh, Gurgoan	Invitee
27	Dr. Bhishm Kumar, Head, HI Division, NIH	Member
28	Dr. V K Choubey, Head, EH Division, NIH	Member
29	Dr. N.C. Ghosh, Head, GWH Division, NIH	Member
30	Dr. V. C. Goyal Scientist F & Head, RCMU, NIH	Member-Secretary

### **Scientists from National Institute of Hydrology, Roorkee**

1. Dr. S.K. Singh, Sc.F
2. Shri C.P. Kumar, Sc. 'F'
3. Dr. Sanjay Kr. Jain, Sc.F
4. Dr. J.V. Tyagi, Sc.F
5. Dr. Sudhir Kumar, Sc.F
6. Smt. Deepa Chalisgaonkar, Sc.F
7. Shri Omkar Singh, Sc.E2
8. Dr S.D. Khobragade, Sc.E1
9. Dr. S.P. Rai, Sc.E1
10. Dr A R Senthil Kumar, Sc.E1
11. Shri S K Verma, Sc. C
12. Smt. Archana Sarkar, Sc.C
13. Shri A K Dwivedi, Sc. C
14. Dr. M.K. Sharma, Sc.C
15. Shri Pankaj K. Garg, Sc.B
16. Dr Ravindra Kale, Sc. B
17. Shri J P Patra, Sc. B
18. Shri Sumant Kumar, Sc. B
19. Dr Rajesh Singh, Sc. B
20. Shri L N Thakral, Sc. B
21. Shri T R Nayak, Sc. E1-RC Sagar

**ANNEXURE-II****Approved Work Program of Different Divisions for the Year 2011-12****ENVIRONMENTAL HYDROLOGY DIVISION**

SN	Study	Team	Duration
<b>Internal Studies</b>			
1	Spatial Variability of Ground Water Quality in Kandi, Sirowal and Shiwalik Belts of Jammu Region, J&K (India)	Omkar Singh (PI), V K Choubey, D.G. Durbude, M K Sharma	DOS: Apr 2010 DOC: Mar 2011 Revised DOC: Sep 2011
2	Environmental Flow Requirement of a River: A case study of Hemavathi River	Dilip G. Durbude (PI), V.K. Choubey, Omkar Singh, M.K. Sharma	DOS: Oct 2009 DOC: Sep 2012
3	Development of low cost media for fluoride removal from drinking water of fluoride affected areas	Rajesh Singh (PI), V K Choubey, Omkar Singh, M K Sharma	DOS: Apr 2011 DOC: Mar 2013
4	Assessment of Groundwater Quality in Hindon River Basin	M.K. Sharma, V. K. Choubey, Omkar Singh, Rajesh Singh	3 Years <b>(New Study)</b>
<b>Sponsored Projects</b>			
5	Assessment of Ground Water Quality in Class I Cities in India - Phase II	V.K. Choubey, M.K. Sharma	DOS: Oct 2008 (Ph-I), Apr 2010 (Ph-II) DOC: Mar 31, 2011 (extended upto Oct, 2011)
6	Impact of sewage effluent on drinking water sources of Shimla city and suggesting ameliorative measures	V.K. Choubey (PI), R.P. Pandey, Omkar Singh, D.G. Durbude, M.K. Sharma, Rajesh Singh	DOS: Apr 2009 DOC: Mar 2012

**GROUNDWATER HYDROLOGY DIVISION**

Reference Code	Study	Team	Duration	Funding Source
<b>Internal Studies</b>				
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)	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)	NIH
3. NIH/GWD/NIH /11-14	Groundwater Fluoride Contamination in different parts of India and study	A.K. Dwivedi (PI) N.C. Ghosh, Anupma Sharma, Sumant Kumar,	3 years (04/11– 03/14)	NIH

	severity of Fluorosis in a Drought prone area	Sanjay Mittal, Ram Chandra		
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)	NIH
<b>Sponsored Projects</b>				
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)	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: Bhishm Kumar, V. C. Goyal, C. K. Jain, Sudhir Kumar, B. Chakravorty, A. K. Lohani , Anupma Sharma, Surjeet Singh, Sumant Kumar	36 months ( Oct, 2011- Sep,2014)	European Union
<b>Consultancy Projects</b>				
7.	Feasibility study of surface water and groundwater availability including identification of potential groundwater recharge sites in the CIFMR campus, Dhanbad		6 months w.e.f. August, 2011.	Engg. Projects (India) Ltd.

### HYDROLOGICAL INVESTIGATIONS DIVISION

Reference Code	Study	Team	Duration/ Status
<b>Internal Studies</b>			
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)
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)

Reference Code	Study	Team	Duration/ Status
NIH/HID/INT/10-12	Identification of Recharge Zones of Some Selected Springs of Uttarakhand Using Isotopes	S. D. Khobragade (PI) Bhishm Kumar, Sudhir Kumar, S. P. Rai, Pankaj Garg + Uttarakhand Jal Sansthan	2 years (04/10-03/12)
NIH/HID/INT/11-13/1	Assessment of Radon Concentration & Identification of Paleo Groundwater in Punjab State	S K Verma (PI), Sudhir Kumar M S Rao, Bhishm Kumar	2 years (04/11-03/13)
NIH/HID/INT/11-13/2	Hydrological Assessment for Artificial Recharge and Water Management in Ghar Area, Saharanpur District, U.P.	P.K.Garg (PI), Sudhir Kumar, Tanveer Ahmad, Rajesh Agarwal, V C Goyal, Bhishm kumar	2 years (04/11-03/13)

Sponsored Projects				
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 + other 13 organizations	5 years (07/07-06/12)	DST
NIH/HID/FRI/08-13	Impact Assessment of Landuse on the Hydrologic Regime in the selected Micro-watersheds in Lesser Himalayas, Uttarakhand	S.P. Rai (PI) Bhishm Kumar J.V. Tyagi	5 years (04/08-03/13)	FRI
NIH/HID/GBPIHED/10-13	Development of Spring Sanctuaries in an Urban and Rural Watershed in District Pauri Garhwal, Uttarakhand	Dr. S.P. Rai (PI), Bhishm Kumar, Sudhir Kumar, Suhas Khobragade, Pankaj Garg	3 years (04/10-03/13)	GBPIHED
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)	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 + DMG, Karnataka	3 years (07/09-6/12)	HP-II
NIH/HID/CON S/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 (07/11-6/13) <b>New study</b>	Forest dept. Chandigarh

Consultancy Projects				
NIH/HID/DJB/10-11	Assessment of Groundwater Resources & Development Potential of Yamuna Flood Plain, NCT, Delhi	Sudhir Kumar (PI) Vijay Kumar + IITD,DU,CGWB, IARI, CWC,DJB	1 year (02/10-01/11) <b>(Consultancy)</b>	Delhi Jal Board
NIH/HID/RSM ML/JKT/10-12	Hydrogeological studies of Jhamarkotra Mines, Udaipur, Rajasthan	Sudhir Kumar (PI), M.S.Rao, S.K. Verma, Pankaj Garg	1.5 years (07/10-12/11) <b>(Consultancy)</b>	RSMML, Udaipur

### SURFACE WATER HYDROLOGY DIVISION

Ref. Code	Study	Team	Duration
<b>Internal Studies</b>			
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
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
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
4. NIH/SWD/NIH/08-	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora, Rakesh Kumar	To be continued
5. NIH/SWD/NIH/10-13	Climatic Scenarios Generation for Satluj Basin using Statistical Downscaling Techniques	Manohar Arora, Rakesh Kumar	3 years
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)
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
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. Jain, Rakesh Kumar	2 years
9. NIH/SWD/NIH/11-14	Hydrological Studies for Upper Narmada Basin.	Jagdish P. Patra, Rakesh Kumar, Pankaj Mani, T R Sapra	3 years

## WATER RESOURCES SYSTEMS DIVISION

S.N.	Study	Team	Duration
<b>Internal Studies</b>			
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)
2.	Web based Information System for Major and important Lakes in India	D. Chalisgaonkar, Suhas Khobragade	1 year (4/10-3/12)
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)
4.	Development of analytical equation for alternate depths for flow in rectangular channels	S.K. Singh	1 year (4/11-3/12)
5.	A transfer function model for event based runoff	S.K. Singh	1 year (4/11-3/12)
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) <b>New Study</b>
<b>Sponsored Projects</b>			
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)
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)
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)
<b>Consultancy Projects</b>			
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)
11.	Glacier Lake Outburst Flood (GLOF) study for Jelam tamak (THDC India Ltd.)	Sanjay K Jain, AK Lohani, L N Thakural, Anju Chaudhary, Tanveer Ahamd	
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	
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, Tanveer Ahamd, PRA	

## **RESEARCH COORDINATION & MANAGEMENT UNIT (RCMU)**

<b>SN</b>	<b>Study</b>	<b>Team</b>	<b>Duration</b>
<b>Internal Studies</b>			
1	Recession Flow Analysis for Evaluation of Spring Flow in Himalayan Region, India	R. V. Kale (PI), V. C. Goyal	DOS: Apr 2011 DOC: Mar 2013