

MINUTES OF THE 31st WORKING GROUP MEETING OF NIH

HELD DURING SEPTEMBER 17-18, 2009

AT

NATIONAL INSTITUTE OF HYDROLOGY ROORKEE



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MINUTES OF THE 31ST MEETING OF THE WORKING GROUP OF NIH HELD DURING SEPTEMBER 17-18, 2009 AT NATIONAL INSTITUTE OF HYDROLOGY ROORKEE.

The 31st meeting of the Working Group of NIH was held in the Society Room of the National Institute of Hydrology, Roorkee during September 17-18, 2009 under the Chairmanship of Shri R. D. Singh, Director, NIH. The list of the members and invitees participated in the meeting is given in Annexure-I.

The meeting was started with observance of one minute silence as a mark of condolence for Late Prof. R. D. Verma, who had expired in the month of July, 2009 at Jodhpur. Prof. Verma was an active member of NIH's Working Group and he had served up to the 30th Working Group (WG) meeting. The Chairman and members of the WG put on record the appreciation of services rendered by Prof. Verma to different working group meetings of NIH.

After the condolence, the meeting started with self introduction of the participants followed by the formal agenda.

ITEM NO. 31.1: OPENING REMARKS BY THE CHAIRMAN

The Chairman, WG welcomed the Working Group members and the Scientists of the Institute present in the meeting. The Chairman gave a brief background of the various technical and research activities taken up by the Institute during the previous six months (April-September, 2009). He informed that the Ministry of Water Resources, Govt. of India under the 'National Water Mission' has entrusted a big responsibility to the Institute for R & D studies related to Climate Change impact on water resources, and has identified NIH as the Nodal organization to that effect. He further informed that in a recent follow up meeting taken by Chairman, CWC, it was decided that any organization/ individual willing to undertake R & D studies related to impact of Climate Change on water resources can financially be supported from Ministry of Water Resources. The Chairman, WG has thus stressed the need of good R & D projects on Climate Change, and invited R & D projects from interested organization/individual.

The Chairman, WG explained the important role being played by the Institute in carrying out the various activities of the World Bank funded HP-II. The activities include: development and implementation of DSS (P) for integrated water resources development and management, undertaking and carrying out Purpose Driven Studies (PDS), organizing a number of training programs, etc. under HP-II. The Chairman expressed that the objectives of this midterm meeting are to take stock and evaluate the progress of scientific activities undertaken during the year 2009 -10 and to guide Institute for its future R & D activities. Thereafter, the Chairman requested the Working Group members to give their observations, suggestions and remarks on the scientific activities of the Institute.

Prof. B. S. Mathur : while appreciating the scientific outputs of the Institute, he opined that each division should have come out with a vision of future research areas along with NIH approach as to how to achieve those before the Working Group to enable the members to give requisite inputs.

Dr. S. K. Mittal : opined that NIH should also monitor water quality data and involve in developing technologies for wastewater treatment. He stressed the need of glacier monitoring data and climate change studies.

Shri K. B. Parmar: suggested requirement of Climate Change studies for western India.

Shri S. K. Gupta: requested for larger cooperation between NIH and Water Resources Departments, Govt. of Uttarakhand.

Dr. S. P. Agarwal: suggested to include quantitative remote sensing for climate change studies.

Shri K. P. Singh: expressed concerns for sedimentation in rivers and reservoirs. He suggested taking up research study for delineating sedimentation profile near to intake structure of powerhouse.

Shri R. K. Jain: appreciated the work done by NIH for NWDA on interlinking of rivers. He stressed the need of undertaking R & D studies on impact of climate change in coastal regions.

Shri Bhopal Singh: suggested that NIH should come out with simple model/method for design flood estimation for practicing engineers. He informed that CWC can work with NIH to that direction.

Director, NIH responded to the remarks given by the members. On the remarks given by Dr. S. K. Mittal, Chairman, WG informed that water quality data monitoring do not come under the purview of NIH. In cases where representative and specific water quality monitoring are required for studies, scientists collect the required data. He further informed that Environmental Hydrology Division of the Institute under a project sponsored by CPCB is generating databases of groundwater quality for number of Class-I cities in India.

After the remarks and suggestions given by the members, Chairman asked Dr. N. C. Ghosh, Member-Secretary, WG to take up the agenda items in sequence.

ITEM NO. 31.2: CONFIRMATION OF THE MINUTES OF THE 30TH MEETING OF THE WORKING GROUP.

The minutes of the meeting of 30th Working Group held during 8-9 April, 2009 were circulated to all the working group members vide letter no. RCMU/WG-30/NIH-09 dated 16th April, 2009. No comments were received.

On this point, Prof. B. S. Mathur remarked that receiving no comments were not a healthy practice. He requested members to spare some times on the minutes and give their valuable suggestions and comments wherever they found befitting to improve the contents of the minutes.

The minutes were confirmed.

ITEM NO. 31.3: PRESENTATION AND DISCUSSION ON THE PROGRESS OF THE WORK PROGRAM OF THE FIVE DIVISIONS FOR THE YEAR 2009-10 INCLUDING THE ACTIONS TAKEN ON THE RECOMMENDATIONS/ DECISIONS OF THE PREVIOUS MEETING AND PRESENTATION AND FINALIZATION OF NEW STUDIES.

During the meeting the status of the current year (2009-10) work program as well as the proposed new studies were discussed division-wise in detail. The Chairman requested the Heads of the Divisions to make the presentation and advised that while presenting the progress, each P.I should stick to the objectives of the study and progress made and results obtained in last six months.

The division-wise progress of each study was taken up for presentation, and discussed in the following sequences:

On 17th September, 2009

- (i) Environmental Hydrology Division**
- (ii) Ground Water Hydrology Division**
- (iii) Hydrological Investigation Division**

On 18th September, 2009

- (iv) Surface Water Hydrology Division**
- (v) Water Resources System Division**

The details of division-wise presentation and suggestions/comments emerged from discussion are given in the following sections.

ENVIRONMENTAL HYDROLOGY DIVISION

Dr. V.K. Choubey, Sc. F & Head (EHD), presented an overview of technical activities & progress made during last six months. Thereafter, he requested the concerned PI/Co-investigators to present the detailed progress of the studies made during past six months. Study-wise suggestions and discussions emerged are given below.

Study No. : NIH/EHD/CPCB/08-10: Assessment of Ground Water Quality in Class – I Cities in India (CPCB sponsored project)

Dr. M K Sharma, Scientist C & Co-PI presented the progress of the study. Dr Sharma informed that out of twenty five class I cities, twelve cities are being covered in first year of the study. The pre-monsoon sampling of twelve class-I cities viz; Guwahati, Raipur, Shimla, Jammu, Shillong, Aizawal, Kohima, Bhubneshwar, Agartala, Dehradun, Itanagar & Gangtok have been completed. About thirty samples from open wells, ring wells, bore wells and handpumps from each of these cities covering residential, industrial, petroleum storage, landfill sites have been collected

and are being analyzed for various water quality constituents viz; major cations and anions, metal ions, bacteriological parameters. Analyses for pesticides residue and PAH are to be taken up. Dr Gurunadharao suggested analysis of pesticides for the collected water samples prior to the other type of analysis as organophosphorous pesticides are volatile in nature.

Study No. : NIH/EHD/HP-II/09-13: **Impact of sewage effluent on drinking water sources of Shimla city and suggesting ameliorative measures**

Dr. V.K. Choubey informed that the study has been awarded under the PDS component of HP-II. After brief introduction about the study by Dr. Choubey, Shri Omkar Singh, Scientist E1 (Co-PI) presented the progress of the study. Shri Singh informed that some basic information, which include collection of reports and sewer network map, have been collected during the last Shimla visit. The concerned officials of I&PH Department (Govt. of H.P) had also visited NIH, Roorkee to discuss about water quality and hydro-meteorological data monitoring in the field. Prof. G.C. Mishra (IIT, Roorkee) advised to identify the source of contamination in groundwater, which is pumped to supplement water supply in Shimla Town. Prof. B.S. Mathur (IIT, Roorkee) suggested that field work activities of NIH and I&PHE (Shimla) need to be clearly spelt out to avoid duplication and gap. Dr. V.V.S. Gurunadharao (NGRI) enquired about the existing capacity of the sewer line in Shimla. Shri Singh informed that it is to be worked out and for which SewerCAD software shall be used with the help of a consultant. The Chairman advised that the component studied and to be studied by I&PHE (Shimla) should also be included in the progress in future.

Study No : NIH/EHD/NIH/07-10: **Modelling of Pesticide Transport in Ground Water – a case study of Metropolitan City – Vadodara**

Dr M K Sharma presented the progress of the study and elaborated the results of the sampling and pumping test carried out in June 2009. Dr Gurunadharao enquired about the distribution of isomers of BHC in the drain samples. Dr Sharma presented the pesticide data showing the distribution of BHC in the drain samples. Dr G C Mishra suggested to check the calculation and formula used for calculating the aquifer parameters. Dr Sharma further elaborated the results of column experiment for adsorption of lindane on soil of Vadodara city. Dr B S Mathur suggested to carry out the column experiment in the column of atleast 4" diameter or in the lysimeter as recommended in literature for column test through which field condition to some extent can be maintained.

Study No : NIH/EHD/NIH/08-09: **Evaluation of water quality of rivers joining Tehri Reservoir and downstream of the reservoir**

Dr M K Sharma presented the objectives and progress of the study and elaborated the results of the sampling carried out in May and August 2009. Dr Sharma informed that the results revealed presence of bacteriological contamination. Chairman suggested to complete and prepare the report giving causes of the pollution.

Study No. NIH/EHD/NIH/09-12: **Environmental Flow Requirement: A case study of river**

Shri. D.G. Durbude, Scientist-C who has recently joined the division, presented the new study on "Environmental flow requirement (EFR). He informed that the study area will be selected as per the data availability. Dr. K. V. Jaykumar (CWRDM, Kozikhode) and Shri R.K. Jain (NWDA) wanted to know the objectives and the methodologies for EFR. Head, EHD informed that there is demand from Karnataka Power Corporation Limited, Bangalore to carry out EFR as a part of EIA study. The Chairman advised to review the work carried out by NIH and other organizations on EFR estimation for finalizing the methodologies.

The work program of the division for the year 2009-10 is given in annexure – II.

GROUND WATER HYDROLOGY DIVISION

Dr. N. C. Ghosh, Scientist 'F' & Head, Ground Water Hydrology division presented a general overview of the activities of Ground Water Hydrology division. He also briefly reported the other scientific works in which scientists of the division are involved. Study-wise suggestions and discussions emerged from the presentation of progress of studies are given below.

Study No.-NIH/GWD/NIH/08-4/09: **Mitigation and Remediation of Ground Water Arsenic Menace in India**

Dr. N. C. Ghosh informed that the vision document along with a supplementary entitled "Plan of Actions" has been completed and submitted to the Ministry of Water Resources on 31st August, 2009. He further informed that a day long workshop inviting officials from related Ministries was organized by the Ministry on 4th September, 2009 at New Delhi to discuss on the 'Vision Document'.

Dr. Ghosh briefly presented the outcomes of the vision document prepared with the help of number of subject experts from different places in the Country.

Study No.-NIH/GWD/NIH/07-03/10: **Quantification of impact of rainwater harvesting on groundwater availability in Aravalli hills**

Dr. Anupma Sharma, P.I. of the study presented about background and objectives of the study, data monitored and field investigations carried-out so far in Savana macro-watershed and progress made in last six months. Superintending Engineer, Irrigation Deptt., Jaipur wanted to know the reasons of inadequate runoff at most of the dam sites in Rajasthan. He mentioned that nearly 905 dams are not

getting designed inflows even there is good rainfall. The Chairman explained that the reason may be due to rainwater harvesting structures, check dams and diversion of flows in the upstream catchment. The Chairman enquired whether any groundwater modeling study would be done to ascertain the effectiveness of all the recharge structures.

Study No.- NIH/GWD/NIH-04/09-03/12 : Impact of Climate Change on Dynamic Groundwater Recharge in a Drought Prone area

Dr. Surjeet Singh, P.I. of the study presented brief background, objectives, and methodology of the study including data collection and processing work undertaken in the previous six months. It was informed that Sonar basin in Madhya Pradesh is selected as the study area. Dr. K. V. Jayakumar enquired about the rainfall data due to climate change effect. Chairman informed that climate change effected rainfall data would be downscaled from Global Circulation Model (GCM) outputs to the basin scale. On enquiry from Prof. Deepak Kashyap about the quantification of changing characteristics of recharge, Mr. C. P. Kumar mentioned that groundwater recharge for various climatic change scenarios will be estimated using Visual HELP model which is based on water balance of the unsaturated zone. Dr. S. K. Singh and Dr. Kashyap suggested to change the title of the study as "*Impact of Climate Change on Groundwater System in a Drought Prone Area*" in place of "Impact of Climate Change on Dynamic Groundwater Recharge in a Drought Prone area".

Study No. : NIH/GWD/NIH/09-02/11 : Study of Rising Ground Water Table in Jodhpur City, and to Evolve a Management Plan to Contain the Rising Trend

Dr. N.C. Ghosh informed that the study has been sponsored by the Groundwater Department, Govt. of Rajasthan with a financial supported of Rs.24.52 lacs. He informed that the Jodhpur city located in the Thar desert is experiencing the trend of rising groundwater level since year 1997, and a large area in the city are affected by the rising groundwater level. Dr. Ghosh gave a brief description about the problem and the expectation of the state Govt. from the study. Dr. Gurnadha Rao enquired about whether the reason of rising groundwater level is because of irrigated water in the catchment. Dr. G.C. Mishra stated that it is a problem of real concern and requires scientific solution. He mentioned his observations noted from his visit to the area recently. Prof. Mishra explained that apparently it shows that water accumulated in the Jodhpur city, which has a bowl shape reservoir, either through lineament or through return flow do not have adequate drainage from the area. The problem is due to imbalance of water in the aquifer. He mentioned that the State Remote Sensing Department could identify lineaments between the Kailana Laka and Takhat Sagar reservoir (source of water) and the Jodhpur City area. Sudden drawdown of groundwater table can not be done as it may cause damage to the building structures. Dr. Gurnadha Rao enquired about the topography of the area. The Chairman enquired from members, if there is any suggestion about the possible technological options as remedial measures.

Study No.- NIH/GWD/NIH/09-08/11: **Identification of Artificial Recharge Sites in a Basin**

Sh. Shobha Ram, presented the objectives, methodologies and possible outcomes of the proposed new study. The Working Group approved the study as proposed.

The approved work program of the division for the year 2009-10 is given in Annexure- II.

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 along with number of research papers published/accepted for publication/communicated, and analytical work carried out at the Nuclear Hydrology Laboratory. The progress of studies was presented by the respective P.I. of the study are given as under:

Study No. : NIH/HID/NIH/2009-12 : **Surface water and Groundwater interaction at selected locations along river Yamuna in NCT, DELHI**

Dr. Sudhir Kumar presented the progress of the study. He informed that this is the second phase of the study. The first phase was completed during March, 2008 and it was felt that detailed investigations with more data are needed. So the second phase was taken up. He informed that groundwater samples have been collected from eighteen existing wells (13 piezometers, 3 hand pumps, 1 Ranney well and 1 shallow tubewell) located along 2 cross sections almost perpendicular to the Yamuna River on the Delhi side. He further informed that previously the river water samples were collected on weekly basis during the monsoon season but now these are collected on daily basis. Water levels are also measured in piezometers at weekly interval on Delhi side of the river Yamuna. He presented the detailed analysis of the isotope data including the isotopic signatures of the rainfall samples, obtained so far as well as the analysis of the water level data. He pointed out that the geological situation is not simple along the river due to the existence of paleo-channels. This makes the river water to move faster in the paleo-channel. At the previous site, well no. 4 represented such a situation while at the new site well no. 1 showed similar variations. Therefore, some more data of the old and new sites will make the picture clearer. Dr. Sudhir Kumar informed about the work being carried out in the direction of flow modelling along the river Yamuna.

Study No. : NIH/HIDIWIN//DST/07-12: **National Programme on Isotope Fingerprinting of Waters of India (IWIN)**

Dr. M. S. Rao presented the progress of the study. He informed that with stable isotopic analysis of air moisture it was possible to distinguish the source of moisture in the air. The $\delta^{18}\text{O}$ of air moisture collected using condensation method was -5‰ for the vapors of local origin while it was close to -22‰ for the monsoon vapors. However, if the moisture was collected by Push and Trap System (trapping vapors at -90°C), the source of moisture could be detected from the difference in linear relationship observed between $\delta^{18}\text{O}$ and $\delta^2\text{H}$ during monsoon and non-monsoon seasons. Minor depletion observed in $\delta^{18}\text{O}$ spectrum during non-monsoon periods (during winters and during pre-monsoon periods) can be due to moisture inception from *western disturbances*. In general, stable isotopic composition ($\delta^{18}\text{O}$, δD) of pre-monsoon vapors are most enriched and monsoon vapors are most depleted while post-monsoon vapors are intermediate between these two. Correlation with meteorological parameters with $\delta^{18}\text{O}$ in air moisture shows that during monsoon season, relative humidity correlates positively with $\delta^{18}\text{O}$ and negatively in the remaining period.

Dr. Rao also informed that groundwater composition at Roorkee can be differentiated as per $\delta^{18}\text{O}$ composition as due to canal ($\delta^{18}\text{O} = -10\text{‰}$), local rain ($\delta^{18}\text{O} = -7\text{‰}$) or due to local impounded water ($\delta^{18}\text{O} = -4\text{‰}$). On the basis of tritium analysis of Ganga river water it was informed that during summer months the river Ganga carries snow melt water with $^3\text{H} = 11\text{ TU}$ while during monsoon months, the rainfall contributed discharge has ^3H about 7 TU.

Prof. B. P. Singh suggested for investigating systematically the distribution of $\delta^{18}\text{O}$ & δD during monsoon and its pre & post seasons. Chairman, WG suggested to compare the NIH data with the participating IWIN member Organizations and with their interpretations to come to a common conclusions. Dr. Bhishm Kumar informed that NIH started these experiments an year before the participating organizations and therefore, after sufficient data are collected by the other IWIN member organizations the common interpretation can be made. He also informed that all the IWIN member organizations are following common experimental and analytical procedure.

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 have been selected near Mussoorie. Arnigad micro-watershed having an area of 3 km^2 is covered with dense oak forest while Bansigad microwatershed having an area of 2 km^2 is covered with degraded mix forest of oak and pine. Both the watersheds are on the south facing hill slope. He informed that other geomorphological features such as geology of area, morphometric parameters and soil characteristics are nearly same only difference is in land cover.

He further informed that the compound weir (120° 'V' Notch and rectangular) and automatic water level stage recorder have been installed in these watersheds for monitoring the continuous stream discharge. Meteorological observatories have been installed near the outlet of each watershed for monitoring the rainfall, temperature, humidity and evaporation etc. The continuous data have been recorded since June 2008 onwards. For isotopic characterization of rain and streams, water samples have been collected for measuring ^{18}O and D analysis and also for ^3H analysis.

While presenting the results of the study he informed that the discharge in degraded watershed varied between minimum $0.01\text{m}^3/\text{sec}$ in the month of June and maximum $1.02\text{m}^3/\text{sec}$ in the month August while in forested watershed it is observed minimum between $0.05\text{m}^3/\text{sec}$ in the month of June and maximum $0.88\text{m}^3/\text{sec}$ in the month of August. Further, hydrograph shows that rainfall response on stream discharge of both watershed is very quick. However, the recession part of hydrograph in the two watersheds differs from each other. The discharge declines slowly in Arnigad stream during post monsoon months while it declines at faster rate in Bansigad stream and the stream dries up in summer months. The results indicate that the ground water storage in the forested watershed is about 25% of the total rainfall while in the degraded forest watershed, it comes to about 12%. Therefore, the stream flowing through the forest sustains the discharge throughout the year due to delayed subsurface flow.

He also presented detailed analysis of the stable isotopic signatures of rain, stream and springs and based on the isotopic analysis it was demonstrated that the technique can be successfully used to separate the various components of the hydrograph. He also presented the results of the investigations on the identification of the recharge zones of the springs.

Dr. Gurunadha Rao enquired whether the springs are perennial or ephemeral. Dr. Rai informed that the selected springs are perennial in nature. Dr. S. K. Singh enquired whether the isotope technique is only useful in real time. Dr. Bhisim Kumar informed that if isotopic data are available then it can be used to separate out the hydrograph components even of the past data.

Study no : NIH/HID/INCID/09-11: **ESTIMATION OF IRRIGATION RETURN FLOW IN SELECTED CANAL COMMAND AREAS IN UTTARAKHAND AND UTTAR PRADESH**

Dr. M.S. Rao informed that the INCID sub-committee has asked to revise the above project with incorporation of some its suggestions and comments. The project will be implemented after approval of the revised project by the INCID sub-committee

Study No. NIH/HID/HP-2/08-125 : **GROUNDWATER MANAGEMENT IN OVER-EXPLOITED BLOCKS OF CHITRADURGA AND TUMKUR DISTRICTS OF KARNATAKA.**

The study was presented by Dr. Sudhir Kumar. He informed that the study has been approved as a purpose driven study under the Hydrology Project II. He further informed that the present study involves a comprehensive multi-institutional, multi-disciplinary and multi-locational study approach. The Groundwater Department of Karnataka State would provide crucial inputs pertaining to hydro-geology, hydrology, land use etc. Conjunctive use of surface/ groundwater, artificial recharge/ draft regulation and institutional interventions would be crucial decision variables.

While reporting the progress of the study he informed that the work on the project could start only from July, 2009 though it was approved in 2008. Two watersheds have been identified in the Tumkur and Chitradurga districts. DEM and Drainage maps of these two watersheds have been prepared. The instruments are being procured and the staff is being engaged to start the work in these watersheds.

Study No. NIH/HID/HP-II/09-12: **GROUNDWATER DYNAMICS OF BIST-DOAB AREA, PUNJAB USING ISOTOPES**

Dr. M. S. Rao informed that this study has started in July 2009. Over the last couple of months, archival data from State and Central agencies working in the BIST Doab region were collected and field work were taken up to collect groundwater and river water samples. The isotopic analysis of water samples clearly indicated that it is possible to resolve the recharge sources of groundwater as to be due to the rivers Beas ($\delta^{18}\text{O} = -7.3 \text{‰}$) or due to the river Satluj ($\delta^{18}\text{O} = -11.35 \text{‰}$) or due to the combination of these two. To identify rainfall recharge contribution, 5 rainwater collecting sites have been established.

Study No. NIH/HID/INT/09-12: **INTEGRATED HYDROLOGICAL INVESTIGATIONS OF ROPAR LAKE,**

Dr. Bhishm Kumar briefly presented the progress of the study. While reporting the background of the study he informed that the study was proposed based on the request of the Punjab State Council of Science and Technology. During the field visit to the site carried out in June, 2009 by the study team, it is observed that the water body referred to as lake, is not actually a lake but a barrage constructed on river Satluj to divert the water through two canals located on it. Dr. Bhishm Kumar informed that on discussion of the matter with the Punjab Council of Science and Technology, it is learnt that the council is mainly interested to know the sedimentation rate in the water body. The study was thus proposed with modified titled as "Sedimentation studies of Ropar Lake using isotope techniques" having objectives as (i) estimation of sedimentation rate in the water body. In light of the restricted objectives, it was proposed that the duration of the study be reduced to one year only, i.e., to be completed by March, 2010. He informed that the sedimentation rate in the lake would be studied using the isotope techniques.

The approved work program of the division for the year 2009-10 is given in Annexure- II.

SURFACE WATER HYDROLOGY DIVISION

Sri Rakesh Kumar, Scientist F and Head of the 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 presented by the respective P.I. of the study. The details are as under:

Study No. NIH/SWD/NIH/08-: **MONITORING AND MODELLING OF STREAM FLOW FOR THE GANGOTRI GLACIER**

Dr. Manohar Arora presented the progress of the study. He informed that the field investigations are in progress and would continue till first week of October. He presented the data collected and analyzed so far. Data of discharge up to August has been analyzed and the flow values computed are in accordance with normal values. He further informed about the installation of AWS at the meteorological observatory.

Dr Apte enquired about how the drifted snow has been separated from the natural snowfall. Dr Arora replied that the drifted snow can not be separated from the natural snowfall. Dr Bishm Kumar informed that advanced technologies made it possible to receive the data at the office directly. Dr. Apte enquired as to how the data of winter could be collected. Dr Arora replied that arrangements are being made to locate a person at site to collect winter data.

Study No. NIH/SWD/NIH/09-11: **ASSESSMENT OF ENVIRONMENTAL FLOW REQUIREMENTS IN RIVER GANGA AT LOHARINAG PALA PROJECT SITE**

Dr Arora informed that the study area has been changed from Loharinag Pala to Teesta site because of a sponsored project by NHPC. In response to query by Shri R.K. Jain about the details of the study area, Dr Arora informed that the study area and data will be provided by NHPC shortly.

Study No. NIH/SWD/NIH/07-09: **DEVELOPMENT OF DROUGHT VULNERABILITY INDICES FOR PREPAREDNESS AND MITIGATION**

Dr R.P. Pandey, PI of the study presented the progress of the study. He informed that based on the request of PI from IIT Bombay for further extension for this project, Ministry of Water Resources has granted extension up to Dec. 2009. Dr. Pandey presented work done for completion of the project. He has also informed that UNESCO has offered its support for publication of methodology developed under this project for its wide circulation. The final project report is scheduled to be submitted to MoWR by 31 December 2009. Dr. Jayakumar of CWRDM, Kerala informed that a Ph.D. thesis has recently been completed in Anna University,

Chennai on assessment of vulnerability to drought. He assured to provide a copy of the thesis to Dr. Pandey.

Study No. NIH/SWD/NIH/08-12: STUDY ON INTEGRATED WATER RESOURCES MANAGEMENT OF A BASIN TO COPE WITH DROUGHTS

Dr R.P. Pandey, P.I. of the study presented objectives and the progress made in the past six months of the study. He informed that the study area has been chosen as the Tons basin in Madhya Pradesh.

Study No. NIH/SWD/NIH/07-09 :RUNOFF AND SEDIMENT MODELING IN A PART OF THE BRAHMAPUTRA RIVER BASIN USING ANN

Mrs. Archana Sarkar, PI of the study presented the background, objectives, methodology and progress made in last six months of the study. Mrs Sarkar informed that the study area includes three gauging sites and one northern tributary. She informed that ANN models for stage-discharge and sediment-discharge at three selected gauging sites namely, Choulduaghat, Pandu and Panchratna have been developed. She informed that the meteorological data for Subansiri River basin (biggest tributary of Brahmaputra in India) had been procured from RMC, Guwahati which had some missing data, however, making use of three years of data at six rainfall stations the rainfall-runoff ANN models was developed. The results presented showed average correlation due to shorter length of data. She further informed about the procurement of long term high resolution gridded data of daily rainfall and temperature for improving the performance of the rainfall-runoff ANN models. The Chairman advised to use the average value of daily gridded rainfall for the basin as input to ANN models. Mr. R.K. Jain enquired about the period of high resolution data. Mrs Sarkar informed that daily rainfall is available at 0.5 deg from 1961-2005 and daily temperature is available at a grid of 1.0 deg from 1969-2005. Sri Bhopal Singh enquired whether the ANN models would segregate snowmelt from runoff due to rain. Mrs Sarkar replied that ANN is a black box approach and it does not segregate the flow in different components. She informed that it is envisaged to take up a new study in coming year in which a conceptual model would be used to carry out snowmelt runoff modeling in part of the Brahmaputra basin.

Study No. NIH/SWD/NIH/09-11 : SNOW MELT RUNOFF MODELING USING FUZZY LOGIC

The progress of the study has been presented along with the progress of the study entitled, "Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin" of the Water Resources Systems Division.

Study No. NIH/SWD/NIH/05-10 : INTEGRATED HYDROLOGICAL STUDY FOR SUSTAINABLE DEVELOPMENT OF TWO HILLY WATERSHEDS IN UTTARANCHAL

Dr. Avinash Agarwal, P.I. of the study presented the progress made in last six months. He presented the progress made using old instrumentation, and based on data status, analysis of spring flow, flow duration curve, spring rainfall analysis, delineation of recharge zone infiltration and rainfall characteristics and water balance. He informed that the instruments required in the second phase of the project have been purchased and installed. Two new river gauging sites one each in Bainsoli and Tayari watershed have been constructed and river gauging has been initiated. He added that the shape file for watersheds for drainage characteristics, land use, soil texture, spring, tanks and instruments sites have been prepared using Arcview. The sediment sampling on four gauging sites is continued manually.

On enquiry from Dr. R.K. Jain about the status of the springs considered in both the watersheds, Dr. Agarwal informed that the watersheds have 21 and 29 springs in total and data of all these springs have been measured since July 1999. Out of these springs some have dried up and some receive interrupted flow during summer. A majority of the springs contribute discharge even during summer months. The information related to the status of spring flow data availability and Ten day flow duration curve have been reported during August 2008 in the form of report to DST.

Dr. K.P. Singh enquired about the working of AWS and its sensors. It was informed that Hobo make AWS was installed in April 2009. Since its installation, the sensors are working satisfactorily.

Study No. NIH/SWD/NIH/07-10 : **HYDROLOGICAL STUDIES IN A FORESTED WATERSHED IN UTTARAKHAND**

Dr. J.V. Tyagi, P.I. of the project presented the progress and results of the study. It was informed that the project is being carried out in collaboration with Forest Training Academy (FTA), Govt. of Uttarakhand in a Sal forested watershed of about 17 ha in Nainital District. Dr. Tyagi informed that based on the analysis of limited data, it was observed that the regeneration is better correlated with incidence of light intensity than the soil moisture storage. The higher regeneration under C1 canopy is mainly due to the higher incidence of light intensity despite lower levels of soil moisture in C1 canopy than in other canopies. The simulation by ANSWERS model showed that the soil erosion is higher in areas under C3 canopy than those under C1 and C2 canopies. The high soil erosion under C3 canopy contributes to uprooting and washing away of tender seedlings during their establishment stage in early monsoon season. This may be one of the reasons, among others, for poor regeneration under C3 canopy. It was further informed that the natural regeneration in Sal species is affected by the 'dying back phenomenon' which results in a very slow progress towards establishment of the seedlings. Therefore, the data of longer duration is needed for analysis of regeneration and establishment of its relationship with soil moisture and light intensity.

Study no. NIH/SWD/NIH/09-12 : **SNOW MELT RUNOFF MODELLING IN SUTLEJ BASIN**

Sri A. R. Senthil Kumar, PI of the project presented the objectives, methodology, and present status of the study. He briefed about the results obtained during the last

six months. The Chairman suggested to develop a separate ANN model for the higher range of values and to compare the results with the general model and to show results in the next working group meeting.

Study No. NIH/SWD/NIH/09-11 : **DATA BOOK-HYDRO-METEOROLOGICAL OBSERVATORY 2001-2008**

Sri Digambar Singh, PI of the project presented the objectives, methodology and present status of the study. He also presented the graphical sample of the data entry of 15 March 2001. The Chief Engineer, Jaipur enquired about the length of the data used. Sri Rakesh kumar replied that such type of report had already been prepared for the period up to 2000 and in the present report data from 2001-2008 will be included.

Study No. NIH/SWD/NIH/09-10: **IMPACT OF CLIMATIC CHANGE ON EVAPORATION**

Dr. Avinash Agarwal presented the objectives, methodology and other details of the proposed new study along with the funds required for this project. Dr. S.P. Agarwal enquired about the parameters that will be used in the development of the model. It was informed that the measurement of temperature and humidity will be carried out at two different heights along with solar radiation and wind velocity to be measured through AWS. The soil temperature and soil moisture will be measured at different depths along with the rainfall. The model will be developed using the data to be gathered. Sri B.P. Singh enquired as to how this project is related with climatic change. It was informed that the model will be developed using the measured climatic variables. This model will be used for prediction of evapotranspiration for 25 to 50 years by downscaling the GCM information of the grid for input variables. The Chairman, WG suggested that the title of the project may be changed from "Impact of Climate Change on Evaporation" to "Impact of Climate Change on evapotranspiration" and the duration of the study may be increased to two years instead of one year.

The approved work program of the division for the year 2009-10 is given in Annexure- II.

WATER RESOURCES SYSTEM DIVISION

Shri R. D. Singh, Head of the Division gave a brief description of the scientific and technical work undertaken and carried out by the Division in last six months. He informed that DSS (Planning) activities were looking after by Dr. Sharad Kumar Jain as Chairman when he was at NIH, and that is how, this activity appears in the work programme of this division. After a brief description, he asked the respective P.Is. for elaborating the progress made in their study in last six months. The progress of studies presented by the respective P.I. is given below.

Study No. NIH/WRSD/NIH/08-03/12: INTEGRATED APPROACH FOR MODELING SNOWMELT RUNOFF AND EFFECT OF CLIMATE CHANGE IN BEAS BASIN

Dr. Sanjay K. Jain presented the objectives and progress of the study He informed that the study has been taken up during September 2008. The hydro-meteorological data have been collected from BBMB, Sundernagar. Subsequently, processing of satellite data (MODIS satellite) have been carried out. A field visit has been made during June 2009 and the sites for discharge measurement and AWS have been selected. Mr. Bhopal Singh informed that CWC have gauging sites at Kothi and at Palchan, and data of these sites can be collected from Shimla office of CWC. Dr. Jain informed that the stream flow has been simulated under present as well as future conditions. The study has been carried out considering hypothetical scenarios of temperature and rainfall. Chairman mentioned that the future projections about climatological variables will be collected from IITM, Pune and the same will be used in the study. For the isotopic studies, Dr. Bhishm Kumar informed that field sampling will be carried out during this winter season and afterwards. It was also informed by Dr. Jain that the procurement of instruments and satellite data is in progress.

Study No. NIH/WRSD/NIH/09-03/13: ASSESSMENT OF EFFECTS OF SEDIMENTATION ON THE CAPACITY/ LIFE OF BHAKRA RESERVOIR (GOBIND SAGAR) ON RIVER SATLUJ AND PONG RESERVOIR ON RIVER BEAS

Dr. Sanjay K Jain informed that a PDS has been taken up by BBMB. NIH is collaborating with BBMB for this study. Dr. Jain presented the objectives and work elements along with the progress of the study. He informed that drainage and DEM maps for both the study area have been prepared using ASTER DEM. In order to procure the satellite data from NRSC, Hyderabad and meet other expenditures, a request of fund transfer has been made to BBMB. After receiving funds from BBMB, the sedimentation study using remote sensing data and the processing of other data will be carried out.

Study No. NIH/WRSD/NIH/08-03/10 : WEB-BASED HYDROLOGY AND WATER RESOURCES INFORMATION SYSTEM FOR INDIA

The study was presented by Mrs. Deepa Chalisgaonkar. Dr. S.P. Agarwal suggested that the source of the maps should be included in the information system. Mr. Jayakumar suggested that latitudes and longitudes may be shown on the maps. He also suggested to include schematic maps of the rivers. Dr S.K. Gupta and Dr Jayakumar have shown interest in getting the information system on the NIH web site. It was informed by Mrs. Chalisgaonkar that the information system has already been uploaded

on the NIH web site and is being accessed by several users. Dr. Jayakumar suggested for providing a link to the web site developed by CWRDM for the water resources of the Karela State, in the information system page of NIH web site. Dr S.P. Agarwal suggested that a disclaimer may be provided to avoid any controversy regarding mismatch of the basin/ state/ international boundaries in the information system web site of NIH. Mr. Bhopal Singh informed that a similar web site 'India WARIS', is being developed by Department of Space for CWC. The PI may contact CWC and department of space for knowing the capabilities.

Study No. NIH/WRSD/NIH/09-04/12: HYDROLOGICAL ASSESSMENT OF UNGAUGED CATCHMENTS (SMALL CATCHMENT)

Dr. P K Bhunya presented the status of the study in brief covering the objectives, methodology, analysis, and results. He further appraised the members about the duration of this purpose driven study (PDS). He informed that the new computer programs have been developed and the preliminary results, which included four nomographs (for unit hydrograph parameters, peak flow, time to peak, and base time) using data of 113 Indian catchments and tables showing calibrated parameters of a non-dimensional flow duration formulae have been obtained. The flow duration curve that was developed recently for 25 years of daily flow data for Hirakud upstream was shown coupled with a smooth curve. He also informed that the new regional water availability methods proposed by USGS, have been applied and some preliminary results were obtained. Dr. Bhunya further added that the geomorphological variables taken in the present study covers a wider range than the methods adopted in the earlier reports/methods by CWC, and the results shows remarkable improvement in the goodness-of-fit. Dr. Bhunya said that he is already in contact with the officers of Govt. of Orissa, and a workshop is planned in Oct/Nov, 2009-2010 where the results shall be discussed. He informed that the three technical publications have been brought out so far. Mr. Bhopal Singh mentioned that the CWC reports are for 12 sub-zones which are homogeneous regions. However, the present study is an attempt to arrive at regional formulae that is valid for a larger region irrespective of any pre-requisite homogeneity tests.

Study No. NIH/WRSD/NIH/ 06-09/5 : USE OF REMOTE SENSING IN SOIL MOISTURE AND WATER BALANCE ESTIMATION – A CASE STUDY OF THE SOLANI CATCHMENT

Dr. Sanjay K. Jain informed that IIRS, Dehradun is also collaborating in this study. He informed that first phase of the report has been completed in March 2009 and an interim report has been prepared. He also informed that an extension of three years was given for this study during the last meeting of the working Group. Dr. S P Agarwal informed that some more satellite data have been procured for this study. He informed that AWS has been procured and will be installed in the catchment area. Chairman suggested that the rainfall runoff modeling of the catchment should be carried out with the created data base.

Study No. NIH/WRSD/NIH/09-03/12: **APPLICATION OF A DISTRIBUTED HYDROLOGICAL MODEL FOR RIVER BASIN PLANNING AND MANAGEMENT**

Dr. M. K. Goel presented the proposed new study in detail. He highlighted the objectives, background, methodology, and proposed outcome of the study. He informed that the main objective of the study is to get familiar with the advantages and limitations of the distributed hydrological models (MIKE SHE/SWAT/MODSIM/NIH) at the scale of river basin and to compare the outcome with semi-distributed modeling approach (MIKE BASIN/HEC HMS). He also briefly presented the distributed river basin planning and management model that has been developed at NIH. The model application was illustrated for the Tapi basin. Sh. Bhopal Singh, Director, CWC enquired about the import/export options of the model. Dr. Goel clarified that the model accounts for import/export at each river segment or a hydraulic structure either within the basin or from/to outside the basin.

Prof. K. V. JayaKumar suggested that for the SWAT model, a GIS interface AvSWAT may be useful for the modelling. He further suggested that possibility of using another public-domain model *Distributed Rainfall Runoff Routing Model* (DRRRM). The model also has GIS interface. Dr S. P. Agarwal, IIRS informed that now ArcSWAT interface is also available for SWAT and this interface may be utilized.

Study No. NIH/WRSD/NIH/09-11: **GIS BASED DAMS AND DROUGHT INFORMATION SYSTEM**

The study was presented by Mr. D.S. Rathore. It was informed that the objective of the study is to utilize dam database for developing the drought indices considering the administrative boundaries on web using a GIS server. A database of dams and diversions and several thematic layers have already been prepared by NIH. The attributes and locations of dams and diversions are available as personal geo-database of MS Access. Salient features of 603 dams, diversions, canal drop hydropower stations were included. Salient features are based on reports, books, and web sites of the state water resources departments. The map contains locations of nearly 1812 dams and diversions. The rainfall data will be obtained from India Water Portal, which has nearly 100 year monthly data. Using this data, the drought index Standard Precipitation Index (SPI) will be computed. The data will be entered in the attribute table of district GIS theme. Dam database and various thematic maps will be published on the web using the Arc GIS Server. Information for the salient features, SPI etc. can be disseminated on the web using the map tip and attribute tables. Dr Jayakumar suggested changing the title of the project to reflect the scope of the study. Keeping this suggestion in view, it was proposed to change the title from 'GIS based hydrological Information System' to 'GIS based dams and drought information system'.

Working group approved the new proposed studies of the WRS Division. The approved work program of the division for the year 2009-10 is given in Appendix II.

ANNEXURE-I

List of Members and Invitees participated in the Working Group Meeting:

| | | |
|-----|---|------------------|
| 1. | Shri R.D. Singh Director, National Institute of Hydrology, Roorkee | Chairman |
| 2. | Prof. B. S. Mathur Deptt. of Hydrology, IIT Roorkee | Member |
| 3. | Prof. G. C. Mishra Deptt. of WRD & M, IIT Roorkee | Member |
| 4. | Prof. D. Kashyap Deptt. of Civil Engg., IIT Roorkee | Member |
| 5. | Dr. S.K.Mittal Scientist F C.S.I.O, Chandigrah | Member |
| 6. | Prof. K.V. Jayakumar Executive Director, CWRDM Kozhikode | Member |
| 7. | Dr. V.V.S. Gurunadha Rao Sc.G NGRI, Hyderabad | Member |
| 8. | Dr. S.K. Gupta Project Coordinantor, CSSRI, Karnal | Member |
| 9. | Shri N.Y. Apte DDGM(H), IMD, New Delhi | Member |
| 10. | Dr. S.P. Agarwal IIRS, Dehradun | Member |
| 11. | Shri R.R. Yadav Director, Dam ID&R, WR unit Jaipur-302004 | Member |
| 12. | Shri K.B. Parmar SE (Hydro), CDO, Gandhinagar | Member |
| 13. | Dr. B.P. Singh C-1/1180, Vasant Kunj, New Delhi – 110070 | Member |
| 14. | Shri R.K. Jain Chief Engineer(HQ), NWDA, New Delhi | Member |
| 15. | Shri Bhopal Singh Director, Hyd. (DSR), CWC, R.K, New Delhi | Member |
| 16. | Dr. K. P. Singh IRI, Roorkee | Member |
| 17. | Shri S.K. Gupta S.E., Jal Sansthan, Uttarkhand, Roorkee | Member |
| 18. | Shri O.P. Abasthi Water Resources Unit, Jaipur | Invitee |
| 19. | Sh. B.M. Shukla Dy. E.E, CDO, Gandhinagar | Invitee |
| 20. | Dr. N.C. Ghosh Scientist- F, NIH, Roorkee | Member-Secretary |

Scientists from National Institute of Hydrology, Roorkee

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|----|---|----|-----------------------------|
| 1. | Dr. Bhishm Kumar, Sc.F & Head Hydrological Investigations Division | 4. | Dr. S.K. Singh, Sc.F |
| 2. | Dr. V K Choubey, Sc.F & Head Environmental Hydrology Division | 5. | Sh. C.P. Kumar, Sc. 'F' |
| 3. | Shri Rakesh Kumar, Sc.F & Head Surface Water Hydrology Division | 6. | Dr. Sanjay Kr. Jain, Sc.E2 |
| | | 7. | Shri Avinash Agarwal, Sc.E2 |
| | | 8. | Shri J.V. Tyagi, Sc.E2 |
| | | 9. | Shri Sudhir Kumar, Sc.E2 |

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|-------------------------------------|-------------------------------|
| 10. Shri D.S. Rathore, Sc.E2 | 22. Dr. M.S. Rao, Sc.C |
| 11. Dr. M.K./ Goel, Sc. E2 | 23. Dr. N Panigrahi, Sc.C |
| 12. Smt. Deepa Chalisgaonkar, Sc.E1 | 24. Shri S K Verma, Sc. C |
| 13. Shri A K Lohani, Sc.E1 | 25. Dr. Rama Mehta, Sc.C |
| 14. Dr. Vijay Kumar, Sc.E1 | 26. Shri Sanjay Kumar, Sc.C |
| 15. Shri R P Pandey, Sc.E1 | 27. Smt. Archana Sarkar, Sc.B |
| 16. Shri Omkar Singh, Sc.E1 | 28. Shri Pankaj K. Garg, Sc.B |
| 17. Shri S.D. Khobragade, Sc.C | 29. Shri Rajan Vatsa, Sc.B |
| 18. Shri P K Bhunya, Sc.C | 30. Shri Manohar Arora, Sc.B |
| 19. Dr. S.P. Rai, Sc.C | 31. Dr. M.K. Sharma, Sc.B |
| 20. Shri A R Senthil Kumar, Sc.C | 32. Shri Digambar Singh, Sc.B |
| 21. Dr. Anupma Sharma, Sc.C | |

Annexure – II

WORK PROGRAM OF ENVIRONMENTAL HYDROLOGY DIVISION FOR THE YEAR 2009-10

| Reference Code | Title of the Project/Study | Study Team | Duration | Funding Agency |
|---------------------|---|---|----------------------|----------------------|
| NIH/EHD/CPCB/08-10 | Assessment of ground water quality in class-1 cities in India | V.K. Choubey (PI) M.K. Sharma | 2 years (2008-10) | CPCB New Delhi |
| NIH/EHD/HP-II/09-13 | Impact of sewage effluent on drinking water sources of Shimla city and suggesting ameliorative measures | V.K. Choubey (PI) R.P. Pandey Omkar Singh M.K. Sharma I&FC Dept., Shimla NICD, New Delhi | 3 years (2009-12) | HP-II |
| NIH/EHD/NIH/07-10 | Modelling of Pesticide Transport in Ground Water – a case study of Metropolitan City – Vadodara | M.K. Sharma (PI) V.K. Choubey A.K. Keshari, IIT-D | 3 years (2007-10) | NIH |
| NIH/EHD/NIH/08-09 | Evaluation of water quality of rivers joining Tehri reservoir and downstream of the reservoirs | M.K. Sharma (PI) V.K. Choubey | 1 year (2008-09) | NIH |
| NIH/EHD/NIH/09-12 | Environmental Flow Requirement of a River | Dilip G. Durbude (PI) V.K. Choubey Omkar Singh M.K. Sharma - New Study | 3 years (2009-12) | NIH |

**WORK PROGRAMME OF GROUND WATER HYDROLOGY DIVISION FOR
THE YEAR 2009-10**

| Reference Code | Project | Project Team | Duration & Status | Funding Source |
|---------------------|---|---|--|---|
| NIH/GWD/NIH /07-10/ | Quantification of Impact of Rainwater Harvesting on Groundwater Availability in Aravalli Hills | Anupma Sharma (PI) N. C. Ghosh C. P. Kumar Sudhir Kumar Rajan Vatsa | 3 years (04/07 – 03/10) | NIH |
| NIH/GWD/NIH /09-12/ | Impact of Climate Change on Dynamic Groundwater System in a Drought Prone Area | Surjeet Singh (PI) C. P. Kumar Anupma Sharma Rajan Vatsa | 3 years (04/09 – 03/12) | NIH |
| NIH/GWD/RJ/0 9-11/ | Study of Rising Ground Water Table in Jodhpur City, and to Evolve a Management Plan to Contain the Rising Trend | N. C. Ghosh (PI) C. P. Kumar Sudhir Kumar B. K. Purandara Anupma Sharma Surjeet Singh Rajan Vasta | 1 year 6 months (08/09 – 02/11) – New Study | Ground Water Deptt., Govt. of Rajasthan |
| NIH/GWD/NIH /09-11/ | Identification of Artificial Recharge Sites in a Basin | Shobha Ram (PI) N.C. Ghosh Anupama Sharma Surjeet Singh Sanjay Mittal | 02 years (10/09 – 08/11) - New Study | NIH |

**WORK PROGRAMME OF HYDROLOGICAL INVESTIGATIONS DIVISION
FOR THE YEAR 2009-10**

| Reference Code | Project | Project Team | Duration | Funding |
|---------------------|---|---|------------------------|----------|
| NIH/HID/U YRB/06-08 | SW and GW Interaction at Selected Locations Along River Yamuna in NCT, Delhi: Phase-II | Sudhir Kumar, M. S. Rao, P. K. Garg | 4/09 – 3/12 (3 yrs) | Internal |
| NIH/HID/D ST/07-12 | National programme on isotope fingerprinting of waters of India (IWIN) | M.S. Rao, B. Kumar, Sudhir Kumar, S.P. Rai, S.K. Verma, Pankaj Garg | 7/07 – 6/12 5 yrs | DST |
| NIH/HID/F RI/08-13 | Impact Assessment of Landuse on the Hydrologic Regime in the selected Micro-watersheds in Lesser Himalayas, Uttarakhand | S.P. Rai, Bhishm Kumar, J.V. Tyagi | 4/08 – 3/13 5 years | FRI |

| Reference Code | Project | Project Team | Duration | Funding |
|-------------------------|--|---|--|----------|
| NIH/HID/H P-II/08-10 | Groundwater Dynamics of Bist-Doab Area, Punjab Using Isotopes | M.S. Rao, Bhishm Kumar, Sudhir Kumar S. K. Verma, Pankaj Garg + Officials of CGWB | 07/2009-06/2012 | HP-II |
| NIH/HID/H P-II/08-13 | Groundwater Management in Over- Exploited Blocks of Chitradurga and Tumkur Districts of Karnataka | Sudhir Kumar, JV Tyagi, Vijay Kumar, B.K. Purandara, S.P. Rai, M.S. Rao | 10/2008-3/2012 | HP-II |
| NIH/HID/I NCID/08-11 | Estimation of irrigation return flow and stream flow regeneration in parts of the selected canal command areas | M S Rao, Bhishm Kumar, S. K. Verma, Pankaj Garg | 2 years from the date of approval from INCID | INCID |
| NIH/HID/I NCID/09-10 | Sedimentation Studies of Ropar Lake, Punjab using isotope techniques | S.D.Khobragade, B. Kumar, S.P.Rai, M.S.Rao, Pankaj Garg, *EHD | 04/09-03/10 (1 years) | Internal |

WORK PROGRAMME OF SURFACE WATER HYDROLOGY DIVISION FOR THE YEAR 2009-10

| Reference Code | Project | Study Team | Duration | Funding Source |
|-------------------|--|--|----------------------------------|----------------|
| NIH/SWD/NIH/07-09 | Development of Drought vulnerability indices for preparedness and mitigation | RP Pandey (PI) A Aggrawal Sanjay K Jain Omkar Singh | 2 years (July 2006 to July 2008) | INCOH |
| NIH/SWD/NIH/07-09 | Runoff and Sediment Modelling in a part of Brahmaputra River Basin using ANN | Archana Sarkar (PI) R D Singh Nayan Sarma | 3 years | NIH |
| NIH/SWD/NIH/09-11 | Assessment of environmental flow requirements in river Teesta. | Manohar Arora (PI) R. D. Singh Rakesh Kumar | 2 year (2009-11) | NIH |
| NIH/SWD/NIH/05-10 | Integrated Hydrological Study for Sustainable Development of two Hilly Watersheds in Uttaranchal | Avinash Agarwal (PI) R.K. Nema | 5 years (2005-10) | DST |
| NIH/SWD/NIH/07-10 | Hydrological studies in a forested watershed in Uttarakhand | J.V. Tyagi (PI) Rakesh Kumar Digamber Singh | 3 years (2007-10) | NIH & FTA |
| NIH/SWD/NIH/09-11 | Snow Melt Runoff Modeling Using Fuzzy Logic | A.K. Lohani (PI) Sanjay K. Jain Rakesh Kumar | 2 years (2009-11) | NIH |

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|-------------------|---|--|------------------------------------|-----|
| NIH/SWD/NIH/08-12 | Study on integrated water resources management of sub-basin to cope with droughts | R.P. Pandey (PI) Ravi V. Galkate Surjeet Singh L.N. Thakral | 4 years (2008-12) | NIH |
| NIH/SWD/NIH/09-12 | Snow Melt Runoff Modeling in Sultej Basin | A.R. Senthil Kumar (PI) Manohar Arora Avinash Agarwal D.S.Rathore Diganbar Singh | 3 years (2009-12) | NIH |
| NIH/SWD/NIH/08- | Monitoring and modeling of streamflow for the Gangotri Glacier | Manohar Arora (PI) Rakesh Kumar | To be continued | NIH |
| NIH/SWD/NIH/09-11 | Data book - hydro-meteorological observatory 2001-2008 | Digambar Singh (PI) A. R. Senthil kumar Manohar Arora | 2 years (2009-11) | NIH |
| NIH/SWD/NIH/09-10 | Impact of climatic change on evapotranspiration | N.K. Bhatnagar (PI) Avinash Agarwal | 2 year (2009-11) - New study | NIH |

**WORK PROGRAMME OF WATER RESOURCES SYSTEM DIVISION FOR
THE YEAR 2009-10**

| Reference Code | Project | Project Team | Duration & Status | Funding Source |
|-----------------------|--|---|-----------------------------|----------------|
| NIH/WRSD/NIH/08-03/12 | Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin | Sanjay K. Jain (PI) Sharad K. Jain Vijay Kumar Bhism Kumar Renoj Theyyan | 4 years (04/08 – 03/12) | HP-II |
| NIH/WRSD/NIH/06-09/5 | Use of remote sensing in soil moisture and water balance estimation – a case study of the Solani Catchment | Sanjay K. Jain (PI) Sharad K. Jain | 3 years (2006-09) | NIH |
| NIH/WRSD/NIH/09-04/12 | Hydrological Assessment of Ungauged Catchments (Small Catchment) | P. K. Bhunya (P.I) Sharad. K. Jain D.S. Rathore P.C. Nayak Niranjan Panigrahy Sanjay Kumar Suhass Khobragade Director (H&WR P), Govt. of Orissa | 03 years (05/09 – 04/12) | HP-II |
| NIH/WRSD/NIH/08-12/12 | Decision Support System (Planning) for Integrated Water Resources Development and | Rakesh Kumar A. K. Lohani D. Chalisgaonkar C. P. Kumar M. K. Goel | 04 years (12/08 – 03/12) | HP-II |

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|-----------------------|--|--|---|-------|
| | Management | Vijay Kumar R. P. Pandey P. K. Bhunya Sanjay Kumar A. Sharma N. Pannigrahy Surjeet Singh | | |
| NIH/WRSD/NIH/08-03/10 | Web-based Hydrology and Water Resources Information system for India | Deepa Chalisgaonkar (PI) D S Rathore S K Jain N Panigrahy | 02 years (04/08 – 03/10) | NIH |
| NIH/WRSD/NIH/09-03/13 | Assessment of Effects of Sedimentation on the Capacity/ Life of Bhakra Reservoir (Gobind Sagar) on River Satluj and Pong Reservoir on River Beas | Sanjay K. Jain (PI) Sharad K. Jain Vijay Kumar J.V. Tyagi Rama Mehta | 04 years (04/09 – 03/13) | HP-II |
| NIH/WRSD/NIH/09-03/12 | Application of a distributed hydrological model for river basin planning and management | M. K. Goel (PI) Vijay Kumar D. S. Rathore Deepa Chalisgaonkar Rama Mehta | 03 years (10/09 – 03/12) - New Study | NIH |

