

**MINUTES of 33rd MEETING OF THE
WORKING GROUP OF NIH**

7 - 8 OCTOBER, 2010



**NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE-247 667**

MINUTES OF THE 33rd MEETING OF THE WORKING GROUP OF NIH HELD DURING OCTOBER 7-8, 2010 AT NATIONAL INSTITUTE OF HYDROLOGY ROORKEE.

The 33rd meeting of the Working Group (WG) of NIH was held in the Society room of the National Institute of Hydrology, Roorkee during October 7-8, 2010 under the Chairmanship of Director, NIH. The list of the members and invitees participated in the meeting is given in **Annexure-I**. Shri R. D. Singh, Director, NIH could not attend the meeting on 7th October, 2010 because of an urgent meeting at BIS, New Delhi, therefore, Dr. Bhishm Kumar, Scientist -F chaired the meeting on 7th October, 2010.

Dr. N. C. Ghosh, Scientist-F & Member-Secretary, WG welcomed the Working Group members, and the Scientists of the Institute present in the meeting. He informed the members about the start up of the Achievements Review Committee constituted by the Ministry of Water Resources, GoI to review the achievements and performances of the Institute for the period 2004-'10. He further advocated that as the Institute has to prepare its 12th Five year plan program, it would be very relevant if the members could suggest some thrust areas for future R & D programmes of the Institute.

ITEM NO. 33.1: OPENING REMARKS BY THE CHAIRMAN

Dr. Bhishm Kumar, Chairman, WG welcomed the Working Group members and Scientists of the Institute present in the meeting. The Chairman informed about the working group meeting and its importance. He stressed the need of guidance of the members to achieve the goal of the meeting. While giving a brief on the various ongoing technical and research activities of the Institute, he informed that since implementation of the 'Consultancy and Technical services' in the month of February, 2010, the Institute has received a number consultancy projects. He, however, expressed that main focus of the Institute will be towards R & D activities and about 20% of time will only be devoted for consultancy services. 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. Thereafter, the Chairman requested the Working Group members to give their general observations, suggestions and remarks on the scientific activities of the Institute. The responses of some of the members were as follows:

Prof. B. P. Singh : While appreciating the initiatives taken by the Nuclear Hydrology Lab, he informed that a good number of contributions has been made from the isotope study. He stressed the need of fundamental research in the area to understand the different hydrological components more clearly.

Prof. P. K. Garg : stressed the need of both basic and applied research. He appreciated the work being carried out by NIH. Prof. Garg suggested that Urban storm runoff management, reuse of wastewaters, wastewater and water

quality management could be some of the thrust areas for the 12th Five year Plan of the Institute.

Mr. C. Ravivarma : suggested that stressed also be given to study the salinewater ingress and intrusion problems in the coastal aquifers.

Dr. V. V. S. Gurunadharao : suggested that NIH being located in the Uttarakhand state, the Institute can help the state in developing its comprehensive water resources planning. He further stressed the need of undertaking research for urban storm water management and climate change impacts. He requested NIH for updating the data generated from Lake studies to NIH's website so that other can use those data.

Mr. A. K. Bhatia : suggested to take up few studies related to recharge of groundwater and their effectiveness evaluation for different hydrogeological settings and groundwater quality for deeper aquifers.

Dr. S. P. Agarwal : advocated that NIH should take lead for developing hydrologic models exclusive for India.

Dr. M. M. Kimothi : informed about the dialogue initiated between NIH and Uttarakhand Space Application Centre for active participation of NIH for helping the state in resolving its challenging water resources issues. He emphasized that state being located in the head reach of the Ganga where it has the impact of snow and glacier melts water, therefore, there are needs of studies to work out impact of climate change on water resources of the state. He further stressed that NIH should play a larger role than as it is now to help the state for different hydrological aspects. He assured for all cooperation from the state side.

Chairman elaborated some of the points raised by the members and appreciated the views and suggestions given by them.

After the self introduction of the members and invitees and suggestions, Chairman asked Dr. N. C. Ghosh, Member-Secretary, WG to take up the agenda items in sequence.

ITEM NO. 33.2: CONFIRMATION OF THE MINUTES OF THE 32nd MEETING OF THE WORKING GROUP.

Dr. Ghosh informed that the minutes of the meeting of 32nd Working Group held during 4-5 March, 2010 were circulated vide letter No. NIH/GWH/WG/2010 dated 30th March, 2010 and no comments were received on the circulated minutes. The minutes were confirmed.

ITEM NO. 33.3: PRESENTATIONS AND EVALUATIONS OF THE PROGRESS OF THE WORK PROGRAMME OF THE FIVE DIVISIONS FOR THE YEAR 2010-'11 INCLUDING ACTIONS TAKEN ON THE DECISIONS OF THE LAST MEETING,

Member Secretary informed that as such there were no specific recommendations on which actions were to be taken; suggestions and comments were study specific, which had been taken care by the respective division.

To facilitate the proceedings of the meeting, the order of presentation of the work programme was taken up in the following sequences:

On 7th October,

- i) Environmental Hydrology Division,**
- ii) Hydrologic Investigation Division,**
- iii) Ground Water Hydrology Division.**

On 8th October,

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

Member Secretary gave a brief account of the work programme of the year 2010-'11 under three categories: (i) internally funding projects, (ii) sponsored projects, and (iii) purpose driven projects under HP-II. It was informed that there are total of 39 studies in which 24 are internally funded, 7 are sponsored, 7 are purpose driven studies, and 1 is DSS(Planning) projects. The research studies under the work programme of the year 2010-'11 are thus worked out to be 38.

During the meeting the status of the work programme for the year 2010-'11 for each study was discussed division-wise in detailed. The Chairman requested the Heads of the Division to make the presentation, and also 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 details of the division-wise presentation and suggestions/ comments emerged from the discussion are given in the **Annexure-II.**

ITEM No. 33.4: PRESENTATION AND FINALIZATION OF THE NEW WORK PROGRAMME FOR THE YEAR 2010-'11.

Three new studies, one by Water Resources System Division, other two respectively Hydrological Investigations Division and Environmental Hydrology Division were proposed to undertake during the year 2010-'11. The proposed studies are:

- (1) Climate variability analysis and its impact on Himalayan watershed in Uttarakhand by Water Resources Division,
- (2) Hydrological studies of Jhamarkorta Mines, Udaipur, Rajasthan by Hydrological Investigations Division,
- (3) Impact of Kumbha Mela 2010 in water quality of surface water and groundwater resources in and around Hardwar city by Environmental Hydrology Division.

Respective Project Investigators (P.Is.) of the above studies had given a brief presentation of each study outlining the objectives, methodologies, time frame and expected outcomes, etc.

After thorough deliberations, the WG recommended the above study for undertaking during the Financial Year 2010-'11. The detailed data of the proposed studies along with the other continuing studies of the Institute for the year 2010-'11 are given in **Annexure – II** with the work programme of respective division.

ITEM No. 33.5 :ANY OTHER ITEMS WITH THE PERMISSION OF THE CHAIR.

Director, NIH and Chairman, WG while thanked the WG members for their vital suggestions and views opined that he has not put any barrier to the scientists for bringing innovative ideas to pursue those to roll over to realities. He asked scientists to work with emerging challenging areas and issues in a time bound framework to help the professionals and implementing agencies in more focus ways.

The Member-Secretary formally offered vote of thanks to all members and participants, and the meeting ended with vote of thanks to the Chair.

ANNEXURE-I

LIST OF MEMBERS AND INVITEES PARTICIPATED IN THE WORKING GROUP MEETING:

1.	Shri R.D. Singh, Director, National Institute of Hydrology	Chairman
2.	Prof. G.C. Mishra Dept. of WRD&M, IIT Roorkee	Member
3.	Prof. D. Kashyap Department of Civil Engg., IIT Roorkee	Member
4.	Prof. P.K. Garg Department of Civil Engg., IIT Roorkee	Member
5.	Sh. A.K. Gupta CGWB, Dehradun	Member
6.	Dr. S.P. Agarwal, IITS, Dehradun	Member
7.	Dr. V.V.S. Gurunadha Rao Sc.F NGRI, Hyderabad	Member
8.	Shri S.K. Malhotra Saharanpur	Member
9.	Er. Ravivarma SE, SGSWRDM, Chennai	Member
10.	Er. Vilvanathan, AEE AEE, SGSWRDM. Chennai	Member
11.	Dr. B.P. Singh Gurgaon	Member
12.	Sh. Sanjeev Kumar CWC, New Delhi	Member
13.	Dr. M.M. Kimothi USAC, Dehradun	Invitee
14.	Dr. N.C. Ghosh, Scientist F, NIH, Roorkee	Member-Secretary

**SCIENTISTS FROM NATIONAL INSTITUTE OF HYDROLOGY,
ROORKEE**

1. Dr. Bishm Kumar, Sc.F & Head Hydrological Investigation Division
2. Dr. V K Choubey, Sc.F & Head Environmental Hydrology Division
3. Shri Rakesh Kumar, Sc.F & Head Surface Water Hydrology Division
4. Dr. V.C. Goel, Sc.F & Head, RCMU
5. Dr. S.K. Singh, Sc.F
6. Sh. C.P. Kumar, Sc. 'F'
7. Dr. Sanjay Kr. Jain, Sc.E2
8. Shri Avinash Agarwal, Sc.E2
9. Shri J.V. Tyagi, Sc.E2
10. Shri Sudhir Kumar, Sc.E2
11. Shri D.S. Rathore, Sc.E2
12. Dr. M.K. Goel, Sc. E2
13. Smt. Deepa Chalisgaonkar, Sc.E1
14. Shri A K Lohani, Sc.E1
15. Dr. Vijay Kumar, Sc.E1
16. Sh. R P Pandey, Sc.E1
17. Sh. Omkar Singh, Sc.E1
18. Sh. S.D. Khobragade, Sc. E1
19. Sh. P K Bhunya, Sc.E1
20. Dr. S.P. Rai, Sc.E1
21. Sh. A R Senthil Kumar, Sc.E1
22. Dr. M.S. Rao, Sc.C
23. Shri S K Verma, Sc. C
24. Dr. Rama Mehta, Sc.C
25. Sh. Sanjay Kumar, Sc.C
26. Smt. Archana Sarkar, Sc.C
27. Sh. A.K. Dwevedi, Sc. C
28. Dr. M.K. Sharma, Sc.C
29. Sh. Pankaj K. Garg, Sc.B
30. Sh. Rajan Vatsa, Sc.B
31. Sh. Digambar Singh, Sc.B
32. Dr. L.N. Thakural, Sc. B
33. Sh. Ravindra V. Kale, Sc. B

ENVIRONMENTAL HYDROLOGY DIVISION

Dr. V.K. Choubey, Sc. F & Head (EHD), presented overview of technical activities & progress of the Division 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. The minutes of each study are given below:

ASSESSMENT OF GROUND WATER QUALITY IN CLASS I CITIES IN INDIA - PHASE II (CPCB SPONSORED PROJECT)

Dr V K Choubey requested Dr M K Sharma to present the progress of the project. Dr Sharma informed that out of twenty five class I cities, twelve cities had been covered in first phase of the study during the year 2009-10 and remaining thirteen cities (Chandigarh, Panjim, Gandhinagar, Shrinagar, Ranchi, Thiruvananthapuram, Imphal, Pondicherry, Kavaratti, Daman, Silvassa, Ratlam, Bilaspur) are being covered in the Phase – II during 2010-11. He further informed that the pre-monsoon sampling of eleven class-I cities of Phase - II 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. Collected samples are being analysed for various water quality constituents viz; major cations and anions, metal ions, bacteriological parameters, metals, pesticides residue and PAH. Dr A K Bhatia enquired about collection of ground water samples from the shallow or deep aquifer. Dr Sharma informed that the samples have been collected from available drinking water sources (shallow, medium or deep aquifer). In a query of Dr P K Garg to attempt spatial variation of water quality parameters using different interpolation techniques, Dr Sharma informed that distribution of different water quality parameters is being attempted using contour diagram to identify the degraded zones not conforming to water quality standards. In a query of Dr Gurunadharao to collect the information related to geology of the study area so that water quality of the study area may be linked with geology, Dr Sharma replied that the information related to physiography and drainage, geology, climate, drinking water supply, waste water generation, population, petroleum storage, ground water potential, existing industries of the study area are also being collected and will be reported. Chairman appreciated the efforts made in the study.

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 informed that one of the objective of the study i.e. the identification of contaminant sources has been accomplished using chemographs of point sources and ground water at different locations. Dr Sharma further added that Model MODFLOW was calibrated using the field data of vadodara city for ground water flow modeling in saturated zone and for contaminant transport modeling, the test run of model MT3D was carried out for TDS for future projections for a period upto 50 years. Dr Sharma presented the results of the analysis. Dr Gurunadha Rao suggested to input the realistic ground water pumping well

abstraction after field survey to refine the result of the model MODFLOW. Dr Sharma noted the suggestion for further compliance. Dr S P Aggrawal enquired about the consideration of aquifer boundary in modeling in saturated zone. Dr Sharma informed that the study is mostly concerned with shallow aquifer and therefore there is no need to define aquifer boundary and Dr Gurunadha Rao supported the fact. Dr M M Kimothi enquired whether the study is demand driven. Dr Sharma informed that the study was conceived on the finding of earlier study carried out by NIH and in collaboration of Gujarat Water Resources Development Corporation, Gandhinagar. Dr Sharma further informed that since the study was expected to be completed by September, 2010 but the development of numerical model for simulation of pesticide transport within a vertical soil column based on laboratory data is remaining and requested the chairman to give the approval to extend the period of completion by six month i.e. March 2011. The Chairman approved the extension of the study by March 2011.

IMPACT OF KUMBHA MELA 2010 ON WATER QUALITY OF SURFACE WATER AND GROUND WATER RESOURCES IN AND AROUND HARDWAR CITY

Dr V K Choubey briefed the research project study and requested Dr M K Sharma to present the progress and results of the study. Surface water samples collected from 11 different locations of river Ganga and 7 ground water samples collected along the periphery of the river and were analysed for Physico-chemical parameters, bacteriological parameters and metal concentrations. The results indicated that all the physico-chemical parameters were found within the limit prescribed for drinking water standards (BIS), however, very high bacteriological contamination (TC>2400) was observed in the river Ganga/canal water and in few ground water samples in the month of January, April, May and June 2010, these waters were not fit for drinking and bathing. Dr M M Kimothi appreciated the study and requested to send the findings of the study to the government of Uttarakhand. Chairman suggested to carry out one more sampling so that the results can be compared with Kumbh period quality. Dr Sharma noted for further compliance.

IMPACT OF SEWAGE EFFLUENT ON DRINKING WATER SOURCES OF SHIMLA CITY AND SUGGESTING AMELIORATIVE MEASURES

Dr. V.K. Choubey, Scientist F & Head/PI briefed about the progress of this study. As desired by the PI, the detail progress of the study was presented by Shri Omkar Singh, Scientist E1. He informed that a field visit was made recently during June-July, 2010 at Shimla by the study team and project staff for organizing a training course and to collect water quality samples from various sources (WTP, STP, Open Drains, Water Supply System, etc.). Accordingly, the water samples were collected & preserved in the field and this process was demonstrated to all the participants in field visit. The analysis of collected water samples has been completed for various physico-chemical and bacteriological parameters. Dr. V.V.S. Gurunadha Rao (NGRI) inquired about the bacteriological contamination of water in the study area. Dr. V.K. Choubey, Scientist F replied about his query on existing bacterial contamination in the water supply system. He also informed that drainage map and DEM of the study area has been prepared and morphometry of drainage network has also been carried out for further use in the study.

ENVIRONMENTAL FLOW REQUIREMENT: A CASE STUDY OF RIVER

Shri. D.G. Durbude, Scientist C presented the brief introduction about the objectives of study followed by the methodology to estimate the environmental flow requirement (EFR) downstream of proposed peak up weir on Cauvery River for constructing underground power house (UGPH) site of Karnataka Power Corporation Limited (KPCL), Bangalore. Initially, EFR will be estimated using the available techniques such as desktop approaches, indices and flow duration curves (FDCs) methods and later on the refinement will be made as per the data availability for flow analysis. The details regarding the catchment characteristics and river reach d/s of the proposed peak up weir is presented. He also highlighted the results obtained by using the flow indices. The members of working group suggested to analyse the flow characteristics of river d/s to study area.

SPATIAL VARIABILITY OF GROUND WATER QUALITY IN KANDI, SIROWAL AND SIWALIK BELTS OF JAMMU REGION, J&K (INDIA)

The progress of the study including brief objectives, methodology and about study area was presented by Shri Omkar Singh, Scientist E1 (PI). PI informed that the ground water quality data of Jammu, Kathua and Udhampur Districts as monitored by NIH, RC, Jammu as well as CGWB will be utilized in this study. The PI informed that spatial variability analysis of ground water quality would be performed for Kandi, Sirowal and Shiwalik belts, for which data sorting has been done. In addition, CGWB, Jammu has been interacted for providing recent years data of ground water quality for inclusion in the analysis. Dr. A.K. Bhatia (CGWB, Dehradun) inquired about the pollution types in the study area. PI replied his query and informed that due to various anthropogenic activities, the pollution threats are increasing in the study area. Accordingly, there is a need to study the spatial variability of ground water quality so that the inferences could be made for deciding appropriate ground water quality monitoring network.

WORK PROGRAMME OF THE ENVIRONMENTAL HYDROLOGY DIVISION FOR THE YEAR 2010-2011

A. Internally Funded Studies

Reference Code	Title of the Project/Study	Study Team	Duration/ Status	Funding
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 (10/07 – 9/10) <i>Continuing study</i>	NIH
NIH/EHD/NIH/09-12	Environmental Flow Requirement of a River	Dilip G. Durbude (PI) V.K. Choubey Omkar Singh M.K. Sharma	3 years (9/09 – 8/12) <i>Continuing study</i>	NIH

NIH/EHD/INT/10-11	Impact of Kumbha Mela 2010 on water quality of surface water and ground water resources in and around Hardwar City	V.K. Choubey (PI) M.K. Sharma Omkar Singh D.G. Durbude	1 year (4/10-3/11)	NIH
NIH/EHD/INT/10-11	Spatial Variability of Ground Water Quality in Jammu and Kashmir Provinces, J&K (India)	Omkar Singh (PI) V.K. Choubey D.G. Durbude M.K. Sharma	1 year (4/10-3/11)	NIH

B Sponsored Studies

NIH/EHD/CPCB/10-11	Assessment of Ground Water Quality in 25 Class I Cities of India – Phase II (Chandigarh, Panjim, Gandhinagar, Shrinagar, Ranchi, Thiruvananthapuram, Imphal, Pondicherry, Kavaratti, Daman, Silvassa, Ratlam, Bilaspur)	V K Choubey (PI) M K Sharma	1 year (4/10-3/11) <i>New Study</i>	CPCB
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C. Purpose Driven Studies Under HP-II

NIH/EHD/HP-II/09-12	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 (4/09 -03/12) <i>Continuing study</i>	HP-II
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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. Dr. Ghosh informed that there are total of 4 research studies approved for the division under the current year, in which 2 are of internally funded, 1 is of sponsored study, and other one is purpose driven study under HP-II. He further gave an account of initiatives taken by the division during last six months and results thereof. Thereafter, Dr. Ghosh requested the concerned PIs to present the detailed progress of the each study. Study-wise suggestions and discussions emerged are given below.

STUDY OF RISING GROUND WATER TABLE IN JODHPUR CITY, AND TO EVOLVE A MANAGEMENT PLAN TO CONTAIN THE RISING TREND.

Dr. N. C. Ghosh, P.I. of the project presented the progress of the study including results obtained so far from the analyses. He informed that the study is of real life concern as the area is experiencing the water logging conditions in many pockets and people are suffering by the rise in groundwater level, and the issue is under subjudice. Towards the progress of the study, Dr. Ghosh informed that based on the data supplied and collected from different agencies, the interim report of the study had been submitted to the GWD, Jodhpur during March, 2010. The main findings offered in the interim report are: reasons of rising groundwater table are because of return flows from surface water usages supported by the Kailana and Takhatsagar waters, and the possibility of seepage from Kailana and Takhatsagar reservoir is remote. However, these observations are subjected to further refinement by analyses and modeling. On presentation of Dr. Ghosh, Prof. Kashyap opined that prior to proceed for modeling, one has to perform the crude water balance of the study area for such study. On this point, Prof. (Retd.) G. C. Mishra, consultant of the study, opined that the analysis is progressing in that director also. Dr. Mishra also explained the parameters estimated from the pumping tests data of large diameter wells and bore wells. Dr. Ghosh informed the house that the study has the commitment to complete it by February, 2011.

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

Dr. Anupma Sharma, P.I. of the project presented the groundwater salinity issues in Coastal Saurashtra and the groundwater monitoring program by State Dept. already in place in the coastal region. The various measures taken by the State Dept. to prevent ingress of saline water through creeks and enhance artificial recharge were also presented. The objectives of the study, details of data collection program undertaken for the Minsar Basin, geology of Minsar Basin, variations in water table and groundwater salinity along the coast were explained. The need for expanding the study area was also explained. Dr. Bhishm Kumar suggested that the impact of any aquaculture activity on groundwater salinity should also be investigated.

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

Dr. Anupma Sharma, P.I. of the project explained about the background of the study, data monitoring and field investigations carried out in Savana macro-watershed during Part-I of the study. The objectives of Part-II of the study were explained. The results of infiltrometer experiments carried out at various sites in the field were presented along with the analysis technique for computing recharge. Dr. D. Kashyap inquired about the depth of the unsaturated zone in the region. To a subsequent inquiry from Dr. G.C. Mishra, it was informed by Mr. C.P. Kumar that the streams in the region are non-perennial and the anicuts

in the watershed recharge groundwater only during monsoon. Prof. G. C. Mishra appreciated the study.

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

Dr. Surjeet Singh, P.I. of the project presented about the downscaling and projected rainfall and temperature for the Sonar basin for 2039, 2069 and 2099 and explained the downscaled results being used in estimation of groundwater recharge for future scenarios. Prof. Deepak Kashyap suggested that the river stages also need to be taken into account for possible climate change in groundwater table simulation. Dr. G.C. Mishra suggested that the increase in temperature will have impact on soil moisture and evapotranspiration and needs due care. Dr. N.C. Ghosh suggested to fit the rainfall distribution from the historical rainfall data, and check whether there is any change in the distribution in the projected rainfall due to climate change.

WORK PROGRAMME OF THE GROUND WATER DIVISION FOR THE YEAR 2010-2011

A. Internally Funded Studies

Reference Code	Project	Project Team	Duration/ Status	Funding Source
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) Continuing study	NIH
NIH/GWD/NIH/10-12	Quantification of Impact of Rainwater Harvesting on Groundwater Availability in Aravalli Hills – Part II: Mathematical Modeling	Anupma Sharma (PI) N. C. Ghosh C. P. Kumar Sudhir Kumar Rajan Vatsa	2 years (04/10 – 03/12) New study	NIH

B. Sponsored Studies

NIH/GWD/NIH/09-11	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 Vatsa	1.5 years (08/09 – 02/11) Continuing study	Ground Water Dept., Govt. of Rajasthan
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C. Purpose Driven Studies Under HP-II

NIH/GWD/HP-II/10-12	Coastal Groundwater Dynamics and Management in the Saurashtra Region, Gujarat.	Anupma Sharma (PI) N. C. Ghosh C. P. Kumar C. K. Jain Sudhir Kumar D. S. Rathore Surjeet Singh Rajan Vatsa + GWRDC, Gandhinagar	2.5 years (10/09 – 06/12) <i>New study</i>	HP-II
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HYDRLOGICAL INVESTIGATION DIVISION

Dr Bhisim 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 house 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:

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 of the first phase of the study and informed that there were some unanswered questions which needed to be addressed properly. He emphasized the importance of sampling frequency and showed the importance of daily sampling of river water which helped in understanding the observed depleted δD peaks in piezometers in both the sections. He further informed that during 2009 floods, it has been observed that water in river water section-2 recharged groundwater only upto first piezometer (PZN-1) and it did not move towards Delhi side, while in section-1, the recharge has been observed upto second piezometer (PZW-2). He further explained that residence time in the floodplain aquifer is large as compared to recharge time.

Discussing the progress of the study, Dr. Sudhir Kumar informed that that due to high and long flooding events this year (2010), the water level in nearby wells has increased 4-5 meters, while it was only 3.52m and 1.8m during 2008 and 2009 respectively. He further informed that all the piezometers in the floodplain got submerged during the floods and samples could not be collected during this period.

The working group noted the progress.

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

Dr. Sudhir Kumar, principal investigator of the project presented the work done under the project during the last six months. He informed that field work was carried out

during April/May 2010 to conduct field experiments and to install some instruments in the two selected watersheds in the Tumkur and Chitradurga districts. He informed that there are large number of tanks in the watersheds and most of the runoff during the monsoon is harvested into these tanks and there is no little or outflow from the watersheds. Rainfall in these watersheds is very erratic, and during the low rainfall years, the tanks are not filled and remain dry. He informed that evaporation pans, soil moisture sensors and rain gauges were installed in both the watersheds to collect data about evaporation rates, soil moisture variation and to collect rainfall samples. No historical data about soil moisture variation and evaporation is available. He further informed that 16 infiltration tests were conducted within and close to the watershed to determine the infiltration rates. The tests have indicated that the infiltration rates are high in the catchment (sandy soils, infiltration rate 10-15 mm/hr) and low in the tank bed (clayey soil, Infiltration rate=1-2 mm/hr). It was also informed that in most of the years, the groundwater wells show for recuperation after the monsoon and there is no long term decline in water table except during the low rainfall years.

Dr Sudhir Kumar emphasized that as there is no outflow from the watershed, only option for groundwater management is to recharge the water collected in the tanks. This will reduce the evaporation losses. He also pointed out that the isotopic investigations have indicated that the water stored in the tanks is not recharging the groundwater, as no enrichment is observed in the groundwater samples collected from the wells.

Dr. Gurunadha Rao suggested that, if possible, groundwater samples should be collected from few locations, near and little away, to some large size tanks and vertical sampling should also be done from the tanks to understand the tanks and groundwater interactions.

The working group noted the progress of the study.

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

Dr. Sudhir Kumar informed that this study is of high importance and has been sponsored by Delhi Jal Board. This study is being carried out in collaboration of CGWB, CWC, IIT Delhi, NRL, DU. The study was initiated in April, 2010. The objectives of this study are (i) to estimate groundwater resources in the Yamuna floodplains, (ii) to estimate GW development potential in space and time through ground water simulation, (iii) assess the impact of groundwater extraction from floodplains on hydrological regime, and (iv) to assess groundwater quality vis-a-vis availability of drinking water. It was informed that most of the required data have been collected from CGWB. Data from CWC and IMD are being collected. Infiltration tests have been conducted in the floodplain and the rate of infiltration has been observed to be 6-8 mm/hr. Survey for groundwater draft was also conducted in the month of June 2010. Based on the data collected, a conceptual model has been prepared and steady state simulations are being carried out to calibrate the model.

Dr. Sudhir Kumar further informed that Dr. AK Keshri of IIT Delhi has proceeded on long leave, therefore a suitable person shall be included in the project to take up the GW quality modelling aspect.

The working group noted the progress of the study.

HYDROGEOLOGICAL STUDIES OF JHAMARKOTRA MINES, UDAIPUR, RAJASTHAN

The principal investigator, Dr. Sudhir Kumar, informed that a new consultancy project, sponsored by RSMML, has been started from 1st July 2010. He informed that the Jhamarkotra mine is facing the threat of closure, as the present dewatering scheme is not yielding the desired drawdown required for the mechanized mining. The top surface level in the mine area was about 600 m above mean sea level (MSL) and mine working has gone to a depth of up to 405 m and 425 m above MSL in D & E block respectively. Further, RSMM Ltd. plans to excavate the deposit up to 320 m above MSL. Groundwater level contours indicate that present water level in the mining area is about 402 m and 421m above MSL (for D & E block respectively) and the groundwater flow direction is from NW to SE. As the water level is very near to the bottom of the mining pit, it is not possible to excavate to further depth unless the water table is lowered. The fractures and solution cavities within the dolomitic limestone provide paths for the movement of the groundwater.

Dr. Sudhir Kumar further informed that the specific objectives of the study are (i) to Identify the source of groundwater in blocks D & E of Jhamarkotra mines through stable isotopic and groundwater dating techniques, (ii) to suggest complete future dewatering scheme to achieve desirable drawdown (10-12 meters) in the D and E blocks of Jhamarkotra mines, and (iii) to explore the feasibility of dewatering of monsoon water from the pit in shortest possible time.

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

The working group noted the progress.

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

Dr. M. S. Rao presented the progress of the study. He informed that the necessary steps were taken-up to incorporate the comments & suggestions given in the 32nd Working Group meeting. In his presentation, he explained that a methodology was developed to link the regional scale weather data with local level isotopic data to characterize the source of moisture using isotopic technique. This is achieved by correlating wind trajectory and cloud dynamics data with isotopic data on local air-moisture. Wind trajectory and water vapor data for the year 2008 and 2009 have been procured from IMD, New Delhi. The data analysis showed that the moisture arriving at Roorkee originates from combination of 7 sources with their magnitude varying during different seasons in a year. Moisture originating from these sources have different isotopic composition. The identified $\delta^{18}\text{O}$ range for these sources are: Western Disturbance: -2.53‰ (i) Bay of Bengal: -6.07 ‰ (ii) Local: Jan. -8.02‰; Mar. -4.40 ‰ (iv) Central Asia: -11.18‰, (v) Arabian Sea -17.14‰ (vi) moisture originating along the

track-Indian Ocean, Arabian Sea and Bay of Bengal: -18.94‰; (vii) Indian Ocean and Arabian Sea (without contribution from Bay of Bengal): -26.25‰.

In addition to the above work, he informed that two more stations at Jammu and Kakinada have been established for collection of Ground Level Vapour (GLV). A total of 1048 samples were collected from March, 2010 to August, 2010 from Roorkee, Sagar, Kakinada & Jammu and out of which 881 number of samples have been analyzed.

He also presented isotopic time series data for GLV taken at Roorkee collected cryogenically at 0°C and -80°C. The presented data clearly indicated change in isotopic characteristic trend during arrival and departure of monsoon. It was also informed that the difference between GLV collected at two different temperatures can provide a new way of identifying arrival and departure of monsoon. He also presented the relationship between absolute humidity and isotopic values of GLV which showed an inverse relationship. During monsoon period absolute humidity was higher and the isotopic depletion was more compared to non-monsoon season.

Dr. N. C. Ghosh and other members suggested to establishing the sampling site at Guwahati to confirm wind and isotopic pattern. Dr. Bhishm Kumar suggested to use d-excess in addition to $\delta^{18}\text{O}$ to confirm the source of moisture. Dr. S. P Agarwal, IIRS, suggested for linking the isotopic data with ITCZ.

The working group noted the progress.

GROUNDWATER DYNAMICS OF BIST-DOAB AREA, PUNJAB USING ISOTOPES

Dr. M. S. Rao presented the progress of the study. He informed that as per the suggestions given in the 32nd working group, samples were collected from deep wells and the isotopic analyses of these samples were completed for the pre-monsoon (June, 2010). He informed that a total of 213 samples of river, canal, groundwater and rain have been collected. All of these were analyzed for δD , 130 for $\delta^{18}\text{O}$ and 46 for tritium concentration. He also informed that archival data related to water availability, draft, land use, rainfall etc., were also collected. The analyzed archival data was presented in thematic maps. Broadly, these maps show groundwater shortage in central zone of Bist Doab. Groundwater in this zone is relatively old compared to that in Kandi zone and confluence zone at Harike and the stage of development exceeded 200%. Observational data show fall in water-table up to 5 m in Jalandhar (5m) and 7 m in Hoshiarpur over the period 2002-2008. In the study region, 22 out of 30 blocks are overexploited. With regards to rainfall observed from 1970-2009, the study area has received low rainfall during the period 2000-2004. However, irrigation needs have increased continuously. This probably led to accelerated fall in water table during this period.

Dr. Rao also presented groundwater quality maps which indicated locally concentrated saline pockets ($\text{EC} > 1000 \mu\text{S}$) due to high NaCl and CaSO_4 concentration in groundwater. At few other places, higher salinity in groundwater (EC in the range 800-1000 μS) has also found/ developed due to evaporation process as evidenced from their enriched isotopic composition. Other than these local zones, groundwater in general is fresh ($\text{EC} < 800 \mu\text{S}$) in the region and is of MgHCO_3 type. He also provided

the information about the forthcoming Workshop under PDS on 'Water availability and Management in Punjab' to be held at Centre of Advanced Studies, Department of Geology, Panjab University Campus, Chandigarh during 13-15th December, 2010.

Dr. Gurunadha Rao commented that the data points used to prepare contour plots for water balance analysis are too less. CGWB's original report should be consulted to get the true village level data and not the average District level data from the open source web-file. The conclusions drawn from the average data can mislead causing wrong interpretation. Prof. B. P. Singh suggested to draw conclusions on groundwater availability in terms of groundwater velocity using the estimated tritium content of groundwater.

The working group noted the progress.

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 km² is covered with dense oak forest while Bansigad micro-watershed having an area of 2 km² 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 both the watersheds is same and the difference is only in land-cover. Discussing the results obtained from the analysis of the various collected data, Dr. S. P. Rai informed that the average air temperature varies between 15.5^oC (minimum) and 25^oC (maximum) in degraded watershed and 18^oC to 22^oC in forested watershed. The relative humidity is observed to be minimum in summer months and maximum in rainy months. The evaporation rate varied from minimum 2.5 mm/day in rainy months to maximum 6 mm/day in summer months. Monthly average discharge in degraded watershed (Bansigad) varies between 0.01 m³/sec (minimum) in the month of November 1.02 m³/sec (maximum) in the month of August. The watershed becomes dry during the May and June. However in forested watershed, it varies between 0.05 m³/sec in the month of June and 0.88 m³/sec in the month of August. It remains perennial throughout the year. Hydrograph analysis reveals that rainfall response on stream discharge of both watersheds is very quick. However, the recession part of hydrograph differs to each other in both watersheds. The discharge declines slowly in Arnigad stream during post monsoon month while it declines at a faster rate in Bansigad stream and stream becomes dry up in summer months. The preliminary observations reveal that the stream flowing through dense forest sustains during non-monsoon months due to input from the delayed subsurface flow. Further, he informed that the total rainfall received during April 2008 to March 2009 in the Arnigad and Bansigad micro watersheds are 2905 mm and 2958 mm respectively. This amount of rainfall is generating runoff of 1627 mm and 1932 mm respectively during April 2008 to March 2009. Monthly distributions of runoff in 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 watersheds respectively. Due to high runoff

during the monsoon period, the bansigad watershed stream gets dry up during premonsoon months. The annual runoff coefficient for Arnigad watershed is 0.6 for 2008-2009 and 0.5 for 2009-2010 while for Bansigad watershed 0.5 for 2008-2009 and 0.2 for 2009-2010. The direct runoff from Arnigad watershed is 0.23 and 0.14 for the 2008-2009 and 2009-2010, respectively and in Bansigad watershed 0.43 and 0.19 for 2008-2009 and 2009-2010 respectively. The infiltration test conducted in different land use condition reveals higher rate of infiltration in the dense oak forest cover.

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 and stream water data. He informed that $\delta^{18}\text{O}$ of rain varies between minimum -21.2‰ 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‰ in the month of August and maximum $+5.7\text{‰}$ in the month of May at Arnigad site. He also presented the relations between δD 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. He also presented the relations for the stable isotopic signatures of stream discharge in the watersheds and pointed out that slope and the intercept of the best fit line of stream discharge of both the watershed are close to local meteoric water line, which indicates that source of stream discharge is only local precipitation. Recharge zone of two springs have been estimated using isotopic techniques.

The working group noted the progress.

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 of 2010 has been started 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 (δD 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 δD and $\delta^{18}\text{O}$.

The isotopic signature of the fresh snow and surface ice samples collected near the snout ranges -4‰ to -13.9‰; and -13.3 to -18.5‰ 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‰ and -13‰. 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 preliminary results reveal that there is wide variation in isotopic signature of meltwater which reflect the contribution from source water changing due to change in melting pattern.

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. He informed that eight and three springs have been selected at different altitudes in Pauri and in Dugargad watersheds respectively to collect the water samples for stable isotopes (δD and $\delta^{18}\text{O}$) radioactive isotope (^3H) 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 δD and $\delta^{18}\text{O}$ for collected spring and rainwater samples are in progress. The δD for the springs have been analysed for the month of May June and July. The springs of Pauri urban area show depletion in the δD value of July month high indicate that there is quick response of recharge due to rainfall in the month of July. However, the δD of Dugargad watershed springs show no variation which is indicator of higher residence time of the springs. The geological and geomorphological details of the area have been collected from the literatures.

The working group noted the progress of the study.

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

The study was presented by Dr. S. D. Khobragade who is the PI for the study. He informed that, this study has been taken up on the request of the Uttarakhand Jal Sansthan with a period of two years. He informed that there are a number of springs in Uttarakhand and many of these are being used as a primary source source of drinking water. However, many of these springs have reported a continuous reduction in their discharge in recent times, while some dry up during summers. Further he informed that, although request has been received to study 10 major important springs in different districts, but keeping in view the feasibility, only 4 springs namely Moli, Ratoli, Gothiyara and Kandha Dhangi falling in Chandrabhaga Watershed in Jakanidhar Block of Tehri Garhwal district have been selected for study have been

taken up in consultation with the Uttarakhand Jal Sansthan, Dehradun. Describing the study area, he informed that the 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 the elevation map of the study area has been prepared. Ground water prospects map has been procured from USAC, Dehradun which would be used later for correlating with the isotope data. He informed that ordinary rain gauges have been installed at three locations namely Jelum, Anjanisain and Koti in the study area and data observers have been appointed to collect data on rainfall, spring discharge, water temperature, air temp, RH etc. He informed that daily rainfall data has been collected from 1 June-30 September, 2010 and that 261 water samples of springs, rain and GW have been collected of which 91 samples have been analyzed for deuterium. He also informed that spring discharge has been measured at 15 days interval for 4 stations during 1 June-30 September, 2010. The preliminary results of the analysis of isotopic signature (deuterium) obtained from analysis of rain samples and spring samples along with the water temperature data of springs were presented, but it was informed that there are certain inconsistencies in the results obtained so far. Dr. Bhishm Kumar said that the results showed some doubts about the samples being collected in the field and clarifications would be sought from the data observers engaged and efforts would be made to ensure that proper sampling is carried out in future.

Dr. G. C. Mishra enquired about the objectives of the study. Sh. Khobragade informed that the objectives of the study are to identify the recharge zones of the springs being studied and to suggest measures in the form of some structural measures. Dr. N. C. Ghosh enquired about the purpose of the water temperature data of spring being collected. It was informed that it would be used to cross check the results of the isotopic analysis as the higher will be the altitude of recharge, lower will be the temperature of spring water.

The working group noted the progress of the study.

The approved work program of the division for the year 2010-11 is given below:

WORK PROGRAMME OF THE HYDROLOGICAL INVESTIGATIONS DIVISION FOR THE YEAR 2010-2011

A. INTERNALLY FUNDED STUDIES

Reference Code	Project	Project Team	Duration/ Status	Funding
NIH/HID/INT/09-12	SW and GW Interaction at Selected Locations Along River Yamuna in NCT, Delhi: Phase-II	Sudhir Kumar (PI) M. S. Rao P. K. Garg	3 years (4/09 – 3/12)	NIH
NIH/HID/INT/10-13	Study of Variability of Snow and Glacier	S.P. Rai (PI) Manohar Arora, Bhishm Kumar,	3 years (4/10 – 3/13)	NIH

Reference Code	Project	Project Team	Duration/ Status	Funding
	Contribution in Melt Water of Gangotri Glacier at Goumukh using Isotopic Techniques	Rakesh Kumar and Naresh Kumar		
NIH/HID/INT/10-12	Identification of Recharge Zones of Some Selected Springs of Uttarakhand Using Isotopes	S. D. Khobragade (PI) Bhishm Kumar Sudheer Kumar S. P. Rai Pankaj Garg + Uttarakhand Jalsansthan	2 years (04/10-03/12)	NIH

B. SPONSORED STUDIES

NIH/HID/DST/07-12	National programme on isotope fingerprinting of waters of India (IWIN)	M.S. Rao (PI) B. Kumar, Sudhir Kumar S.P. Rai S.K. Verma Pankaj Garg + 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/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) (Consultancy)	Delhi Jal Board
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/RSMML/JKT/10-12	Hydrological study of Jhamarkotra Mines, Udaipur, Rajasthan	Sudhir Kumar (PI), M.S.Rao, S.K. Verma, Pankaj Garg	New Study (Consultancy) 1.5 years (07/10-12/11)	RSMML, Udaipur

C. PURPOSE DRIVEN STUDIES UNDER HP-II

NIH/HID/H P-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/H P-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

SURFACE WATER HYDROLOGY DIVISION

Dr. 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.

INTEGRATED HYDROLOGICAL STUDY FOR SUSTAINABLE DEVELOPMENT OF TWO HILLY WATERSHEDS IN UTTARANCHAL

Dr. A Agarwal presented the progress of the project to the house in brief. It was informed that the project duration has been completed and an extension up to December 2010 was granted for completing the report without additional funding. A detailed presentation of the work of last five years along with the phase one data and results, was made. The progress of the project in relation with the old instrumentation, data status, analysis of spring flow, flow duration curve, spring rainfall analysis, delineation of recharge zone, infiltration and rainfall characteristics, water balance, new instrumentation, two new river gauging sites was presented. Further the shape file for watersheds for drainage characteristics, land use, soil texture, spring, tanks and instruments sites were explained. The developed sediment rating curves, estimated sediment and socio economic survey results were also presented.

Dr. V C Goyal inquired about the use of present instrumentation as the project is ending. It was informed that the data acquisition through the instrumentation will continue as an internal research project and with modified objectives. Dr. B Kumar pointed out that the results derived through the use of nuclear technique can be further enhanced by providing some information of rainfall, temperature etc. It was agreed to improve the results before submission of final report.

The Chairman advised to incorporate month wise water availability/ shortage of each spring and possibilities of water storage tanks for both drinking and irrigation purposes. It was also suggested to locate the places where the spring discharge can be increased.

HYDROLOGICAL STUDIES IN A FORESTED WATERSHED IN UTTARAKHAND

Dr. J.V. Tyagi, P.I. of the project presented the objectives and results of the study. It was informed that the project is completed and the draft report prepared. Based on the analysis of data, it was concluded that the natural regeneration was highest under C1 (up to-0.30) canopy followed by C2 (0.30-0.50), and C3 (0.50-0.70) canopies. The variation soil moisture and light intensity under various canopies was established. The linear regression between incremental score of plot regeneration and average soil moisture content of different durations showed a highest R^2 value of 0.156 for the average soil moisture content at 100 cm depth during the period (January to June and November to December). The R^2 value of linear regression between incremental score of plot regeneration and annual average light intensity was obtained as 0.688 which indicates that the regeneration is largely dependent on the light intensity conditions during the year. The multiple linear regression between the incremental score of plot regeneration and the average light intensity and average soil moisture content of the period (Jan. to June and Nov. to Dec.) at 100 cm depth revealed that about 80% of variation in regeneration is explained by both the factors. Analysis of rainfall-runoff data revealed that the runoff from the watershed varied from about 5 to 15% of the event rainfall depending on the rainfall intensity. Spatial rates of soil erosion, simulated using ANSWERS model, revealed that the erosion in C3 canopy < C1 canopy < C2 canopy in all the events. No correlation was found between soil erosion rates and the regeneration. The Chairman, desired that this study should be included for presentation during the forthcoming TAC meeting.

SNOW MELT RUNOFF MODELING USING FUZZY LOGIC

Dr A.K.Lohani, Scientist E1, and PI presented the progress of the work. He informed that the catchment area of river Beas up to Pandoh dam site has been selected for the development of a fuzzy logic based snow melt runoff model. He further informed that the fuzzy set theory can be successfully applied in hydrologic modelling which is generally nonlinear in nature. He also presented the methodology adopted for developing the model. He informed that various input data vector were considered for the fuzzy based snowmelt runoff modeling. He mentioned that the analysis of the study is complete and report writing is in progress. Further, he explained the results of the study in detail. The Chairman suggested that the comparison of fuzzy rule based model and conceptual snowmelt runoff model should be presented in the report. Dr S.K. Singh, Scientist F inquired about the applicability of the developed Fuzzy model to other basins. Dr. Lohani informed that for the same model structure cannot be used directly for the other basins. The fuzzy model structure is basin specific as it is derived from the historical data of the specific basin.

STUDY ON INTEGRATED WATER RESOURCES MANAGEMENT OF A BASIN TO COPE WITH DROUGHT

The PI of the project Dr R.P. Pandey presented the progress of the study and reported the work done after the last meeting in March. The PI informed that the soil map,

DEM, drainage map, land use map, etc. have been prepared for the study area in Tons basin. Trend analysis of monthly rainfall data for annual and monsoon, summer and winter seasons were presented in map form. The PI further informed that the discharge data for two sites in Tons basin has been obtained from CWC office Varanasi and this data is being analyzed. Matter is being perused with IMD for obtaining rainfall and other meteorological data. PI reported that a report on inventory of water resources in the basin is being prepared to assess strategic water resources for utilization during drought.

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 for the period from April 2009 to February 2010. He also presented the progress of the study during March 2010 to September 2010. Dr S. P. Agarwal, IIRS, Dehradun suggested to use MARS software to select the significant inputs to the ANN models. He also suggested to include the snow cover area as one of the inputs to the ANN model. The Chairman of the working group also supported the suggestions of Dr. Agarwal.

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 background, objectives, methodology and progress 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 requires snow cover mapping which would be an input to the snowmelt runoff model in later part of the study. She further informed that MODIS-TERRA satellite data at 8-daily interval have been downloaded from NASA's website for eight years (2000-2008). She told that out of a total of 364 downloaded and processed scenes, 232 cloud free scenes have been used for snow cover mapping in the study area. She presented the snow depletion curves and maps showing spatial & temporal variation of snow cover area within the basin. Dr. S.P. Agarwal, Member of the working group asked about the month of minimum snow cover in the study area. Mrs Sarkar replied that minimum snow cover has been observed during the month of July. Mrs Sarkar informed that the behavior of snow accumulation and depletion is different for western and eastern Himalayan regions. In western Himalayas, snow accumulation takes place in winters and depletion during summers. Whereas, in Eastern Himalaya, there is summer accumulation as well as summer depletion of snow.

STUDY ON ENVIRONMENTAL FLOW FROM PROPOSED DAM OF TEESTA STAGE IV HE PROJECT

Dr Rakesh Kumar informed the Working Group that the study has been completed and the draft report submitted to NHPC. The results of the study were presented before a technical committee at NHPC Faridabad. The Chairman explained the results obtained by various methods viz. Tenants method, Modified Tenants method, Flow Duration Method, 7Q10 Method and the analysis of flow data using the intermediate contributions as well.

MONITORING AND MODELLING OF STREAMFLOW FOR THE GANGOTRI GLACIER

Dr Rakesh Kumar explained the progress of the study. He informed the house that for the current year the field investigations were started in the month of May and have been closed on 7th October 2010. He informed the house that Dr Arora PI of the study could not present the progress as he was on a field visit to the project site. He explained the data collected and informed about the analysis of the meteorological and discharge data. The Chairman informed that the data have been collected successfully by the AWS and during the winter season also and data will be collected for carrying out the analysis

CLIMATIC SCENARIOS GENERATION FOR SATLUJ BASIN USING STATISTICAL DOWNSCALING TECHNIQUES

Dr Rakesh Kumar explained the details of study and briefed the Working Group about the progress made so far. He informed that the basin has been identified and the GCM output of the NIES will be downloaded and analysed for carrying out the study.

DATA BOOK-HYDRO - METEOROLOGICAL OBSERVATORY 2001-2008

Shri Digambar Singh presented the progress of the study for the period from April 2009 to September 2010. He also informed that entry of the hourly temperature for two and half years has been completed and the entry of hourly humidity data has been completed for one year. The entry of rainfall has been completed for four years. He also presented the graphical sample of the data entry for hourly temperature, rainfall and humidity and informed that preparation of the data book is under progress.

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

Dr. Avinash Agarwal proposed the new study with the following objectives: (i) detailed hydrological monitoring, collection of data at watershed scale and creation of a centralized database for watershed for the benefit of the users, (ii) development of implementable technology for water availability analysis, and (iii) interaction and transfer of developed implementable technology to users. The study area and methodology were also presented in brief. The working group suggested that the objective no. (ii) development of implementable technology for water availability analysis should be modified with application of implemental technology for water availability. Further the objective no. 3 should include the transfer of findings through interaction workshops involving state line departments; NGO's and be modified as interactive workshops with state line departments and NGO's.

**WORK PROGRAMME OF SURFACE WATER HYDROLOGY
DIVISION FOR THE YEAR 2010-11**

S. No. & Ref. Code	Title	Study Team	Duration	Funding Source
1.NIH/SWD/NIH/05-10	Integrated Hydrological Study for Sustainable Development of two Hilly Watersheds in Uttaranchal	A. Agarwal	5 years	DST
2. NIH/SWD/NIH/07-10	Hydrological studies in a forested watershed in Uttarakhand	J.V. Tyagi Rakesh Kumar Digamber Singh	3 years (up to August, 10)	NIH & FTA
3. NIH/SWD/NIH/09-11	Snow Melt Runoff Modeling Using Fuzzy Logic	A.K. Lohani, Sanjay K. Jain Rakesh Kumar	2 years	NIH
4.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. Thakral	4 years	NIH
5.NIH/SWD/NIH/09-12	Snow Melt Runoff Modelling in Sultej Basin	A.R. S. Kumar Manohar Arora A. Agarwal D.S.Rathore Digambar Singh	3 years	NIH
6. NIH/SWD/NIH/10-13	Snowmelt Runoff Modeling and Study of the Impact of Climate Change in part of Brahmaputra River Basin	Archana Sarkar	3 years	NIH
7. NIH/SWD/NIH/09-10	Study on Environmental Flow From proposed Dam of Teesta Stage IV HE Project	Manohar Arora R. D. Singh Rakesh Kumar	1 year	NHPC
8. NIH/SWD/NIH/08-	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora Rakesh Kumar	To be continued	NIH
9. NIH/SWD/NIH/10-13	Climatic Scenarios Generation for Satluj Basin using Statistical Downscaling Techniques	Manohar Arora Rakesh Kumar	3 years	NIH
10 NIH/SWD/NIH/09-11	Data book - hydro-meteorological observatory 2001-	Digambar Singh A. R. S. kumar Manohar Arora	2 years	NIH

	2008			
11. NIH/SWD/NIH/09-11	Impact of climatic change on evaporation	N.K. Bhatnagar A. Agarwal	2 years	NIH
12. NIH/SWD/NIH/10-13	Climatic variability analysis and its impact on Himalayan watershed in Uttarakhand	A. Agarwal, Manohar Arora R K Nema	New Study 3 years (Nov. 11 - Oct. 13)	NIH

WATER RESOURCES SYSTEMS DIVISION

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 explained the work carried out during the last six months. He informed that satellite data from NRSC have been procured and processing of the data has been completed. Field visits have been carried out during April, June and September 2010 for sample collections from the field. He informed that samples have been analysed by Dr. S.P. Rai, Sc. E1, and Hydrological Investigations Division. Dr. Rai explained the results obtained for one of the site i.e. Dhundi. The trend analysis of rainfall and temperature data has been carried out by Dr. Vijay Kumar. The results of trend analysis were presented. Dr. P K Garg said that snow depth can also be included for estimation of snowmelt runoff. Dr. Jain informed that it is not possible to get snow depth and also energy balance approach requires a lot of data. Dr. S.P. Agarwal said that using remote sensing (passive) snow depth can be measured up to some extent. Dr. N C Ghosh asked about trend analysis, Dr. Vijay Kumar explained the work carried out. Chairman also said that application of energy balance approach can be taken up. Dr. P K Garg asked about the use of instruments after completion of the project. Chairmand said that the data will be collected after completion of the project.

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 some of the satellite data has been received and after obtaining all the data reservoir sedimentation assessment will be carried out for both the reservoirs. He has shown the data base created in Arc SWAT. The sediment discharge analysis carried out for different sites of Satluj basin by Dr. Vijay Kumar was presented. Dr. S P Agwarwal asked about the application of ANN in sediment discharge relationships. Dr. R Mehta replied the question. Dr. M K Goel suggested that in sediment discharge relationship inclusion of time of the last rainfall will improve the results.

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 house regarding duration of this purpose driven study (PDS). Also informed the house about the progress of studies that was presented in last working group, and the works carried from inception of this project till date Dr. Bhunya presented the status of hydrological data base that was collected during this period, required toposheet in the study along with the indents submitted to SOI. Dr. Bhunya also briefed regarding the imageries, and four experimental small catchment that was done during this period using the available imageries in remote sensing lab., including the indents that is in process. Also he presented the technical results that included geomorphological data of about 15 small catchments in the study area, and the validation. He also presented the revised results of heterogeneity tests, and the regional flood frequency model-parameter, regional hydrographs parameters, flow duration curves obtained using the earlier method and a new method. Dr. Bhunya further briefed the house about the last training course, and regarding the future works to be taken up. The photos taken recently by staffs during the last visit to the basins were displayed and the technical publications including a book on soft computing techniques that was proposed in this project area were also discussed. He also presented the next year's work-program.

INTERNAL STUDIES

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 was completed in March 2009 and an interim report has been prepared. He informed that energy balance equation has been applied for computation of ET in the catchment. He presented the results of the study. Dr. V C Goyal asked the utility of the study in the field. Dr. Jain informed that such type of study can be helpful for irrigation purpose in the field. Dr. Suhas asked about the verification of the results. Dr. Jain informed since there is no observed record from the field therefore validation of the results is not possible.

COMPUTATIONALLY SIMPLE FUNCTIONS FOR APPROXIMATING NORMAL AND LOG-NORMAL DISTRIBUTIONS.

Dr. S. K. Singh, Scientist F, presented the progress of the study along with its objectives, methodology and practical usefulness. A computationally simple function (calculations for which can be performed on a hand-held calculator) has been developed for representing the cumulative distribution function (CDF) of the normal distribution, which can be easily transformed to represent the CDF of the log-normal distribution. The testing and possible improvement of the developed function is in progress. It has practical utility in studies dealing with the flood frequency and estimation of flood using IUH assumed as a frequency distribution, and in other fields (e.g., economics, and banking) where normal and log-normal distributions are used. The developed computationally simple function would be of help to field engineers and practitioners.

Dr. P. K. Garg suggested that the developed functions can also prove to be useful in the studies dealing with the sharpness of image in the area of remote-sensing. The suggestion was well received with an open possibility of a joint study of this type also involving Dr. Sanjay Jain, Scientist E2 of the Institute.

A SIMPLE IUH MODEL FOR RUNOFF MODELING

Dr. S. K. Singh, Scientist F, presented the progress of the study along with its objectives, methodology and outcome. A computationally simple function/distribution for instantaneous unit hydrograph for event based runoff modeling has been developed, the calculations for which can be performed on a hand-held calculator. The testing and refinement of the developed function is in progress and it is also intended to impart to it a possible conceptual and physical justification with practical illustration to published field data. It has two parameters, one of which is the time- base of unit hydrograph. If the time-base is considered a known parameter for given input and output, the developed function reduces to a one parameter IUH model. Because of the computational simplicity of the developed function, it can be a viable alternative to the widely used Nash-model/gamma-distribution for deterministic modeling of event-based runoff. Thus, it would be of help to field engineers and practitioners.

Dr. S. P. Agrawal enquired if it is also intended to estimate the parameters of the developed IUH model while considering the illustrative application of the model; Dr. S. K. Singh replied in affirmative.

APPLICATION OF A DISTRIBUTED HYDROLOGICAL MODEL FOR RIVER BASIN PLANNING AND MANAGEMENT

Dr. M. K. Goel (MKG) presented the progress of the study. He informed that the database of the study area (Upper Bhima basin) is being developed/ fine-tuned in the format compatible with the NIH model. He showed the processed DEM of the basin and the GIS layers for basin boundary, drainage and boundaries of different sub-basins (depending on the gauging locations) generated from it. The geo-referenced soil map of the Maharashtra state obtained from NBSSLUP, Nagpur and the digitized soil boundaries were presented. The hydrological properties of soils have also been obtained from NBSSLUP. MKG informed that because of repeated updation of hydrological database for the pilot basin study under DSS, the hydrological database development is still in progress. Most of such data has been converted to MS-EXCEL format and is being arranged in the NIH model format for the application of the model. The location of around 150 rainfall stations which has been added to the existing 61 stations was also presented. MKG informed that setup for the MIKE BASIN model for the study area has made significant progress. He also briefed about two three other models (SWAT, MODSIM, and HEC-HMS) for the application in the present study.

In response to a comment from Dr. S. P. Agarwal, Head (Water Resources), IIRS, MKG informed that spatially distributed NIH model has been developed at NIH for understanding the comprehensive hydrology of a river basin. He informed that model computes various components of the hydrological cycle at daily time step and has components for overland flow computation, reservoir operation, soil moisture modeling, demand computation for domestic and irrigation etc. The Director, NIH added that since it is in-house development, any modification or new addition can be

carried out subsequently. Since a lot of database has been developed for the Upper Bhima basin, it is worthwhile to apply various models to this basin for comparison of results. In response to a query from Dr. Agarwal, MKG informed that it is a conceptual model which works at daily time step. This time step is selected in view of the availability of hydrological data in India and the need of modelling for larger river basins.

NIH_ReSyP–A SOFTWARE FOR RESERVOIR ANALYSIS (VERSION-1)

MKG presented the progress of the study. He informed that software development is near-finalization. Various forms have been reformatted and visual appearance of the forms has been greatly improved. A stand-alone routine for graphical presentation of results has been added. In addition, EXCEL-based graphical option has also been retained. The model visualization was demonstrated in the meeting. However, some problems were encountered in invoking some modules.

MKG informed that programs have been finalized for the spillway gate regulation and reservoir sedimentation analysis though their conversion in modular form is still under progress. He informed that it is proposed to organize a training program in the recent future for propagating the use of the software among various states. Dr. S. P. Agarwal enquired about the availability of the software. Director NIH informed that a policy for this purpose would be finalized in near future.

GIS BASED DAMS AND DROUGHT INFORMATION SYSTEM

The progress of the report was presented by Shri D.S. Rathore. It was informed that the Mapserver software was downloaded and installed, map files were prepared and web page development was initiated. Rainfall for SPI values are estimated and consolidated list was prepared. Snap shots of the web pages were displayed. In the main web page, a dropdown list was provided to navigate to pages for an application, namely all dams, storage dams, hydropower dams and drought information. In ‘all dams’ option, layers namely, basin, major basin, rivers, major rivers and dams may be displayed. Major rivers are annotated. River’s name and dam’s name, state and basin may be queried. It was further proposed to acquire district layer from SOI and populate drought attributes in the table. Web pages for options storage dams, hydropower dams and drought information will be developed. Dr S.P. Aggarwal inquired if query for count of dams in the basin may be generated. It was informed that presently it is not envisaged to provide this query. Dr P.K. Garg inquired regarding type of drought being considered and its spatial unit. It was informed that only meteorological drought is presently covered at district scale. Chairman replied that the scope of the study is limited at present. Later the scope of the study may be expanded.

WEB BASED INFORMATION SYSTEM FOR MAJOR AND IMPORTANT LAKES IN INDIA

Mrs. Deepa Chalisgaonkar presented the study. She informed that the web based system intends to provide information regarding the various hydrological and limnological aspects of the major and important lakes of India. The framework of the system has been developed. The framework was also displayed in the meeting. The clickable maps of India and its states have also been developed. Location of lakes on the clickable map of Rajasthan is under progress. Information on about 50 lakes of India has been collected and edited for the purpose of inclusion in the system. The

details of National lake conservation programme and RRR (repair, renovation and restoration) programme of water bodies has been included in the system. Some basic information on various aspects of lake hydrology, classification of lakes, lake eco system, and limnology has been incorporated in the system. The frame work of the system is under development is given below:



Working group noted the progress of the study

PREDICTION OF DISPERSION COEFFICIENT OF STREAMS USING KRIGING TECHNIQUE

Dr. Vijay Kumar, Scientist 'E1' and PI presented the objectives of the study and methodology to be adopted. It is intended to use the kriging technique for the prediction of dispersion coefficient in streams from the flow and cross-sectional characteristics of streams. Dr. S P Agarwal, Scientist, IIRS, Dehradun suggested to use the co-kriging technique as several variables are involved. The PI informed that to take care of several variables, it is intended to form non-dimensional groups of variables and thus the intended kriging technique would take into account several variables related to stream flow and geometric properties of the stream.

ANALYSIS OF WATER MANAGEMENT SCENARIOS IN TAPI RIVER BASIN USING MIKE BASIN

Dr. Rama Mehta presented the study and informed that first objective of this study i.e. Identification of water resources issues in the study area is in progress. Study about the existing problems in Water Resources Development of Tapi river basin has been carried out. She told about the major and minor projects existing in basin area. Rainfall and Runoff data have to be collected for all 12 sub-basins in Tapi basin with installed rain gauge and discharge stations. She told that the data is available from 1990 to 1996

with Dr. M.K.Goel in the institute. Correspondence is in progress to collect the remaining data from concerned agencies. Procurement of other hydrological data for various water resources systems are also under progress. Director NIH, asked her to prepare a month-wise distributed work plan and show that during next meeting.

WORK PROGRAMME OF THE WATER RESOURCES SYSTEMS DIVISION FOR THE YEAR 2010-2011

A. Internally Funded Studies

Reference Code	Project	Project Team	Duration/ Status	Funding
NIH/WRSD/NIH/09-12	Application of a distributed hydrological model for river basin planning and management	M. K. Goel (PI) Vijay Kumar D. S. Rathore Deepa Chalisingaonkar Rama Mehta	3 years (10/09 – 03/12) Continuing study	NIH
NIH/WRSD/NIH/09-12	Use of remote sensing in soil moisture and water balance estimation-case study of the Solani catchment	Sanjay K. Jain and J. V. Tyagi IIRS Dehradun	3 years (04/09 – 03/12) Continuing study	NIH
NIH/WRSD/NIH/09-11	GIS based dams and drought information system	D.S. Rathore (PI) Deepa Chalisingaonkar R.P. Pandey	1.5 years (10/09-3/11) New study	NIH
NIH/WRSD/NIH/10-11	<i>NIH_ReSyP</i> – A software for Reservoir Analysis (Version – 1)	M. K. Goel (PI) Deepa Chalisingaonkar	1 year (4/10-3/11) New study	NIH
NIH/WRSD/NIH/10-11	Web Based Information System For Major And Important Lakes in India	Deepa Chalisingaonkar (PI) Suhas Khobragade	2 years (4/10-3/12) New study	NIH
NIH/WRSD/NIH/10-11	Analysis of water management scenarios in Tapi River basin using MIKE Basin	Rama Mehta (PI) M.K. Goel Vijay Kumar	3 years (4/10-3/11) New study	NIH
NIH/WRSD/NIH/10-11	Computationally simple functions for approximating normal and log- normal distributions	Sushil K. Singh (PI)	1 year (4/10-3/11) New study	NIH
NIH/WRSD/NIH/10-11	A simple IUH model for runoff modeling	Sushil K. Singh (PI)	1 year (4/10-3/11) New study	NIH
NIH/WRSD/NIH/10-11	Prediction of dispersion coefficient of streams using kriging technique	Vijay Kumar (PI) S K Singh	1 year (4/10-3/11) New study	NIH

B. Purpose Driven Studies under HP-II

Reference Code	Project	Project Team	Duration/ Status	Funding
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-IITR Vijay Kumar Bhism Kumar Renoj Theyyan	<i>4 years (04/08 – 03/12)</i> Continuing study	HP-II
NIH/WRSD/NIH/09-04/12	Hydrological Assessment of Ungauged Catchments (Small Catchment)	P. K. Bhunya (PI) D.S. Rathore P.C. Nayak Niranjan Panigrahy Sanjay Kumar Suhass Khobragade Director (H&WR P), Govt. of Orissa	<i>3 years (05/09 – 4/12)</i> Continuing study	HP-II
NIH/WRSD/NIH/08-03/13	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-IITR Vijay Kumar J.V. Tyagi Rama Mehta	<i>4 years (04/09 – 3/13)</i> Continuing study	HP-II