AGENDA AND AGENDA NOTES FOR THE 31ST MEETING OF THE WORKING GROUP OF NIH

17-18 SEPTEMBER, 2009
AT 1100 HRS.
IN NIH SOCIETY ROOM

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NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE-247667

AGENDA AND AGENDA NOTES FOR THE 31ST MEETING OF THE WORKING GROUP OF NIH

AGENDA ITEMS

ITEM NO. 31.1 Opening remarks by the Chairman

ITEM NO. 31.2 Confirmation of the minutes of 30th meeting of the Working Group

ITEM NO. 31.3 Presentation and discussion on the progress of the work programme 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 of the five divisions for the year 2009-2010

ITEM NO. 31.4 Any other item with permission of the Chair.

ITEM NO. 31.1 OPENING REMARKS BY THE CHAIRMAN

ITEM NO. 31.2 Confirmation of the minutes of 30th meeting of the Working Group

The 30th meeting of the Working Group was held during 8-9 April, 2009. The minutes of the meeting were circulated to all the members and invitees vide letter No. RCMU/WG-30/NIH-09 dated 16th April 2009. No comments have been received on the circulated minutes. A copy of the minutes of the 30th Working Group is given in Annexure A.

The Working Group may please confirm the minutes.

ITEM NO. 31.3 PRESENTATION AND DISCUSSION ON THE PROGRESS OF THE WORK PROGRAMME 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 OF THE FIVE DIVISIONS FOR THE YEAR 2009-2010

The Work Programme of the Five Divisions of the Institute for the year 2009-10 was considered by the 30th meeting of the Working Group and the recommended programme was approved by the TAC.

During the present meeting, the status of the current year's (2009-10) work programme shall be presented division-wise. Some new project proposals/studies are also being presented for consideration of the Working Group.

This item has been organized in the following order:

1) **Environmental Hydrology Division**
2) **Ground Water Hydrology Division**
3) **Hydrological Investigation Division**
4) **Surface Water Hydrology Division**
5) **Water Resources System Division**

The Working Group may please consider the progress of the current year Work Programme and also approve the proposed new studies for the year 2009-10.

WORK PROGRAMME OF THE ENVIRONMENTAL HYDROLOGY DIVISION FOR THE YEAR 2009-2010

S. No. & Reference Code	Title of the Project/Study	Study Team	Duration	Funding Agency
1. 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 Status : **In progress**	CPCB New Delhi
2. 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 Status : **In progress**	HP-II
3. 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 (Oct., 07 to Sept. 2010) **Status : In progress**	NIH
4. 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 Status : In progress	NIH

NEW PROJECT PROPOSALS

S. No. & Reference Code	Title of the Project/Study	Study Team	Duration	Funding Agency
5. 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	NIH

The progress of approved work programme for the year 2009-10 and details of the new studies are given in Annexure-I.

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

S. No. & Reference Code	Project	Project Team	Duration & Status	Funding Source
1. 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) **Status:** In progress	NIH
2. NIH/GWD/NIH /08-09/	Vision document on "Mitigation and Remediation of Ground Water Arsenic Menace in India"	*Coordinators*: NIH & CGWB	08 months (09/08 – 04/09) **Status:** Completed & Submitted to MoWR	MOWR
3. NIH/GWD/NIH /09-12/	Impact of Climate Change on Dynamic Groundwater Recharge in a Drought Prone Area	Surjeet Singh (PI) C. P. Kumar Anupma Sharma Rajan Vatsa	3 years (04/09 – 03/12) **Status:** In progress	NIH

NEW PROJECT PROPOSALS

S. No. & Reference Code	Project	Project Team	Duration	Funding Source
4. 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 Vasta	1 year 6 months (08/09 – 02/11) **- New Study**	Ground Water Deptt., Govt. of Rajasthan
5. 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

The progress of approved work programme for the year 2009-10 and details of the new studies are given in Annexure-II.

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

S. No. & Reference Code	Project	Project Team	Duration	Funding
1. 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	4/09 – 3/12 (3 years)	Internal
2. 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	7/07 –6/12 (5 years)	DST
3. NIH/HID/FRI/08-13	Impact Assessment of Landuse on the Hydrologic Regime in the selected Micro-watersheds in Lesser Himalayas, Uttarakahand	S.P. Rai (PI) Bhishm Kumar J.V. Tyagi	4/08 – 3/13 (5 years)	FRI
4. NIH/HID/HP-II/09-12	Groundwater Dynamics of Bist-Doab Area, Punjab Using Isotopes	M.S. Rao (PI) Bhishm Kumar Sudhir Kumar S.K. Verma Pankaj Garg + Officials of CGWB	7/2008-6/2012 (3 years)	HP-II
5. NIH/HID/HP-II/09-12	Groundwater Management in Over- Exploited Blocks of Chitradurga and Tumkur Districts of Karnataka	Sudhir Kumar (PI) J.V. Tyagi Vijay Kumar B.K. Purandara S.P. Rai M.S. Rao	7/2009-6/2012 (3 years)	HP-II
6. NIH/HID/INCID/09-11	Estimation of irrigation return flow and stream flow regeneration in parts of the selected canal command areas	M S Rao (PI) Bhishm Kumar S. K. Verma Pankaj Garg	2 years from the date of approval from INCID	INCID
7. NIH/HID/INT/09-12	Integrated Hydrological Investigations of Ropar Lake, Punjab	S.D.Khobragade (PI) B. Kumar N.C.Ghosh Sudheer Kumar S.P.Rai M.S.Rao S.K.Verma Pankaj Garg & One scientist from EHD	04/09-03/12 (3 years)	Internal

The progress of approved work programme for the year 2009-10 is given in Annexure-III.

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

S. No. & Reference Code	Project	Study Team	Duration	Funding Source
1. 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) plus extended period	INCOH
2. 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
3. NIH/SWD/NIH/09-11	Assessment of environmental flow requirements in river Ganga at Loharinag Pala project site	Manohar Arora (PI) R. D. Singh Rakesh Kumar	2 year	NIH
4. 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	DST
5. NIH/SWD/NIH/07-10	Hydrological studies in a forested watershed in Uttarakhand	J.V. Tyagi (PI) Rakesh Kumar Digamber Singh	3 years	NIH & FTA
6. NIH/SWD/NIH/09-11	Snow Melt Runoff Modeling Using Fuzzy Logic	A.K. Lohani (PI) Sanjay K. Jain Rakesh Kumar	2 years	NIH
7. 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. Thakaral	4 years	NIH
8. NIH/SWD/NIH/09-12	Snow Melt Runoff Modelling in Sultej Basin	A.R. Senthil Kumar (PI) Manohar Arora Avinash Agarwal D.S.Rathore Diganbar Singh	3 years	NIH
9. NIH/SWD/NIH/08-	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora (PI) Rakesh Kumar	To be continued	NIH
10. NIH/SWD/NIH/09-11	Data book - hydro-meteorological observatory 2001-2008	Digambar Singh (PI) A. R. Senthil kumar Manohar Arora	2 years	NIH

NEW PROJECT PROPOSALS

S. No. & Reference Code	Project	Study Team	Duration	Funding Source
11. NIH/SWD/NIH/09-10	Impact of climatic change on evaporation	N.K. Bhatnagar (PI) Avinash Agarwal	1 year	NIH

The progress of approved work programme for the year 2009-10 and details of the new studies are given in Annexure-IV.

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

S. No. & Reference Code	Project	Project Team	Duration & Status	Funding Source
1. 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) **Status**: In progress	HP-II
2. NIH/WRSD/NIH/09-04/12	Hydrological Assessment of Ungauged Catchments (Small Catchment)	Sharad. K. Jain (PI) D.S. Rathore P.C. Nayak Niranjan Panigrahy Sanjay Kumar Suhas Khobragade Director (H&WR P), Govt. of Orissa	03 years (05/09 – 04/12) **Status**: In progress	HP-II
3. NIH/WRSD/NIH/08-12/12	Decision Support System (Planning) for Integrated Water Resources Development and Management	Rakesh Kumar A. K. Lohani D. Chalisgaonkar C. P. Kumar M. K. Goel Vijay Kumar R. P. Pandey P. K. Bhunya Sanjay Kumar A. Sharma N. Pannigrahy Surjeet Singh	04 years (12/08 – 03/12) **Status**: In progress	HP-II
4. 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) **Status**: In progress	NIH
5. 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) **Status**: In progress	HP-II

NEW PROJECT PROPOSALS

S. No. & Reference Code	Project	Project Team	Duration	Funding Source
6. NIH/WRSD/NIH/09-03/11	Water table evolution due to subsurface drainage with arbitrary Recharge using a numerical model	Sushil K. Singh (PI)	1year and 6 months (09/09 – 03/11) **Status:** **- New Study**	NIH
7. 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

The progress of approved work programme for the year 2009-10 and details of the new studies are given in Annexure-V.

ANNEXURES

MINUTES OF THE 30TH WORKING GROUP MEETING

ANNEXURE-A

MINUTES OF THE 30TH MEETING OF THE NIH WORKING GROUP HELD DURING APRIL 8 – 9, 2009 AT NIH, ROORKEE

The 30th meeting of the NIH Working Group was held in the Society Room of the National Institute of Hydrology, Roorkee during April 8 – 9, 2008 under the chairmanship of Shri R.D. Singh, Director, NIH. The list of the participants of the meeting is given in Appendix-I.

ITEM NO. 30.1 OPENING REMARKS BY THE CHAIRMAN

The Chairman, Working Group welcomed the Working Group members and the Scientists of the Institute at the Working Group meeting. The Chairman gave a brief background of the various technical and research activities taken up by the Institute during the previous six months. He informed that Climate Change studies have been assigned a very high priority in the recent past and Ministry of Water Resources, Govt. of India has taken up a National Water Mission in this regard. The details about these aspects are available on the website of MoWR. The Institute has been entrusted a big role in carrying out the studies on Climate Change. He also informed that the Technical Advisory Committee (TAC) of the Institute has recommended that NIH should come out with a Vision Document for carrying out various research activities in future. In compliance of the recommendations of the TAC meeting, a brain storming session was organized by the Institute during 16-17 March, 2009 and details of the Vision document would be explained by Dr. Bhishm Kumar, Scientist 'F' and Member Secretary, TAC. The Chairman also explained that the Institute is playing an important role in carrying out the various activities of the World Bank funded HP-II. The Institute is a nodal agency for development and implementation of DSS (P) for integrated water resources development and management. The activities of development and implementation of DSS (P) are in progress. The Chairman also apprised the members that the Institute has also taken up some Purpose Driven Studies under the HP-II. A number of training programs and workshops have also been organized by NIH. Thereafter, the Chairman requested Dr. Bhishm Kumar, Scientist 'F' to explain about the Vision document of the Institute. Dr. Bhishm Kumar presented the details of the Vision 2020 of NIH and its various thrust areas. Thereafter, the Chairman requested the Working Group members to give their observations, suggestions and remarks about the Vision and thrust areas as well as other scientific aspects for carrying out research work by NIH.

Dr. R D Verma appreciated the work being carried out by NIH and hoped that NIH would carry out better research work in future. He stressed that the climate change is a very important area of research and presently NIH does not have a separate division on Climate Change. He opined that establishment of a separate division at NIH would improve the working and capacity building activities on climate change at NIH. He also expressed that earlier arid zone hydrology was one of the themes of research studies at NIH and studies on arid zone hydrology should continue at NIH. Dr. Verma informed that he being the Member of the American Geophysical Union has brought alongwith him four papers on Climate Change. He provided the papers to the Chairman, Working Group for reference.

Dr. B P Singh expressed that NIH is doing very good research work in the area of Hydrology and he appreciated that NIH has come out with the Vision and thrust areas. He suggested that efforts should be made to study how the available water in hydrological cycle can reach the users. He also mentioned that Climate Change is also a very important area of research and studies should be carried out for studying the effects of climate change on water resources so that the water planners can take into consideration the impact of Climate Change into account for planning, development and management of water resources.

Dr. S V Navada stated that new technologies are available for collection of data and modeling of hydrological processes specifically for isotopic measurements and NIH should have advanced isotopic data collection instruments and hydrological modeling packages.

Dr. K V Jayakumar stated that NIH has been doing commendable research work and there is a need for taking up of the capacity building and training activities for hydrological analysis and water resources management.

Prof. P K Garg emphasized that though NIH is carrying out appreciable research work in the area of Flood and Drought Management, yet there is a need for taking up studies for management of disasters resulting from landslides and glaciers. He also suggested that there is a need for carrying out studies for underground mapping of pipes and other features related to water.

Dr. S. P. Agarwal stated that the data of soil moisture is an important hydrological variable and radar data may be used for obtaining data on soil moisture. He also stressed that people want solutions of hydrological problems also there is a need to make people aware of new technological developments. He advised that NIH should carry out the studies on flood inundation and flood hazard modeling.

Shri K B Parmar opined that flood and drought management are very important areas of hydrology and water resources management. He desired that studies on real time flood forecasting should be taken up by NIH.

Shri R M Bhardwaj stated that there is a wide variability in the estimates of water resources of India and there is a need for accurate estimation of water resources. He also emphasized that

with increase of population per capita availability of water would be reducing and demand for water is going to increase and therefore technology should be developed for recycle and reuse of water.

Dr. R Vishwanatham opined that there is a need for carrying out studies for reducing reservoir sedimentation. He stressed that NIH has carried out some work on sedimentation of reservoirs and the results obtained by NIH should be used in practice.

Shri V Tamilarasan expressed his happiness on the Vision Document and thrust areas. He felt that availability of data for carrying out the hydrological studies is one of the main problems. He stressed the need for sharing of data and development of common formats for processing, analysis, retrieval and sharing of data.

Shri M R Chakraborty opined that floods and droughts are important areas of research and dam safety and water resources management projects coming for clearance to CWC require the knowledge and procedures on these aspects. He also stated that DSS (P) would also be quite useful for integrated water resources development and management. He stressed that water quality management is also an important area of research as quality of water is reducing due to point and non-point pollution.

Shri N Y Apte felt that in addition to the thrust areas identified by NIH, the social aspects as well as social benefits resulting from the studies should also be studied. Dr. V V S Gurunadha Rao stated that there is a need for carrying out studies on climate change. He also made a presentation on impact of climate change on water resources. The presentation made by Dr. V V S Gurunadha Rao was appreciated by the members of the Working Group meeting.

In response to the various suggestions / observations / comments of the Working Group members, the Chairman, Working Group informed that due to manpower constraints, the Division on Climate Change is not functional at NIH. But, a Climate Change has been set up. He also informed that Climate Change Cells have also been set up at CWC, CGWB and Brahmaputra Board and roles of these cells have also been defined. He further explained that after the man power improves in future, then only a Division on Climate Change could be set up at NIH. The studies related to problems of arid zone are being carried out under the theme of Drought Management Studies. About the procurement of instruments on isotopic data collection the suitability of the isotopic data collection instruments would be studied and the instruments would be procured as per the requirement of the Institute. With regard to the capacity building, the Chairman informed that NIH is organizing the training courses / seminars / symposia / national and international conferences. During the previous year, 17 such activities have been carried out. The Chairman informed that studies on Floods land Drought Management are being carried out by the Institute and studies on flooding due to landslides and glaciers would also to be taken up by the Institute based on the availability of manpower at the Institute. He also

informed that a study on soil moisture assessment is being carried out in collaboration with IIRS, Dehradun and a presentation on the results of the study would be made during the meeting.

While responding to carrying out studies on flood forecasting, the Chairman informed that NIH is not an operational organization but the Institute would be carrying out the studies on applications and development of flood forecasting models. He also informed that the website of the Institute is being upgraded and the information regarding important studies carried out by the Institute will be placed on the website.

The Chairman also informed that the Institute has carried out a number of studies on reservoir sedimentation and the issues raised by the Working Group Members would be further studied under the thrust area of sustainable water resources management. He also stated that regarding sharing of data, guidelines are being prepared by the Ministry of Water Resources.

ITEM NO. 30.2 CONFIRMATION OF THE MINUTES OF THE 29TH MEETING OF THE WORKING GROUP

Shri Rakesh Kumar, Scientist F and Convener informed that the 29th meeting of the Working Group was held during 30 September – 01 October, 2008 and the minutes of the meeting were circulated to all the members and invitees vide letter no. RCMU/WG-29/NIH-08 dated 20th October 2008. No comments have been received on the circulated minutes. The members did not offer any comments. The minutes were confirmed.

ITEM NO. 30.3 PRESENTATION & DISCUSSIONS ON THE PROGRESS OF THE WORK PROGRAMME OF THE FIVE DIVISIONS FOR THE YEAR 2008-09 INCLUDING THE ACTIONS TAKEN ON THE DECISIONS OF THE LAST MEETING

AND

ITEM NO. 30.4 PRESENTATION AND FINALIZATION OF THE NEW WORK PROGRAMME OF THE FIVE DIVISIONS FOR THE YEAR 2009-10

During the meeting the status of current year's (2008 – 09) work programme as well as the new proposed work programme were discussed division-wise. The Chairman urged the Heads of the

Divisions to make the presentations and advised that the progress of each study should be presented with the details of objectives, progress made, results and outcome. He also desired that the research work carried out during the recent six months should be explained in detail.

The division-wise progress of each study of the following Divisions was taken up for discussions:

On April 8th, 2009

1. **Environmental Hydrology Division**
2. **Hydrological Investigations Division**
3. **Ground Water Hydrology Division**

On April 9th, 2009

4. **Surface Water Hydrology Division**
5. **Water Resources Systems Division**

The details of division-wise presentations and discussions are given as follows.

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 Co-investigators to present the detailed progress of the studies made during past six months. The minutes of each study are given below:

1. ASSESSMENT OF GROUND WATER QUALITY IN CLASS – I CITIES IN INDIA (CPCB SPONSORED PROJECT)

Dr V K Choubey requested Dr M K Sharma to present the progress of the project study. Dr Sharma presented the research proposal in brief. He informed that out of 25 class I cities, current year 12 class I cities will be covered and pre-monsoon sampling of six cities viz; Guwahati, Shillong, Agartala, Aizawl, Kohima and Itanagar have been completed. 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 analysed for various water quality constituents viz; major cations and anions, metal ions, pesticides and

bacteriological parameters. Dr Sharma further informed that the sampling from the remaining six cities will be carried out in the month of April and May 2009. Dr S K Jain enquired the need of irrigation quality of ground water in case of cities (urban areas). Dr Sharma replied that the ground water is well being used for gardening purpose in the cities that is why irrigation quality is also being taken care of. Dr V V S Gurunadharao, NGRI suggested to increase the number of samples. Dr R M Bhardwaj, CPCB informed that the objective of project study is just to create base line quality data for each class I Cities of India and is to be completed within the scheduled time framework and only thirty number of samples are being collected from each cities.

2. HYDROLOGICAL STUDIES FOR RESTORATION OF THE RENUKA LAKE, DISTRICT SIRMAUR (HP)

Dr V K Choubey requested Shri Omkar Singh, Scientist E1 to present the progress of study. Dr. R.D. Verma (Jaipur) appreciated the study of the Renuka lake. He suggested to adopt biological means for conservation and restoration of the lake. Dr. S.V. Nevada (BARC) enquired about isotope analysis of the lake water samples collected to study the isotopic characteristics of the lake. PI informed that water samples have been analysed in the Isotope laboratory and being interpreted. Dr. V. V. S. Gurunadarao (NGRI) wanted to know about phosphate induced eutrophication in the lake and he suggested that this lake is a phosphate limiting lake. PI noted the valuable suggestions for including in the report. The PI informed that final report is under preparation.

3. 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 carried out in December 2008 and batch experiment for adsorption of lindane on soil for optimizing condition for the column study for different operating variables. Dr R D Verma appreciated the work carried out. Dr V V S Gurunadharao suggested to refer the work carried out by NGRI in Vadodara region and agreed to provide a copy of report on the related work carried out by NGRI for reference purpose. Dr Sharma noted the suggestion and further informed the house that State authority Ground Water Resources Development Corporation Ltd. (GWRDC), Gandhinagar, Gujarat has provided the ground water data for carrying out the modeling. Dr A K Keshari, IIT, Delhi has been contacted for taking the technical guidance in place of Dr S V N Rao, who has left the institute and Dr Keshari has kindly agreed. The Chairman approved the propose change in the study group.

4. EVALUATION OF WATER QUALITY OF RIVERS JOINING TEHRI RESERVOIR AND DOWNSTREAM OF THE RESERVOIR

Dr V K Choubey informed that the said study has been referred by MOWR. Dr M K Sharma presented the objectives and progress of the study and elaborated the results of the sampling carried out in December 2008. He informed that the results could not be appropriately interpreted on the basis of one month monitoring data. The chairman suggested to carry out the sampling on bimonthly basis to get the clear picture about variation in water quality of the rivers joining the Tehri reservoir and downstream of the reservoir.

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

Dr. V.K. Choubey informed that this study being funded by NIH under the PDS component of the HP-II. He informed that as per follow up actions with the I&PH Department (Govt. of H.P), letter dated 20.3.2009, a field visit is proposed to visit the study area during April/May, 2009 for preliminary investigations and selection of monitoring sites for hydro-meteorological and water quality parameters. He also informed that award letter is awaited.

HYDROLOGICAL INVESTIGATIONS DIVISION

Dr Bhishm Kumar, Sc F and Head of the H. I. Division presented the brief details of various studies being carried out under the H. I. 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. The details are given as under:

1. 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 earlier ten piezometers were installed along the river Yamuna in June 2007 (5 each on both sides of the river) and eight more piezometers were installed in August 2008. One more cross-section of exiting hand pumps near village Jhangola, was used for collecting samples. Therefore, now water samples are being collected from twenty one existing wells (18 piezometers, 6 shallow hand pumps, 1-shallow tube well, 1-Renney well) located along 3 cross sections across the Yamuna River along with water sample from the river Yamuna. Water level in piezometers is measured at 15 days interval on both the sides of the River Yamuna while rainwater samples are collected, whenever it occurs, since July/August 2007. The isotopic composition of $\delta^{18}O$ in rain varies from -0.41‰ to -9.31‰. Isotopic analysis of the groundwater and river water samples collected till February 2009 have been completed, The analysis indicates that Yamuna is recharging groundwater on Delhi side (Palla sector) mostly during flood season. Dr. Kumar indicated the velocity of groundwater flow at different locations (location of piezometers) and informed that the river water takes normally 3 years to reach at the pumping location (particularly at Renney well). Groundwater velocity in the floodplain has been confirmed through salt dilution experiments carried out during February 2009. He further informed that due to floods in Yamuna River in August 2008, the floodplain on the Delhi side of the River by upto 3 meters. The flood water that has recharged the shallow aquifer will make the groundwater available for the next couple of years. The average contribution from floodplain to the pumped water has been estimated to be 39% and 50% for the water years 2007-08 and 2008-09 respectively. However, the exact contribution of the river Yamuna will be estimated after getting more data from the newly installed piezometers.

Chairman asked that the pumping of river water during the lean flow period was required to be evaluated as the river has more than the required discharge during the monsoon season. Dr. Sudhir Kumar informed that the seasonal contribution of the river was evaluated during the year 2007-08 that varies from 7% to 40%. The same will be evaluated for the year 2008-09 and details will be provided in the report of the study. But, it appears that the river water that enters in the flood plains during the monsoon season continues to be pumped during the other seasons keeping in view the long time travel. Dr. B.P. Singh suggested to carry out the mathematical modelling of recharge in the floodplain. Dr. Bhishm Kumar informed that as the IInd phase of the study (2009-12), therefore modeling exercise will be carried out in the next phase.

The members of the Working Group noted the progress of the study.

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

Dr. M. S. Rao presented the progress of the study. He informed that during the period from August, 2008 to 31st March, 09 total 753 samples (air moisture, groundwater, precipitation and river) have been collected from NIH IWIN Centres (Roorkee and Sagar) and the same were analyzed. He further informed that isotopic composition of air-moisture during the monsoon season is $\delta^{18}O$ =-13‰ with D_{excess} = 70‰ whereas, in the post monsoon this changes to $\delta^{18}O$ =-5‰ with D_{excess} = 30‰. This change in D_{excess} can be effectively used in monitoring the arrival and withdrawal date of monsoon vapors. During the monsoon period, the peaks RH and D_{excess} correlates well in time but on temperature data they appear 2 months after reaching of summer maximum temperature. The hourly data on isotope in air-moisture indicate isotopic variation in air moisture over day & night due to vertical atmospheric dynamics. With regards to surface-water groundwater interaction, it was reported that the Upper Ganga Canal at Roorkee recharges the shallow aquifers over a distance ~2km across the canal beyond which the local precipitation dominates. In investigation of methodological details, it was informed that separation of moisture is complete and rapid using liquid nitrogen condensers whereas the condensation methods normally using ice as condensing medium cause incomplete retrieval of moisture and thus can lead to erroneous results.

To a question asked by Dr. Navada on altitude dependent changes in isotopes in air moisture at Roorkee station, Dr. Rao informed that such variations are normally observable for altitude variation over several 10s of meters whereas within 20 meters of altitude variation such changes are not observable and the supporting results for this were shown in the last Working Group meeting. Dr. Apte asked whether it is possible to distinguish the source of moisture to be Bay of

Bengal or Arabian Sea; Dr. Rao replied that it is possible and also informed that Dr. Anendya Sarkar from IIT Kharagpur has published a paper on similar lines. Dr. V.V.S. Gurunadha Rao from NGRI suggested for looking at vapor pressure to correlate with isotopic data on air-moisture. Dr. Rao appreciated the suggestion.

The WG members noted the progress under the project.

3. 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 Bansigad and Arnigad near Musoorie, have been selected for hydrological studies. The Arnigad micro-watershed covers an area of 2.85 km^2 and is covered with dense Oak forest and its altitude varies between 1640 m and 2220 m. While the Bansigad micro-watershed covers an area of 1.9 km^2 and lies between altitudes 1600m to 2060 m. He further informed that the landuse type in this watershed is degraded oak and pine mixed forest and agriculture. Dr. Rai informed that a hydro-meteorological observatory has been installed in the each watershed. Also, a compound Notch along with an automatic water level recorder has been constructed at the outlets of both the watersheds for monitoring the discharge data continuously. Suspended sediment data and TDS are also being collected on daily basis. The various data collected during June, 2008 to December, 2009 were presented along with trends in variation. The preliminary results indicate that the runoff coefficient is higher in the degraded watershed in comparison to the forested watershed. The pattern of discharge w.r.t. rainfall was presented for both the watersheds. Analyses of the sediment data indicates high rate of erosion from the degraded watershed compared to the forested watershed.

Dr. Rai informed that water samples are being collected from both V notch sites on daily basis for $\delta^{18}O$ and δD and ^{3}H analyses. About 250 samples have been analysed out of 500 collected so far during the past six months. The interpretation of the isotopic data and the isotopic analyses of remaining samples are in progress.

Dr. V. Tamilarasan enquired about the method followed for the determination of sediment yield. Dr. Rai informed that gravimetric method is being used for this purpose. Dr. B. P. Singh enquired about the criterion of dense and degraded forest cover. Dr. Rai informed that canopy cover density has been taken into consideration for categorizing the watershed. Dr. Parmer enquired about the procedure of determining the TDS. Dr. Rai informed that after filtering the sample, the remaining water was evaporated in oven at $60^{0}C$ and difference of

weight gives the TDS per litre. Dr. S.P. Agrawal pointed out that sediment yield looks lower in comparison to average sediment yield reported in other cases, particularly in Uttarakhand. Dr. S. P. Rai explained some difficulties in taking the samples during the time rainout process or immediately after the rain due to which our estimate may be lower. Therefore, the points raised by Dr. S. P. Agrawal will be considered for further cross check during the coming monsoon season..

The WG members noted the progress under the project.

4. ESTIMATION OF IRRIGATION RETURN FLOW IN SELECTED CANAL COMMAND AREAS IN UTTARAKHAND AND UTTAR PRADESH

Dr M. S. Rao informed that the proposal of this study was presented in the meeting of INCID on 22nd Jan., 2008, at CWC, New Delhi. Formally the project was approved in the meeting with the suggestion that estimation of regeneration of river/canal water should be included in the proposal along with the water quality. In the mean time WALMI Lucknow showed its willingness to be one of the partners of this project. As earlier IRI, Uttarakhand was the partner of this project which later on disassociated therefore, the revised proposal after including the WALMI, Lucknow as partner of the study and incorporating the suggested modifications was submitted again to the INCID. But on recent enquiry, it was told that approval of the project at the level of MoWR will take some more time. Dr. Rao informed that this project will be taken up only after its approval from INCID.

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

The study was presented by Dr. Sudhir Kumar. He informed that this study has been approved as a purpose driven study under the Hydrology Project II and yet to start. 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. After a detailed understanding of hydro-geology, hydrology and land use practices, conceptual and real-life models (specific and general) would be developed within Simulation-Optimization framework to arrive at policy guidelines for managing and regulating

the groundwater resources by state agencies. The services of experts in groundwater management and modelling will be hired to achieve the output as per the objectives and to finalize the policy guidelines for optimal groundwater management. The project will seek to build strong linkages between stake holders and regulating agencies through capacity building strategies for effective groundwater governance and harmonized groundwater use. He informed that the programme of work for the next six months along with the budget to utilize during the current financial year was presented during the last Working Group meeting. But due to some administrative problems that are to be sorted out at the level of HP-II Cell, progress could not be made under this project.

6. GROUNDWATER DYNAMICS OF BIST-DOAB AREA, PUNJAB USING ISOTOPES

Dr. M. S. Rao informed that this study has started in Nov. 2009 with objectives to identify recharge zones, recharge sources and flow pattern of groundwater in BIST Doab. In a field work carried out in the month of January 09, total 90 groundwater and 10 surface water samples were collected and analyzed for isotopic systematics. From the preliminary investigations it was inferred that the groundwater in the Bist Doab is formed mainly due to mixing of Satluj River water and local precipitation. For the detailed investigation, sampling stations will be established in 2009-10 to collect river water, groundwater and rainwater samples at regular intervals and also for monitoring of groundwater hydrograph in multiple aquifers data loggers will be installed at 2 -3 locations. However, due to some administrative problems that are to be sorted out at the level of HP-II Cell, further progress could not be made under this project.

7. IDENTIFICATION OF SOURCE OF SEEPAGE AND LOCATION OF SEEPAGE IN TEHRI DAM USING ISOTOPIC TECHNIQUE

Dr. S.P. Rai informed that a request was received from the Tehri Hydro Power Corporation, Tehri (THDC) in order to identify the source of leakage/seepage in the first stage and then the location of seepage in the reservoir. Later on, it was decided that THDC will collect the water samples as per the advice of NIH and also provide the required hydrological data to NIH. He presented the progress of the study. He also pointed out that there are two locations of seepage in the reservoir that are contributing seepage in drainage galleries AGR-3 and AIGR. He further informed that isotopic and discharge data reveal 5 to 7 days time leg between the water entry from the reservoir and its appearance from the seepage points in the drainage galleries. Dr. Rai also presented the variation of reservoir level with seepage discharge that indicates that reservoir

is the source of seepage in AGR-3 and AIGR galleries. But he showed that the isotopic evidences reveals reservoir as the major source of seepage only in five cases (D5, D6, D7, D10 and D11) while the isotopic signature of seepage from the sixth location (D9) do not match with the reservoir. He further showed that D9 bears the signature of groundwater which indicate that seepage through D9 is due recharge from precipitation. The Working Group members noted the progress of the study. Dr. Rai also pointed out the elevation range of the seepage points in reservoir in both cases i.e., seepage locations of D5, D6, D7 and , D10, D11 groups in reservoir.

Dr. Gurunath Rao suggested that TDS can also be considered to distinguish the source of leakage i.e., reservoir or the groundwater. Dr. Rai informed that the EC has been measured for the reservoir and seepage water, hence it will be cross checked whether it works or not in the present case. Dr. B. P. Singh enquired that how seepage from D9 is considered as ground water? Dr. Rai informed that isotopic signature of seepage from D9 location is in close correlation with hand pump (groundwater) water, while it does not match with the isotopic signature of reservoir water from any depth.

The WG members noted the progress under the project.

8. INTEGRATED HYDROLOGICAL INVESTIGATIONS OF ROPAR LAKE, PUNJAB

Dr. Bhishm Kumar informed that it is a new study being proposed by the Division. He further informed that earlier it was planned to take up a study on Pushkar Lake in Rajasthan and accordingly it was included in the agenda notes which were circulated to the Working Group members. However, during the study on groundwater dynamics in the Bist-Doab region, it was informed by the CGWB that the water to the region was being supplied by the canals coming from the Ropar lake and the discharge and running days of the canal has decreased in recent years which may be the cause of groundwater scarcity in this region besides the more withdrawal of groundwater for irrigation. So it was decided to take up study on the Ropar lake which is Ramsar site and needs to be studied for the various problems being faced by it. Results of the two studies would be helpful in understanding and managing the hydrological problems in the area. Dr. Verma informed that the study of Pushkar Lake is also a very important one therefore, whenever the study of Pushkar Lake is taken up, Prof. Rohit Goyal and Prof. A. B. Gupta of MNIT, Jaipur should be consulted as they have done work on the lake. . Dr. Bhishm Kumar informed that the study of Pushkar Lake would be taken up after the completion the study of Ropar Lake.

Shri. S. D. Khobragade presented the study on Ropar Lake. He informed that the Ropar Wetland is a manmade lake constructed on river Sutlej for diversion of water into Sirhind canal. It is located at about 45 Kms. in the north-west of Chandigarh at 30°57'-31006' N latitude and 76°25'-76°36' E longitude at an elevation of 275 m amsl. It is a shallow wetland with a maximum depth of 6 m and has water spread area of 8 sq. km. He further informed that the wetland is extremely important ecologically, economically and socially. The water of the lake is being used for irrigation and industrial use and the water being supplied through the canal is subsequently being used for drinking also. It is an important destination for tourism and recreation. It has a high ecological value as 119 species of birds and 20 species of fishes have been reported in this wetland area. It was declared as wetland of national importance in 1992 by Ministry of Environment & Forests, Govt. of India and was included in the Ramsar List of Wetlands of International Importance in 2002. However, the lake is facing many environmental threats. Important threats include siltation, encroachment, eutrophication and pollution etc. He further informed that very little conservation work has been implemented on the lake which included plantation in 30 ha, 12000 ft. fencing and soil conservation works in 121 ha out of 4700 ha area needing treatment. He said that no scientific investigations have been carried out so far to evolve the conservation and sustainable development of the lake. He informed that the objectives of the study would include the evaluation of water balance parameters, sedimentation rate and expected useful life, water quality and pollution aspects, water quality modeling of the lake and to suggest the suitable measures for the proper conservation and sustainable development of the lake.

Dr. Gurunadha Rao asked that what aspect would be covered under the water quality modelling to which Sh. Khobragade informed that modelling of eutrophication of the lake would be attempted. Dr. Jayakumar informed that a study on Asthmudi Lake in Kerala, which is also a Ramsar site, has been completed by the CWRDM and the report would be completed within 15 days. He said that the report would be sent to NIH for reference.

The members of the working Group agreed to take up this study for the next three years.

The programme of studies for the year 2009-10 of the H.I. Div. is given in the Annexure-I.

GROUND WATER HYDROLOGY DIVISION

Dr. N. C. Ghosh, Scientist 'F' & Head, Ground Water Hydrology Division presented the general overview of the activities of the division. He also briefly reported about the other scientific and administrative works carried out by the division during the year 2008-2009 and the scientific papers published /sent for publication by the scientists. Study-wise suggestions and discussions emerged are given below.

1. MITIGATION AND REMEDIATION OF GROUND WATER ARSENIC MENACE IN INDIA

Dr. N. C. Ghosh informed about the background for taking-up this study. He indicated that a vision document is being prepared involving experts from the respective topics related to mitigation and remediation of ground water arsenic menace in India. Mr. M. R. Chakraborty enquired if the geological formation is responsible for arsenic menace. Dr. Ghosh explained about various hypotheses in this regard. Dr. R. D. Verma pointed out that impact of arsenic on human health is very serious. He suggested to investigate proper adsorption phenomenon in order to find out an economic solution for arsenic problem. Dr. V. V. S. Gurunadha Rao opined that optimum pumping scheme should be suggested for arsenic affected areas. Dr. G. C. Mishra indicated that in a previous study carried out by NIH, several peaks were observed due to dewatering, which implies localized nature of the problem due to source of arsenic in the geological strata. He suggested to take soil samples upto water table for analysing their arsenic content, accordingly in-situ remediation measures can be planned. Dr. Mishra further suggested to check the efficiency of equipment by checking the arsenic content before and after filtering. It was informed by Dr. Ghosh that two more chapters are yet to receive and the document would require a series of review and editing and hence may come out by May, 2009.

2. QUANTIFICATION OF IMPACT OF RAINWATER HARVESTING ON GROUNDWATER AVAILABILITY IN ARAVALLI HILLS

Dr. Anupma Sharma explained about background and objectives of the study, data monitoring and field investigations being carried-out in Savana macro-watershed, tracer studies being undertaken and current progress of the study. She also presented the qualitative influence of the impact of water harvesting structures on the availability of groundwater in Gangeshwar watershed. Dr. Anupma Sharma also informed that "Wells for India" (an NGO) is supporting in data monitoring and field investigations for this study. Dr. V. V. S. Gurunadha Rao enquired

about the spread area of anicut and opined that this study will also be useful in the context of climate change due to extreme rainfall events. Mr. K. B. Parmar suggested that integrated water balance study may be taken-up. Dr. Tamilarasan observed that drainage density of the study area is very high and suggested to quantify the impact of rainwater harvesting structures. Dr. G. C. Mishra indicated that due to high evaporation, soil moisture deficiency will be high. Therefore, it needs to be ascertained how much water is actually getting recharged to groundwater system. Dr. Mishra further suggested to find the rise in water table through Hantush solution. Chairman suggested to conduct groundwater modeling study in order to find the impact of rainwater harvesting structures on groundwater availability in the study area.

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

Mr. C. P. Kumar presented brief background about climate change and its likely impact on groundwater resources. He also explained about the study area (Sonar basin, Madhya Pradesh) and proposed methodology (using Visual HELP and Modflow) to find the impact of climate change on groundwater recharge. Dr. B. P. Singh indicated that the study should be conducted in an area where change in climate has been observed. Chairman clarified that outputs of the Global Circulation Model are downscaled to the basin scale and accordingly used in the climate change studies. Dr. G. C. Mishra suggested that runoff should be computed in the study area alongwith use of a distributed model. Mr. C. P. Kumar informed that due to simplistic approach and ease of use, Visual HELP has been proposed to be used in this study. Mr. Kumar further informed that the same methodology has been used by other researchers during last few years. Mr. Rakesh Kumar suggested exploring the possibility of using MIKE-SHE software package.

4. WATER TABLE EVOLUTION DUE TO SUBSURFACE DRAINAGE WITH ARBITRARY RECHARGE USING A NUMERICAL MODEL

The proposed study could not discuss because Dr. S. K. Singh, the proposer of the study was absent in the meeting.

The work programme finalized for the division for the year 2009- 2010 is as under.

SURFACE WATER HYDROLOGY DIVISION

Shri Rakesh Kumar, Scientist F and Head of the Surface Water Hydrology Division presented the 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 given as under:

1. DEVELOPMENT OF DROUGHT VULNERABILITY INDICES FOR PREPAREDNESS AND MITIGATION

Dr. R.P. Pandey, Scientist E1 presented details of the project and explained the methodology used for assessment of drought vulnerability and for derivation of integrated drought vulnerability indices for preparedness and mitigation. He informed that the study was taken up for five sites representing different climatic zones, physio-graphical heterogeneity, cropping systems and socio-economic conditions, etc. The relevant data/information/maps etc. have been obtained from various sources. Inventories of drought events and physiographic conditions for different study sites were prepared. During previous year the Sonar basin observed delayed onset of monsoon and it has affected the cropping pattern to large extent. To study the effect of delayed monsoon the survey was conducted in Patharia, Batiagarh and Damoh blocks of Damoh district falling in lower catchment area and Kesli block of Sagar district falling in upper catchment of Sonar river basin. Generally region experiences onset of monsoon in second week of June but this year monsoon was delayed by 3-4 weeks. In Sagar district monsoon started in last week of June and in Damoh district monsoon started in 2nd week of July. In Damoh district monsoon effectively started from 14th July in almost all blocks and the cultivation could be started in 3rd week of July. Similarly, investigations were conducted for other sites too. Drought conditions also prevailing in Mahaboobnagar, district of A.P. during the year 2006 and 2007 and the crops were significantly affected both in kharif and Rabi season. However, in other sites namely, Balangir, Nanded, and Bijapur normal rainfall occurred and no drought conditions were observed in above three sites during past two years. Hydro-meteorological data were analysed and Standard Precipitation Index(SPI), Effective Drought Indes (EDI), Decile Index and percent deviation from normal were applied for identification of droughts. Also relationship of evapotranspiration/precipation (EP/Pa) with SPI, EDI, % normal Pa, Decile Index were developed to examine the applicability of above indices at different sites. The classification of the indices was revised for their suitability at our sites. Further, fine tuning of the proposed methodology and report writing are in progress.

2. INTEGRATED WATER RESOURCES MANAGEMENT OF SUB-BASIN TO COPE-UP WITH DROUGHTS

Dr. R.P. Pandey, Scientist E1 presented details of the study. He informed the various objectives and methodology of the study. The study will be carried out for the Tons sub basins lying in Madhya Pradesh. The visit for the study area was taken up for preliminary investigations and data collection during December 2008. Concerned agencies like CWC and IMD have been contacted for obtaining the discharge and meteorological data. Toposheets and other information is being obtained from various sources. The Chairman suggested that as this study is very important to cop with drought problems for integrated water resources management of any basin, hence it is required to carry out a comprehensive study of the various aspects.

3. IMPACT OF CLIMATE CHANGE ON THE FLOW CHARACTERISTICS OF BEAS RIVER AT PANDOH DAM SITE

The study was presented by Dr. A.K. Lohani, Scientist 'E1'. He informed that the present study is taken up under the action plan chalked out by Ministry of Water Resources under the National Action Plan for Climate Change. Prime Minister's Council on Climate Change, in its first meeting decided that MoWR should initiate studies for major rivers whose waters come from snow melt. In the action plan prepared by MoWR, it was decided that the NIH should carry out such studies in the Indus, Ganga and Brahmputra basins. Further, Dr Lohani presented the objectives of the study and the progress of the work carried out from April, 2008 to March, 2009. He informed the house that the analysis has been completed and the draft report is ready. He further mentioned that Shri R.D. Singh, Director, NIH has advised to carry flow duration analysis with the existing flow data and and indicate the impact of climate change on flow duration series. Dr S.K. Jain, Scientist 'F' enquired about the difference between the present study and the Purpose Driven Study (PDS) proposed under HP-II in which Dr Sanjay Kumar Jain is PI. Dr Lohani informed that the present study is carried out as per the requirement of Ministery of Water Resources and it has some limited scope and objectives. Further, Shri R.D. Singh, Director, NIH informed that the present study is having some specific objective and the results of this study will be used in another study related to reservoir operation under climate change scenario. Further, Dr. Sanjay Kumar Jain Scientist E1 informed that the results of this study will be the part of the PDS as it covers one of the objectives of the PDS study.

4. IMPACT OF CLIMATIC CHANGE ON THE FLOW CHARACTERISTICS OF A SUB-BASIN OF GANGA BASIN (BHAGIRATHI BASIN UP TO TEHRI DAM)

Dr. Sanjay Kumar, Scientist C presented the study on "Impact of Climatic Change on the Flow Characteristic of a sub-basin of Ganga Basin (Bhagirathi Basin up to Tehri Dam)". He gave the brief background and explained the methodology adopted in the study. He informed that Snow Cover Area (SCA) of the study area is calculated using satellite data (MODIS) in different elevation zones (twelve zones). The capabilities of the SNOWMOD model and the details of the hydro-meteorological data used in the model were presented. Dr. Sanjay Kumar explained the effect of the temperature change on the runoff characteristic of the Bhagirathi river at Tehri and presented the simulated runoff using the SNOWMOD model and explained the findings of the study. Mr. Apte from IMD informed about the studies on climatic change conducted by IITM Pune.

5. MONITORING AND MODELING OF STREAMFLOW FOR THE GANGOTRI GLACIER

Dr. Manohar Arora, Scientist B presented the progress of the ongoing study. He intimated the working group that the data collected earlier have been analysed and the report has been submitted to the DST. All the objectives laid down in the project were achieved. Since the last year the investigations in the Gangotri glacier are being carried out by the Institute funds. He presented the hydrological and hydro - meteorological data for the ablation season 2008. The installation of an AWS at the observatory at the Bhojwasa site will be taken up this season. The techniques for discharge measurements being followed elsewhere in other headwaters of Himalayan basin were also explained.

6. MODELLING OF SUSPENDED SEDIMENT CONCENTRATION USING ARTIFICIAL NEURAL NETWORKS

Shri A. R. Senthil Kumar, Scientist C presented the objectives, brief methodology, development of ANN models and results of the study. He explained the results achieved during recent six months. He also explained the methodology adopted in estimating the status of the reservoir storage for the next 100 years using Artificial Neural Networks (ANN). Shri B. K. Parmar, Superintending Engineer, CDO, Gujarat suggested to put the sediment load in tons/hectare/year. Shri Senthil kumar replied that this would be incorporated while preparing the final report of the study.

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

Dr. Avinash Agarwal, Scientist E1, presented the progress of the project. He informed about the previous progress of the project in relation with the old instrumentation, data status, analysis of spring flow, flow duration curves, spring rainfall analysis, delineation of recharge zone infiltration and rainfall characteristics and water balance. Further he informed that the instruments required in the second phase of the project have been purchased and installed at the watershed sites. He added that the shape file for watersheds for drainage characteristics, land use, soil texture, springs, tanks and instruments sites have been prepared using Arcview and the sediment sampling on both the watershed is continuing manually. He also informed that the soil texture for Anjanisain watershed is not available and will be taken from National Soil Survey Atlas and work on modelling is in progress.

8. HYDROLOGICAL STUDIES IN A FORESTED WATERSHED IN UTTARAKHAND

Dr. J.V. Tyagi, Scientist E1 & P.I. of the project presented the progress of the project. He explained the background, objectives, progress and the 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. Among a number of factors that affect the natural regeneration of Sal, a majority of the factors remain more or less uniform over a small area as of the present study. However, the soil moisture, soil erosion, and light intensity vary spatially depending on the canopy density, and the variation of these factors could be attributed to differential regeneration under various canopies. Therefore, the main objectives of the project were to study the variation of soil-hydrological and environmental parameters viz. soil moisture storage, light intensity and soil erosion under various micro-environments due to overhead canopy and their effect in terms of the variation in natural regeneration of Sal. Besides the progress made during current year, the preliminary results of study, based on the so far available data of 4 1/2 years, were presented. 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, a long-term data on regeneration, soil moisture storage and light intensity is needed to account for 'dying back phenomenon' and to develop suitable relationships among various parameters and the regeneration.

9. RUNOFF AND SEDIMENT MODELING IN A PART OF THE BRAHMAPUTRA RIVER BASIN IN INDIA

Mrs Archana Sarkar, Scientist B presented the background, objectives, methodology and progress of the study. Mrs Sarkar informed that the study area includes three gauging sites and one northern tributary. She informed the house that ANN models for stage-discharge and sediment-discharge at three selected gauging sites namely, Choulduaghat, Pandu and Panchratna have been developed and validated with observed data. The results are good and correlation is more than 90%. Rating curves using conventional technique have also been developed for the three sites. She further informed that the meteorological data for Subansiri River basin (biggest tributary of Brahmaputra in India) has been procured and during the coming year rainfall-runoff modeling as well as sediment yield modelling would be taken up.

10. SNOW MELT RUNOFF MODELING USING FUZZY LOGIC

Dr A.K. Lohani, Scientist E1 presented the objectives of the proposed study entitled "Snow Melt Runoff Modeling Using Fuzzy Logic". He informed that during the snowmelt modeling of Beas catchment using SNOWMOD model it was felt that a fuzzy rule based model can be applied for the computation of snow melt runoff. Further he highlighted the methodology of the conventional snow melt modeling approach and its limitations. Shri R.D. Singh, Director, NIH advised to highlight the advantages of the fuzzy rule based system. Dr Lohani informed that the intelligent computing tools such as fuzzy logic can approximate virtually any (measurable) function up to an arbitrary degree of accuracy. The advantage of intelligent computing is that one need not have a well defined physical relationship for converting an input to an output. With fuzzy logic it is possible to describe available knowledge directly in linguistic terms and according rules. Quantitative and qualitative features can be combined directly in a fuzzy model. This leads to a modeling process, which is often simpler, more easily manageable and closer to the human way of thinking compared with conventional approaches. Dr Lohani informed that the fuzzy rule based approach would be applied to simulate snow melt runoff in the proposed study. An attempt will be made to use the same input data in the fuzzy model as used by the conventional snow melt model. Furthermore, fuzzy models will also be developed with the input vector comprising of temperature, snow cover area, rainfall and other available meteorological variables.

11. ENVIRONMENTAL FLOW REQUIREMENT FOR RIVER GANGA AT LOHARI NAGPALA POWER PROJECT SITE

Dr. Manohar Arora, Scientist B presented the results of the study completed on the "Environmental Flow Requirement of River Ganga at Lohari Nag Pala Power Project". He explained that the study was undertaken on the request by NTPC and in the limited time the study was concluded using the two approaches. He further reiterated that there are other methods available which can also be looked into and the study can be dealt in a fresh way for another two years. Dr Bhardwaj enquired about the data requirement and its frequency. Dr Arora explained that in the hydrologic method daily flow data is needed for the analysis. Dr R D Verma enquired how the portion on ecology was dealt since there is no expertise available at the Institute. Dr Arora replied that NTPC had outsourced the ecological work to an expert and the report was prepared by the concerned expert. However, final agreement on flow release was made considering the recommendations from the study carried out by NIH and the experts' opinion.

12. SNOW MELT RUNOFF MODELLING IN SUTLEJ BASIN

Shri A. R. Senthil Kumar, Scientist C presented the objectives, methodology and results to be achieved in the study. He also explained that SRM, SNOWMOD and ANN models would be used to simulate the snow melt runoff and comparison among the models would carried out. He listed out the requirement of data for the study and proposed to procure satellite imageries for 10 scenes. Shri Jayakumar, Executive director, CWRDM, Kunnamangalam suggested to compare the results of the conceptual models with soft computing techniques such as ANN, Fuzzy logic and Genetic Algorithm.

13. DATA BOOK-HYDRO-METEOROLOGICAL OBSERVATORY

Shri Digambar Singh, Scientist B presented the objectives and methodology of the studies. He also briefed that hydro meteorological data are observed daily and a data book containing the statistics of the observations would be prepared. Shri Apte, IMD, New Delhi inquired about the period of the data to be presented in the data book since NIH has got 25 years of data for NIH observatory. Shri Manohar Arora replied that such type of data books are already available up to 2000 in the Institute.

The programme of the studies for the year 2009 – 10 of the Surface Water Hydrology Division is given in annexure – IV.

WATER RESOURCES SYSTEMS DIVISION

Dr. S.K. Jain, Scientist F and Head Water Resource Systems Division appraised the Working Group member about the various studies being carried by the WRS division. He also informed about other scientific and administrative works being carried out by the division. The various PIs presented the progress of the studies. The details of discussions are given below.

1. DEVELOPING DECISION SUPPORT SYSTEM (PLANNING) FOR INTEGRATED WATER RESOURCES DEVELOPMENT AND MANAGEMENT

Dr S K Jain presented the progress of the study. He informed that this study has five components (i) Surface water resources planning, (ii) Integrated operation of reservoirs, (iii) Conjunctive use of surface water and ground water resources, (iv) Drought management, and (v) Water quality management in a river basin. He also informed that DHI Denmark have been appointed as the consultants to develop the DSS. The consultant have initiated work and are currently visiting various states for familiarization, review of data availability and to identify the focus basin.

2. HYDROLOGIC STUDIES FOR KEN-BETWA LINK PROJECT

Dr S K Jain briefed about the Ken-Betwa link. Dr. Vijay Kumar presented the progress of this consultancy work. He informed that the work was done in two phases. The final report of Phase-I was submitted long back. The Phase-II study has also been completed and a final report was prepared and submitted to NWDA. As per requirement of NWDA, both the reports (Phase-I and Phase-II) were combined into one final report and this final report has been submitted to NWDA. It was also informed that a Chapter on 'Hydrology and Water Assessment' was prepared and same has been included in the DPR prepared by NWDA. Mr Parmar (SE, WRD, Gujarat) enquired about the diversion flood. Dr S K Jain explained that the estimation of diversion flood is for the construction phase of the dams.

3. IMPACTS OF DAMS AND DIVERSIONS ON HYDROLOGY

The progress of the study was presented by Mr D.S. Rathore. It was informed that in the study various GIS layers, namely basin, sub basin, river, dams, physiography etc. were prepared from

atlas with plates in the scale of 1:2 M. A data base of the salient features of the dams was also prepared in database software, namely MS Access. This database was joined with the attribute table of the point map of dams in ArcGIS software. With this operation, the salient features are available in the GIS for query operations. Using the GIS, summery statistics of the storage for basin, state etc. can be prepared. Geographic coordinates of 1812 medium and major dams were entered in the database. In the data base, salient features of 614 dams and diversions have been included. Out of these, locations of 414 dams and diversions were available.

Evaporation estimation for five reservoirs was also done. Estimation was done on monthly basin using water level data for the reservoirs and evaporation rates (mean monthly). Annually, evaporation was nearly 6- 8% of the live storage for four reservoirs and nearly 23% for Jayakawadi. A review of the hydrological and morphological impact of the dams was also presented. The study is complete and the final report is under preparation.

4. DEVELOPMENT OF EMPIRICAL METHODS FOR ASSESSMENT OF THE RESERVOIR SEDIMENTATION

Dr. Sanjay K. Jain presented the objectives and scope of the proposed study. He informed that the data of a number reservoir have been collected and analyses have been made. Dr, Jain informed that depth, capacity of 87 reservoirs have been collected. Data of 69 reservoirs were found complete. On the basis of analysis, reservoirs have been classified into four types. For each type of reservoir, design curves have been plotted. In this way, coefficients for design for Indian reservoir have been obtained. Dr. Sharad K. Jain further elaborated the work carried out. Member from APERL said that the study will be useful for reservoir sedimentation assessment. Mr. R.D. Singh opined that the results of the study can be used to estimate revised capacity of the reservoirs.

5. USE OF REMOTE SENSING IN SOIL MOISTURE AND WATER BALANCE ESTIMATION – A CASE STUDY OF THE SOLANI CATCHMENT

Dr. Sanjay K. Jain presented the objectives and progress made so far. He informed that IIRS, Dehradun is also collaborating in this study. Mr. R D Singh said that assessment of soil moisture using satellite data is one of the objectives of the study therefore it should be given adequate attention. Dr. S P Agarwal informed that microwave remote sensing data will also be used for

assessment of soil moisture. Dr. Tamilarasan suggested taking data of RISAT for this purpose. Mr. Chakrovarty from CWC appreciated the work carried out.

Dr. Sharad K. Jain stated that the duration of this study was up to March 2009 and sought extension of the study for another term of three years in collaboration with IIRS. The Working Group agreed for extension of the study and Dr Agrawal of IIRS also expressed willingness to continue collaboration with NIH for this work. WG asked the division to prepare an interim report of the work carried out so far.

6. HYDROLOGICAL ASSESSMENT OF UNGAUGED CATCHMENTS (SMALL CATCHMENT)

Dr P K Bhunya presented the objectives and progress of the study. He informed the house about the new methods developed and the preliminary results which included a statistical table of annual peak flow data of 38 Indian catchments and three graphs showing a non-dimensional analysis of flood peaks and a comparison of synthetic methods to an observed flood hydrograph. He presented results of a new flow duration curve model using available data of 22 ungauged catchments in Mahanadi basin. Mr. Chakrovarty from CWC emphasized that the regional formulae for synthetic hydrographs were developed long ago and now RDSO is not collecting routinely data from gauging sites at bridge catchments.

Mr Rakesh Kumar informed that RDSO reports were prepared nearly 10 to 15 years ago and the present work will also utilize development in flood frequency analysis techniques. Recent and updated database for the study area will be used and representative parameters for the catchments will be obtained using advanced techniques. Any improvement obtained from advanced techniques will be highlighted. Mr. Chakrovarty emphasized to include regional flow duration curves as an objective in the study. Director, NIH informed the house that such studies had been completed earlier in sub-Himalayan catchments.

7. WEB-BASED RIVER BASIN INFORMATION SYSTEM FOR INDIA

Mrs. Deepa presented the progress of the study. She informed that a web based water resources information system is being developed. This year the information related to river basins of the country has been incorporated in the system and during the next year, the subbasin wise information including maps will be incorporated. She added that the software developed under this study can be used as a framework for integrating the hydrological information from national

to sub-regional level. Such a system is useful to support decision making to address the river basin issues in a comprehensive manner. Dr Jayakumar suggested adding a disclaimer statement in the web-page.

The Working Group noted the satisfactory progress of the ongoing studies.

8. INTEGRATED APPROACH FOR MODELING SNOWMELT RUNOFF AND EFFECT OF CLIMATE CHANGE IN BEAS BASIN

Dr. Sanjay K. Jain presented the background and objectives of the study and informed that the study has been started in September 2008. As a first step, a visit to Sundernagar/Pandoh was made in the first week of September 2008 and the following Data have been collected from BBMB, Sundar Nagar.

- Rainfall (1979-2007): Manali, Bhuntar, Largi, Banjar, Sainj, Janjhely, Pandoh
- Temperature (1986-2005): Manali, Bhuntar, Largi and Pandoh
- Discharge (1966-2007): Manali, Beas at Bhuntar, Parbati at Bhuntar, Thalout Tirthan Khad, Sainj Khad, Pandoh, Bhakli khad at Pandoh and Junikhad

The base maps (drainage/contour/DEM) of the study area have been prepared from Survey of India toposheets and converted into digital form. The Digital Elevation Model (DEM) has been divided into number of elevation bands. MODerate-resolution Imaging Spectroradiometer (MODIS) satellite data (weekly) for the study area has been obtained from National Snow and Ice Data Center (NSDIC). The Snow Cover Area (SCA) for the years 2000-2003 have been computed and depletion curve have been prepared. This snow cover area for different elevation bands has been computed using SCA maps and DEM. The procurement of instruments and satellite data has been initiated.

9. 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 the above PDS has been taken up by BBMB under the HP-2 project. They have now requested NIH for collaboration in this study. Therefore this study has been proposed under the work program of Water Resources Systems Div. Dr. Jain informed about the objectives and work elements of the study. BBMB has already informed about the

approval of chairman, BBMB for partnership of NIH in the study. The duration of the study is four years. The objectives of the proposed study are:

- Collection and development of data for the catchment and the reservoir by latest techniques.
- Analysis of existing sediment data at various locations in the catchments of river Satluj and Beas.
- Soil erosion modelling for both the catchments
- Development of mathematical model for instant study of Sedimentation to assess life of reservoirs.
- Dissemination of knowledge, findings and applications of the developed models to field Engineers through preparation of manual, leaflets & by organizing workshop & seminars.

WG approved the new proposed studies of the WRS Division.

ANY OTHER ITEM WITH THE PERMISSION OF THE CHAIR

The Chairman apprised the Working Group members about the issues raised by Dr. S K Mazumder, Member of the Annual General Meeting of N.I.H. Society regarding the functioning of the Institute.

Regarding the issues related to "better coordination between the Governmental organization (NIH) and the private organizations as many private sector companies are participating in the development of the Water resources and other infrastructure in the country". The members opined that this is an administrative issue and can be taken up by the Institute with the Ministry of Water Resources. Regarding the issue that "NIH should start a regular PG program in the specialized areas of hydrology and also conduct short duration training courses in different areas of the water resources", the members felt that NIH is already conducting short duration courses in the various areas of hydrology and water resources. Regarding to start a regular PG program by the Institute, it was felt that Department of Hydrology, Water Resources Development & Management, Civil Engineering Department, Earth Sciences Department of IIT, Roorkee are already conducting the M.Tech. courses. There is always a shortage of students even for these courses at some of these Departments and as such NIH does not require to begin any such course.

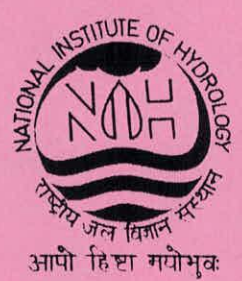
The meeting ended with a vote of thanks to the Chair.

ANNEXURE-I

THE 31ST MEETING OF THE NIH WORKING GROUP

ENVIRONMENTAL HYDROLOGY DIVISION

Progress of Studies & Details of New Studies



NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE – 247667

EHD - 1|10

1. PROJECT REFERENCE CODE: NIH/EHD/NIH/08-10/10

Title of the study: Assessment of Ground Water Quality in 25 Class I Cities of India (Guwahati, Raipur, Shimla, Jammu, Shillong, Aizawal, Kohima, Bhubneshwar, Agartala, Dehradun, Itanagar & Gangtok)

Study Group: V K Choubey, Scientist 'F'
M K Sharma, Scientist' C'

Date of start: October, 2008

Duration of the study:

Phase I: 2008-09 (Twelve cities)
Phase II: 2009-10 (Thirteen Cities)

Weather externally funded or not: Yes, CPCB, Delhi

Point wise objectives:

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

Brief methodology:

- Identification of industrial areas, residential areas, petrol pumps and bulk storage of petroleum production, municipal solid waste disposal (land fill) areas
- Identification of (about 30) locations covering shallow and deep aquifer regions.
- Sampling of ground water in pre- and post-monsoon seasons
- Physico-chemical parameters: pH, EC, TDS, Alkalinity, Hardness, COD, BOD, Major Cations (Na, K, Ca, Mg), Major Anions (HCO_3, Cl, SO_4, NO_3), Minor Ions (F, PO_4, B).
- Bacteriological Parameters: Total and Faecal Coliform
- Toxic (Heavy) Metals: As, Cd, Cr, Pb, Hg, Cu, Ni, Fe, Zn, Mn
- Pesticides: DDT, Total BHC, Endosulphan, Lindane, Aldrin, Deildrin, Carbamat, 2,4 D, Malathion, Parathion, Pyriphos, Chloropyriphos
- Polynuclear Aromatic Hydrocarbon (P AH): location-specific
- Data for pre- and post-monsoon seasons will be processed as per BIS and WHO standards to examine the suitability of ground water for drinking purpose, ionic relationships will be developed and water types will be identified. Spatial distribution map will be prepared in the form of contour diagrams to identify degraded water quality zones. Suitability of ground water for irrigation purpose will be assessed on the basis of total soluble salts, SAR, RSC and boron content. Classification of water will be made

using Piper trilinear diagram, Durov plots, Chadha's diagram,U S Salinity Laboratory Classification and Gupta Classification.

Progress/Present Status:

- First round of sampling (Pre-monsoon) from the twelve class - I cities (Guwahati, Raipur, Shimla, Jammu, Shillong, Aizawal, Kohima, Bhubneshwar, Agartala, Dehradun, Itanagar & Gangtok) has been completed (30 samples from each city, Total number of Samples 360).
- Maps of 12 Class I Cities have been prepared.
- Details about the study area (12 Class- I cities) covering physiography and soil type, geography, surface and subsurface hydrology, potential of ground water, depth of shallow and deep aquifers, climate, geology, population, industries, bulk storage of petroleum production, water supply, water treatment plants, waste disposal sites etc. collected and are being compiled.
- Digestion/concentration of the samples for metal analysis completed.
- Extraction, concentration and drying of samples for pesticides analysis completed.
- Physico-chemical, bacteriological, metal analysis completed for the first round of sampling (Pre-monsoon 2009).
- Processing of data is under progress completed as per BIS standards for the first round of sampling.

Expected date of completion: September, 2010

2. PROJECT REFERENCE CODE: NIH/EHD/NIH/09-03/12

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

Study Group:

Project Investigator

Dr V K Choubey, Scientist 'F' & Head (EHD), NIH

Co-Investigators

Dr. R.P. Pandey, Scientist 'E1	Superintending Engineer, I & PHE
Shri Omkar Singh, Scientist 'E1	Dept., Shimla (H.P.)
Dr. M.K. Sharma, Scientist 'C'	Executive Engineer, I & PHE Dept., Shimla (H.P.)
	One Scientist of NICD, New Delhi

Date of start: 1.4.2009

Duration of the Study: 3 years (up to 31.3.2012)

Weather externally funded or not: Yes, HP-II

Point wise Objectives:

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

Brief Methodology:

1. Analysis of Eco-hydrological and basin characteristics of Shimla City.

   a. Generation of basin characteristics maps using ILWIS GIS/ERDAS.

b. Analysis of spatial and temporal variation of rainfall data using statistical methods or SWDES and HYMOS by collecting historical data.
c. Generation of runoff volumes in different rivers/streams/tributaries/nallas using similar approach mentioned above.
d. Collection of demographic data and other statistics of Shimla City.
e. Analysis of hydrological data from ecological/EFR point of view.

2. Assessment of water quality variable in drinking water sources and sewage effluent.
   a. Monitoring of water quality parameters, essential for drinking water, from different drinking water sources and sewage effluent on quarterly basis using standard methods.
   b. Microbiological/virological investigations of water/waste water through NICD, New Delhi.

3. Analysis of pollutant transportation mechanism in drinking water source and source identification of sewage effluent influx in drinking water using modeling approach. Study of existing sewerage network and sewage disposal practices in the City using SEWERCAD Software.

4. Impact assessment of sewage effluent toxicants in drinking water sources from public health point of view based on analysis of the pollutants and suggesting possible remedial measures.

5. Dissemination of knowledge, findings and application of the developed model to field engineers and common people through preparation of Manual, leaflets, booklets and by organizing workshops/ seminars.

Results achieved with Progress/Present Status:

- Review of relevant literature
- Interaction with I&PHE, Shimla
- Processing of purchase of required software (Bentley SewerCAD) for rehabilitation/augmentation of existing sewage network (In Progress).
- Processing of purchase of water quality and hydro-meteorological equipment (In Progress).
- Interaction/discussion with I. & PHE official regarding the water supply & sewage network of the Shimla city. Information related to water supply, STP's, maps of existing sewage network has been collected.
- Officials from I&PHE visited NIH Roorkee and had discussion to install hydro-meteorological & hydrological instruments in the Shimla Town.
- Processing for the recruitment of the staff.

Expected date of completion: March, 2012

3. PROJECT REFERENCE CODE: NIH/EHD/NIH/07-10/10

Title of the Study: Modelling of Pesticide Transport in Ground Water – a case study of Metropolitan City –Vadodara

Study Group:

Principal Investigator:	M K Sharma, Scientist 'B'
Co-Principal Investigator:	V K Choubey, Scientist 'F'
	A K Keshari, Associate Professor, IIT, Delhi

Date of start: October 2007

Duration of the Study: Thee Years

Weather externally funded or not: Internally funded

Problem Definition and Study Area:

Metropolitan city Vadodara witnessed a sudden spurt in industrial activity with the establishment of Gujarat Refinery, Indian Oil Corporation. Metropolitan city of Vadodara is the industrial nucleas of the Gujarat State. During the recent study carried out by NIH, very high concentration of pesticide lindane was observed in ground water of metropolitan city Vadodara.

Therefore there is a need to study the lindane migration pattern in the ground water of metropolitan city Vadodara from future projections.

Objectives of the Study:

- To develop a contaminant source identification model from point source
- To study and characterize the contaminant (pesticide) migration pattern in the ground water in space and time for prediction purposes

Brief Methodology:

- Methodology will involve flow and transport of organo-chloro pesticide (Lindane) through column study (experimental) in unsaturated zone and modelling flow and transport using MODFLOW & MT3D in saturated zone. Initially, the model will be calibrated using data collected along space & time for a period of one year
- Calibrated model will be used to predict contaminant concentrations along the planning horizon.

Results achieved with Progress/Present Status:

i) Pre-monsoon field visit of the metropolitan city Vadodara and surrounding area was made in the month of June, 2009 and collected 45 water and waste water samples from open wells, tube wells and piezometeric wells maintained by GWRDC and identified main sources of pollution (drains) for analysis in the laboratory. The characteristics of the identified drains and rivers is given in Table 1:

Table 1: Characteristics of the identified drains and rivers

Drain/Rivers	pH	EC, µS/Cm	TDS, mg/L	DO, mg/L	BOD, mg/L
Nandesari	-	-	-	-	-
GACL	-	-	-	-	-
Gujarat Refinery	6.48	3726	2385	0.0	2.90
IPCL	7.19	12530	8019	3.8	7.70
Kamati Bagh	6.41	6115	3913	0.0	5.30
GIDC	-	-	-	-	-
River Vishwamitri	7.10	1624	1039	0.0	17.3
River Jambua	7.12	2175	1392	0.0	10.7

ii) Carried out the pumping test in a large diameter open well at Asoj, Vadadara Taluka and calculated the aquifer parameters viz; Field Permeability, Transmissibility, Specific Yield and Radius of influence using observed field data.

iii) The collected samples from open wells, tube wells and piezometeric wells and drains are being analysed for organochloro pesticides.

iv) For transport of pesticides in unsaturated zone of the study area, optimized conditions for adsorption of lindane on soil were maintained in the column of 25 cm. 10 ppm lindane was loaded in the column and 25 ml effluent fractions were collected maintaining constant elfluent rate. The concentration of lindane is being analysed in the collected different fraction.

Expected Outcome/Output:

- Identification of unknown source
- A predictive model will be developed
- Suggested measures for the control and management of contaminant in ground water system will be helpful for policy makers and stake holder.

Expected date of completion: September, 2010

4. PROJECT REFERENCE CODE: NIH/EHD/NIH/08-08/09

Title of the Study: Evaluation of water quality of rivers joining Tehri Reservoir and downstream of the reservoir

Study Group: M K Sharma, Scientist' B'
V K Choubey, Scientist 'F'

Date of start: September, 2008

Duration of the study: One year

Weather externally funded or not: Internal (As suggested by MOWR)

Point wise objectives:

iii) To examine the suitability of water of the rivers joining Tehri reservoir and downstream for various designated uses

iv) To identify possible sources of pollution and assess the actual changes in river water quality after commissioning of Tehri Hydroelectric Project

Brief methodology:

- Identification of sampling sites in the rivers joining Tehri reservoir and downstream of Tehri Reservoir
- Sampling of water in different seasons
- Physico-chemical parameters: pH, EC, TDS, Alkalinity, Hardness, COD, BOD, Major Cations (Na, K, Ca, Mg), Major Anions (HCO_3, Cl, SO_4, NO_3), Minor Ions (F, PO_4).
- Bacteriological Parameters: Total and Faecal Coliform
- Data for different seasons will be processed as per BIS and WHO standards to examine the suitability of river water for drinking purpose. Suitability of river water for irrigation purpose will be assessed on the basis of total soluble salts, SAR, RSC.

Results achieved with Progress/Present Status:

Pre-monsoon sampling of Tehri reservoir and its joining rivers has been carried out in the month of May 2009 and eleven water samples from reservoir from three locations at different depths, one sample each from river Bhilangana and Bhagirathi, two downstream samples from Zero point and Koteshwar have been collected and analysed for physico-chemical parameters, bacteriological parameters (Total and Faecal coliform) and metals (Fe, Mn, Zn, Cu, Cr, Cd, Pb, Ni). The sediment samples were also collected from Bhagirathi and Bhilangana rivers and are being analysed for metal concentration. The results of the analysis are below:

- All the physico-chemical parameters analysed, were found with in the desirable limit of drinking water.
- DO and BOD values vary from 4.4 to 9.0 mg/L and 0.4 to 1.6 mg/L respectively.
- Almost concentration of all water quality parameters increases with increase in depth in the reservoir.

Parameters	Minimum	Maximum	Average
pH	7.28	8.34	7.78
EC, µS/Cm	140	269	221
TDS, mg/L	90	172	142
Hardness, mg/L	61	103	84
HCO_3, mg/L	61	81	73
Cl, mg/L	2.0	22	12
SO_4, mg/L	13	32	16
NO_3, mg/L	1.10	2.20	1.52
PO_4, mg/L	0.03	0.63	0.15
F, mg/L	0.03	0.62	0.27
Na, mg/L	3.7	9.9	7.6
K, mg/L	1.9	3.4	2.8
Ca, mg/L	18	35	24
Mg, mg/L	2.0	11	6.0
DO, mg/L	4.4	9.0	6.9
BOD, mg/L	0.40	1.60	1.07

- Assessment of suitability of these river water and reservoir water for irrigation purpose on the basis of total soluble salts, SAR, RSC revealed that these waters are of excellent quality for irrigation purpose.
- Sampling for monsoon season has been carried out in the month August 2009.

Expected outcomes:

- The changes in river water quality after commissioning of Tehri Hydroelectric Project

Expected date of completion: August, 2009

4. PROJECT REFERENCE CODE: NIH/EHD/NIH/08-08/09

Title of the Study: Evaluation of water quality of rivers joining Tehri Reservoir and downstream of the reservoir

Study Group: M K Sharma, Scientist' B'
V K Choubey, Scientist 'F'

Date of start: September, 2008

Duration of the study: One year

Weather externally funded or not: Internal (As suggested by MOWR)

Point wise objectives:

iii) To examine the suitability of water of the rivers joining Tehri reservoir and downstream for various designated uses

iv) To identify possible sources of pollution and assess the actual changes in river water quality after commissioning of Tehri Hydroelectric Project

Brief methodology:

- Identification of sampling sites in the rivers joining Tehri reservoir and downstream of Tehri Reservoir
- Sampling of water in different seasons
- Physico-chemical parameters: pH, EC, TDS, Alkalinity, Hardness, COD, BOD, Major Cations (Na, K, Ca, Mg), Major Anions (HCO_3, Cl, SO_4, NO_3), Minor Ions (F, PO_4).
- Bacteriological Parameters: Total and Faecal Coliform
- Data for different seasons will be processed as per BIS and WHO standards to examine the suitability of river water for drinking purpose. Suitability of river water for irrigation purpose will be assessed on the basis of total soluble salts, SAR, RSC.

Results achieved with Progress/Present Status:

Pre-monsoon sampling of Tehri reservoir and its joining rivers has been carried out in the month of May 2009 and eleven water samples from reservoir from three locations at different depths, one sample each from river Bhilangana and Bhagirathi, two downstream samples from Zero point and Koteshwar have been collected and analysed for physico-chemical parameters, bacteriological parameters (Total and Faecal coliform) and metals (Fe, Mn, Zn, Cu, Cr, Cd, Pb, Ni). The sediment samples were also collected from Bhagirathi and Bhilangana rivers and are being analysed for metal concentration. The results of the analysis are below:

- All the physico-chemical parameters analysed, were found with in the desirable limit of drinking water.
- DO and BOD values vary from 4.4 to 9.0 mg/L and 0.4 to 1.6 mg/L respectively.
- Almost concentration of all water quality parameters increases with increase in depth in the reservoir.

Parameters	Minimum	Maximum	Average
pH	7.28	8.34	7.78
EC, µS/Cm	140	269	221
TDS, mg/L	90	172	142
Hardness, mg/L	61	103	84
HCO_3, mg/L	61	81	73
Cl, mg/L	2.0	22	12
SO_4, mg/L	13	32	16
NO_3, mg/L	1.10	2.20	1.52
PO_4, mg/L	0.03	0.63	0.15
F, mg/L	0.03	0.62	0.27
Na, mg/L	3.7	9.9	7.6
K, mg/L	1.9	3.4	2.8
Ca, mg/L	18	35	24
Mg, mg/L	2.0	11	6.0
DO, mg/L	4.4	9.0	6.9
BOD, mg/L	0.40	1.60	1.07

- Assessment of suitability of these river water and reservoir water for irrigation purpose on the basis of total soluble salts, SAR, RSC revealed that these waters are of excellent quality for irrigation purpose.
- Sampling for monsoon season has been carried out in the month August 2009.

Expected outcomes:

- The changes in river water quality after commissioning of Tehri Hydroelectric Project

Expected date of completion: August, 2009

5. PROJECT REFERENCE CODE: NIH/EHD/NIH/09-09/12

Title of the Study: Environmental Flow Requirement of a River

Study Group: Mr. Dilip G. Durbude, Scientist- C
Dr. V.K. Choubey, Scientist F & Head
Mr. Omkar Singh, Scientist- E1
Dr. M.K. Sharma, Scientist- C

Date of start: 1.10.2009

Duration of the Study: 3 years

Weather externally funded or not: Internal

Point wise Objectives:

- To review the present status of environmental flow estimation methodologies for rivers.
- To assess environmental flow requirements in a selected river/reach using appropriate methodology.
- To assess river water quality for drinking, irrigation, fisheries, etc.

Brief Methodology:

A critical review of the existing literature on EFR methodologies would be carried out. Based on the review, an appropriate method would be selected for EFR analysis. Initially, the EFR analysis would be carried out by using look-up tables, desktop analysis and flow duration curves (FDCs) as used in river basin planning. River water quality would also be assessed as per standard methods for various designated uses.

Mile Stones and Expected Outcome/Output:

Review paper on existing EFR methodologies
Assessment of river water quality
Estimation of Environmental Flow Requirement

Expected date of completion: **30.9.2012**

ANNEXURE-II

THE 31ST MEETING OF THE NIH WORKING GROUP

GROUND WATER HYDROLOGY DIVISION

Progress of Studies & Details of New Studies

NATIONAL INSTITUTE OF HYDROLOGY
राष्ट्रीय जल विज्ञान संस्थान
आपो हि ष्ठा मयोभुवः

NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE – 247667

GWHD-1 | 1 1

1. PROJECT REFERENCE CODE: NIH/GWD/NIH/07-03/10

Title of the study: Quantification of Impact of Rainwater Harvesting on Groundwater Availability in Aravalli Hills

Study Group: Anupma Sharma (PI), Scientist-C
N. C. Ghosh, Scientist-F
C. P. Kumar, Scientist-F
Sudhir Kumar, Scientist-E2
Rajan Vatsa, Scientist-B

Date of start: April 1, 2007

Duration of the study: Three years (2007 – 2010)

Whether externally funded or not: Internal funding

Objectives of the study: To quantify impact of rainwater harvesting schemes on groundwater availability at micro and macro watershed scale in Aravalli hills.

Brief methodology: The technical program of the proposed study comprises the following:

1. Identification of observation network.
2. Collection and monitoring of required data.
3. Data processing and creation of database on GIS.
4. Tracer studies to determine fate of harvested rainwater recharged to groundwater.
5. Mathematical modeling to analyse the hydrological impact of rainwater harvesting schemes.

Progress/Present status:

1. *Identification of study area* – The Savana macro-watershed has been selected for detailed investigations in the Jaisamand Lake Catchment.
2. *Literature review* – Relevant literature review carried out.
3. *Data collection* – Several field visits to the study area have been undertaken by the scientists working on the project. During the visits, data pertaining to ground water level, water quality, geology and soil were collected. In addition, rainfall data and other necessary data related to water harvesting structures such as catchment area, area of submergence etc. were also collected. Satellite data have been procured to study the landuse and presence of lineaments etc. Data monitoring in Savana watershed was initiated in May 2008. Wells identified for water level monitoring and water levels are being monitored regularly. Six raingauges installed in the watershed and adjacent locations are also being monitored.
4. *Field tests* – One infiltration experiment was conducted in June 2009. Other field tests are planned in Nov./Dec. 2009.

5. *Database preparation* – Using the data collected/monitored in Savana watershed, preparation of database on GIS and data analysis is under progress.
6. *Tracer studies* – Tracer studies are underway in the watershed at two harvesting sites that would provide insight into the potential and actual volume of rainwater that can be harvested, along with determining the fate of the harvested rainwater that is recharged to groundwater. For this purpose, relevant data are being collected every two weeks.
7. *Morphometric analyses* – Analysis of morphometric characteristics of the watershed is under progress.
8. Qualitative assessment of water harvesting schemes made in Gangeshwar macro-watershed.

Expected date of completion: March 2010

2. PROJECT REFERENCE CODE: NIH/GWD/NIH/08-09/

Title of the study: Vision Document on "Mitigation and Remedy of Groundwater Arsenic Menace in India".

Study Group: NIH and CGWB under the aegis of MoWR

Date of Start: September, 2008

Duration of the study: 8 months. Completed in August, 2009

Funded by: Ministry of Water Resources, Govt. of India

Objectives: To prepare a vision document emphasizing; up to date status of the problem, state-of-art of scientific knowledgebase and technologies available both nationally & internationally, technologies in place, work to be undertaken, roadmap to achieve targets, framework of activities, and methods of operation of the envisages tasks.

Methodology

The contents of the document had been finalized by the Follow up Committee of the "2nd Advisory Council on Artificial Recharge of Ground Water, MoWR". Based on the subject matter of each Chapter, contributions from identified resource persons fitting to the respective subject areas have been obtained. Following are the resource persons contributed to the documents:

(i) Prof. K. J. Nath, Chairman-West Bengal Arsenic Task Force;
(ii) Prof. Dipankar Chakraborty, School of Environmental Studies, Jadavpur University;
(iii) Dr. S. P. Sinha Roy, Ex.-member, CGWB and Former Chairman, Arsenic Task Force, West Bengal;
(iv) Mr. Ram Mohan Mishra, Joint Secretary (A), Ministry of Water Resources, Govt. of India, New Delhi;
(v) Dr. S.K. Sharma, Consultant (GW), Ministry of Water Resources, Govt. of India, New Delhi;
(vi) Dr. B. B. Basu, Director, School of Fundamental Research, Kolkata;
(vii) Dr. N. C. Ghosh, Scientist-F, NIH-Roorkee;
(viii) Dr. C. K. Jain, Scientist-F, NIH-Guwahati;
(ix) Shri Abhijit Roy, Superintending Hydrogeologist, CGWB-ER, Kolkata;
(x) Dr. Dipankar Saha, CGWB-MER-Patna;
(xi) Dr. Bhaskar Das, School of Environmental Studies, Jadavpur University, Kolkata;
(xii) Dr. Subhash Chandra Mukherjee, Department of Neurology Medical College, Kolkata;
(xiii) Dr. Shyamapada Pati, Department of Obstetrics and Gynaecology, IPGMER, SSKM Hospital, Kolkata;
(xiv) Dr. Khitish Chandra Saha, Professor (Retd.), Deptt. of Dermatology, School of Tropical Medicine, Kolkata;
(xv) Dr. S.K. Srivastava, Scientist-B, Central Ground Water Board, Lucknow.

The compilation of each chapter has been professionally edited by Dr. Nagendra Kumar, Associate Professor, Deptt. of Humanities and Social Sciences, IIT Roorkee.

Results achieved:

The Vision document containing of a total of ten chapters: the chapters 1-5 explain knowledge base, understanding and technological opportunities available, state-of-affairs of arsenic contamination in India and different corrective measures taken and shortcomings experienced; while the chapter-6 in fact, brings out a critical appraisal of chapters 1-; the chapter-7 focuses the gaps and identifies areas requiring future initiatives, the Chapters 8-10 derive a "Comprehensive Plan of Actions" envisaging roadmap, financial requirement and the method as to how the mission can be coordinated and accomplished, has been brought out. A supplementary document entitled **"Plan of Actions"** emerged from the main document has also been brought out to facilitate initiation of framework of activities.

The document has been submitted to Ministry of Water Resources, Govt. of India for consideration.

3. PROJECT REFERENCE CODE: NIH/GWD/NIH/09-03/12

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

Study Group: Surjeet Singh (PI), Scientist-C
C. P. Kumar, Scientist-F
Anupma Sharma, Scientist-C
Rajan Vatsa, Scientist-B

Date of Start: April 1, 2009

Duration of the Study: Three years (2009-2012)

Whether externally funded: No

Objectives of the Study:

1. To quantify the impacts of climate change on groundwater recharge in a part of Sonar basin, Madhya Pradesh.
2. To simulate the groundwater levels and investigate the temporal response of the aquifer system to historic and future climate periods.

Brief Methodology:

The technical program of the proposed study comprises the following:

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

Progress/Present status:

1. *Identification of study area* – The upper Sonar basin up to Garhakota has been selected for detailed investigations in the Bundelkhand region of Madhya Pradesh.
2. *Literature review* – Relevant literature review has been carried out.
3. *Data collection* – One field visit to the study area was made by the principal investigator of the project. During this visit, data pertaining to ground water level, well location details, well lithology, geology, soil and rainfall were collected in addition to other necessary information related to the study site. Satellite data for the study area, already

available at the headquarter, have been used to study the land use and presence of lineaments, etc.

4. *Database preparation* - Preparation of database on GIS and data analysis is under progress. Basin boundary, road network, drainage network, village location map have been prepared. Soil map and Theissen polygon map of rain gauge stations have been developed. Location of bore well and dug well is also marked in the basin map. Image classification for the computation of land use in the basin is under progress.
5. The work related to identification of sites to conduct the soil tests for hydraulic conductivity and infiltration rates is also completed.

Expected date of completion: March 2012

4. PROJECT REFERENCE CODE: NIH/GWD/NIH/09-02/11

Title of the Study: Study of Rising Ground Water Table in Jodhpur City, and to Evolve a Management Plan to Contain the Rising Trend

Study Group:
Dr. N. C. Ghosh, Scientist-F, GWHD
Mr. C. P. Kumar, Scientist-F, GWHD
Dr. Sudhir Kumar, Scientist-E2, HID
Dr. B. K. Purandara, Scientist-E1, RC, Belgaum
Dr. Anupma Sharma, Scientist-C ,GWHD
Dr. Surjeet Singh, Scientist-C, GWHD
Mr. Rajan Vasta, Scientist-B, GWHD

In addition to internal study team, expertise on required subject matter from IIT Roorkee will be sought.

Date of Start: 16th August, 2009

Duration of the study: One year 6 months

Project cost: 24.52 lacs

Funded by: Ground Water Department, Govt. of Rajasthan

Objectives of the Study:

1. Identification of cause(s) of rising ground water levels in Jodhpur city.
2. Development of an effective and sustainable management plan for maintaining the water table of the area at a safe level to avoid any negative impact on the civil structures and population of the area.

Methodology:

1. Diagnosis survey of the area
2. Analysis of different hydrological and hydro-geological data to establish trends and variability, parameters estimation, delineations of variables, etc.
3. Aquifer delineation and characterization to ascertain fractures and lineaments, etc.
4. Isotope study to identify the sources of seepage
5. Groundwater quality analysis
6. Water balance approach
7. Aquifer modeling for different stress condition to determine responses consequent to storage and recovery.

Expected outcome

1. An interim report based on preliminary study, after six months from the date of award of study. The interim report will include suggestions for effective short term remedial measures for mitigating the problem of rising ground water levels.
2. The final report identifying cause(s) responsible for rising ground water levels and suggestions for sustainable solution of the problem.

5. PROJECT REFERENCE CODE: NIH/GWD/NIH/09-08/11

Title of the Study: Identification of Artificial Recharge Sites in a Basin

Study Group: Mr. Shobha Ram, PRA (PI)
Dr. N.C. Ghosh, Scientist-F
Dr. Anupama Sharma, Scientist-C
Dr. Surjeet Singh, Scientist-C
Mr. Sanjay Mittal, SRA

Date of Start: October 1, 2009

Duration of the Study: Two year (Oct, 09 to August, 2011)

Whether externally funded: No

Objectives of the Study

1. To study various artificial recharge methods and to suggest suitable methods for artificial recharge in different potential areas in a basin.
2. To study various factors which influence groundwater scenario in an aquifer and to suggest the suitable sites for artificial recharge to augment groundwater recharge.

Brief Methodology

Literature review.

Field visits will be made and data will be collected from lined departments, namely, CGWB, SGWB, etc.

Generation of various thematic layers viz. soil, geology, geomorphology, topography, contour, DEM, water table fluctuation, etc. using GIS software.

Identification of factors viz. soil, geology, geomorphology, topography, water table availability, groundwater fluctuation, water table rise, etc. facilitating recharge to take place.

Determination of sets of weight for different information layers.

A set of rules will be designed to demarcate the most suitable zones for artificial recharge sites.

A resultant image would be generated showing the suitable location for artificial recharge in the basin.

The information from all the thematic maps generated will be used to suggest suitable method of artificial recharge for the different areas of the basin.

Preparation of final report.

Milestones and Expected Output / Outcome

The study will identify the sites suitable for artificial groundwater recharge and therefore enable better management of groundwater resources.

Expected Date of Completion : August 31, 2011

TECHNOLOGY TRANSFER

The Division in association with Water Resources Development Directorate, Govt. of West Bengal is organizing a six day training Workshop on "*Artificial Groundwater Recharge and Aquifer Management*" during October 5-10, 2009 at Kolkata for the officials of Water Resources Investigation and Development Departments. The training workshop is financially (Rs. 4.5 lacs) supported by the Govt. of West Bengal. Faculties to the training workshop have been drawn from resource persons from number of organizations, such as; Academic Institution, Central and State Govt. Departments, and R & D organizations.

PURPOSE DRIVEN STUDY

The Division has also submitted a Purpose Driven Study under Hydrology Project (Phase –II) on "*Coastal Groundwater Dynamics and Management in the Saurashtra Region, Gujarat*" in collaboration with Gujarat Ground Water Resources Department. The project amount is Rs. 55.14 lacs (NIH component). Approval from MOWR is awaited.

ANNEXURE-III

THE 31ST MEETING OF THE NIH WORKING GROUP

HYDROLOGICAL INVESTIGATIONS DIVISION

Progress of Studies

NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE – 247667

1. Project Reference Code: NIH/HID/INT/2009-12

Title of the Study:	Surface Water and Groundwater Interaction at selected locations along River Yamuna in NCT, Delhi (Phase-II)
Study Group:	Sudhir Kumar (PI) M. S. Rao P. K. Garg
Date of start:	April 2009
Duration:	03 years (March, 2012)
Funding:	Internal

Objectives

i) To study the surface water and groundwater interaction along river Yamuna in National Capital Territory of Delhi.

ii) To determine the extent of surface water groundwater interaction.

Background:

To understand the surface water groundwater intersection in NCT Delhi, a study was carried out during 2006-09. This study was carried out taking one cross-section of piezometers across river Yamuna. This study indicated significant interaction of surface water with groundwater in the Palla area of Delhi. But due to complex hydrogeological conditions in the area, like presence of paleochannels etc, some questions remained partially answered. Also due to the sensitivity of the study, it was recommended by the WG and TAC to extend this study for a further period of 3 years to have reliable results. Keeping this in mind it was decided to repeat the study at one more cross section in this area.

Brief Methodology

Isotopic Approach

Isotopic tracers provide a mean for identifying the actual mass transport of water in the hydrologic cycle. The approach is based on the fact that the rivers originating at higher altitudes have a different stable isotopic composition than that of the local precipitation in plains. The stable isotopic composition ($\delta^{18}O$) of the Yamuna River water is more depleted (-8 $^{0}/_{00}$ to –12 $^{0}/_{00}$) than that of groundwater derived from infiltration of local precipitation (– 5 $^{0}/_{00}$ to – 6 $^{0}/_{00}$).

Therefore, stable isotopes of hydrogen and oxygen can be used to determine the contribution of groundwater to river or vice versa.

Groundwater Modelling Approach

Surface and groundwater interaction would be analysed using modelling approach. A 3-dimensional groundwater model, MODFLOW, would be calibrated to the field conditions to corroborate and compliment the isotopic approach used in the study. This approach will help in assessing the groundwater, flood recharge and river boundary components that contribute to the pumping.

Progress / Present Status

i) 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.

ii) During the monsoon season, the river water samples are being collected on daily basis. The figure given below shows the variation of $\delta^{18}O$ in the river Yamuna during the monsoon season.

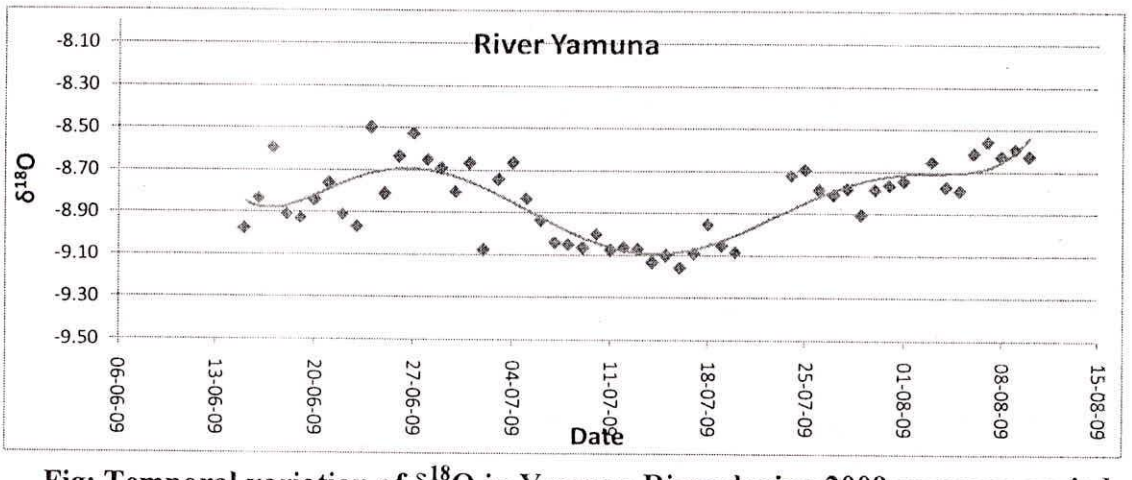


Fig: Temporal variation of $\delta^{18}O$ in Yamuna River during 2009 monsoon period

iii) Water levels are being measured in piezometers at weekly interval on Delhi side of the river Yamuna.

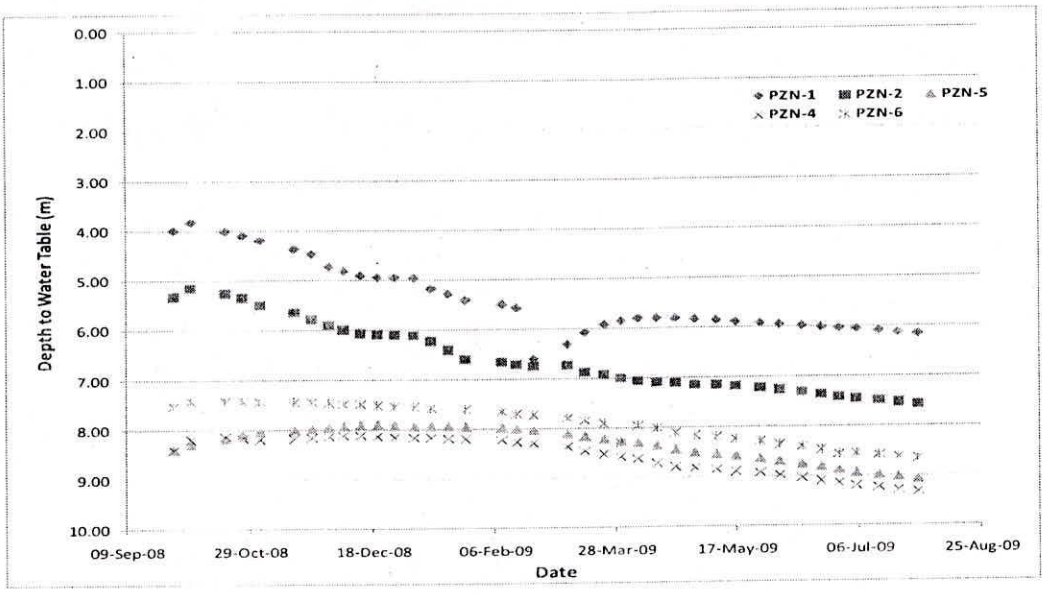


Fig.: Temporal variation of Depth to water table along section-2.

iv) Isotopic analysis of the samples collected till July has been completed. The variation of $\delta^{18}O$ with time in different piezometers is shown below.

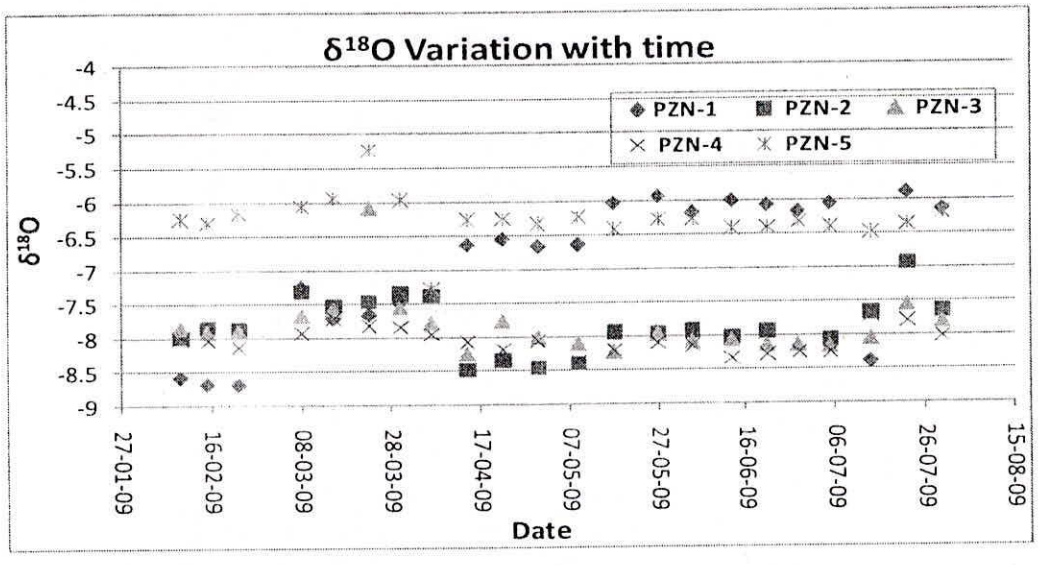


Fig.: Temporal variation of $\delta^{18}O$ with time along section-2

v) Rainfall samples are being collected for measuring the isotopic composition of rain. The other details along with interpretation of the data will be presented during the meeting.

Expected Date of Completion: 31st March, 2012

2. Project Reference Code: NIH/HID/DST/07-12

Title of the Study: National Programme on Isotope Fingerprinting of Waters of India (IWIN)

Study Group: M.S. Rao (PI)
B. Kumar,
Sudhir Kumar
S.P. Rai
S.K. Verma
Pankaj Garg

Date of start: July 2007

Duration: 5 years

Ending date: June, 2012

Funding: DST

Participating organizations: PRL, **NIH**, BARC, NRL (IARI), NIO, NGRI, CPCB, CWC, CGWB, IMD, CRIDA, IIT-KGP, Anna Univ., CWRDM

Objectives

i) Identifying Regional/local water vapour components in the local atmosphere.

ii) Quantifying the partitioning of vapours into rain and re-partitioning of rain into various components as evapotranspiration, soil moisture, stream flow* and groundwater* (*these samples will be collected by the participating organizations).

iii) Residence time of vapour/water in different inland hydrological units.

iv) Atmospheric/surface water/groundwater interaction on seasonal and spatial basis.

v) Developing a web resource for isotope hydrology data-base of the Indian sub-continent.

Brief Methodology

Sample collection:

a) Daily sampling of atmospheric moisture from near ground level and from Push & trap method by using LN_2 and methanol at NIH, Roorkee and near ground level at R.C. Sagar.

b) Sampling of precipitation at Roorkee and Sagar.

c) Weekly sampling of the river Ganga (HDR) from Upp. Ganga Canal, Roorkee.

d) Fortnightly sampling of groundwater from depths approx. 10 m & 40 m at Roorkee and monthly sampling from shallow aquifer at Sagar.

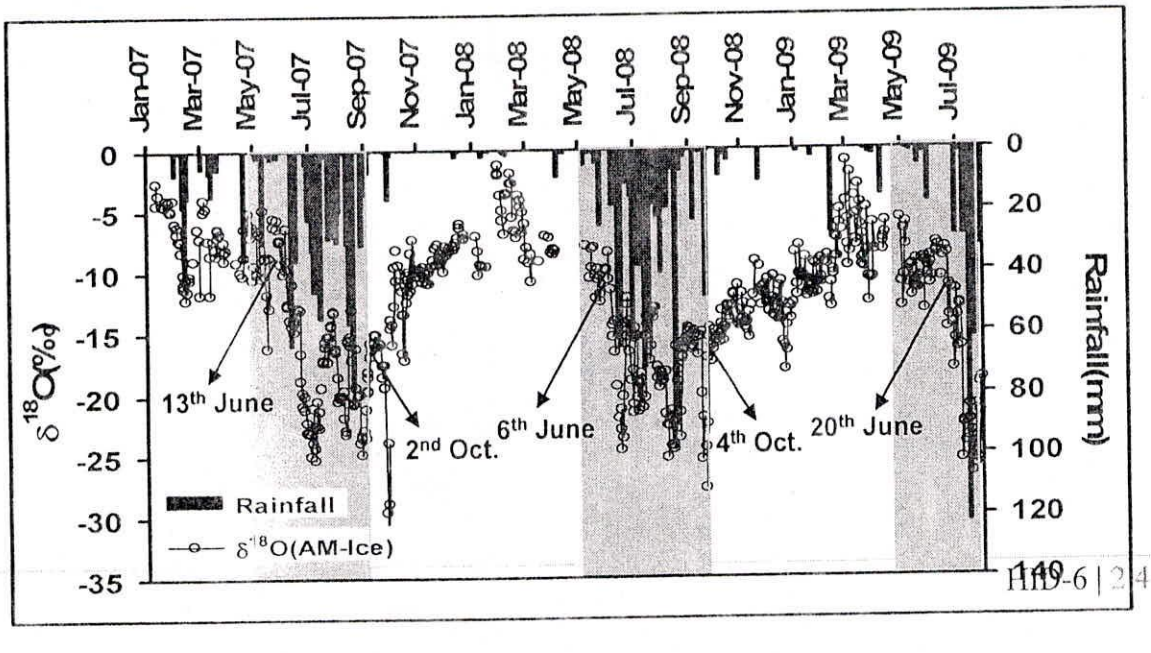
(i) ***Analysis:*** δD, $\delta^{18}O$ analysis of river water, groundwater, precipitation and atmospheric moisture, and ^{3}H analysis of river and groundwater samples.

(ii) ***Data collection:*** Meteorological and hydrogeological data from State/Central Govt. Organizations.

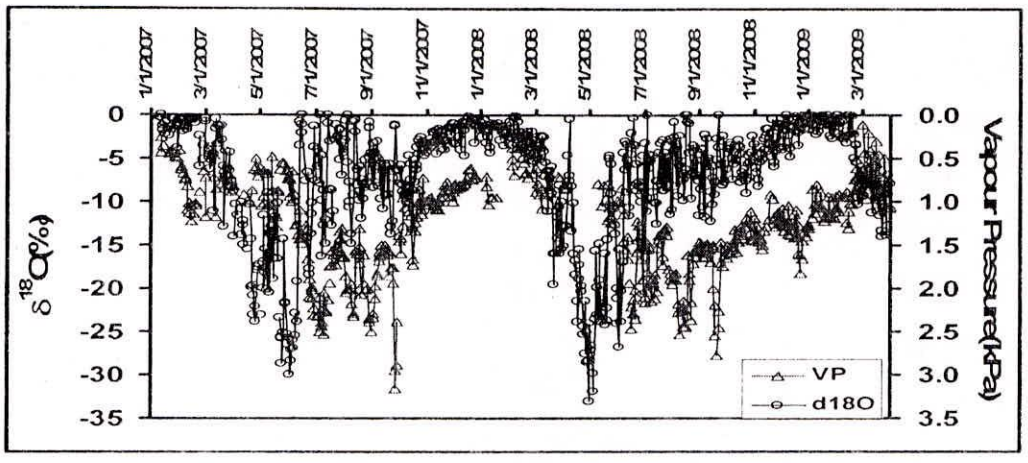
(iii) ***Interpretation of data:*** Final interpretation of the data will be carried out jointly with IWIN member organizations at PRL, Ahmedabad.

Progress / Present Status:

- Total 410 samples were collected at NIH, Roorkee and Sagar during the period from March to July 2009,. These include atmospheric moisture, rainwater, groundwater and river water.
- Stable isotope analysis of all the samples have been completed at NH Laboratory.
- One Research Scientist has been appointed through open advt. in the regional and national newspapers
- Progress of the IWIN project (NIH component) was presented in the 3rd Coordination Meeting of IWIN held on 22-23 May, 2009 at PRL, Ahmedabad.
- Laboratory based atmospheric moisture collection using push & trap method using LN_2+Methanol slush has been started.
- A plot of $\delta^{18}O$ of atmospheric moisture (condensation) and rainfall amount with time is shown below indicating arrival of monsoon vapours during the years 2007, 208 and 2009. The plot of $\delta^{18}O$ clearly indicates the effect of monsoon vapours on the isotopic signatures of atmospheric moisture.



As per the suggestion of Dr. V.V.S. Gurunadha Rao from NGRI, plots indicating the variation of $\delta^{18}O$ composition of atmospheric moisture and vapour pressure with respect to time are shown below. The plots indicate more or less similar pattern of variation as observed in case of $\delta^{18}O$ of atmospheric moisture and air temperature with time. More details will be discussed during the presentation.



The summary of the samples collected and analyzed is given below in Table 1 and the average values of $\delta^{18}O$, δD and D_{excess} of atmospheric moisture for the year 2007 and 2008 are shown in Table 2.

Table 1: Summary of the samples collected and analyzed

Station	Sample type	Frequency	No. of samples collected & analyzed	
			March – July, 2009	Since July, 2007
Roorkee	Atmos. Moisture	1/day		
	* By condensation		131	718
	* By Push & Trap		88	575
	Rain samples	Event based	20	106
	Groundwater	Twice/month	58	94
	Upper Ganga Canal	Weekly	21	262
Total			318	1755
Sagar	Atmos. Moist. (Ice)	1/day	85	569
	Groundwater	Monthly	3	36
	Lake	Monthly	4	22
Total Samples Analyzed			410	2382

Table 2 : Average $\delta^{18}O$,δD and D_{excess} values for the year 2007, 08

Period	Year	$\delta^{18}O$	δD	D_{excess}
Before on-set of monsoon (1^{st}-30^{th} May)	07 08	-8.71 -10.14	-11.27 -22.27	58.43 58.83
Average		-9.42	-16.77	58.63
End of Monsoon (1^{st}-30^{th} Sept)	07 08	-19.42 -17.75	-74.09 -68.97	82.52 73.90
Average		-18.58	-71.53	78.21

Expected Date of Completion: June, 2012

3. Project Reference Code: NIH/HID/FRI/08-13

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

Study Group: S.P. Rai (PI)
Bhishm Kumar
J.V. Tyagi
Rajeev Tiwari (FRI)

Date of Start: March 2008

Duration: 05 years

Funding: Rs. 3.5 lac, Forest Research Institute, Dehradun

Objectives:

i) Impact of forest cover on stream discharge pattern.

ii) To separate surface runoff & ground water components in the stream discharge using conventional and isotopic technique

iii) Soil erosion under different forest cover.

iv) Identification of recharge zone of stream & springs using isotopic techniques

v) To define the role of forest on hydrological regime

Brief Methodology:

- Two micro-watersheds with different forest covers having almost same geological and geographical features have been selected.
- Input parameters such as (precipitation, Infiltration, Temperature, Humidity, forest cover) and output parameters such as (discharge, sediment load, evaporation, and evapotranspiration) of micro-watersheds are being monitored using auto and manual instruments.
- Stable isotopes of oxygen and hydrogen, environmental radioisotopes like Cs-137, Pb-210 and H-3 will be used for the study of recharge zones, hydrograph separation and soil erosion pattern along with conventional techniques.

Progress / Present Status

Two watersheds namely, Arnigad and Bansigad have been selected near Mussoorrie. Arnigad micro-watershed having as area of 3 km^2 is covered with dense oak forest while Bansigad micro-watershed 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. Highest and the lowest elevations of both the project area are approximately equal. Other morphometric parameters such as, relief ratio, stream order, form factor, and elongation ratio etc are almost same. Geology of the both the watershed is same and the difference is only in land-cover.

The compound weir (120^0 '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 ^{3}H analysis.

The average air temperature varies between 15.5^0C (minimum) and 25^0C (maximum) in degraded watershed and 18^0C to 22^0C in forested watershed. The relative humidity is observed 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. Discharge in degraded watershed vary between 0.01m^3/sec (minimum) in the month of June and 1.02 m^3/sec (maximum) in the month August while in forested watershed, it vary between 0.05 m^3/sec in the month of June and 0.88 m^3/sec in the month of August. Hydrograph shown below 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 decline slowly in Arnigad stream during post monsoon month while it decline at faster rate in Bansigad stream and stream become dry up in summer months. The preliminary observations reveal that the stream flowing through dense forest sustains during nonmonsoon months due input from the delayed subsurface flow.

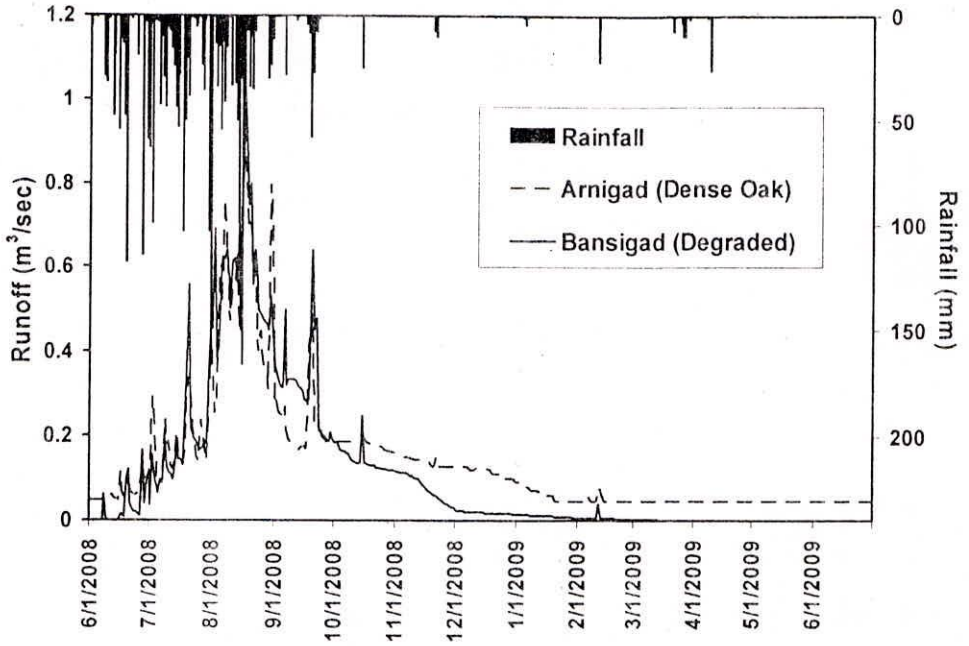


Fig: Rainfall-runoff relationship on daily basis from Arnigad and Bansigad micro-watershed.

Isotopic Composition of Rain and Stream Discharge

$\delta^{18}O$ of rain varies between minimum –21.2 ‰ in the month of September and maximum +2.6 ‰ in the month of June at Bansigad site and it varies between minimum –16.7 ‰ in the month of August and maximum +5.7 ‰ in the month of May at Arnigad site. The statistical analysis of the monthly isotopic data of rainfall for the Bansigad and Arnigad watershed for the period from June 2008 to June 2009 reveals the following relation between δD and $\delta^{18}O$:

$\delta D = (8.24) * \delta^{18}O + 14.16 \quad r^2 = 0.97$ (Bansigad Watershed)

$\delta D = (8.05) * \delta^{18}O + 11.38 \quad r^2 = 0.98$ (Arnigad Watershed)

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 ($\delta D = (8.0) * \delta^{18}O + (11.5)$, $r^2 = 0.98$). Seasonal and storm-wise variation has been also recorded, which will be useful in hydrograph separation.

In stream discharge, $\delta^{18}O$ varies from -12.9 ‰ in the month of August to -7.5 ‰ in the month of June in Bansigad watershed while it varies from -9.9 ‰ in the month of August to -7.56 ‰ in the month of May in Arnigad watershed. 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 dominates by surface runoff while during non rainy months, subsurface flow dominates. The stable isotopic signatures of stream discharge in the watersheds depict the following relations.

$\delta D = (7.91) * \delta^{18}O + 11.93 \quad r^2 = 0.80$ (Bansigad Watershed)

$\delta D = (7.90) * \delta^{18}O + 11.55 \quad r^2 = 0.98$ (Arnigad Watershed)

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.

The sediment delivery from both the watersheds has been measured on the basis of daily sampling during monsoon period. The suspended concentration in stream water discharged through V notch in the forested watershed has been found varying from 2 mg/l during summer months to 8170 mg/l during rainy period while it was recorded from 2 mg/l to 5860 mg/l in the degraded watershed of Bansigad.

Expected Date of Completion: March, 2013

4. Project Reference Code: NIH/HID/HP-II/09-12

Title of the Study: Groundwater Dynamics of Bist Doab Area, Punjab, using Isotopes (PDS Under HP-II)

Study Group: M.S. Rao (PI)
Bhishm Kumar
Sudhir Kumar
S.K. Verma
Pankaj Garg + Officials of CGWB

Date of Start: July 2009

Duration: 03 years

Ending Date: June 2012

Funding: PDS under HP-II

Technical Collaboration: CGWB, NWR, Chandigarh.

Objectives

i) Identifying groundwater recharge zone and recharge sources using groundwater dating and stable isotope technique

ii) Groundwater modelling

Brief Methodology

i) Sample collection: surface and groundwater at regular intervals.

ii) Data Collection: Hydrogeological, hydrometeorological, topographical data

iii) Generating various thematic maps: Land use, soil map, aquifer geometry etc.

iv)Measurements: Chemical, stable and radioactive analysis of samples.

v) Interpretation: Integrated analysis of sample data with the hydregeological data to identify recharge zones, recharge sources and flow pattern

vi) Groundwater flow modeling

Progress / Present Status:

vi) Literature has been collected from the Dept. of Sci. & Techn., Chandigarh; PAU, Ludhiana, Punjab Remote Sens. Centre, Ludhiana and other institutes.

vii) Three project staff namely, Research Associate- (1 no.), JRF (1 no.), and Sr. Technical Assistant (1 no.) have been appointed

viii) Procurement of various equipment and data is in progress

ix) Two field visits were undertaken in June, 2009 and the third one has been completed in the last week of August 09. Total 278 water samples were collected during the field visits from rivers, canals, hand pumps (shallow and deeper), piezometers (shallow and deeper), and rainfall etc for the analyses of stable isotopes of oxygen, hydrogen, environmental tritium and water quality parameters.

x) 8 sites have been identified where local persons have been deputed to collect rainwater/groundwater/surface water samples. Three rain-gauge sites in the upper-Bhabhar region (>450m alt), 2 in plains inside the Doab region (300-400 m alt) and one at Harike site (300 m alt) have been finalised for the collection of rainfall data and samples.

xi) Monthly Rainfall data have been collected from Water Resources & Environmental Directorate, Punjab for the districts of Ropar, Firozpur, Ludhiana, Kapurthala, Jalandhar, Amritsar, Hoshiarpur from the period from Jan, 2005 – June, 2008.

xii) Water chemistry data of the groundwater is collected for the year 2007 for 40 sites.

xiii) For groundwater sampling 26 piezometric sites are identified out of which 15 sites are shallow and 11 are deep.

xiv) Depth to water table data (1999-2005) has been collected from CGWB, Chandigarh for 23 blocks and 41 sites.

xv) Results: (i) Analyzed groundwater flow pattern (ii) Isotopic analysis of all the measured samples so far indicates that (i) the Satluj River water is isotopically depleted with respect to the Beas River water (by 3‰ in $\delta^{18}O$ and 28‰ in δD) and (ii) the river Kali Bein and groundwater in the central region of the study area are mainly formed through local precipitation with moderately affected by evaporation process. The extent of evaporation is found less in groundwater close to Beas and Satluj Rivers (Fig 1). The preliminary investigations suggest that it is possible to investigate formation of groundwater resource using isotopic analysis.

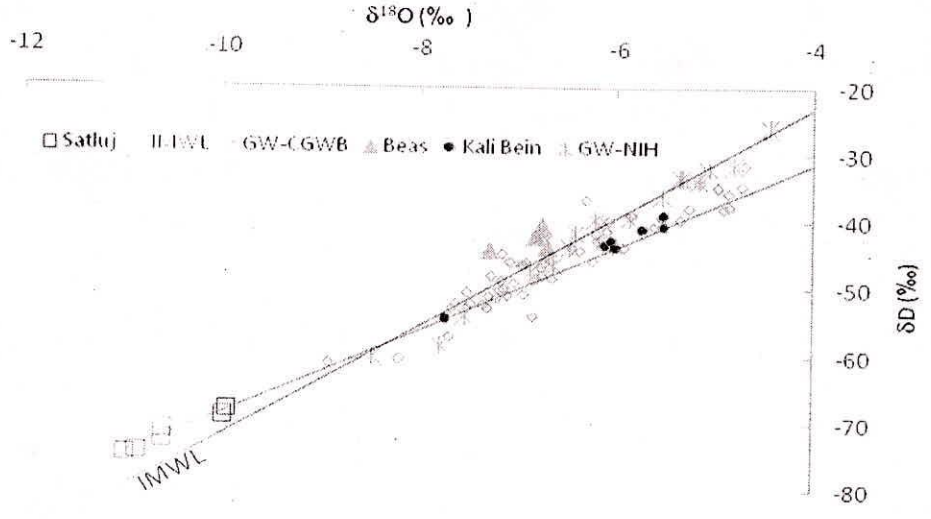


Fig 1: Isotopic characteristic of groundwater and surface water in BIST Doab.

More details of the study and isotopic signatures of different sources in the study area will be presented during the meeting.

Expected Date of Completion: JUNE, 2012

5. Project Reference Code: NIH/HID/HP-II/09-12

Title of the Study: Groundwater Management in Over- Exploited Blocks of Chitradurga and Tumkur Districts of Karnataka

Study Group: Sudhir Kumar (PI)
J.V. Tyagi
Vijay Kumar
B.K. Purandara
S.P. Rai
M.S. Rao

Date of Start: July 2009

Duration: 03 years

Funding: PDS under HP-II

Objectives

i) To analyze groundwater productivity at specific study sites including artificial recharge structures and an assessment of potential increases and their contribution to rural livelihood improvement.

ii) To develop integrated understanding of hydrologic, social, economic, and institutional perspectives.

iii) To improve stakeholder engagement and community participation for developing a common vision, goal and partnership for managing Basin's groundwater resources.

iv) To identify anthropogenic interventions and evaluate their likely impact for effective groundwater management.

v) To arrive at a model for management and regulation of identified over-exploited blocks on an operational basis.

Brief Methodology

The problem requires a comprehensive multi-institutional, multi-disciplinary and multi-locational study approach. The State Groundwater Departments would provide crucial inputs pertaining to hydro-geology, hydrology, land use etc. Inputs from NGO's and other stake holder's will also be considered. Conjunctive use of surface/ groundwater, artificial recharge/ draft regulation and institutional interventions would be crucial decision variables. After a detailed understanding of hydro-geology, hydrology and land use practices, conceptual and real-life models (specific and general) would be developed, within Simulation-Optimization framework (Rao et al 2004, 2006) to arrive at policy guidelines for managing and regulating the groundwater resources by state agencies. Insight obtained from groundwater modeling and experience

of groundwater hydrologists/ hydro-geologists will be used in arriving at policy guidelines which will be the basis for optimal groundwater management. The project will seek to build strong linkages between stake holders and regulating agencies through capacity building strategies for effective groundwater governance and harmonized groundwater use.

Steps of the proposed methodology are as follows:

i) Selection of Watersheds: Two watersheds have been be selected
ii) Assessment of data availability and data gap
iii) Technology development: This will involve following subheads.
   a) Reconnaissance surveys
   b) Data base development: Spatial, temporal, socio-economic
   c) Digitization of data
   d) Integration of data
   e) Procurement of equipment/ software and field interventions
   f) Groundwater assessment, modeling and calibration
   g) Groundwater management modeling and future scenarios
   h) Optimal Policy evaluation for sustainable development and management
iv) Organizational of capacity building
v) Training of stakeholders
vi) Scope of extension/ replication to other study areas

Progress / Present Status

Two watersheds, classified as over-exploited by DMG and CGWB, were identified in the Tumkur (4C3H4) and Chitradurga (4D3D5) districts for taking up the groundwater management studies. But on investigations, it was found that the watershed 4D3D5 is not a proper watershed. Thus, a visit was made during last week of June 2009 to Bangalore to identify another over exploited watershed in Chitradurg district. Another watershed (4D3D2) was identified for carrying out the studies. The salient features of the watersheds finalized for the study are given below in Table:

Watershed	4C3H4	4D3D2
District	Tumkur	Chitradurg
Taluk	Koratagere (80%) Tumkur	Challakere (93%)
Latitude	$13^0 15' - 13^0 45' N$	$14^0 18' - 14^0 35' N$
Longitude	$77^0 06' - 77^0 30' E$	$76^0 20' - 76^0 50' E$
Area	152400 ha	93700 ha
Basin	Pennar Basin	Lower Tungbhadra
Main Stream	Suvarnamukhi	Garani Halla
Geology	Granitic Gneiss	Gneiss, Schist
Stage of GW development	233 %	140%
Command/Non Command	Non Command	Non Command
Agroclimatic zone	Central and Eastern dry	Central dry zone
Soils	Red sandy soil and Red	Red loamy soil

- Appointment of staff has been made. One project staff has already joined and others are expected to join shortly.
- Creation of GIS data base is in progress, Base map, drainage map and contour maps have been prepared
- Groundwater data for last 10 years has been collected and is being analysed.
- The list of instruments to be procured has been finalized, it is proposed to purchase following field equipment for each watershed
    - Automatic rain Gauge
    - Automatic water level recorder
    - Digital groundwater level recorders
    - Soil Moisture meters
    - Hydrological observatory

The procurement of the equipment is under progress.

Expected Date of Completion: 30th June, 2012

6. Project Reference Code: NIH/HID/INCID/09-11

Title of the Study: Estimation of Irrigation Return Flow and Stream Flow Regeneration in Parts of the Selected Canal Command Areas

Study Group: M S Rao
Bhishm Kumar
S K Verma
Pankaj Garg
O. P. Dubey (WALMI, Lucknow)

Date of Start: from the date of approval- awaited

Duration: 2 years from the date of approval by INCID (MoWR)

Funding: Rs. 39,77,200/-, for NIH (Total Funding Rs. 54,68,400/-), (INCID, MoWR (Approval Awaited)

Objectives

i) Estimation of irrigation return flow in different types of soils and crops in the selected canal command areas (two) using isotopes.

iii) Development of suitable mathematical formulation for estimation of irrigation returns flow with rainfall/irrigation and soil type/ type of crops.

The study will also answer the questions like,

i) Irrigation return flow to different crops in different seasons

ii) Irrigation return flow in different types of soils

iii) Relation among different influencing parameters like rainfall, type of soil, crop and irrigation return flow

Brief Methodology

- Procurement of data for sub-surface strata, water table, groundwater draft, hydrometerological data, remote sensing data, land use, cropping pattern, soil map water demand, and literature related to the work carried out in the study area by different institutions/organizations.
- Generating study area maps, drainage, field map, DEM etc.
- Field survey to identify suitable sites for sample collection for isotope analysis and groundwater inventory for water quality survey.
- Collection of groundwater/surface-water for tritium dating and stable isotopic analysis.

- Collection of soil samples and injection of tritium in the identified sites before sowing of crops.
- Collection of soil samples after the crop harvesting.
- Analysis of soil samples for the measurement of volumetric moisture content, bulk density, particle size analysis etc. for both the set of soil samples.
- Distillation of soil moisture from second set of soil samples and its analysis for injected tritium. Estimation of irrigation-return-flow for different crop/soil pattern.
- Measurement of ^{3}H (environmental and artificially injected, both), ^{2}H and ^{18}O.
- Correlation maps between measured isotopic data, salinity and water table. Interpretation of results.
- Modelling of groundwater flow and regeneration flow component using field & laboratory data
- Preparation of reports and research contribution.

Progress/ Present Status

This study was referred by the ministry of water resources, Govt. of India. The proposal of this study was sent to INCID by the MoWR. The INCID Sub-committee-III approved the project technically in the meeting held on 22nd Jan 2008 with a suggestion to revise the project to include the regeneration flow component and to add ground water quality aspects. Accordingly, the project was revised and submitted to the committee in March, 2008. The project will start as soon as the approval will be received.

Expected Date of Completion: 02 years from the date of approval

7. Project Reference Code: NIH/HID/INT/09-12

Title of the Study: Integrated Hydrological Investigations Of Ropar Lake, Punjab

Study Group: Sh. S. D. Khobragade (PI)
Dr. Sudhir Kumar
Dr. S. P. Rai
Dr. M. S. Rao
Sh. S. K. Verma

Date of Start: April, 2009

Duration of the Study: 3 years (April, 2009 to March, 2012)

Objectives

This study was approved in the last working group meeting with the following objectives:

(i) Water availability status of the lake

(ii) Energy balance and hydrodynamics of the lake

(iii) Sedimentation rate and expected life of the lake

(iv) Water quality and other pollution aspects of the lake

d) Measures for systematic management and conservation of the lake

However, during the field visit to the site carried out in June, 2009 along with two other scientists of the Division, it was 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. Thus, it does not have any clear cut boundary. It is actually a water spread area formed due to damming of the flow of river Satluj for diversion through the canals. The water spread is a slightly elongated part or widening of the River Satluj at the barrage which is in continuation with the river. Since it is in continuation with the river water, it is difficult to tell where water spread is demarcated from the main river. The flow in the river leading to the barrage is manually controlled on daily basis through the Bhakra Dam depending upon the demand and availability. It was also observed that there is no standing water in the water body as wetland because the water is being constantly discharged through the two canals emerging from the barrage which are manually managed through the gates of the barrage. Thus, since the water body is a river (and not a lake) and it does not have standing water so it would be difficult to determine water balance components such as evaporation losses; and other energy balance components. Moreover, the water availability in the water body varies on daily basis as per the

release from the Bhakra dam, which is known; and it does not vary because of natural climatic variation only. Moreover, from the discussion with the Punjab Council of Science and Technology, it was let known that the council is mainly interested in knowing the sedimentation rate in the water body and water quality. Thus, it is proposed to modify and limit the objectives of the study to:

(i) Sedimentation rate in the water body

(ii) Water quality status of the water body

(iii) Measures for reducing the sedimentation and preserving water quality

For studying water quality aspects and the analysis of samples in the Water Quality Laboratory of the EHD, the name of a scientist from Environmental Hydrology Division (EHD) was initially included in the study team. But subsequently, the Head, EHD has expressed its inability to spare the services of any scientist for the purpose due to its own work load. Therefore, very limited water quality work, restricted to the physico-chemical and few other parameters, will be carried out under this study.

In light of the restricted objectives, it is proposed that the duration of the study has been reduced to a year only. Therefore, it is proposed complete the study by March, 2010.

Brief Methodology

The sedimentation rate in the lake would be studied using the isotope techniques. Sediment cores would be collected from different regions of the of the water body and would be analyzed for Cs-137 activity. Water samples from the water body would be collected and analyzed at the water quality laboratory of the Institute to determine the water quality of the water body. Causes of sedimentation as well as water quality deterioration (if any) would be identified and based on the analysis of the results; measures for conservation of the water body would be suggested.

Progress / Present Status

The equipment required to analyze sediment samples could not be installed due to delay in supply of the equipment therefore, the work of sediment cores collection could not be initiated. The instrument has been installed in the last week of August 09 and samples can be analyzed in the month of September 09. Therefore, accordingly field visits will be made to collect the sediment cores and water samples for isotopic and water quality analysis.

Thus, not much progress has been made in the study so far. However, the P.I. is also involved simultaneously in the INCOH sponsored project on Pichhola lake. Under this study following work has been carried out in the last six months.

i) Possible impact of rising global temperature due to global warming on the future evaporation rates from the Pichhola and other lakes of Udaipur regione

ii) Field experiment to assess the impact of presence of water hyacinth on evaporation rates from the lake

iii) Determination of local pan coefficients for estimating lake evaporation from pan data for the Pichhola lake and other lakes of Udaipur region.

The results of these investigations are being finalized and would be presented in the working group meeting.

In view of the difficulty in getting the data on Ropar lake, as well as reduction in the objectives of the study, it was also tried to explore the possibility of conducting studies on Pushkar Lake, Ajmer (as initially planned and proposed in the working group, before shifting the priority to Ropar lake study). Accordingly a visit was made to the lake site at Pushkar, and to concerned departments at Ajmer and Jaipur during June 09. It was observed that the restoration work on the lake has been initiated including desilting, catchment treatment, rejuvenation of channels of inflowing stream etc. So, it was decided not to initiate the study till the restoration works are completed.

In the mean time, requests were received by the HI Division for taking up studies on drying springs of Uttarakhand using isotope techniques. Accordingly, two visits were made to the

Uttarakhand Jalsansthan Office, Dehradun as well as to the catchment area of the Mossy fall and Talligarh spring located in the upper part of the Mussoorie Hills for selecting the sites suitable for sample collection and installation of equipment. Some information and past discharge data including identifying the persons who will help in sample and data collection programme have been sought from the concerned department before proposing the study. The response is still awaited

Expected Date of Completion

The study on Ropar lake was initially proposed for three years, and was supposed to end by March, 2112. However, in view of the revised objectives, it is proposed to complete the study by March, 2010.

ANNEXURE-IV

THE 31ST MEETING OF THE NIH WORKING GROUP

SURFACE WATER HYDROLOGY DIVISION

Progress of Studies & Details of New Studies

NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE – 247667

SWHD-1 | 3 6

1. PROJECT REFERENCE CODE: NIH/SWD/NIH/07-09

Title of the study: Development of Drought Vulnerability Indices for Preparedness and Mitigation

Study group: RP Pandey, Sc E1, & P.I.
A Aggrawal, Sc E2
Sanjay K Jain, Sc E2
Omkar Singh, ScE1

Date of start: July 2006

Duration of the study: July 2006 to March 2009

Funding: MOWR through INCOH

Objectives of the Project:

This research project was taken up with following objectives:

- Identify and characterize the drought indicative parameters – meteorology, hydrology, agriculture and social in realizing drought and preparedness.
- Prepare drought vulnerability scenario under different conditions for macro and micro level physio-graphical units – watershed or district / villages.
- Capacity building in understanding / realizing the preparedness and vulnerability indices.
- Generate guidelines for timely recognition, preparedness planning, vulnerability reduction, and mitigation of drought.

Description of the project activities and completed work

The study was taken up in five sites representing different climatic zones, physio-graphical heterogeneity, cropping systems and socio-economic conditions, etc. were identified in five different districts in the country. Long term rainfall records (monthly and yearly) for the past 50-100 years were collected from various sources/agencies/State Revenue departments/ Institutions etc. Stream flow data has also been obtained for some of the study sites from state Water Resources Departments wherever stream gauges exists. Stream flow data for other sites will also be collected from CWC if available. Ground water level observations were collected from various sources for Sonar, Lanth, Don, Manar and Sarlasagar sub-basin. Observers/field men were placed at project study sites for regular monitoring, observation and survey etc. the sites and liaisoning/links was established with other departments located at study sites for comprehensive data gathering/data monitoring and for keeping precise watch

on the development of water stress and drought conditions in the study areas. Data base preparation and information compilation work for different study sites was completed for hydro-meteorological data and preparation of GIS data base like digitization of maps, preparation of DEM, maps of crop coverage, land use and soil cover etc. Remote Sensing for 27-scenes of (LISS-3 data) were procured from NRSA. Above data was processed and analyzed. The results of hydro-meteorological data analysis and various GIS layers on morphological components have been integrated to device drought vulnerability scenarios in space and time.

Inventories of drought events and physiographic conditions for different study sites were prepared. For example, the topographic conditions and poor groundwater availability in the Sonar-sub basin, inherently cause water shortages during the summer months. During drought years, condition of water shortages aggravates and the region faces severe water stress even in domestic water supply. In spite of the above problems, the pace of water resources development in this region had been inadequate. Severe and prolonged water stress due to deficit of rainfall over the prolonged periods with reference to normal rainfall expectation is considered to describe meteorological droughts in general term.

During previous year (2006-07) the Sonar basin observed delayed onset of monsoon and it has affected the cropping pattern to large extent. To study the effect of delayed monsoon the survey was conducted in Patharia, Batiagarh and Damoh blocks of Damoh district falling in lower catchment area and Kesli block of Sagar district falling in upper catchment of Sonar river basin. Farmers were interviewed to assess their views on planning and strategies to face such circumstances in the study area. The major kharif crops in the region are soyabean, sorghum, black gram and arhar. The majority of farmers have adopted soyabean since decade due to its suitability and high yield in the region. Generally region experiences onset of monsoon in second week of June but this year monsoon was delayed by 3-4 weeks. In Sagar district monsoon started in last week of June and in Damoh district monsoon started in 2nd week of July. In Damoh district monsoon effectively started from 14th July in almost all blocks and the cultivation could be started in 3rd week of July. Similarly, investigations were conducted for other sites too. Drought conditions also prevailing in Mahaboobnagar, district of A.P. during the year 2006 and 2007 and the crops were significantly affected both in kharif and Rabi season. However, in other sites namely, Balangir, Nanded, and Bijapur normal rainfall occurred and no drought conditions were observed in above three sites during past two years. Hydro-meteorological data were analysed Standard Precipitation Index(SPI), Effective Drought Indes (EDI), Decile Index and percent

deviation from normal were applied for identification of droughts. Also relationship of evapotranspiration/precipation (EP/Pa) with SPI, EDI, % normal Pa, Decile Index were developed to examine the applicability of above indices at different sites. Also the classification of above indices was revised for their suitability at our sites. Annual rainfall deviations w.r.t. normal and estimated time series for Standard Precipitation Index are shown below for Mahboobnagar site.

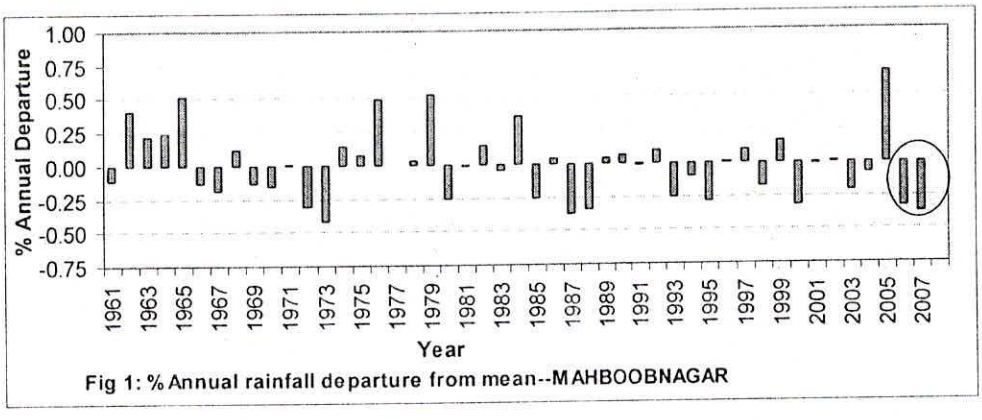


Fig 1: % Annual rainfall departure from mean--MAHBOOBNAGAR

Second year's work started in time. The teams have conducted surveys in June-September 2007. Liss-3 data were analyzed for estimation of NDVI, a scene for above analysis is shown below.

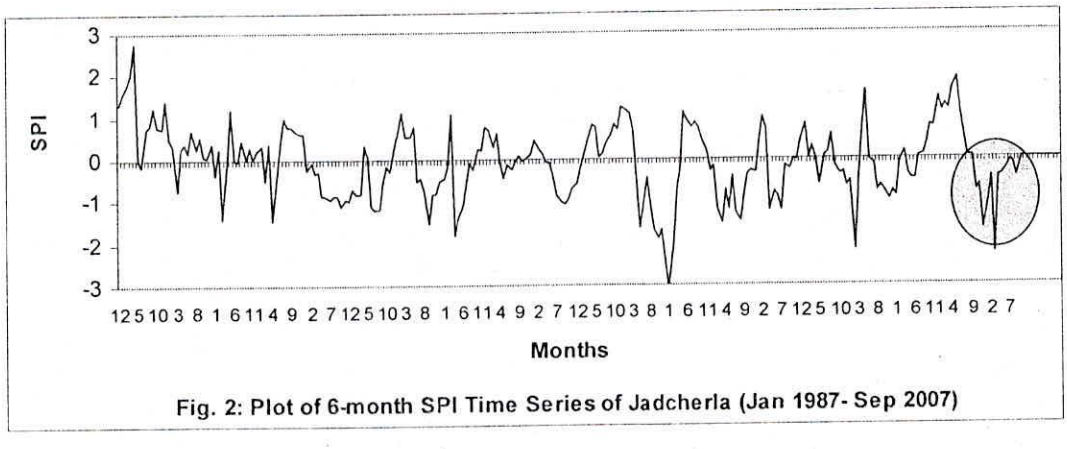


Fig. 2: Plot of 6-month SPI Time Series of Jadcherla (Jan 1987- Sep 2007)

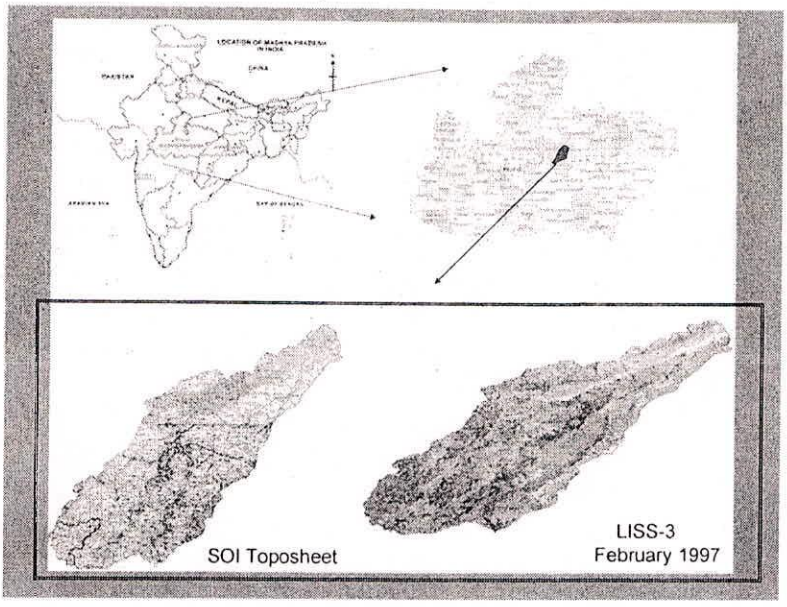


Fig. : One of the study area at Sonar Basin in M.P.

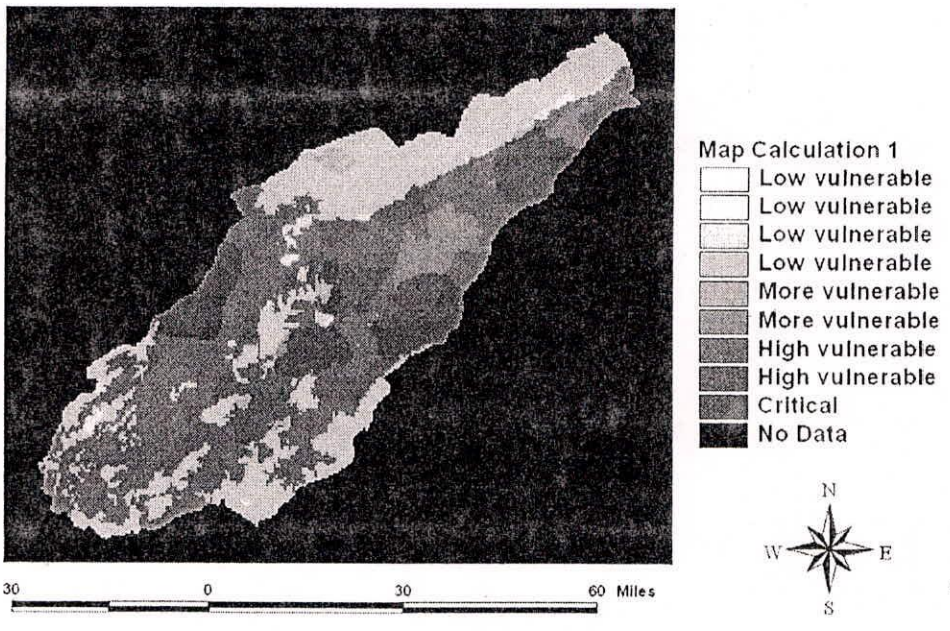


Fig.: Integrated drought vulnerability map for Sonar Basin

The weighted-value vulnerability maps have been prepared for other study sites and an integrated drought vulnerability index has been proposed.

Proposed Integrated drought vulnerability Index (DVI)

$$DVI = \frac{\sum W_i}{kN}$$

Where,

DVI = Drought Vulnerability Index

N = Number of indicators under consideration

wi = Weights of drought vulnerability indicators , *(where, i= 1,2,.....N)*

k = Upper limit of vulnerability weights *(Say, range = 0-k, where, k is highest value of Wi)*

Proposed Classification of DVI

Sl. No	Values of DVI	Vulnerability Class
1	0 - 0.2	Least vulnerable
2	0.2 – 0.4	Moderately vulnerable
3	0.4 – 0.6	vulnerable
4	0.6 – 0.8	severely vulnerable
5	>0.8	Critically vulnerable

The proposed index is validated using physical ground truthing and NDVI estimates. Guidelines for timely recognition of onset of drought, assessment of vulnerability to drought and mitigation options are being incorporated in report. Further, fine tuning of the proposed methodology and report writing are in progress. Complete project work and results have already been presented in the previous working group meeting in March 2009.

On the request of PI at IIT Bombay, MoWR/INCOH has granted extension for submission of final project report by Dec 2009.

2. PROJECT REFERENCE CODE: NIH/SWD/NIH/07-09

Title of the Study: Runoff and Sediment Modelling in a Part of Brahmaputra River Basin using ANN

Study group: Archana Sarkar, Sc C
R D Singh, Director
Nayan Sarma (I.I.T. Roorkee)

Date of Start: April 1, 2007

Duration of the Study: 3 years

If externally funded: In house R&D project

Objectives of the study

- Development of gauge discharge curves at important gauging sites of Brahmaputra River (Indian sites) using ANN
- Development of sediment rating curves at selected gauging sites (Indian sites) of the Brahmaputra river using ANN
- Rainfall runoff and sediment yield modelling in a sub basin of Brahmaputra river basin in India using ANN

Brief methodology

1. Collection of meteorological data (rainfall, temperature, evaporation), hydrological data (discharge, suspended sediment concentration), topographic maps from Survey of India, for the study area.
2. Development of rating curves and ANN models for stage-discharge and sediment-discharge processes at three selected gauging sites of the Brahmaputra river. Comparison of the two techniques.
3. Rainfall runoff modelling for the selected sub basin using back propagation ANN.
4. Development of back propagation ANN models for sediment yield simulation for the sub basin. The input to ANN models will include geomorphological parameters besides meteorological & hydrological data.

Results achieved with progress/present status

- Three important gauging sites of Brahmaputra River, viz, Pandu and Pancharatna, (Indian sites) have been identified for development of Gauge discharge and sediment discharge rating curves using Back propagation ANN models. Daily discharge, stage and suspended sediment concentration data for the three gauging sites has been procured. ANN models for stage-discharge as well as sediment

discharge rating curves have been developed for the sites Pandu and Panchratna. In addition, ANN models for stage-discharge as well as sediment discharge rating curves have been developed for the site Choulduaghat (outlet of Subasiri sub-basin).

- For Runoff simulation in a sub basin of Brahmaputra River in India, Subansiri river basin has been identified. Subansiri is a north bank tributary of Brahmaputra River and it is highly flood prone as well as carries high sediment load for which rainfall-runoff-sediment studies are very important. The drainage map and digital elevation model of this sub basin has been prepared. All other relevant information regarding this sub basin has been collected from literature. Daily and hourly discharge data for the tributary has being procured from CWC office in Guwahati during a field trip during May 2008. Daily rainfall, maximum and minimum temperature data has been procured from IMD in the form of high resolution gridded data. Daily rainfall is available at 0.5 deg grid and daily max, min & mean temperature is available at 1.0 deg grid. Data has been extracted for relevant grid points of Subansiri basin. The structure of ANN models has been identified and the rainfall-runoff ANN models are being trained and validated.
- For sediment yield simulation in a sub basin of Brahmaputra river, back propagation ANN models will be developed for the Subansiri river basin. The input to ANN models will include geomorphological parameters besides meteorological & hydrological data. The structure of ANN models has been identified and the input data is being prepared for training of these ANN models.

Expected date of completion : March 31, 2010.

Quarter-wise Bar chart (2009-10)

Activities	I	II	III	IV
Procurement of high resolution daily rainfall and temperature data from IMD, extraction of data for Subansiri basin and preparation of input data	---------			
ANN model development, training and validation for rainfall-runoff modeling in Subansiri basin		---------		
ANN model development, training and validation for sediment yield modeling in Subansiri basin			---------	
Compilation of results and Report writing				--------

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

Title of the Study: Assessment of Environmental Flow Requirements in River Ganga at Loharinag Pala Project Site

Study group: Manohar Arora Sc 'C'

R. D. Singh, Director

Rakesh Kumar Sc 'F'

Date of start: 01.04.2009

Duration of study: Two Years

If externally funded: No

Objectives of the study:

The objectives of the study are:

- To study the hydrologic flow characteristics of the River Ganga
- To assess environmental flow requirements (EFR) in River Ganga at Loharinag Pala project site

Methodology:

The study was initiated with the aim to determine EFR at Loharinag Pala power project site. In this study for the assessment of EFR two methods will be used. The first one is Flow Duration Curve method. In this methodology Seventeen fixed percentage points are taken for the computation of dependable flows. The flow duration curve plotted using these fixed points is termed as reference flow duration curve. The Six EMCs (Environmental Management Classes) are used in this study and six corresponding default levels of EWR may be defined. It starts with the unmodified and largely natural conditions (rivers in classes A and B), where no or limited modification is present or should be allowed from the management perspective. In moderately modified river ecosytems (Class C rivers), the modifications are such that they generally have not (or will not – form the management perspective) affected the ecosystem integrity. Largely modified ecosystems (Class D rivers) corresponds to considerable modification from the natural state where the sensitive biota is reduced in numbers and extent. Seriously and critically modified ecosystems (Classes E and F) are normally in poor conditions where most of the ecosystem's functions and services are lost. The other method is Tenant's method. This method is based on the computation of MAR. Recently the Institute has been awarded a sponsored project of determining EFR in River Teesta. The EFR will be determined using Holistic method. The habitat modeling will be carried out by CIFRI Kolkata. The hydrological method

will be dealt by the Institute. The methodology will be developed in detail and utilized for determination of EFR of River Teesta.

Expected outcome: The study will be useful to the hydropower companies like NHPC.

4. PROJECT REFERENCE CODE: NIH/SWD/NIH/05-10

Title of study: Integrated Hydrological Study for Sustainable Development of two Hilly Watersheds in Uttaranchal.

Study group: Avinash Agarwal, Sc E2
R.K. Nema, SRA

Date of start: July 2005

Duration of study: 5 Years

Whether externally funded: DST

Objectives of the project:

Department of Science & Technology, Govt. of India, initiated a network of projects on hydrological study of small watersheds, in different agro-ecological regions of the country with following as broad objectives.

- Detailed hydrological monitoring, collection of data at sub-watershed scale and creation of a centralized database for watershed for the benefit of the users
- Rainfall-runoff-sediment yield studies to develop strategies for conservation of soil and water resources
- Delineation of recharge and discharge zones of springs using nuclear techniques
- Water management planning for domestic use and crop production purposes
- Develop linkages with state line departments, local technical NGO's etc.
- To act as a hub for transfer of NRDMS technologies related to watershed management

Study Area

The study area of this project lies in 'Western Himalaya' agro-ecological region of the Sub-humid Ecosystem at elevation of 720 m to 2350 m. Climate in this region is warm with air temperature 3°C to 35°C sub-humid to humid and per-humid with average annual rainfall 900 mm to 1200 mm.

i) Chandrabhaga watershed

The Chandrabhaga watershed is located geographically between 30^0 18' N to 30^0 19' N and 78^0 35' E to and 78^0 36' E, Jakhnidhar block of Tehri-Garhwal district (Uttarakhand). The total area of watershed is 4.34 Km^2. It is Subhumid with

moderate rainfall with annual average of 1200 mm. The springs of Anjanisain flow through deep gorges posing added physical strain for those who draw water.

ii) Danda watershed

The Danda watershed is 4.42 Km^2 is located geographically between 30° 14' N to 30° 16' N and 78° 37' E to 78° 39' E Jakhnidhar block of Tehri-Garhwal district (Uttarakhand). The altitude in this watershed ranges from 780 m to 1700 m above MSL. It is Subhumid with moderate rainfall with annual average of 900 mm.

Brief methodology followed

Watershed management is a continuous process of measurement and implementation of policies. The collection of data is the first step to begin planning for managing natural resources of a watershed. Using an integrated approach of hydrological instrumentation, investigation, remote sensing and GIS, a database of spatial and non-spatial data in two watersheds will be prepared. Appropriate modeling will be done to simulate hydrological behaviors of two watersheds (Chandrabhaga and Danda) and parameters will be established utilizing observed hydrological data.

Results achieved with progress/ past status

(i) Monthly analysis of hydro-metrological data

Regular hydro-metrological data since Jan 99 to Dec 2007 have been compiled specially for weighted rainfall, runoff from v-notch, springs in the watershed and for pan evaporation. The daily data has been converted to monthly, annul and water year basis for plotting, presentation and for different analysis for further requirements.

(ii) Spring flow analysis

The spring flow in the watershed are the major source of available water during the periods of unavailability of rain. Total around forty one numbers of springs are under observation for both the watersheds and daily spring flow discharge is being recorded. As for as possible all the available springs in the watersheds is being considered. The construction of ten daily flow duration curves was done as per the procedure of Institute of Hydrology. The spring behavior was identified considering cumulative mean monthly rainfall values starting from June and cumulative stream flow for the same period.

(iii)Delineation of recharge Zone

The recharge zone of the spring for both the watersheds is identified using nuclear techniques. Under nuclear techniques two type of analysis viz. O_{18} and H_2 are carried out for the water samples collected in both the watersheds for rainfall, V-notch and all the springs under observation in both the watersheds. Similarity of trend for the plots of O_{18} versus H_2 highlights the source of water being same.

(iv) Rainfall-runoff-sediment yield studies

In absence of continuous record of sediment concentration, the sediment- runoff relationship is developed for both the watershed from the data collected during year 99 to 03. Based on the collected data, the relationship of the form of second order polynomial and exponential are developed. The correlation coefficient of the relationships indicates that the polynomial equation is better than exponential equation in present case. Using the developed polynomial relationships, the sediment yield from the watersheds for water years has been estimated.

(v) Water Balance

The daily rainfall, runoff and the pan evaporation data collected from the watershed has been converted to monthly scale. The measured evaporation (ET) has been converted to potential evapotranspiration (PET), the potential evaporation is converted to actual evapotranspiration (AET) and the surplus/deficit by using equation based on method ER, SCS and ER, FAO. A summary of the findings of water balance is reported in table 1.

Table 1: The major findings for the Chandrabhaga and Danda watersheds.

Variables	Chandrabhaga	Danda
Total numbers of effective springs	22 Nos.	21 Nos.
Average spring flow	0.17 l/s	0.22 l/s
Average 10 day flow	Lower	higher
Total volume of water from all springs	24.86 mm	37.93 mm
Average runoff at V notch	189.39 mm	274.40 mm
Average annual rainfall(eight years)	1067 mm	742.8 mm
Average annual rainfall(long term)	1200 mm	900 mm
Water balance	+155 mm	-350 mm

The total amount of availability of water through springs in Danda watershed is greater than Chandrabhaga. The runoff from Danda watershed is higher than Chandrabhaga watershed. The average annual rainfall in Danda watershed is lower than Chandrabhaga. The water deficit for Danda watershed indicated through water balance (Table 1).

(vi) Use of ERDAS and ARC VIEW for modelling.

The Chandrabhaga watershed delineated on 1:25,000 scale and Danda on 1:50,000 in order to construct digital elevation model. The contour layers are drawn and DEM constricted along with automatic drainage system. On trial basis, the satellite imaginary for year 2000 was taken from global land cover facility (glcf.umiacs.umd.edu) and land use classification is done.

Results achieved with progress/ present progress

(i) Data collection and construction of two new river gauge sites.

The existing instrumentation has been modified and updated with following instrumentation as reported below and all the data is being collected automatically. The manual data collection is only for the pan evaporation as a cross checking and for sediment load at four gauging sites during the storms. Unfortunately in the present year the sediment data could not be obtained because of the failure of rain in hills.

Table 2: Instruments working at Chandrabhaga watershed.

GPS No.	Description	GPS Position	Altitude ft	Altitude m
177	ARG Dapoli (Old)	N30 18.636 E78 35.281	4982	1519
178	ARG Saima (New) A1 2042225	N30 18.206 E78 35.082	3945	1202
180	ARG Bainsoli (Old)	N30 18.160 E78 35.442	3737	1139
182	ARG SBMA (Old)	N30 18.705 E78 35.902	4145	1263
183	ARG Mingwali (New) A1 2042226	N30 18.963 E78 35.833	3953	1205
185	ORG Anjanisain (Old)	N30 18.840 E78 35.408	4991	1521
179	V-notch Saima (Old) 2266639	N30 18.147 E78 35.175	3910	1192
181	V-notch Bainsoli (New) 2266640	N30 18.705 E78 35.755	4080	1244
184	AWS Anjanisain (New)	N30 18.892 E78 35.612	4114	1254

The installed AWS collets the information regarding air temperature, humidity, solar radiation, soil temperature, wind velocity, wind thrust. The water mark collects the soil moisture at seven depths and soil temperature at one depth as shown in figure 1. The evaporation recording is done with recorder as well as with water level recorder installed in the pan. Two v-notchs one at Bainsoli and another

at Tayari were constricted and water logger installed for recording. The v-notch site at Rumdhar was renovated for v-notch crest level to have minimum depth of water in weir pond.

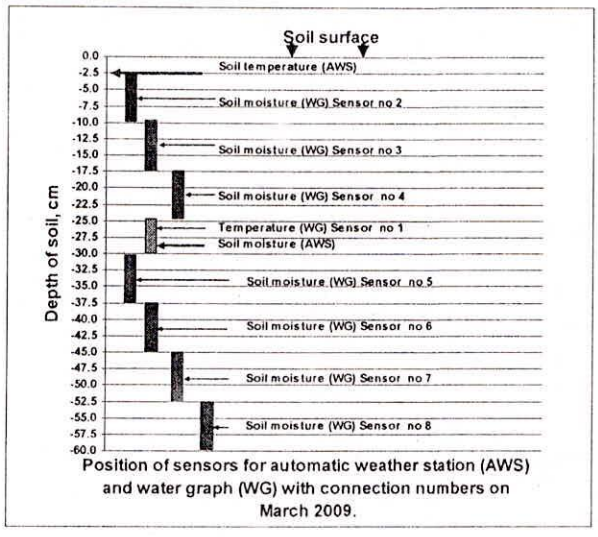


Figure 1: Depths of soil moisture recording.

Table 2: Instruments working at Danda watershed.

GPS No.	Description	GPS Position	Altitude ft	Altitude m
108	ARG Gajeli (Old)	N30 14.144 E78 38.510	3694	1126
163	ARG Danda (New) D1 2267601	N30 14.681 E78 37.447	2517	767
161	ARG Tayari (New) D2 2267602	N30 14.355 E78 37.782	3336	1017
159	ARG Rumdhar (New) D3 2267603	N30 14.511 E78 38.183	3053	931
162	ARG Mingwali (New) D4 2267604	N30 15.036 E78 37.761	3292	1003
109	V-notch Rumdhar (Old) 2266641	N30 14.319 E78 38.206	3312	1009
160	V-notch Tayari (New) 2266642	N30 14.328 E78 37.739	3122	952

(ii) Use of ERDAS and ARC VIEW

With due scanning of the available imaginaries on the site of National Remote Sensing Center, the following imaginaries have been identified and a request for purchase has been mailed to concerned officer.

Description of image	Date	Area
Satellite : IRSP6 Sensor : L4MX Imaging Orbit : 1223 Segment : 2 Strip: 1 Scene: 060	11-Jan-2004	Chandrabhaga Danda
Satellite : IRSP6 Sensor : L4MX Imaging Orbit : 3397 Segment : 2 Strip: 2 Scene: 052	12-Jun-2004	Chandrabhaga Danda
Satellite : IRSP6 Sensor : L4MX Imaging Orbit : 11311 Segment : 2 Strip: 2 Scene: 043	21-Dec-2005	Danda
Satellite : IRSP6 Sensor : L4MX Imaging Orbit : 12547 Segment : 1 Strip: 1 Scene: 066	18-Mar-2006	Chandrabhaga Danda
Satellite : IRSP6 Sensor : L4MX Imaging Orbit : 22294 Segment : 2 Strip: 2 Scene: 043	02-Feb-2008	Chandrabhaga
Satellite : CARTOSAT-1 Path: 530 Row: 258 Mode: STEREO	05-Jan-2007	Chandrabhaga Danda
Satellite : CARTOSAT-1 Path: 529 Row: 258 Mode: STEREO	24-Nov-2007	Chandrabhaga Danda

(iii)Survey of water bodies

A detailed survey for all the water bodies including tanks (percolation, storage) and springs has been carried out and their locations have been identified in the area using GPS, Goggle earth and Arcview. This shape file will be used while running SWAT

(iv)Survey of the area

A detail survey for both the watersheds in respect of population, land holding, springs, tanks and all user point of water with location using GPS is to be indicated in order to find out the specific location of the user and the requirement of the water for population. A performa has been designed and the survey will be done in next two three months. This will help in making water user source map for use in SWAT.

Expected date of completion: June, 2010

Quarterly schedule for year 2009-10

Activity	3rd quarter (O N D)	4th quarter (J F M)	1st quarter (A M J)	2nd quarter (J A S)
Procurement & installation of instruments	Completed			
Field survey & data collection	Manual data collection in respect of sediment sample at four sits will be continued.			
Laboratory analysis	Analysis of sediment samples			
Analysis & modeling	▪ Preparation of GIS data base, model application and results, interpretation of results. ▪ Analysis of spring flow in relation of domestic demands. ▪ Identification of area for increasing infiltration			
Preparation of GIS database	▪ Procurement of satellite imaginary for different years. ▪ Preparation of land use map for the years. ▪ Preparation of house hold water demand maps for use in SWAT. ▪ Application of SWAT model.			
Report preparation	▪ Will be continued			

5. PROJECT REFERENCE CODE: NIH/SWD/NIH/07-10

Title of the study: Hydrological Studies in a Forested Watershed in Uttarakhand

Study Group: J.V. Tyagi, Sc E2

Rakesh Kumar, Sc F

Sri Digamber Singh, Sc B

Date of Start: April, 2007 (Phase II)

Duration of Study: 3 years

Whether externally funded or not: NIH and FTA (Haldwani)

Objectives:

A Sal forested watershed of about 17 ha was selected in Nainital District in consultation with the FTA, Haldwani with the following objectives.

(i) To study the variation of soil moisture storage vis-à-vis the natural regeneration of Sal forest under different canopy densities.

(ii) To study the variation of light intensity and its effect on natural regeneration under various canopy densities.

(iii)To simulate the spatial erosion on the watershed using ANSWERS model and to study the effect of the erosion rates on the natural regeneration.

(iv)To help FTA in carrying out hydrological monitoring of forested watersheds.

Brief methodology:

The soil moisture storage and the light intensity will be monitored on long term basis in experimental plots laid out under different canopy density classes. The natural regeneration in the experimental plots would be monitored through annual surveys and the relationship would be developed between the soil moisture storage, light intensity and the natural regeneration using the long term data. Since the high runoff velocity on steep slopes causes high soil erosion and results into uprooting and washing away of tender seedlings, the spatial distribution of soil erosion would be estimated using ANSWERS model to identify the areas of high erosion and thereby to study the effect of erosion on regeneration. Also, a field estimate of spatial erosion would be made through pegs in the experimental plots.

Progress / Present Status:

Experimental plots of 40mX40m size were demarcated under different canopy density classes of C1, C2 and C3, representing respectively the areas where canopy density had reduced to (0-0.30), (0.30-0.50), and (0.50-0.70). The soil moisture in these plots is being measured at weekly intervals at 0.25, 0.50 and 1 m depths using soil moisture sensors. The observations on light intensity under different canopy densities are being taken at fortnightly interval starting from May 2008. The regeneration survey of Sal species in these experimental plots was conducted in 2004 and was repeated in 2005, 2006, 2007 and 2008. The daily and short interval rainfall is being measured using an ordinary rain gauge (ORG) and a tipping bucket rain gauge respectively. The runoff from the watershed is being monitored with the help of a 'V' notch and stage level recorder. The runoff samples from the storm runoff are collected for analysis of sediment yield from the watershed. Besides above, a number of hydrological investigations (viz., determination of infiltration rate, saturated hydraulic conductivity, soil texture, soil physico-chemical properties, soil moisture characteristic curves) and field surveys viz., topographic survey and plain table survey were carried out. Based on these investigations and surveys, the DEM, slope map, aspect map, drainage map, soil texture map and land use map were prepared. The data collected so far have been analyzed and plotted.

Key Results:

Analysis of soil moisture and regeneration data

Soil moisture observations of different depths were analyzed for weighted soil moisture in experimental plots. The temporal variation of average soil moisture under different canopies was plotted on water year basis (Fig. 1). Based on the regeneration survey, the annual score of regeneration was also computed for individual plots. The annual average score and the incremental score of plot regeneration was then computed for each canopy category (Table 1). The 'dying back phenomenon' was observed from the analysis of regeneration data of 2008 which indicates that data of longer duration was required to derive the relationship between soil moisture and regeneration.

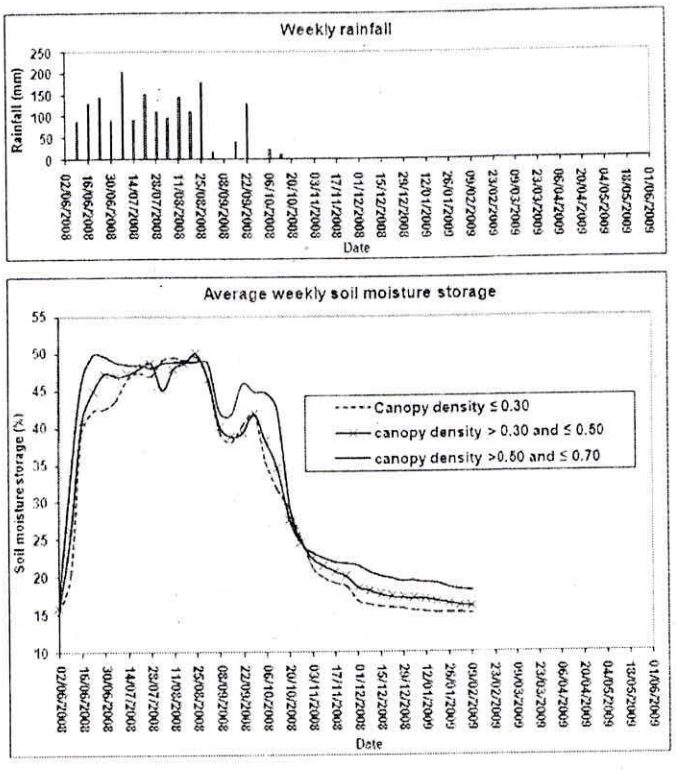


Fig 1: Average soil moisture storage under various canopy densities during 2008-09

Table 1: Year-wise average score and annual incremental score of plot regeneration

Canopy class	Average Score of Plot regeneration (Plot Area = 40X40 m^2)						Annual Average Incremental Score of Plot				
	03-04	04-05	05-06	06-07	07-08	08-09	04-05	05-06	06-07	07-08	08-09
C1	7206	7255	7647	7982	8356	8397	49	392	335	374	41
C2	5727	5758	6319	6450	6880	6912	31	561	131	430	32
C3	3671	3697	4696	4849	4330	4333	26	999	153	-519	3

In order to study the behavior of regeneration in relation to the soil moisture content, the average soil moisture content during October 15 - June 14 at 50 cm depth and the annual incremental score of regeneration was also plotted for different canopy categories (Fig. 2). As can be seen from the plot, the soil moisture is highest in canopy class C3, but the regeneration is lowest. Similarly, the soil moisture in C2 canopy is lowest but the regeneration is higher than the C3. The soil moisture in C1 canopy remains in between C2 and C3 but the regeneration is found highest in this canopy. This indicates that the soil moisture alone is not responsible for differential regeneration of Sal under different canopy densities.

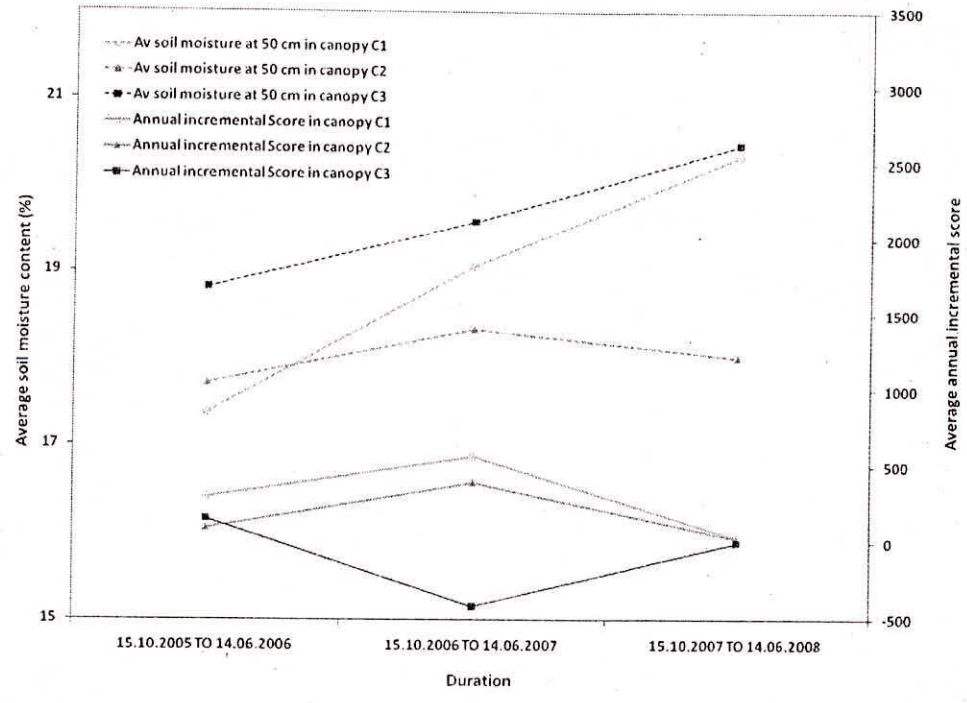


Fig. 2: Year-wise average soil moisture content and annual incremental score of regeneration in different canopies

Analysis of soil erosion

ANSWERS model was used to simulate the discharge and sediment yield at the watershed outlet (Fig. 3) and spatial erosion on the watershed (Fig. 4). The runoff coefficient for rainfall events varied from 0.03 to 0.15. The simulation results show that the soil erosion is higher in areas under C3 (0.5 – 0.7) canopy than those under C1 (up to 0.3) canopy. The high soil erosion in these areas 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.

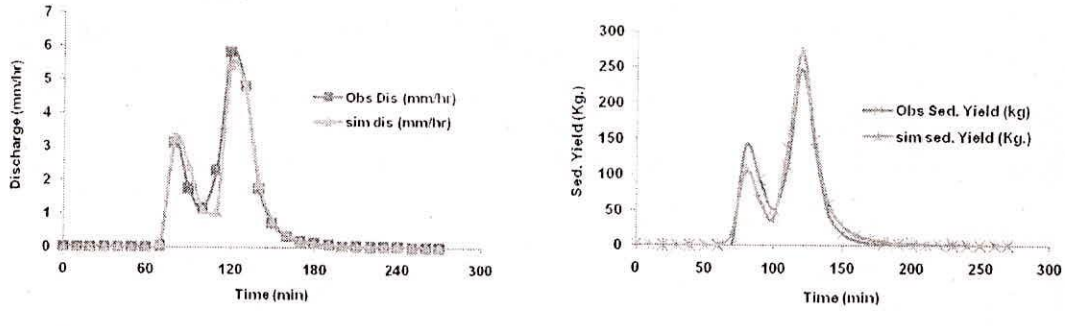


Fig. 3: Simulation of discharge and sediment yield by ANSWERS model

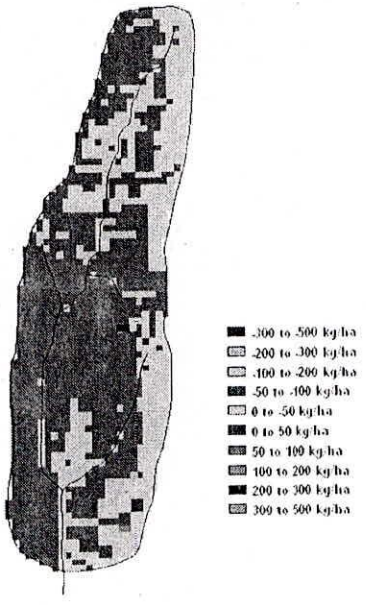


Fig. 4: Simulation of spatial erosion on the study watershed by ANSWERS model

Analysis of light intensity

The available observations on light intensity during the current year show that the incidence of light intensity is highest under C1 canopy and decreases as the canopy gets thicker in C2 and C3 (Fig. 5). The higher incidence of light under C1 canopy probably causes better regeneration in these areas. However, more data is required to establish a relationship between light intensity and regeneration. The data collection would therefore continue in 2009-10.

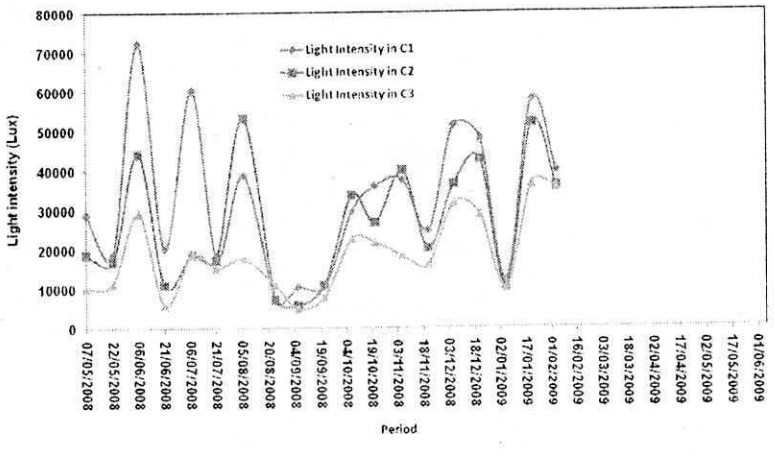


Fig. 5: Temporal variation of light intensity under different canopy densities

Expected date of completion: March, 2010.

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

Title of study:	Snow Melt Runoff Modeling Using Fuzzy Logic
Study group:	A.K. Lohani, Sc 'E1' & PI
	Sanjay Kumar Jain, Sc 'E2', Co-PI
	Rakesh Kumar, Sc 'F' & Co-PI
Date of start:	01.04. 2009
Duration of the study:	Two Years
If externally funded:	No

Objectives of the project:

- To calibrate and validate snow melt model for selected basin.
- To simulate snow melt runoff for the study basin using snowmelt model.
- To investigate the potential of fuzzy rule based system in modelling snow melt runoff.
- To assess performance of fuzzy rule based system relative to snowmelt model.

Introduction

Modeling of streamflow from a basin is based on transformation of incoming precipitation to outgoing streamflow by considering losses to the atmosphere, temporary storage, lag and attenuation. In most part of the world the seasonal short-term variation in streamflow reflects the variation in rainfall. But in higher latitude and altitudes where snowfall is predominant, runoff depends on heat supplied for snowmelt rather than the timing of precipitation. Hence, to understand the hydrological behavior and simulate the streamflow it is very important to model the snowmelt runoff. A hydrological model has been calibrated, validated and applied for simulating the snow melt runoff in the recently completed study entitled "Impact of Climate Change on the Flow Characteristics of Beas River at Pandoh Dam Site". The degree day factor used in the model is based on the only meteorological variable temperature. The hydrological model uses daily values of mean temperature, snow cover area and rainfall as input and computes daily stream flows.

Now a day's soft computing tools are being used to model various hydrological process. The advantage of fuzzy rule based approach is that one need not have a well defined physical relationship for converting an input to an output. In this study fuzzy rule based approach would be applied to simulate snow melt runoff. An attempt will be

made to use the same input data in the fuzzy model as used by the conventional snow melt model. Furthermore, fuzzy models will also be developed with the input vector consisting of temperature, snow cover area, rainfall and other available meteorological variables

Study area

The Beas River is an important river of the Indus River system. The Beas basin up to Pandoh dam is proposed as the focus area of the present study. Beas River originates from the eastern slopes of Rohtang pass of Himalayas at an elevation of 3900 m and flows in nearly north-south direction up to Larji, where it takes a nearly right angle turn and flows towards west up to the Pandoh dam. The catchment of the Beas basin up to Pandoh dam is 5278 km^2 out of which only 780 km^2 is under permanent snow. Mostly the catchment area comprises of precipitous slopes and the rocks are mainly bare. The altitude varies from 832 m near Pandoh to more than 5000 m near Beo-Toibba. A major portion of the catchment lies under degraded forests and cultivated land and therefore the proportion of the silt and sand are of fine, medium and coarse configuration.

Progress/ Present Status

Progress of the data collection, data processing, modeling and analysis is briefly given below:

- The base maps (drainage/contour/DEM) of the study area have been prepared in GIS data base. The DEM has been divided into number of elevation bands. Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data (weekly) for the study area have been obtained from National Snow and Ice Data Center (NSDIC). The snow cover area for the years 2000-2005 have been computed and depletion curved have been prepared. This snow cover area for different elevation bands has been computed with SCA and DEM
- Processed the collected discharge, rainfall and temperature data of the study.
- Statistical analysis of collected data has been carried out.
- A hydrological model for the selected snow covered basin has been calibrated and tested.
- Literature on Fuzzy rule base modeling has been reviewed.
- Development of Fuzzy rule base model for the snowmelt runoff modeling is under progress.

Expected Output/outcome of the study

Major Outcome: The study will provide a fuzzy rule based methodology for modelling snow melt runoff.

Output: The output of the study will be in the form of technical report and research papers.

Expected date of completion: March 2011

Work elements including time scheduling

Task	Apr. 2009-Sep. 2009	Oct. 2009-Mar. 2010	Apr. 2010-Sep. 2010	Oct. 2009-Mar. 2011	Status
Data Collection & Processing					**Completed**
Calibration and validation of hydrological model					**Completed**
Simulation of snow melt runoff using snowmelt model					**Under Progress**
Development of Fuzzy rule based model for snow melt modeling					**Under Progress**
Comparison of Fuzzy rule based model and snowmelt model.					

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

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

Study group: R.P. Pandey, Sc. E1
Ravi V. Galkate, Sc. C
Surjeet Singh, Sc. C
L.N. Thakaral, SRA

Date of start: Dec. 2008

Duration of the study: 4 years

Funding: Internal

Objectives:

The specific objectives of this project are to:

i. Developing inventory of drought events and water resources in the study sub-basin.
ii. Identification of strategic surface and groundwater resources to be used in drought situations.
iii. Study of alternative means for minimizing adverse impacts of droughts.
iv. Characterization of drought based on hydro-meteorological, environmental, and socio-economic aspects in the selected basin(s).
v. Identification of zones vulnerable to drought in the study sub-basin(s).
vi. Devising integrated water management plan for minimizing water stress on crops, human and animal life during drought situation.

Proposed study area:

Tons sub-basins in Madhya Pradesh

Work Plan for the study

Proposed work plan for the project consists of the following steps.

1. Reconnaissance survey, subsequent field visits and liasoning with the concerned departments/offices etc. in the proposed study areas.
2. Collection of maps and topo-sheets plus other documented relevant information for study site/region
3. Establishment field observation points for real-time data monitoring.
4. Collection of long term hydro-meteorological and other relevant data/records.
5. Random sampling and collection/investigation of socio-economic and environmental information.

6. Procurement/collection of meteorological records from IMD and stream flow records from various sources.
7. Procurement of hydro-meteorological equipments and computing appliances for the project.
8. Developing inventory of drought events, their impact and identification of indigenous knowledge (ITKs) on drought mitigation in the study areas.
9. Digitization of maps, toposheets, preparation of maps of drainage, landuse, cropping system, DEM, water availability maps (SW & GW), irrigation maps etc. using GIS.
10. Analysis of meteorological, hydrological data and agricultural records for establishing regional drought indicators/indices.
11. Impact assessment of drought on economy, environmental and social aspects.
12. Preparation of state of art report on drought management along with traditional practices
13. Evaluation of proposed indicators/indices with the past as well as the current information/records and verification of indices and vulnerability criteria.
14. Classification of zones vulnerable to drought and water scarcity (preparation of vulnerability maps and their physical verification with ground truth).
15. Assessment/quantification of existing surface and ground water resources in the study areas.
16. Dry spell analysis and studies of low flow regime.
17. Quantification of prevailing water demands and supplies.
18. Formulation first hand water resources management plan for field execution and its persuasion with local administration/developmental functionaries to minimizing adverse impacts of drought.
19. Near real time field monitoring of drought and application of proposed drought management plan/alternate strategies through state Government/field organizations.
20. Field training for execution officials/stack holders.
21. Monitoring and mid-term evaluations of first hand plan under item 18.
22. Identification of the effective water management practices for drought mitigation.
23. Finalization of comprehensive water resources management plan under drought situation on the regional basis.

Progress of project work:

Second visit to the study area is planned in Sept/Oct. 2009 for field investigations, surveys and data collection. Agencies like CWC and IMD have been contacted to

obtain discharge data and meteorological data respectively. An inventory of water resources in the basin is being prepared and will be brought out as interim report.

Expected date of completion: Dec. 2012

Work schedule

a. Date of Commencement – Dec- 2008
b. Duration of Study - 4 years ;
c. Table: Phase-wise activities for completion of targets *(Milestones)*

Activity (months)→	1 to 6	7 to 12	13 to 18	19 to 24	25 to 30	31 to 36	37 to 42	42 to 48
Procurement & installation of instruments & establishment of field data collection center								
Inventory of Water resources, drought events etc. in the study sites.								
Monitoring of Rainfall, Temperature, Water level, Crop condition, Soil type, Water stress								
Collection of data on: 1. Rainfall, temperature, evaporation, from agencies 2. Water flow information from CWC / state agencies 3. Ground water level from CGWB / state departments. 4. Crop type and area 5. Socio-economic Profile 6. Drought event related information								
Studying events and prevailed conditions								
Data analyses and identification of critical parameters that influences drought situations								
Procurement of satellite data corresponding to drought events – IRS, MetSat, NOAA								
Creation of geo-information base								
Experiments &development of Drought Index								
Development of Warning / Alert System for water management actions								
Reporting / Assessment of progress								
Presentation of –status, achievement								
Final Report Submission								

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

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

Study group: A. R. Senthil kumar Sc E1
Manohar Arora, Sc C
Avinash Agarwal, Sc, E2
D. S. Rathore, Sc E2
Digambar Singh, Sc B

Date of start: 1st April 2009

Duration: 3 YEARS

Sources of funding: NIH funded

Objectives of the study:

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

Brief methodology:

SNOWMOD and SRM

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

ANN model

In many of the ANN applications in water resources only three-layered feed forward structure has been used and can generate arbitrarily complex decision regions. So three layered feed forward structure is selected for the ANN model in this study also. The training of the model is done by back propagation algorithm. The performance of the model is evaluated by coefficient of correlation, root mean squared error, model efficiency and percentage error in peak flow estimation.

The catchment of Sutlej up to Rampur is considered for the analysis.

Results achieved with progress/present status

The required data for the study are available from 1987 to 2000 on daily basis. The data are processed and the gaps are filled by standard procedure. The maximum and minimum temperature, rainfall is available at Kalpa, Kaza, Namagia, Rackchham and Rampur. The snowfall data are available at Kalpa, Kaza, Namagia, Rackchham The

discharge is available at Rampur. The maximum discharge, 2766.4 cumecs was observed on 01-08-2000 during the period of 01-01-1987 to 31-12-2000. The whole data set is divided into two sets for the training and validation purpose of the ANN model. The data from 1991 to 2000 is considered for the training of the model since it contains the extreme value of discharge at Rampur. The data from 1987 to 1990 is considered for the validation of the model. The autocorrelation and partial autocorrelation properties of the discharge series indicate that lag 1 series has significant influence in the discharge at a given time. The cross correlations of maximum and minimum temperature, rainfall, snowfall series of all stations considering one at a time and the time series of discharge suggest the following model for predicting the discharge at Rampur.

$$Q_{ram,t} = f\{R_{ram,t-1}, R_{kal,t-1}, R_{rak,t-1}, R_{kaz,t-1}, R_{nam,t-1}, S_{kal,t-5}, S_{rak,t-4}, S_{kaz,t-4}, S_{nam,t-4}, TMX_{ram,t-5}, TMN_{ram,t-2}, TMX_{kal,t-4}, TMN_{kal,t-2}, TMX_{rak,t-3}, TMN_{rak,t-2}, TMX_{kaz,t}, TMN_{kaz,t}, TMX_{nam,t-3}, TMN_{nam,t-2}, Q_{ram,t-1}\}$$

ANN models with different combinations of input variables have been trained and the performance of best ANN model for each combination is given as below in the tabular form.

Table 1 Calibration and validation results of ANN models

Model No	Input combinations	ANN Sturcutre	Calibration				Validation			
			CORR	EFF	RMSE	Percent error in peak flow estimation	CORR	EFF	RMSE	Percent error in peak flow estimation
1	$R_{ram,t-1}$, $R_{kal,t-1}$, $R_{rak,t-1}$, $R_{kaz,t-1}$, $R_{nam,t-1}$, $S_{kal,t-5}$, $S_{rak,t-4}$, $S_{kaz,t-4}$, $S_{nam,t-4}$, $TMX_{ram,t-5}$, $TMN_{ram,t-2}$, $TMX_{kal,t-4}$, $TMN_{kal,t-2}$, $TMX_{rak,t-3}$, $TMN_{rak,t-2}$, $TMX_{kaz,t}$, $TMN_{kaz,t}$, $TMX_{nam,t-3}$, $TMN_{nam,t-2}$, $Q_{ram,t-1}$	20-10-1	0.99	99.10	30.56	-0.09	0.97	94.73	77.88	4.23
2	$TMX_{ram,t-5}$, $TMN_{ram,t-2}$, $TMX_{kal,t-4}$, $TMN_{kal,t-2}$, $TMX_{rak,t-3}$, $TMN_{rak,t-2}$, $TMX_{kaz,t}$, $TMN_{kaz,t}$, $TMX_{nam,t-3}$, $TMN_{nam,t-2}$, $Q_{ram,t-1}$	11-5-1	0.99	98.56	38.73	-0.79	0.99	97.86	49.56	-0.43
3	$TMX_{ram,t-5}$, $TMX_{kal,t-4}$, $TMX_{rak,t-3}$, $TMX_{kaz,t}$, $TMX_{nam,t-3}$, $Q_{ram,t-1}$	6-7-1	0.99	98.29	42.29	-5.17	0.99	96.88	59.90	-4.79
4	$TMN_{ram,t-2}$, $TMN_{kal,t-2}$, $TMN_{rak,t-2}$, $TMN_{kaz,t}$, $TMN_{nam,t-2}$, $Q_{ram,t-1}$	6-2-1	0.98	97.60	50.02	-53.97	0.99	97.82	50.11	-14.59
5	$R_{ram,t-1}$, $R_{kal,t-1}$, $R_{rak,t-1}$, $R_{kaz,t-1}$, $R_{nam,t-1}$, $TMX_{ram,t-5}$,$TMN_{ram,t-2}$, $TMX_{kal,t-4}$, $TMN_{kal,t-2}$, $TMX_{rak,t-3}$, $TMN_{rak,t-2}$, $TMX_{kaz,t}$, $TMN_{kaz,t}$, $TMX_{nam,t-3}$, $TMN_{nam,t-2}$, $Q_{ram,t-1}$	16-16-1	0.99	99.20	28.87	-0.08	0.97	94.98	75.97	-14.34
6	$S_{kal,t-5}$, $S_{rak,t-4}$, $S_{kaz,t-4}$, $S_{nam,t-4}$, $TMX_{ram,t-5}$, $TMN_{ram,t-2}$, $TMX_{kal,t-4}$, $TMN_{kal,t-2}$, $TMX_{rak,t-3}$, $TMN_{rak,t-2}$, $TMX_{kaz,t}$, $TMN_{kaz,t}$, $TMX_{nam,t-3}$, $TMN_{nam,t-2}$, $Q_{ram,t-1}$	15-15-1	0.99	98.83	34.64	-1.62	0.99	96.91	59.64	-1.63
7	$R_{ram,t-1}$, $R_{kal,t-1}$, $R_{rak,t-1}$, $R_{kaz,t-1}$, $R_{nam,t-1}$, $S_{kal,t-5}$, $S_{rak,t-4}$, $S_{kaz,t-4}$, $S_{nam,t-4}$, $TMX_{ram,t-5}$, $TMN_{ram,t-2}$, $TMX_{kal,t-4}$, $TMN_{kal,t-2}$, $TMX_{rak,t-3}$, $TMN_{rak,t-2}$, $TMX_{kaz,t}$, $TMN_{kaz,t}$, $TMX_{nam,t-3}$, $TMN_{nam,t-2}$,	19-4-1	0.93	85.83	121.60	-27.72	0.91	81.58	145.55	-21.94

From the above table, the model 2 is found to be the best model based on the performance indices during calibration as well as validation of the model. The figures

1 & 2 depict the performance of the best ANN model. The scatter plot for the ANN calibration indicates that the all range of discharge values are simulated fairly well. Whereas the medium and high range values of discharge are slightly deviated from the observed values during the validation of the model.

Expected date of completion: 31 March 2012

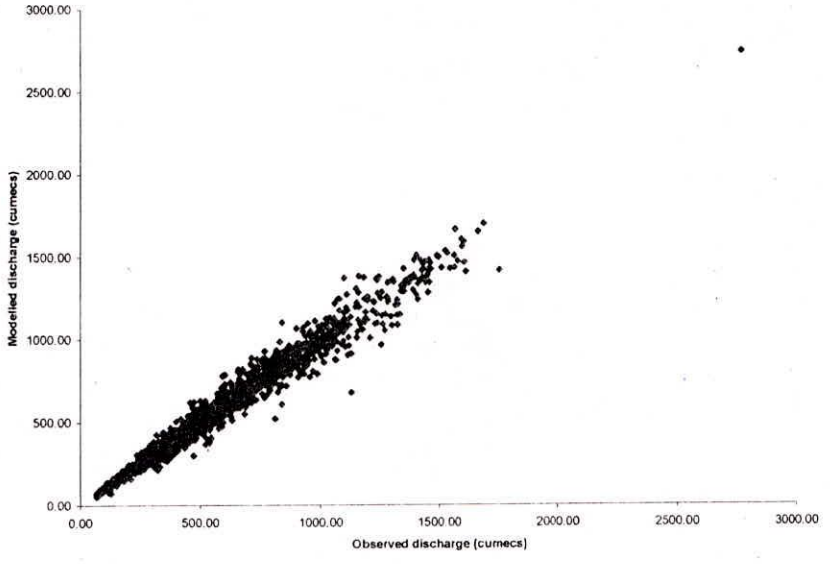


Fig. 1 Scatter plot of observed Vs modelled discharge at Rampur for ANN model during calibration

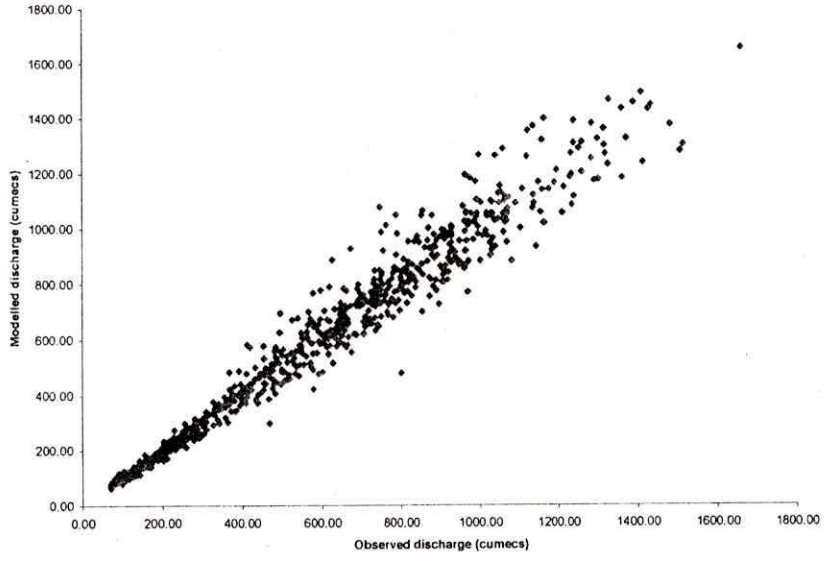


Fig. 2 Scatter plot of observed Vs modelled discharge at Rampur for ANN model during validation

9. PROJECT REFERENCE CODE: NIH/SWD/NIH/08-

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

Study group: Manohar Arora Sc 'B'
Rakesh Kumar Sc 'F'

Date of start: 01.04. 2008

Duration of the study: To be continued

If externally funded: No

Objectives of the project:

The objective of this study includes:

i. Continuous monitoring of meteorological and hydrological data for monthly and seasonal specific water yield and its variability from the year to year
ii. To study the melt water storage and drainage characteristics of the glacier
iii. To improve the hydrological model for simulating daily streamflow

Methodology

The methodology involves collection and analysis of hydro-meteorological and discharge data of the glacier site. The second step is to develop and apply a snow melt model for streamflow generation and identification of different runoff components.

Status

The field investigations were started in the last week of April 2009. The investigations were started with minimum observations as full fledged observations progressed from 28th May 2009 due to General Elections. The cross-section of river channel was determined at the site and observations are made continuously. The observations will be carried till the end of the ablation season i.e. October first week. The Institute has been monitoring the hydro-meteorological parameters during the ablation season using conventional methods. This year the Institute has installed an Automatic Weather Station (AWS) at the Meteorological Observatory near the snout of Gangotri Glacier. The AWS will continuously record the observations of various hydro-meteorological parameters throughout the winter season at desired interval of time. The AWS has the following sensors:

1) Air temperature and relative humidity sensor
2) Baraometric pressure sensor
3) wind speed and direction sensor

4) Albedometer
5) Ultrasonic snow depth
6) Net pyranometer
7) Tipping bucket rain gauge
8) Infra red snow surface temperature sensor

The mathematical modeling of flows has been carried out till year 2007. The same will be carried out including the recent data in the validation. Earlier the precipitation values recorded at Bhojwasa site were used for all the elevation zones. This will be modified using the relation

$$P = P_0 [(1 + \eta(z-z_0)) / (1-\eta(z-z_0))]$$

Where P_0 is the station precipitation, z_0 is the station elevation, and η (km – 1) is a factor defined to vary seasonality.

Expected date of completion: This study will be continued for a longer duration and the data collected will be utilized for the climate change studies.

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

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

Study group: Digambar Singh, Sc B
A. R. Senthil kumar Sc E1
Manohar Arora, Sc C

Date of start: 1st April 2009

Duration: 2 Years

Sources of funding: NIH funded

Objectives of the study:

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

Brief methodology:

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

Status

The entry of the data (temp, rainfall, humidity and wind velocity on hourly bases) in SWDES is under progress.

11. PROJECT REFERENCE CODE: NIH/SWD/NIH/09-10

Title of study: Impact of climatic change on evaporation

Study group: N K Bhatnagar, SRA
Avinash Agarwal, Sc 'E2'

Date of start: 1st October, 2009

Duration of study: One Year

Whether externally funded: NIH (Rs. 675,000)

Objectives of the project:

- Application of heat balance method for estimation of short interval evaporation and Bowen Ratio.
- Study of microenvironment and impacts of climate change on evaporation.
- Study of heat flux in microenvironment during day and night.

Brief methodology:

(i) Estimation of evaporation and Bowen Ratio: Bowen ratio is the ratio of energy fluxes from one medium to another by sensible heat (H) and latent heat LE respectively below as;

$$\beta = H/LE \quad (1)$$

In which H and LE are defined as

$$H = \rho C_p K_h \Delta T / \Delta Z \quad (2)$$

$$L = \rho K_w \Delta q / \Delta Z \quad (3)$$

$$\beta = C_p K_h \Delta T / L K_w \Delta q \quad (4)$$

$$\beta = C_p \Delta T / L \Delta q = C_p (T_1 - T_2) / L (q_1 - q_2) \quad (5)$$

$$LE = H/\beta$$

(ii) Estimation of latent and sensible heat fluxes: Since the calculation of sensible heat flux is difficult, it is the first, the LE is estimated using net radiation measurement and the radiation balance approach below as;

$$R_N = H + LE + H_G \quad (6)$$

$$R_N = (\beta * LE) + LE + H_G \quad (7)$$

$$LE = (R_N - H_G) / (1 + \beta) \quad (8)$$

$$H_G = R_N - LE (1 + \beta) \quad (9)$$

Using Equation 9 the value of H_G can be calculated and the same could also be verified through measurements recorded on the field.

(iii)Estimation of evaporation: Once we have calculated LE, it is easy to calculate the quantity of water evaporated (assuming no water limitation in air and sufficient mixing of air). Recall that LE and the amount of water evaporated are related by the latent heat of vaporization (λV). Specifically, LE divided by λV gives evaporated water, but the LE flux is expressed in Wm^{-2}, and a watt is a joule per second, thus to calculate the quantity of millimeters of evaporation per hour use LE / λV * 3600 seconds per hour. This will result in hourly evaporation and the total evaporation throughout the day and night by summing the values.

(iv) Data requirements: NIH Observatory in respect of air temperature, evaporation, humidity and through instrumentation the wind velocity, pan water temperature, soil moisture at different depths, air temperature and humidity at two different heights.

(v) Instrument required:

- Automatic weather station (1), Water level recorders (2), Air temperature recorders (2)
- Soil moisture sensors with data loggers:(temperatures (4), humidity(2), moisture(5), radiation(1)

Mile stones and expected outcome/ output

- The sensible heat and evaporation (day and night) in relation with the availability of moisture will be two important parameters that will be modeled along with temperature and can be extrapolated for future scenario by down scaling the temperature information and its forecasting for next 25 to 50 years.
- The methodology will be applied to data being collected under DST Project at Chandrabhaga watershed.

Expected date of completion: September, 2010

Quarterly schedule for year 2009-10

Activity	3rd quarter (O N D)	4th quarter (J F M)	1st quarter (A M J)	2nd quarter (J A S)
Procurement & installation of instruments				
Data collection				
Analysis & modeling				
Preparation of report				

ANNEXURE-V

THE 31ST MEETING OF THE NIH WORKING GROUP

WATER RESOURCES SYSTEM DIVISION

Progress of Studies & Details of New Studies

NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE – 247667

1. PROJECT REFERENCE CODE: NIH/WRSD/NIH/08-03/12

Title of the Study:	Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin
Study Group:	Dr. Sanjay K. Jain, Scientist-E2 Dr. Sharad K. Jain, Professor, IIT, Roorkee Dr. Vijay Kumar, Scientist-E1 Dr. Bhism Kumar, Scientist-F Dr. Renoj Theyyan, Scientist-C
Date of Start:	1st April 2008
Duration of the study:	Four years
If externally funded:	Approved as PDS under HP-2, budget Rs. 77.50 Lacs

Objectives:

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

1. To create spatial data (consisting of snow cover area and DEM) and meteorological/hydrological data base for the study area
2. To estimate snow cover area and its temporal variation using remote sensing data.
3. To estimate snow melt runoff in Beas River at Pandoh dam.
4. To study the composition of stable isotopes $\delta^{18}O/\delta D$ in the winter snow, summer rainfall, ice core and melt water and separate snow, rain and glacier melt components in the river flow.
5. To study major ion chemistry (Ca, Mg, K, Na, SO_4, Cl, HCO_3, NO_3,) of winter snow, summer rainfall, ice core and melt water in the river flows.
6. To study trend of precipitation, temperature and stream flow in Beas basin using parametric and non parametric approaches, and
7. To investigate the impact of likely future changes in climate on stream flow in the study area using GCM/RCM based scenarios.

Brief Methodology

The methodology consists of four stages as described below:

Stage1: In this stage, data related to the study area including maps, flow and meteorological data, development works taken place so far and the relevant data in terms of land features, vegetation, land-use etc. will be collected and a database will be created.

Stage-2: For this, snow cover area curves will be prepared from satellite data and then snow cover depletion maps will be prepared.

Stage-3: Stream flow from the basin will be estimated by using the available snowmelt runoff model. The whole basin will be divided into elevation zones. The model will compute daily runoff from the snow covered area and snow free area separately. The model will be calibrated using the dataset and then the results will be validated.

Stage-4: Evaluation of the trend of temperature, rainfall and stream flow in a Himalayan basin. The major objective of the study is to analyze the trend of the above mentioned meteorological variables in the last three decades. Trend analysis will be carried out using linear regression method and non parametric method.

Stage-5: The effect of climate change on runoff will be studied by applying changes in temperature and precipitation to the data from the meteorological stations used in the model. To study the effect of climate change on snowmelt runoff under changed conditions, GCM generated scenarios will be applied.

Results achieved with progress/present status

The base maps (drainage/contour/DEM) of the study area have been prepared in GIS data base. The DEM has been divided into number of elevation bands. The rainfall, temperature and streamflow data have been collected from BBMB, Sundernagar. Trend analysis of rainfall, runoff and temperature is in progress. The snow cover area for the years 2000-2005 have been computed and depletion curved have been prepared. This snow cover area for different elevation bands has been computed with SCA and DEM. The snow cover maps for the years 1990-2000 have been prepared using temperature and snow cover area relationship. The simulation of the stream flow has been carried out. The simulation has been carried out using hypothetical scenarios to see the impact of climate change. The analysis of the results obtained is in progress.

Procurement of satellite data from NRSC, Hyderabad and purchase of instruments are in progress.

Expected date of completion: March, 2012

2. PROJECT REFERENCE CODE: NIH/WRSD/NIH/09-04/12

Title of the Study: Hydrological Assessment of Ungauged Catchments (Small Catchment)

Study Group: Pradeep Kumar Bhunya, Scientist-E1
Rakesh Kumar, Scientist-F
Sharad. K. Jain, Professor, IIT, Roorkee
D.S. Rathore, Scientist-E2
P.C. Nayak, Scientist-C
Niranjan Panigrahy, Scientist-C
Sanjay Kumar, Scientist-C
Suhas Khobragade, Scientist-E1
Director (Hydrology and W.R. Planning-I), Govt. of Orissa

Date of Start: May, 2009

Duration of the Project: Three Years (2009-2012)

If Externally Funded: PDS under HP-II

OBJECTIVES:

1. To calibrate and validate an event based model employing unit hydrograph approach to the available data of flood events for the gauged catchments in the region.
2. To identify few robust flood frequency distributions that may be used for the computation of return period flood for the gauged catchments in the region.
3. To develop regional flood formulae using statistical correlation of the observed peak characteristics with important catchment and storm characteristics, for the estimation of the peak, and time to peak for the ungauged catchments in the region.
4. To develop regional unit hydrograph, and regional flood frequency analysis procedures utilizing the available data and methodologies.
5. To develop methodology for the regionalization of the hydrological parameters for the computation of the water availability for the ungauged catchments in the region.

Brief Methodology

Briefly the following steps are followed for this study:

(i) Carry out the homogeneity tests.

(ii) Regionalize the pdfs parameters used for transmuting the UH using available UH for a region.

(iii) Development of Regional formulae for peak flow and time to peak of UH for the region on the basis of geomorphological characteristics of the basins using new methods like ANN, Fuzzy and non linear regression models.

(iv) Explore the potentiality of new synthetic unit hydrograph methods (gamma, beta, Weibull) and identify the best method for the region.

(v) Regionalization of parameters of the robust AMS model

(vi) Deriving regional formulae

(vii) Regional formulae for q(T) using regression techniques.

(viii) Peak over threshold methods

(ix) Regionalization of flow duration curves using available data.

(x) Uncertainty and risk factor analysis

Results achieved with progress/present status

A. The following regional formulae were developed for the regions to be used in ungauged catchment in the region to estimate peak flood and time to peak for different storms.

(i) Mahanadi subzone 3(d),

B. Parameters of the UH were regionalized using a non linear regression and ANN for hydrograph relationships for use in following the regions.

(i) Mahanadi sub-zone; In addition 10 catchments (not in region) were used for the analysis.

C. Regional flow duration curve were developed for the following regions to estimate the dependable flows for the ungauged catchments:

(i) Mahanadi subzone 3(d),

Maps and imageries: Toposheet: Number of SOI for all the small catchments have been prepared, and indents prepared. Imageries required for the study area have been prepared. In addition to these certain hydrological data from Government of Orissa have been collected along with the recent drawings of the basins.

Future

In future, it is envisaged to add a few more physiographic parameters using remote sensing imageries and GIS, which are sometime difficult to interpret from the Survey of India toposheets or might have changed due to natural and human activities in the region.

CWC has already stipulated design return periods for different schemes depending on their size (small, medium, and large) alongwith the specification for using either PMF or SMF for design flood computation. Therefore, it is envisaged to analyses various distributions and recommends a standard statistical distribution for flood frequency analysis in the region. The theoretical analysis shall include all the recent developments in the topic and the latest available data of the region.

Issues and recommendations for the study area

1. Mahanadai, Rushukulya, and Brahmani catchments in state of Orissa that are included in the study area are fast developing industrial belts. Therefore, there is always a need for engineers to plan water availability, design flood for planning of culverts, bridges, road embankments etc. Such works require estimation of design return period flood, peak floods for different storm, and unit hydrographs of different durations. Most of these parameters are to be computed for flow contribution from small catchments that are ungauged, a standardized procedure of flood estimation, and regional formulae would be very much useful to the field engineers.
2. Government of Orissa is initiating small to medium water harvesting structures and tanks for artificial recharge purpose mainly in southern part (Rushukulya catchment) prone to drought. For design of such structures, water availability studies are pre-requisite. A regional flow duration curve along with empirical regional formulae to estimate mean flow shall assist the field engineers in computing the design parameters for small-ungauged areas. In addition to these design and sanction of small projects in the state, which require design return period flood, unit hydrograph and water availability analysis gets delayed because of lack of data or lack of any standard procedures. Further the existing regional formulae for such design parameter estimation, if exists, need to be updated and standardized with latest available data and methods.
3. Studies so far recommend regional formulae for return period flood, regional parameters of flow duration curves for a selected region.

3. PROJECT REFERENCE CODE: NIH/WRSD/NIH/08-12/12

Title of the Study: Decision Support System (Planning) for Integrated Water Resources Development and Management

Project Team:
Rakesh Kumar
A K Lohani, Scientist-E1
D Chalisgaonkar, Scientist-E1
C P Kumar, Scientist-F
M K Goel, Scientist-E2
Vijay Kumar, Scientist-E1
R P Pandey, Scientist-E1
P K Bhunya, Scientist-E1
Sanjay Kumar, Scientist-C
A Sharma, Scientist-C
N Pannigrahy, Scientist-C
Surjeet Singh, Scientist-C

Funding: Hydrology Project

Objective:

To develop a Decision Support System to support the process of decision making covering (i) Surface water resources planning, (ii) Integrated operation of reservoirs, (iii) Conjunctive use of surface water and ground water resources, (iv) Drought management, and (v) Water quality management in a river basin.

This study will culminate with the development of a comprehensive DSS (Planning) under the Hydrology Project – II.

Progress:

The project commenced on December 1, 2008. NIH has held a series of preparatory workshops to introduce participating states and central agencies to the concept, practicalities and data needs of DSS in preparation for HP-II. The stating point in the DSS development is to undertake a 'need analysis' to define the nature of the water resources issues to be addressed by the DSS. NIH has already taken a preliminary need analysis at one of the workshops, which identified the nature and priority of water resources issues and outputs of each of the five components, i.e. the desired DSS capabilities.

The development of the DSS will begin with development of mathematical models, compilation and integration of existing data sources and development of generic DSS. This generic DSS will be applied to a pilot basin. This will provide opportunities and

developing systems and processes for data compilation, model development and DSS application to other case study basins. Finally DSS will be tested and refined.

Consultants and NIH Scientists visited 9 States and their proposed study areas.They reviewed the data collection activities carried out by the concerned State Agencies and suitability of the basin for considering the Pilot Basin for DSS Planning Project.

The first task of the consultancy is DSS (Planning) Needs Assessment which is completed during the month of June, 2009. After completion of the first task, the consultants have organized a workshop on "DSS need assessment" in order to present the various activities carried out and the findings and recommendations of the first task before the participants from the implementing agencies and invited experts.

Expected Date of Completion: This study is linked with the progress of the Hydrology Project – II.

4. PROJECT REFERENCE CODE: NIH/WRSD/NIH/08-03/10

Title of the Study: Web-based Hydrology and Water Resources Information system for India

Study Group: Deepa Chalisgaonkar, Scientist-E1
D S Rathore, Scientist-E2
S K Jain, Scientist-E2
N Panigrahy , Scientist-C

Date of Start: April 1, 2008

Duration: 2 years

Funding: Internal

Background

Protection and sustainable use of water resources requires spatially and temporally distributed information about the different elements of hydrologic cycle such as precipitation, evaporation, runoff, etc. Further, these elements interact and are influenced by earth features including topography, soil, land use, land cover, and drainage network. Clearly, timely and reliable information on the earth features and hydrologic variables is required for optimal management of water resources. Such information for India, particular the spatial data is lacking and one comes across different data from different sources. Recently GIS has evolved as a powerful data management system to generate and analyze different type of thematic maps that are typically required for hydrological studies. In view of this, a Hydrology and Water Resources Information System (HWRIS) is being developed at National Institute of Hydrology, Roorkee which gives hydrological information including thematic maps about India from national / basin / sub-basin level to provide a common, integrated, and quantitative geo-spatial framework.

Brief methodology

Today internet has been widely accepted as a medium of information exchange. Keeping this in view, the HWRIS is being developed on web platform. The system will have hydrological information about India from nation to sub basin level in the form of tables, figures and thematic maps on various themes and sub themes as shown in table 1. The national / basin /sub basin level information are being obtained from various sources, e.g., atlases, internet etc. Some of the maps are being prepared using GIS software. Since some of the maps are dynamic, the system is being provided with facility to handle time series of maps. In addition, maps showing population density, agro-ecological regions,

water related problems including natural hazards areas, flood affected areas, drought affected states etc. are also being included in the system

The HWRIS will offer a uniform and consistent representation of hydrologic information about India to have one common efficient hydrological information system for the country.

Results achieved with progress/present status:

Web based frame work of the system has been prepared. In this system the hydrology related information of India has been incorporated under various themes covering topography, water facts, river basins, water resources utilization, climate and thematic maps. The information about water policy, constitutional provisions for water use, treaties (international and inter-state), tribunals, and water related information from ancient literature has been provided in the system. The option of e-learning and online ET-computation using commonly used methods has also been included in the system. The maps of Indian river basins have been prepared using GIS tools. The hydrology related information of these basins has been presented in tabular form along with the maps of the basins. Thematic maps of the basins are also being prepared / collected. The subbasin maps of these river basins have also been prepared and have been incorporated in the system. The beta version of the system has been installed on the website of the Institute.

Table 1: Different Themes of HWRIS

Topography	Water Facts	River Basins	Climate	Water Resources Utilization	Thematic Maps
• Overview • States & River	• Water Availability ➢ *Surface water Availability* ➢ *Ground Water Availability* ➢ *Glaciers* ➢ *Lakes* • Total Water Requirements ➢ *Annual Water Requirements* ➢ *Basinwise Water Requirements* ➢ *Statewise Water Requirements* ➢ *Water Use Changing Trends* • Water Budget of India • Water Pricing in India • Financial Aspects of Irrigation	• Area of Inland Drainage in Rajasthan Desert • Brahmaputra & Barak • Brahmani & Baitarni • Cauvery • Ganga • East Flowing Rivers Between Mahanadi and Pennar • East Flowing Rivers Between Pennar and Kanyakumari • Godavari • Indus • Krishna • Mahanadi • Mahi • Minor River Basins Draining in to Bangladesh and Myanmar • Narmada	• Climatic Regions • Rainfall ➢ *Annual Precipitations* ➢ *Summer Monsoon* ➢ *Winter Monsoon* ➢ *Monsoon Onset* ➢ *Western Disturbances* ➢ *Cyclones* • Temperature • Evaporation • Humidity	• Water Resources Projects • Drinking • Irrigation • Hydropower • Industrial Use • Environment Use & Ecology • Interlinking of Rivers • Water Quality ➢ *Water Quality Standards* ➢ *River Water Quality* ➢ *Ground Water Pollution*	• Agroecological Regions • Dams • Landuse Map • Population Density • Rivers • Soil Map • Vegetation • Water Related Problems ➢ *Natural Hazards Areas* ➢ *Flood Affected Areas* ➢ *Drought Affected States* ➢ *Arsenic Affected Areas* ➢ *Fluoride Affected Areas*

	Projects in India	• Pennar • Sabarmati • Subernarekha • West Flowing Rivers of Kuch, Saurashtra including Luni • West Flowing Rivers from Tapi to Tadri • West Flowing Rivers from Tadri to Kanyakumari • Tapi	• Radiation • Wind Direction • Dew Point		

5. PROJECT REFERENCE CODE: NIH/WRSD/NIH/09-03/13

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

Study Group: Sanjay K. Jain, Scientist-E2
Sharad K. Jain, Professor, IIT, Roorkee
Vijay Kumar, Scientist-E1
J.V. Tyagi, Scientist-E2
Rama Mehta, Scientist-C

Date of Start: 1st April 2009

Duration of the Study: 4 Years

If Externally Funded: PDS of BBMB

Objectives

PDS has been taken up by BBMB. They have requested NIH for collaboration in this study. Therefore this study has been proposed under the work program of Water resources Div. BBMB has already informed about the approval of chairman, BBMB for partnership of NIH in the study. The objectives of the study are as follows:

- Collection and development of data for the catchment and the reservoir by latest techniques.
- Analysis of existing sediment data at various locations in the catchments of river Satluj and Beas.
- Soil erosion modelling for both the catchments
- Development of mathematical model for instant study of Sedimentation to assess life of reservoirs.
- Dissemination of knowledge, findings and applications of the developed models to field Engineers through preparation of manual, leaflets & by organizing workshop & seminars.

Brief Methodology:

Creation of database

• Topographical maps of catchments of Satluj and Beas preferably the scale of 1:250000/1:50000 for drainage contour etc.	BBMB
• Conversion of catchments map into Digital map.	NIH
• Landuse map using Remote Sensing data.	NIH
• Soil map of the catchments.	BBMB
• Digital Elevation Model (DEM) of the catchments.	NIH

- Pre – impoundment and the latest observed cross- sections of Bhakra and Pong reservoir etc. — BBMB
- Database comprising of rain-fall, discharge, sediments analysis for various existing sites located in Bhakra & Pong Catchments. — BBMB

Assessment of sedimenation rate

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

Modelling of soil erosion/sediment yield

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

Results achieved with progress/present status

The study was awarded to BBMB under HPII (PDS). NIH is collaborating in this study and this study started in April 2009. As per the project document, in this year sedimentation rate and soil erosion of two catchments have to be carried out. The data of the two study catchments have been collected from BBMB. For procurement of satellite data, fund transfer from BBMB is in progress. In the mean time, ASTER DEM at 30 m resolution has been downloaded from Internet. DEM of the two study area have been prepared. After getting sufficient funds from BBMB for this study, procurement of satellite data from NRSC will be done.

Expected Date of Completion: 31st March 2013

6. PROJECT REFERENCE CODE: NIH/WRSD/NIH/09-03/11

Title of the study: Water table evolution due to subsurface drainage with arbitrary Recharge using a numerical model

Study group: Sushil K. Singh, Scientist-F

Date of start: September 2009

Duration of the study: One and half year

Whether externally funded: No

Objectives:

To obtain the evolution of water table due to subsurface parallel drains using a numerical model and compare the results with those obtained using the analytical solutions proposed by the writer, under different conditions of recharge. The writer's solutions for evolution of water table due to subsurface drains is given in

Singh, S. K., "Generalized analytical solutions for groundwater head in a horizontal aquifer in the presence of subsurface drains." *Journal of Irrigation and Drainage Engineering*, ASCE, 135(3), May/June 2009, 295-02.

Brief methodology:

It intended to use the writer's analytical solutions and a numerical model.

Expected date of completion: 31st March 2011

7. PROJECT REFERENCE CODE: NIH/WRSD/NIH/09-03/12

Title of the Study: Application of a distributed hydrological model for river basin planning and management

Study Group: M. K. Goel, Scientist-E2
Vijay Kumar, Scientist-E1
D. S. Rathore, Scientist-E2
Deepa Chalisgaonkar, Scientist-E1
Rama Mehta, Scientist-C

Start Date: October 01, 2009

Duration: Two and half Years (Up to 31 March 2012)

Whether external funded: Internal -Rs.10.00 Lacs (Rs. Ten Lacs only)

Objectives:

The envisaged objectives of the study are:

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

Methodology:

In this study, it is proposed to use a distributed hydrological model (say, MIKE SHE or SWAT or some other suitable model) at the scale of a river basin for integrated planning and management of surface and ground water resources. It is proposed to apply the model to the Upper Bhima Basin up to Ujjani dam. The detailed database of the basin will be developed for the application of distributed model and the limitations of the availability of data would be assessed in relation to the requirement. Different GIS tools and ancillary sources of data would be used for the generation of distributed database from the point measurements.

In addition, it is also proposed to apply a semi-distributed model for the test basin (say, MIKE BASIN or some other suitable model) so as to compare the relative effectiveness of the two approaches in addressing various water related issues at the basin scale.

Proposed outcome

The study will bring out the advantages and limitations of using a distributed modelling approach for dealing with various water related issues at the scale of a river basin.

8. PROJECT REFERENCE CODE: NIH/WRSD/NIH/09-03/11

Title	-	GIS based hydrological Information System
Project Team	-	D. S. Rathore Deepa Chalisgaonkar R.P. Pandey
Start Date	-	October 01, 2009
Project Duration	-	1 year 06 months
Financial Req.	-	Rs.22.00 Lakhs (Rs. Twenty two Lakh only)
Funding	-	Internal

Objectives:

The envisaged objectives of the study are:

1. To publish dam database on web using GIS server.
2. To study drought indices at district level and publish on the web.

Data

The attributes and locations of dams and diversions are available as personal geodatabase of MS Access. Salient features of 603 dams, diversions, canal drop hydropower stations were entered. Salient features are based on reports, books, and web sites of the state water resources departments. Most of the storage and area value in the database are design values. From atlases, index maps, books etc. the locations of dams and diversions, river and basins in India are digitized. The map contains locations of nearly 1812 dams and diversions. Administrative database will be obtained from Survey of India.

Methodology

The dams and diversion database will be published on web using Arc GIS Server software. The river, basins layers will also be published. The salient features will be displayed as map tip or in tabular form. Query will also be developed. It will be possible to navigate the map and select layers for display using the check boxes.

Rainfall data in raster or tabular form will be collected. From the extracted time series of the rainfall data, the drought indices (such as Standardised Precipitation Index) will be estimated. The indices will be populated in the attribute database of the administrative thematic map (e.g. district). From this map, a drought index thematic map will be generated. The attribute will be displayed as map tip. It will be possible to navigate the map and select layers for display using the check boxes.

Proposed Outcome:

A GIS based hydrological information system will be developed for dams database, drought indices and miscellaneous thematic maps.

Expected Date of Completion: 31st March, 2011