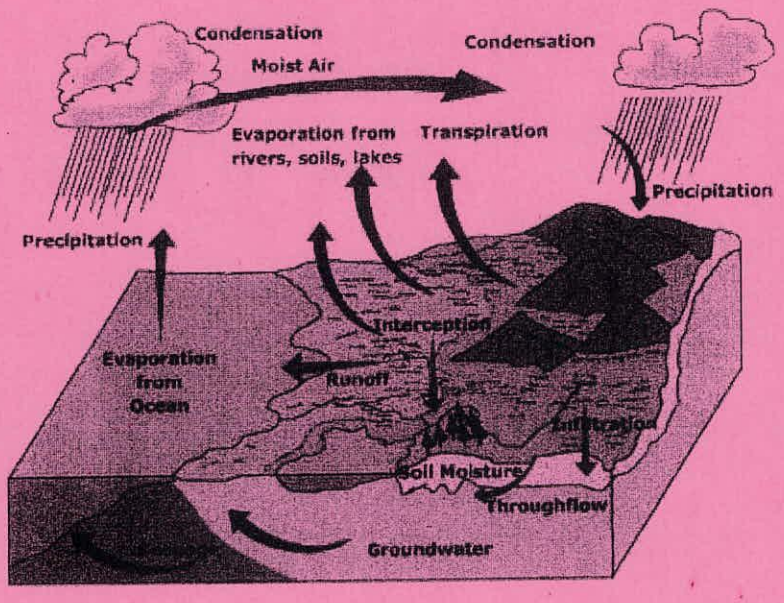
AGENDA AND AGENDA NOTES FOR THE 34th MEETING OF THE WORKING GROUP OF NIH

APRIL 7-8, 2011
AT 1100 HRS.



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NATIONAL INSTITUTE OF HYDROLOGY

ROORKEE-247667

AGENDA AND AGENDA NOTES FOR THE 34th MEETING OF THE WORKING GROUP OF NIH

AGENDA ITEMS

ITEM NO. 34.1 **OPENING REMARKS BY THE CHAIRMAN**

ITEM NO. 34.2 **Confirmation of the minutes of 33rd meeting of the Working Group**

The 33rd meeting of the Working Group was held during October 7-8, 2010. The minutes of the meeting were circulated to all the members and invitees vide letter No. NIH/GWD/WG/10 dated November 12, 2010. No comments were received on the circulated minutes. A copy of the minutes of the 33rd Working Group is given in **Annexure A.**

The Working Group may please confirm the minutes.

ITEM NO. 34.3: **Action taken on the decisions/recommendations of the previous Working Group meeting**

During the 33rd Working Group meeting, following recommendations/ suggestions had been made by the Working Group members. The actions taken on the recommendations/ suggestions are as follows:

Item	Recommendations/suggestions	Action Taken
Under item no. 33.1	Prof. P K Garg suggested that urban storm runoff management, reuse of wastewater, wastewater and water quality management could be taken up by NIH during the 12th Plan.	Suggestions are noted.
	Sri C Ravivarma opined that salinewater ingress and intrusion problems in the coastal aquifers should be studied.	Suggestions are noted.
	Dr V V S Gurunadharao stressed the need of undertaking research for urban storm water management and climate change impacts.	NIH is already pursuing number of studies on climate change issues.
	Sri A K Bhatia suggested few studies related to recharge of groundwater and evaluation of their effectiveness for different hydro-geological settings and groundwater quality for deeper aquifers.	Suggestions are noted.

	Dr S P Agarwal advocated for NIH taking up the lead in developing hydrologic models exclusively for India.	Suggestions are noted.
	Dr M M Kimothi opined that NIH should play a larger role to help the State of Uttarakhand in resolving its challenging water resources issues.	Suggestions are noted.

ITEM NO. 34.4: Presentation and discussion on the status and progress of the work programme for the year 2010-2011.

The approved Work Programme of the Five Divisions of the Institute for the year 2010-11 has been given in the **Annexure B** 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 division-wise work programme has been categorized in three groups: (a) Internally funded studies, (b) Sponsored studies, and (c) Purpose Driven Studies under HP-II. The numbers of projects being handled by each division under different categories are given below:

Division	**Completed**		**Ongoing**		**Total**
	Internally funded	Sponsored (including HP-II)	Internally funded	Sponsored (including HP-II)	
Environmental Hydrology	03	01	02	01	**07**
Ground Water Hydrology	0	01	02	01	**04**
Hydrologic Investigation	0	0	03	07	**10**
Surface Water Hydrology	02	01	07	0	**10**
Water Resources System	03	0	03	04	**10**
Total	**08**	**03**	**17**	**13**	**41**

During the present meeting, Division-wise progress and status of the work programme for the year 2010-11 shall be presented in detail. The Working Group may please consider the progress and status of the Work Programme for the year 2010-2011.

ITEM NO. 34.5: Presentation and finalization of the work programme for the year 2011-2012.

The Division-wise work programme proposed for the year 2011-12 is given in **Annexure B** (last section of each Division) 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
6. Research Coordination & Management Unit (RCMU)

Division-wise studies have been grouped under two broad categories- (1) New studies and (2) Ongoing studies. For each category, the studies are grouped as either internally funded study or sponsored study, as given below:

Division	**New**		**Ongoing**		**Total**
	Internally funded	Sponsored (including HP-II)	Internally funded	Sponsored (including HP-II)	
Environmental Hydrology	01	0	02	01	**04**
Ground Water Hydrology	02	0	02	01	**05**
Hydrologic Investigation	02	0	03	07	**12**
Surface Water Hydrology	0	0	07	0	**07**
Water Resources System	0	0	03	04	**07**
RCMU	01	0	0	0	**01**
Total	**06**	**0**	**17**	**13**	**36**

The Working Group may please consider the proposed Work Programme of the Divisions for the year 2011-2012.

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

ANNEXURE – A

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

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

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

ITEM NO. 33.1: OPENING REMARKS BY THE CHAIRMAN

Dr. Bhishm Kumar, Chairman, WG welcomed the Working Group members and Scientists of the Institute present in the meeting. The Chairman informed about the working group meeting and its importance. He stressed the need of guidance of the members to achieve the goal of the meeting. While giving a brief on the various ongoing technical and research activities of the Institute, he informed that since implementation of the 'Consultancy and Technical services' in the month of February, 2010, the Institute has received a number consultancy projects. He, however, expressed that main focus of the Institute will be towards R & D activities and about 20% of time will only be devoted for consultancy services. The Chairman, WG explained the important role being played by the Institute in carrying out the various activities of the World Bank funded HP-II. The activities include: development and implementation of DSS (P) for integrated water resources development and management, undertaking and carrying out Purpose Driven Studies (PDS), organizing a number of training programs, etc. Thereafter, the Chairman requested the Working Group members to give their general observations, suggestions and remarks on the scientific activities of the Institute. The responses of some of the members were as follows:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

On 7th October,

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

On 8th October,

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

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

During the meeting the status of the work programme for the year 2010-'11 for each study was discussed division-wise in detailed. The Chairman requested the Heads of the Division to make the presentation, and also advised that while presenting the progress, each P.I should stick to the objectives of the study and progress made and results obtained in last six months.

The details of the division-wise presentation and suggestions/ comments emerged from the discussion are given in the **Annexure-II.**

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

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

(1) Climate variability analysis and its impact on Himalayan watershed in Uttarakhand by Water Resources Division,

(2) Hydrological studies of Jhamarkorta Mines, Udaipur, Rajasthan by Hydrological Investigations Division,

(3) Impact of Kumbha Mela 2010 in water quality of surface water and groundwater resources in and around Hardwar city by Environmental Hydrology Division.

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

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

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

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

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

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ANNEXURE-I

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

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

SCIENTISTS FROM NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE

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

ANNEXURE - B

ENVIRONMENTAL HYDROLOGY DIVISION

WORK PROGRAMME FOR THE YEAR 2010-2011

S.No.	Title of the Project/Study	Study Team	Duration	Page#
1	Assessment of Ground Water Quality in 25 Class I Cities of India – Phase II (Chandigarh, Panjim, Gandhinagar, Shrinagar, Ranchi, Thiruvananthapuram, Imphal, Pondicherry, Kavaratti, Daman, Silvassa, Ratlam, Bilaspur)	**Dr. V.K. Choubey; Sc. F** Dr. M.K. Sharma, Sc. C	2 years	13
2	Modelling of Pesticide Transport in Ground Water – a case study of Metropolitan City – Vadodara	**Dr. M.K. Sharma, Sc. C** Dr. V.K. Choubey; Sc. F Dr. A.K. Keshari, Assoc. Professor (IIT-D)	3 years	16
3	Impact of sewage effluent on drinking water sources of Shimla city and suggesting ameliorative measures	**Dr. V.K. Choubey; Sc. F** Dr. R.P. Pandey, Sc. E1 Shri Omkar Singh, Sc. E1 Shri D.G. Durbude, Sc. C Dr. M.K. Sharma, Sc. C Dr. Rajesh Singh, Sc. B	3 years	24
4	Environmental Flow Requirement of a River: A case study of Hemavathi River	**Mr. Dilip G. Durbude, Sc. C** Dr. V.K. Choubey, Sc. F Mr. Omkar Singh, Sc. E1 Dr. M.K. Sharma, Sc. C	3 years	28
5	Impact of Kumbha Mela 2010 on water quality of surface water and ground water resources in and around Hardwar City	**Dr. V K Choubey, Sc. 'F'** Dr. M K Sharma, Scientist' C' Sh. Omkar Singh, Sc.' E1' Sh. D.G. Durbude, Sc. ' C'	1 years	19
6	Spatial Variability of Ground Water Quality in Kandi, Sirowal and Shiwalik Belts of Jammu Region, J&K (India)	**Sh. Omkar Singh, Sc.' E1'** Dr. V K Choubey, Sc. 'F' Sh. D.G. Durbude, Sc. ' C' Dr. M K Sharma, Scientist' C'	1 year	21

WORK PROGRAMME FOR THE YEAR 2011-2012

S.No.	Title of the Project/Study	Study Team	Duration	Page#
1	Impact of sewage effluent on drinking water sources of Shimla city and suggesting ameliorative measures	**Dr. V.K. Choubey; Sc. F** Dr. R.P. Pandey, Sc. E1 Shri Omkar Singh, Sc. E1 Shri D.G. Durbude, Sc. C Dr. M.K. Sharma, Sc. C Dr. Rajesh Singh, Sc. B	3 years	24
2	Environmental Flow Requirement of a River: A case study of Hemavathi River	**Mr. Dilip G. Durbude, Sc. C** Dr. V.K. Choubey, Sc. F Mr. Omkar Singh, Sc. E1 Dr. M.K. Sharma, Sc. C	3 years	28
3	Spatial Variability of Ground Water Quality in Kandi, Sirowal and Shiwalik Belts of Jammu Region, J&K (India)	**Sh. Omkar Singh, Sc.' E1'** Dr. V K Choubey, Sc. 'F' Sh. D.G. Durbude, Sc. ' C' Dr. M K Sharma, Scientist' C'	1 Year (Extn. upto 30.9.2011)	21
		NEW PROPOSAL		
4.	Development of low cost media for fluoride removal from drinking water of fluoride affected areas.	**Dr. Rajesh Singh, Sc. "B",** Dr. V. K. Choubey, Sc. 'F' Shri Omkar Singh, Sc. 'E1 Dr. M.K. Sharma, Sc. 'C'	2 Year (w.e.f. 1.4.2011)	31

ENVIRONMENTAL HYDROLOGY DIVISION

Study No. 1 (Completed)

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

2. Name of PI & Co-PI:

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

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

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

5. Scheduled date of completion: 31.3.2011

6. Study objectives:

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

7. Statement of the problem:

The ground water quality of urban areas of the country is mainly affected by domestic and sewage waste produced by the increasing population of the country and industrial effluent generated by different industrial activities. Therefore regular monitoring of ground water sources is essential to see the effect of these on their quality.

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

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

relationships will be developed and water types will be identified. Spatial distribution map will be prepared in the form of contour diagrams to identify degraded water quality zones. Suitability of ground water for irrigation purpose will be assessed on the basis of total soluble salts, SAR, RSC and boron content. Classification of water will be made using Piper trilinear diagram, Durov plots, Chadha's diagram,U S Salinity Laboratory Classification and Gupta Classification.

9. Timeline and justification for time over runs: The expected date of completion of the above study is 31.3.2011.

10. Objectives vis-à-vis achievements:

Objectives	Achievements
i) To examine the suitability of ground water for various designated uses ii) To identify degraded water quality zones and possible sources of pollution and specific parameters not conforming to water quality standards	Out of 25 Class I Cities, 12 Class I Cities were covered during 2009-10 and progress with results has been presented in earlier working group. Remaining 13 Class I Cities were to be covered during 2010-11. **34th Working Group Meeting** • Second round of sampling (Post -monsoon) from the twelve class - I cities has been completed (30 samples from each city, Total number of Samples - 330). • Physico-chemical and bacteriological analysis of Post-monsoon sampling completed. • Digestion/concentration of the samples (Post-monsoon) for metal analysis is in progress. • Metal analysis of Pre-monsoon sampling completed. • Metal analysis of Post-monsoon sampling completed. • Processing of data is under progress as per BIS standards for the first round of sampling. • Pesticide analysis is in progress.

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

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

- Data for pre- and post-monsoon seasons processed as per BIS and WHO standards to examine the suitability of ground water for drinking purpose.
- Ionic relationships developed and water types identified.
- Spatial distribution map is being prepared in the form of contour diagrams to identify degraded water quality zones.

- Suitability of ground water for irrigation purpose assessed on the basis of total soluble salts, SAR, RSC and boron content.
- Classification of water is under progress using Piper trilinear diagram, Durov plots, Chadha's diagram,U S Salinity Laboratory Classification and Gupta Classification.

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

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

15. Major items of equipment procured: None

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

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

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

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

20. Shortcomings/difficulties, if any: Class I City Shrinagar could not be covered due to security reason. The matter has been discussed with CPCB and CPCB has agreed to suggest another class I City in place of Shrinagar. A letter in this regard is being sent to CPCB.

21. Future plan: Nil

Study No. 2 (Completed)

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

2. Name of PI & Co-PI:

- M K Sharma, Scientist' C', National Institute of Hydrology, Roorkee (PI)
- V K Choubey, Scientist 'F', National Institute of Hydrology, Roorkee (Co-PI)
- A.K. Keshari, Professor, Indian Institute of Technology, New Delhi

3. Type of study: Internal

4. Date of start: October 2007

5. Scheduled date of completion: 31.3.2011

6. Study objectives:

- 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

7. Statement of the problem:

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.

8. Approved Action Plan:

Quarter-wise Work Programme for the Year 2007-2011

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
2007-08	-	-	Field visit & Data collection	Field visit & Data collection
2008-09	Field visit, Sampling & Analysis	Field visit, Sampling & Analysis	Field visit, Sampling & Analysis	Field visit, Sampling & Analysis
2009-10	Field visit, Sampling & Analysis	Field visit, Sampling & Analysis	Processing and Analysis of Data, Modelling	Processing and Analysis of Data, Modelling
2010-11	Processing and Analysis of Data, Modelling	Processing and Analysis of Data, Modelling	Writing of the Report	Writing of the Report

9. Timeline and justification for time over runs: The expected date of completion of the above study is 31.3.2011.

10. Objectives vis-à-vis achievements:

Objectives	Achievements
• To develop a contaminant source identication model from point source • To study and characterize the contaminant (pesticide) migration pattern in the ground water in space and time for prediction purposes	• Contaminant sources were identified and reported in the earlier working group. • For Ground water flow modeling in saturated zone, Model MODFLOW was calibrated using the field data of vadodara city and for contaminant transport modeling, the test run of model MT3D was carried out and reported in the earlier working group. **34th Working Group Meeting** o Calibrated Model MODFLOW was further tried to improve using the field data of vadodara city and for contaminant transport modeling, MT3D was run for pesticide concentration for future projections along space & time for a period upto 50 years.

11. Recommendations/Suggestions in previous meetings of WG/TAC/GB along with action taken: Dr Gurunadha Rao suggested to input the realistic ground water pumping well abstraction to refine the result of the model MODFLOW

12. Analysis and Results:

Model MODFLOW was input the realistic ground water pumping well abstraction to refine the result of the model MODFLOW and for contaminant transport modeling, MT3D was run for pesticide concentration for future projections along space & time for a period upto 50 years and found that model is giving good result.

13. Adopters of the results of the study & their feedback: The study was conceived in collaboration of Gujarat Water Resources Development Corporation, Gandhinagar (Gujrat) and the report will be submitted to the said agency.

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

15. Major items of equipment procured: MODFLOW MT3D Software was purchased.

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

17. Data procured and/or generated during study: Baseline data of ground water Quality of Vadodara city

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

(pesticide) migration pattern in the ground water in space and time for prediction purposes will helpful for policy makers and stake holder

19. Specific linkages with institutions and/or end-user/beneficiaries: Gujarat Water Resources Development Corporation, Gandhinagar (Gujrat)

20. Shortcomings/difficulties, if any: None

21. Future plan:

- Contaminant transport modeling in other part of the country based on gained experience from this study
- Publish research papers

Study No. 5 (Completed)

1. Title of the Study: Impact of Kumbha Mela 2010 on water quality of surface water and ground water resources in and around Hardwar City

2. Name of PI & Co-PI:

- Dr V K Choubey, Scientist 'F', National Institute of Hydrology, Roorkee (PI)
- Dr M K Sharma, Scientist' C', National Institute of Hydrology, Roorkee (Co-PI)
- Sh. Omkar Singh, Scientist.'E1', National Institute of Hydrology, Roorkee (Co-PI)
- Sh. D.G. Durbude, Scientist. 'C', National Institute of Hydrology, Roorkee (Co-PI)

3. Type of study: Internal

4. Date of start: January, 2010

5. Scheduled date of completion: 31.3.2011

6. Study objectives:

i) To assess the adverse impact of Kumbha mela activities during January – June 2010.

ii) To examine the suitability of surface water and ground water resources in and around Hardwar City for various designated uses.

7. Statement of the problem:

To bathe in the Ganga is a lifelong ambition for Hindus and they congregate in incredible numbers for the Sangam, Sagar Mela and Kumbh Mela festivals. Recently Kumbh mela 2010 was celebrated at Haridwar and on this occasion, nine main snan (Bathe) were held. To assess the adverse impact of Kumbha mela activities on the quality of river Ganga and ground water in and around Haridwar city during January – June 2010, this study was conceived.

8. Approved Action Plan:

- Identification of sampling sites in the river Ganga and ground water sources in and around Hardwar City being extensively used for drinking purpose.
- Sampling of surface water (River Ganga) at different locations and ground water sources at fortnight interval of time till June 2010.
- 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 sets will be processed as per BIS and WHO standards to examine the suitability of river water and ground water for drinking purpose. Suitability of river water for irrigation purpose will be assessed on the basis of total soluble salts, SAR, RSC.

9. Timeline and justification for time over runs: The expected date of completion of the above study is 31.3.2011.

10. Objectives vis-à-vis achievements:

Objectives	Achievements
i) To assess the adverse impact of Kumbha mela activities during January – June 2010. ii) To examine the suitability of surface water and ground water resources in and around Hardwar City for various designated uses	• Sampling of surface water (River Ganga) at 11 different locations and 7 ground water sources at fortnight interval of time from January to June 2010 was carried out (In all 11 sampling) and the collected samples were analysed for Physico-chemical parameters, Bacteriological parameters and metal concentrations. The result of the study has already been presented in previous working group. **34th Working Group Meeting** • One more sampling was carried out in the month of Januray 2011 for creating base line data to compare the result obtained. • The collected samples were analysed for Physico-chemical parameters, Bacteriological parameters and metal concentrations.

11. Recommendations/Suggestions in previous meetings of WG/TAC/GB along with action taken: One more sampling was suggested to be carried out for creating base line data to compare the result obtained. One more sampling in the month of January 2011 was carried out.

12. Analysis and Results:
The results of the analysis of samples collected in January 2011 was compared with previous sampling data, no significant difference was observed in the quality of river Ganga

13. Adopters of the results of the study & their feedback: Central and State government agencies working on river Ganga

14. List of deliverables: The deliverables of this study would be final report.
15. Major items of equipment procured: None
16. Lab facilities used during the study: Water Quality Laboratory

17. Data procured and/or generated during study: Water Quality of river Ganga and ground water in and around Haridwar city was generated

18. Study Benefits/ Impact: Impact of Kumbh Mela-2010 on surface and ground water quality of Hardwar

19. Specific linkages with institutions and/or end-user/beneficiaries: Central and State government agencies working on river Ganga

20. Shortcomings/difficulties, if any: None

21. Future plan: Nil

Study No. 6 (Completed)

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

2. Name of PI & Co-PI:

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

3. Type of study: Internal

4. Date of start: 1.4.2010

5. Scheduled date of completion: 31.3.2011

6. Study objectives:

a) Spatial variability analysis of groundwater quality in the study area
b) Hydro-chemical classification of ground water quality parameters and their prioritization for regular monitoring in the study area
c) Suggestion for improvement of water quality monitoring network on the basis of spatial variability analysis in the study area

7. Statement of the problem:

The information on the spatial variability of groundwater quality is useful for proper planning and management of groundwater resources. The knowledge of spatial variability of ground water quality is also essential for making reliable ground water quality interpretations and for making accurate predictions of ground water quality at any particular location in the aquifer. The study area of Jammu, Kathua and Udhampur Districts is subjected to a lot of increasing pressure of anthropogenic activities viz., industrialization and intensive agricultural and horticultural activities. These activities are posing a great risk of ground water quality deterioration. The spatial distribution of ground water quality and appropriate monitoring network is very essential for ground water quality management. Therefore, in the present study, it is proposed to study spatial variability of ground water quality in a part of Jammu Region representing Sirowal, Kandi and Siwalik areas of Jammu, Kathua and Udhampur Districts.

8. Action Plan:

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

9. Timeline and justification for time over runs: The expected date of completion of the reports was 31.3.2011. The extension is requested for six months for completion and final submission of the report.

10. Objectives vis-à-vis achievements:

Objectives	Achievements
a)	• Review of literature • Spatial variability analysis (semi-variogram) of existing ground water quality data of the study area for different parameters viz., pH, EC, total hardness, alkalinity, chloride, nitrate, sulphate, calcium, magnesium, sodium, potassium, phosphate, etc. has been completed. • Interaction was made with CGWB, Regional Office, Jammu for providing additional ground water quality data of the study area for improvement of the analysis.
b)	• Hydro-chemical classification of ground water quality parameters and their prioritization for regular monitoring in the study area is in progress
c)	• To be suggested based on final findings of the variogram analysis of ground water quality data

11. Recommendations/Suggestions in previous meetings of WG/TAC/GB along with action taken: While proposing the study, the working group advised to initially carry out the present study for Jammu Region keeping in view the availability of ground water quality data. The suggestions are duly taken care of and the study has been confined to Kandi, Terai and Siwalik areas of Jammu Region.

12. Analysis and Results:

In the present study, spatial variability analysis of ground water quality would be carried out on the basis of similar hydro-geological conditions in the study area such as for Kandi belt, Terai (sirowal) and Shiwalik parts of Jammu region. The ground water quality data monitored by NIH and CGWB would be used for spatial variability analysis using GEO-EAS (Geo-Environmental Assessment Software, USEPA, 1991)/ Surfer (Golden Software Inc). The prioritization of ground water quality parameters would be carried out for managing ground water quality and long term monitoring of dominant water quality parameters in the study area using Principal Component Analysis. The Hydrochemical facies of ground water quality data would be prepared using GWW software).

13. Adopters of the results of the study & their feedback: The present study is an internal study. In this study, it was conceived to perform spatial variability analysis of ground water quality & levels for suggesting improvement in existing ground water quality monitoring network and prioritization of ground water quality for regular monitoring. The adopters of this study could be Central/State/NGO's working in the study area.

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

15. Major items of equipment procured: Nil

16. Lab facilities used during the study: Nil

17. Data procured and/or generated during study: The ground water quality data of previous investigations as carried out by the Western Himalayan Regional Centre of NIH, Jammu has been proceed as per need of the study. The procurement/collection of recent years ground water quality data of Central Ground Water Board, Jammu is in progress.
of the study area is under process from

18. Study Benefits/ Impact:

Measurable indicators	Achievements
Spatial variability analysis of ground water quality/maps	In progress
Prioritization & classification of ground water quality	In progress

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

20. Shortcomings/difficulties, if any: Nil

21. Future plan:

- Visit to CGWB, Jammu and WHRC, Jammu for recent and additional data for the study. In this connection, interactions are made with the CGWB, Jammu.
- The analysis of variogram, preparation of contour maps of ground water quality and report writing.

Study-3 (On-going)

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

2. **Study Group:**
   - V K Choubey, Scientist 'F', National Institute of Hydrology, Roorkee (PI)
   - Dr. R.P. Pandey, Scientist 'E1, National Institute of Hydrology, Roorkee (Co-PI)
   - Shri Omkar Singh, Scientist 'E1, National Institute of Hydrology, Roorkee (Co-PI)
   - Shri D.G. Durbude, Scientist 'C', National Institute of Hydrology, Roorkee (Co-PI)
   - M K Sharma, Scientist' C', National Institute of Hydrology, Roorkee (Co-PI)
   - Dr. Rajesh Singh, Scientist 'B', National Institute of Hydrology, Roorkee (Co-PI)
   - I & PHE Dept., Shimla (H.P.)
   - NICD, New Delhi

3. **Type of Study**: Sponsored

4. **Date of start:** 1.4.2009

5. **Scheduled date of completion:** 31.3.2012

6. **Study Objectives:**
   - Analysis of Eco-hydrological, water quality and basin characteristics of Shimla town. Assessment of water quality variable in drinking water sources and sewage effluent.
   - Analysis of pollutant 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.

7. **Statement of problem:**
   - Himachal Pradesh is one of the States which is included in the HP Phase II.
   - Mass levels Jaundice have been reported due to influx of pollutants/bacteria in the drinking water in Shimla Town during 2007.
   - After discussions with the officials of Himachal Pradesh, it is found that the assessment of impact of sewage effluent on drinking water sources of Shimla city is the real problem and needs to be assessed scientifically.

8. **Approved action Plan:**
   - Analysis of hydro-meteorological and basin characteristics of Shimla City using SWDES and ERDAS/ILWIS.
   - Assessment of water quality parameters in drinking water sources and sewage effluent.

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

9. Timeline:

Major Activities	1st year	2nd year	3rd year
Data collection			
Literature survey			
Staff appointment			
Purchase of equipment			
Field survey			
Generation of Maps, RS & GIS Applications			
Analysis & Interpretation of WQ data			
Sewage Network, Pollution transport mechanisms and impact assessment			
Preparation of Interim report			
Training/Workshop			
Preparation of Final Report			

10. Achievements

Objective	Achievement
Analysis of eco-hydrology, Hydro-meteorology and basin characteristics of study area	Digital Elevation Model (DEM) of study area generated. Watershed Characteristics are evaluated for problematic area of Shimla City lying under Yamuna basin. R.S. Data of Shimla was collected and under process.
Analysis of water quality parameters in drinking water sources and sewage effluent of study area	Water quality data analyzed for various physico-chemical & bacteriological parameters (pH, EC, TDS, hardness, HCO3, Cl, SO4, NO3, PO4, F, Na, K, Ca, Mg, BOD, COD, total coliform, faecal colliform, etc.).
Source Identification of sewerage effluent	Digitization/Preparation of Sewer Network

influx into drinking water	map of Study Area (Sanjauli - Maliana Zone). Relevant data of manhole and conduit network of study area (Sanjauli - Maliana Zone) was processed Test Run for the given data (Sanjauli - Maliana Zone) of Bentley SewerCAD software was performed to understand the functioning of Sewer CAD Eight Manholes are over flooded in Sanjaul-Malayana Zone during test run.
Dissemination of knowledge	Three days Training course on "Water quality and its management" was organised during 28 June-1 July., 2010 at HIPA, Shimla" for field engineers.

12. Recommendation in previous meetings and action taken:

Dr. V.V.S. Gurunadha Rao (NGRI) inquired about the bacteriological contamination of water in the study area.	Bacterial analysis of water samples is already carried out.

13. Analysis and Results:

- Four Sites were identified where water is contaminated
- Digital Elevation Model (DEM) of study area generated
- Watershed Characteristics completed.
- Test Run for the given data (Sanjauli - Maliana Zone) of Bentley SewerCAD software was performed to understand the functioning of Sewer CAD
- Eight Manhole are over flooded in Sanjaul-Malayana Zone during test run

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

15. Deliverables:

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

16. Equipment Procured/under process

a. Digital water quality instruments (pH, EC, Turbidity meter, Laminar Airflow Cabinet),
b. Hydro-meteorological (TBRG),
c. SewerCAD

17. **Laboratory facilities used**
    a. Water quality laboratory
    b. Remote Sensing laboratory

18. **Data procured and generated**
    a. RS data from IRS-P6 LISS III
    b. Sewer network of Sanjauli-Malyana and Dhali zone
    c. SOI Toposheet of Shimla city
    d. Drainage map of Yamuna City
    e. DEM of Shimla city

19. **Study Benefits:**

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

20. **Specific linkage with Institution/end user/ beneficiaries:**
    I & PHE Dept., Shimla (H.P.)

21. **Shortcomings:** Availability of desired data of the study area.

22. **Future Plan:**
    - Field investigation and analysis
    - Refinement of results of sewerCAD by incorporating the remaining data
    - Training Program
    - Public awareness

Study-4 (on-going)

1. **Title of the Study:** Environmental Flow Requirement: A case study of Hemavathi River

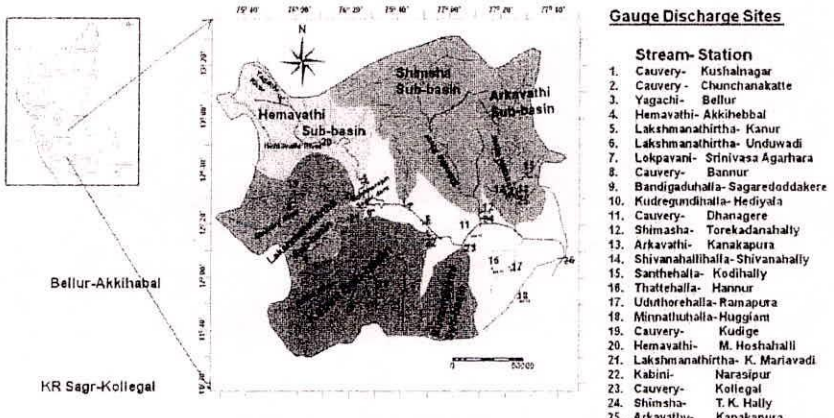
2. **Study Group: :**
   - D.G. Durbude, Scientist 'C', National Institute of Hydrology, Roorkee (PI)
   - V K Choubey, Scientist 'F', National Institute of Hydrology, Roorkee (Co-PI)
   - Omkar Singh, Scientist 'E1, National Institute of Hydrology, Roorkee (Co-PI)
   - M K Sharma, Scientist' C', National Institute of Hydrology, Roorkee (Co-PI)

3. **Type of Study**: Internal

4. **Date of start:** 1.10.2009

5. **Scheduled date of completion:** 30.9.2012

6. **Location map**



Location of CAUVERY SUB-BASINS

Gauge Discharge Sites

	Stream- Station
1.	Cauvery- Kushalnagar
2.	Cauvery - Chunchanakatte
3.	Yagachi- Bellur
4.	Hemavathi- Akkihebbal
5.	Lakshmanathirtha- Kanur
6.	Lakshmanathirtha- Unduwadi
7.	Lokpavani- Srinivasa Agarhara
8.	Cauvery- Bannur
9.	Bandigaduhalla- Sagaredoddakere
10.	Kudregundihalla- Hediyala
11.	Cauvery- Dhanagere
12.	Shimasha- Torekadanahally
13.	Arkavathi- Kanakapura
14.	Shivanahallihalla- Shivanahally
15.	Santhehalla- Kodihally
16.	Thattehalla- Hannur
17.	Uduthorehalla- Ramapura
18.	Minnathuhalla- Huggiant
19.	Cauvery- Kudige
20.	Hemavathi- M. Hoshahalli
21.	Lakshmanathirtha- K. Mariavadi
22.	Kabini- Narasipur
23.	Cauvery- Kollegal
24.	Shimsha- T. K. Hally
25.	Arkavathy- Kanakapura
26.	Cauvery- Biligundlu

7. **Study Objectives:**
   - To review the present status of environmental flow assessment 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.

8. **Statement of problem:**

Harnessing the hydropower potential to mitigate the power demand, there is a need to develop river flow diversion type hydropower projects. These activities will, however have adverse impact on the fluvial ecosystem. To maintain the health, function and integrity of the river ecosystem through protection of aquatic organism dwelling in these fluvial ecosystems, an appropriate estimate of environmental flow is required.

9. **Approved action Plan:**

- An appropriate method would be selected for EFR analysis based on a critical review of the existing literature on EFR methodologies.
- 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.

10. **Timeline:**

Major Activities	1st year	2nd year	3rd year
Literature survey			
Secondary Data collection			
Field survey			
Procurement of Stream Flow Data			
Generation of Maps, RS & GIS Applications			
Sampling, Analysis & Interpretation of WQ data			
Preparation of Interim report			
Preparation of Final Report			

11. **The objective and achievement during last six months**

Objectives	Achievements
Secondary data collection	The Cauvery basin location map, toposheets, stream gauging details of Cauvery basin, etc.
Procurement of stream flow data	The stream-flow data procured from Water Resources Development Organisation, Bangalore at various gauging stations such as Yagachi@Belur, Hemavathi@Hadige, Hemavathi@Akkihebal,Cauvery@Kollegal located in Cauvery Basin.
Analysis of stream flow data	The stream flow data at selected gauging stations was analysed using the Hydrological Index method such as Modified Tenant method, EMC FDC method, etc.
Preparation of interim report	The report is under preparation
Field visit	The field visit is planned in the month of March 2011 for field data collection to analyse the biotic environment, such as aquatic life, hydrological characteristics of the basin.

12. **Recommendation:** In the last working group, the members of working group suggested to analyse the daily stream flow data characteristics. Accordingly, the daily stream flow

data of Kollegal gauging station was analysed for its magnitude and variation. This shows that the river is perennial.

13. Analysis and Results:

- The two reaches on river Cauvery are selected where the power generation/water resources projects may created in future.
- The location map of the selected river reaches are prepared
- The stream-flow data procured from Water Resources Development Organisation, Bangalore at various gauging stations such as Yagachi@Belur, Hemavathi@Hadige, Hemavathi@Akkihebal, Cauvery@Kollegal located in Cauvery Basin.
- The stream flow data along with other ancillary data for the selected river reach were digitised/computerised for further analysed for its basic statistics.
- The stream flow data at selected gauging stations was analysed using various EFA methodologies such as Hydrological Index method, and desktop approaches.
- The interim report is under preparation
- The field visit is planned in the month of March 2011 for field data collection to analyse the biotic environment, such as aquatic life, hydrological characteristics of the basin.

14. Adopters of the results of the study: Karnataka Power Corporation Limited/Karnataka State Govt., State Irrigation Dept. of Karnataka.

15. Deliverables:

Status report for EFA methodology
Estimation of Environmental Flow Requirement

16. Data Procured and Generated:

- Stream flow data for various gauging stations such as Yagachi@Belur, Hemavathi@Hadige, Hemavathi@Akkihebal, Cauvery@Kollegal located in Cauvery Basin.
- Drainage map of Cauvery basin, Flow duration curves

17. Study Benefits:

Measurable indicators	Achievements
The percentage of Mean Annual Flow to be maintained as an environmental flow	

18. Specific linkage with Institutions and/or end-users/ beneficiaries: Karnataka Power Corporation Limited/Karnataka State Govt., State Irrigation Dept. of Karnataka.

19. Shortcomings: Nil

20. Future Plan:

1. Field visit for field data collection to analyse the biotic environment, such as aquatic life, hydrological characteristics of the basin.
2. Stream flow data analysis using Environmental Management Class-Flow Duration Curve (EMC-FDC) approach

Study – 7 (New Proposal)

1. **Title of the Study:** Development of low cost media for fluoride removal from drinking water of fluoride affected areas.

2. **Study Group:**
   - Dr. Rajesh Singh, Scientist 'B', National Institute of Hydrology, Roorkee (PI)
   - Dr. V K Choubey, Scientist 'F', National Institute of Hydrology, Roorkee (Co-PI)
   - Shri Omkar Singh, Scientist 'E1, National Institute of Hydrology, Roorkee (Co-PI)
   - M K Sharma, Scientist' C', National Institute of Hydrology, Roorkee (Co-PI)

3. **Type of Study**: Internal

4. **Nature of Study:** Technology Development

5. **Date of start:** 1.4.2011

6. **Scheduled date of completion:** 31.3.2013

7. **Study Objectives:**
   - Development of low cost media for removal of fluoride from drinking water.
   - Establishing the mechanism involved in removal of fluoride.
   - Establishing the capacity of media for fluoride removal.

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

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

10. **Methodology**
    a. Media will be synthesized from fly ash and red soil.
    b. Characterization of media will be done by SEM, TEM, XRD and wet analysis.
    c. Sorption study will be done in CSTR to find out sorption mechanism and kinetics of sorption.
    d. Column study will be done for application in field scale.
    e. The developed low cost material will be tested in the actual field condition.

11. **Timeline:**

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

13. **Deliverables:**
    - Paper
    - Report

14. **Proposed measurable indicator**
    - Solution of identified problem.
    - New product

15. **Technology transfer possibilities**
    - Yes

16. **Involvement of end users/beneficiaries:** Local people

17. **Specific linkage with Institution and /or other NGOs**: Under identification with the problematic area authorities

18. **Major items of equipment needed:** WQ Lab facilities of NIH

GROUNDWATER HYDROLOGY DIVISION

WORK PROGRAMME FOR THE YEAR 2010-2011

S.No & Reference Code	Title	Study Team	Duration	Page#
1. NIH/GWD/NIH/09-11	Study of Rising Ground Water Table in Jodhpur City, and to Evlove a Management Plan to contain the Rising Trend	N.C. Ghosh (PI) C.P. Kumar Sudhir Kumar Anupma Sharma Surjeet Singh Rajan Vatsa	1yr 6m (9/09-3/11)	35
2. NIH/GWD/NIH/09-12	Impact of Climate Change on Dynamic Groundwater System in a Drought Prone Area	Surjeet Singh (PI) C.P. Kumar Anupma Sharma Rajan Vatsa	3 years (4/09-3/12)	37
3. NIH/GWD/NIH/10-12	Quantification of Impact of Rainwater Harvesting on Ground water Availability in Aravalli Hills – Part II: Mathematical Modelling	Anupama Sharma (PI) C.P. Kumar N.C. Ghosh Sudhir Kumar Rajan Vatsa Shobha Ram Sanjay Mittal	2 Years (4/10-3/12)	40
4. NIH/GWD/HP-II/10-12	Coastal Groundwater Dynamics and Management in the Saurashtra Region , Gujarat	N.C. Ghosh (Co-ordinator) Anupma Sharma (PI) C.P. Kumar A.D. Gohil C.K. Jain Sudhir Kumar D.S. Rathore Surjeet Singh Rajan Vatsa	2 yrs 8m (26/10-31/12)	43

WORK PROGRAMME FOR THE YEAR 2011-2012

S.No & Reference Code	Title	Study Team	Duration	Page#
1. NIH/GWD/NIH/09-12	Impact of Climate Change on Dynamic Groundwater System in a Drought Prone Area	Surjeet Singh (PI) C.P. Kumar Anupma Sharma Rajan Vatsa	3 years (4/09-3/12)	37
2. NIH/GWD/NIH/10-12	Quantification of Impact of Rainwater Harvesting on Ground water Availability in Aravalli Hills – Part II: Mathematical Modelling	Anupama Sharma (PI) C.P. Kumar N.C. Ghosh Sudhir Kumar Rajan Vatsa Shobha Ram Sanjay Mittal	2 Years (4/10-3/12)	40
3. NIH/GWD/HP-II/10-12	Coastal Groundwater Dynamics and Management in the Saurashtra Region , Gujarat	N.C. Ghosh (Co-ordinator) Anupma Sharma (PI) C.P. Kumar A.D. Gohil C.K. Jain Sudhir Kumar D.S. Rathore Surjeet Singh Rajan Vatsa	2 yr 8m (26/10-31/12)	43
NEW PROPOSAL				
4. NIH/GWD/NIH/11-14/1	Ground water Flouride Contamination in Different Parts of India and Study Severity of Fluorosis in a Drought Prone Area	A.K. Dwivedi (PI) Shobha Ram N.C. Ghosh Anupma Sharma Sumant Kumar Sanjay Mittal Ramchandra	3 years (2011-2014)	48
5. NIH/GWD/NIH/11-14/2	Management of Aquifer Recharge (MAR) and Aquifer Storage Recovery (SAR)	Sumant Kumar (PI) Rajan Vatsa N.C. Ghosh C.P. Kumar	3 years (4/11-3/14)	52

GROUND WATER HYDROLOGY DIVISION

PROJECT REFERENCE CODE: NIH/GWD/NIH/09-11

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 Team	: N. C. Ghosh (PI); C. P. Kumar; Sudhir Kumar; Anupma Sharma; Surjeet Singh; Rajan Vatsa
Supporting staffs	: Dr. Shobha Ram, Sanjay Mittal; Dinesh Kumar; Saravanan; Vikrant Singh
Consultant	: Prof. (Retd.) G. C. Mishra
Funding Agency	:Sponsored (Ground Water Department, Govt. of Rajasthan)
Project cost	: 24.52 lacs
Project Duration	: 1 year 6 months from September, 2009
Date of completion	: March, 2011.

Objectives:

- Identification of causes of rising ground water levels in Jodhpur city.
- 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.

Progress:

The work related to terms of reference of the project nearly in completion stage. Some work related modeling and aquifer responses for different stress conditions to develop scenarios are in progress. It has been planned to work out feasibility of sub-surface drainage system to drain the accumulated water from the city area to the suitable location away from the city and thereafter pumping /draining out the water for appropriate usages.

The analyses and investigations envisaged in the study are:

(i) Detailed description of the problematic and the study area,

(ii) Geological formations and aquifer characterization,

(iii) Hydro-meteorological data and analysis,

(iv) Demography and water requirement,

(v) stage-area-capacity data of the Kailana-Takhatsagar reservoir,

(vi) Inflow-outflow data analysis of the Kailana-Takhatsagar reservoir,

(vii) Groundwater data analysis,

(viii) Sewerage and city's drainage data analysis,

(ix) Water balance of the study area,

(x) Aquifer parameters estimation,

(xi) Groundwater quality data and analysis,

(xii) Discritization of the study area, and input data for groundwater modeling,

(xiii) Modeling scenario for different remedial options,

(xiv) Remedial options and groundwater management plan.

Out of the fourteen work elements, all elements except the last two have been completed; and write up is in progress simultaneously. We have the commitment to submit the final report by 31st March, 2011.

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

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

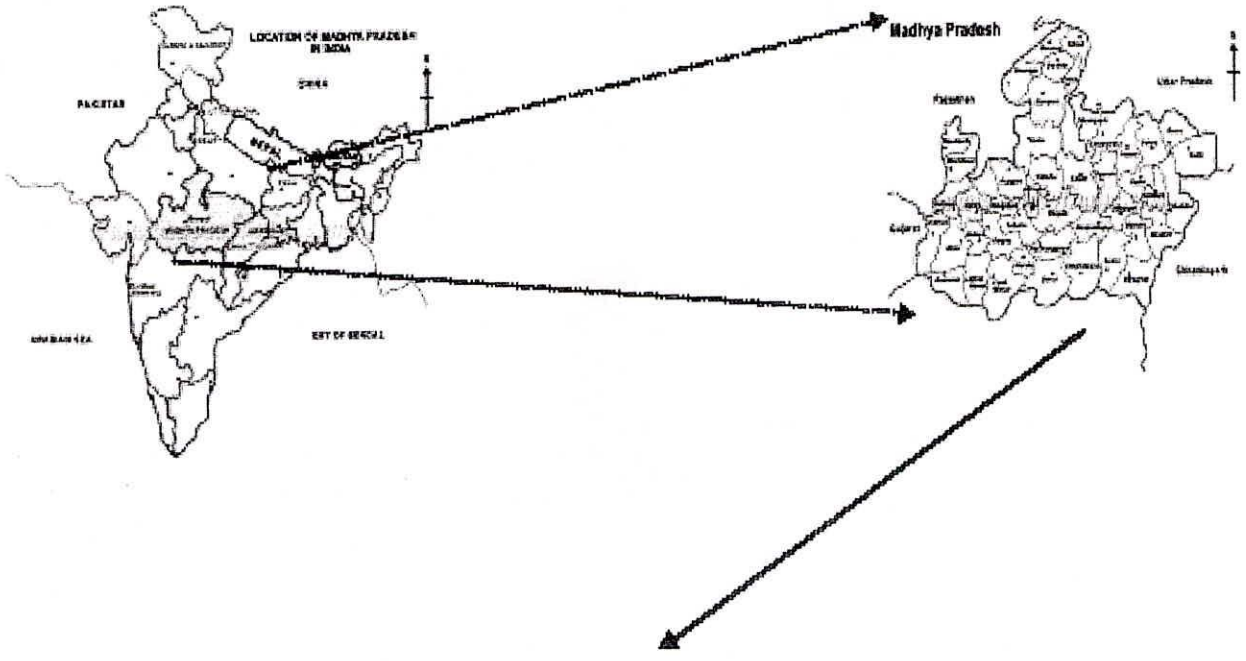
Study Group: Dr. Surjeet Singh (Scientist-C, GWH) - PI
Mr. C. P. Kumar (Scientist-F, GWH)
Dr. Anupma Sharma (Scientist-C, GWH)
Mr. Rajan Vatsa (Scientist-B, GWH)

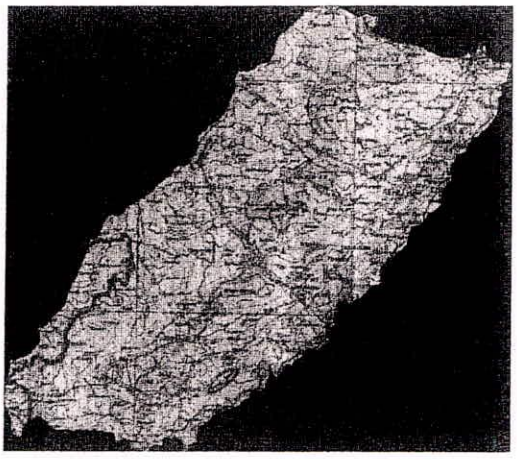
Funding: Internal

Date of Start: April, 2009

Scheduled Date of Completion: March, 2012

Location Map:





Statement of the Problem

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

Approved Action Plan

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

Objectives & Achievements

To quantify the impacts of climate change on groundwater recharge in a part of Sonar basin, Madhya Pradesh.	Generation of future rainfall and temperature series has been completed. Since the testing of soil samples is just completed in laboratory, estimation of recharge is under progress.
To simulate the groundwater levels and investigate the temporal response of the aquifer system to historic and future climate periods.	Will be taken up from April, 2011.

Analysis and Results

Statistical analysis of rainfall and temperature for future trend has been completed. Downscaling of rainfall and temperature for the year 2039, 2069 and 2099 and estimation of recharge rates is also completed. The estimation of site specific recharge rates at various locations is under progress.

List of deliverables

Database generation, generation of future rainfall and temperature series for projected climate change, estimation of groundwater recharge for present and projected rainfall; and simulation of groundwater levels.

Lab Facility used under the Study

Soil and water laboratory of NIH was used for testing of soil-moisture characteristics data and grain-size analysis during 2010 and 2011.

Data Procured and Generated

Various meteorological data viz. rainfall, minimum and maximum temperature, humidity, wind speed, etc. were collected from India Meteorological Department, Pune. Other hydrological data viz. groundwater levels, gauge and discharge, lithologs, etc. were collected from the State Govt. Departments.

Study Benefits

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

Shortcomings/Difficulties:

Estimation of recharge is under progress as the testing of soil samples is just completed.

Future Plan

- Estimation of groundwater recharge based on available precipitation and temperature records and anticipated changes to these parameters (using Visual HELP).
- Quantification of the spatially distributed recharge rates using the climate data and spatial soil survey data.
- Simulations of groundwater flow using each recharge data set and evaluation of the changes in groundwater flow and levels on time.

PROJECT REFERENCE CODE: NIH/GWD/NIH/10-12/

Title of the Study: **Quantification of Impact of Rainwater Harvesting on Groundwater Availability in Aravalli Hills – Part II: Mathematical Modeling**

Study Group:

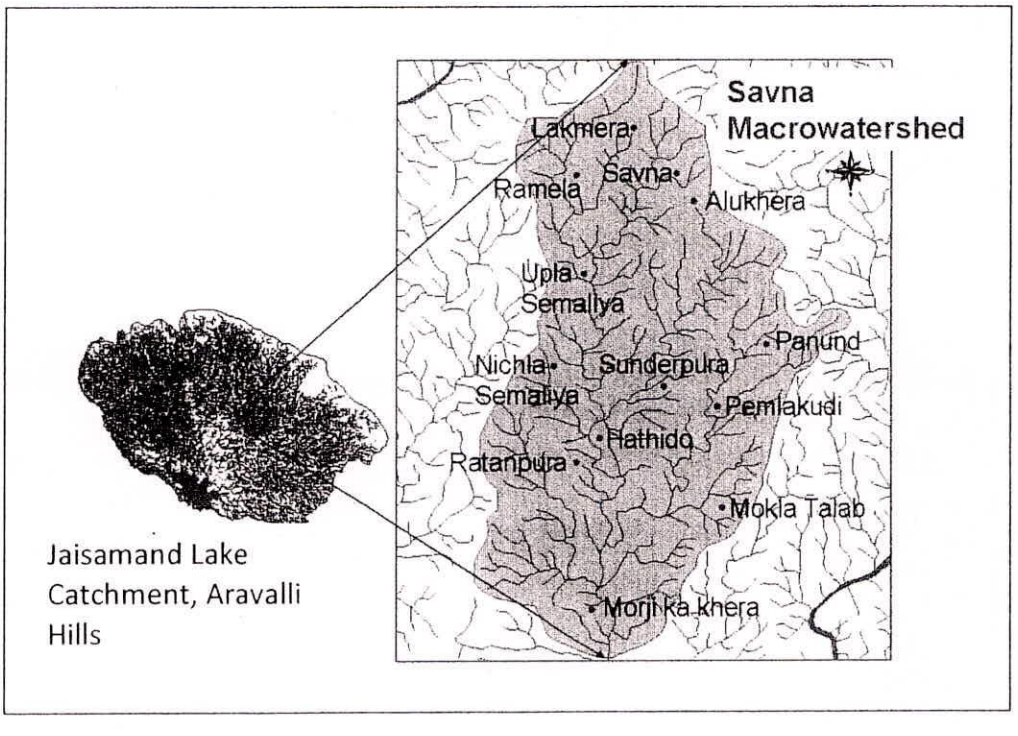
Dr. Anupma Sharma (Scientist-C, GWH) – PI
Mr. C. P. Kumar (Scientist-F, GWH) – Co-PI
Dr. N. C. Ghosh (Scientist-F & Head, GWH)
Dr. Sudhir Kumar (Scientist-E2, HI)
Mr. Rajan Vatsa (Scientist-B, GWH)
Mr. Shobha Ram (PRA, GWH)
Mr. Sanjay Mittal (SRA, GWH)

Type of Study: Internal funding with manpower and logistic support from local non-governmental agencies and beneficiaries of the study.

Date of Start: April 1, 2010

Scheduled Date of Completion: March 2012

Location Map:



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

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

Approved Action Plan: The action plan of the study comprises the following:

1. Field and lab experiments to determine soil moisture retention characteristics and saturated hydraulic conductivity.
2. Estimation of recharge to groundwater, utilizing the database developed in Part I of study.
3. Mathematical modeling to analyse the hydrological impact of rainwater harvesting schemes on groundwater availability.

Objectives vis-à-vis Achievements:

Objectives	Achievements
Field visits	Three visits undertaken since April 2010.
Data monitoring	Quarterly water level monitoring of 314 wells. For wells located near four anicuts in Nichla Semaliya and Hathido villages in Savna watershed, monitoring on fortnightly basis in monsoon and on monthly basis in non-monsoon.
Field and lab experiments	Experiments using Guelph permeameter at 5 sites, and collection of 54 soil samples for analysis in lab. Analysis of data for saturated hydraulic conductivity completed.
Mathematical modeling	Test runs on VS2DT to compute water flux through unsaturated zone.

Analysis and Results

1. Analysis of data for saturated hydraulic conductivity
2. Test runs on VS2DT to compute water flux through unsaturated zone.

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

List of Deliverables:

1. Reports – Interim Report
2. Papers

Major Items of Equipment Procured: TDR soil moisture meter

Lab Facilities used during the Study:

1. Soil and Water Lab, NIH
2. Nuclear Hydrology Lab, NIH

Data Procured and/or Generated during the Study:

Data Generation

1. Hydrogeological database
2. Landuse database
3. Soil database

Study Benefits/Impact:

Measurable indicators	**Achievements**
Generation of database on GIS for Savna Macrowatershed	Database pertaining to hydrogeology, landuse and soil under progress
Technology transfer	User interactive training

Specific Linkages with Institutions and/or End-Users/Beneficiaries:

- Logistic support from Udaipur based local non-governmental agency Wells for India.
- End-users/beneficiaries: local villagers

Shortcomings/difficulties, if any: -

Future plan:

1. Data monitoring and data analysis to continue.
2. Development of mathematical model

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

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

Study Group:

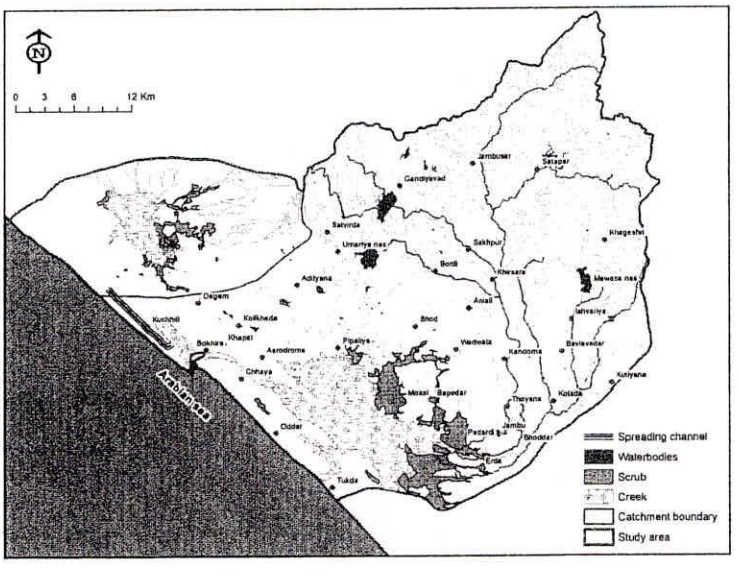
- Study Coordinator : Dr N C Ghosh, NIH
- PI : Dr. Anupma Sharma, NIH
- Co-PI : Mr. C P Kumar, NIH
  Mr. A D Gohil, GWRDC, Gandhinagar
- Co-investigators : NIH - Dr. C.K. Jain; Dr. Sudhir Kumar;
  Mr. D.S. Rathore; Dr. Surjeet Singh; Mr Rajan Vatsa
  GWRDC - Research Officer, Gandhinagar; Geologist,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

Type of Study: Sponsored; *Purpose Driven Study* under World Bank funded Hydrology Project Phase-II (HP-II). Study in collaboration with Gujarat Water Resources Development Corporation (GWRDC), Govt. of Gujarat, Gandhinagar

Date of Start: Oct. 26, 2009

Scheduled Date of Completion: June 31, 2012

Location Map:



Study Area: Minsar River Basin, Coastal Saurashtra, Gujarat

Study Objectives:

1. To characterize the various hydrologic components and establish their quantitative inter-relationships in the coastal aquifer system.
2. To identify causes of increasing groundwater salinity and its far reaching consequences on the coastal aquifer system, and to establish the physico-chemical mechanism of mixing of freshwater-saltwater in the coastal aquifer system of Saurashtra region.
3. To simulate the transport of saltwater in the coastal aquifer system through numerical modeling and study impact of existing aquifer management practices on the groundwater regime.
4. To evaluate the impact of anticipated climate change on groundwater recharge and dynamics of coastal aquifer system and suggest suitable remedial measures.
5. Analysis of effect of water quality degradation due to saltwater intrusion on the socio-economic growth.
6. Rollover of project output to State Departments in Gujarat and concerned users in terms of technology transfer of technical know-how gained during the project for implementation of program for sustainable development of coastal groundwater resources.

Statement of the Problem:

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

Approved Action Plan:

1. Collection and monitoring of data and identification of data gaps.
2. Development of thematic maps using remote sensing and GIS.
3. Isotope analysis and water quality assessment.
4. Field tests and geophysical surveys, hydrogeological surveys in study area.
5. Development of hydrological water balance model.
6. Hydrogeochemical/geophysical surveys for 3D mapping and monitoring of freshwater-saltwater interface.
7. Numerical modeling of saltwater transport in the coastal aquifer system.
8. Field experiments for artificial recharge.
9. Evolve guidelines for optimal design of possible remedial measures in terms of pumping policy and artificial recharge.
10. Evaluation of the impact of anticipated climate change on groundwater recharge and dynamics of coastal aquifer system for different scenarios of sea level rise and rainfall events and suggest suitable remedial measures.
11. Analysis of affect of water quality degradation due to saltwater intrusion on the socio-economic growth.
12. Organization of training courses for state departments.

Objectives vis-à-vis Achievements:

Objectives	Achievements
Literature review	Ongoing
Field visits	Three since April 2010.
Data collection	Collection of lithologs, geological maps, pump tests, groundwater draft, reservoirs, check dams, spreading channel, land use, irrigation schemes, relevant reports and maps
Procurement of data	Meteorological data from IMD and satellite data from NRSC
Data monitoring	Water level and water quality data monitoring on quarterly basis in 40 wells and on monthly basis in 26 wells, including creeks and reservoir schemes near coast.
Installation of piezometers	Total 16 piezometers drilled in the study area by GWRDC.
Field experiments	Experiments using double ring infiltrometer: 23 sites Guelph permeameter: 22 sites Soil samples from field: 31 disturbed and 19 undisturbed soil samples collected Water samples for isotope analyses: 20 water samples Carbon dating: samples collected from three sites Pump test conducted: One
Database preparation	Digitization of drainage network and other water bodies, marshy areas, water supply and irrigations schemes, administrative boundaries, and elevation contours completed. DEM of Minsar basin developed.
Data analysis	Analysis of satellite data, pump tests, landuse, water table and water quality data under progress. Analysis of soil samples and data for infiltration and saturated hydraulic conductivity completed.
Organization of training course	One training course on 'Coastal Groundwater Modeling and Management' organized for Officers of State Departments from Coastal HP-II States, during Nov. 22-26, 2010 at WALMI, Anand, Gujarat.

Analysis and Results

1. Topography of Minsar River Basin
2. Analysis of soil samples
3. Generation of water table contours
4. Analysis of TDS levels in groundwater and groundwater quality

Adopters of the Results of the Study and their Feedback: Study yet to be completed

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

1. Reports – Interim Report
2. Training Programs

Major Items of Equipment Procured:

1. One GPS procured
2. Procurement of salinity data logger, geophysical resistivity meter, bailer samplers, and TLC meter under progress

Lab Facilities used during the Study:

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

Data Procured and/or Generated during the Study:

Data Procurement

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

Data Generation

1. Hydrogeological database
2. Landuse database
3. Soil database

Study Benefits/Impact:

Measurable indicators	**Achievements**
Generation of database on GIS for Minsar River Basin	Database pertaining to hydrogeology, landuse and soil under progress
Technology transfer	One training course on 'Coastal Groundwater Modeling and Management' organized for Officers of State Departments from Coastal HP-II States, during Nov. 22-26, 2010 at WALMI, Anand, Gujarat.

Specific Linkages with Institutions and/or End-Users/Beneficiaries:

Study in collaboration with Gujarat Water Resources Development Corporation (GWRDC), Govt. of Gujarat, Gandhinagar

Shortcomings/Difficulties, if any: -

Future plan:

1. Data monitoring, field surveys and data analysis to continue.
2. Development of numerical model

PROJECT REFERENCE CODE: NIH/GWD/NIH/11-14/1

Title of the Study:	**Ground water Fluoride Contamination in Different Parts of India and Study Severity of Fluorosis in a Drought Prone Area**
Study Group:	Mr. A. K. Dwivedi (Scientist-C, GWH) - PI Dr. Shobha Ram (PRA, GWH) - Co-PI Dr. N.C. Ghosh (Scientist-F & Head, GWH) Dr. Anupma Sharma (Scientist-C, GWH) Mr. Sumant Kumar (Scientist-B, GWH) Mr. Sanjay Mittal (SRA, GWH) Mr. Ramchandra (RA, GWH)
Type of Study:	Internal
Nature of Study:	Research

Location Map:

In India more than 25 million populations of 15 states are under threat,

(Less than 30 % of district affected)

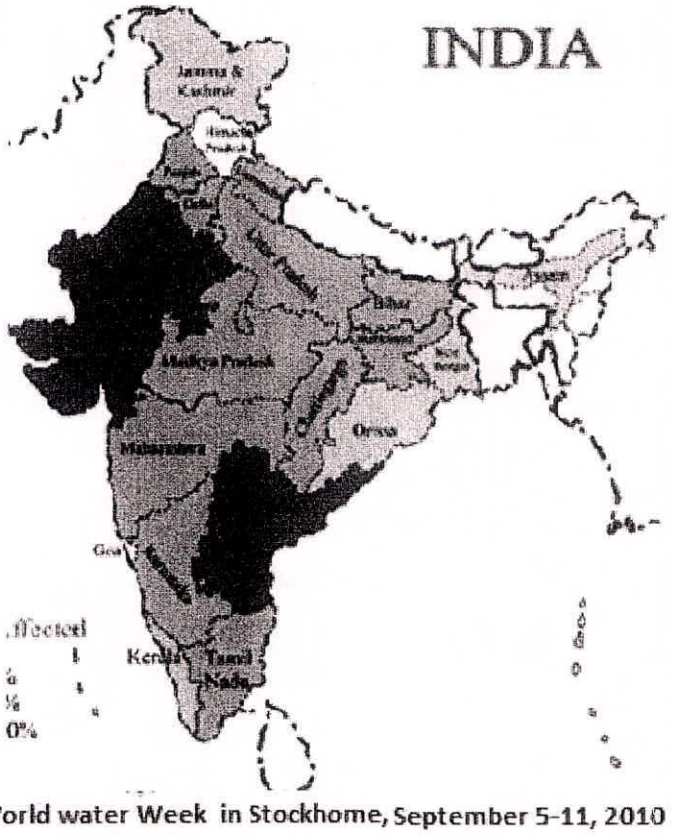
Jammu & Kashmir,
Kerala,
Delhi,
Orissa

(30-50 % of district affected)

Bihar,
Hariyana,
Karnataka,
Maharasthra,
Madhya Pradesh,
Punjab

(Above 50% of district affected)

Andhra Pradesh,
Gujarat,
Rajasthan,
Tamil Nadu,
Uttar Pradesh



Source: Presentation on World water Week in Stockhome, September 5-11, 2010

Study Objectives:

- To prepare status report on Ground Water Fluoride Contamination in India.
- Study of variability and severity of fluorosis in a drought prone area.

Statement of the Problem:

India is among the 23 nations around the globe where health (including user need identification) problems occur due to excess ingestion of fluoride (>1.5 mg/l) by drinking water. Consumption of polluted fluoride drinking water poses rise of causing several diseases because fluoride influences quality of ground water. Excess intake of fluoride through drinking water causes fluorosis on human beings in many states of India. Most people in the affected areas suffer from dental fluorosis and skeletal fluorosis such as mottling of teeth, deformation of ligament, bending of spinal column and ageing problem (Nature and Science 2010; 8(11):20-26). Most common health effect is Dental Fluorosis; long term exposure to excess fluoride results in skeletal fluorosis and other reported health effects are: gastro intestinal disorder, neurological effects, reproductive effects, developmental effects enzyme inhabitation and birth defects. Even in one the states of India 'Rajasthan', nearly 30 districts out of 32 districts are badly affected by fluoride ingestion [CGWB http://cgwb.gov.in/gw_profiles/st_Rajasthan.htm]; where the fluoride concentration is reported to be more than 1.5 mg/litre i.e. permissible limit for human consumption. as per WMO norms.

End users/beneficiaries of the study: Stakeholders/ Academic and Research Communities/ Planning & Policy makers

Whether a new study: Yes

Baseline data/information on the study:

Fluoride contamination like arsenic in ground water poses threat both to human and animal kingdom. The problem is more intensive in drought prone area where ground water happens to be the only source of drinking water under stress conditions, especially during summers. Numerous studies have been made, but, there is a need to compile & update the status in present context of its spread. Earlier studies on fluorosis have not been able to predict and correlate the diseases exactly with fluoride or other contaminants.

Methodology:

- Collection of water quality field data from different State and Central Government Organizations;
- Periodic collection of water samples and their analysis in laboratory;
- Preparation of fluoride maps for the selected regions;
- Analysis of field data to determine the extent of fluoride Contamination in ground water of the study area;
- Developing correlation between fluorosis and fluoride etc.

Action Plan and Timeline:

The duration of the study is three years w.e.f. April 2011 (2011-2014)

S.No	Action	Time Line			Remarks
		2011-12	2012-13	2013-14	
1.	Literature Survey				This would be done in the first year of the study to appraise with the problem
2.	Collection of Data				Collection of various types of data from different sources
3.	Lab analysis and numerical analysis of the data				Extensive visits will be arranged in the study area for collection of the field data and Lab analysis and also numerical analysis would be performed at the NIH headquarters.
4.	Preparation of Status Report/ Interim Reports				Status report will be prepared in the year 2011-12. Subsequently half yearly and annual reports will be prepared and submitted as in house activity.
5.	Publications & outreach				In addition to publication, mass awareness and training programs will be organised

Data Requirements (and expected sources): As indicated above

List of Deliverables:

Field testing kit would be required
Papers – one each year
Reports: Status Report – One number
Interim reports - four numbers
Annual reports - two numbers
Training Programme: As per needs

Proposed Measurable Indicators for: Assessment of study's achievements

Solution of the identified problems;
Improvement in Skills

IPR potential and issues:

NA

Technology transfer possibilities	:	Through outreach programs
Involvement of end users/beneficiaries	:	All concerned with the Fluoride menace
(any consultation held with them while preparing this study proposal?)		Not consulted
Specific linkages envisaged with Institutions and/or other NGOs	:	To be explored
Major items of equipment needed		The latest state of art equipments as per requirements for testing in the field and the lab

PROJECT REFERENCE CODE: NIH/GWD/NIH/11-14/2

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

Study Group	:	Mr. Sumant Kumar (Scientist 'B', GWH) - PI Mr. Rajan Vatsa (Scientist 'B', GWH) – Co-PI Dr. N. C. Ghosh (Scientist 'F' & Head, GWH) Mr. C. P. Kumar (Scientist 'F', GWH)
Type of study	:	Internal
Nature of study	:	Technology or technique development
Location Map		Two Catchment areas, one from Punjab (Alluvial) and another from Karnataka (Hard Rock) are proposed.

Objectives:

- To identify the potential recharge sites for groundwater (GW) augmentation.
- To manage the augmented GW resources for subsequent potential uses.

Statement of the Problem, End Users/Beneficiaries of the Study:

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

In this study, two catchment areas of India would be taken for management of aquifer recharge and aquifer storage recovery. A comprehensive strategy and guidelines will be developed indicating as to how artificial groundwater recharge is to be managed for augmentation of groundwater resources and for its subsequent recovery and potential uses. It is expected that the study will provide a scientific guideline to the policy makers in supporting the prospect of existing artificial groundwater recharge programs.

Whether a new study: Yes

Methodology:

- Study is envisaged for two hydrogeologic regimes viz. alluvium formation and hard rock formation.
- Each hydrogeologic regime will represent a particular catchment of a river/stream.

- Different hydrologic components of the respective catchments will be analyzed to determine the potentiality of surface water for groundwater recharge.
- Supply and demand of water for the respective catchments will be analyzed.
- Probable sites for groundwater recharge will be identified based on hydrological and hydrogeological conditions of the study areas.
- Potential groundwater recharge components will be estimated and volumetric quantity of recharge will be determined/computed and the response of aquifer will be simulated accordingly.
- Managed aquifer recharge would thereafter be assessed for demand management using appropriate tools.

Timeline : 1st April 2011 to 31st March 2014 (3 years)

Data Requirements Various meteorological, hydrogeological, hydrological and remote sensing data will be collected/purchased from various Central/State Government agencies.

List of Deliverables : Reports and papers etc.

Proposed measurable indicators for assessment of study's achievements:

- Improved availability and management of GW resources

HYDROLOGICAL INVESTIGATION DIVISION

WORK PROGRAMME FOR THE YEAR 2010-2011

A. INTERNALLY FUNDED STUDIES

Reference Code	Project	Project Team	Duration/ Status	Page#
NIH/HID/INT/09-12	SW and GW Interaction at Selected Locations Along River Yamuna in NCT, Delhi: Phase-II	Sudhir Kumar (PI) M. S. Rao P. K. Garg	3 years *(4/09 – 3/12)*	64
NIH/HID/INT/10-13	Study of Variability of Snow and Glacier Contribution in Melt Water of Gangotri Glacier at Goumukh using Isotopic Techniques	S.P. Rai (PI) Manohar Arora, Bhishm Kumar, Rakesh Kumar and Naresh Kumar	3 years *(4/10 – 3/13)*	89
NIH/HID/INT/10-12	Identification of Recharge Zones of Some Selected Springs of Uttarakhand Using Isotopes	S. D. Khobragade (PI) Bhishm Kumar Sudheer Kumar S. P. Rai Pankaj Garg	*2 years* *(04/10-03/12)*	97

B. SPONSORED STUDIES/CONSULTANCY STUDIES

NIH/HID/DST /07-12	National programme on isotope fingerprinting of waters of India (IWIN)	M.S. Rao (PI) B. Kumar, Sudhir Kumar S.P. Rai S.K. Verma Pankaj Garg	5 years *(07/07–06/12)*	58
NIH/HID/FRI/ 08-13	Impact Assessment of Landuse on the Hydrologic Regime in the selected Micro-watersheds in Lesser Himalayas, Uttarakahand	S.P. Rai (PI) Bhishm Kumar J.V. Tyagi	5 years *(04/08– 03/13)*	78
NIH/HID/DJB /10-11	Assessment of Groundwater Resources & Development Potential of Yamuna Flood Plain, NCT, Delhi	Sudhir Kumar (PI) Vijay Kumar AK Keshari, IIT Delhi S. Shekhar, Delhi Univ. YB Kaushik, CGWB PS Datta, ICAR Executive Engineer, CWC AK Gupta, Delhi Jal Board	1 year *(02/10-01/11)* *To be extended upto12/11*	83
NIH/HID/GB PIHED/10-13	Development of Spring Sanctuaries in an Urban and Rural Watershed in District Pauri Garhwal, Uttarakhand	Dr. S.P. Rai (PI) Bhishm Kumar Sudhir Kumar Suhas Khobragade Pankaj Garg	3 years *(04/10-03/13)*	93
NIH/HID/RS MML/2010-11	Hydrogeological Studies Of Jhamarkotra Mines, Udaipur, Rajasthan	Dr. Sudhir Kumar, (PI) Sh. SK Verma, Sh. Pankaj Garg,	1 year (07/10-06/11)	103

C. PURPOSE DRIVEN STUDIES UNDER HP-II

NIH/HID/HP-II/09-12	Groundwater Dynamics of Bist-Doab Area, Punjab Using Isotopes	M.S. Rao (PI) Bhishm Kumar Sudhir Kumar S.K. Verma PankajGarg+CGWB Officials	3 years *(07/09-6/12)*	68
NIH/HID/HP-II/09-12	Groundwater Management in Over- Exploited Blocks of Chitradurga and Tumkur Districts of Karnataka	Sudhir Kumar (PI) J.V. Tyagi Vijay Kumar B.K. Purandara S.P. Rai M.S. Rao	3 years *(07/09-6/12)*	73

PROPOSED WORK PROGRAMME FOR THE YEAR 2011-2012

A. INTERNALLY FUNDED STUDIES

Reference Code	Project	Project Team	Duration/ Status	Page#
NIH/HID/INT/09-12	SW and GW Interaction at Selected Locations Along River Yamuna in NCT, Delhi: Phase-II	Sudhir Kumar (PI) M. S. Rao P. K. Garg	3 years *(4/09 – 3/12)* ***Continuing study***	64
NIH/HID/INT/10-13	Study of Variability of Snow and Glacier Contribution in Melt Water of Gangotri Glacier at Goumukh using Isotopic Techniques	S.P. Rai (PI) Manohar Arora, Bhishm Kumar, Rakesh Kumar and Naresh Kumar	3 years *(4/10 – 3/13)* ***Continuing study***	89
NIH/HID/INT/10-12	Identification of Recharge Zones of Some Selected Springs of Uttarakhand Using Isotopes	S. D. Khobragade (PI) Bhishm Kumar Sudheer Kumar S. P. Rai Pankaj Garg	***2 years*** *(04/10-03/12)* ***Continuing study***	97
NIH/HID/INT/11-13	Hydro-geological assessment of Ghar area for artificial recharge and water management planning	Pankaj Garg (PI) Dr. Sudhir Kumar Tanveer Ahmad Rajesh Agarwal Dr. V.C. Goyal Dr. Bhishm Kumar	***2 years*** *(04/11-03/13)* ***New study***	108
NIH/HID/INT/11-13	Assessment of Radon Contamination in Waters and Identification of Paleo-groundwater in Punjab State	Sh. S. K. Verma Dr. Sudhir Kumar Dr. M. S. Rao Dr. Bhishm Kumar	***2 years*** *(04/11-03/13)* ***New study***	111

B. SPONSORED STUDIES/CONSULTANCY STUDIES

NIH/HID/DST /07-12	National programme on isotope fingerprinting of waters of India (IWIN)	M.S. Rao (PI) B. Kumar, Sudhir Kumar S.P. Rai S.K. Verma Pankaj Garg	5 years *(07/07–06/12)* ***Continuing study***	58
NIH/HID/FRI/ 08-13	Impact Assessment of Landuse on the Hydrologic Regime in the selected Micro-watersheds in Lesser Himalayas, Uttarakahand	S.P. Rai (PI) Bhishm Kumar J.V. Tyagi	5 years *(04/08– 03/13)* ***Continuing study***	78
NIH/HID/DJB /10-11	Assessment of Groundwater Resources & Development Potential of Yamuna Flood Plain, NCT, Delhi	Sudhir Kumar (PI) Vijay Kumar AK Keshari, IIT Delhi S. Shekhar, Delhi Univ. YB Kaushik, CGWB PS Datta, ICAR Executive Engineer, CWC AK Gupta, Delhi Jal Board	1 year *(02/10-01/11)* *To be extended upto12/11* ***Continuing study***	83

NIH/HID/GB PIHED/10-13	Development of Spring Sanctuaries in an Urban and Rural Watershed in District Pauri Garhwal, Uttarakhand	Dr. S.P. Rai (PI) Bhishm Kumar Sudhir Kumar Suhas Khobragade Pankaj Garg	3 years *(04/10-03/13)* ***Continuing study***	93
NIH/HID/RS MML/2010-11	Hydrogeological Studies Of Jhamarkotra Mines, Udaipur, Rajasthan	Dr. Sudhir Kumar, (PI) Sh. SK Verma, Sh. Pankaj Garg,	1 year (07/10-06/11) ***Continuing study***	103

C. PURPOSE DRIVEN STUDIES UNDER HP-II

NIH/HID/HP-II/09-12	Groundwater Dynamics of Bist-Doab Area, Punjab Using Isotopes	M.S. Rao (PI) Bhishm Kumar Sudhir Kumar S.K. Verma PankajGarg+CGWB Officials	3 years *(07/09-6/12)* ***Continuing study***	68
NIH/HID/HP-II/09-12	Groundwater Management in Over- Exploited Blocks of Chitradurga and Tumkur Districts of Karnataka	Sudhir Kumar (PI) J.V. Tyagi Vijay Kumar B.K. Purandara S.P. Rai M.S. Rao	3 years *(07/09-6/12)* ***Continuing study***	73

HYDROLOGICAL INVESTIGATIONS DIVISION

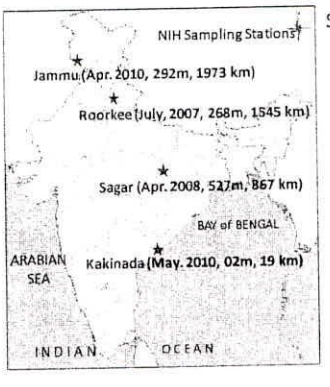
ITEM NO. 34.2 ACTIONS TAKEN ON THE ADVICE / DECISIONS OF THE 33ND MEETING

Actions taken pertaining to individual studies, if any, are discussed separately for each study under the Item No. 34.3 (11)

ITEM NO. 34.3: PROGRESS OF THE WORK PROGRAMME OF THE DIVISION FOR THE YEAR 2010-11

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

1	**Title of the study**	**NATIONAL PROGRAMME ON ISOTOPE FINGERPRINTING OF WATERS OF INDIA (IWIN)**
2	**Name of PI, Co-PI, & their affiliations**	Dr. Bhishm Kumar, Scientist F & Head HID (PI-national) Dr. MS Rao, Scientist C (PI-Internal)
3	**Type of study**	Sponsored (Funded by DST vide IR/54/ESF/05-2004 dated July17, 2007)
4	**Date of start** **Scheduled date of completion**	September, 2007 August, 2012
5	**Location map**	Samples are collected by NIH from 4 sites (Roorkee, Sagar, Jammu and Kakinada) and member of organizations collect samples from 85 sites all over India.
	IWIN SAMPLING LOCATIONS MAP	



Sampling by other organizations

Organization	Locations
Anna University	01
CGWB	31
CPCB	16
CRIDA	26
CWRDM	01
IIT-Kharagpur	01
IMD	05
NGRI	01
NIO	01
NRL-IARI	01
PRL	01

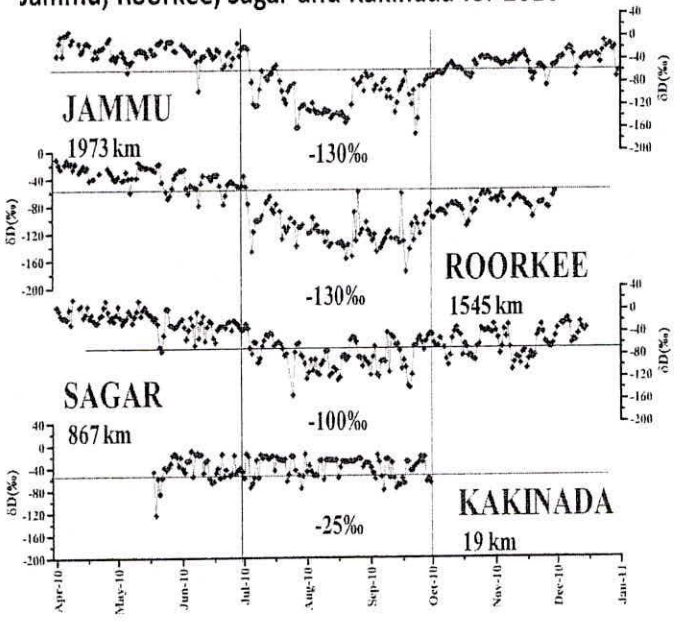
6	**Study objectives**	1. Identifying regional/local water vapour components in the local atmosphere.

		2. Residence time and exchange estimate of vapour/water in different hydrological units. 3. Identifying dominant sources of water vapour supply (Arabian sea/ Bay of Bengal/local and long distant continental sources) during different seasons. 4. Isotopic database development.
7	**Statement of the problem**	To identify the source of air moisture during different seasons
8	**Approved action plan**	

Year	April, 2011 to August, 2012 (Appendix I)	Remark
April, 2011-August, 2012	**Sampling**: At Roorkee: (1) Rain (event based), (2) ground level vapour (GLV) by Condensation and P&T methods (daily), (3) groundwater and (4) surface water (River Ganga) At Sagar: Items 1-3 as at Roorkee (GLV by cond.) At Jammu: Items 1-3 as at Roorkee (GLV by cond.) At Kakinada: Items 1-2 as at Roorkee (GLV by cond.) **Data Collection**: Hydro-meteorological at Roorkee , Sagar, Jammu and Kakinada. **Analysis**: Analysis of water samples (NIH, Sagar, Jammu & Kakinada) and samples provided by participating organizations for δD, $\delta^{18}O$ and ^{3}H. **Data interpretation** **Report writing**	Report preparation as per the Appendix I

9	**Timeline and justification for time over runs**	**Appendix-1**
10	**Objectives vis-à-vis achievements**	

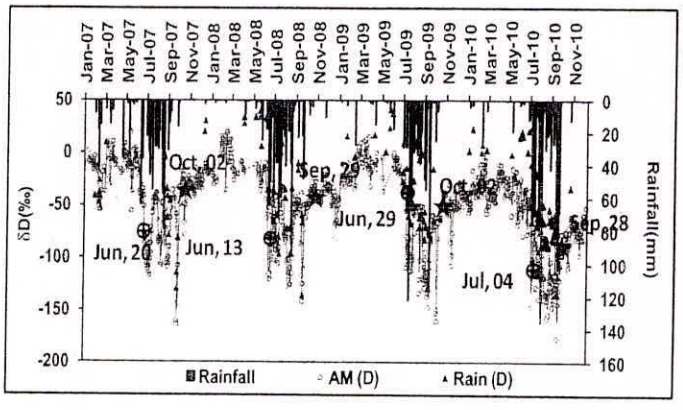
Objective	Status	Work Done
Identifying regional/local water vapour components in the local atmosphere	Achieved	• Qualitatively resolved the regional/local water vapour components in the local atmosphere and identified through correlation of isotopic data with wind trajectory
Identifying dominant sources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

	Isotopic database development	Achieved	Isotopic database has been developed for approximately 18000 samples =5000 (NIH) + 13000 (PRL)	
11	**Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken**	➢ **Suggestion:** For confirming wind and isotopic pattern a new station in North-East should be established ➢ **Action Taken:** Required instrumentation is getting fabricated and will be installed by the April, 2011. ➢ **Suggestion:** Isotopic data should be correlated with Kalpana Satellite data for interpretation ➢ **Action Taken:** IMD, New Delhi has been contacted. The relevant (integrated humidity data upto 10 kms) is expected to be received by April, 2011.		
12	**Analysis and Results** Progress ❖ Collected about 1000 samples since September, 2010 and out of which 653 samples have been measured Results ❖ Analysed & compared variation in isotopes (δD) of GLV for Jammu, Roorkee, Sagar and Kakinada for 2010 ❖ Analysed & interpreted Isotopic components (δD_{GLV} , $\delta D_{Rainfall}$, $\delta D_{P\&T}$) and the Rainfall Amount for onset and withdrawal of monsoon and change in monsoon pattern at Roorkee for 2007-10	**Variation in isotopes (δD) of GLV for Jammu, Roorkee, Sagar and Kakinada for 2010**  		

- Developed empirical relation to predict $\delta D_{P\&T}$ using data for $\delta D_{cond.}$ and humidity data for 2009-10

- Analysed cross correlation between δD_{GLV} & Absolute Humidity at Roorkee 2007-2010
  δD_{GLV} at Roorkee & Sagar 2008-10
  δD_{GLV} at Roorkee & Jammu 2010

Variation in Isotopic components (δD_{GLV}, $\delta D_{Rainfali}$) and the Rainfall Amount for onset and withdrawal of monsoon and change in monsoon pattern at Roorkee for 2007-10



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

Empirical relation to predict $\delta D_{P\&T}$ using data for $\delta D_{cond.}$ and humidity data for 2009-10

Pre-Monsoon (March-June)
δD (Pred trap) = 0.38*(δD cond.)+0.67*(A.H.)-60.3

Monsoon(July-September)
δD (Pred trap) = 0.84*(δD cond.)+0.29*(A.H.)-30.2

Post-Monsoon(October-November)
δD (Pred trap) = 0.95*(δD cond.)+3.88*(A.H.)-75.3

Winter(December-February)
δD (Pred trap) = 0.94*(δD cond.)+3.43*(A.H.)-73.2

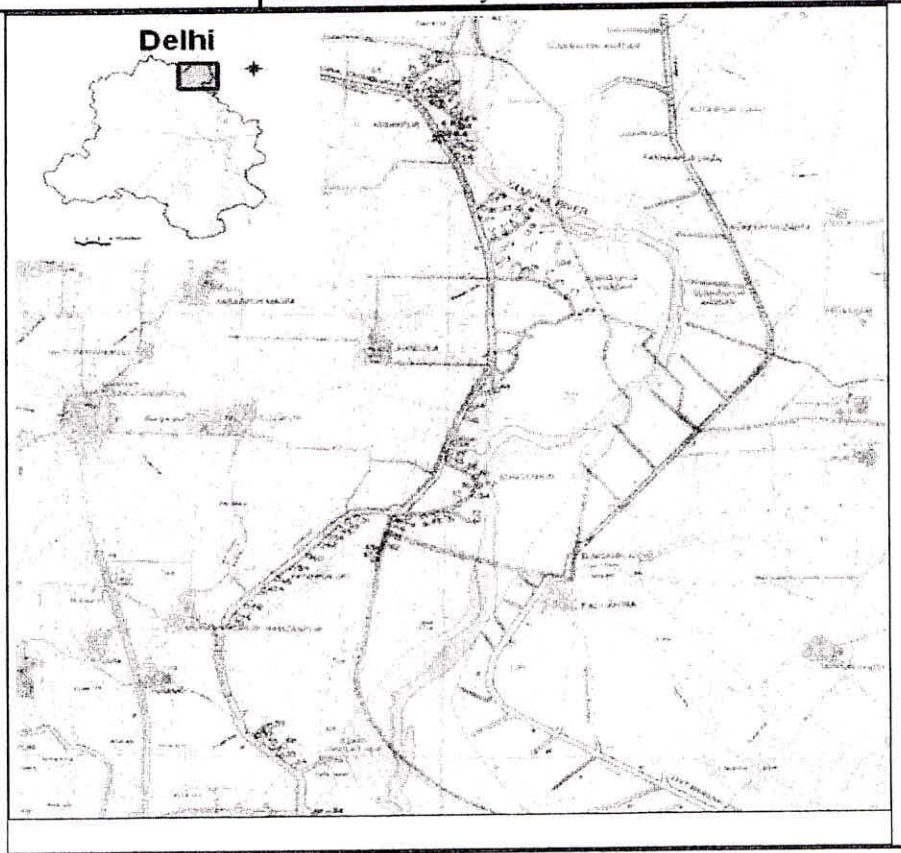
		<table><tr><th>Cross correlation b/w stations/seasons</th><th>Parameters</th><th>Significant values above +0.01</th><th>Cross correlation Coff., Lag</th></tr><tr><td>Roorkee</td><td>AH vs. δD</td><td>-</td><td>-0.63</td></tr><tr><td>Roorkee/Monsoon</td><td>AH vs. δD</td><td>-</td><td>-0.44</td></tr><tr><td>Roorkee/Non Monsoon</td><td>AH vs. δD</td><td>0.31</td><td>+0.31</td></tr><tr><td>Roorkee-Sagar</td><td>δD_R vs. δD_S</td><td>0.75</td><td>+0.75</td></tr><tr><td>Roorkee-Sagar/Monsoon</td><td>δD_R vs. δD_S</td><td>0.62</td><td>+0.62</td></tr><tr><td>Roorkee-Sagar/Non Monsoon</td><td>δD_R vs. δD_S</td><td>0.65</td><td>+0.65</td></tr><tr><td>Roorkee-Jammu</td><td>δD_R vs. δD_J</td><td>0.51</td><td>+0.51</td></tr><tr><td>Roorkee-Jammu/Monsoon</td><td>δD_R vs. δD_J</td><td>0.41</td><td>+0.41</td></tr><tr><td>Roorkee-Jammu/ Non-Monsoon</td><td>δD_R vs. δD_J</td><td>0.39</td><td>+0.39,3 days</td></tr></table>
13	**Adopters of the results of the study and their feedback**	
14	**List of deliverables** (e.g. equipment, papers, reports, software, manuals, brochures, flyers, training programmes, users interaction workshops)	➢ One Paper presented at AOGS conference ➢ 13 technical persons have been trained at various stages of the project
15	**Major items of equipment procured**	NIL
16	**Lab facilities used during the study**	Isotope Ratio Mass Spectrometer
17	**Data procured and/or generated during the study**	• The wind trajectory data for years 2007-10 procured from NHAC-NWP, IMD, New Delhi • The water vapour data, Outgoing Long wave Radiation data for 2008-10 (Kalpana satellite) procured from Sat-Met., IMD, New Delhi
18	**Study Benefits / Impact**	➢ Presenting the progress of the work in the PRC meeting ➢ Utilization of the budget as per the allocation under various heads
19	**Specific linkages with Institutions and/or end-users/beneficiaries**	Participating Organization: • Anna University, BARC, CGWB, CPCB, CWC, CWRDM, IMD, IIT-Kharagpur, NGRI, NIO, NRL-IARI, PRL
20	**Shortcomings / difficulties, if any**	NIL
21	**Future plan**	❖ The sampling of GLV, rain, river and groundwater will continue in this year. ❖ Establishing new site in North-east ❖ Scientific/technical publication/reporting in consultation with IWIN Secretariat.

Appendix – 1

ACTION PLAN WITH TIME LINE FOR THE STUDY ON NATIONAL PROGRAMME ON ISOTOPE FINGERPRINTING OF WATERS OF INDIA

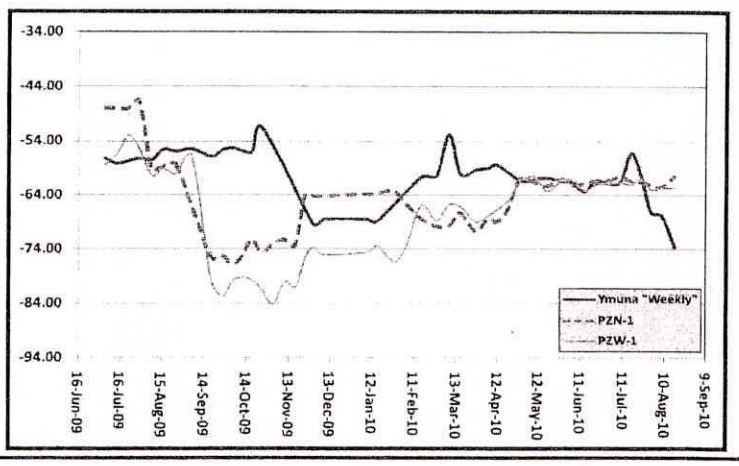
Activity	1st	2nd	3rd	4th	5th	6th
Sampling from all stations of NIH (air moisture, groundwater, precipitation)	♦	♦	♦	♦		
Establishment of new sampling site in NE region	♦					
Collection of data from IMD	♦					
Isotopic analysis (δD and $\delta^{18}O$) of samples	♦	♦	♦	♦		
Water Quality analysis of SW and GW samples			♦	♦	♦	
Isotopic analysis (δD and $\delta^{18}O$) of SW and GW samples		♦	♦	♦	♦	
First Draft Report				♦		
Second Draft Report					♦	
Final Report						♦

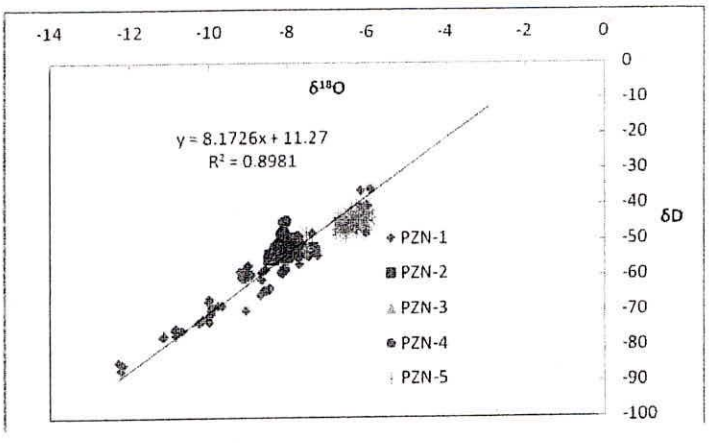
2. *REFERENCE NUMBER: NIH/HID/INT/2009-12*

1	**Title of the study**	**SURFACE WATER AND GROUNDWATER INTERACTION AT SELECTED LOCATIONS ALONG RIVER YAMUNA IN NCT, DELHI (*Phase-II*)**
2	**Name of PI, Co-PI, & their affiliations**	Dr. Sudhir Kumar, Scientist E2 (PI) Dr. MS Rao, Scientist C Sh. Pankaj Garg, Scientist B
3	**Type of study**	Internal (Refinement of the earlier study sponsored by UYRB, MoWR, GoI)
4	**Date of start** **Scheduled date of completion**	1st April, 2009 31st March, 2012
5	**Location map**	Study area lies in NCT Delhi near the border of Haryana and Uttar Pradesh. The floodplain is 1.2 – 1.5 km wide and is constrained by embankments on both the sides.
		
6	**Study objectives**	5. To study the surface water and groundwater interaction along river Yamuna in National Capital Territory of Delhi. 6. To determine the extent of surface water groundwater interaction.

7	**Statement of the problem**	The States falling in the Upper Yamuna Basin have an agreement on sharing of Yamuna River water. According to the agreement, Haryana has to release certain amount of water from Tajewala Barrage to maintain certain level of water at Wazirabad Barrage. Delhi has constructed 90 tube wells in the floodplains of the river Yamuna to extract groundwater. Haryana has an apprehension that these wells are inducing recharge from the river and thus they have to release more amount of water to maintain the ponding level at Wazirabad.
8	**Approved action plan**	**Appendix-2**
9	**Timeline and justification for time over runs**	**Appendix-2**
10	**Objectives vis-à-vis achievements**	

Objective	Status	Work Done
To study the surface water and groundwater interaction along river Yamuna in National Capital Territory of Delhi.	Achieved	Weekly samples have been collected from river water, 13 piezometers till date Rainfall samples also collected Samples analysed for isotopic characterisation till December 2010 Water level in piezometers is measured at weekly interval.
To determine the extent of surface water groundwater interaction.	Achieved	

11	**Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken**	NIL
12	**Analysis and Results** i) Groundwater samples have been collected from eighteen existing wells located along 2 cross sections almost perpendicular to the Yamuna River on the Delhi side. ii) Water level monitoring indicated that during the monsoon season of 2009 the recharge to the	

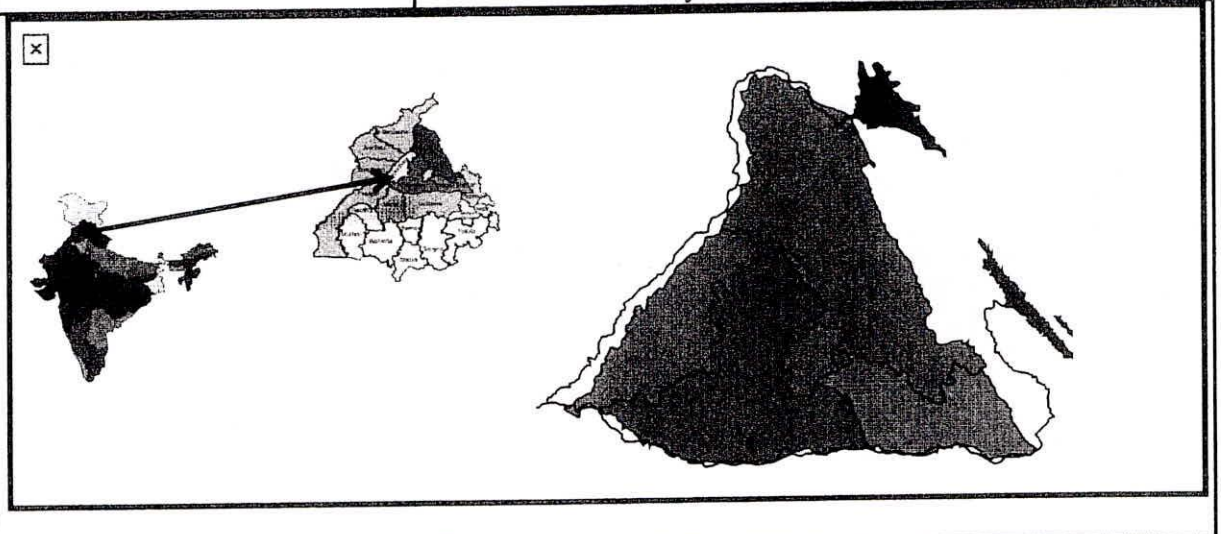
	floodplain was only up to 1.8 m whereas during 2008 it was up to 3.52 meters. iii) During the monsoon season of 2009 and 2010, the daily river water samples have been collected. The figure given below shows the variation of $\delta^{18}O$ in the river Yamuna during the monsoon season 2009 and 2010. iv) Isotopic variation in piezometers along section-II indicates that river usually interacts only upto piezometer no 1. After this the interaction of river is not significant. The other details along with interpretation of the data will be presented during the meeting.	**Daily $\delta^{18}O$ variation in river Yamuna water during 2009 and 2010 monsoon**  **$\delta^{18}O$- δ D relation in waters of piezometers along section-2.**
13	**Adopters of the results of the study and their feedback**	Delhi Jal Board and Upper Yamuna River Board
14	**List of deliverables**	Report & Paper
15	**Major items of equipment procured**	NIL
16	**Lab facilities used during the study**	Isotope Ratio Mass Spectrometer
17	**Data procured and/or generated during the study**	Isotopic Data and water level data at 13 locations within the Yamuna Floodplain in Palla area
18	**Study Benefits / Impact**	Quantification of the groundwater recharge from Yamuna river has been computed
19	**Specific linkages with Institutions and/or end-users/beneficiaries**	Upper Yamuna River Board
20	**Shortcomings / difficulties, if any**	NIL
21	Future plan	The project shall be closed in March 2011

Appendix – 2

ACTION PLAN WITH TIME LINE FOR THE STUDY ON ASSESSMENT OF GROUNDWATER RESOURCES & DEVELOPMENT POTENTIAL OF YAMUNA FLOOD PLAIN, NCT DELHI

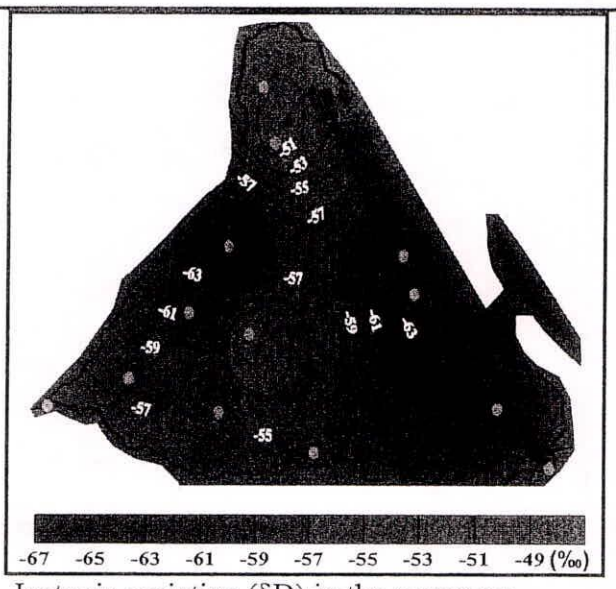
Activity	1st	2nd	3rd	4th	Primary Responsibility
Collection of all required data	♦				DJB / CGWB
Compilation of existing hydrogeological data	♦				DU / CGWB
Identification of Data Gaps	♦				NIH+ others
Identification of wells for water level monitoring	♦				CGWB
Establishment of field stations, if required	♦	♦			CGWB
Infiltration tests	♦				NIH / IITD
Identification of wells for WQ monitoring	♦				IITD
RL Survey of GW wells	♦				CGWB
Groundwater level monitoring	♦	♦	♦		CGWB
Pump Tests to determine Sp. Yield and hyd. Con / Transmissivity		♦			CGWB
Collection of SW and GW samples for water quality and/or isotopic analysis		♦	♦		CGWB / IITD / NRL
Survey to determine groundwater draft/ any other relevant information from FP		♦	♦		CGWB
Development of Aquifer geometry in and around YFP			♦		DU / CGWB
Analysis of Water Quality of SW and GW samples		♦	♦		DPCC / CPCB
Analysis of stable isotopes (δD and $\delta^{18}O$) of SW and GW samples		♦	♦		NIH
Assessment of GW resources of the Yamuna FP in NCT Delhi			♦		CGWB / NIH
Estimation of Natural Recharge to groundwater			♦		CGWB / NIH
Determination of groundwater flow direction in reference to river Yamuna			♦		NIH
Delineation of groundwater contaminated areas with in Floodplain			♦		IITD
Identification of areas suitable for GW abstraction w.r.t. WQ			♦		IITD
Creation of GIS data base for GW modelling					NIH
Development of Conceptual model			♦		All
Calibration of Model			♦		All
Development of GW extraction scenarios			♦		NRL / IITD
Simulation of impact of GW abstraction on SW and GW resources			♦		NIH / IITD
Simulation of groundwater recharge in the Yamuna FP from Monsoon Floods				♦	NIH / CGWB
Report finalisation				♦	All

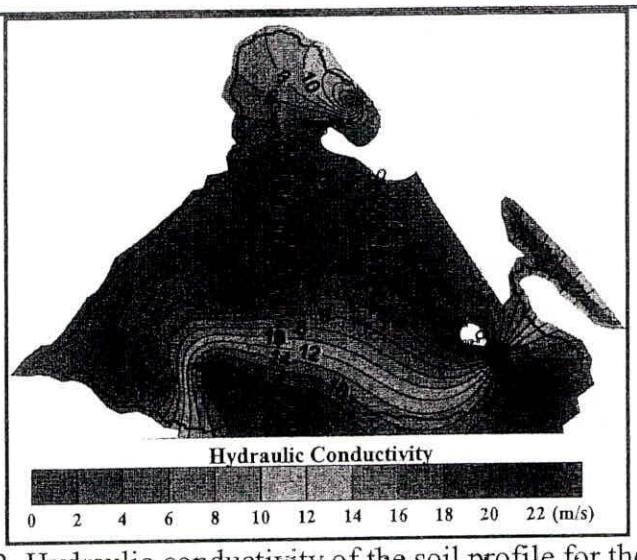
3. PROJECT REFERENCE CODE: NIH/HID/HP-II/09-12

1	**Title of the study**	**GROUNDWATER DYNAMICS OF BIST DOAB AREA, PUNJAB, USING ISOTOPES**
2	**Name of PI, Co-PI, & their affiliations**	Dr. BHISHM KUMAR (PL) Dr. M.S. RAO (PI)
3	**Type of study**	Sponsored PDS under HP-II
4	**Date of start** **Scheduled date of completion**	1st July, 2009 30th June, 2012
5	**Location map**	The Bist Doab (Fig 1) is a triangular region and covers an area of 9060 km^2. The area lies between $30^0$51' and $30^0$04' N latitude and $74^0$57' and $76^0$40' E longitude. It comprises the districts Hoshiarpur, Kapurthala, Jalandhar and Nawanshahar districts and parts of the districts Roop Nagar of Punjab State, India. It is bounded by Shiwaliks in the north-east, the river Beas in the north east-south west and the river Satluj in south east-south west. The area is drained by the perennial rivers Satluj and Beas and their tributaries. They coalesce at the Harike. The climate of the area is influenced by the Himalayas in the north.
		
6	**Study objectives**	Identifying groundwater recharge zone and recharge sources using groundwater dating and stable isotope technique Groundwater modelling
7	**Statement of the problem**	The BIST- DOAB region, region between R. Satluj and R. Beas, experiences high amount of groundwater depletion due to increased agricultural activities. Hence, it is imperative to identify the recharge zones and recharge source of groundwater.

8	**Approved action plan**	**Appendix- 3**
9	**Timeline and justification for time over runs**	**Appendix- 3**
10	**Objectives vis-à-vis achievements**	

Objective	Status	Work Done
Identifying groundwater recharge zone and recharge sources using groundwater dating and stable isotope technique	In Progress	10 daily samples have been collected from river water, groundwater have been collected. Rainfall samples also collected. Samples analysed for isotopic characterisation till December 2010 and samples have been collected up to Mar 2011
Groundwater Modelling	In Progress	DEM downloaded, Collected district level landuse data for 20yrs,

11	**Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken**	NIL
12	**Analysis and Results** The analysis of water samples for Hydrogen have been completed for the previous field work samples (9 BIST) till Sep. 2010 and that for Oxygen (9 BIST) and 10 BIST (Both Oxygen and Hydrogen) till Dec. 2010 are on queue. Weighted average of isotopic variation (δD) in the monsoon precipitation are shown in fig..1	 Fig 1. Isotopic variation (δD) in the monsoon precipitation

	The hydraulic conductivity of the soil profile for the top 10m in the study area have been calculated using the available strata charts Fig. 2.	 Fig 2. Hydraulic conductivity of the soil profile for the top 10m
13	**Adopters of the results of the study and their feedback**	CGWB (NWR), Chandigarh and Punjab Water Resources Development and Management Department
14	**List of deliverables** (e.g. equipment, papers, reports, software, manuals, brochures, flyers, training programmes, users interaction workshops)	Organized Regional Workshop on Water Availability and Management in Punjab Held at Chandigarh during December 13-15, 2010. The findings & recommendations were printed (Annexure: 1). Two papers based on the data generated under the present PDS investigations were also presented. • Assessment of water quality in groundwater in Bist-Doab region. Rao, M.S, Gupta, A. K., Kumar, B., Krishan, G., Kumar, B., Rawat, Y. S., Marwah, S. and Gupta, S. • Isotopic characteristics of water in Bist-Doab and their hydrological significance. Rao, M.S, Purushothaman, P., Kumar, B., Krishan, G., Rawat, Y. S., Gupta, V. and Garg, P. (2010)
15	**Major items of equipment procured**	NIL
16	**Lab facilities used during the study**	Isotope Ratio Mass Spectrometer
17	**Data procured and/or generated during the study**	Isotopic Data for the entire BIST- DOAB region was generated Water quality, depth to water table and strata charts from CGWB have been procured
18	**Study Benefits / Impact**	Generated various thematic maps (GW Flow Pattern etc) Organized Regional Workshop WAMIP-2010 Developed collaborations/network with CGWB (NWR), Chandigarh and Punjab Water Resources Development and Management Department

		Generated data base through sample survey and data collection.
19	**Specific linkages with Institutions and/or end-users/beneficiaries**	Punjab Water Resources Development and Management Department Punjab Water Supply and Sanitation Department
20	**Shortcomings / difficulties, if any**	Aquifer specific Water sampling from deep piezometers, Procurement and installation of field based instruments/equipments
21	**Future plan**	• Installation of AWLR (6 nos.) in selected piezometers in consultation with CGWB, NWR, Chd. • Fence diagram - WQ+Isotope data • Groundwater Modeling. • Final Report

Appendix-3

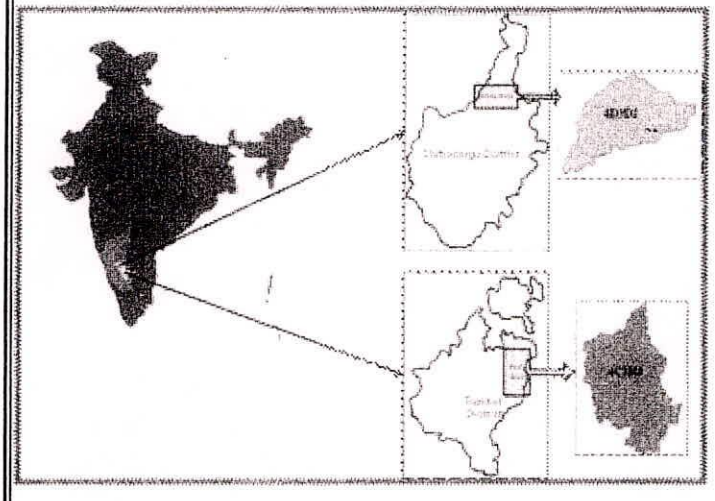
ACTION PLAN WITH TIME LINE FOR THE STUDY ON GROUNDWATER DYNAMICS OF BIST DOAB AREA, PUNJAB, USING ISOTOPES

Activity	Apr. 2011- Mar. 2012			
	1st	2nd	3rd	4th
Collection of field related data (Rainfall and groundwater level)	✓	✓	✓	
Appointment of laboratory staff (R.A and Senior Technician)	✓			
Procurement & Installation of field/laboratory instruments	✓	✓		
Collection of groundwater, surface water, precipitation	✓	✓	✓	✓
Surface water and groundwater data processing	✓	✓	✓	
Procurement of software				
Construction and installation of piezometers at crucial locations, if required	✓	✓		
Mathematical modelling for groundwater potential, optimum pumping, conjunctive use and watershed management.		✓	✓	
GIS and remote sensing based analysis of irrigation water management and conjunctive use based data analysis for groundwater flow pattern and velocity.	✓	✓	✓	
Identification of recharge zones and recharge sources.		✓	✓	
Integration of water quality, stable & radioactive isotope data and field data along with modelling to develop a general scenario for groundwater flow in aquifers.		✓	✓	

Activity	Apr. 2011- Mar. 2012			
	1st	2nd	3rd	4th
Collection of field related data (Rainfall and groundwater level)	✓	✓	✓	
Preparation of final report and publications			✓	✓

4. *PROJECT REFERENCE CODE : NIH/HID/HP-II/09-12*

1	**Title of the study**	**GROUNDWATER MANAGEMENT IN OVER-EXPLOITED BLOCKS OF CHITRADURGA AND TUMKUR DISTRICTS OF KARNATAKA**
2	**Name of PI, Co-PI, & their affiliations**	Dr. Sudhir Kumar (PI), NIH Dr. Jaivir Tyagi, NIH Dr. Vijay Kumar, NIH Dr. SP Rai, NIH Dr. Anupama Sharma, NIH Dr. BK Purendra, NIH, HRRC, Belgaum
3	**Type of study**	Sponsored PDS under HP-II
4	**Date of start** **Scheduled date of completion**	1st July 2009 31st March 2012
5	**Location map**	

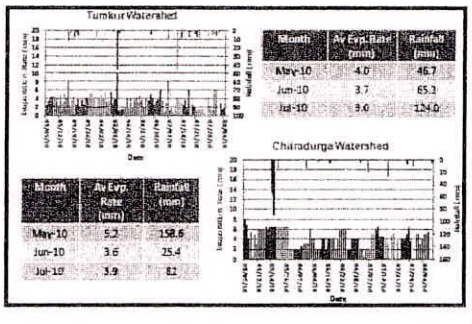


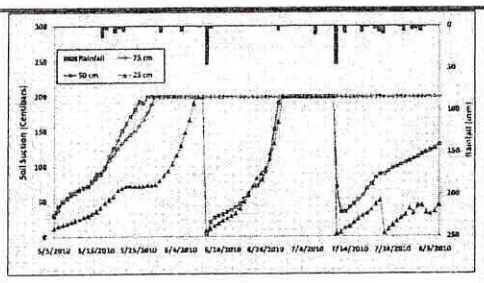
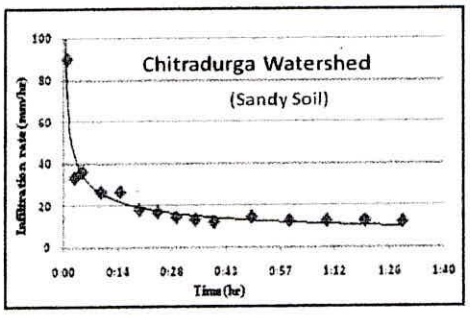
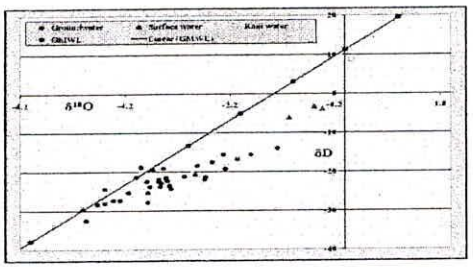
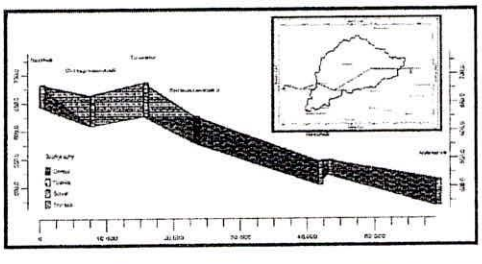
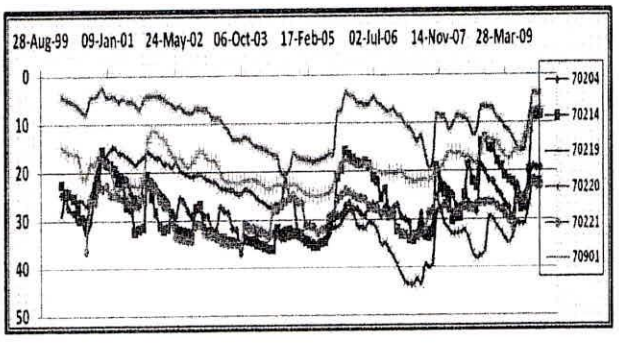
District	Tumkur	Chitradurga
Talus	Kortagere (80%) Tumkur (20%)	Challakere (93%) Molakalmuru (7%)
Watershed	4C3H4	4D3D2
Latitude	$13^0 14'$ - $13^0 44'$ N	$14^0 17'$ - $14^0 34'$ N
Longitude	$77^0 02'$ - $77^0 28'$ E	$76^0 22'$ - $76^0 49'$ E
Area	89846 ha	64843 ha
Elevation	618-1261 m	461-902 m
Basin	Pennar Basin	Lower Tungbhadra
Main Stream	Suvarnamukhi	Garani Halla
Geology	Granitic Gneiss	Gneiss, Schist
Stage of GW development	233 %	140%

		Command / Non Command	Non Command	Non Command
		Agroclimatic zone	Central and Eastern dry zone	Central dry zone
		Soils	Red sandy soil and Red loamy soil	Red loamy soil
6	**Study 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		
7	**Statement of the problem**	Today groundwater resources are exploited as a common pool resource in an open access framework by one and all. This has resulted in over exploitation of groundwater resources leading to falling groundwater levels and deterioration of groundwater quality. The accessibility and availability of groundwater in space and time is the biggest advantage of groundwater. Further, surface water availability is prone to high variability in space and time due to erratic monsoon rainfall conditions in south East Asian countries including India. Therefore there is a growing realization among hydrologists, hydro-geologists and socio-economic scientists that groundwater development and its management is key to poverty alleviation in developing countries, wherein large sections of rural population are illiterate and their livelihood support depends on low productive agriculture.		
8	**Approved action plan**	**Appendix 4**		
9	**Timeline and justification for**	**Appendix 4.** The procurement of data and instruments has		

	time over runs	delayed the work schedule
10	**Objectives vis-à-vis achievements**	

Objective	Achievement
To analyze groundwater productivity at specific study sites including artificial recharge structures and an assessment of potential increases and their contribution to rural livelihood improvement.	Work in progress
To develop integrated understanding of hydrologic, social, economic, and institutional perspectives.	Work in progress
To improve stakeholder engagement and community participation for developing a common vision, goal and partnership for managing Basin's groundwater resources.	Work in progress
To identify anthropogenic interventions and evaluate their likely impact for effective groundwater management.	Work in progress
To arrive at a model for management and regulation of identified over-exploited blocks on an operational basis.	Work in progress

11	**Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken**	Dr. Gurunadha Rao suggested that, if possible, groundwater samples should be collected from few locations, near and little away, to some large size tanks and vertical sampling should also be done from the tanks to understand the tanks and groundwater interactions.
12	**Analysis and Results** 	• Two watersheds have been identified in the Tumkur and Chitradurga districts for carrying out groundwater management studies. • Hydrometeorological Instruments (Evaporation pan, Soil moisture sensors and Rain gauge) have been installed in the field and data is being analysed. • GIS Database has been prepared for both the watersheds including Base map, Drainage map, Road map and Water storage structures maps etc. • Infiltration tests conducted at 16 locations in both the watersheds. • Water level data (Depth to water level and reduced water level) have been collected for about 14

	   	observation wells in Chitradurga watershed (only for 2009) and 15 in Tumkur watershed (from 1971 to 2009). and contours prepared. • Rainfall data of 8 rain gauge stations for Chitradurga watershed (from 2004 to 2008) and 16 rain gauge stations for Tumkur watershed (from 1971 to 2008) is being analyzed. • Litholog data has been analysed, lithological sections of both the watersheds prepared. • Water Quality data have also been collected for 13 observation wells for Chitradurga watershed (2009) and 20 for Tumkur watershed (from 1997 onwards). • About 35 groundwater samples from Chitradurga and Tumkur watershed have been collected and analysed for Stable isotopic analysis. 
13	**Adopters of the results of the study and their feedback**	Karnataka Government, the States with hard rock aquifers
14	**List of deliverables** (e.g. equipment, papers, reports, softwares, manuals, brochures, flyers, training programmes, users interaction workshops)	Report, papers, methodology, brochure and training program
15	**Major items of equipment procured**	Automatic Rain Gauges and water level recorders
16	**Lab facilities used during the study**	Isotope lab, Soil water lab and Hydrological Investigations lab

17	**Data procured and/or generated during the study**	Remote Sensing data
18	**Study Benefits/Impact**	
19	**Specific linkages with Institutions and/or end-users/beneficiaries**	The output from the study is expected to provide policy guidelines for developing, managing and regulating groundwater resources on a sustainable basis for over exploited regions.
20	**Shortcomings / difficulties, if any**	Delay in procurement of data and instruments Lack of historical data
21	**Future plan**	As per activity chart

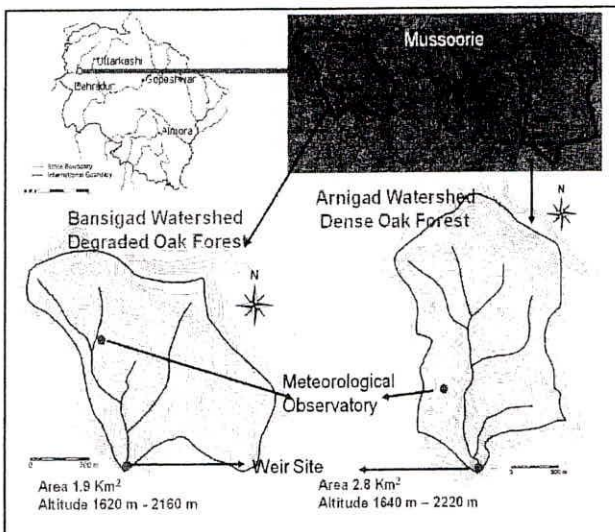
Appendix – 4

ACTION PLAN WITH TIME FOR THE STUDY ON GROUNDWATER MANAGEMENT IN OVER - EXPLOITED BLOCKS OF CHITRADURGA AND TUMKUR DISTRICTS OF KARNATAKA

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
Selection of watersheds	♦	♦										
Reconnaissance surveys		♦	♦									
Data collection (historical)		♦	♦									
Problem conceptualization			♦	♦								
Meetings with participating agencies	♦	♦										
Appointment of project staff	♦	♦	♦									
Procurement of Equipment	♦	♦	♦	♦								
Socio-Economic analysis									♦	♦		
Installation of Equipment					♦	♦						
Procurement of software				♦	♦	♦						
Database development			♦	♦	♦	♦	♦	♦	♦			
Field interventions to promote artificial recharge								♦	♦	♦	♦	
Development of conceptual model									♦			
Development of GW utilization guidelines										♦	♦	
Capacity building and training programs								♦	♦			♦
Report writing											♦	♦

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

1	**Title of the study**	**IMPACT ASSESSMENT OF LANDUSE ON THE HYDROLOGIC REGIME IN THE SELECTED MICRO-WATERSHEDS IN LESSER HIMALAYAS, UTTARAKHAND**
2	**Name of PI, Co-PI, & their affiliations**	Dr. S. P Rai, Sc. 'E1'(PI), Dr. Bhishm Kumar Sc. 'F' and Dr. J.V. Tyagi Sc' E2'from NIH with Sh. Rajeev Tiwari, IFS, FRI
3	**Type of study**	Collaborative with FRI, Dehradun Total: Rs. 3 lac (NIH Component)
4	**Date of start, scheduled date of completion**	April, 2008 March, 2013
5	**Location map**	



Area of watershed Arnigad Bansigad	 ~3 km^2 ~2 km^2
Landuse Arnigad Forest Cover (Dense Oak) Bansigad Forest Cover(Sparsed Mixed)	 86% 65%
Geology of both watershed	Similar
Geomorphology	Almost similar
Altitude variation Arnigad Bansigad	 1640-2220 m 1620-2160 m

6	**Study objectives**	• Impact of forest cover on stream discharge pattern • To separate surface runoff & ground water components in the stream discharge using conventional and isotopic technique. • Soil erosion under different forest cover • Identififaction of recharge zone of stream & springs using isotopic technique.
7	**Statement of the problem**	Efforts to understand the hydrology of the Himalayan region and impact of forests on watershed level are limited. Studies on the hydrology of the Himalayan Mountains have made it clear that the hydrological research conducted in this region so far is inadequate to support the commonly-held notion that deforestation and other anthropogenic activities by the mountain

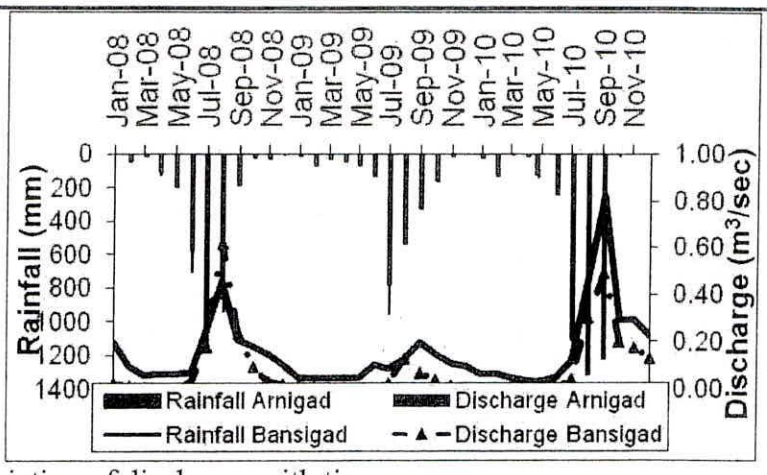
		inhabitants cause floods in the adjacent plains. Because major studies have been conducted at the experimental plot do not necessarily hold true at the catchments scale Mainly the studies conducted on plot scale or small catchments of only a few hectares lacks the continuous data of all extreme conditions so that unusual storm events are often not included in the study period. The impact of forests, which cover the head-waters of many of the major river systems of the Indo-Gangetic plains, could not be studied, mainly because of difficult terrain conditions and other logistical problems Therefore, to study the impact of forest cover on hydrology of Himalayan watersheds, this study was was started in collaboration of Forest Research Institute, Dehradun.
8	**Approved action plan**	**Appendix-5**
9	**Timeline and justification for time over runs**	**Appendix-5**
10	**Objectives vis-à-vis achievements**	

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

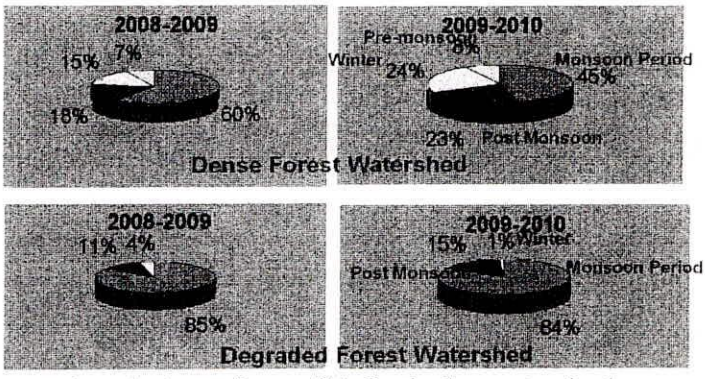
11	**Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken**	NIL
12	**Analysis and Results** • Two watersheds under varied forest cover Hydrometeorological data collection of both the watershed is continuing. • The compound weir (120^0 'V' Notch and rectangular)	

and automatic water level stage recorder have been installed in both watersheds for monitoring the continuous stream discharge.

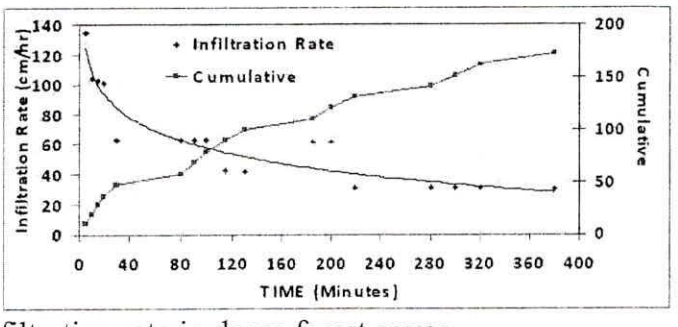
- Meteorological observatories have been installed near the outlet of each watershed for monitoring the rainfall, temperature, humidity and evaporation etc.
- The continuous data have been recorded since June 2008 onwards (Meteorological data on daily basis and stream discharge on continuous)
- Samples of streams, springs and handpump have been collected isotopic analysis and analysis is under progress.
- Infiltration tests conducted in the both watershed under different landuse conditions
- Monitoring of the sediment data is in progress.
- Rainfall and runoff on the monthly basis has been computed.
- Recharge to groundwater in the both water shed has computed.
- Analysis of soil loss using SWAT model is in progress.



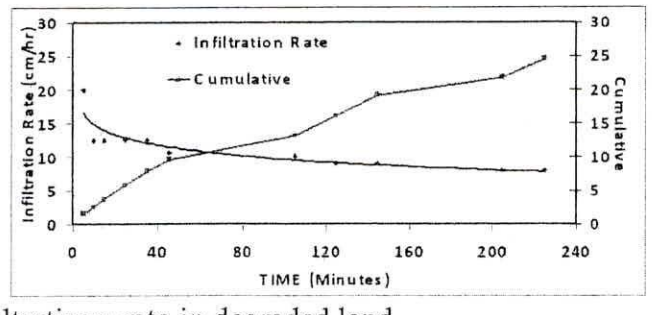
Variation of discharge with time



Seasonal variation of runoff in both the watersheds



Infiltration rate in dense forest cover



Infiltrationn rate in degraded land

13	**Adopters of the results of the study and their feedback**	R & D organizations, and state forest departments, also watershed conservation and management agencies.
14	**List of deliverables**	Papers
15	**Major items of equipment procured**	NIL
16	**Lab facilities used during the study**	Isotope and Hydrological Investigations Laboratory
17	**Data procured and/or generated during the study**	Hydrometeorological data and Isotopic data of the both the watershed.
18	**Study Benefits / Impact**	

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

19	**Specific linkages with Institutions and/or end-users/beneficiaries**	FRI
20	**Shortcomings/difficulties, if any**	Working as project partner
21	**Future plan**	Rainfall-runoff modeling using SWAT

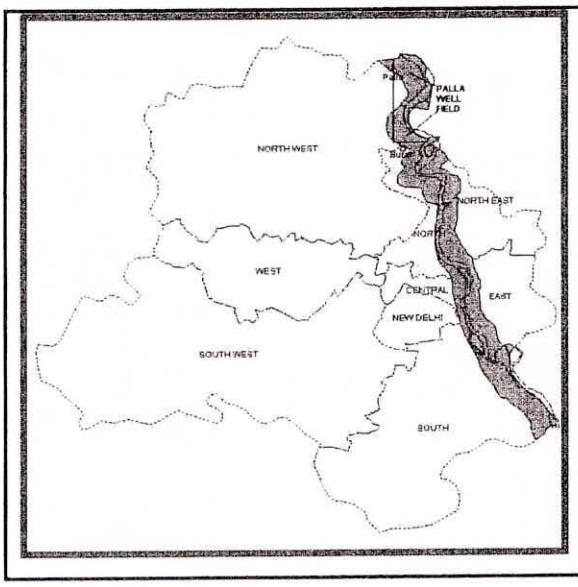
Appendix-5

ACTION PLAN WITH TIME LINE FOR THE STUDY ON IMPACT ASSESSMENT OF LANDUSE ON THE HYDROLOGIC REGIME IN THE SELECTED MICRO-WATERSHEDS IN LESSER HIMALAYAS, UTTARAKHAND

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th
Collection discharge data with the help of FRI	♦	♦	♦	♦	♦			
Collection of meteorological data with the help of FRI	♦	♦	♦	♦	♦			
Identification of Data Gaps	♦							
Collection of water samples for isotopic(δD and $\delta^{18}O$) analysis	♦	♦	♦	♦				
Measurement of δD and $\delta^{18}O$)	♦	♦	♦	♦	♦	♦		
Rainfall runoff analysis on monthly basis		♦	♦	♦				
Hydrograph separation using the isotope data			♦	♦	♦	♦		
Establishment of altitude effect		♦	♦	♦				
Identification of recharge zones of springs and streams				♦	♦	♦		
Estimation of Natural Recharge to groundwater		♦	♦					
Creation of GIS data base for SWAT		♦	♦					
Analysis of data using SWAT			♦	♦				
Development of Conceptual model				♦	♦			
Calibration of Model					♦	♦		
First Draft Report						♦		
Second Draft Report							♦	
Final Report								♦

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

1	**Title of the study**	**ASSESSMENT OF GROUNDWATER RESOURCES & DEVELOPMENT POTENTIAL OF YAMUNA FLOOD PLAIN, NCT DELHI**
2	**Name of PI, Co-PI, & their affiliations**	Dr. Sudhir Kumar, NIH (PI) with investigators from CGWB, CWC IIT Delhi, DU, NRL, and DJB
3	**Type of study**	Consultancy Delhi Jal Board Total: Rs.36.267 lac (NIH Component: Rs.26.594 lac)
4	**Date of start, scheduled date of completion**	1st April, 2010 (Proposed to be extended upto December, 2011)
5	**Location map**	

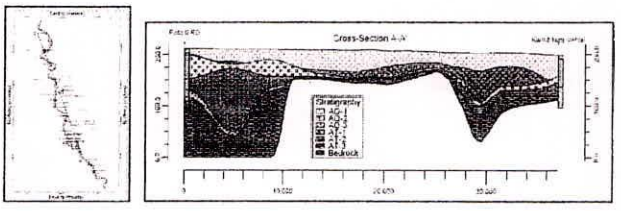
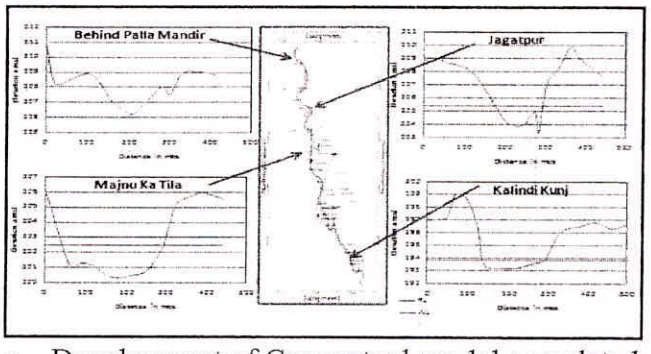
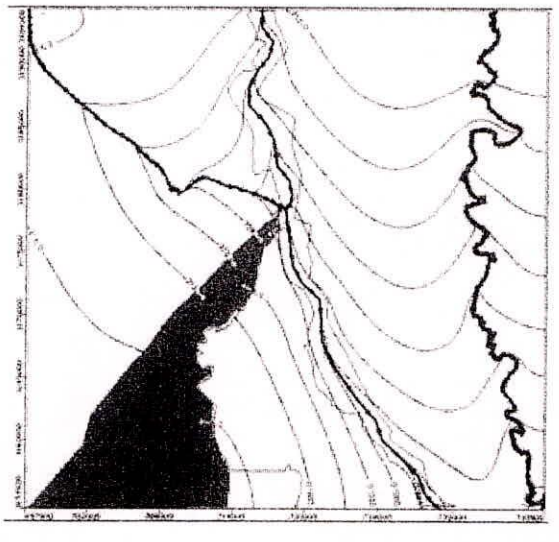


Area of NCT Delhi	≈ 1483 Km^2
Area of Yamuna FP in Delhi	≈ 97 Km^2 (7%)
Stretch of Yamuna in Delhi	≈ 35 Km
Curved length of river	≈ 50 Km
Area of FP under water during lean season	≈ 16.5 km^2 (17%)
Average slope of river bed	≈ 0.4 m/km
Width of Yamuna FP	1.5 to 3 km
Floodplain ground levels	216m to 193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

6	**Study objectives**	• Estimation of groundwater resources in the Yamuna floodplains. • Estimation of groundwater development potential in space and time through ground water simulation studies. • Assessment of the impact of groundwater extraction from floodplains on hydrological regime.

		• Assessment of groundwater quality vis-a-vis availability of drinking water.
7	**Statement of the problem**	The existing sources for water supply to NCT Delhi are not enough to meet the gross water requirement for all uses. Water from River Yamuna and its canal systems, Ganga and Satluj from BBMB are the main sources of water supply to Delhi, about 15 % requirements of Delhi are met from groundwater. Still there is a deficit of about 20 % of requirement. The floods during this period recharge the adjacent riverbanks in addition to the direct rainfall recharge in the alluvial flood plains in the vicinity of the river. The low flows during non-monsoon season are mostly from base flow and/or snowmelt runoff. Pumping from production wells along the banks from this naturally replenishing groundwater reservoir may help in meeting the demand during the non-monsoon season on a sustainable basis. Therefore, the study is aimed at finding the groundwater potential of the Yamuna floodplain falling within the Delhi territory.
8	**Approved action plan**	**Appendix 6**
9	**Timeline and justification for time over runs**	The project was to be completed by 31st March 2011. Due to unavailability of Prof AK Keshari, IITD, the work on water quality aspect could not be taken up. An extension of nine months is required for the same, as the work of IITD is also to be taken up by NIH.
10	**Objectives vis-à-vis achievements**	

Objective	Achievement
Estimation of groundwater resources in the Yamuna floodplains.	Groundwater draft from the YFP has been estimated
Estimation of groundwater development potential in space and time through ground water simulation studies.	Discharge data of Yamuna is being collected from CWC
Assessment of the impact of groundwater extraction from floodplains on hydrological regime.	Can be achieved after the model calibration
Assessment of groundwater quality vis-a-vis availability of drinking water.	Can be achieved after the model calibration

11	**Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken**	NIL
12	**Analysis and Results** • All available data with CGWB has been collected regarding lithologs, pump tests and water levels. • Groundwater levels are being monitored every month. • Samples for groundwater quality and isotopic analysis collected and analysed. • Infiltration tests conducted in the Yamuna flood plain • Litholog data has been analysed and aquifer geometry of the YFP finalised • Survey to determine groundwater draft / any other relevant information from floodplain has been completed • Estimation of Natural Recharge to groundwater has been completed • Groundwater flow direction with reference to river Yamuna has been established • Creation of GIS data base for GW modelling completed • River Cross-sections have been prepared	  • Development of Conceptual model completed • Calibration of model under progress ***STEADY STATE SIMULATION*** 
13	**Adopters of the results of the study and their feedback**	Delhi Jal Board

14	**List of deliverables** (e.g. equipment, papers, reports, softwares, manuals, brochures, flyers, training programmes, users interaction workshops)	Report and Papers
15	**Major items of equipment procured**	NIL
16	**Lab facilities used during the study**	Isotope and Hydrological Investigations Laboratory
17	**Data procured and/or generated during the study**	Isotopic data of the Yamuna floodplain Aquifer geometry of the Yamuna floodplain
18	**Study Benefits / Impact**	

Activity	Status
Collection of all required data	Completed
Compilation of existing hydrogeological data	Completed
Identification of Data Gaps	Completed
Identification of wells for water level monitoring	Completed
Establishment of field stations, if required	Completed
Infiltration tests	Completed
Identification of wells for WQ monitoring	Completed
RL Survey of GW wells	Completed
Groundwater level monitoring	Continued
Pump Tests to determine Sp. Yield and hyd. Con / Transmissivity	Could not be started, old data being used
Collection of SW and GW samples for water quality and/or isotopic analysis	Continued
Survey to determine groundwater draft/ any other relevant information from FP	Completed
Development of Aquifer geometry in and around YFP	Completed
Analysis of Water Quality of SW and GW samples	Not started
Analysis of stable isotopes (δD and $\delta^{18}O$) of SW and GW sampl s	Continued
Assessment of GW resources of the Yamuna FP in NCT Delhi	Continued
Estimation of Natural Recharge to groundwater	Continued
Determination of groundwater flow direction in reference to river Yamuna	Completed
Delineation of groundwater contaminated areas with in Floodplain	Not Started
Identification of areas suitable for GW abstraction w.r.t. WQ	Not Started
Creation of GIS data base for GW modelling	Completed
Development of Conceptual model	Continued
Calibration of Model	In progress
Development of GW extraction scenarios	Not Started
Simulation of impact of GW abstraction on SW and GW resources	Not Started
Simulation of groundwater recharge in the Yamuna FP from	Not Started

	Monsoon Floods		
	Report finalisation	Not Started	
19	Specific linkages with Institutions and/or end-users/beneficiaries	Delhi Jal Board	
20	Shortcomings/difficulties, if any	Bringing together the various partners and work as a cohesive team	
21	Future plan	The water quality work is to be started and modeling exercise to be completed	

Appendix – 6

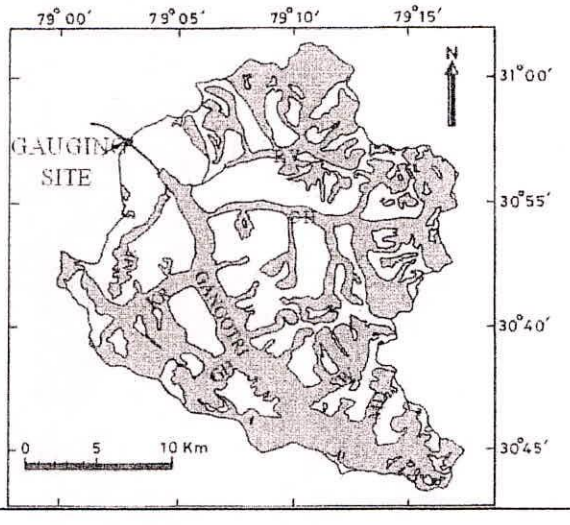
ACTION PLAN WITH TIME LINE FOR THE STUDY ON ASSESSMENT OF GROUNDWATER RESOURCES & DEVELOPMENT POTENTIAL OF YAMUNA FLOOD PLAIN, NCT DELHI

Activity	1st	2nd	3rd	4th	Primary Responsibility
Collection of all required data	♦				DJB / CGWB
Compilation of existing hydrogeological data	♦				DU / CGWB
Identification of Data Gaps	♦				NIH+ others
Identification of wells for water level monitoring	♦				CGWB
Establishment of field stations, if required	♦	♦			CGWB
Infiltration tests	♦				NIH / IITD
Identification of wells for WQ monitoring	♦				IITD
RL Survey of GW wells	♦				CGWB
Groundwater level monitoring	♦	♦	♦		CGWB
Pump Tests to determine Sp. Yield and hyd. Con / Transmissivity		♦			CGWB
Collection of SW and GW samples for water quality and/or isotopic analysis		♦	♦		CGWB / IITD / NRL
Survey to determine groundwater draft/ any other relevant information from FP		♦	♦		CGWB
Development of Aquifer geometry in and around YFP			♦		DU / CGWB
Analysis of Water Quality of SW and GW samples		♦	♦		DPCC / CPCB
Analysis of stable isotopes (δD and $\delta^{18}O$) of SW and GW samples		♦	♦		NIH
Assessment of GW resources of the Yamuna FP in NCT Delhi			♦		CGWB / NIH
Estimation of Natural Recharge to groundwater			♦		CGWB / NIH
Determination of groundwater flow direction in reference to river Yamuna			♦		NIH
Delineation of groundwater contaminated areas with in			♦		IITD

Activity	1st	2nd	3rd	4th	Primary Responsibility
Floodplain					
Identification of areas suitable for GW abstraction w.r.t. WQ			♦		IITD
Creation of GIS data base for GW modelling					NIH
Development of Conceptual model			♦		All
Calibration of Model			♦		All
Development of GW extraction scenarios			♦		NRL / IITD
Simulation of impact of GW abstraction on SW and GW resources			♦		NIH / IITD
Simulation of groundwater recharge in the Yamuna FP from Monsoon Floods				♦	NIH / CGWB
Report finalisation				♦	All

7. REFERENCE NUMBER: NIH/HID/INT/2010-13

1	**Title of the study**	**STUDY OF VARIABILITY OF SNOW AND GLACIER MELT CONTRIBUTION IN MELT WATER OF GANGOTRI GLACIER AT GAUMUKH USING ISOTOPIC TECHNIQUES**
2	**Name of PI, Co-PI, & their affiliations**	Dr. S.P. Rai Sc 'E1', Dr Manohar Arora Sc. 'C', Dr. Bhishm Kumar Sc 'F', Dr. Rakesh Kumar Sc. 'F'and Sh. Naresh Kumar
3	**Type of study**	Internal
4	**Date of start, scheduled date of completion**	: April, 2010
5	**Location map**	

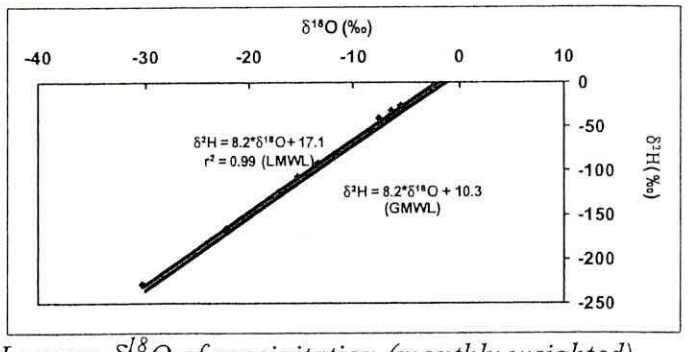


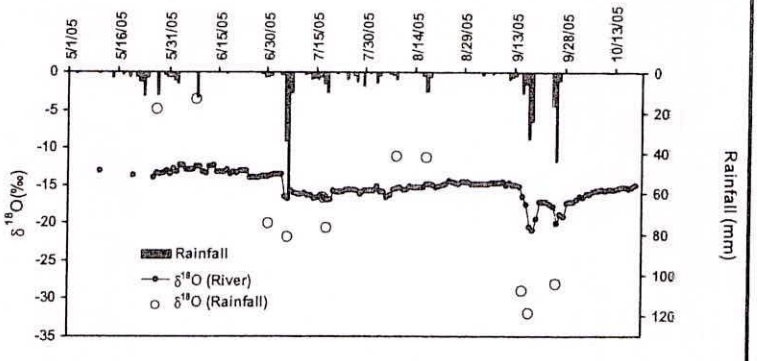
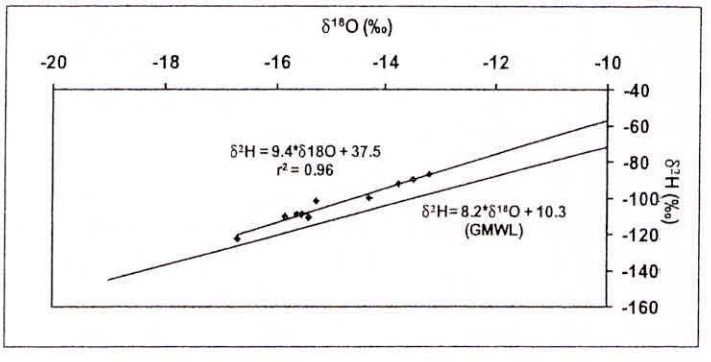
Glacier Type	Valley
Elevation Range	4000-7000 m
Length	30 km
Width:	~0.2 to2.35 km
Total Area: Glacerised Area	~556 km^2: ~286 km^2

6	**Study objectives**	• Isotopic Characterisation of Melt Water and individual components (Snow- Glacier melt, groundwater, rainfall-runoff) • Estimation of Snow and Glacier melt contribution separately and its variability with time
7	**Statement of the problem**	The snow and glacier melt runoff contributes significantly to all north India Himalayan rivers during summer when demand of water increases for hydropower, drinking and irrigation etc. Due to lack of information on hydrological processes of snow/glacier regime and assured availability of melt water, water resources management policies at lower reaches of the glacier fed rivers are often formulated without considering the impact of snow and glacier on river hydrology. Himalayan glaciers are sensitive indicator of climate

		changes as the worlds other mountains glacier. Snow and glacier melt isotopic composition can provide information on atmospheric circulation such as responses to climatic fluctuations, changes in the strength of south west summer monsoon, and western disturbances Therefore this study has been taken to study the isotopic composition of snow, rain, ice and meltwter which will be useful in separation of various component of stream discharge and in long term will be useful to understand the source of moisture and impact of climate change on melting patter.
8	**Approved action plan**	**Appendix-7**
9	**Timeline and justification for time over runs**	**Appendix-7**
10	**Objectives vis-à-vis achievements**	

Objective	**Achievement**
Isotopic Characterisation of Melt Water and individual components (Snow- Glacier melt, groundwater, rainfall-runoff).	Samples are collected for the ablation period 2004, 2005, 2006 2007, 2008 and 2010
Estimation of Snow and Glacier melt contribution separately and its variability with time	Isotopic characterization of snow/glacier for premonsoon, monsoon and post monsoon have been developed along with rainfall

11	**Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken**	NIL
12	**Analysis and Results** • The plot of δ^2H versus $\delta^{18}O$ for all precipitation samples collected during the ablation period of 2004 and 2008. The Local Meteoric Water Line (LMWL) developed as δ^2H = 8.2 (±0.10) x $\delta^{18}O$ + 17.1 (±1.53) (n = 15, r2 = 0.99) for a complete ablation period which is showing higher slope and y intercept in comparison	 *δ^2H versus $\delta^{18}O$ of precipitation (monthly weighted) during the ablation period 2004 and 2008.*

	to from the GMWL .. • The isotopic signature of the fresh snow and surface ice samples collected from different altitudes in the accumulation and ablation zones of the Western Himalayan glaciers by various workers and under the present study from Gangotri glacier are between -4.5‰ and -14‰ for snow and -13‰ to -25‰ for glacier. • It has been observed that the isotopic values of melt initially follow the average $\delta^{18}O$ values of snow ranged between -12‰ to -13.8‰. • The abrupt change in $\delta^{18}O$ values during the rainfall reflects the contribution from the rainfall-runoff to the stream. • $\delta^{2}H$ vs $\delta^{18}O$ plot for the meteoric water line developed for melt water of Gangotri Glacier at Gomukh site and the best fit line is $\delta^{2}H=9.4 \pm 0.7*\delta^{18}O + 37.5 \pm 9.7$, $R^2 = 0.96$, n = 16 (2004-2005), which is consistent with LMWL of higher Himalayan snow and glacier with a slope of 8.7 and intercept of 29.9.	 *Variation of $\delta^{18}O$ in melt water during ablation period of 2005.*  *$\delta^{2}H$ versus $\delta^{18}O$ of meltwater (monthly weighted) during the ablation period 2004 and 2008.*
13	**Adopters of the results of the study and their feedback**	R & D organizations
14	**List of deliverables** (e.g. equipment, papers, reports, softwares, manuals, brochures, flyers, training programmes, users interaction workshops)	Papers
15	**Major items of equipment procured**	NIL
16	**Lab facilities used during the study**	Isotope and Hydrological Investigations Laboratory

17	**Data procured and/or generated during the study**	Isotopic data of the snow, ice, meltwater and rainfall at the altitude of 3800 m.
18	**Study Benefits / Impact**	

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

19	**Specific linkages with Institutions and/or end-users/beneficiaries**	NIL
20	**Shortcomings/difficulties, if any**	Collection of samples at high altitude
21	**Future plan**	Hydrograph separation using the isotopic techniques.

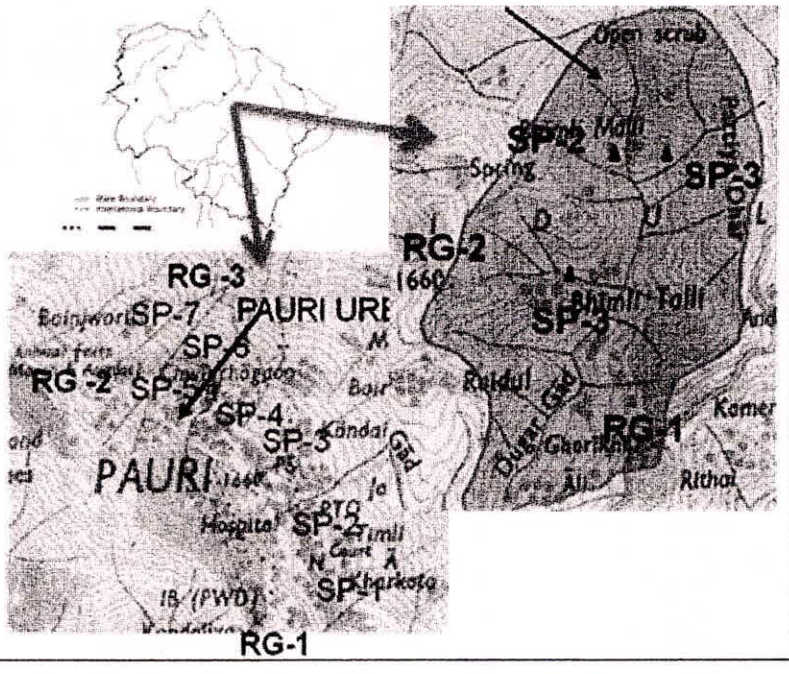
Appendix-7

ACTION PLAN WITH TIMELINE FOR THE STUDY ON ESTIMATION OF SNOW AND GLACIER MELT CONTRIBUTION IN MELT WATER OF GANGOTRI GLACIER AT GAUMUKH USING ISOTOPIC TECHNIQUES

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th
Collection of melt water, precipitation, ice and snow samples for isotopic(δD and $\delta^{18}O$) analysis	♦	♦			♦	♦		
Measurement of δD and $\delta^{18}O$ in laboratory			♦	♦		♦	♦	
Development of meteoric water line for melt water			♦	♦			♦	
Establishment of moisture source				♦	♦		♦	
Analysis of discharge data				♦	♦	♦	♦	
Separation of different component of meltwater using the isotope model				♦	♦	♦	♦	
First Draft Report						♦		
Second Draft Report							♦	
Final Report								♦

8. *REFERENCE NUMBER: NIH/HID/INT/2010-13*

1	**Title of the study**	**DEVELOPMENT OF SPRING SANCTUARIES IN AN URBAN AND A RURAL WATERSHEDS IN DISTRICT PAURI GARHWAL, UTTARAKHAND**
2	**Name of PI, Co-PI, & their affiliations**	Dr. S.P. Rai Sc 'E1', Dr. Bhishm Kumar Sc 'F', Dr. Sudhir kumar, Sc 'E2', and Sh. Pankaj Garg Sc. 'B'
3	**Type of study**	Internal
4	**Date of start, scheduled date of completion**	April, 2010
5	**Location map**	

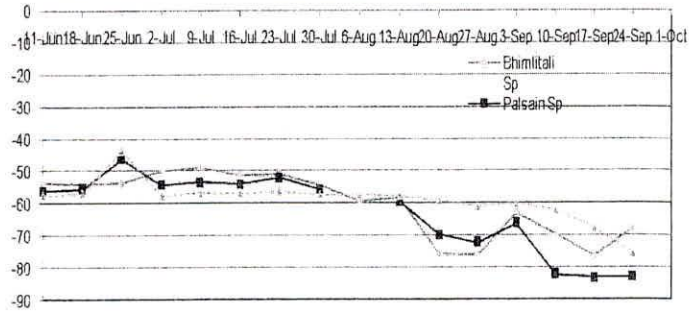


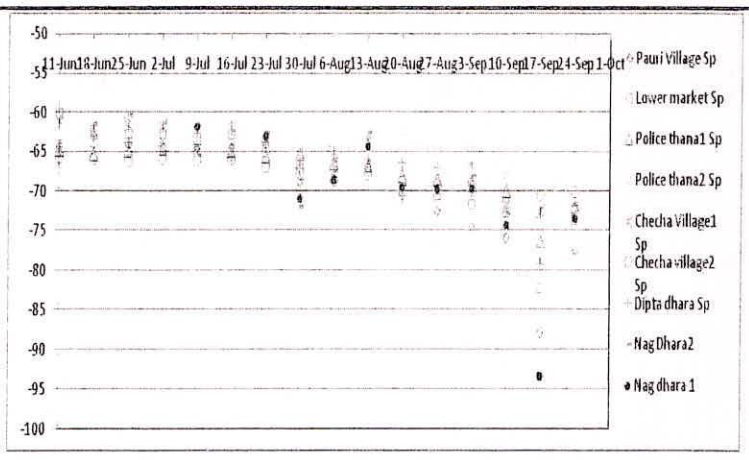
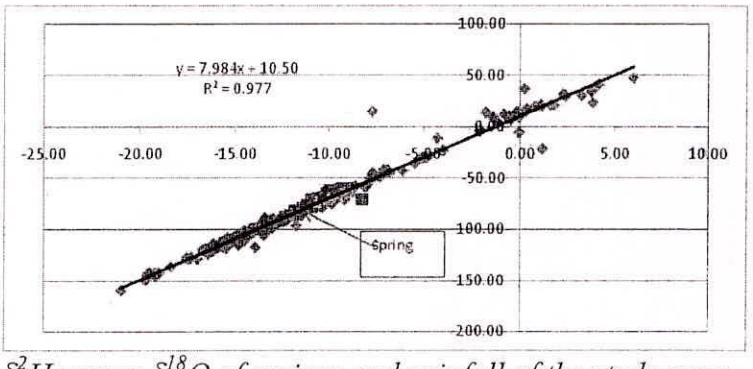
Study Area	
Pauri Town	
Dugar Watershed	

6	**Study objectives**	• To decipher the recharge zone of springs falling in the study area. • To analyze the relationship between rainfall, evaporation, landuse/land cover and ecological factors with spring discharge (GBPIHED, Srinagar) • Formulation of strategies to implement spring sanctuary strategy in the identified recharge area in order to enhance the discharge
7	**Statement of the problem**	Ground water flow in the form of springs and seepages in the hilly terrain. Springs are the major source of drinking and other household activities in the hilly terrain. The dwindling of discharges of springs and spring fed streams in the populated Lesser Himalayan terrain of Western Himalayas

		has become a matter of serious concern. In this connection, Jal Sansthan Uttarakhand has approached to NIH for identification of recharge zone. GBPIHED, Srinagar Unit has approached to NIH for collaborative study of recharge zone identification and implementation of recharge techniques. The fundamental question related to Springs are: ❖ Where did water originates? ❖ How fast is the Water moving? ❖ How much water is flowing? ❖ Is discharge declining? ❖ How we can rejuvenate drying springs?
8	**Approved action plan**	**Appendix-8**
9	**Timeline and justification for time over runs**	**Appendix-8**
10	**Objectives vis-à-vis achievements**	

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

11	**Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along with the action taken**	NIL
12	**Analysis and Results** • The plot of δ^2H springs samples collected from Dugargad watershed show the depletion after the July and maximum depletion is in the month of September. • Similarly, springs samples collected from Pauri city show the depletion after the July and maximum depletion is in the month of September • The plot of δ^2H versus $\delta^{18}O$	 Variation of δ^2H *in springs of Dugar gad watershed*

	for all springs and rainfall samples collected during June to September 2010 show the Local Meteoric Water Line (LMWL) as $\delta^2H = 8.0) \times \delta^{18}O + 10.5$ which is similar to GMWL . • These results indicate that source of these springs are local precipitation. • Establishment of altitude effect is under process which will help to identify the recharge zones of springs.	 Variation of δ^2H *in springs of Pauri city*  δ^2H *versus* $\delta^{18}O$ *of springs and rainfall of the study area.*
13	**Adopters of the results of the study and their feedback**	Jalsansthan Uttarakhand
14	**List of deliverables**	
15	**Major items of equipment procured**	NIL
16	**Lab facilities used during the study**	Isotope and Hydrological Investigations Laboratory
17	**Data procured and/or generated during the study**	Isotopic data of the springs and rainfall of study area
18	**Study Benefits / Impact**	

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

19	**Specific linkages with**	NIL

	Institutions and/or end-users/beneficiaries	
20	**Shortcomings/difficulties, if any**	
21	**Future plan**	.

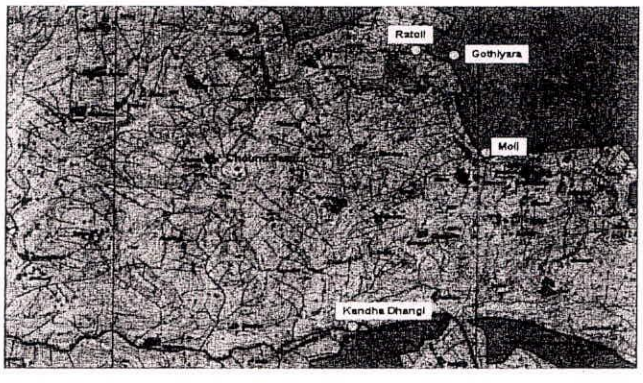
Appendix-8

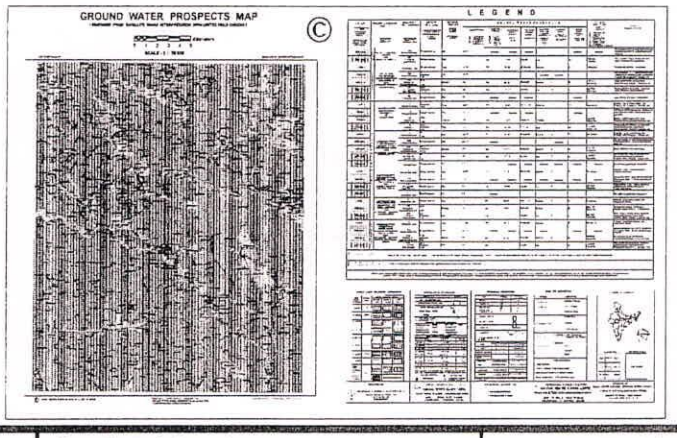
ACTION PLAN WITH TIME LINE FOR THE STUDY ON DEVELOPMENT OF SPRING SANCTUARIES IN AN URBAN AND A RURAL WATERSHEDS IN DISTRICT PAURI GARHWAL, UTTARAKHAND

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th
Collection of spring, rainfall and stream samples for isotopic(δD and δ^{18}O) analysis with the help of GBPIHED, Srinagar unit	♦	♦	♦	♦	♦	♦		
Measurement of δD and δ^{18}O in laboratory	♦	♦	♦	♦	♦	♦	♦	
Development of meteoric water line for spring, rainfall etc			♦	♦		♦	♦	
Establishment Altitude effect				♦	♦			
Analysis of discharge data of spring and its relationship with isotope data			♦	♦		♦	♦	
Estimation of recharge zones of spring					♦	♦		
Formulation of strategies for development of spring sanctuaries						♦	♦	
First Draft Report						♦		
Second Draft Report							♦	
Final Report								♦

9. *PROJECT REFERENCE CODE: NIH/HID/INT/10-12*

1	**Title of the study**	**IDENTIFICATION OF RECHARGE ZONES OF SOME SELECTED SPRINGS OF UTTARAKHAND USING ISOTOPES**
2	**Name of PI, Co-PI, & their affiliations**	Dr. S. D. Khobragade, Sc-E1, HID, NIH (PI) Dr. Bhishm Kumar, Sc-F; Dr. Sudhir Kumar, Sc-E2; Dr. S. P. Rai, Sc-E1And Sh. Pankaj Garg, Sc-B.
3	**Type of study (sponsored/ consultancy/ referred/ internal). If referred, mention the reference**	Referred. The study has been taken up on the request of Uttarakhand Jalsansthan, Dehradun.
4	**Date of start, scheduled date of completion**	Date of Start: April, 2010 Scheduled date of completion: March, 2012.
5	**Study area:**	





Location	4 Springs located in the Chandrabhaga Watershed in Jakhanidhar Block, Devprayag in Tehri Garhwal district of Utarakhand in the catchment of river Bhagirathi
Morphology	Terrain of the study area is highly rugged with steep slopes
Geology	greenish grey slaty and schistose phyllite inter-bedded with quartzite
Soil	Shallow, varying in texture and depth
Altitude variation	800-2300 m

6	**Study objectives**	• To identify the recharge areas of some selected springs of Uttarakhand, and • To suggest remedial measures for the rejuvenation of these springs
7	**Statement of the problem**	There are a number of springs in Uttarakhand which are facing problem of reduction in discharges over the years. A

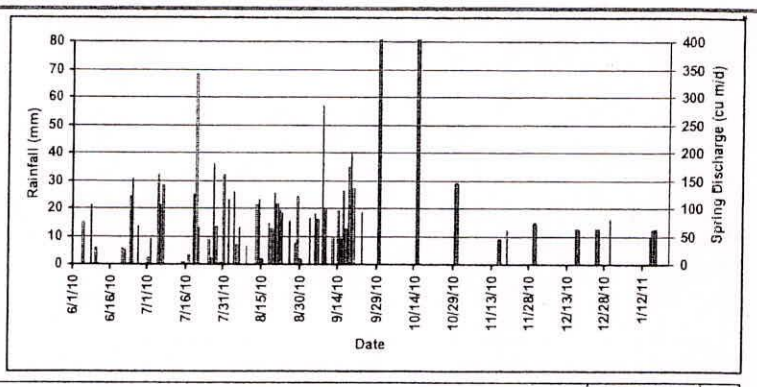
			request has been received from Uttarakhand Jalsansthan, Dehradun to study the springs of about 10 districts which are the only sources of water in their respective regions. However, keeping in view the feasibility, only a few springs (4) have been taken up in the first phase.
8	**Approved action plan**	Please See Appendix-9	
9	**Timeline and justification for time over runs**	Please See Appendix-9	
10	**Objectives vis-à-vis achievements**		

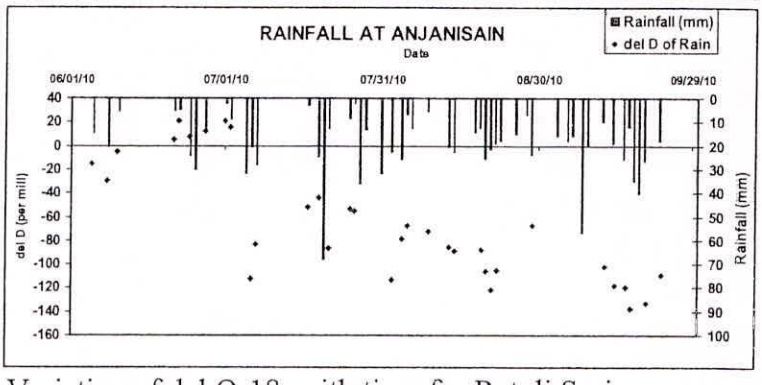
Objective	Achievement
i) Collection of rainfall and discharge data	Monitoring of rainfall data and stream discharge data is continuing
ii) Collection and laboratory analysis of water samples from rain, springs and hand pump	Water samples have been collected for rain water, spring water and hand pump. Collection of water samples is also continuing
iii) Analysis of response of spring to rainfall	Response of the springs to rainfall both in terms of discharge and isotopic signatures have been analyzed.
iv) Analysis of isotopic characteristics of rain water, spring water and hand pump water	Variation in isotopic signatures of the rain water, spring water and hand pump water including δ-O 18 versus δ D relationship has been analysed.
v) Establishment of altitude effect for the study area	Analysis has been carried out. However, more data are required. For the purpose. These data would be generated to establish the altitude effect

11	**Recommendations/suggestions in previous meetings of Working Group/TAC/GB along with the action taken**	None Specific
12	**Analysis and Results** • Discharge data for the four springs have been monitored at a 15 days interval • Rainfall has been collected at three locations on daily basis since 1st June, 2010. • More than 200 water samples from rain, spring	Variation of spring discharge with rainfall for Ratoli Spring

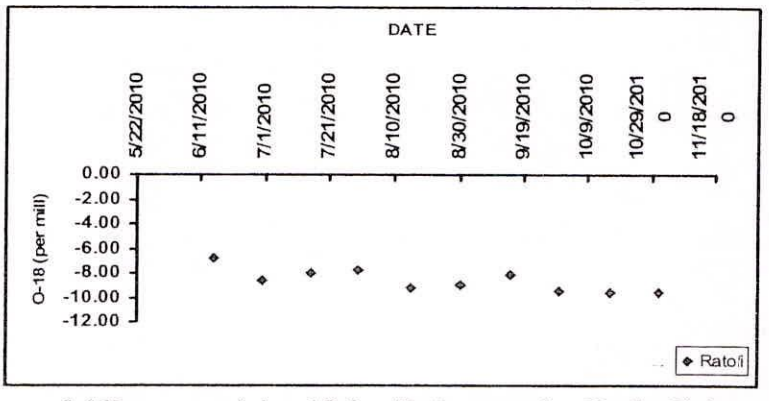
and ground water have been collected and analyzed for δ-O18 and δ-D.

- Analysis of the variation of rainfall versus- spring discharge indicates a delayed response of the springs to the rainfall as far as discharge is concerned.
- Analysis of the δ-O18 data of the three locations indicate that the area receives some local rainfall during June to mid July and the isotopic signatures are enriched. However, heavier rainfall received thereafter during the monsoon indicates depleted isotopic signatures.
- Local meteoric line for the study area has been developed.
- Establishment of altitude effect is in progress.

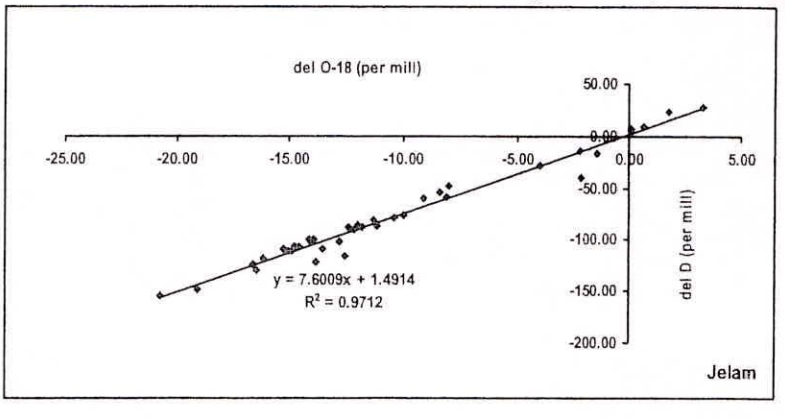




Variation of del O-18 with time for Ratoli Spring



del D versus del o-18 for Rain samples-Daily Values



13	**Adopters of the results of the study and their feedback**	Uttarakhand Jalsansthan, Dehradun. Feedback will be received after the final results are communicated to them.

14	**List of deliverables** (e.g. equipment, papers, reports, softwares, manuals, brochures, flyers, training programmes, users interaction workshops)	i) Report with recommendations for the recharge of springs ii) Rainfall, discharge and isotopic data iii) Research papers iv) Interaction workshop with Jalsansthan Authorities
15	**Major items of equipment procured**	None (Minor equipment like raingauges, temperature meter, humidity meter, etc have been procured
16	**Lab facilities used during the study**	Nuclear Hydrology Lab Remote sensing Lab
17	**Data procured and/or generated during the study**	i) Rainfall data ii) Spring discharges iii) Isotopic data for rainfall, springs and hand pumps
18	**Study Benefits / Impact**	

Indicator	Status
Selection of 4 springs for the study	Completed
Installation of raingauges at 3 sites	Completed
Geomorphological details	Some information collected
Lat., long and altitude of Springs, raingauge and handpump sites	Completed
Collection of rainfall data	Completed
Collection of discharge data	Completed
Collection of spring water, ground water and rain water samples for water isotopic analysis	Completed/To Continue
Laboratory analyses of the collected water samples	Completed
Interpretation of collected data	Completed/To continue
Development of local meteoric line	Completed
Establishment of altitude effect	More data are awaited

19	**Specific linkages with Institutions and/or end-users/beneficiaries**	The study has been taken up on the request of the Uttarakhand Jalsansthan, Deharadun.
20	**Shortcomings/difficulties, if any**	i) The study area is very difficult for field work as it is located in the high hills without roads and is having forest with a threat of wild animals as well as slip ii) There is no competent subordinate technical staff attached with me to assist in data compilation, preliminary data processing and map preparation etc. iii) I am still in the learning process of isotope and yet to develop the understanding of the science. This is causing some inconvenience in data interpretation and analysis. This is also causing some difficulties in the planning of activities for data generation as many of the things are not known to me in advance (for example minimum number of raingauge stations, no. of hand pump locations etc)

		iv) I am simultaneously involved in many other activities of the Division/Institute such as preparing research papers, attending conference, preparing agenda notes/minutes/presentations of Working Groups /TAC/ARC/Society/GB/Divisional RFD, organization of Training course and regional workshop, stock verification, member of Rajbhasha Committee, OIC (Workshop including AC System), PIO for RTI, Hindi Week Celebrations, Canteen Committee, member of Interview committees for project staffs etc , Field visits, Jal Chetna Magazine etc, as well as worked as Secretary of NIHRC during the period. So, even after over-working regularly, there is very little time left for the study.
21	**Future plan**	Identification of recharge zones and recharge structures for the study springs.

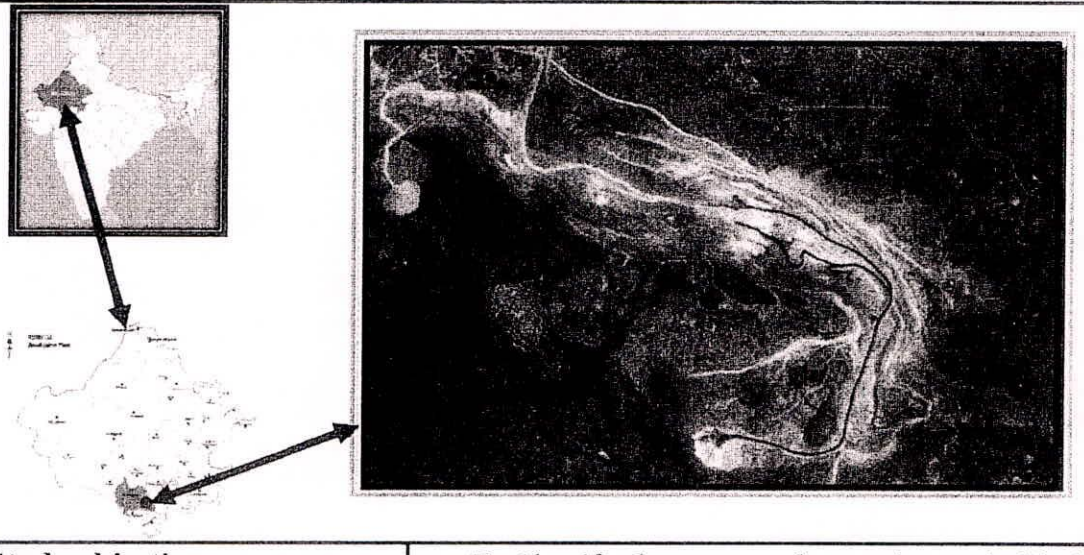
Appendix-9

ACTION PLAN AND TIMELINE FOR THE STUDY ON IDENTIFICATION OF RECHARGE ZONES OF SOME SELECTED SPRINGS OF UTTARAKHAND USING ISOTOPES

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

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

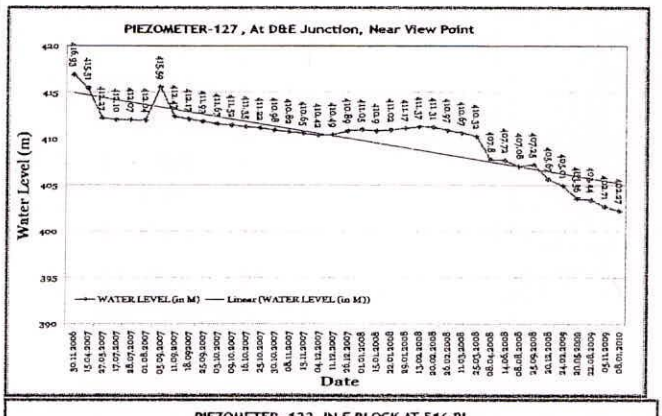
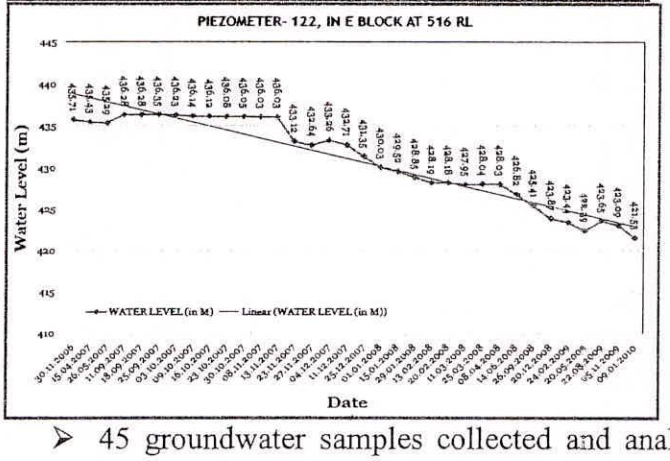
10. PROJECT REFERENCE CODE: NIH/HID/RSMML/10-11

1	**Title of the study**	**HYDROGEOLOGICAL STUDIES OF JHAMARKOTRA MINES, UDAIPUR, RAJASTHAN**
2	**Name of PI, Co-PI, & their affiliations**	Dr. Sudhir Kumar, Scientist E2 (PI) Sh. SK Verma, Scientist C Sh. Pankaj Garg, Scientist B
3	**Type of study** (sponsored/consultancy/referred/internal). If referred, mention the reference	Consultancy RSMML, Udaipur. Amount: 13.17 Lakh
4	**Date of start, scheduled date of completion**	1st July 2010
5	**Location map**	
		
6	**Study objectives**	• To Identify the source of groundwater in blocks D & E of Jhamarkotra mines through stable isotopic and groundwater dating techniques • To suggest complete future dewatering scheme to achieve desirable drawdown (10-12 meters) in the D and E blocks of Jhamarkotra mines • To explore the feasibility of dewatering of monsoon water from the pit in shortest possible time • To suggest measures for protection of groundwater quality in nearby wells • To ensure sustainability of groundwater supply to Udaipur city
7	**Statement of the problem**	Jhamarkotra Phosphate Mine is the largest and fully mechanised rockphosphate mine of India. The deposit at Jhamarkotra is complex with the phosphate bed dipping steeply and buried under a thick pile of massive and hard sedimentary rocks. Mining of these rock phosphate deposits

		is far more difficult than that in most parts of the world. The geometry of the ore body (i.e. thin and steeply dipping) had resulted in long and narrow pits with great depth extension, which involves very high stripping ratio with high lead and lift for waste and mineral. Mining is further complicated by the presence of an estimated 35 MCM of static water in an underground aquifer in the mine area. The working levels are kept dry by continuous pumping of ground water through tube-wells constructed on periphery of the pit limit. The water in the aquifer has to be drained out adding up to the cost. The top surface level in the mine area was about 600 m above mean sea level (MSL) and mine working has gone to a depth of up to 405 m and 425 m above MSL in D & E block respectively. Further, RSMM Ltd. plans to excavate the deposit up to 320 m above MSL. Groundwater level contours indicate that present water level in the mining area is about 402 m and 421m above MSL (for D & E block respectively) and the groundwater flow direction is from NW to SE. As the water level is very near to the bottom of the mining pit, it is not possible to excavate to further depth unless the water table is lowered. The fractures and solution cavities within the dolomitic limestones provide paths for the movement of the groundwater and under the present condition of water level the mine is facing the threat of closure.
8	**Approved action plan**	**Appendix 10**
9	**Timeline and justification for time over runs**	**Appendix 10**
10	**Objectives vis-à-vis achievements**	

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

11	**Recommendations/suggestions in previous meetings of Working Group/TAC/GB should be mentioned along**	Regarding dewatering of the mine pit, Dr Gurunadha Rao suggested that a garland canal type of structure can be suggested so that all water entering into the mining pit can be arrested and pumped out.

	with the action taken	
12	**Analysis and Results**	➢ Creation of GIS database is in progress. ➢ Drainage and lithological maps in and around mine area has been prepared. ➢ Groundwater level data in the mine area has been analysed.   ➢ 45 groundwater samples collected and analysed for isotopic analysis.
13	**Adopters of the results of the study and their feedback**	Rajasthan State Mines and Mineral Limited
14	**List of deliverables**	Report & Papers
15	**Major items of equipment procured**	NIL
16	**Lab facilities used during the study**	Instruments in Nuclear Hydrology Lab and Hydrological Investigations Lab.
17	**Data procured and/or generated during the study**	Isotopic data of the mine area
18	**Study Benefits / Impact**	The status of various activities is given below. Other activities have not yet been started.

ACTIVITY	STATUS
Collection and supply of all required data by RSMML	Completed

	Compilation of existing hydrogeological data	Completed	
	Identification of Data Gaps	Completed	
	Identification of wells for water sampling	Completed	
	Establishment of raingauge station	Completed	
	Collection of SW and GW samples for water quality and isotopic analysis	Completed	
	Collection of samples for groundwater dating	Completed	
	Groundwater level monitoring in and around mine area	In progress	
	Creation of GIS data base for GW modelling	Completed	
	Water Quality analysis of SW and GW samples	In progress	
	Isotopic analysis (δD and $\delta^{18}O$) of SW and GW samples	In progress	
	Determination of groundwater flow direction	In Progress	
19	**Specific linkages with Institutions and/or end-users/beneficiaries**	The dewatering plan will be provided to the Mine authority for implementation	
20	**Shortcomings / difficulties, if any**	No difficulty till now	
21	**Future plan**	As per activity chart	

Appendix – 10

ACTION PLAN WITH TIME LINE FOR THE STUDY ON HYDROGEOLOGICAL STUDIES OF JHAMARKOTRA MINES, UDAIPUR, RAJASTHAN

Activity	1st	2nd	3rd	4th	5th	6th
Collection and supply of all required data by RSMML	♦					
Compilation of existing hydrogeological data	♦					
Identification of Data Gaps	♦					
Identification of wells for water sampling		♦				
Establishment of raingauge station		♦				
Collection of SW and GW samples for water quality and isotopic analysis		♦	♦	♦		
Collection of samples for groundwater dating		♦		♦		
Infiltration tests			♦			
Groundwater level monitoring in and around mine area		♦	♦	♦	♦	
Pump Tests to determine Sp. yield and Hyd. Cond. (by RSMML)				♦		
Estimation of groundwater draft			♦	♦		
Creation of GIS data base for GW modelling			♦			
Analysis of Lithologs and development of Aquifer Geometry			♦			
Water Quality analysis of SW and GW samples			♦		♦	
Isotopic analysis (δD and $\delta^{18}O$) of SW and GW samples		♦	♦	♦	♦	

Activity	1st	2nd	3rd	4th	5th	6th
Estimation of Natural Recharge to groundwater				♦		
Feasibility of dewatering of monsoon water from the pit in shortest possible time				♦		
Determination of groundwater flow direction				♦		
Identification of the source of groundwater in blocks D & E of Jhamarkotra mines				♦		
Measures for protection of GW quality in nearby wells					♦	
Development of Conceptual model				♦		
Calibration of Model					♦	
Development of mine dewatering Plan						♦
Assessment of availability of GW for Udaipur city						♦
First Draft Report				♦		
Second Draft Report					♦	
Final Report						♦

ITEM NO. 34.3: PROPOSED WORK PROGRMME OF THE DIVISION FOR THE YEAR 2011-12

Besides the 10 studies which the Division has been undertaking during 2010-11, and which would continue in the year 2011-12, the following two new studies are proposed in the work programme of the Division for the year 2011-12.

NEW STUDIES

11. PROJECT REFERENCE CODE: NIH/HID/INT/11-13

Title of the Study: **HYDROLOGICAL ASSESSMENT FOR ARTIFICIAL RECHARGE AND WATER MANAGEMENT IN GHAR AREA, SHARANPUR DISTRICT, U.P.**

Study Group:
Pankaj Garg, Sc.B (PI)
Dr. Sudhir Kumar, Sc.E2
Tanveer Ahmad, PRA, WRS Div.
Rajesh Agarwal, RA, RCMU
Dr. V.C. Goyal., Sc.F, RCMU
Dr. Bhishm Kumar, Sc.F

Type of Study Internal

Nature of Study Data generation and technology adaptation including Promotion of citizen and state action for water conservation, augmentation and prevention: a goal under National Water Mission.

Date of Start: April, 2011
Date of Completion March, 2013

Study Objectives:

- To identify the groundwater recharge zones and groundwater flow velocity for Ghar area
- To identify sites for water harvesting structures for Ghar area

Statement of the Problem:

Two blocks of district Saharanpur which fall in Ghar area namely, Muzaffarabad and Sadhauli Kadim will be taken for this study. The availability of groundwater and surface water is limited in these both blocks which poses problem to meet out the need of drinking water as well as water for irrigation. As per the data taken from UP Ground Water Deptt., the groundwater utilization in Muzaffarabad is 97.42% while in Sadhauli Kadim 94.62%. Therefore, presently the both block falls in dark category and require artificial recharge measures.

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

Study Area:

The study area for this study will be Muzaffarabad and Sadhauli Kalim blocks of Saharanpur District in Western Uttar Pradesh. The area of the Muzaffarabad block is 40621 ha and Sadhauli Kalim block is 38767 ha.

There are total 130 Govt. tubewells and 5333 private tubewells and pumping sets in Block Muzaffarabad while only 6 Govt tubewells and 4196 private tubewells and pumping sets are available in Block Sadhauli Kadim which draw groundwater for meeting out the drinking and irrigation needs. Keeping in view the considerable exploitation of groundwater in both these blocks, these fall under the Dark Category. Therefore, there is a need to assess the hydrogeological conditions in the study area for taking up the artificial recharge measures.

Methodology:

1) Data Collection: hydro-geological, hydro-meteorological, topographical data.
2) Sample collection: surface, groundwater and precipitation waters at the required intervals.
3) Infiltration tests.
4) Generating maps: various thematic maps such as land use, soil map, catchment map etc.
5) Analysis of groundwater table, water quality data, stable and radioactive isotopes of samples.
6) Suggesting suitable structures/measures for artificial recharge.

Action plan & time line:

S. N.	Activity	2011-12				2012-13			
		Ist Q	2nd Q	3rd Q	4th Q	1st Q	2nd Q	3rd Q	4th Q
1.	Review of literature and purchase of map & data etc	√	√						
2.	Collection of hydro-geological data/informations for the study area		√	√					
3.	Infiltration test & collection of samples	√		√	√	√	√	√	
4.	Preparation of various maps of the study area				√	√	√	√	
5.	Analysis of data in Lab				√	√	√	√	
6.	Interpretation of data (Recharge zone)				√	√	√	√	
7.	Mass Awareness programme							√	
8.	Writing of report (Interim/Final)				√				√

Data requirement & Expected source:

1. Groundwater level data (UPGWD/CGWB)
2. Land use pattern (Survey of India)
3. Soil type (NBSSLUP, Nagpur/Delhi)
4. Groundwater quality (UPGWD)
5. Rainfall (Past 10-15 years from IMD/State GWD)

List of deliverables:

The output of the study would be in the form of a report. The report would contain analysis of the various isotopic and hydro-geological data for the study area, and recharge zones identified for the study area. However, the following will be made available information about the,

- Land Use
- Groundwater Conditions
- Rainfall-Runoff relationship
- Present Irrigation practice
- Possibility to increase the groundwater recharge through deepings the pond at village level, artificial recharge to well/tanks, earthen buns etc.

IPR potential and issues:

NIL

Involvement of End Users/beneficiaries:

1. UP State Ground Water Deptt., Saharanpur Division
2. CGWB, Regional Directorate, Lucknow
3. Local NGO's active in the study area
4. Local District Administration

Specific linkages envisaged with Institutions and/or other NGOs:

1. Sharing of Data
2. Joint field work
3. Partnership in mass awareness programme
4. Help and coordinated efforts in action oriented programme

Major items of equipment needed: Nil

12. PROJECT REFERENCE CODE: NIH/HID/INT/11-13

Title of study: **ASSESSMENT OF RADON CONTAMINATION IN WATERS AND IDENTIFICATIONOF PALEO-GROUNDWATER IN PUNJAB STATE**

Study Group:

Sh. S. K. Verma, Sc. C, P.I.
Dr. Sudhir Kumar, Sc. E2
Dr. M. S. Rao, Sc. C
Dr. Bhishm Kumar, Sc. F

Type of study: Internal

Nature of study: Data generation and Technology adaptation along with focused attention to vulnerable areas including over exploited areas under goal no. iii of National Water Mission.

Date of Start: April, 2011
Date of Completion March, 2013

Study Objectives:

- To measure radon concentration in waters
- To identify paleo-groundwater in deep aquifers

Statement of the problem:

Radon (222 Rn) is a radioactive, colorless, odorless, tasteless noble gas, occurring naturally as the decay product of Uranium. It has a half-life of 3.8 days. Radon gas is considered to be a health hazard due to its radioactivity. It can cause serious diseases like lung cancer if it exceeds certain limit. It has been found that in a country like USA more than 30,000 deaths occur every year due to high radon concentration in water as well as in air. High concentrations of Radon have been observed in certain parts of India also during preliminary studies carried out by various investigators. Therefore a National Working Group has been constituted by the Govt. of India to study the radon concentration in different materials. NIH has been entrusted to study the radon concentration in waters. Keeping in view the facts mentioned above, this study is proposed to be carried out in parts of Punjab state to meet out first objective of the study.

Paleo-groundwaters are those groundwaters which are thousands years old. People are drawing groundwater from deeper aquifers without the knowledge of their dynamics. Some of the deeper aquifers may have paleo water which may not serve the needs for water supply for longer time. However, such sources can be used to fulfill some specific needs. Therefore there is a need to map the paleo-waters to avoid huge investments on other Industrial and/or urbanizational developments in such areas. Keeping this in view, the mapping of paleo-groundwater is proposed in the Punjab state where tapping of deeper aquifers has started at large scale.

End users/beneficiaries of the study:

- State and central govt. organizations dealing with water resources management.
- Research and development organizations interested in water sector.
- NGOs working in the field of watershed development.
- General Public in the study area through technical workshop/public awareness programme.

Whether study is a new study/extension of previous studies: New study

Study area:

This study will be carried out in the Punjab State. The primary information about the location of wells drilled by central/state organization will be collected and based on the information available, existing wells will be selected for collecting water samples. The water samples from major rivers from different locations will also be collected.

Methodology:

In order to study the radon contamination in the study area at different locations, different kinds of water samples i.e. river water, lake water, groundwater from shallow as well as deeper aquifers will be collected for in-situ radon measurement as well as for chemical analyses in the laboratory. Spatial and temporal variation of radon concentration in different kinds of waters will be studied. The water samples from deeper aquifers for existing tube wells & piezo meters will also be collected for tritium and ^{14}C dating. The hydro-geological data will also be collected for the study area in order to study the hydro geological features to be linked with the radon contamination in waters and paleo-groundwater.

Action plan & time line:

Sr. No	Activity	2011-2012				2012-2013			
		1st Q	2nd Q	3rd Q	4th Q	1st Q	2nd Q	3rd Q	4th Q
1.	Review of literature, Collection of hydro-geological data/informations for the study area etc.	√	√						
2.	Preparation of index map of study area, selection of locations/sites for experimental works etc.	√	√						
3.	Collection of water samples for radon measurement & tritium analysis, measurement of radon		√	√	√				
4.	Lab. analysis of water samples for tritium dating			√	√	√			
5.	Collection of water samples for ^{14}C dating					√	√		
6.	Lab. analysis of water samples for ^{14}C dating						√	√	

7.	Analysis and interpretation of data						√	√	
8.	Preparation of interim report/Part-1				√				
9.	Writing of report								√

Data requirements & Expected source:

- Information of wells located in the study area along with location map (CGWB and/or any other state organization)
- Lithologs of wells (CGWB and/or any other state organization)
- Water level data of the wells (CGWB and/or any other state organization)

List of deliverables: Papers and reports along with the data on radon concentration and paleo-groundwater.

IPR potential and issues: No

Involvement of end users/beneficiaries:
CGWB and state water resources/groundwater departments of the concern state have been consulted while preparing this study proposal.

Specific linkages envisaged with Institutions and/or other NGOs:

5. Sharing of Data
6. Joint field work

Major items of equipment needed: The procurement of Radon survey meter is under process.

SURFACE WATER HYDROLOGY DIVISION

WORK PROGRAMME FOR THE YEAR 2010-11

S. No. & Ref. Code	Title	Study Team	Duration	Page#
1. NIH/SWD/NIH /05-10	Integrated Hydrological Study for Sustainable Development of two Hilly Watersheds in Uttaranchal	A. Agarwal R.K.Nema	5 years (7/05-12/10)	116
2. NIH/SWD/NIH /09-11	Snow Melt Runoff Modeling Using Fuzzy Logic	A.K. Lohani, Sanjay K. Jain Rakesh Kumar	2 years (4/09-3/11)	121
3. NIH/SWD/NIH /09-11	Data book - hydro-meteorological observatory 2001-2008	Digambar Singh A. R. S. kumar Manohar Arora	2 years (4/09-3/11)	124
4. NIH/SWD/NIH /08-12	Study on integrated water resources management of sub-basin to cope with droughts	R.P. Pandey Ravi V. Galkate Surjeet Singh L.N. Thakaral	4 years (12/08-12/12)	127
5. NIH/SWD/NIH /09-12	Snow Melt Runoff Modelling in Sultej Basin	A.R. S. Kumar Manohar Arora A. Agarwal D.S.Rathore Digambar Singh	3 years (4/09-3/12)	132
6. NIH/SWD/NIH /10-13	Snowmelt Runoff Modeling and Study of the Impact of Climate Change in part of Brahmaputra River Basin	Archana Sarkar R.D. Singh Rakesh Kumar Sanjay K. Jain	3 years (4/10-3/13)	136
7. NIH/SWD/NIH /08-	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora Rakesh Kumar	To be continued (4/08-Long term)	140
8. NIH/SWD/NIH /10-13	Climatic Scenarios Generation for Satluj Basin using Statistical Downscaling Techniques	Manohar Arora Rakesh Kumar	3 years (4/10-3/13)	143
9. NIH/SWD/NIH /09-11	Impact of climatic change on evaporation	N.K. Bhatnagar A. Agarwal	2 years (10/09-9/11)	146
10. NIH/SWD/NIH /10-13	Climatic variability analysis and its impact on Himalayan watershed in Uttarakhand	A. Agarwal, Manohar Arora R K Nema	3 years (11/10-10/13)	148

WORK PROGRAMME FOR THE YEAR 2011-12

S. No. & Ref. Code	Title	Study Team	Duration	Page#
1. NIH/SWD/NIH /08-12	Study on integrated water resources management of sub-basin to cope with droughts	R.P. Pandey Ravi V. Galkate Surjeet Singh L.N. Thakaral	4 years (12/08-12/12)	127
2. NIH/SWD/NIH /09-12	Snow Melt Runoff Modelling in Sultej Basin	A.R. S. Kumar Manohar Arora A. Agarwal D.S.Rathore Digambar Singh	3 years (4/09-3/12)	132
3. NIH/SWD/NIH /10-13	Snowmelt Runoff Modeling and Study of the Impact of Climate Change in part of Brahmaputra River Basin	Archana Sarkar R.D. Singh Rakesh Kumar Sanjay K. Jain	3 years (4/10-3/13)	136
4. NIH/SWD/NIH /08-	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora Rakesh Kumar	To be continued (4/08-Long term)	140
5. NIH/SWD/NIH /10-13	Climatic Scenarios Generation for Satluj Basin using Statistical Downscaling Techniques	Manohar Arora Rakesh Kumar	3 years (4/10-3/13)	143
6. NIH/SWD/NIH /09-11	Impact of climatic change on evaporation	N.K. Bhatnagar A. Agarwal	2 years (10/09-9/11)	146
7. NIH/SWD/NIH /10-13	Climatic variability analysis and its impact on Himalayan watershed in Uttarakhand	A. Agarwal, Manohar Arora R K Nema	3 years (11/10-10/13)	148

SURFACE WATER HYDROLOGY DIVISION

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

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

b) Study group: Avinash Agarwal, Sc E2 & P.I., SWH Div.
R K Nema, SRA, SWH Div.

c) Type of Study: Sponsored by DST

d) Date of start: July 2005

e) Scheduled date of completion: June 2010 (Extended up to Dec. 2010)

f) Location map / Study area:

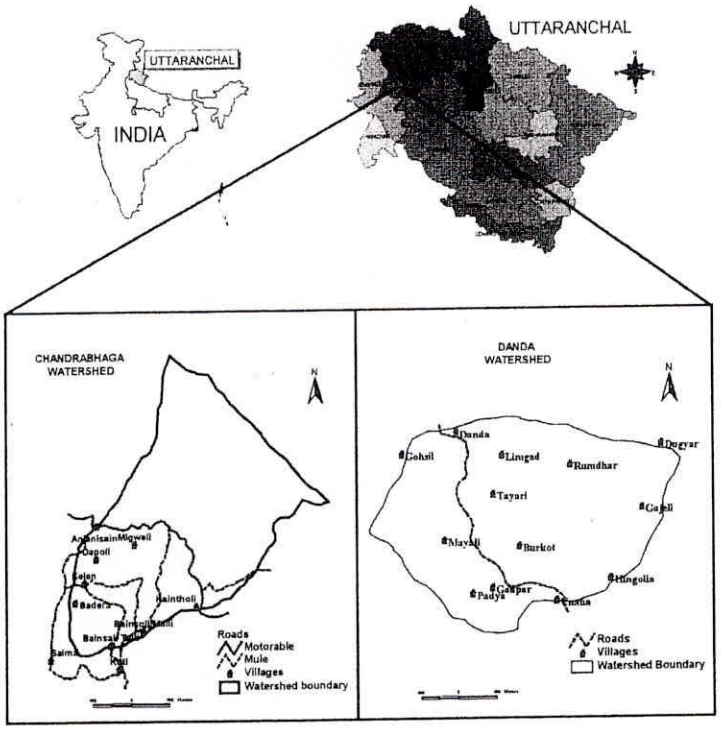


Fig. 1: Chandrabhaga and Danda watersheds.

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.

g) 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

h) Statement of the problem:

Detailed hydrological monitoring of two watersheds for sustainable development, water management planning for domestic use and crop production purposes.

i) Achievements:

S.No.	Objective	Achievement	Remarks
1.	Detailed Hydrological Monitoring	Achieved	Data collected for rainfall, evaporation, through AWS (air temperature, humidity, solar radiation, wind velocity and thrust, due point temperature), Soil moisture at different depths, soil temperature, Spring flow, stream flow etc. The data was subjected to different analysis.
2.	Rainfall-runoff-sediment yield studies	Achieved	Relationships were developed for both the watersheds. The relationships were also developed for all the springs of the watershed.
3.	Delineation of recharge and discharge zones	Achieved	A detailed study was done for identification of recharge zone for the springs of the area. Rainfall of different elevations was also studied for identification of different recharge zone.
4.	Water management planning for domestic	Achieved	Through a detailed survey, monthly spring wise domestic demand and its location were identified and compared with availability of minimum spring.

			Crop water requirement was also identified.
5.	Develop linkages with state line departments	Partially achieved	Regular interaction was held with state line departments. Meetings at village level were carried out informing about the work being carried out by the NIH and its uses to public
6.	To act as a hub for transfer of NRDMS technologies	Achieved	Data hub and technology hub for representative basins (Chandrabhaga and Danda watershed) of Uttarakhand has been created.

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

Dr. S P Agarwal pointed out that the presentation of percentage available soil moisture is to be corrected and the scale of the graph be corrected.	Graph is corrected.
Dr. V C Goyal inquired about the use of present instrumentation as the project is ending.	It was informed that the data acquisition through the instrumentation will continued.
Dr. B Kumar pointed out that the results derived through the use of nuclear technique can be further enhanced by providing some information of rainfall, temperature etc. It was agreed to improve the results before submission of final report	Impact of rainfall at different elevation is being incorporated in report
Secretary WG indicated for a presentation to TAC of the work fulfilling all objectives and if not the reasons behind it.	When required will be presented
Chairmen WG advised to incorporate month wise water availability/ shortage of each spring and possibilities of water storage tanks for both drinking and irrigation purposes. It was also suggested to locate the places as to how the spring discharge can be increased.	The suggestion has very well being considered. Availability/ shortage spring and month wise identified. Requirement of storage tank/ infiltration structure for each spring is demarked.

k) Results

i. Monitoring of rainfall was carried out at multiple sites in each watershed using automated rain gauges. Average annual rainfall is slightly less than 1200 mm in Chandrabhaga and 900 mm in Danda, and about 70% rainfall is received during monsoon period.

ii. Runoff measurements of two watersheds were analyzed for its variability and flow duration curve. The errors in measurement during high flow could not be avoided due to the limitations of V-notch size and during low flow as leakage through fractured ground stratum.

iii. Rainfall-runoff relationships were developed for monsoon, non-monsoon and yearly basis with correlation respectively 77, 55 & 69 percent for Chandrabhaga and 63, 23 & 46 percent for Danda watershed. The average runoff coefficient based on ten and four years data was respectively 0.22 and 0.23 respectively for Chandrabhaga and Danda watersheds. Results of phase one indicates as 'Due to hydro-geological features, high infiltration is observed and only about 15 to 20% rainwater appears as runoff during individual events".

iv. Evaporation is estimated using pan evaporation data monitored on daily basis. A detailed estimation of vegetation and biomass in the watersheds will be required for realistic estimation of ET losses.

v. Soil moisture in top 60 cm of soil remains more than 30 percent only in monsoon months (15^{th} July to 15^{th} October).

vi. A detailed survey for domestic water use dependency on each spring was carried out in order to identify the domestic load on respective spring. Daily availability of spring water was estimated for each spring based on the long record for the conditions of low, average and high flow years. Results indicate the excess / defecate and the requirement of storage tank/s and or infiltration tank/s for all and specific spring.

vii. Low flow duration corves were prepared for each spring and an average low flow duration curve for the watersheds was developed.

viii. Due to hydro-geological features, high infiltration is observed and only about 15 to 20% rainwater appears as runoff during individual events.

ix. The isotope analysis indicated that the water from the springs is same as of the rainfall of the area and that flowing in river and springs. The finding is also supported by visualizing the quick response of springs with the on set of rainfall. Finding suggests that water storage strategies and an increase in infiltration are required in order to increase the discharge from the specific springs with in the watershed boundary. It could be by construction of storage and infiltration tanks and the use of micro-topographic for storage of rainwater.

x. Management of water, and not the availability of water, is a problem in the area. Planning is required especially for proper storage and management of water and if required the transfer of water in collaboration with the existing social laws, from "excess" areas to "shortage" areas, through gravity flow or by pumping.

xi. Water storage structures are essentially required to store spring flow of the non use periods for domestic use during non-monsoon months. Suitable and sound technical design of water storage structures are required to mitigate the water scarcity problems.

xii. Water harvesting structures are required to store rainwater in monsoon months in order to increase the spring flow only in required selected springs. Possible suitable sites will be upstream of spring, and sound technical design of water harvesting structures as available to mitigate the water scarcity problems.

xiii. A hydro-meteorological data hub has been created as representative of Uttarakhand hills. This information could be utilized as regional information when dealing with hydrology of the region.

xiv. A linkage is required to apply the results of the study for improvement of the

socio-economic status of the watershed community. Development of alternate management scenarios, e.g. in horticulture could be appropriate solution in present scenario.

l) **List of deliverables:**

User interaction work shop can be arranged describing position watershed and the activities they should adopt. Planning of sustainable development of watershed.

m) **Major items of equipment procured: Nil**

n) **Lab facilities used during the study:** (1) Soil water lab (2) Nuclear Hydrology lab.

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

p) **Study benefits/impacts:**

Pilot study for the hills of Uttarakhand for regional application.

q) **Specific linkage with institutions and/or end-users/ beneficiaries:** End users

r) **Shot comings/ difficulties:** Nil

s) **Future plan:** Report writing is in progress.

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

a) **Title of study:** **Snow Melt Runoff Modeling Using Fuzzy Logic**

b) **Study group:** A.K. Lohani, Sc 'E1' & PI, SWH Div.
Sanjay K. Jain, Sc 'E2', Co-PI, WRS Div.
Rakesh Kumar, Sc 'F' & Co-PI, Head SWH Div.

c) **Type of study:** Internal

d) **Date of start:** April 1, 2009

e) **Scheduled date of completion:** March 31, 2011

f) **Location map / Study Area:**

The Beas basin up to Pandoh dam is proposed as the focus area of the present study (Figure 1). The Beas River is an important river of the Indus River system. It originates at an elevation of 3900 m and the length of the river up to the Pandoh dam is 116 km. 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. The altitude varies from 832 m near Pandoh to more than 5000 m near Beo-Toibba. Some of the major tributaries which join the Beas River upstream of Pandoh dam are: Parvati River near Bhuntar, Tirthan and Sainj rivers near Larji, Sabari nala near Kulu and Bakhli khad near Pandoh dam. All these rivers are perennial and the flow varies considerably during different months of the year.

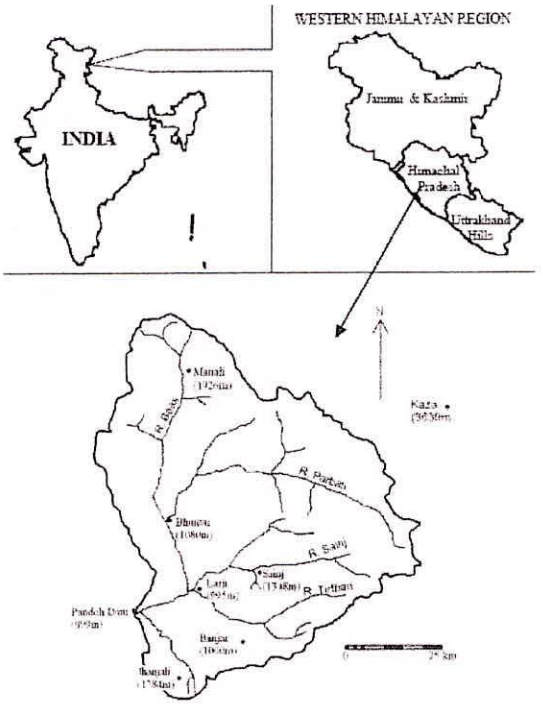


Fig. 1: Location Map of the Study area

g) Objectives of the study:

- 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.

h) Statement of the problem

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. In this study fuzzy rule based approach with different input vectors has been applied to simulate snow melt runoff. Further, the results of the Fuzzy rule based model have been compared with the conceptual snow melt runoff model.

i) Approved Action Plan: Work elements including time scheduling:

Task	Apr. - Sep. 2009	Oct. 2009- Mar. 2010	Apr. - 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					Completed
Development of Fuzzy rule based model for snow melt modeling					Completed
Comparison of Fuzzy rule based model and snowmelt model.					Completed

j) Analysis and results

Collected, processed and analysed rainfall and temperature time series data. Collected and analysed digital data and prepared GIS data base including base maps, drainage map, contour map, DEM etc. of the study area. Further, classified the basin into number of elevation bands using DEM and computed snow cover area for the years 2000-2005 have been. A conceptual snow melt runoff hydrological model for the

selected snow covered basin has been developed. The developed model has been calibrated with the observed data. Further, Snowmelt runoff models for the basin has been developed using fuzzy logic. The fuzzy logic based models have been tested for different input model structures. Furthermore, the results of the conceptual snowmelt rainfall-runoff models have been compared with the Fuzzy logic based models (Figure 2). Overall the results indicate that the fuzzy rule based methodology may provide a well performing and relatively easy solution that may readily be integrated into existing snowmelt runoff modeling models to provide a performance enhancement. The study is completed and report writing is in progress.

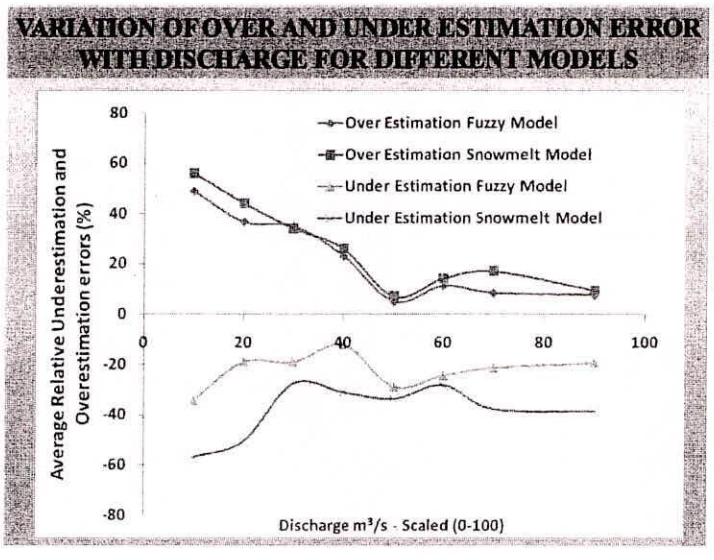


Fig. 2: Variation of over and under estimation error for fuzzy and conceptual models.

k) 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.

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

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

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

c) **Type of study:** Internal

d) **Date of start:** 1 April 2009

e) **Scheduled date of completion:** March 31, 2011

f) **Location map / study area:** NIH campus

g) **Objectives of the study:**

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

h) **Statement of the problem:**

Hydro-meteorological data is an initial and foremost requirement for the planning and execution of any water resources projects. NIH 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.

i) **Approved action plan**

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

j) **Achievements**

Objectives (for the period April 2010- March 2011)	**Achievements**
Entry of hourly rainfall data from hyetograph	Partially Completed
Entry of hourly humidity data from hygrograph	Partially Completed
Entry of hourly temperature from thermograph	Partially Completed

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

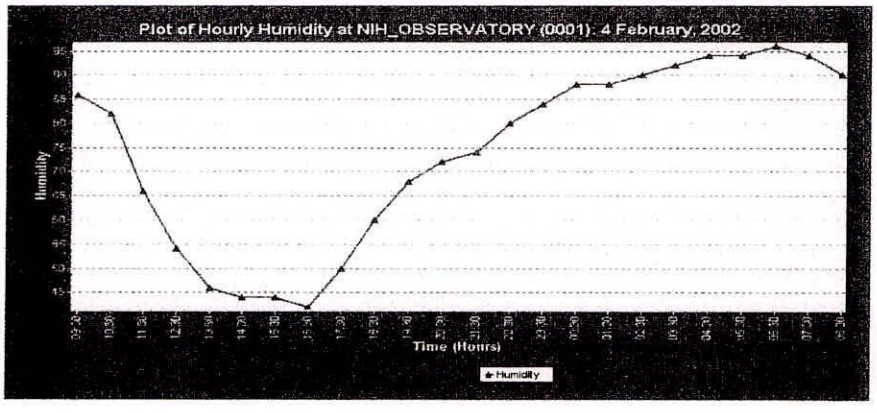
l) **Analysis and Results**

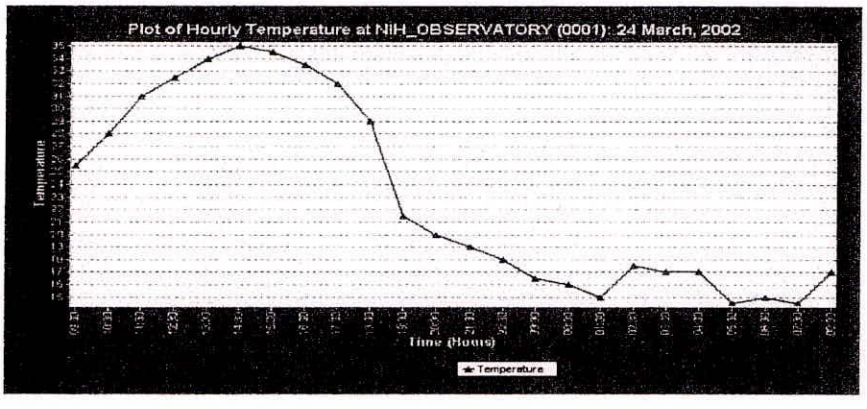
Brief methodology

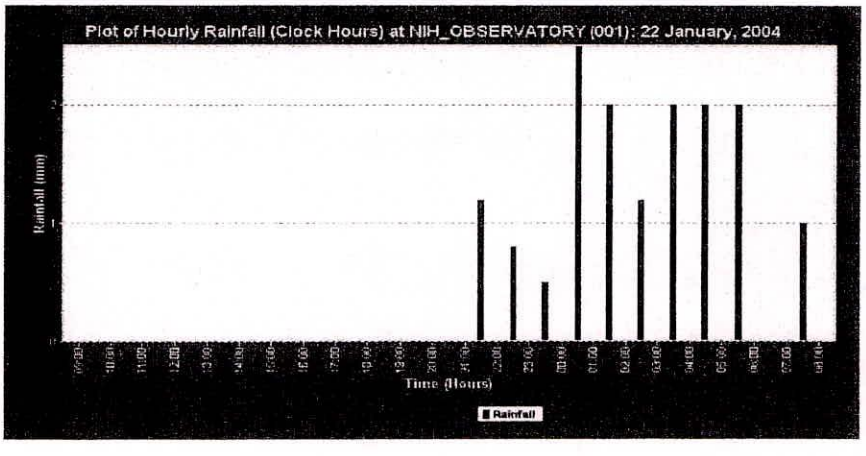
It is planned to enter the data in SWDES software and the related statistics of the data will be brought out in tabular forms.

Results

The hourly data of rainfall, relative humidity, temperature from the year 2001 to 2004 have been entered in SWDES. Some sample plots are given as follows:







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

R & D organisations, Academic institutions and field engineers from state government departments.

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

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

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

q) **Future plan:** It is requested to extend the study for one more year to enter the remaining data and bring out the final report.

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

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

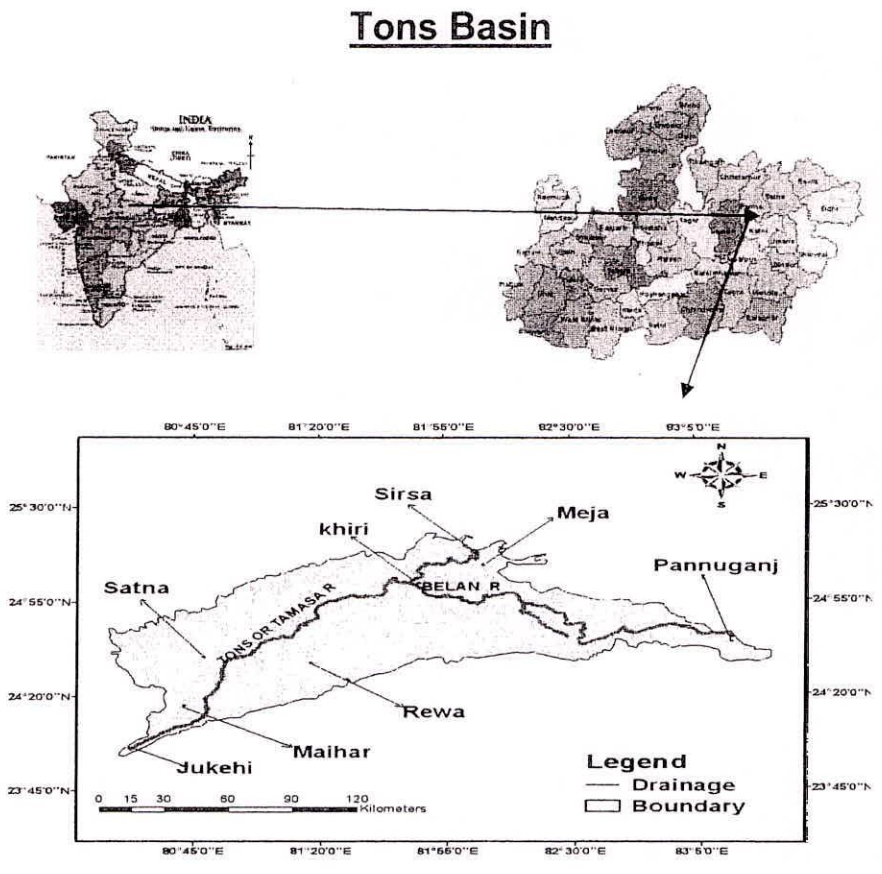
b) Study group: R.P. Pandey, Sc. E1 & P.I., SWH Div.
Ravi V. Galkate, Sc. E1 & Co-P.I., RC Sagar
Surjeet Singh, Sc. C, GW Div.

c) Type of study: Internal

d) Date of start: Dec. 2008

e) Scheduled date of completion: Dec. 2012

f) Location map / study area:



g) Objectives:

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

i. Developing inventory of drought events and water resources in 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. Delineation of zones vulnerable to drought in the study sub-basin(s).
vi. Devise integrated water management plan to cope with drought.

h) Statement of the problem:

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

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

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

j) Achievements:

Discharge data from CWC has been collected for two sites namely Meja-Road and Satna. Analysis of stream flow data is in progress. Data procurement from IMD is in progress. Preparation of inventory report on of water resources in the basin is in progress. Required maps of the study area like drainage map, DEM, and soil map have been prepared. Inventory of problems in the study area is being prepared. Trend analysis of monthly, seasonal and annual rainfall has been carried out for basin.

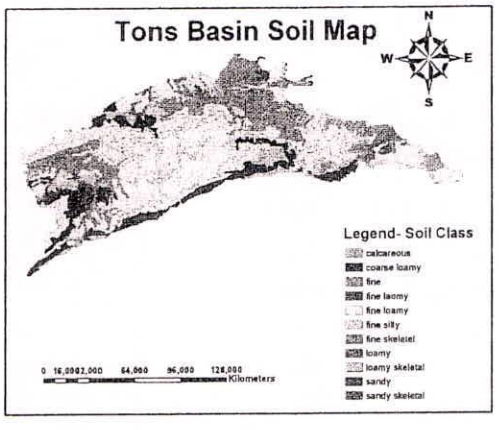
Objectives	Achivements
Field survey & data collection	Preliminary data collection Completed
Inventory of Water resources, drought events etc. in the study sites.	To be completed by March 2011
Preparation of base maps	Completed
Collection of rainfall data, and stream flow data from CWC	Completed

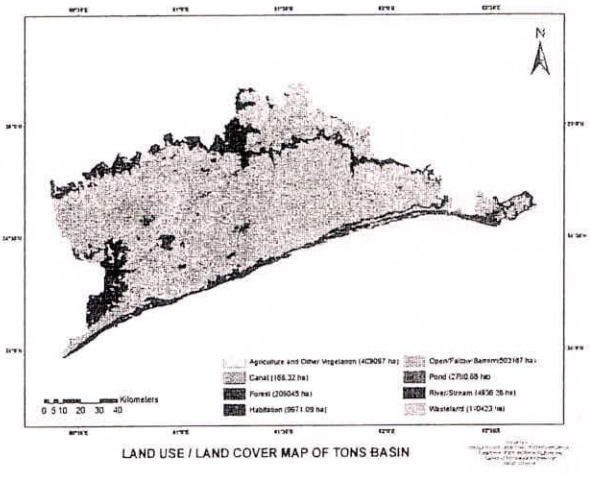
Collection of ground water level from CGWB / state departments, and Temperature, evaporation from IMD	Partially Completed
Crop type and area, Socio-economic Profile & Drought event related information	Partially Completed

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

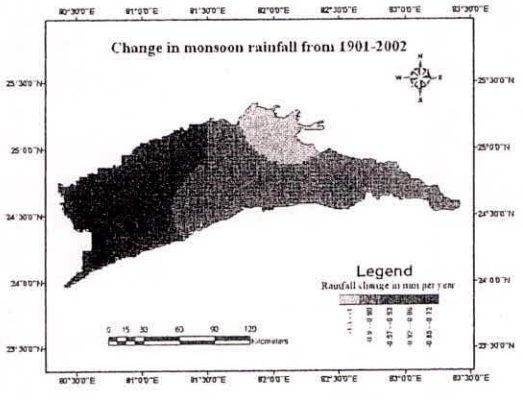
There was no specific recommendation/suggestion from WG & TAC.

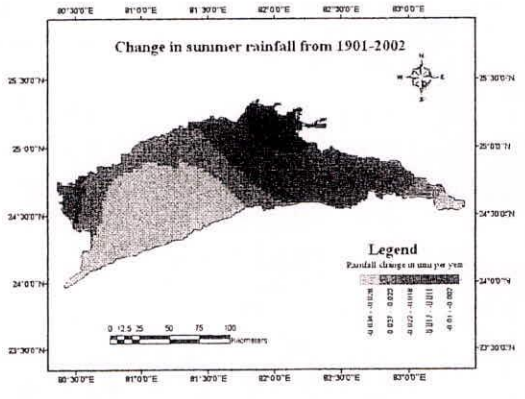
l) Analysis and results

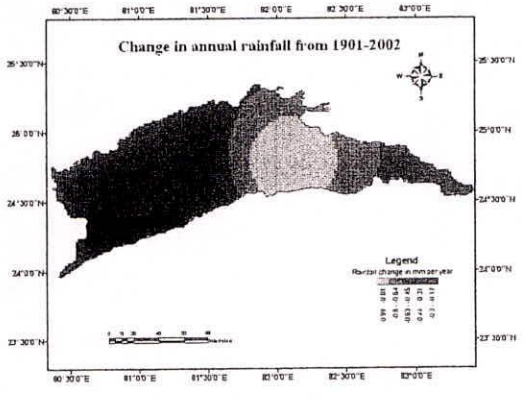


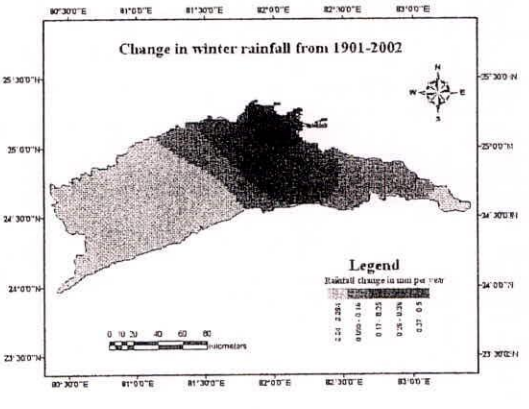


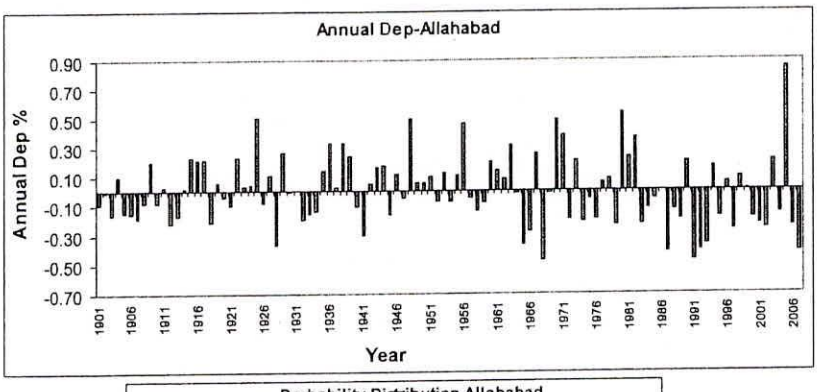
LAND USE / LAND COVER MAP OF TONS BASIN

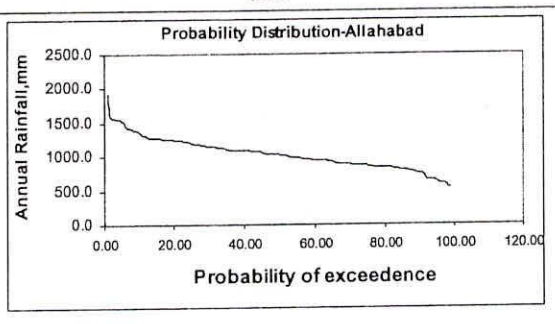


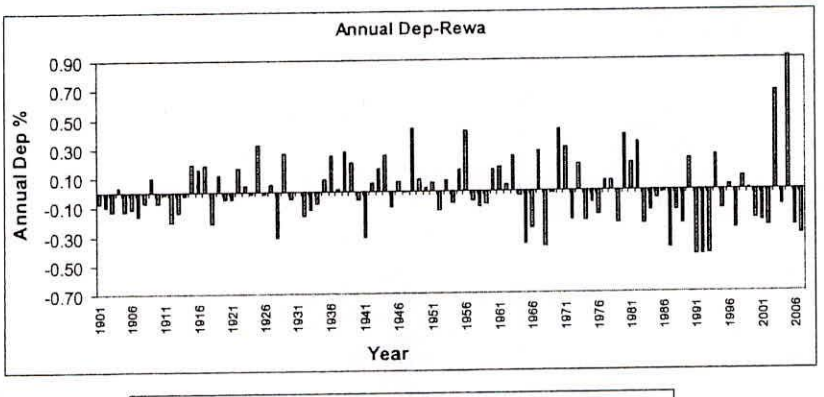


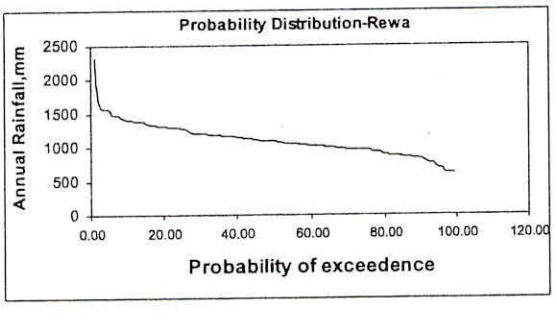












A summary of the analysis conducted so far is as follows.

i. Area experiences recurrence of drought at an average frequency of once in 5 years.
ii. Unprecedented economic losses and great suffering are often reported in the affected areas. Reduced agricultural production, mass migration and famine threat are major concern in the study area.
iii. Western part of the basin has observed falling trends of monsoon rainfall during past 102 years

iv. Limited and scarce water resources and demand is very high for agriculture.
v. Year 2007 experienced the acute drought situation in this area and caused 50-60% agricultural production losses.
vi. Limited and scarce water resources. Demand increasing at a rapid rate due to demographic shifts and lifestyle changes.
vii. Area needs attention and an integrated water resources management approach which includes drought management as an important component.

m) List of deliverables:

i. An Interim report to be prepared on the work done in 2010-2011
ii. This study is finally expected to evolve a methodology to deal with drought situation for minimizing crop losses and water stress in semiarid and dry sub humid areas
iii. A training course for one week duration is scheduled to be held on drought mitigation and management in Apri/May 2011

n) Major items of equipment procured: Nil

o) Lab facilities during the study: Nil

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

q) Future plan of work under this project

Activity (months)	1 to 6	7 to 12	13 to 18	19 to 24	25 to 30	31 to 36	37 to 42	42 to 48
Studying events and 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								
Knowledge dissemination								
Final Report Submission								

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

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

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

c) **Type of study:** Internal

d) **Date of start:** 1 April 2009

e) **Scheduled date of completion:** March 31, 2012

f) **Location map / study area:**

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

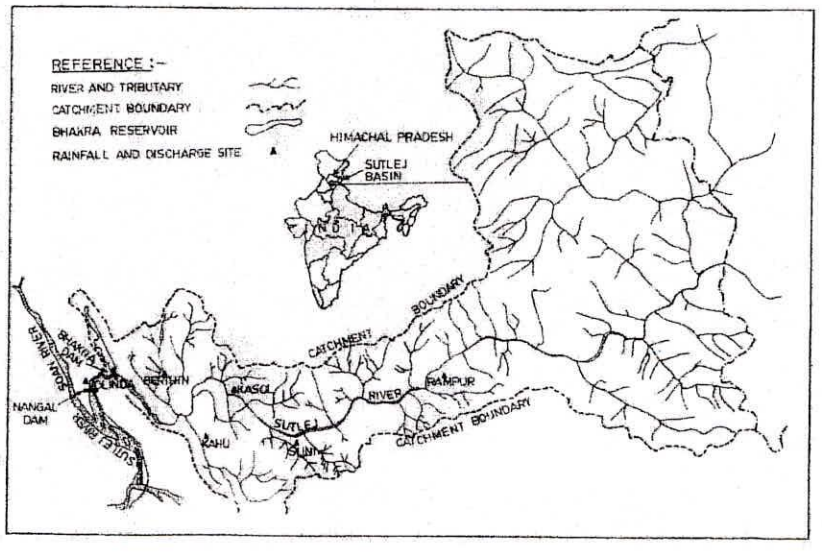


Fig. 1: Index map of Sutlej basin

g) **Objectives of the study:**

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

h) Statement of the problem:

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

i) Approved action plan:

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

j) Achievements:

Objectives (for the period April 2010-March 2011)	**Achievements**
1. Computation of snow covered area from satellite imageries	Completed
2. Simulation of streamflow components by calibrating the parameters of SNOWMOD	Trial runs have been taken with the calibrated parameters. Fine tuning of parameters calibration is under progress

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

Recommendation/suggestion	Action taken
1. Dr S. P. Agarwal, IIRS, Dehradun suggested to use MARS software to select the significant inputs to the ANN models. He also suggested to include the snow cover area as one of the inputs to the ANN model.	These suggestions will be considered while running ANN model again during the next year.

l) **Analysis and Results:**

SNOWMOD and SRM

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

ANN Model

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

Results

The ANN models for simulating the streamflow at Rampur considering the continuous data of rainfall, snowfall, minimum temperature, maximum temperature and streamflow at Rampur have been developed and compared the results with the ANN models for low, medium and high range of streamflow.

The conceptual model SNOWMOD has been used for the simulation of flows. The availability of cloud free images for calculating the snow covered area is limited. Therefore relationships between cumulative temperature and snow cover are established and are given as follows for the zones considered.

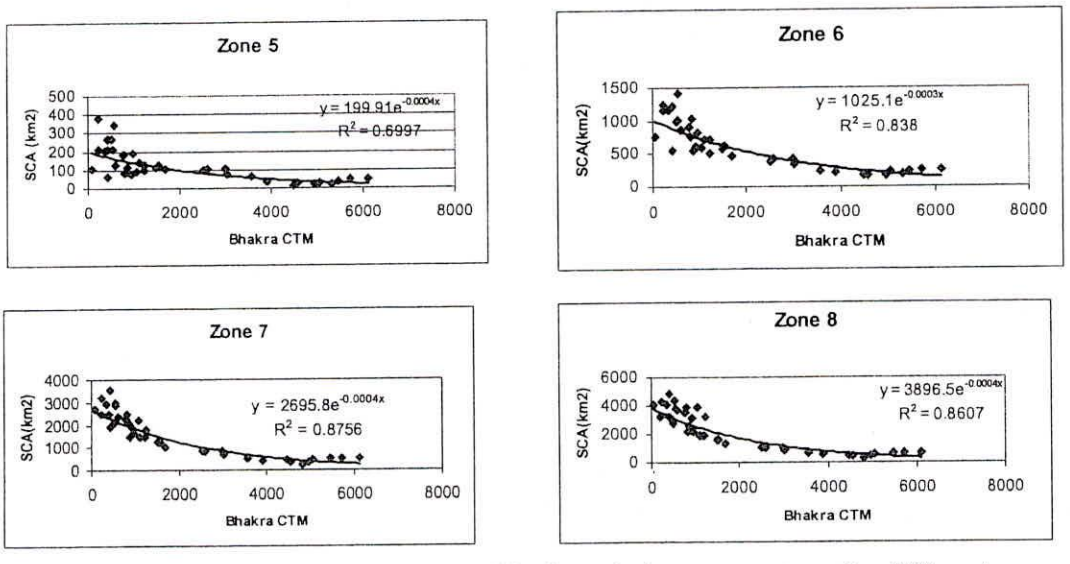


Fig. 2: Relationship of Snow cover area Vs Cumulative temperature for different zones

These relationships are used to get the daily values of snow cover area. The data set of 1999 to 2004 is divided into two parts and the data of 1999 to 2002 are considered for the calibration of parameters in SNOWMOD. It is observed that the snow computation has been overestimated slightly with the calibrated parameters and it is being looked into. However with these calibrated parameters a validation run has been taken. The validation results will be shown later on after completely calibrating and fine tuning the parameters. The computations of runoff from rainfall and base flow are satisfactory as can be seen from the following figure.

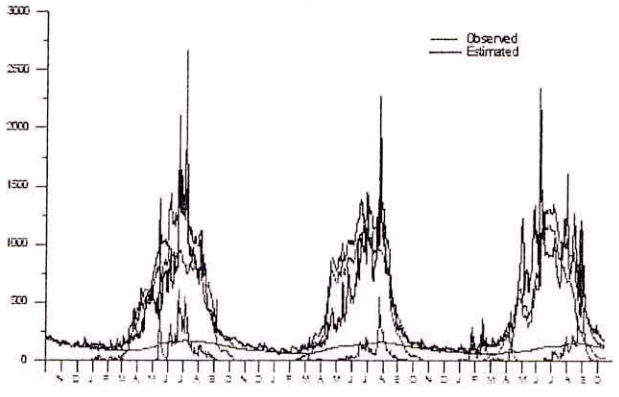


Fig. 3: Simulation results of runoff components

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

Water Regulation Division, BBMB, Nangal.

n) Deliverables:

Research papers and reports

o) Data generated in the study:

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

p) Study benefits/impacts:

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

q) Future plan:

The streamflow at Rampur will be simulated by SRM model and the results of the model will be compared with the results of ANN model and SNOWMOD.

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

a) Title of study: **Snowmelt Runoff Modeling and Study of the Impact of Climate Change in part of Brahmaputra River Basin**

b) Study group: Archana Sarkar (PI), Sc 'C', SWH Div.
R.D. Singh, Director
Rakesh Kumar, Head & Sc. 'F', SWH Div.
Sanjay K. Jain, Sc. 'E2', WRS Div.

c) Type of study: Internal

d) Date of start: April 1, 2010

e) Scheduled date of completion: March 31, 2013

f) Study Area:

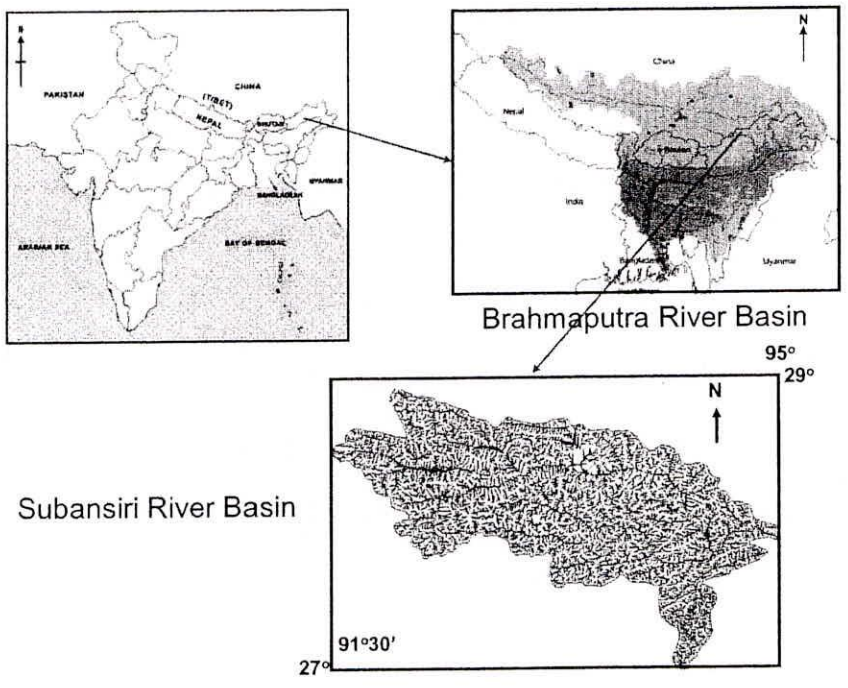


Fig. 1: Study Area

g) Objectives of the study:

1. To estimate snow cover area using remote sensing data
2. To estimate snow melt runoff in Subansiri River at Choulduaghat site.
3. To study trend of precipitation and temperature using parametric and non parametric approaches, and
4. To investigate the impact of likely future changes in climate on stream flow using precipitation and temperature scenarios in the study area.

h) Statement of the problem:

Prime Minister's Council on Climate Change, in its first meeting decided that MoWR should initiate studies for major rivers whose waters come from snow melt. Accordingly, MoWR chalked out an Action Plan to take up related studies on Indus, Ganges and Brahmaputra River basins through CWC, NIH and Brahmaputra Board. The present study has been taken up with this background.

i) Approved action plan:

Activities	I Year	II Year	III Year
To estimate snow cover area and its temporal variation in study basin	⟷		
Preparation of a technical report on "Snow Cover estimation and its temporal variation in a part of Brahmaputra River basin"	⟷		
To estimate stream flow (including snowmelt runoff) in Subansiri River at Choulduaghat site through calibration and validation of hydrological model.		⟷	
To simulate stream flow for the study basin in present climatic conditions using long term records		⟷	
Preparation of a technical report on "Snowmelt Runoff Modelling in a part of Brahmaputra River basin"		⟷	
To study trend of precipitation and temperature using parametric and non parametric approaches			⟷
To simulate stream flow for the basin considering various scenarios of climate (temperature and precipitation) variables and evaluate the impact of changes in climatic variables on stream flow			⟷
Compilation of results and preparation of final technical report			⟷

j) Progress:

Objectives (for the period April 2010- March 2011)	**Achievements**
1. Literature collection for the technical report on "Snowmelt Runoff Modelling and Study of the Impact of Climate Change in part of Brahmaputra River basin"	Completed
2. Downloading MODerate resolution Image Spectral radiometer (MODIS) snowcover data products for part of Brahmaputra River Basin from the internet for the years 2000-2009.	Completed

3. Analysis and interpretation of weekly MODIS snowcover data collected for the period of 2000-2009 for part of Brahmaputra River Basin.	Completed
4. Preparation of technical report on "Snow Cover estimation and its temporal variation in a part of Brahmaputra River basin".	To be completed by March 31, 2011.

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

l) Analysis and Results:

Data Used

- Survey of India toposheets at a scale of 1:250,000
- Satellite data of MODIS TERRA
  MOD10A2 data has been used for a period of eight years, i.e, Oct 2000 to Sept 2008.
  MOD10A2 are 8-day composite snow data products at a resolution of 500m.
- SRTM DEM

Methodology: The Algorithm of snow-cover

The Normalized difference Snow Index (NDSI) for MODIS is:

$$NDSI = \frac{Band\ 4 - Band\ 6}{Band\ 4 + Band\ 6}$$

Snow is characterized by much higher NDSI values than other surface types. Pixels with NDSI of greater than 0.4 are considered snow covered and the pixels with slightly-lower NDSI, but high NDVI (greater than) values can be considered as snow-covered forests.

Results

- MODIS/Terra satellite high resolution snow mapping products provided an excellent opportunity to define details in the spatial and temporal snow cover distribution in Subansiri Basin.
- Based on the MODIS snow cover data during 2000–2008, the snow cover distribution is spatially quite variable over the Subansiri basin due to the complex terrain.
- The most persistently snow covered areas occur in the middle portion of the basin in the form of a band which lies within large mountain ridges. In the upper and lower part of the basin, SCA are relatively small and less persistent.
- The highest SCA, typically of the order of 47%, are mostly concentrated at elevations higher than 5400m.
- During the summer months (e.g. July and August), the basin retains approximately 1-2% snow cover made up of scattered, patches of snow.

- Maximum snow accumulation and melting times over the year vary, but generally are later as the elevations increase.
- In addition the larger interannual variabilities occur in the late fall and winter months.

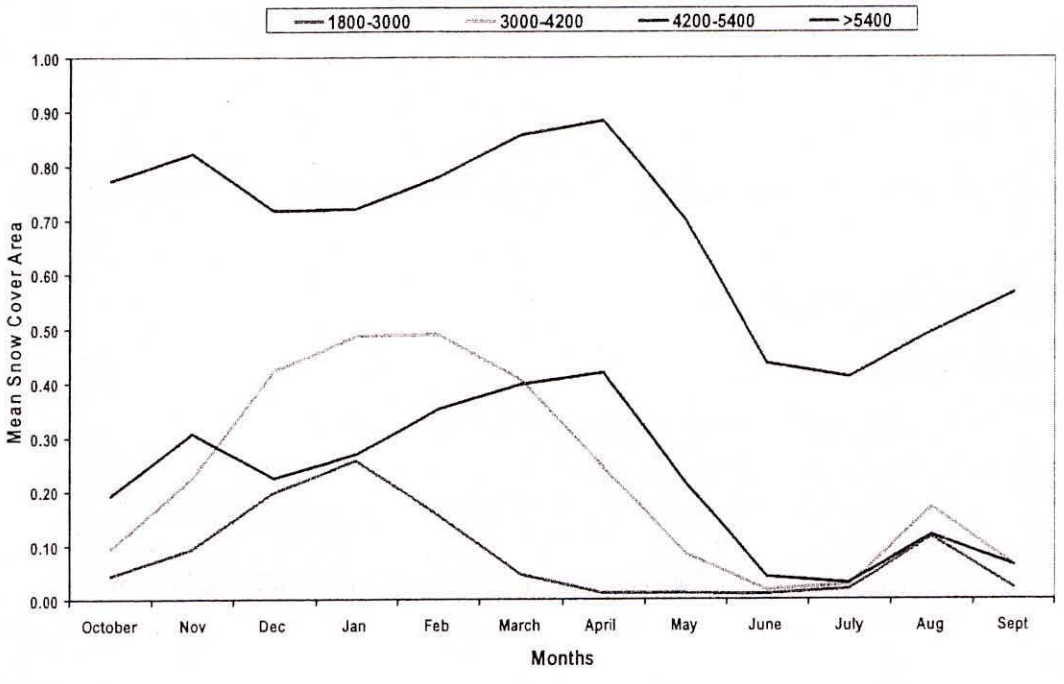


Fig 2: Spatial and Temporal Variation of SCA in Subansiri Basin (2000-2008)

m) Expected adopters:

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

n) Deliverables:

Research paper entitled "Spatio-Temporal Variation of Snow Cover in A part of Brahmaputra Basin based On MODIS/TERRA" published and presented in the international symposium on "Benefitting for Earth observation" at ICIMOD, Kathmandu, Nepal from 4-6 October 2010.

o) Data procured and/generated during the study:

- MODerate resolution Image Spectral radiometer (MODIS) snowcover data products (MOD10A2 8-day composite) for Subansiri River Basin for the years 2000-2009.
- SRTM DEM

p) Future plan:

As per the approved action plan.

7. ROJECT REFERENCE CODE: NIH/SWD/NIH08-

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

b) Study group: Manohar Arora Sc 'B', SWH Div.

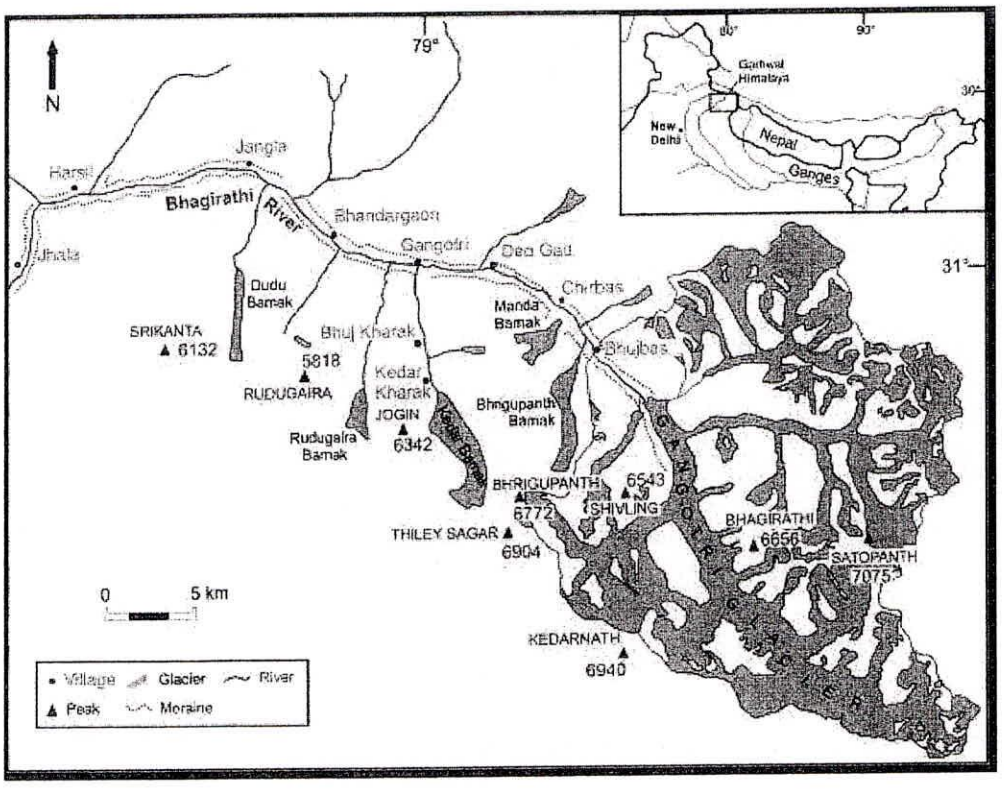
Rakesh Kumar Sc 'F', SWH Div.

c) Type of study: Internal

d) Date of start: 01.04. 2008

e) Scheduled date of completion: Long term study

f) Location map:



g) Objectives of the project:

The objective of this study includes:

i. Continuous monitoring of meteorological and hydrological data for monthly and seasonal specific water yield and its variability from the year to year

ii. To improve the hydrological model for simulating daily streamflow

h) Statement of the problem:

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

i) **Approved action plan:**

Year	May to October	November to April	Remark
All Years	Field investigations & Data Collection	Data analysis	Report preparation after three years

j) **Objectives vis a vis Achievements:**

Objectives	Achivements
Continuous monitoring of meteorological and hydrological data for monthly and seasonal specific water yield and its variability from the year to year	The data collection and field investigations for the year 2011 will be started in the month of May 2011
To improve the hydrological model for simulating daily streamflow	The simulation of flow will be carried out after collection of three years of data.

k) **Recommendations of Working Group/TAC/GB:**

The study may be continued for long term to link with climate change.

l) **Analysis and Results:**

The hydrometeorological data collected for the three ablation seasons during 2008 to 2010 was analysed and processed to understand the weather conditions and melting pattern of the glacier. Average monthly rainfall for June, July, August and September has been computed to be 21.9, 71.7, 52.1 and 116.7 mm, respectively. The total rainfall and its distribution over the summer season are found to vary from year to year. For example, the total rainfall for the summer season (10 May to 30 September) for 2008, 2009 and 2010 was recorded to be 295.5, 117.2 and 477.1 mm. Based on 3 years data average seasonal rainfall for the Gangotri Glacier was observed to be about 316.6 mm.

The average daily maximum and minimum temperatures over the summer season were computed to be 14.9 °C and 4.4 °C, respectively, whereas average mean temperature was 9.6 °C. Diurnal variations in temperature indicate that generally maximum temperature is observed sometimes around 1400 hours while the minimum at the early morning. Mean monthly temperatures for June, July, August and September were 16.0, 15.7, 15.4 and 13.3°C, respectively, suggesting that July was the warmest month.

Analysis of wind data shows that on an average the daytime wind speeds are much stronger (4 times) than the nighttime winds. Generally, the duration of daily mean sunshine hours becomes maximum in May and minimum in August. On the seasonal scale daily mean sunshine hours were 5.4 hours. Monthly total pan evaporation was 59.6, 122.5, 96, 78, and 72.3 mm for the month of May, June, July, August and September respectively. Mean daily evaporation for the summer season as a whole is found to be 3.0 mm, which is comparable to the pan evaporation data observed at foothill station of the Himalayas. The combination of weather conditions like longer sunshine duration, little rainfall, low humidity and high wind speed could have

attributed to higher evaporation in the month of May. On the other hand, weather conditions allowed for lower evaporation in October.

The discharge showed increasing trend from May onward, reached to its highest value in July and then started reducing. The maximum and minimum daily mean discharge observed during study period was 7.9 to 216.8 m^3/s. The mean monthly discharge observed for May, June, July, August and September was 35.8, 65.3, 110.7, 127.8 and 57.3 m^3/s, respectively. Almost similar trend of distribution of runoff is observed for all the years. The strong storage characteristics of the Gangotri Glacier are reflected by the comparable magnitude of runoff observed during daytime and nighttime.

Suspended sediment concentration in the observed discharge was very high. More over it was very much variable over the melt season. Daily mean concentration varied between 20 to 10540 ppm. Mean monthly suspended sediment concentration for May, June, July, August and September during the study period was 992, 1411, 2123, 1862 and 561 ppm, respectively. Mean monthly total suspended sediment loads for may, June, July, August and September during the study period was found to be 60, 294, 664, 670, 101 $\times 10^3$ tonnes respectively.

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

The study is a part of long term action plan on climate change by the Institute.

n) List of deliverables:

1. Draft Report for the year 2008 – 2011 has been submitted. The report for 2011 – 2014 will be prepared after completion of three years of investigations.
2. Research papers are being brought out.

o) Major items of equipment procured: Nil

p) Lab facilities during the study: Analysis of suspended sediment samples in Soil Lab.

q) Data generated in the study: Meteorological and hydrological data for the Gangotri Glacier.

r) Study Benefits/Impact: The study is being conducted under the long term action plan on climate change as per instructions of MOWR. The meteorological and discharge data would be utilised in studying the characteristics of the Gangotri glacier under changing climate.

s) Specific linkages with Institutions/beneficiaries: The data collected is also being shared with the authorities of Gangotri National Park. The details of sediment concentration are being communicated to the downstream Dam authorities.

t) Shortcomings/Difficulties: The study involves four months of extensive field work and maintenance of construction site etc. Without the support of project staff it is difficult to manage data collection.

u) Future Plan: The study will be conducted for long term. The Himalayan glaciers are poorly monitored. There is very little or sparse data of Himalayan Glaciers The collected data will be used for climate change studies.

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

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

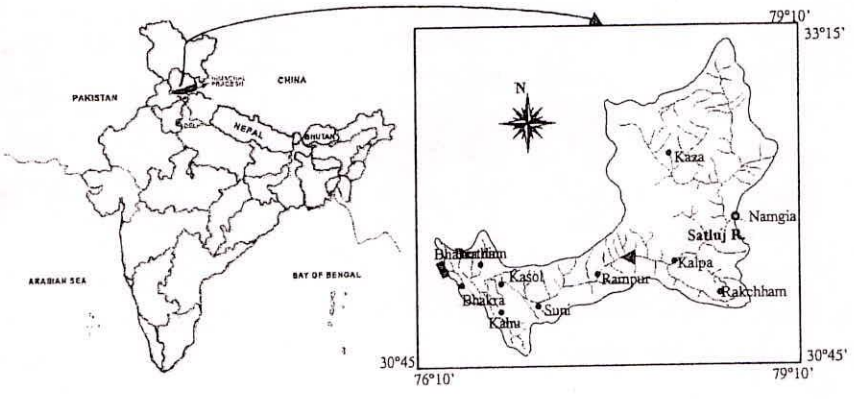
b) **Study Group:** Manohar Arora Sc 'C', SWH Div.
Rakesh Kumar Sc 'F', SWH Div.

c) **Type of study:** Internal

d) **Date of Start:** 1.04.2010

e) **Scheduled date of completion:** 31.03.2013

f) **Location map:**



g) **Objectives:** The objectives of the study are:

i. To Downscale the GCM Output of NIES and NCEP Re-analysis data.

ii. To predict future climatic scenarios for Satluj basin.

h) **Statement of the problem:**

For studying the impact of climate change the future climatic scenarios are needed. These scenarios will be downscaled for the Satluj basin using statistical downscaling technique.

i) **Approved action plan:**

Year	April - June	July-Sept	Oct-Dec	Jan-March
2010	Literature Survey	Literature Survey	Dev. of Methodology	Development of Methodology & Data Collection
2011	Data Processing	Data Processing	Downloading of GCM output	Downloading of NCEP/ NCAR data
2012	Analysis of data	Analysis of data	Preparation of report	Preparation of report

j) Objectives vis a vis achievement:

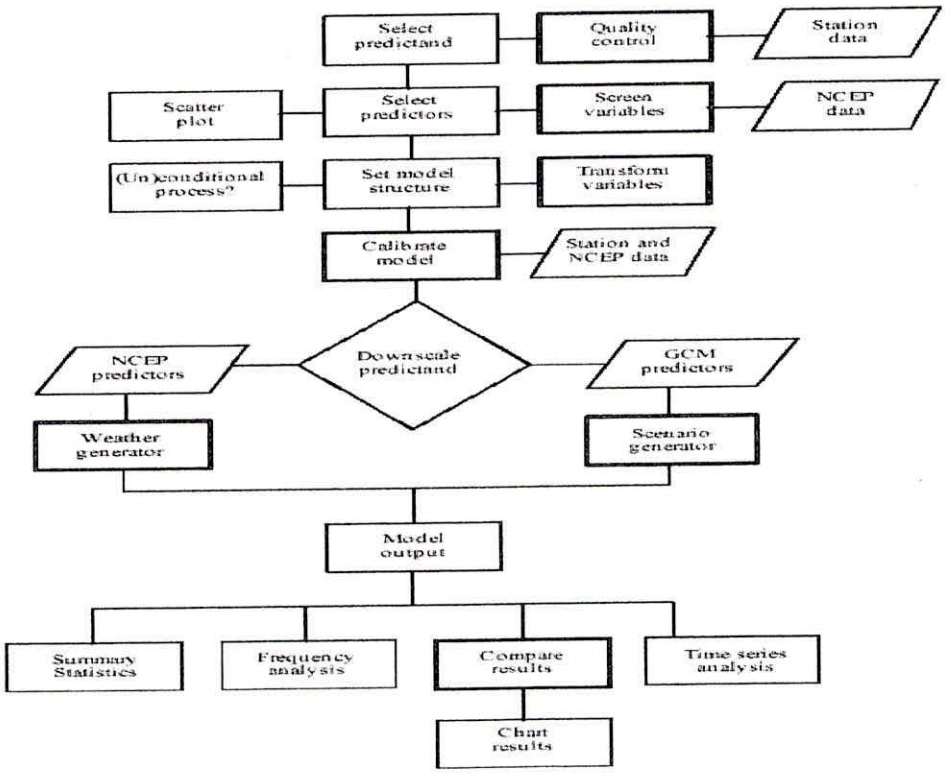
Development of Methodology & Data Collection	The tentative methodology has been developed. The data has been collected.

k) Recommendation/Suggestion of Working Group:

No specific recommendation

l) Analysis & Results:

The climate change information required for many impact studies is of spatial scale much finer than that provided by global or regional climate models. Projections of climatic variables globally can be performed with General Circulation Models (GCMs), which provide projections at large spatial scales. Such large-scale climate projections must then be downscaled to obtain smaller-scale hydrologic projections with appropriate linkages between the climate and hydrologic variables. Statistical downscaling (also called empirical downscaling) is a tool for downscaling climate information from coarse spatial scales to finer scales. It may be applied as an alternative, or as a supplement, to dynamic downscaling (i.e., regional modeling).



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

The study will benefit the departments like SJVNL and BBMB.

n) **List of deliverables:**

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

o) **Major items of equipment procured:** Nil

p) **Lab facilities during the study**: Desktop study.

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

r) **Study Benefits/Impact:** The study will develop the capabilities to downscale future climatic scenarios at basin scale. This scenarios generated may be used to assess the impact of climate change

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

t) **Shortcomings/Difficulties:** This is the first study of this kind being taken up. As more and more downscaling at basin scale is done the methodology will become robust.

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

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

a) Title of study: **Impact of climatic change on evapotranspiration**

b) Study group: N K Bhatnagar, SRA, SWH Div.
Avinash Agarwal, Sc 'E2', SWH Div,

c) Date of start: 1st October, 2009

d) Type of study: Internal

e) Scheduled date of completion: Sept. 2011

f) Location map: NIH Meteorological Observatory

g) Objectives of the study:

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

h) Statement of the problem:

The accurate and short term estimation of evapotranspiration still remains a real challenge. The energy balance/ Bowen ratio method has shown to give reliable measurements in many studies (Tanner, 1968). The method is difficult to apply due to varying heat capacity and extensive measurement of temperature and wind profile. Further, its application to urban area is difficult due to relatively large heat capacity. However, Webb's average Bowen Ratio method eliminates the needs to consider short-term energy storage changes, is of obvious utility (Webb, 1964).

Expected value of Et can be expressed as a function of time if historical data are available, The usual procedure is to correlate the observed Et with meteorological data such as air temperature, humidity, wind, percent of sunshine etc.

i) Recommendation and suggestions in previous meeting of working group: Nil

j) Achievements:

Objective	Achievements
Obj. 1: Application of heat balance method for estimation of short interval evapotranspirtion and Bowen Ratio.	Water pressure and air pressure data using data loggers, borrowed from DST project, was collected and meteorological daily data from the NIH observatory was collected. Rest of the data could not be collected in wait of instrumentation as the same was under process of procurement.
Obj. 2: Study of microenvironment and impacts of climate change on evaporation/ evapotranspiration	Input data will be collected only after the instrumentation.
Obj. 3: Study of heat flux in microenvironment during day and night	Input data will be collected only after the instrumentation.

k) **Analysis and results:**

i. Monitoring of atmospheric pressures and water pressures in the Evaporation Pan at NIH Meteorological observatory was carried out by automatic data loggers hourly w.e.f. 11/11/2009 to 5/8/2010.
ii. Daily Meteorological data for the same period was collected from NIH Met. Observatory.
iii. Cumulative daily evaporation analysis for the above mentioned period was done and the graphs were plotted.

l) **Major items of equipment procured:** Nil

m) **Lab facilities used during the study:** NIH Meteorological Observatory

n) **Data procured and /or generated:**

Atmospheric pressures and water pressures data has been recorded

o) **Study benefits/impacts:**

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.

p) **Specific linkage with institutions and/or end-users/ beneficiaries:** End users

q) **Shortcomings/ difficulties:** Procurement of instruments could not accomplished.

r) **Future plan:** Analysis is in progress and instrumentation is needed for the study.

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

a) Title of the study: **Climatic variability analysis and its impact on Himalayan watershed in Uttarakhand.**

b) Study Group: Avinash Agarwal, Sc E2 & P.I., SWH Div.
Manohar Arora Sc C & Co.P.I., SWH Div.
R K Nema, SRA, SWH Div.

c) Type of study: Internal

d) Date of start: Nov. 2010

e) Scheduled date of completion: Oct. 2013

f) Location map / study area:

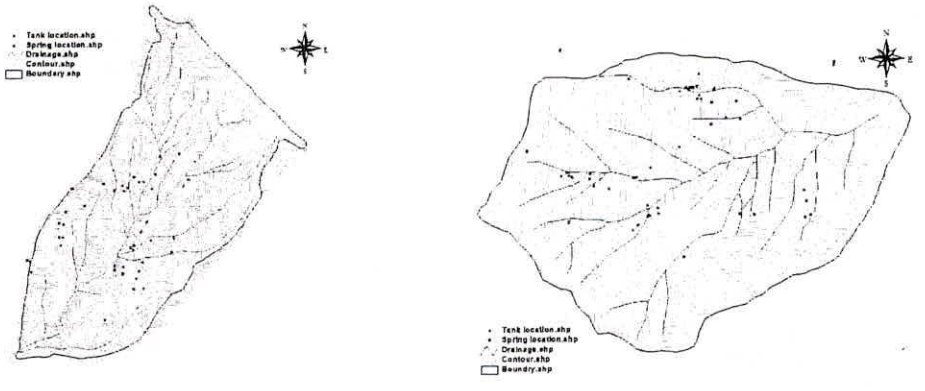


Fig. 1: Map of Chandrabhaga and Danda watersheds

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

g) Objectives of the study:

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

ii. Application of implemental technology for water availability.

iii. Interactive workshops with state line departments and NGOs.

h) Statement of the problem:

A project funded by Department of Science & Technology, Govt. of India, has completed on June 2010 having extensive monitoring of small watershed in Himalayan region of Uttrakhand. A net work of instrumentation of above project exists in two watersheds as a pilot monitoring system in Himalayan region. This net work of instrumentation will be used to obtain the objective of the project.

i) Approved action plan:

Year	1st quarter (A M J))	2nd quarter (J A S)	3rd quarter (O N D)	4th quarter (J F M)
2010			Maintenance and up keeping of installed equipments	Processing and analysis of data collected during 2010
2011	Interactive workshop	Literature review and development of model	Interpretation of results	Processing and analysis of data collected during 2011
2012	Development of appropriate model	Interactive workshop	Interpretation of results	Processing and analysis of data collected during 2012 Interactive workshop
2013	Analysis of current data with historical data	Interactive workshop	Preparation of report	

j) Achievements:

(i) Data collection, instrumentation and processing and analysis: Maintenance and up keeping of installed equipments (3rd quarter) and Processing and analysis of data collected during 2010 (4th quarter) achieved.

(ii) Regular visits of study area as below with objective thereof.

- **September, 2010**
  - Replacement of temperature sensor.
  - Installation of additional water level recorder.
  - Other regular activity.
- **October, 2010**
  - Routine checking of instruments and sites.
- **January, 2011**
  - Two skilled workers appointed one in each watershed
  - Two semi-skilled workers appointed one in each watershed
  - Data download
  - Visits of sits
  - Meeting with *Gram Pradhans*

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

Working group suggested that the objective no two may be modified as "Application of implemental technology for water availability".	Modified as suggested
Further the objective three should include the transfer of findings through interaction workshops involving state line department/s, NGO's and be modified as "Interactive workshop with state line departments and NGOs".	Modified as suggested

l) **Results:**

Continuous monitoring of watersheds (Chandrabhaga, Danda) with the help of existing instrumentation for Rainfall (10 locations), runoff (4 locations), AWS (rainfall, temperature, humidity, wind speed & direction incoming radiation, pan evaporation and soil moisture (different depths), soil temperature (different depths). Quarter wise down loading and updating data hub is in progress.

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

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

o) **Lab facilities used during the study:** Nil

p) **Data procured and /or generated:** The data hub for the watersheds has been created and updated

q) **Study benefits/impacts:** Hill habitat and State Government and other agencies.

r) **Specific linkage with institutions and/or end-users/ beneficiaries:** Village wise interactive work shops in the watershed are proposed

s) **Shot comings/ difficulties:** Nil

t) **Future plan:** As proposed in the action plan.

WATER RESOURCES SYSTEM DIVISION

WORK PROGRAMME FOR THE YEAR 2010-2011

S.No.	Title	Study Team	Duration	Page#
1.	GIS based dams and drought information system	D.S. Rathore (PI) D.Chalisgaonkar R.P. Pandey Yatveer Singh Tanvear Ahmad	1 yr 6 month (10/09-3/11)	153
2.	NIH_ReSyp-A software for Reservoir Analysis (Ver.-I)	M.K. Goel D. Chalisgaonkar	1 year (4/10-3/11)	156
3.	Prediction of dispersion coefficient of Streams using Kriging technique	Vijay Kumar S.K. Singh	1 Year (4/10- 3/11)	158
4.	Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin	Sanjay K. Jain Bhishm Kumar Vijay Kumar S.P. Rai Renoj Theyyan	3 Years (4/09 – 3/12)	162
5.	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 S.K. Jain Vijay Kumar J.V. Tyagi Rama Mehta	3 Years (4/09-3/12)	165
6.	Hydrological Assessment of Ungauged Catchments (Small Catchment)	P. K. Bhunya (PI) Rakesh Kumar Vijay Kumar D.S. Rathod Sanjay Kumar P.C. Nayak Y.R.S. Rao	2 Years (May 2009 to May 2012)	168
7.	Application of a distributed hydrological model for river basin planning and management	M.K. Goel Vijay Kumar D.S. Rathore D. Chalisgaonkar Rama Mehta	2 yr 6 month (10/09-3/12)	174
8.	Analysis of water management scenarios in Tapi River basin using MIKE Basin	Rama Mehta (PI) M.K. Goel Vijay Kumar/ D.S. Rathore	3 years (4/10-3/13)	184

WORK PROGRAMME FOR THE YEAR 2011-2012

S.No.	Title	Study Team	Duration	Page#
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2.	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 S.K. Jain Vijay Kumar J.V. Tyagi Rama Mehta	3 Years (4/09-3/12)	165
3.	Hydrological Assessment of Ungauged Catchments (Small Catchment)	P.K.Bhunya (PI) Rakesh Kumar Vijay Kumar D.S. Rathod Sanjay Kumar P.C. Nayak Y.R.S. Rao	2 Years (May 2009 to May 2012)	168
4.	Application of a distributed hydrological model for river basin planning and management	M.K. Goel Vijay Kumar D.S. Rathore D. Chalisgaonkar Rama Mehta	2 yr 6 month (10/09-3/12)	174
5.	Analysis of water management scenarios in Tapi River basin using MIKE Basin	Rama Mehta (PI) M.K. Goel Vijay Kumar/ D.S. Rathore	3 years (4/10-3/13)	184
NEW PROPOSAL				
6.	Vetting of Water Availability studies of the Gulf of Khambhat Development Projects (Kalpasar Project)	M.K. Goel Vijay Kumar	6 Months (4/11-10/11)	177
7.	Web based Information System for Major and important Lakes in India	D. Chalisgaonkar Suhas Khobragade	1 year (4/11-3/12)	180

WATER RESOURCES SYSTEM DIVISION

PROJECT REFERENCE CODE: NIH/WRS/NIH/09-11

Title of study - **GIS based dams and drought information system**

Study group - D. S. Rathore, Sc E2, PI
Deepa Chalisgaonkar, Sc E1, Co-PI
R.P. Pandey, Sc E1, Co-PI
Yatveer Singh, SRA, Tanvear Ahmad, PRA

Type of study - Internal

Date of start - October 01, 2009

Scheduled date of completion- 31st March 2011

Location map/ study area

Details (location and salient features) of dams and diversions available at NIH in GIS/ database format (source: atlas, reports, books, web sites etc.) was utilized. Salient features for 600 dams and location for 1800, both location and salient features for 400 dams were available. For the drought study, district monthly average rainfall data for 103 years were utilized (source: Indiawater Portal). The districts polygon GIS map is not yet available from SOI India in digital format since price is not finalized for organizations (multiple users).

Objectives:

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

Statement of the problem

The information on dams and drought will be put on internet/ intranet using open source Web GIS software, Mapserver. For dams, the salient features will be displayed. For drought, the rainfall for SPI classes at several time scales will be displayed.

Approved action plan: None

Achievements:

Objective (for period April 2010- March 2011)	Achievements
To publish dam database on web using GIS server	Completed (for Intranet)
To study drought indices at district level and publish on the web	Tables for Rainfall for various SPI classes and time scales were prepared. Web GIS application is under development.

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

None

Analysis and results:

Web GIS

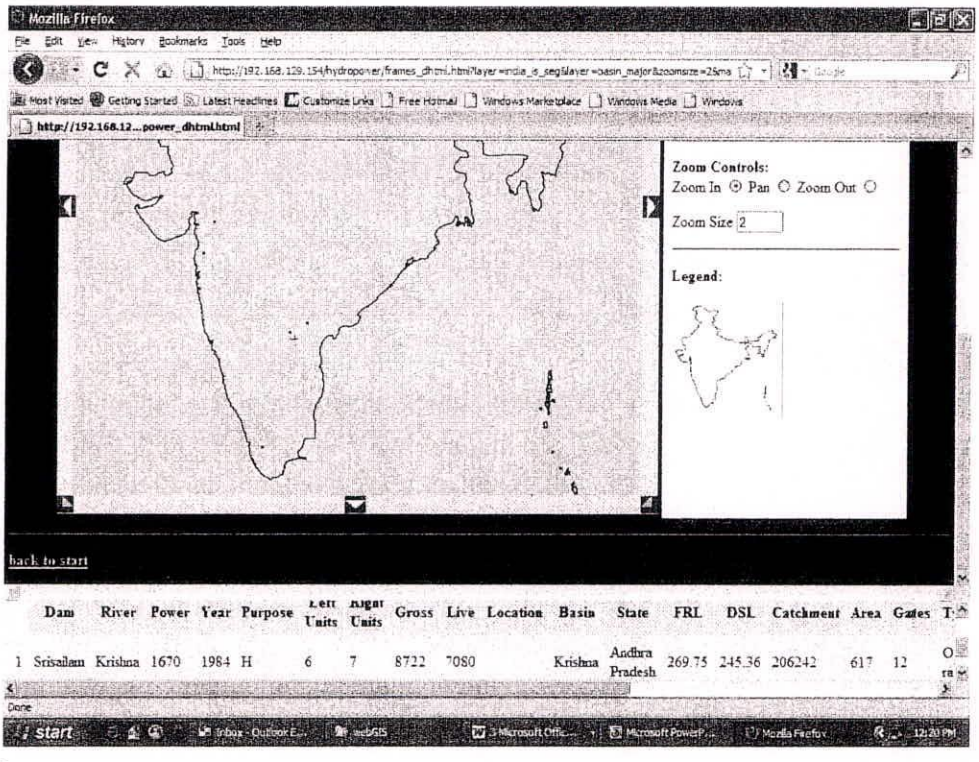
OSGeo Foundation's Mapserver software and Mapserver's Itasca application were used. The applications allow map navigation, query and GIS layer selection. Elements of the web pages are map display, controls, scale, legend, index map and query frame.

Web GIS for dams

The applications consist of web pages, namely all dams, storage and hydropower dams. 'All dams' page displays, dam's thematic map. Spatial query displays information on name, basin and state. Storage and hydropower pages display dams for which the data base contains the relevant information. Spatial query displays the salient features.

Drought index

SPI drought index was selected for the study. Maximum Likelihood estimate of parameters of Gamma distribution for rainfall were obtained using Thom approximation. Rainfall values corresponding to various SPI were obtained.



Results

A snap shot of the Mapserver application for dams is shown in Fig. 1.

Adopters of the results of the study and their feedback

NIH, Feedback will be obtained when the system is finalized

Deliverable

Intranet application, papers, report

Data generated in the study

None

Study benefits and impacts

Dams and drought related information will be available over intranet. The information may be utilized in scientific studies.

Future plan

None

* * *

Project Reference Code –

Title of Study - *NIH_ReSyP* – A software for Reservoir Analysis (Version – 1)

Study Group - M. K. Goel
Deepa Chalisgaonkar

Type of Study - Internal

Start Date - April 01, 2010

Scheduled date of completion - 31st March, 2011

Location map/Study Area

This is a software development study and does not have any specific study area.

Objectives of the study:

The envisaged objectives of the study are:

1. To complete the basic development of *NIH_ReSyP* – a WINDOWS based software developed at NIH for Reservoir systems analysis.
2. To add modules for reservoir sedimentation analysis and spillway gate regulation.
3. To prepare the information brochure and display material for mass awareness for the developed software.

Statement of the problem:

To develop NIH_ReSyP – a WINDOWS based software developed at NIH for Reservoir systems analysis.

Approved Action Plan:

Year	April - June	July – Sept	Oct – Dec	Jan - March
2010-11	Software development for various modules regulation	Extensive testing of the model	New modules for reservoir sedimentation & spillway gate	Information brochure & display material

Achievement:

Objectives (April 2010 - March 2011)	Achievements
1. Software development for various modules	1. Nearing completion
2. Testing of software	2. In-progress
3. Addition of two modules	3. Fortran programs developed & data forms prepared
4. Information brochure & display	4. In-progress

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

Recommendations	Action Taken
1. Dr. S. P. Agarwal enquired about the availability of the software.	1. NIH policy would be finalized in near future.

Analysis & Results:

The results will be presented in the WG meeting.

Adopters of the results of the study and their feedback:

This is a user-friendly software for various kind of reservoir analysis. This will help the field engineers in the analysis of a multi-purpose multi-reservoir system for conservation and flood control purposes.

Deliverables:

A software, information brochure, and display material.

Data generated in the study:

Nil

Study benefits/impacts:

This is a user-friendly software for various kind of reservoir analysis. This will help the field engineers in the analysis of a multi-purpose multi-reservoir system for conservation and flood control purposes.

Future plan:

After the software development is completed, it is planned to organize a workshop/training course for the State Engineers for training them in the use of the software.

* * *

a) Title of the study: **Prediction of dispersion coefficient of streams using kriging technique**

b) Study Group: Dr. Vijay Kumar, Sc. E1, WRS Div.
Dr. S K Singh, Sc. F, WRS Div.

c) Type of Study: Internal

d) Date of Start: April 1, 2010.

e) Scheduled date of completion: March 31, 2011

f) Study area:

Published authentic laboratory and field data will be used.

g) Objectives of the study:

i) Review of different empirical methods for predicting dispersion coefficient of a stream.

ii) To develop a method for predicting the dispersion coefficient from the flow and geometric parameters of stream using kriging technique.

iii) To illustrate the application of the method using published authentic laboratory and field data.

iv) To compare the results obtained using the developed model with those obtained using available empirical equations.

h) Statement of the problem:

Dispersion is the hydraulic process by which a plume of contaminant spreads longitudinally and dilutes. Dispersion of solutes in streams and channels has been of concern to hydrologists, civil engineers and environmental scientists for the last many decades. It is an important parameter known to govern the one-dimensional transport of solute in streams. It finds application in the solution of various problems, e.g. abatement of pollution, forecasting of pollution due to accidental release of hazardous chemical, prediction of water temperature due to thermal discharges from cooling plants, assessment of assimilative capacity, aeration rate of streams, and so on. Identification of the dispersion coefficient is a pre-requisite for the solution of all dispersion problems. Longitudinal dispersion coefficient in natural streams can be determined by using experimental studies which are very expensive and time-consuming. Numerous empirical and semi-empirical equations have also been proposed by various researchers to predict the longitudinal dispersion coefficient from flow and cross-sectional parameters of the stream. This study focus on development of a method for predicting the dispersion coefficient from the flow and geometric parameters of stream using kriging technique.

i) Approved action plan:

Year	April-June	July-Sept	Oct-Dec	Jan-Mar
2010-11	Literature survey	Development of methodology using kriging technique	• Application of the developed method using published authentic laboratory and field data. • Application of available empirical equations using published authentic laboratory and field data.	• To compare the results obtained by developed method with the results obtained using empirical equations. • Report writing

j) Achievements:

Year	Objectives	Achievements
2010-11	• Literature survey.	Review of different empirical methods for predicting dispersion coefficient of a stream has been carried out.
	• Development of methodology using kriging technique.	Development of a method for predicting the dispersion coefficient from the flow and geometric parameters of stream using kriging technique is completed. However, further improvement is under taken.
	• Application of the developed method using published authentic laboratory and field data.	Published authentic laboratory and field data has been collected for application of the developed model and a set of data has been selected for illustration of the developed model.
	• Application of available empirical equations using published authentic laboratory and field data.	Done.
	• To compare the results obtained by developed method with the results obtained using empirical equations.	Under progress.
	• Report writing	Under progress.

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

Recommendation/suggestion	Action Taken
Sh. R D Singh, Director NIH and Chairman of the Working Group, suggested to include the data requirement to estimate the dispersion coefficient of streams in the final report.	This suggestion is being taken care of while writing the report.

i) Analysis and results:

Review of different empirical methods for predicting dispersion coefficient of a stream has been carried out. Various authors who have proposed these models are: Taylor (1954), Elder (1959), Fischer (1967, 1975), McQuivey and Keefer (1974), Liu (1977), Iwasa and Aya (1991), Seo and Cheong (1998), Deng *et al* (2001) and Kashefipour and Falconer (2002).

Experimental data (discharge, width of water surface, flow depth, average flow velocity, shear velocity, slope and measured dispersion coefficient) have been collected from literature for various reaches of different rivers.

Kriging describes the behaviour of a natural phenomenon relying on two different variables. For the present study, variables such as discharge, shear velocity, flow depth, flow velocity, and slope can be paired as two input location variables for the prediction of dispersion coefficient as regional variable (ReV). Different experimental semi-variograms are drawn and fitted with different theoretical models. Some of the results are shown below.

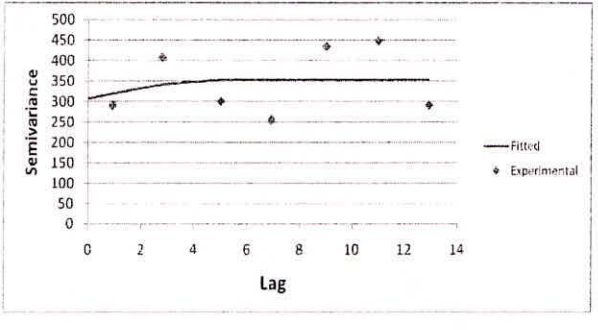


Fig1. Semi-variogram analysis using discharge and shear velocity.

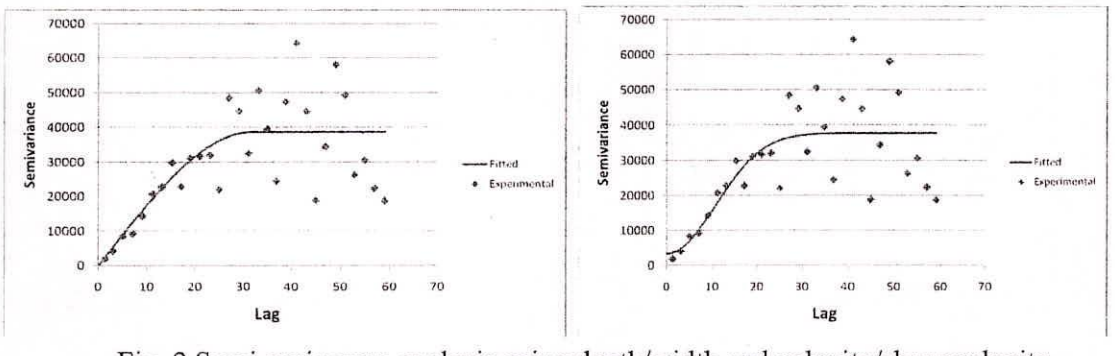


Fig. 2 Semi-variogram analysis using depth/width and velocity/shear velocity.

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

Central and State agencies dealing with river water pollution. Researchers and modelers working in the area of river water pollution.

n) Deliverables:

Research papers and reports.

o) Data generated in the study:

Published authentic laboratory and field data has been used.

p) Study benefits/impacts:

The developed method for predicting the dispersion coefficient from the flow and geometric parameters of stream using kriging technique would be helpful in dealing with practical problems such as Abatement of river pollution, forecasting of pollution due to point sources of pollution or accidental release of hazardous chemical.

* * *

a) Title of the Study : Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin

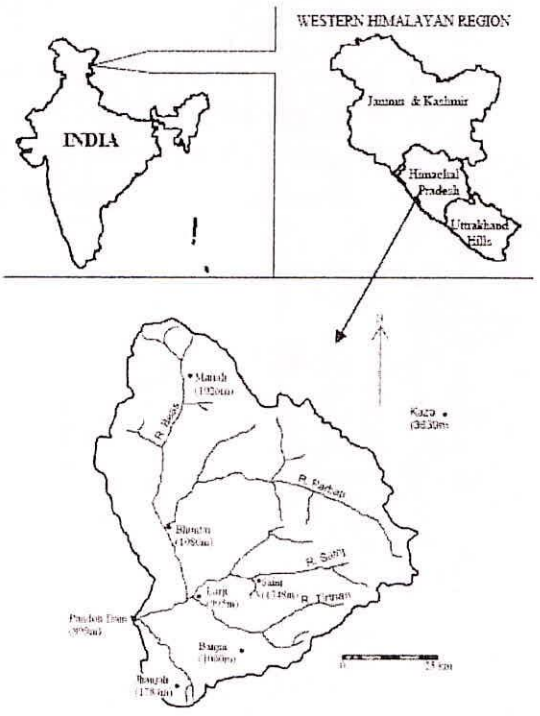
b) Study Group : Dr. Sanjay K. Jain, Dr. Bhishm Kumar, Dr. Vijay Kumar, Dr. S. P. Rai Dr. Renoj Theyyan.

c) Date of Start : 1st April 2009

d) Schedule date of completion : March 2012

e) Type of study : PDS under HP II

f) **Location map / Study area**



g) 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 meltwater 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 meltwater 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.

h) Statement of the problem:

This study is being carried out under HPII. The simulation of snowmelt runoff will be carried out using remote sensing data and hydrological model. The field samples will be analysed in Nuclear Hydrology Lab. For separation of runoff into snow/glacier melt runoff. Impact of climate change on stream flow will be studied with the help of future scenarios.

i) Approved action plan: Work plan approved for four year is as follows:

Activity	Year 1	Year 2	Year 3	Year 4
Reconnaissance surveys, Data collection				
Problem conceptualization				
Meetings with participating agency				
Appointment of project staff				
Procurement of data, equipment, software, consultancy				
Database development				
Field visits for sample collection				
Applications of conceptual model				
Model calibration & Validation				
Development of climate change scenarios and impact studies				
Report writing				

j) Achievements

Year	Objectives (for the period April 2010 - March 2011)	Achievements
2010-11	i) Analysis of data and trend analysis	Partially achieved
	ii) Creation of data base in GIS	Achieved
	iii) Simulation of snowmelt runoff model	Achieved
	iv) Generation of climate change scenarios	Under process
	v) Samples collection from the field	Under process

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

There was no specific recommendation pertaining to the study.

l) Analysis and Results:

Trend analysis of rainfall, runoff and temperature has been carried out using regression analysis, ManKendall and Sen's interpretor. As per this analysis, temperature at Bhunter and Largi is showing increasing trend and rainfall at all the station except one shows decreasing trend. The snows cover area for the years 2000-2009 have been prepared from MODIS data. IRS WiFS and AWiFS data have been collected from NRSC, Hyderabad and snow cover maps have prepared. The model is applied at two more sites i.e. at Manali and Bhunter.

For carrying out isotopic analysis, samples have been collected from a number of sites. Weekly samples have been collected from all the sites for the period October 2010 to Jan. 2011. Two field visits in November 2010 and Jan. 2011 have been made. Analysis of these samples is under progress and results will be presented during the meeting.

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

Bhakra Beas Management Board

n) Deliverables

Reports and research papers

o) Data generated in the study

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

a) 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

b) Study Group :Dr. Sanjay K. Jain, Dr. S. K.Jain, Dr. Vijay Kumar, Dr. J.V.Tyagi, Dr. Rama Mehta

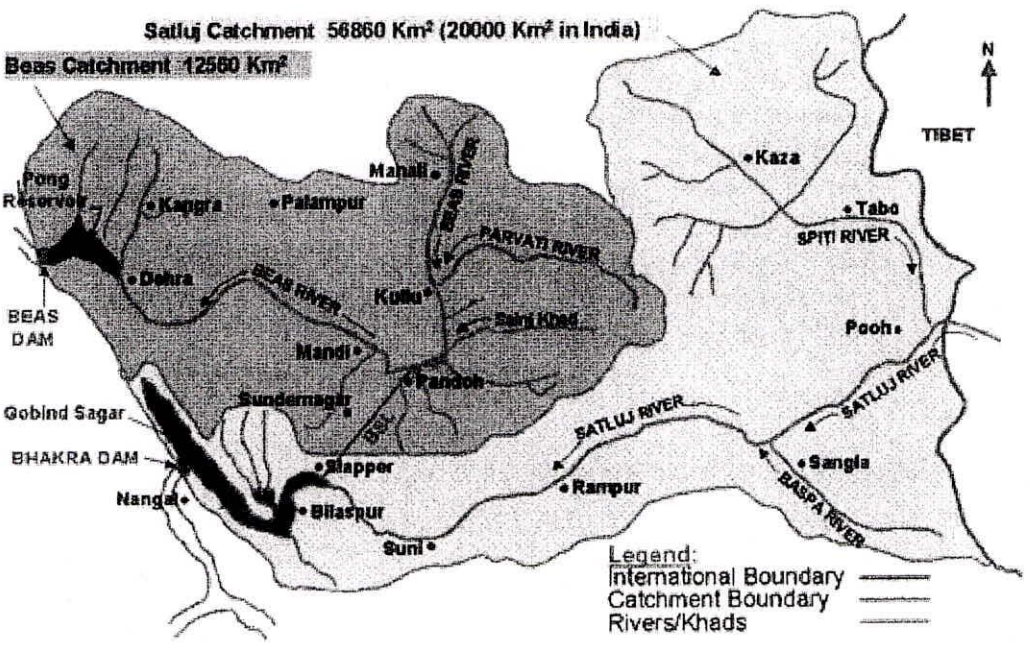
c) Date of Start : 1st April 2009

d) Schedule date of completion : March 2012

e) Type of study : PDS under HP II

f) **Location map / Study area**

SATLUJ & BEAS BASINS



g) **Objectives :**

The objectives of the study are as follows:

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

h) Statement of the problem:

This Purpose Driven Study (PDS) has been taken up by BBMB. They have requested NIH for collaboration in this study. Therefore this study has been proposed under the work program of the division. BBMB has already informed about the approval of chairman, BBMB for partnership of NIH in the study.

i) Approved action plan

Creation of database

- Topographical maps of catchments of Satluj and Beas preferably the scale of 1:250000/1:50000 for drainage, contour etc. — BBMB
- Conversion of catchments map into Digital map. — NIH
- Landuse map using Remote Sensing data. — NIH
- Soil map of the catchments. — BBMB
- Digital Elevation Model (DEM) of the catchments. — NIH
- Pre – impoundment and the latest observed cross- sections of Bhakra and Pong reservoir etc. — BBMB
- Database comprising of rain-fall, discharge, sediments analysis for various existing sites located in Bhakra & Pong Catchments. — BBMB

Assessment of sedimenation rate

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

Modelling of soil erosion/sediment yield

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

j) Achievements

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

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

There was no specific recommendation pertaining to the study.

l) Analysis and Results:

Processing of satellite data has been completed. Sedimentation rate using remote sensing data have been completed. Results will be presented during the meeting. Satellite data for both the catchments i.e. Satluj up to Bhakhra and Beas up to Pong have been procured. Land use map have been prepared. Land use map, DEM etc. have been converted into Arc SWAT format for sediment yield modeling. The progress will be presented in the meeting. Daily rainfall, temperature, sediment and stream flow data of these two basins have been collected up to December 2009. Sediment discharge relationships for Satluj basin on the basis of regression

analysis, sediment transport models and soft computing techniques like ANFIS and ANN have been deployed. Discharge data are used as input data and sediment yield as output data for entire study. A training course (Soil erosion and reservoir sedimentation using remote sensing and GIS) has been organised for BBMB officials during 11-13 October 2010 at BBMB, Nangal.

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

Bhakra Beas Management Board

n) Deliverables

Reports and research papers

o) Data generated in the study

Landuse, DEM, soil etc. maps from satellite data/ancillary data, sedimentation rate from two reservoirs, and sediment yield map from two catchments.

PROJECT REFERENCE CODE: 12/94/2005-B & B/VOL-V/922-953 dated 3/9/2008.

(a) TITLE OF THE PROJECT: HYDROLOGICAL ASSESSMENT OF UNGAUGED CATCHMENTS (SMALL CATCHMENT)

(b) STUDY GROUP:

Principal Investigator (PI): Dr. Pradeep Kumar Bhunya, Sc. E1

Co-PIs : Dr. Rakesh Kumar, Sc. F, Head (Surface Water Div.)
Dr. Vijay Kumar, Sc.E1, WRS Div
Investigators : D S Rathore (Sc. E2, WRS Div.); Dr. Sanjay Kumar (Sc. C, Surface Water Div), Dr. P. C. Nayak (Sc. C, RC Kakinada); Dr. Y R S Rao (Sc.E2, RC Kakinada)

Nodal Officers Representing From Govt. Of Orissa: (i) Director (Hydrology and W.R. Planning-I), Govt. Of Orissa, (ii) Er. S K Malik (Deputy Director) and Er. S B Mohanty (Assistant Director) at Director of Hydrometry, Govt. Of Orissa. (vide letter No- Dir-Hyd-HP II-PDS 24/7-617 dated 6/8/2007).

(c) TYPE OF STUDY; PDS (Under Hydrology project-II), Funded externally under HP II, vide Letter No. 12/94/2005-B & B/VOL-V/922-953 dated 3/9/2008.

(d) DATE OF START: May, 2009

(e) DURATION OF THE STUDY AND SCHEDULED DATE OF COMPLETION: Duration of three years (2009-2012), and expected date of completion is May, 2012.

(f) OBJECTIVES OF THE STUDY:

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

(g) STUDY AREA AND LOCATION MAP

The Ministry has recommended small catchments in Mahanadi basin as a study area for this project (ref: Letter No. 12/94/2005-B & B/VOL-V/922-953 dated 3/9/2008). Since the basins of Rushukulya and Brahmani are near Mahanadi and has a confluence at *Puri* and *Cuttack* districts, a few selected small catchments from these two basins are envisaged to be included in this project so as to make the results refined.

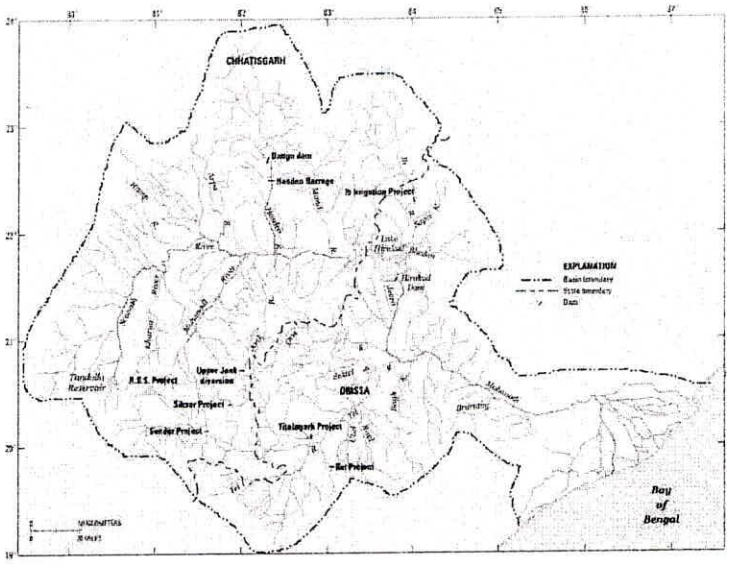


Figure: Mahanadi basin in *Orissa* and *Chatisgarh* states.

(h) STATEMENT OF THE PROBLEM AND BRIEF METHODOLOGY

Briefly the following steps are followed for this study:

(i) Testing few homogeneity tests. (ii) Regionalize the pdf parameters used for transmuting the UH using available UH for a region., (iii) Regional formulae for peak flow and time to peak of UH for the region on basis of geomorphological characteristics of the basins using new methods like ANN, Fuzzy and non-linear regression model, (iv) Explore the potentiality of new synthetic unit hydrograph methods (gamma, beta, Weibull) and identify the best method for the region, (v) Regionalization of parameters of the robust AMS model, (vi) Deriving regional formulae, (vii) Regional formulae for q (T) using regression techniques, (viii) Peak over threshold methods, (ix) Regionalization of flow duration curves using available data, (x)Uncertainty and risk factor analysis

(i) APPROVED ACTION PLAN AND EXPECTED OUTCOME

On basis of the detailed study and analyzing the results of other organizations working on this area in the region, a standardized design practice is to be developed for the ungauged catchments in the region. The following are the expected outcome from the project.

1. Regional unit hydrograph relationships for the region are to be developed. Knowing the catchment characteristics for an ungauged catchment in the region from the available topographical sheet and climatological data, the UH for that catchment can be derived for the region. This shall provide the user to opt among five methods (Snyder, SCS, Gamma, Beta and Weibull method) and the methods to estimate UH parameters like time to peak and peak flow form geo morphological data.
2. Recommend a standard statistical distribution procedure for homogeneity tests.
3. Regional formulae to be used for ungauged catchment in the region to estimate peak flood and time to peak for different storms. The formulae shall be derived with latest data and shall also provide the uncertainty.
4. Recommend a standard POT method for return period flood computation when the annual maximum series is short.
5. Regional flow duration curve to estimate the dependable flows for the ungauged catchment.
6. A menu driven software to accomplish the above works.

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

Sl	Technical Component	Technical Activity	09-10		10-11		11-12	
			1	2	1	2	1	2
1.	Literature survey and watershed identification and data collection.	Literature survey						
		Watershed survey						
		Collection of historical data						
		Primary investigation and verification of data						
2	Model application	Application of available model to storm data						
		Analysis, interpretation & reporting of results						
3.	Model development (Extrapolation, pruning, network size and generalization)	Application of to storm data	1					
		Programming & model application	2					
		Analysis, interpretation & reporting of results						
4.	Analysis of GIS data	Collection/digitization of data, analysis, interpretation, and reporting of results						
5.	Application of recent SUH models	Available model understanding						
		Programming & model application						
		Analysis, interpretation & reporting of results						
6.	Application of allied hydrological models.	Model development						
		Programming & model application						
		Analysis, interpretation & reporting of results						
7.	Development of a user interface software							
7.	Final report	Summarization of results & reporting						
8.	Dissemination of outcome	Organization of workshop						

(j) ACHIEVEMENTS AND RECOMMENDATION IN THE LAST WG MEETING

1. Using GIS, and available toposheet, multiple map overlays were prepared for matching the geomorphic and basin characteristics and their corresponding changes. In addition, renaissance survey were conducted with field visits.
2. Land-use conditions including change in geomorphology, was studied using a sweep method to view both the imagery and respective toposheet in Arc-GIS. This was done for about five small catchments, that was available.
3. Available hydrologic data and morphological characteristics like annual peak discharge, catchment area, length of the main stream, equivalent channel slope, geomorphological characteristics of the basins, land use conditions, soil type, and rainfall character tics etc were analyzed for few sites within the study area. The works involved consistency using different statistical measures for various period length, discordancy and heterogeneity measures for the available data. The results showed nine sites out of all 36

sites were discordant with the others in the respective regions. The heterogeneity measures was on-going and could not presented in totality.

4. A new approach for regionalizing the parameters for a proposed equation were attempted using Fuzzy-neuro method. A standardize regional flow duration curves in some selected ungauged catchment in the region were shown using data Mahanadi (3d) collected from CWC report. These works had to be refined in future.
5. The parameters of the UH were regionalized using a non linear regression and ANN for hydrograph relationships for 10 catchments in the region.

A training course was conducted under India-Hydrology Project Phase-II during 26 – 30 July 2010. This is as per the norms given by the Institute calendar (under HP 2). As per the requests of some of the participants, a training course on such allied topics has been discussed with Director (Hydrometry), Bhubaneswar and proposed during this year in Orissa.

(k) **Recommendations** : There was no such critical suggestions and recommendations from the working group

(l) RESULTS ACHIEVED DURING THIS PERIOD (OCT, 2010-FEB,2011)

Earlier some runoff (daily, monthly average) were collected from CWC for four gd sites in Mahanadi. The data length wise in time term has been added, that was collected during tours from state hydrometry, and CWC Bhubaneswar. Processing of streamflow and gage data has been completed for Naraj, and Jenapur for the year 2000-2009. Two major objectives i.e. rating curves has been completed for the above sites, using four methods, they are Grigorton, Weibull, Blom's and CWC guidelines that was used earlier in their reports. The fitting of the curves has also been tried with exponential/logarithm and power equation. In addition to the data discussed above, a few toposheet i.e. about four 1:50000 scale of Mahanadi basin has been scanned in a major scale, and about two more imageries have been downloaded from net, and after a review and inspection: ten toposheet for the study area have been scanned for further use in the study. This has been done for about three small catchments, compared to last quarterly progress. The work is going-on for other catchments. A detail results regarding the morphological parameters, and their variations (regional) for the Mahanadi small catchments from imageries interpretation to be used for GIUH. With the recently procured data, two works are going on, i.e. (i) to refine the previous results of regional heterogeneity and discordant tests, and (ii) SUH development using short-term flood events for use in hydrograph derivation and, along with the UH parameters in regional scale , and (iii) development of flow duration curves. As asked by the authority from Hyderabad regarding the satellite imagery dates (passing row/path), it was revised, and received the soft copies of the required imageries, along with the non-restricted SOI toposheets from GSI. A letter for consultancy support under PDS (HP-II) has been submitted earlier, and seven interests of firms /Institutes have been proposed. Since this activity has been planned for the last phase in the project period, the letter of interest for the consultancy support works proposed shall be sent to firms by this year end. This includes encamping sub-programs (sub-computation) dealing vitally for developing a user-friendly tool for the PDS. Also it includes development of the specifications, formats and framework for computerized databases (including spatial databases) and procurement of any databases, satellite imagery/GIS databases, computer equipment, etc. for the DSS. In addition to these, revised hydrological equipments sanctioned by the Ministry have been proposed for procurement. Out of the results obtained so far, some technical papers have been submitted for review, so that the methods and approach might be examined and be

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

(m) ADOPTERS OF THE RESULTS OF THE STUDY AND THEIR FEEDBACK

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

(n) DELIVERABLES:

Research papers, user friendly menu and catalogue with focus on a real problem, that of estimating design flood magnitude at sites with either short records, or no flow data at all.

(o) DATA GENERATED IN THE STUDY:

Type of data	Stations / basins	source
Discharge data (AMS)	23 small catchments on Mahanadi (3d sub-zone) for 34 years (1957-1987)	CWC reports for sub zones
Discharge data (AMS) and G & D data	20 stations on Mahanadi and Brahmani with prominent GD sites are: Tikarpara, Sukuma, Kantamal, ,Kesing, Pandigaon,Salebhata,,Sundergarh	Department of Hydrometry, Govt. of Orissa, and Irrigation department
Discharge data (AMS)	Peak flow data of 3a, 3b, and 3f sub zones	CWC reports for sub zones
Peak hourly -runoff data during floods	23 small catchments on Mahanadi along with 10 other streams (like Myntdu, Banjar, Burhner, Br-253, and others for UH comparison)	Department of Hydrometry, CWC, MeSEB (Assam)
Geomorphological data like L, Lc, A and slope	23 small catchments on Mahanadi	CWC reports for sub zones a
Rainfall data	Daily maximum and annual for Lower Brahmani, Mahanadi and Rushukulya (Annexure). The data to be procured from IMD is being prepared (stations and code)	Department of Hydrometry,
G & D data	Rengali reservoir (g/d data) on Brahmani	FC department (Govt. of Orissa)
Maps	Geomorphological maps prepared by the office of E-i-C, Govt. of Orissa for Mahanadi, Brahmani and Rushululya	Restricted

(p) STUDY BENEFITS/IMPACTS:

The study shall give as an user friendly menu and catalogue with focus on a real problem, that of estimating design flood magnitude at sites with either short records, or no flow data at all. This shall focus on two types of flood analysis i.e. with short-term

data and daily or annual maximum data base. It would be useful for the Hydrological Design Aids project under HP-II.

(q) **FUTURE PLAN:**

In future, it is envisaged to add a few more physiographic parameters using remote sensing imageries and GIS, which are sometime difficult to interpret from the Survey of India toposheets or might have changed due to natural and human activities in the region. CWC has already stipulated design return periods for different schemes depending on their size (small, medium, and large) along with the specification for using either PMF or SMF for design flood computation. Therefore, it is envisaged to analyses various distributions and recommends a standard statistical distribution for flood frequency analysis in the region. The theoretical analysis shall include all the recent developments in the topic and the latest available data of the region.

Project Reference Code –

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

Study Group - M. K. Goel
Vijay Kumar
D. S. Rathore
Deepa Chalisgaonkar
Rama Mehta

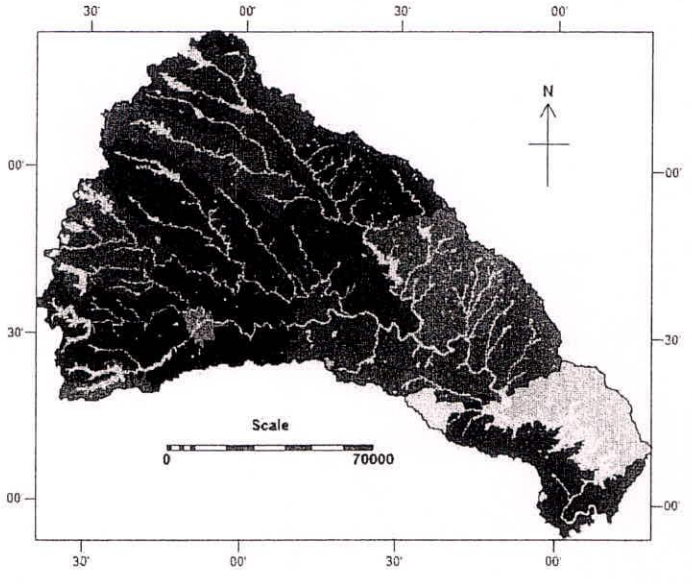
Type of Study - Internal

Start Date - October 01, 2009

Scheduled date of completion - 31st March, 2012

Location map/Study Area

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



Objectives of the study:

The envisaged objectives of the study are:

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

Statement of the problem:

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

Approved Action Plan:

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

Achievement:

Objectives (April 2010 – March 2011)	Achievements
1. Database development 2. Review of models 3. Application of Mike Basin Model 4. Application of NIH Model	1. Completed for Mike basin model and significant progress for NIH model 2. Review of models for HEC/ SWAT, and MODSIM models 3. In-progress 4. In-progress

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

Recommendations	Action Taken
1. Prof. K. V. Jaya Kumar/Dr. S. P. Agarwal suggested that for the SWAT model, a GIS interface ArcSWAT may be useful for the modelling. 2. He also suggested the possibility of using another public-domain model *Distributed Rainfall Runoff Routing Model* (DRRRM).	1. This GIS interface will be used. 2. This model will be reviewed and downloaded. After application of other envisaged models, this model will be used in the study.

Analysis & Results:

The results will be presented in the WG meeting.

Adopters of the results of the study and their feedback:

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

Deliverables:

Research papers and reports.

Data generated in the study:

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

Study benefits/impacts:

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

Future plan:

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

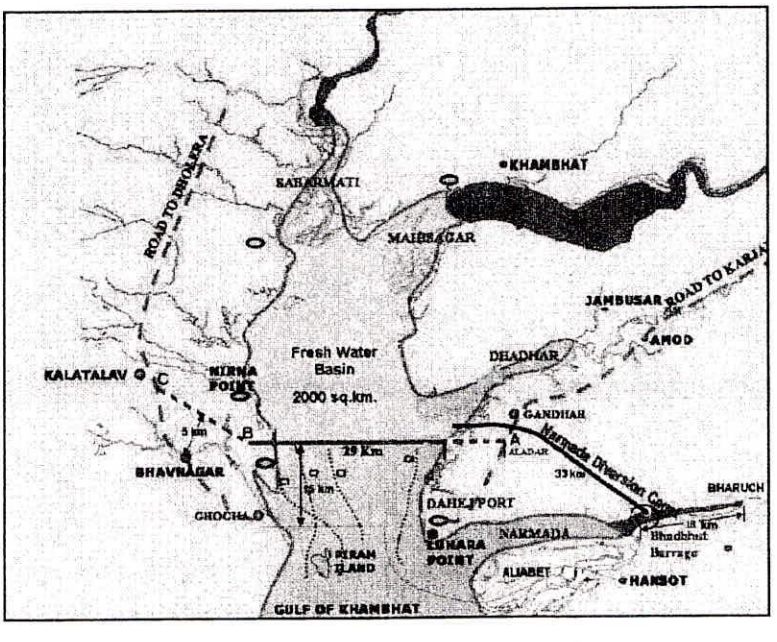
* * *

Project Reference Code – CS-12/2011-11/NIH(WRS)

Title of Study	-	Vetting of Water Availability Studies of the Gulf of Khambhat Development Project (Kalpasar Project)
Study Group	-	M. K. Goel Vijay Kumar
Type of Study	-	Consultancy
Start Date	-	April 29, 2010
Scheduled date of completion	-	October 29, 2010 (In view of the revised analysis by CDO, likely to be extended up to Oct 29, 2011)

Location map/Study Area

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



Objectives of the study:

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

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

Statement of the problem:

To review the water availability study of Gulf of Khambhat Development Project carried out by the Central Designs Organisation (CDO), Govt. of Gujarat.

Approved Action Plan:

Year	April - June	July – Sept	Oct – Dec	Jan - March
2010-11	Collection of reports and database used in study Inception report	Visit to Gujarat & discussion about the study	Model simulation, checking of results and report preparation	-

Achievement:

Objectives (April 2010 – March 2011)	Achievements
1. Collection of reports & database	1. Completed
2. Visit to Gujarat & discussion with Gujarat team	2. Completed. Detailed comments have been given for compliance.
3. Model simulation & checking of results	3. Work is in progress at CDO after detailed deliberations at NIH, Roorkee
4. Report preparation	4. After completion of Step 3.

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

Nil

Analysis & Results:

The CDO, Gandhinagar has carried out studies for different river basins and the reports were provided to NIH for our observations. After detailed studies of the reports and after discussing various aspects with the officials of

Gujarat Government during the field visit in August/September 2010, the comments on the studies were submitted to the Kalpasar Department. The reply to the comments was submitted by the CDO Gujarat in December, 2010 and detailed discussion on the reply was made with the Gujarat officials in the meeting held during January 24 - 28, 2011. Detailed comments have been given again to CDO for compliance.

Meanwhile, the ASTER satellite DEM has been downloaded and drainage network and sub-basin layout have been worked out for various sub-basins. Using the layout of different rainfall stations, Thiessen weights have been worked out for different sub-basins. The procedure was also demonstrated during the visit of the Gujarat team in January, 2011.

The CDO has been requested to finalize the rainfall and discharge stations (State, CWC, and IMD) and collect the data for the generation of long-term discharge series using the developed rainfall-runoff relationships.

Adopters of the results of the study and their feedback:

Narmada, Water resources, Water supply, and Kalpasar Department, Govt. of Gujarat.

Deliverables:

A report detailing the water availability estimations in the proposed Kalpasar project from various contributing river basins.

Data generated in the study:

Nil

Study benefits/impacts:

This study will evaluate the water availability analysis in the proposed Kalpasar project.

Future plan:

Nil

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Progress of existing studies

a) Title of the study : Web Based Information System for Major and Important Lakes in India

b) Study group : Deepa Chalisgaonkar, Scientist 'E1'
Suhas Khobragade, Scientist 'E1'

c) Type of study : Internal

d) Date of start : April 1, 2010

e) Scheduled date of completion: March 31, 2012

f) Study area : India

g) Objective :

(i) To develop a framework for web-based information for major and important lakes in India.

(ii) To compile the information related to major and minor lakes of India

(iii) To use web as a platform for the dissemination of this information to the users.

h) Statement of the problem:

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

i) Action plan:

Year	April – Jun	Jul - Sep	Oct - Dec	Jan - Mar
2010-11	Planning the design of the Information system and development of the framework Review of Literature	Preparation of clickable map of India showing different states Review of literature	Preparation of clickable map of Rajasthan showing lakes of Rajasthan Review of literature	Review and Compilation of information related to 15 lakes of Rajasthan and about 20 other lakes of India
2011-12	Review, compilation and incorporation of the literature/material to lake hydrology in the system	Preparation of clickable maps of MP, Uttarakhand, J& K, Punjab, Haryana and HP. Review and compilation of literature related to lakes of MP, Uttarakhand, J& K, Punjab, Haryana and HP.	Preparation of clickable maps of AP, Maharashtra, Karnataka, TN, Kerala etc Review and compilation of literature related to AP, Maharashtra, Karnataka, TN, Kerala etc	Final testing, debugging and installation of Lake Information System

j) Achievements

Year	Objectives (for the period April 2010 - March 2011)	Achievements
2010-11	i) Planning the design of the Information system and development of the framework	Achieved
	ii) Preparation of clickable map of India showing different states	Achieved
	iii) Preparation of clickable map of Rajasthan showing lakes of Rajasthan	Achieved
	iv) Review and Compilation of information related to 15 lakes of Rajasthan and about 20 other lakes of India	Achieved

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

There was no specific recommendation pertaining to the study.

l) Analysis and Results:

The fundamental design criterion for the system is to cast it as a geo-spatial, WWWeb-based information repository of the lake related information system. Using standard internet and Web-based programming protocols (HTML, full W3C compliance, java scripting), it has full portability. Through straightforward GUIs and geo-spatial map retrieval, the computer codes are transparent to the users, thus making the system highly user-friendly.

The framework of the system has been developed. The clickable maps of India and its states have also been developed. The software is being developed using client-server technique as shown in Fig. 1.

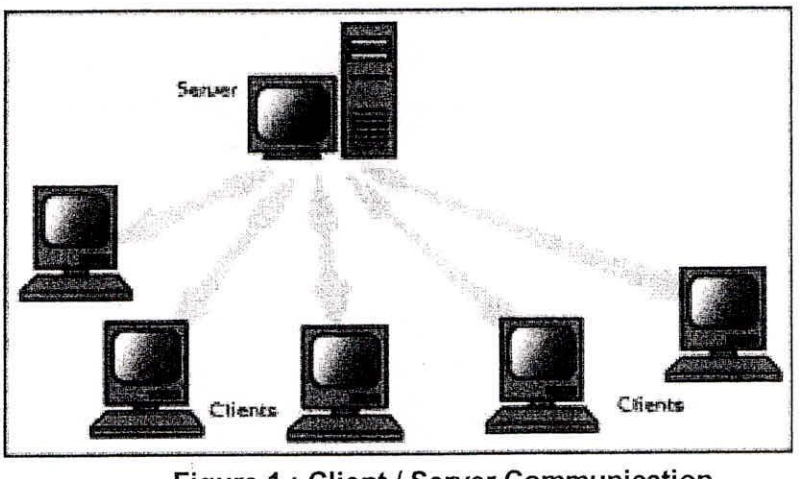


Figure 1 : Client / Server Communication

A distributed, three-tiered architecture has been used. This includes a client application and a server application. The client application inputs the parameters and then send the requests to the server site. The server application collects the requests from the client site and sends the results to the client layer. The main screen of the software is shown in Fig.2.

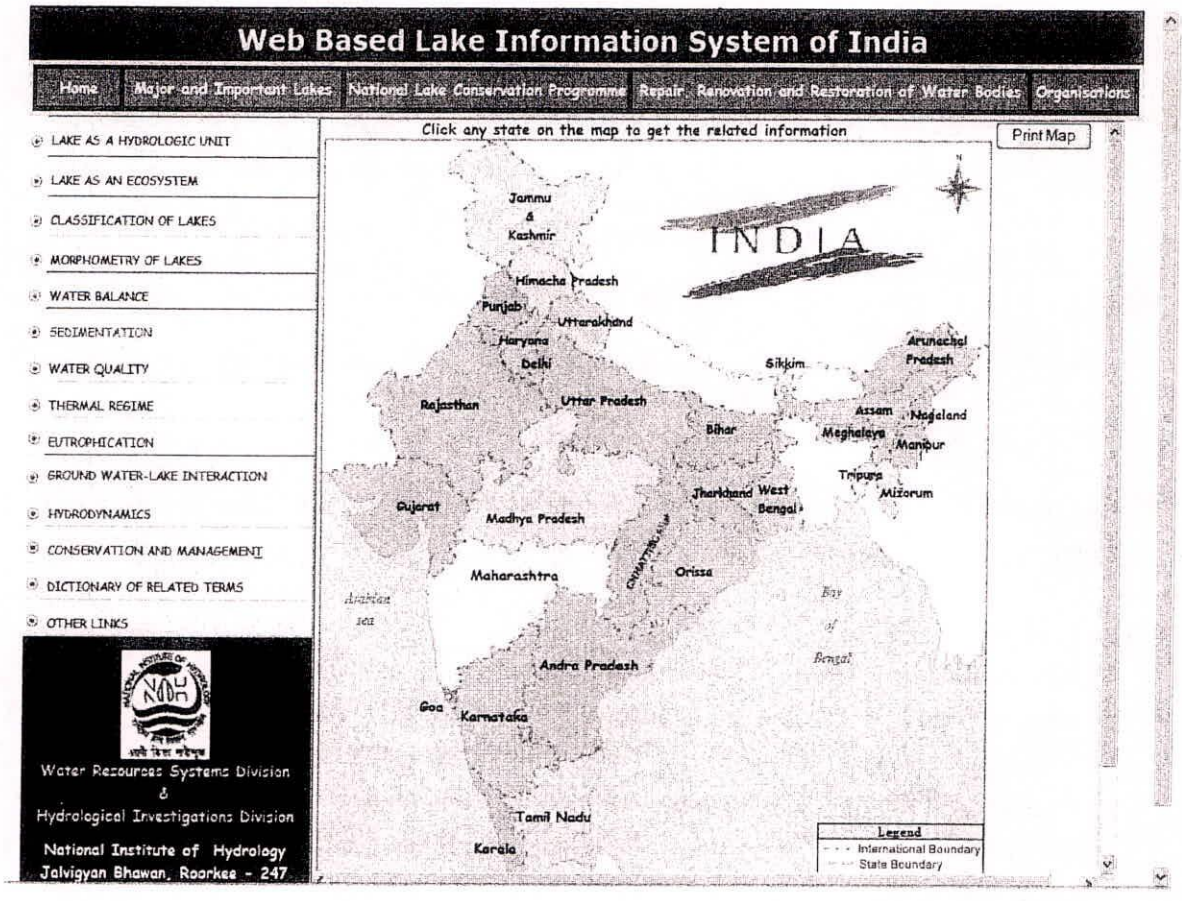


Fig. 2 : Main Screen of WEBLIS

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

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

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

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

The information which would be made available in the information system being developed would be of great help to all those who are working in the area of lake conservation and management. This information would also be of great help to the policy makers, managers and field engineers who are directly involved in the management and conservation of the lakes.

n) Deliverables

Software, reports and research papers

o) Data generated in the study

The information related to lakes is being collected from various sources. The clickable maps of India and its states, showing the locations of the lakes, are being developed. Once a particular lake is clicked, information related to that lake would be available to the user. Except for the maps, no other primary data is being generated for the study. Only secondary data available from various sources would be compiled and made available to users.

p) Study benefits / impacts

The package intends to provide information regarding the various hydrological and limnlogical aspects of the major and important lakes of India. The information includes diagrams/text describing the lakes of India and data on water quality, water availability, sedimentation, sediment chemistry, biological data etc as reported by various researchers for different lakes. At present such a data based are not available in India. This is the first attempt of its kind. This information and data base would be of immense help to all those who are working in the area of lake conservation and management not only to carry out further research but or framing conservation and management measures.

q) Future plan

Since there are thousand of lakes in India, attempt will be made to include as many lakes as possible. The WEBLIS will be installed on the *web server* and can be accessed through *WWW* techniques. Presently it is planned to include information only on major and important lakes. However, in future efforts would be made to add information on as many lakes as available.

Project Reference Code: NIH/WRSD/NIH/10-11

a) **Title of the study:** Analysis of water management scenarios in Tapi River basin using MIKE Basin.

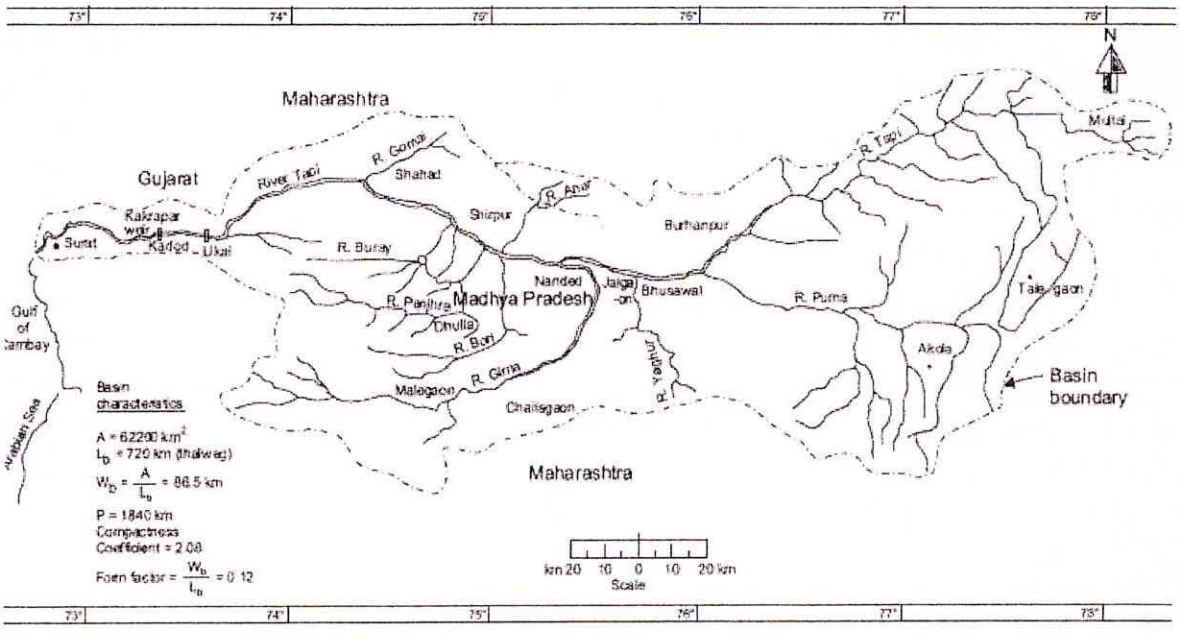
b). **Study group:** Rama Mehta (PI)
M.K. Goel (Co-PI)
Vijay Kumar / D.S.Rathore(Co-PI)

c). **Type of study:** Internally

d). **Date of Start:** April, 2010

e). **Scheduled date of completion:** **March 31, 2013**

f). **Location map / study area:**



g). **Objectives of the study:**

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

h). **Statement of the problem:**

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

i). **Approved action plan:**

Work	First year	Second year	Third year
1. Identification of water resources issues other information in the study area. 2. Collection of hydrological and meteorological data for all sub-basins from concern states/ NTBO, 3. Study of model and its Input data files formats.	<.....>		

1. Visit to NTBO office ,Surat to collect relative data for study. <.....>
2. Data files preparation (dfso input files) for all sub-basins in Tapi basin according to the Mike basin requirement.
3. Rainfall runoff modeling for each sub-basin using NAM model.
4. Mike basin modeling for Tapi basin with all sub-basins ' outputs.

1. Analysis of different water management scenarios <...>
2. report writing and paper publication

j). Achievements:

Objectives (for the period April 2010- March 2011)	Achievements
1. Identification of water resources issues and other information in the study area. 2. Collection of data for sub-basins from concern states/ NTBO, 3. Study of the model for its input data.	1. Done 2. Data collection is in progress 3. Preparation of input data files (Dfso files) are in progress

k). Recommendation / Suggestions in previous meeting of working group/ TAC/ GB:

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

l). **Analysis & Results:** Will be shown in study presentation.

m). **Adopters of the results of the study and their feedback:**
NTBO, State Agencies: Maharashtra, Gujarat, Madhya Pradesh

n). **Deliverables:**
Research papers and report.

o). **Data generated in the study:**
The hydrological and meteorological data is to be collect from the concerned divisions of NTBO offices in M.P., Gujarat and Maharashtra. Correspondence is in progress.

p). **Study benefits / Impacts:**
The Study will give a better idea about Water Management Scenario of Tapi River Basin.

q). **Future Plan:**
Knowledge of Mike basin software and its applications for Tapi basin for water management can be used for other river basins in India.

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RESEARCH COORDINATION AND MANAGEMENT UNIT

WORK PROGRAMME FOR THE YEAR 2011-12

1. **Title of the study:**

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

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

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

3. **Type of study**

   Internal (NIH funded)

4. **Nature of study**

   Technology Adaptation

5. **Study objectives**

   I. To develop a technique to assess the reliability of the spring flow as a sustainable sources of drinking and domestic water by analyzing the flow characteristics
   II. To assess the potential for the springs development as a water source

6. **Statement of the problem**

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

developing countries, recession flow analysis is a very cost-effective and accurate alternative.

7. **End users/beneficiaries of the study**

The population living downstream of these springs

8. **Whether study is a new study/extension of previous studies (in case of extension, reference of all previous studies should be provided)**

New study

9. **Baseline data/information on the study area and results of previous studies**

Daily time series of spring flow data and precipitation data
There is no any previous study

10. **Methodology**

Recession Flow Analysis Model

In proposed study, daily spring flow data will be analyzed by a mechanistic recession flow model [Brutsaert and Nieber, 1977] to determine the dry season spring flow behavior. This recession flow analysis is based on the Boussinesq equation, which describes flow in unconfined aquifers. This method is one of the cost-effective mean to indirectly estimate catchment-wide hydraulic parameters. Primarily, this method was developed and utilized for stream drought flow analysis and recently, extended for spring flow analysis [Malvicini, 2005]. Note that, outflow of the springs one or more days after precipitation in a Karst region can be assumed to occur from upstream aquifers along the underground flow path to the spring. This type of flow is known variously as base flow, drought/recession flow, or low flow. Usually, an analysis of spring hydrograph might actually be more appropriate, because they only drain the groundwater and are not sensitive to bank storage or precipitation-related components. Springs integrate the signal of geological and hydrological processes over large spatial areas and long periods of time; hence, they are an indirect source of information. Therefore, spring flow analysis gives the reasonably accurate prediction of the aquifer characteristics. It has been also found that although a simple geometry is employed in the mathematical development of recession flow analysis method, it would be able to perform well despite of complicated basin geometry.

11. **Action plan and timeline**

Action plan

The collected spring flow and rainfall data will be analyzed for continuity and consistency of the record. In next step, the model will be formulated and will be tested for its accuracy. Then, formulated model will be used for the recession spring flow analysis.

The results of the analysis will be produced in the form of research publication, technical report and procedure for field organisations.

Time-Line

Date of start: April 2011
Duration: 2 years

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

12. **Data requirements (and expected sources)**

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

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

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

a) Papers
b) Report

14. **Proposed measurable indicators for assessment of study's achievements** (e.g. solution of identified problem, improved availability of resources, new technologies/products/processes/ services developed/adapted, adoption of newly developed product indicated by number of adopters, improvement in existing technique indicated by salient features, improvement in skills, etc.)

a) New technologies/processes
b) Improvement in skill

15. **IPR potential and issues**

To be identified at later stage

16. **Technology transfer possibilities**

The new technique as well as the results of this study will be disseminated in the training/seminar organized for field engineers/organizations.

17. **Involvement of end users/beneficiaries (any consultation held with them while preparing this study proposal?)**

No

18. **Specific linkages envisaged with Institutions and/or other NGOs**

No.

19. **Major items of equipment needed (mention if any new equipment is to be procured)**

No

REFERENCES

Brutsaert, W. and J. L. Nieber (1977), Regionalized drought flow hydrographs from a mature glaciated plateau, Water Resources Research, 13(3), 637-643.

Malvicini, C. F., T. S. Steenhuis, M. T. Walter, J. Y. Parlange and M. F. Walter (2005), Evaluation of spring flow in the uplands of matalom, Leyte, Philippines, Advances in Water Resources.