# AGENDA AND AGENDA NOTES FOR THE 33rd MEETING OF THE WORKING GROUP OF NIH

## 7 - 8 OCTOBER, 2010
## AT 11:00 HRS (IST)
## IN NIH SOCIETY ROOM


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

# AGENDA AND AGENDA NOTES FOR THE 33rd MEETING OF THE WORKING GROUP OF NIH

## AGENDA ITEMS

**Item No. 33.1** Opening remarks by the Chairman

**Item No. 33.2** Confirmation of the minutes of the 32nd meeting of the Working Group

**Item No. 33.3** Presentations and evaluations of progress of the Work Programme of the five divisions for the FY 2010-11 including the actions taken on the decisions of the last meeting

**Item No. 33.4** Presentation and finalization of the new work programme for the year 2010-11

**Item No. 33.5** Any other items with the permission of the Chair

## ITEM NO. 33.1 OPENING REMARKS BY THE CHAIRMAN

## ITEM NO. 33.2 Confirmation of the minutes of 32nd meeting of the Working Group

The 32nd meeting of the Working Group was held during 4-5 March, 2010. The minutes of the meeting were circulated to all the members and invitees vide letter No. NIH/GWD/WG-10/2010 dated 30th March, 2010. No comments were received on the circulated minutes. A copy of the minutes of the 32nd Working Group is given in **Annexure –A *(Pages A1-A4).***

*The Working Group may please confirm the minutes.*

## ITEM NO. 33.3: Presentations and evaluations of progress of the Work Programme of the five divisions for the FY 2010-11 including the actions taken on the decisions of the last meeting

As such, no specific general recommendations had been made by the Working Group members; suggestions and comments were specific to studies presented by the scientists.

The approved Work Programme of the Five Divisions of the Institute for the year 2010-11 has been given in the **Annexure B *(Pages A5 –A10)*** 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:

| Name of the Division | No. of Projects | | |
|---|---|---|---|
| | Internally Funded Project | Sponsored Project | PDS under HP-II |
| **Water Resources System Div.** | 8 | 0 | 4* |
| **Surface Water Hydrology Div.** | 8 | 2 | 0 |
| **Ground Water Hydrology Div.** | 2 | 1 | 1 |
| **Hydrologic Investigation Div.** | 2 | 3 | 2 |
| **Environmental Hydrology Div.** | 4 | 1 | 1 |
| **TOTAL** | **24** | **7** | **8** |

*** One project is development of DSS (Planning) under HP-II**

The progress and status of the studies of each division have been given in **Annexure C** ***(Pages C1 – C61).***

During the present meeting, division-wise progress and status of the work programme for the year 2010-'11 shall be presented in details as per the following order:

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

***The Working Group may please consider the progress and status of the Work Programme for the year 2010-11.***

## ITEM NO. 33.4: Presentation and finalization of the work programme of the five divisions for the year 2010-11.

Division-wise new studies for the year 2010-11 and their detailing have been given in **Annexure D** ***(Pages D1-D6)*** in the following sequences:

During the meeting, each division will elaborate further on the proposed work programme.

***The Working Group may please consider the proposed new study.***

**ITEM NO. 33.5 :** Any other item with the permission of the chair.

# ANNEXURES – A & B

**ITEM NO. 33.2: ANNEXURE-A**

**MINUTES OF THE 32ND MEETING OF THE WORKING GROUP OF NIH HELD DURING MARCH 4-5, 2010 AT NATIONAL INSTITUTE OF HYDROLOGY ROORKEE.**

The 32nd meeting of the Working Group of NIH was held in the Society room of the National Institute of Hydrology, Roorkee during March 4-5, 2010 under the Chairmanship of Shri R. D. Singh, Director, NIH. The list of the members and invitees participated in the meeting is given in **Annexure-I**.

**ITEM NO. 32.1: OPENING REMARKS BY THE CHAIRMAN**

The Chairman, WG welcomed the Working Group members and the Scientists of the Institute present in the meeting. The Chairman gave a brief of the various ongoing technical and research activities of the Institute. He informed that the Ministry of Water Resources, Govt. of India under the 'National Water Mission' has entrusted a big responsibility to the Institute for R & D studies related to Climate Change impact on water resources, and has identified NIH as the Nodal organization to that effect. 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. He further informed that the Governing Body of the Institute has recently approved the consultancy rules for the Institute and it has come into effect from February, 2010. The scientists of the Institute in future will be able to receive some financial benefits from the consultancy projects to be undertaken. The Chairman also expressed that the Working Group meeting generally convene during the beginning of a financial year has the importance based on the fact that in this meeting, the members have to guide the Institute in finalizing the work programme for the next year and to take stock and evaluate the progress of scientific activities undertaken during the previous year i.e., for the year 2009 -10. Thereafter, the Chairman requested the Working Group members to give their general observations, suggestions and remarks on the scientific activities of the Institute.

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

**ITEM NO. 32.2: CONFIRMATION OF THE MINUTES OF THE 31st MEETING OF THE WORKING GROUP.**

The minutes of the meeting of 31st Working Group held during 17-18 September, 2009 were circulated vide letter No. NIH/GWH/WG/09 dated 14th October 2009. The suggestions giving emphasis on some areas for research received from Sri K. P. Singh, RO, IRI, Roorkee vide letter no. 565/H-2/R-58 dated 27.10.2009 was placed before the members. Members observed that those were suggestions to undertake new studies on specific areas but not comments on the minutes. As no comments were received from any other members, *the minutes were confirmed*

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**ITEM NO. 32.3: ACTION TAKEN ON THE DECISIONS/ RECOMMENDATIONS OF THE PREVIOUS WORKING GROUP MEETING**

Dr. N. C. Ghosh, Member-Secretary, WG gave a brief account of the actions taken on the recommendations/decisions of the 31st working group meeting.

**ITEM NO. 32.4: PRESENTATION AND DISCUSSION ON THE STATUS AND PROGRESS OF THE WORK PROGRAMME OF THE FIVE DIVISIONS FOR THE YEAR 2009-'10, AND, PRESENTATION AND FINALIZATION OF THE WORK PROGRAMME OF THE FIVE DIVISIONS FOR THE YEAR 2010-11.**

In view of the some of the scientists' involvement in an urgent World Bank meeting on 4th March at New Delhi, the order of presentation of the work programme was taken up in the following sequences:

**On 4th March,**

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

**On 5th March,**

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

Member Secretary gave a brief account of the previous year work programme (2009-'10) including number of studies concluded and being concluded during the year, and also the proposed work programme for the year 2010-11under three categories: (i) internally funding projects, (ii) sponsored projects, and (iii) purpose driven projects under HP-II. It was informed that out of 33 studies ( 18-internally funded; 9-sponsored; and 6 purpose driven) of the year 2009-'10, 10 studies have/are being concluded by the March, 2010, and remaining, 23 projects shall go as continuing studies during the year 2010-'11. Along with those 23 continuing studies, different divisions have proposed to undertake 15 more new studies under the work programme of the year 2010-'11. The studies proposed under the work programme of the year 2010-'11 thus worked out to be 38 (24-internally funded, 7-sponsored, and 7-PDS under HP-II).

During the meeting the status of the previous year (2009-10) work program as well as the proposed programme for the year 2010-2011 were discussed division-wise in detail. 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 for the previous year studies, and the objectives, methodology, milestones, and work elements for the work programme of the year 2010-11 in respect of both continuing and new studies.

Division-wise work programme for the year 2010-'11 as recommended by the Working Group is given below.

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

**ITEM NO. 32.6: ANY OTHER ITEM WITH THE PERMISSION OF THE CHAIR.**

Member Secretary, WG informed that the present composition of the Working Group was constituted couple of years back. However, the Institute felt the need of reconstitution of the Working Group in view of the emerging thrust areas of research and other impinging issues. The present Working Group has three committees, approved by the Governing Body, they are: (i) Surface Water Group, (ii) Ground Water Group, and (iii) Hydrological Observation and Instrumentation Group. To get advantages of different experts, the Institute since last couple of years has been convening meetings of the Working Group for continuous two days by combining all three groups into a single meeting. This has proven good results.

Chairman, WG invited suggestions from the members and scientists in that respect. It was emerged from the meeting that a single Working Group can be constituted in place of three groups drawing experts from all over the Country fitting to the Institute's future scientific requirement. The meeting can be organized for continuous two days. It was further suggested that members should be drawn in such a way that they should be from various fields of expertise including members from nongovernmental stakeholders and independent experts.

The meeting ended with vote of thanks to the Chair.

**ANNEXURE-I**

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

| | | |
|---|---|---|
| 1. | Shri R.D. Singh<br>Director, National Institute of Hydrology, Roorkee | **Chairman** |
| 2. | Prof. G. C. Mishra<br>Deptt. of WRD & M, IIT Roorkee | Member |
| 3. | Prof. D. Kashyap<br>Deptt. of Civil Engg., IIT Roorkee | Member |
| 4. | Dr. S.K.Mittal<br>Scientist F C.S.I.O, Chandigrah | Member |
| 5. | Dr. V.V.S. Gurunadha Rao<br>Sc.G NGRI, Hyderabad | Member |
| 6. | Dr. K. Shivanna<br>Professor, Homi Bhabha National Institute,<br>Head, Isotope Hydrology Section, BARC,Mumbai | Member |
| 7. | Dr. S.K. Gupta<br>Project Coordinator, CSSRI, Karnal | Member |
| 8. | Shri N.Y. Apte<br>DDGM(H), IMD, New Delhi | Member |
| 9. | Dr. S.P. Agarwal<br>IIRS, Dehradun | Member |
| 10. | Shri Rishi Srivastava<br>Deputy Director, CWC<br>R.O. Directorate New Delhi | Member |
| 11. | Shri S.K. Malhotra<br>S.E., U.P. Irrigation, Saharanpur | Member |
| 12. | Shri Subash Mitra<br>S.E., IRI, Roorkee | Member |
| 13. | Shri D. S. Bundela<br>Sr. Scientist, CSSRI, Kernal | Invitee |
| 14. | Dr. N.C. Ghosh<br>Scientist- F, NIH, Roorkee | Member-Secretary |

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

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

**Agenda 33.2 Annexure –B**

# WORK PROGRAMME OF THE FIVE DIVISIONS FOR THE YEAR 2010-2011

## WATER RESOURCES SYSTEM DIVISION

### A. Internally Funded Studies

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

## B. Purpose Driven Studies under HP-II

| Reference Code | Project | Project Team | Duration/ Status | Funding |
|---|---|---|---|---|
| NIH/WRSD/NIH/08-03/12 | Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin | Sanjay K. Jain (PI)<br>Sharad K. Jain-IITR<br>Vijay Kumar<br>Bhism Kumar<br>Renoj Theyyan | *4 years (04/08 –03/12)* ***Continuing study*** | HP-II |
| NIH/WRSD/NIH/09-04/12 | Hydrological Assessment of Ungauged Catchments (Small Catchment) | P. K. Bhunya (PI)<br>D.S. Rathore<br>P.C. Nayak<br>Niranjan Panigrahy<br>Sanjay Kumar<br>Suhas Khobragade<br>Director (H&WRP), Govt. of Orissa | *3 years (05/09 – 4/12)* ***Continuing study*** | HP-II |
| NIH/WRSD/NIH/08-03/13 | Assessment of Effects of Sedimentation on the Capacity/ Life of Bhakra Reservoir (Gobind Sagar) on River Satluj and Pong Reservoir on River Beas | Sanjay K. Jain (PI)<br>Sharad K. Jain-IITR<br>Vijay Kumar<br>J.V. Tyagi<br>Rama Mehta | *4 years (04/09 – 3/13)* ***Continuing study*** | HP-II |

## SURFACE WATER HYDROLOGY DIVISION

## A. Internally Funded Studies

| Reference Code | Project | Study Team | Duration/ Status | Funding |
|---|---|---|---|---|
| NIH/SWD/NIH/09-11 | Snow Melt Runoff Modeling Using Fuzzy Logic | A.K. Lohani (PI)<br>Sanjay K. Jain<br>Rakesh Kumar | *2 years (4/09-3/11)* ***continuing study*** | NIH |
| NIH/SWD/NIH/08-12 | Study on integrated water resources management of sub-basin to cope with droughts | R.P. Pandey (PI)<br>Ravi V. Galkate<br>Surjeet Singh<br>L.N. Thakaral | *4 years (12/08-11/12)* ***continuing study*** | NIH |
| NIH/SWD/NIH/09-12 | Snow Melt Runoff Modelling in Sultej Basin | A.R. Senthil Kumar (PI)<br>Manohar Arora<br>Avinash Agarwal<br>D.S.Rathore<br>Digambar Singh | *3 years (4/09-3/12)* ***continuing study*** | NIH |
| NIH/SWD/NIH/08- | Monitoring and modelling of streamflow for the Gangotri Glacier | Manohar Arora (PI)<br>Rakesh Kumar | *Long term continuing project* | NIH |
| | Data book – hydro- | Digambar Singh | *2 years* | NIH |

| | | | | |
|---|---|---|---|---|
| NIH/SWD/NIH/09-11 | meteorological observatory 2001-2008 | (PI)<br>A. R. Senthil kumar<br>Manohar Arora | *( 4/09-3/11)*<br>***continuing study*** | |
| NIH/SWD/NIH/09-11 | Impact of climatic change on evaporation | N.K. Bhatnagar (PI)<br>Avinash Agarwal | *2 years*<br>*( 9/09-8/11)*<br>***continuing study*** | NIH |
| NIH/SWD/NIH/10-13 | Snowmelt Runoff Modeling and Study of the Impact of Climate Change in part of Brahmaputra River Basin | Archana Sarkar (PI) | *3 years*<br>*(4/10-3/13)*<br>***New study*** | NIH |
| NIH/SWD/NIH/10-13 | Climatic Scenarios Generation for Satluj Basin using Statistical Downscaling Techniques | Manohar Arora (PI)<br>Rakesh Kumar | *3 years*<br>*(4/10-3/13)*<br>***New study*** | NIH |

### B. Sponsored Studies

| Reference Code | Project | Study Team | Duration/ Status | Funding |
|---|---|---|---|---|
| NIH/SWD/NIH/05-10 | Integrated Hydrological Study for Sustainable Development of two Hilly Watersheds in Uttaranchal | Avinash Agarwal (PI)<br>R.K. Nema | *5 years*<br>*(7/05 – 6/10)*<br>***Continuing study*** | DST |
| NIH/SWD/NIH/09-11 | Study on Environmental Flow from proposed Dam of Teesta Stage IV HE Project | Manohar Arora (PI)<br>Rakesh Kumar | *1 year*<br>*(9/09-8/11)*<br>***Continuing study*** | NHPC |

## HYDROLOGICAL INVESTIGATIONS DIVISION

### A. Internally Funded Studies

| Reference Code | Project | Project Team | Duration/ Status | Funding |
|---|---|---|---|---|
| NIH/HID/INT/09-12 | SW and GW Interaction at Selected Locations Along River Yamuna in NCT, Delhi: Phase-II | Sudhir Kumar (PI)<br>M. S. Rao<br>P. K. Garg | 3 years<br>*(4/09 – 3/12 )*<br>***Continuing study*** | NIH |
| NIH/HID/INT/10-12 | Identification of Recharge Zones of Some Selected Springs of Uttarakhand Using Isotopes | S. D. Khobragade (PI)<br>Bhishm Kumar<br>Sudheer Kumar<br>S. P. Rai<br>Pankaj Garg | *2 years*<br>*(04/10-03/12)*<br>***New study*** | NIH |

### B. Sponsored Studies

| | | | | |
|---|---|---|---|---|
| NIH/HID/DST/07-12 | National programme on isotope fingerprinting of waters of India (IWIN) | M.S. Rao (PI)<br>B. Kumar,<br>Sudhir Kumar<br>S.P. Rai<br>S.K. Verma | 5 years<br>*(7/07 –6/12)*<br>***Continuing study*** | DST |

| | | | | |
|---|---|---|---|---|
| | | Pankaj Garg | | |
| 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)<br>Bhishm Kumar<br>J.V. Tyagi | 5 years<br>(4/08 – 3/13)<br>***Continuing study*** | FRI |
| NIH/HID/DJB/10-11 | Assessment of Groundwater Resources & Development Potential of Yamuna Flood Plain, NCT, Delhi | Sudhir Kumar (PI)<br>Vijay Kumar<br>AK Keshari, IIT Delhi<br>S. Shekhar, Delhi Univ.<br>YB Kaushik, CGWB<br>PS Datta, ICAR<br>Executive Engineer, CWC<br>AK Gupta, Delhi Jal Board | 1 year<br>(02/10-01/11)<br>***New Study*** | Delhi Jal Board |

### 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)<br>Bhishm Kumar<br>Sudhir Kumar<br>S.K. Verma<br>PankajGarg+ CGWB Officials | 3.5 years<br>*(10/08-3/12)*<br>***Continuing study*** | HP-II |
| NIH/HID/HP-II/09-12 | Groundwater Management in Over-Exploited Blocks of Chitradurga and Tumkur Districts of Karnataka | Sudhir Kumar (PI)<br>J.V. Tyagi<br>Vijay Kumar<br>B.K. Purandara<br>S.P. Rai<br>M.S. Rao | 3.5 years<br>*(10/08-3/12)*<br>***Continuing study*** | HP-II |

## GROUND WATER HYDROLOGY DIVISION

### A. Internally Funded Studies

| Reference Code | Project | Project Team | Duration/ Status | Funding Source |
|---|---|---|---|---|
| NIH/GWD/NIH/09-12 | Impact of Climate Change on Dynamic Groundwater Recharge in a Drought Prone Area | Surjeet Singh (PI)<br>C. P. Kumar<br>Anupma Sharma<br>Rajan Vatsa | 3 years<br>*(04/09 – 03/12)*<br>***Continuing study*** | NIH |
| NIH/GWD/NIH/10-12 | Quantification of Impact of Rainwater Harvesting on Groundwater Availability in Aravalli Hills – Part II: Mathematical Modeling | Anupma Sharma (PI)<br>N. C. Ghosh<br>C. P. Kumar<br>Sudhir Kumar<br>Rajan Vatsa | 2 years<br>*(04/10 – 03/12)*<br>***New study*** | NIH |

## B. Sponsored Studies

| | | | | |
|---|---|---|---|---|
| NIH/GWD/NIH/09-11 | Study of Rising Ground Water Table in Jodhpur City, and to Evolve a Management Plan to Contain the Rising Trend | N. C. Ghosh (PI)<br>C. P. Kumar<br>Sudhir Kumar<br>B. K. Purandara<br>Anupma Sharma<br>Surjeet Singh<br>Rajan Vatsa | 1.5 years<br>*(08/09 – 02/11)*<br>***Continuing study*** | Ground Water Dept., Govt. of Rajasthan |

## C. Purpose Driven Studies Under HP-II

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

# ENVIRONMENTAL HYDROLOGY DIVISION

## A. Internally Funded Studies

| Reference Code | Title of the Project/Study | Study Team | Duration/ Status | Funding |
|---|---|---|---|---|
| NIH/EHD/NIH/07-10 | Modelling of Pesticide Transport in Ground Water – a case study of Metropolitan City – Vadodara | M.K. Sharma (PI)<br>V.K. Choubey<br>A.K. Keshari, IIT-D | 3 years<br>*(10/ 07 – 9/10)*<br>***Continuing study*** | NIH |
| NIH/EHD/NIH/09-12 | Environmental Flow Requirement of a River | Dilip G. Durbude (PI)<br>V.K. Choubey<br>Omkar Singh<br>M.K. Sharma | 3 years<br>(9/09 – 8/12)<br>***Continuing study*** | NIH |
| NIH/EHD/INT/10-11 | Impact of Kumbha Mela 2010 on water quality of surface water and ground water resources in and around Hardwar City | V.K. Choubey (PI)<br>M.K. Sharma<br>Omkar Singh<br>D.G. Durbude | 1 year<br>*(4/10-3/11)*<br>***New Study*** | NIH |
| NIH/EHD/INT/10-11 | Spatial Variability of Ground Water Quality in Jammu and Kashmir Provinces, J&K (India) | Omkar Singh (PI)<br>V.K. Choubey<br>D.G. Durbude<br>M.K. Sharma | 1 year<br>*(4/10-3/11)*<br>***New Study*** | NIH |

**B Sponsored Studies**

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

**C. Purpose Driven Studies Under HP-II**

| | | | | |
|---|---|---|---|---|
| NIH/EHD/HP-II/09-12 | Impact of sewage effluent on drinking water sources of Shimla city and suggesting ameliorative measures | V.K. Choubey (PI)<br>R.P. Pandey<br>Omkar Singh<br>M.K. Sharma<br>I&FC Dept., Shimla<br>NICD, New Delhi | 3 years<br>*(4/09 -03/12)*<br>***Continuing study*** | HP-II |

## Agenda Item 33.3

# ANNEXURE - C

# WATER RESOURCES DIVISION

**1. Title of the Study : Integrated approach for snowmelt runoff studies and effect of anthropogenic activities in Beas basin**

**Study Group** : Dr. Sanjay K. Jain, Dr. Bhism Kumar, Dr. Vijay Kumar, Dr. S. P. Rai Dr. Renoj Theyyan.
**Date of Start** : 1st April 2009

**Duration of the study:** Four years

**Whether externally funded or not :** Approved as PDS under HP-2, budget Rs. 77.50 Lakhs

**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.

**Brief Methodology**

Stream flow from the basin will be estimated by using the available snowmelt runoff model. The whole basin will be divided into elevation zones. The model will compute daily runoff from the snow covered area and snow free area separately. The model will be calibrated using the dataset and then the results will be validated. One of the objectives of the study is to analyse the trend of the above mentioned meteorological variables in the last three decades. Trend analysis will be carried out using linear regression method and non parametric method. Isotopic analysis will be carried out to separate snow and glacier melt runoff. The effect of climate change on runoff will be studied by applying changes in temperature and precipitation to the data from the meteorological stations used in the model. To study the effect of climate change on snowmelt runoff under changed conditions, GCM generated scenarios will be applied.

**Results achieved with progress/present status**

The base maps (drainage/contour/DEM) of the study area have been prepared in GIS data base. The rainfall, temperature and stream flow data up to August 2010 have been collected from BBMB, Sundernagar. 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 snow 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.

For carrying out isotopic analysis, samples have been collected from a number of sites. Five sites have been finalised for regular sampling of river and precipitation samples for detailed isotopic and chemical analysis. These sites are Beas Kund, Koti, Dhundhi, Manali and Bhunter. At each site a staff has been engaged for the sample collection. Daily samples have been collected from all the sites for the period April to August 2010. Analysis of these samples are under progress.

**Expected date of completion:** March 2012

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

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

**Date of Start** : 1st April 2009

**Duration of the Study** : 3 Years

**If Externally Funded** : PDS of BBMB

**Objectives of the Study:**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. The objectives of the study are as follows:

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

**Brief Methodology:**

**Creation of database**

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

**Assessment of sedimenation rate**

| | |
|---|---|
| • Sedimentation assessment by remote sensing | NIH |
| • Sedimentation assessment by hydrographic survey | BBMB |

**Modelling of soil erosion/sediment yield**

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

**Results achieved with progress/present status**

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. Nearly twenty five years data (from 1980 to 2005) has been used for the model training i.e. almost 9000 set of values. In which 5000 set of values are used for training the model, 2500 values are used for testing and 1500 for checking/validation of the model with all techniques. This study indicates the ability of neuro-fuzzy neural network models to model the stream flow discharge - suspended sediment relationship. The NF models perform better than the regression rating curve techniques in estimation of suspended sediment. This study used only data from Kasol site for full water year, further work using more data from various sites separated for monsoon and non-monsoon seasons is under progress.

Preparation of data base in AVSWAT model has been done. The progress will be presented in the meeting. For assessment of reservoir sedimentation using remote sensing, request for procurement of satellite data from NRSC has been made. A training course (Soil erosion and reservoir sedimentation using remote sensing and GIS) will be organised for BBMB officials during 11-13 October 2010 at BBMB, Nangal.

**Expected Date of Completion:** 31st March 2012

**3. Title** - **GIS based dams and drought information system**

**Study group** - D. S. Rathore, Deepa Chalisgaonkar, R.P. Pandey, Yatveer Singh, Tanvear Ahmad

**Date of start** - October 01, 2009

**Duration of the study and expected date of completion** - one and half year, 31st March 2011

**Whether external funded or not** - No

**Objectives of the study:**

1. Dynamic web site development for dam database and thematic maps for India (using Web GIS).
2. Dynamic web site development for SPI for districts in India (using Web GIS).

**Brief methodology**

**Data collection:** Data for dams and drought were collected. For dams, salient feature information e.g. storage, RL, dimension, catchment area, waterspread, power units and capacity (left and right bank), spillway details, purpose etc. were available. Thematic maps namely rivers, basins and dams were available in GIS. For drought monthly rainfall for all districts in India were collected. A Gamma distribution was fit using Thom approximation for Maximum Likelihood estimation of parameters. Rainfall values corresponding to various SPI values (Z- score) were obtained in MS Excel.

**Web site development:** Mapserver, an open- source Web GIS software was selected for web site development. HTML code of Itasca Tutorial of Mapserver will be modified for the proposed application.

**Results achieved with progress/ present status**

**Data processing for drought SPI:** Rainfall for SPI values for each month and each district in India were computed. A consolidated table is prepared for the monthly rainfall corresponding to various SPI values (Z- score).

**Web site development:** D**ams and thematic maps of India**
In the main page, a dropdown list is provided to navigate to pages for an application, namely all dams, storage dams, hydropower dams and drought information. At present 'all dams' option is developed. In this option, theme basin, major basin, rivers, major rivers and all dams (as in the available database prepared from atlas and other sources) may be displayed. Major rivers are annotated. Rivers and dams may be queried.


GIS Based Dams and Drought Information System
Choose an Action:
Browse map
Query feature
Query multiple features
Select Layers to Display:
India
Basin Major
Basins
Refresh Map
Zoom Controls:
Zoom In
Pan
Zoom Out
Zoom Size 2
Legend:
Dam
Rivers_major
Basin
India
0 140 280 420 560 mi
0 220 440 660 880 km
back to start

| | | |
|---|---|---|
| **4. 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 |
| **Start Date** | - | October 01, 2009 |
| **Exp. End Date** | - | 31st March, 2012 |
| **Funding** | - | Internal |

**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.

**Methodology:**

In this study, distributed hydrological models (say, MIKE SHE or SWAT or NIH model or some other suitable model) at the scale of a river basin are being used for integrated planning and management of surface and ground water resources. The models are being applied to the Upper Bhima Basin up to Ujjani dam. The detailed database of the basin is being developed for the application of distributed model. Different GIS tools and ancillary sources of data are being used for the generation of distributed database from the point measurements.

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

**Present Progress**

The database is being developed/fine-tuned for the study area in the format compatible with the NIH model. The GIS layers have been imported in ILWIS system for DEM, talukas, landuse, drainage, rainfall stations, river gauge stations, climate stations, GW wells, and water bodies.

The DEM of the basin has been finalized and the GIS layers for slope, aspect, drainage, and sub-basins have been generated. The soil map of the Maharashtra state has been obtained from NBSSLUP, Nagpur and the same has been geo-referenced with other GIS layers considering the location of various cities and river crossings. The map is being digitized. The hydrological properties of soils have also been obtained from NBSSLUP. Because of repeated updation of hydrological database for the pilot basin study under DSS, the hydrological database development is in progress. Most of such data has been converted to MS-EXCEL format and is being arranged in the NIH model format for the application of the model.

The setup for the MIKE BASIN model for the study area is also in progress. The progress will be presented in the meeting.

**Expected Date of Completion** **March 31, 2012**

5. **Title of Study:** ***NIH_ReSyP*** **– A software for Reservoir Analysis (Version – 1)**

**Study Group** - M. K. Goel, Deepa Chalisgaonkar

**Start Date** - 1st April, 2010

**Exp. End Date** - 31st March, 2011

**Funding** - Internal

**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.

**Methodology:**

Work is going on for the development of WINDOWS based software for various kind of reservoir analysis. Different modules of the software include capacity computation, conservation operation, flood control operation, hydropower analysis, reservoir routing, and miscellaneous other modules.

It is proposed to develop the stand-alone package so that it could be worked with in any computer. It is also proposed to add a few more modules to the existing system. It is also envisaged to prepare the information brochure for the software for first-hand information of the package.

**Present Progress:**

The software is near finalization. Various forms have been reformatted and errors have been removed. A stand-alone routine for graphical presentation of results has been added. In addition, EXCEL-based graphical option has been retained. The use of the model would be demonstrated in the meeting.

The programs have been finalized for the spillway gate regulation and reservoir sedimentation analysis. However, their conversion in modular form is still under progress.

**Expected Outcome**
A WINDOWS based stand-alone software for various kind of reservoir analysis.
**Expected Date of Completion** **March 31, 2011**

**6. Title of Study :** **Web Based Information System For Major And Important Lakes In India**

**Date of Start :** April 1, 2010

**Duration :** 2 years

**Funding :** Internal

**Project Team :** Deepa Chalisgaonkar and Suhas Khobragade

**Objective of the Study :**

To develop a web-based information system for major and important lakes in India.

**Results achieved with status:**

The web based system intends to provide information regarding the various hydrological and limnlogical aspects of the major and important lakes of India. The framework of the system has been developed. The clickable maps of India and its states have also been developed. Location of lakes on the clickable map of Rajasthan is under progress. Information on about 50 lakes of India has been collected and edited for the purpose of inclusion in the system. Some basic information on various aspects of lake hydrology and limnology has been incorporated in the system.

**Expected date of completion: March, 2012**

| | | |
|---|---|---|
| **7. Title of the study** | **:** | **Analysis of water management scenarios in Tapi River basin using MIKE Basin.** |
| **Study group** | **:** | Rama Mehta, M.K. Goel and Vijay Kumar |
| **Date of Start** | **:** | April, 2010 |
| **Duration** | **:** | Three years |
| **Funded** | **:** | Internally |

**Objective of the Study:**

Different Water Management Scenarios such as Water allocation, Reservoir Operation will be visualized and analyzed for Tapi river basin upto Ukai dam using Mike basin software.

**Brief Methodology:**

Mike Basin is a simulation model for water allocation representing the hydrology of the basin in space and time. The planning for future water development within a basin require river basin management from the study of individual aspects in a framework to take an integrated analysis. A water reservoir management tool such as Mike Basin centered on a basin wide representation of the water availability and potential users of water offers a basis for such framework.

Mike Basin operates on the basis of a digitized river network generated directly on the computer screen in the map view. All information regarding the configuration of the river branch network, location of water users, channels for intakes and outlets to and from water users, reservoirs are also defined by on-screen editing.

**Input Data:** Basic input to the model consist of time series of various types. Basically only time series of catchment run-off is required to have a model setup to run. Additional input files define reservoir characteristics and operation rules of each reservoir, meteorological time series and data pertinent to each water supply or irrigation scheme such as bifurcation requirements and other information describing return flows. Additional data describes hydraulic conditions in river reaches and channels, hydropower characteristics, groundwater characteristics etc.

| | | |
|---|---|---|
| **Mile Stone and Expected** | : | Complete report with result analysis, Research Papers in |
| **Outcome/ Output** | **:** | International and National Journals and Conferences. |
| **Expected data of Completion** | **:** | March, 2013. |

| | | |
|---|---|---|
| 8. **Title of the study** | **:** | **Computationally simple functions for approximating normal and log-normal distributions.** |

**Study group** : Sushil K. Singh, Scientist F, and R. D. Singh, Director

**Date of start** : April 2010
**Duration of the study and expected date of completion**: One year; March 2011

**Whether externally funded**? No

**Objectives of the Study:**

(1) To develop computationally simple functions for approximating normal and log-normal distributions.

(2) To illustrate and demonstrate the practical application of the developed simple functions for solving hydrologic problems.

**Brief methodology:**

The tabulated values of the exact distribution function are intended to be used and a mathematical function is intended to be developed utilizing the experience, expertise, and available relevant tools.

Published authentic field data (multiple-storm data) from different catchments are intended to be used for the illustration and assessment of the performance of the developed model

It would be helpful in practical studies dealing with frequency analysis of floods, deterministic modeling of flood prediction using unit hydrograph assumed as a frequency distribution, error theory in which the errors are assumed to follow a normal distribution. It would be also be helpful in studies of other disciplines where normal and lognormal distributions are being used

**Progress:**

1. Review of literature including has been completed.
2. Compilation of data has been completed.
3. Development and testing of computationally simple functions for normal and log-normal distributions is in progress.

9. **Title of the study : A simple IUH model for runoff modelling**

**Study group** : Sushil K. Singh, Scientist F

**Date of start** : April 2010

**Duration of the study and expected date of completion**: One year; March 2011

**Whether externally funded?** No

**Objectives of the Study:**

(1) To develop a computationally simple function/distribution for instantaneous unit hydrograph for event based runoff modeling.

**(2)** To illustrate and demonstrate the application of the developed simple function/distribution on field data.

**Brief methodology:**

1. The objective is intended to be accomplished utilizing the experience, expertise, and concepts developed by the investigator in his prior international paper in this area.
2. Published authentic field data (multiple-storm data) from different catchments are intendend to be used for the illustration and assessment of the performance of the developed model.
3. It would be useful in practical studies dealing with the assessment and prediction of runoff or duration and peak of a flood due to a complex and critical rain-storm over a catchment.

**Progress:**

1. Review of literature has been completed.
2. Compilation of data has been completed.
3. Development and testing of computationally simple function/distribution for representing the instantaneous unit hydrograph is in progress.

| | | |
|---|---|---|
| **10 Title of Study** | **:** | **Prediction of Dispersion Coefficient of Streams using Kriging Technique** |
| **Study Group** | : | Dr. Vijay Kumar, Dr. S K Singh |
| Date of Start | **:** | **April 1, 2010.** |
| **Duration of the Study** | : | One year (April 2010 – March 2011) |
| **Funding** | : | Internal |

**Objectives of the Study :**

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. The objectives of the study are:

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.

**Progress**

i) Numerous empirical formulae based on hydraulic and morphometric characteristics have been proposed to quantify the longitudinal dispersion coefficient,. 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).

ii) Development of a method for predicting the dispersion coefficient from the flow and geometric parameters of stream using kriging technique is under progress.

iii) Published authentic laboratory and field data has been collected for application of the developed model.

**Expected date of Completion:** March 31, 2011

**11. TITLE OF THE PROJECT:** HYDROLOGICAL ASSESSMENT OF UNGAUGED CATCHMENTS **(**SMALL CATCHMENT) - MAHANADI SUB-BASIN

## STUDY GROUP:

**Principal Investigator (PI):** Dr. Pradeep Kumar Bhunya, Sc. E1
**Co-PIs :** Dr. Rakesh Kumar, Sc. F, Head (Surface Water Div.), Dr. P. C. Nayak, Sc. C, RC Kakinada, Dr. Vijay Kumar, Sc.E1
**Investigators** : D S Rathore, Sc. E2, Dr. Sanjay Kumar (Sc. C, Surface Water Div),

**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).

**DATE OF START:** May, 2009

**DURATION OF THE STUDY AND EXPECTED DATE OF COMPLETION:** Duration of three years (2009-2012) Expected date of completion is May, 2012.

**FUNDED:** Funded externally under HP II, vide Letter No. 12/94/2005-B & B/VOL-V/922-953 dated 3/9/2008.

**OBJECTIVES**:

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

**STUDY AREA**

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.

**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

**RESULTS ACHIEVED WITH PROGRESS**

Hydrological data used in this study were collected from CWC reports, Deptt. Of Hydrometry (govt. of Orissa), SOI toposheet and specific points from field visit i.e. renaissance survey and from remote sensing imageries. In addition to these, available imageries have been downloaded from web, and some have been used from office. For new imageries, and SOI top sheets, an indent have been submitted. Using GIS, and available toposheet, overlays are prepared. Conventionally multiple maps are prepared for same area e.g. watershed, land use, geomorphology, common boundaries are drawn manually to verify whether these characteristics are matching in different maps or there is any change. For studying any land-use conditions including change in geomorphology, if any, a sweep method has been used viewing the imagery and respective toposheet in Arc-GIS. The results for a small catchment i.e. Br-385 was shown in interim report and discussed in WGM. This has been done for about five small catchments, and the work is going-on for other catchments.

The hydrological data used in this study include (i) annual peak discharge, (ii) catchment area, (iii) length of the main stream, (iv) equivalent channel slope, (v) geomorphological characteristics of the basins, (vi) land use conditions, and (vii) soil type, and (viii) rainfall character tics etc. However, the available hydrologic data and morphological characteristics of a few sites within the study area have been checked at two stages: (a) Consistency using different statistical measures for various period length (b) Discordancy and heterogeneity measures for the available data. In the investigation, out of all 36 sites, nine were found to be discordant with the others in the respective regions. The heterogeneity measures $H_1$, $H_2$, and $H_3$ computed before and after removing the discordant stations and these results are accounted for in calibration of the return period flood model. This was for maximum daily flows, however for short-term hydrological data; selected events were checked with water balance using loss, interception, and base flow variables. On basis of the recent methods that is being followed worldwide, regional flood frequency curves, and regional formula have been developed for some selected small catchments (where data are available) the region. A new approach for regionalizing the parameters for a proposed equation was attempted using Fuzzy-neuro method. As per the objectives, after reviewing the earlier works, a systematic approach was followed to standardize regional flow duration curves in the study area so far. Regionalization of hydrological parameters of the flow duration curves using available data of the region was used for the development of regional flow duration curve in selected ungauged catchment in the region. Regional flow duration curve were developed for the following regions to estimate the dependable flows for the ungauged catchments. For this analysis few catchments i.e. twenty small catchments from Mahanadi (3d) using CWC report data were used. These works is envisaged to be refined in future.

Using the results, the regional formulae for Mahanadi sub-zone were developed for the regions to be used in ungauged catchment in the region to estimate peak flood and time to peak for different storms. The pparameters of the UH were regionalized using a non linear regression and ANN for hydrograph relationships for use in following the regions: (i) Mahanadi sub-zone; (ii)In addition 10 catchments (not in region) were used for the analysis.

In addition to these, new hydrological equipments sectioned 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. Enquiry is being on for the liable / feasible firms or Institutes for consultants doing these allied works, and some lists of firms have been collected that shall be submitted through procedure. 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 November in Orissa. Some specific data that was indented earlier, have been procured from CWC.

# SURFACE WATER HYDROLOGY DIVISION

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

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

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

**Date of start :** July 2005
**Duration of study :** 5 Years (July 2005 to June 2010)
**Funding :** DST, New Delhi

**Objectives of the Study:**

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

**a) Study Area**

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

**Chandrabhaga and Danda watersheds**

The Chandrabhaga watershed is located geographically between $30^{0}$ 18' N to $30^{0}$ 19' N and $78^{0}$ 35' E to and $78^{0}$ 36' E, and Danda between 30° 14' N to 30° 16' N and 78° 37' E to 78° 39' E Jakhnidhar block of Tehri-Garhwal district (Uttarakhand). It is Subhumid with moderate rainfall with annual average of 900 mm.

**b) Results achieved with Progress/ Present status**

**(i) Data collection, instrumentation and construction of two gauge sites.**

The existing instrumentation was updated with latest instrumentation as reported in 32nd WG meeting. The evaporation recording is continued with recorder as well as with water level recorder installed in the pan as well as in air. Soil moisture at seven depths and soil temperature at one depth is through water mark. Two gauge sites were developed (Bainsoli, Tayari) and water level is being recorded with the help of pressure gauges.The v-notch site at Rumdhar was renovated.

**(ii) Analysis of hydro-metrological data**

Regular hydro-metrological data since Jan. 1999 to Dec. 2010 have been processed especially for weighted rainfall, runoff and springs flow in the watershed and for pan evaporation. The daily data has been converted to monthly, annual and water year basis for processing and analysis.

**(iii) Water Balance**

The daily rainfall, runoff and the pan evaporation data collected from the watershed has been converted to monthly scale. The measured evaporation (ET) has been converted to potential evapotranspiration (PET). The potential evaporation is converted to actual evapotranspiration (AET) and the surplus/deficit by using

equation based on method ER, SCS and ER, FAO. A summary of the findings of water balance is reported in table 1.

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

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

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

**(iv) Survey of water bodies**

A detailed survey for all the water bodies including tanks (percolation, storage) and springs has been carried out and their locations have been identified in the area using GPS, GIS data will be utilized for the simulation using SWAT.

**(v) Spring flow analysis**

Total around forty one numbers of springs are under observation for both the watersheds and daily spring flow discharge is being recorded. Ten daily flow duration curves were developed as per the procedure of Institute of Hydrology. The spring behavior was well identified considering cumulative mean monthly rainfall values starting from June and cumulative stream flow for the same period.

**(vi) Water potential survey of the area**

A detail survey for both the watersheds in respect of population, land holding, water use, water availability through springs, tanks and all user point of water with location using GPS has been carried out to find out the specific location of the user and the requirement of the water for population. In addition the results can identify surplus and defecate locations for formulating water transfer policies imposing local laws on water transfer.

**(vii) Rainfall-runoff-sediment yield studies**

In absence of continuous record of sediment concentration, the sediment- runoff relationship is developed for both the watershed from the data collected during year 99 to 03 and the data of year 08, 09 and 10. Based on the collected data, the relationships of the exponential form are developed for high and low sediment concentration. The correlation coefficient of the developed relationships varied form 0.32 to 0.85. Using the developed exponential relationships, the sediment yield has been estimated.

**(viii) Use of ERDAS and ARC VIEW for modelling**

The Chandrabhaga watershed delineated on 1:25,000 scale and Danda on 1:50,000 in order to construct digital elevation model. The contour layers are drawn and DEM constricted along with automatic drainage system. A nine numbers of satellite imaginaries being used for the analysis.

**(ix) Collection of soil samples in Chandrabhaga watershed**

A total number of three hundred soil samples have been collected from Chandrabhaga watershed for analysis and soil classification. The samples are under analysis in soil water Lab of the Institute. A soil map will be developed from the results for model development.

**(x) Delineation of recharge Zone**

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

**Expected date of completion:** June, 2010

## 2. PROJECT REFERENCE CODE: NIH/SWD/NIH/07-10

| | | |
|---|---|---|
| **Title of the study** | **:** | **Hydrological Studies in a Forested Watershed in Uttarakhand** |
| **Study Group** | **:** | J.V. Tyagi, Sc E2, Rakesh Kumar, Sc F,<br>Digamber Singh, Sc B |
| **Date of Start** | **:** | April, 2007 (Phase II) |
| **Duration of Study** | **:** | 3 years (Extended up to August 2010) |
| **Funding** | **:** | NIH and FTA (Haldwani) |

**Objectives of the Study:**

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

(i) To establish a small experimental Sal forested watershed and monitor the hydrological and environmental parameters viz. rainfall, runoff, sediment yield at the watershed outlet and soil moisture, light intensity, soil erosion and natural regeneration of sal under different micro-environments due to overhead canopy of varying density.

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

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

(iv) To develop suitable relationships of natural regeneration of sal with soil moisture and light intensity.

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

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

**Results:**

Based on the results of various analyses carried out in the study, the following conclusions were drawn.

1. The natural regeneration was found highest under C1 (up to-0.30) canopy followed by C2 (0.30-0.50), and C3 (0.50-0.70) canopies. The average incremental plot score of regeneration over 4 years period was computed as 1335, 646 and -167 for the canopy densities of C1, C2 and C3 respectively. The C3 canopy showed the dying back with a regeneration score of -167 over 4 years of study.
2. The temporal plots of weekly soil moisture storage revealed that the soil moisture values at 25 cm depth increased quickly with occurrence of rainfall and also depleted at a faster rate as compared to those at 50 cm and 100 cm depths. Also the soil moisture sustains for longer duration at 100 cm depth.

3. The analysis of monthly average soil moisture under C1, C2 and C3 canopies revealed that the difference in soil moisture among three canopies is highest at 100 cm depth which decreases with the decrease in depth. At 100 cm depth, the soil moisture is found to be highest under C3 canopy followed by that under C2 and C1 canopies. It is indicative of higher withdrawal of soil moisture under C1 canopy. A trend similar to 100 cm depth is also observed at 50 cm, though the difference in soil moisture levels in C2 and C1 canopies is very small. At 25 cm depth the trend is not very clear and the soil moisture regime in three canopies is found to interchange with time. This is probably due to the fact that the depletion of soil moisture at 25 cm depth is affected more by evaporation than transpiration.

4. The $R^2$ values of linear regression between incremental score of plot regeneration (over 4 years) and average soil moisture content of different durations (over 4 years) were obtained as 0.156 and 0.153 for average soil moisture during the periods (January to June and November to December) and (Jan. to June) respectively at 100 cm depth; and $R^2$ values as 0.103 and 0.088 for respective periods at 50 cm depth. No correlation was found with soil moisture at 25 cm depth. These values of $R^2$ indicate that the regeneration is governed by the soil moisture content of dry months especially at 100 cm depth than that at 50 and 25 cm depth. The low values of $R^2$, however, indicate that soil moisture could explain only little variation in regeneration and other factors might play a major role.

5. The incidence of light intensity was highest under C1 canopy that decreased with the increase in canopy density.

6. The $R^2$ value of linear regression between incremental score of regeneration (over 4 years) and annual av. light intensity was obtained as 0.688 which indicates that the regeneration is largely dependent on light intensity conditions during the year.

7. For the multiple linear regression between the incremental score of plot regeneration and the average light intensity and average soil moisture content of the period (Jan. to June and Nov. to Dec.) at 100 cm depth, the coefficient of linear multiple correlation (r) of 0.894 and the $R^2$ value of 0.798 indicates that about 80% of variation in regeneration is explained by both the factors. The student's 't' test indicated that the values of both light intensity and soil moisture content are significant at ($p < 0.01$) and ($p < 0.025$) respectively.

8. Analysis of rainfall-runoff data revealed that the runoff from the watershed varied from about 5 to 15% of the event rainfall depending on the rainfall intensity.

9. In application of ANSWERS model to the study watershed, the Nash-Sutcliffe efficiencies in estimating the runoff and sediment yield for 4 rainfall events were obtained in the range of (95.88 - 98.14%) and (91.70 - 94.92%) respectively. The model performance with these high efficiencies is considered quite well for hydrologic models.

10. Apart from estimating temporal runoff and sediment yield at the watershed outlet, the model also estimated the spatial distribution of soil erosion and deposition rates in the watershed. The average rate of soil loss from the watershed was found to vary between 17.52 to 151.77 kg/ha for the four events. A shift in erosion zones from one erosion category to another category was observed from event to event depending on the variation in rainfall intensities and runoff production.

11. A comparative analysis of soil erosion under different canopy classes revealed that the erosion in C3 canopy < C1 canopy < C2 canopy in all the events. The average incremental plot score of regeneration was found highest under C1 canopy followed by C2 and C3 canopy. These data do not indicate adverse effect of erosion on the regeneration.

    The results of the study amply indicated that the soil moisture and light intensity are crucial parameters for management of natural regeneration in sal forests. These results would prove quite useful to the State Departments of Forests in formulating the forest management plans and incorporating the practices that ensure adequate soil moisture and light penetration. Ensuring adequate regeneration and sustained productivity is at the heart of any scientific silvicultural system.

**Major contributions of the study**

The major contributions of the study can be summarized as follows.

1. Establishment and instrumentation of a sal forested watershed and training to FTA officials on monitoring the hydrological behavior of watersheds.

2. Monitoring, collection, compilation and analysis of large data set of (a) natural regeneration of sal, (b) weekly soil moisture at multi depths under various canopy densities, (c) fortnightly light intensity under various canopy densities, and (d) rainfall, runoff and sediment yield from sal forested watershed.
3. Development of suitable relationships of natural regeneration of sal with soil moisture and light intensity.
4. Quantification of Soil hydrological parameters in the experimental watershed.
5. Quantification of runoff and spatial distribution of soil erosion in a forested watershed.
6. Analysis of effect of soil erosion on natural regeneration under various canopy densities.

**Expected date of completion:** Study is completed and draft report prepared.

**PROJECT REFERENCE CODE: NIH/SWD/NIH/09-11**

| | | |
|---|---|---|
| **Title of study** | **:** | **Snow Melt Runoff Modeling Using Fuzzy Logic** |
| **Study group** | **:** | A.K. Lohani, Sc 'E1' & PI, Sanjay K. Jain, Sc 'E2', Co-PI |
| | | Rakesh Kumar, Sc 'F' & Co-PI |
| **Date of start** | **:** | 01.04. 2009 |
| **Duration of the study** | **:** | Two Years (April 2009 – March 2011) |
| **Funding** | **:** | Internal |

**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.

**a) Progress/ Present Status (April 2010 – September 2010)**

Progress of the data collection, data processing, modeling and analysis is briefly given below:
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. Carried out an extensive review of applications of fuzzy rule based techniques in hydrological modeling. A 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, validation is in progress.

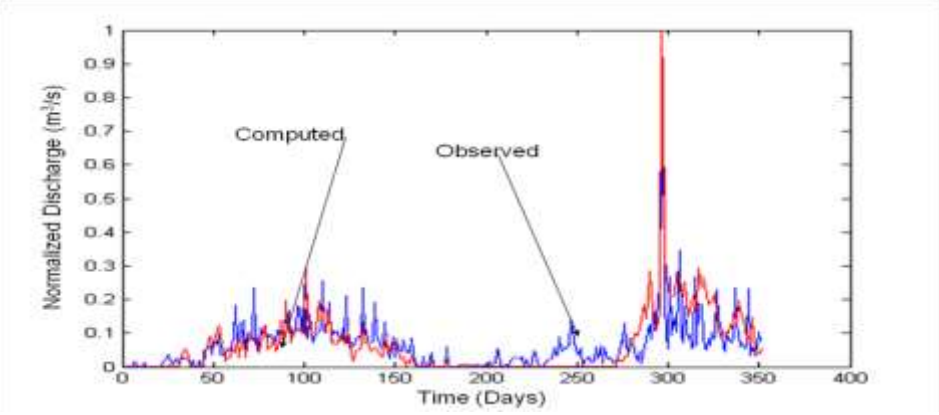



Figure 1: Results: Comparison of Observed and computed discharge

**b) 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 | | | | | **Under Progress** |
| Development of Fuzzy rule based model for snow melt modeling | | | | | **Under Progress** |
| Comparison of Fuzzy rule based model and snowmelt model. | | | | | |

**Expected date of completion:** March 2011

**3. PROJECT REFERENCE CODE: NIH/SWD/NIH/08-12**

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

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

**Date of start** **:** Dec. 2008

**Duration of the study** **:** 4 years

**Funding** **:** Internal

**Objectives of the Study:**

The specific objectives of this project are to:

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

**a) Study area:**

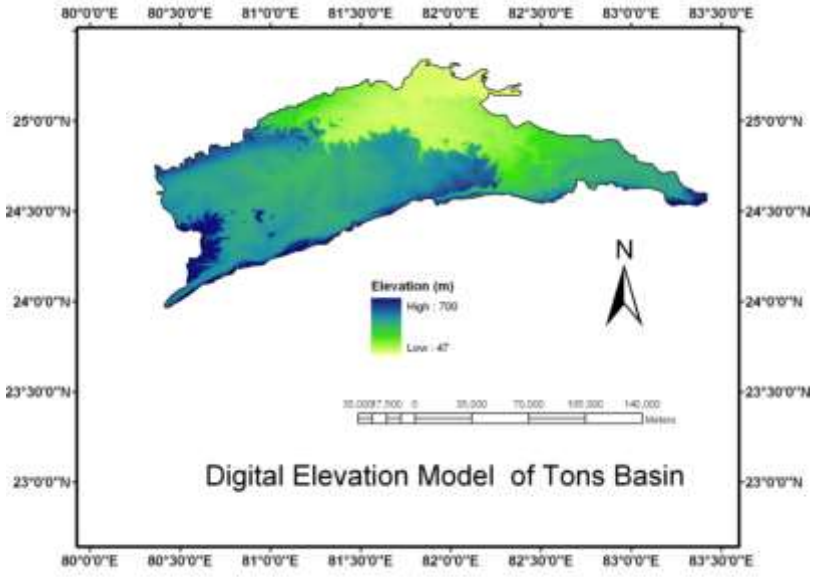
The study has been taken up in Tons sub basins in Madhya Pradesh. Location map of the study area is shown below


.

**b) Results achieved with progress/present status**

Discharge data from CWC has been collected for two sites namely Meja-Road and Satna. Data procurement from IMD is in progress. Preparation of inventory report on of water resources in the basin is in progress. DEM map of the study is shown below for ready reference. 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. A summary of the analysis conducted so far is as follows.

1. Area experiences recurrence of drought at an average frequency of once in 5 years.
2. 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.
3. Western part of the basin has observed falling trends of monsoon rainfall during past 102 years
4. Limited and scarce water resources and demand is very high for agriculture.
5. Year 2007 experienced the acute drought situation in this area and caused 50-60% agricultural production losses.
6. Limited and scarce water resources. Demand increasing at a rapid rate due to demographic shifts and lifestyle changes.
7. Area needs attention and an integrated water resources management approach which includes drought management as an important component.




**Expected date of completion**: Dec. 2012

## 4. PROJECT REFERENCE CODE: NIH/SWD/NIH/09-12

| | | |
|---|---|---|
| **Title of the study** | **:** | **Snow Melt Runoff Modelling in Sultej Basin** |
| **Study group** | **:** | A. R. Senthil kumar Sc E1, Manohar Arora, Sc C, Avinash Agarwal, Sc E2, D. S. Rathore, Sc E2, D. Singh, Sc B |
| **Date of start** | **:** | 1 April 2009 |
| **Duration** | **:** | 3 YEARS |
| **Funding** | **:** | NIH funded |

**Objectives of the study:**

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

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

**Results achieved with progress/present status**

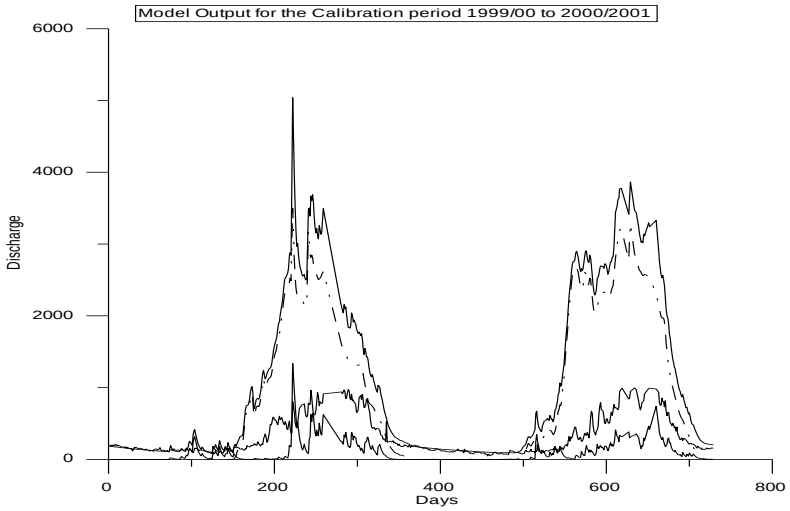
ANN models for continuous discharge, low discharge and medium and high discharges were developed and results were compared with each other during the first year of the study.

The conceptual model SNOWMOD has been used for the simulation of flows. The basic steps included.

- Division of a basin into elevation zones
- Processing of meteorological data
- Temperature distribution
- Precipitation distribution
- Form of precipitation
- Depletion of snow covered area
- Rain-induced melt
- Accounting of losses

- Routing of surface and subsurface flow

The data of rainfall, temperature, snow cover area and discharge were collected for the period 1999 to 2004. The rainfall data at the six stations were available. These six stations have been considered for the calibration of the parameters. The data of temperature were available at 5 stations and these have been used for the calibration period. The parameters have been calibrated for the period 1999 to 2001. The validation will be completed by utilising the calibrated parameters.




**Expected date of completion:** 31 March 2012

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

| | | |
|---|---|---|
| **Title of study** | **:** | **Snowmelt Runoff Modeling and Study of the Impact of Climate Change in part of Brahmaputra River Basin** |
| **Study group** | **:** | Archana Sarkar (PI) |
| **Date of start** | **:** | 1st April, 2010 |
| **Duration of study** | **:** | Three Years |
| **Funding** | **:** | In house study |

**Objectives of the Study**

Considering the importance of snowmelt runoff in Himalayan basin and also effect on stream flow because of climate change, the objectives of the study are:

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.

**Results achieved with Progress / Present status**

In order to estimate the snow cover area in a basin of size 28,000 Sq. Km, Moderate Resolution Imaging Spectroradiometer (MODIS) data has been selected. MODIS data at 500m resolution is available free of cost from the NASA website. Moreover, the spatial coverage is good being weekly data.

On December 18, 1999, the National Aeronautics and Space Administration (NASA) Earth Observing System (EOS) Terra satellite was launched with a complement of five instruments, one of which is MODIS. Among all the comprehensive observations on cloud, ocean, and earth surface characteristics available from the Terra MODIS, the snowcover product is available since February of 2000. With improved spatial resolution (500-m globally), high temporal frequency (weekly/daily), enhanced capability to separate snow and clouds due to more spectral bands (particularly in the short-wave infrared), as well as a consistently applied, automated snow-mapping algorithm, MODIS snow products user guide for collection 4 data products, available at http:// modis-snow-ice.gsfc.nasa.gov/sug_main.html, MODIS provides an excellent, advantageous opportunity to study the snow cover over large, relatively inaccessible regions. Snow cover products based on MODIS carried by both Terra and Aqua satellites on the NASA spacecraft launched in 1999 and 2002, respectively, are one of the most successful optical snow cover products. The MODIS 8-day composite snow data eliminates the cloud obscuration and thereby provides more consistent and cloud-free coverage than daily resolution data products.

For the present study, the 8-day composite snow data products at 500m resolution from Terra satellite have been used. The weekly data (scenes) have been selected for the study basin and downloaded for a period of eight years (2000-2008). This comprises of 459 scenes. The data comes with HDF extension which has been converted to IMG extension for all the scenes. The projection system has been changed from sinusoidal to orthographic for all the scenes. The basin has been divided into 10 elevation zones. Preliminary analysis and interpretation of the weekly MODIS data for the years 2006-2009 is under process.

**Expected Date of Completion:** March 31, 2013

**Bar Chart**

| | **April-June** | **July-Sept** | **Oct-Dec** | **Jan-March** |
|---|---|---|---|---|
| **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" | | | | |
| **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. | | | | |
| **3.** Analysis and interpretation of weekly MODIS snowcover data collected for the period of 2000-2009 for part of Brahmaputra River Basin. | | | | |
| **4.** Preparation of technical report on "Snow Cover estimation and its temporal variation in a part of Brahmaputra River basin". | | | | |

**7. PROJECT REFERENCE CODE: NIH/SWD/NIH/09-10**

| | | |
|---|---|---|
| **Title of study** | **:** | **Study on Environmental Flow From proposed Dam of Teesta Stage IV HE Project** |
| **Study group** | **:** | Manohar Arora Sc 'C', R. D. Singh, Director, Rakesh Kumar Sc 'F' |
| **Date of start** | **:** | 16.09.2009 |
| **Duration of study** | **:** | One Year |
| **Funding** | **:** | NHPC |

**Objectives of the study:**

- To study the hydrologic flow characteristics of the River Teesta
- To assess environmental flow requirements in River Teesta

**Results achieved with progress/present status**

The study has been completed and draft report is prepared. The results of the study were presented before the committee at NHPC Faridabad. It is observed that the release of 5 cumec as environmental flow daily satisfies the EFR requirement of a Class C River.

**Expected outcome:** The study is sponsored by NHPC.

**8. PROJECT REFERENCE CODE: NIH/SWD/NIH08-**

| | | |
|---|---|---|
| **Title of study** | **:** | **Monitoring and Modelling of Streamflow for theGangotri Glacier** |
| **Study group:** | | Manohar Arora Sc 'B', Rakesh Kumar Sc 'F' |
| **Date of start:** | | 01.04. 2008 |
| **Duration of the study:** | | To be continued |
| **Funding** | **:** | Internal |

**Objectives of the Study:**

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

**Results achieved with Progress / Present status**

The field investigations were started in the first week of May 2010. The cross-section of river channel was determined at the site and observations are made continuously. The observations will be carried till the end of the ablation season i.e. October first week. The Institute has been monitoring the hydro-meteorological parameters during the ablation season using conventional methods. This year the data collected by Automatic Weather Station (AWS) at the Meteorological Observatory near the snout of Gangotri Glacier was also downloaded. The other field data and AWS data analysis is in progress.

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

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

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

| | | |
|---|---|---|
| **Study Group** | **:** | Manohar Arora Sc 'C', Rakesh Kumar Sc 'F' |
| **Date of Start** | **:** | 1.04.2010 |
| **Duration of study** | **:** | Three Years. |
| **Funding** | **:** | Internal |

**Objectives of the study:** :

- To Downscale the GCM Output of NIES and NCEP Re-analysis data.
- To predict future climatic scenarios for Satluj basin.

**Results achieved with Progress / Present status**

The development of computer program for converting GCM output to usable form is in progress.

**Expected date of Completion:** 31.03.2013.

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

| | | |
|---|---|---|
| **Title of the study** | **:** | **Data Book- Hydro-Meteorological Observatory 2001-2008** |
| **Study group** | **:** | Digambar Singh, Sc B, A. R. Senthil kumar Sc E1, Manohar Arora, Sc C |
| **Date of start** | **:** | 1 April 2009 |
| **Duration** | **:** | 2 Years |
| **Funding** | **:** | Internal |

**Objectives of the Study:**

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

**Status**

The entry of the Data (temperature, rainfall, humidity on hourly basis) in SWDES is under progress. The daily humidity data for the year 2001, rainfall data for the years from 2001-2004 and temperature data for the years 2001-2002 have been entered.

**Expected date of completion:** 31st March, 2011

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

| | | |
|---|---|---|
| **Title of study** | **:** | **Impact of climatic change on evapotranspiration** |
| **Study group** | **:** | N K Bhatnagar, SRA, Agarwal, Sc 'E2' |
| **Date of start** | **:** | 1st October, 2009 |
| **Duration of study** | **:** | Two Years (up to 30 Sept. 2011) |
| **Funding** | **:** | Internal |

**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.

**Brief methodology:**

Climate change is expected to exacerbate stresses on water resources with population growth, economic and land-use change, and urbanization. On a regional scale, mountain snow, glaciers and small ice caps play a crucial role in freshwater availability. Changes in precipitation and temperature lead to changes in runoff and water availability. Runoff is projected with high confidence to decrease by 10 % to 30 % over some dry regions at mid-latitudes and dry tropics, due to decreases in rainfall and higher rates of potential evapotranspiration and evapotranspiration (IPCC, 2007). The accurate estimation of evapotranspiration still remains a real challenge. The energy balance/ Bowen ratio method has been shown to give reliable measurements (Tanner, 1968).

**Evaporation and Bowen Ratio:** A Bowen ratio is the ratio of energy fluxes from one medium to another by sensible heat (H) and latent heat LE respectively. It is defined as below;

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

where;

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

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

Assuming coefficients $K_h$ and $K_w$ equal:

$$\beta = C_p \Delta T / L \Delta q = C_p (T_1 - T_2) / L (q_1 - q_2) \quad (4)$$

$LE = H/\beta$

**Latent and sensible heat fluxes:** Since the calculation of sensible heat flux is difficult, it is the first, the LE is estimated using net radiation measurement and $H_G$ with the radiation balance approach.

**Mile stones and expected outcome/ output:**

- Differential water level recorder installed in NIH observatory.
- Hourly water air pressures, water air temperature.
- Processed for day and night time hourly evaporation.
- Data for *Chandarbhaga* watershed collected from DST project for Pan pressure, air pressure, temperature (air), temperature soil (two depths), soil moisture (seven depths), solar radiation (incoming)

**Expected date of completion:** 30th Sept., 2011

# HYDROLOGICAL INVESTIGATIONS DIVISION

**Item No. 33.2 Actions taken on the advice / decisions of the 32nd meeting**

| S.N. | Advice/decision of 32nd meeting | Action Taken |
|---|---|---|
| 1 | Correlation of the isotopic data trend between IWIN stations in relation with the wind trajectory may be studied | The wind trajectories maps for various dates have been collected from NHAC-NWP, IMD, New Delhi and these were compared with the isotopic value of GLV at Roorkee |
| 2 | Rainfall samples should be collected from more locations to get regional perspective of meteorological phenomenon for IWIN study | Two new stations have been established: 1. Jammu (w.e.f. April, 2010) and 2. Kakinada (May, 2010) and data are being collected. |
| 3 | Kalpana Satellite data should be used for interpretation of isotopic data for IWIN study | For acquiring the digital satellite data registration with division of Satellite Meteorology, IMD, New Delhi has been made. `Simultaneously, satellite data (cloud cover picture) at 8 hourly intervals is also being downloaded for qualitative interpretation. |
| 4 | Investigation of aquifer dependant isotopic characteristic of groundwater may be carried out for the Bist Doab study | Isotopic characteristics of shallow aquifers has already been analyzed and results were presented in previous working group. After the last Working Group, samples from 19 no. of deep wells (>100 m) were collected from Punjab Water Resource Development and Management (PWRDM) and CGWB and were analysed |

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

| | | |
|---|---|---|
| **TITLE** | **:** | **NATIONAL PROGRAMME ON ISOTOPE FINGERPRINTING OF WATERS OF INDIA (IWIN)** |
| **STUDY GROUP** | **:** | Dr. M. S. Rao (PI) and Dr. Bhishm Kumar |
| **DATE OF START** | **:** | September, 2007 |
| **DURATION** | **:** | 5 Years (September, 2007-August, 2012) |
| **FUNDING** | **:** | DST |
| **PARTICIPATING ORGANIZATIONS** | **:** | NIH, PRL, BARC, NIO, NGRI, NRL-IARI, CPCB, CWC, CWRDM, CRIDA, IMD, IIT-Kharagpur, Anna university |

**Objectives of the Study:**

i) Identifying Regional/local water components in the local atmosphere.
ii) Quantifying the partitioning of vapors into rain and re-partitioning of rain into various components as evapotranspiration, soil moisture, stream flow* and groundwater* (*these samples will be collected by the participating organizations).
iii) Residence time of /water in different inland hydrological units.
iv) Atmospheric/surface water/groundwater interaction on seasonal and spatial basis.
v) Developing a web resource for isotope hydrology data-base of the Indian sub-continent.

**BRIEF METHODOLOGY:**

(i) ***Sample collection:***

a) Daily sampling of Ground Level Vapour (**GLV**) by *Push & Trap* and condensation methods by using $LN_2$ and methanol at NIH, Roorkee and by condensation method at R.C. Sagar.
b) Sampling of precipitation at Roorkee and Sagar on event basis.
c) Weekly sampling of the river Ganga from Upper Ganga Canal, Roorkee.
d) Fortnightly sampling of groundwater from depths approximately 10 m & 40 m at Roorkee and monthly sampling from shallow aquifer at Sagar.

(ii) ***Analysis:***

$\delta D$, $\delta^{18}O$ analysis of river water, groundwater, precipitation and GLV, and $^{3}H$ analysis of river and groundwater samples.

(iii) ***Data collection:***

Meteorological and hydro-geological data from State/Central Government organizations.

(iv) ***Interpretation of data:***

`Final interpretation of the data will be carried out jointly with IWIN member organizations at PRL, Ahmedabad.

**PROGRESS / PRESENT STATUS:**

(1) Two new IWIN centres were established at Jammu and Kakinada. With addition of these two stations, NIH-IWIN will have total 4 stations well distributed along the air-moisture trajectory from Bay of Bengal coast line to NW Himalaya.

| IWIN Stations | Date of start | Alt. (above msl in m.) | Lat/Long | Approx. Arial distance from coast (km) | Water Sampling* |
|---|---|---|---|---|---|
| Roorkee | July, 2007 | 268 | $29^{o}52'N$, $77^{o}53'E$ | 1545 | GLV, RW, GW, R |
| Sagar | April, 2008 | 527 | $23^{o}50'N$, $78^{o}50'E$ | 867 | GLV, RW, R, L |
| Jammu | April, 2010 | 292 | $32^{o}42'N$, $74^{o}51'E$ | 1973 | GLV, RW, GW |
| Kakinada | May, 2010 | 02 | $16^{o}57'N$, $82^{o}15'E$ | 19 | GLV, RW |

*RW=Rain water; R=River; GW=Groundwater, L=Lake

(2) A total of 1048 samples were collected from NIH, Roorkee, Sagar, Jammu and Kakinada during the period February, 2010 to August, 2010. The number of samples collected and the analysis status is given in the table 1.

Table 1. Summary of the samples collected and analyzed

| | **Sample type** | **Frequency** | **No. of samples (Feb., 10 to Aug.,10)** | |
|---|---|---|---|---|
| | | | **Collected** | **Analysed for deuterium** |
| Roorkee | ➢ GLV<br>➢ Using Ice<br>➢ Using $LN_2$ (near ground)<br>➢ Rain samples<br>➢ Groundwater<br>➢ River Ganga | <br>Daily<br>Daily<br><br><br>Event based | <br>193<br>175<br><br><br>53 | <br>193<br>175<br><br><br>53 |

| | | | | |
|---|---|---|---|---|
| | | Twice/month | 57 | 57 |
| | | Weekly | 23 | 23 |
| Sagar | ➢ GLV<br>➢ Using Ice<br>➢ Rain water<br>➢ Groundwater<br>➢ Surface water | Daily | 212 | 174 |
| | | Event Based | 41 | 3 |
| | | Monthly | 11 | 7 |
| | | Twice/month | 16 | 10 |
| Jammu | ➢ GLV<br>➢ Using Ice<br>➢ Rain water<br>➢ Groundwater | Daily | 131 | 131 |
| | | Event Based | 34 | 34 |
| | | Monthly | 5 | 5 |
| Kakinada | ➢ GLV<br>➢ Using Ice<br>➢ Rain water | Daily | 89 | 89 |
| | | Event Based | 8 | 8 |
| Total Samples Analyzed | | | 1048 | 962 |

(3) The change in isotopic composition of GLV has been examined with respect to wind trajectories collected from IMD, New Delhi. A correlation between the wind trajectory map and isotopic data for GLV at Roorkee for the winter (Jan-Feb), pre-monsoon (Mar-May) and Monsoon (Aug.) is shown in the Fig. 1 to 3. Five types of source of moisture can be observed from the wind trajectories: (i) Moisture of local origin (Local Source - LS) (ii) Moisture arriving from NW direction of India due to western disturbance with the most probable source as Mediterranean sea (MS) (iii) Winds originating from Arabian Sea (AS) (iv) Winds originating from Bay of Bengal (BoB) (v) Winds originating from combination of Arabian Sea and Bay of Bengal. It can be observed from the correlation map that isotopic depletion of GLV is in the order type (ii) < type (iii) < type (iv) < type (v). The isotopic value of type (i) GLV is depleted with respect to the GLV arrived prior to the development of local moisture. These observations reflect extent of isotopic depletion of GLV due to combination of *source of moisture (MS, AS, BoB, AS+BoB), continental effect and evaporation effect (LS)*.

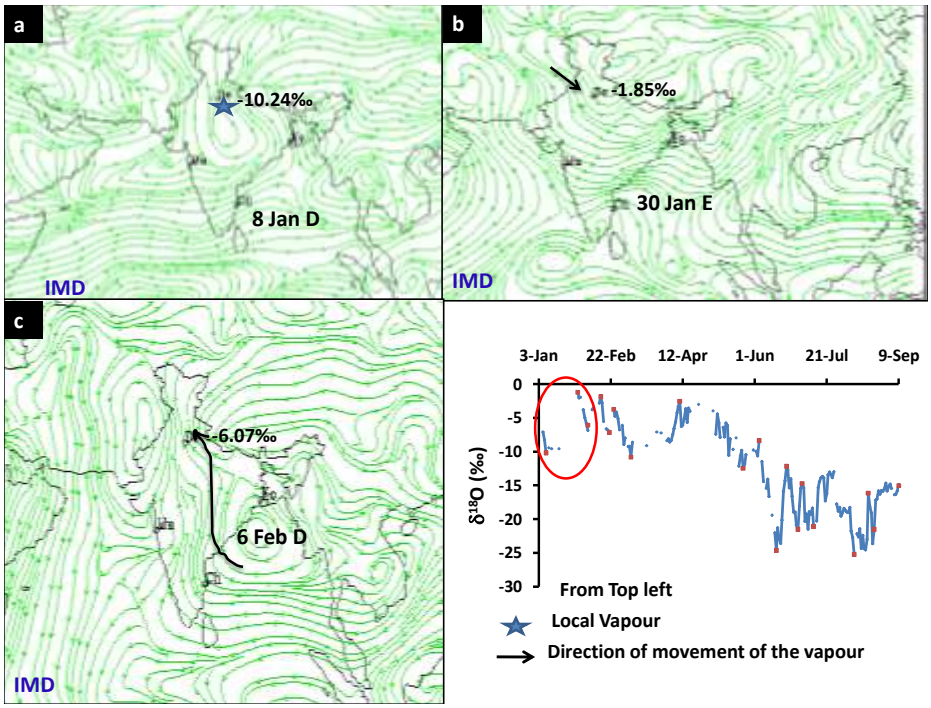



Fig. 1: (a-c) Wind trajectory and changes in isotopic composition of GLV at Roorkee in Jan-Feb 2010 (D: Delhi).

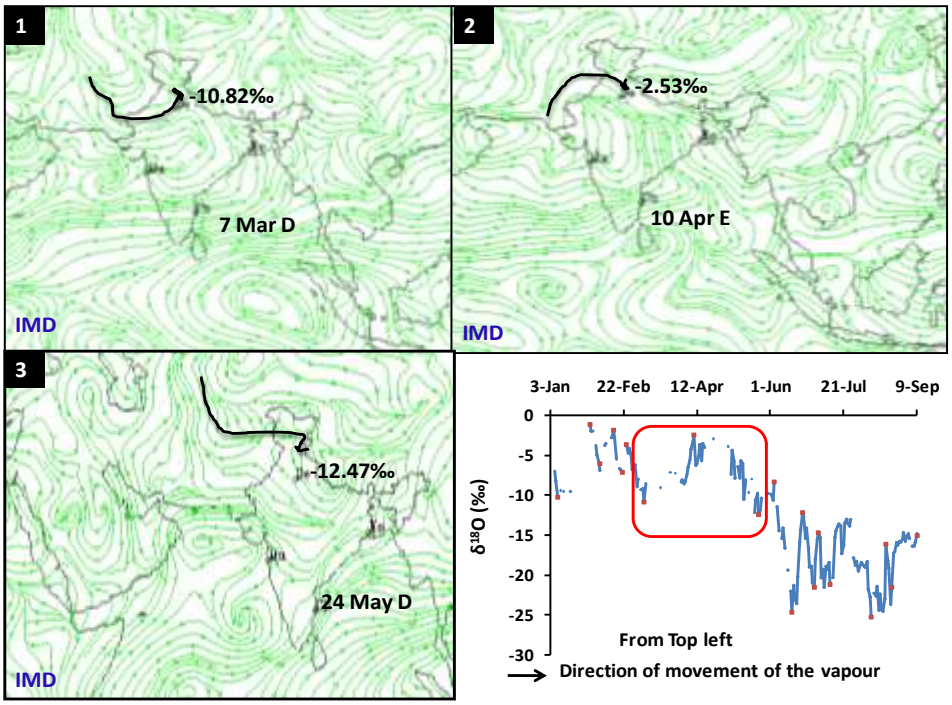



Fig. 2: (a-c) Wind trajectory and changes in isotopic composition of GLV at Roorkee in Mar-May 2010 (D: Delhi).

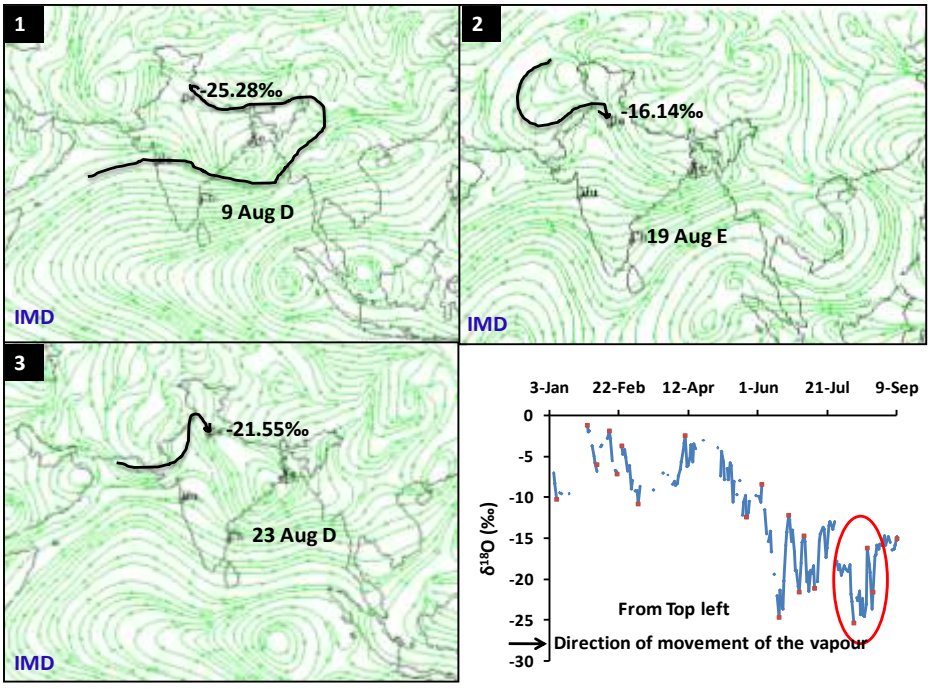



Fig. 3: (a-c) Wind trajectory and changes in isotopic composition of GLV at Roorkee in Aug. 2010 (D: Delhi).

(4) The collection of GLV and rainfall samples and their analysis is continued for the period March - August 2010. The time variation trend of isotopic composition of GLV and rainfall is similar to that for the similar period for 2009.

(5) The isotopic values of GLV collected by condensation (at 0˚C) method are more enriched in pre-monsoon period as compared to isotopic values of GLV collected by Push and Trap method (at -70 to -80 ˚C), while during monsoon period no such difference is observed in the isotopic values of GLV. This may be due to temperature dependent fractionation effect. This phenomenon may be used to decipher the onset and withdrawal of monsoon.

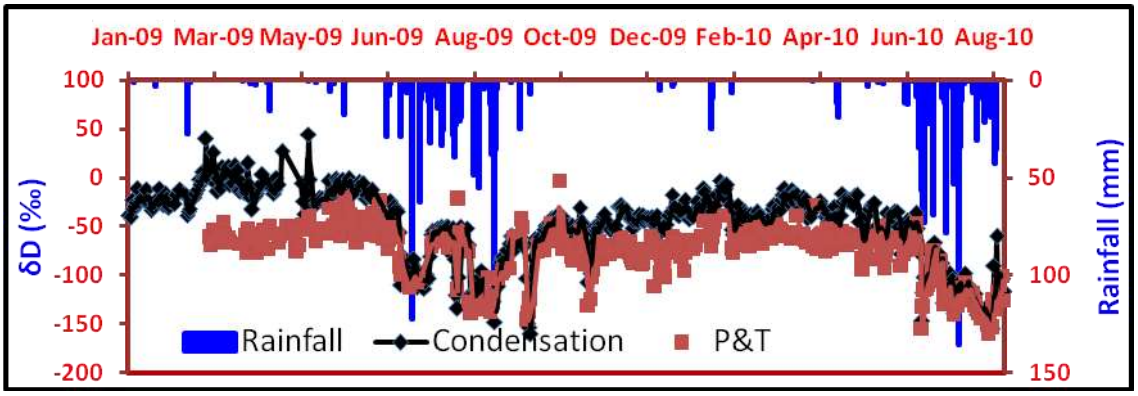



Fig. 4. Seasonal effect of Push & Trap and condensation methods on air moisture sampling

**EXPECTED DATE OF COMPLETION:** SEPTEMBER, 2012

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

**TITLE : SURFACE WATER AND GROUNDWATER INTERACTION AT SELECTED LOCATIONS ALONG RIVER YAMUNA IN NCT, DELHI (Phase-II)**

**STUDY GROUP :** Dr. Sudhir Kumar (PI), Dr. MS Rao, Sh. Pankaj Garg

**DATE OF START :** April 2009

**DURATION :** 3 years (March, 2012)

**FUNDING :** Internal

**Objectives of the Study**

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

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

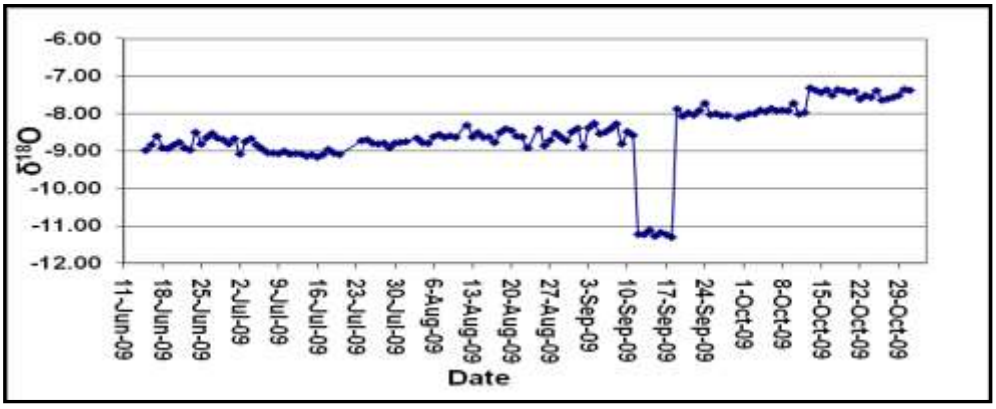
**PROGRESS / PRESENT STATUS**

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.

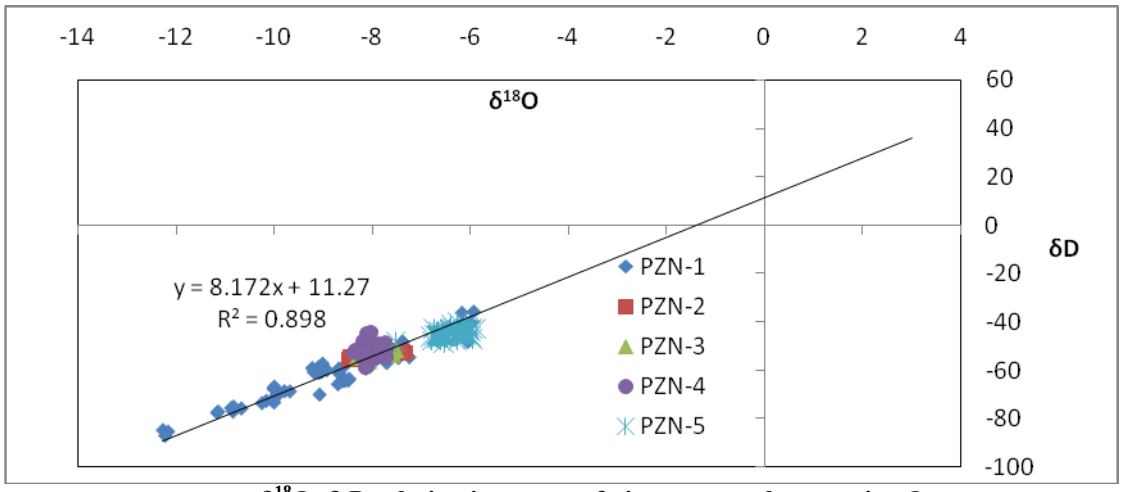
ii) Water level monitoring indicated that during the monsoon season of 2009 the recharge to the floodplain was only upto 1.8 m whereas during 2008 it was upto 3.52 meters.

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.

**Daily $\delta^{18}O$ variation in river Yamuna water during 2009 monsoon**




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.




**$\delta^{18}O$- δ D relation in waters of piezometers along section-2.**

The other details along with interpretation of the data will be presented during the meeting.

**EXPECTED DATE OF COMPLETION:** March, 2012

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

**TITLE : GROUNDWATER DYNAMICS OF BIST DOAB AREA, PUNJAB, USING ISOTOPES (PDS UNDER HP-II)**

**STUDY GROUP :** Dr. M. S. Rao (PI) and Dr. Bhishm Kumar

**DATE OF START :** July, 2009

**DURATION :** 3 years (July 2009 to June, 2012)

**FUNDING :** MoWR (World Bank aided)

**Tech. Collaboration :** CGWB, NWR, Chandigarh.

**Objectives of the Study:**

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

ii) Groundwater modelling

**BRIEF METHODOLOGY:**

1) Sample collection: surface and groundwater at regular intervals.
2) Data Collection: Hydrogeological, hydrometeorological, topographical data
3) Generating various thematic maps: Land use, soil map, aquifer geometry etc.
4) Measurements: Chemical, stable and radioactive analysis of samples.
5) Interpretation: Integrated analysis of sample data with the hydregeological data to identify recharge zones, recharge sources and flow pattern
6) Groundwater flow modeling

**PROGRESS / PRESENT STATUS:**

i) Isotopic characteristics of Shallow aquifers has already been analyzed and results were presented in previous working group. After the last Working Group, samples from 19 no. of deep wells (>100 m) were collected from Punjab Water Resource Development and Management (PWRDM) and CGWB and were analysed. (Figure 1)

ii) Analysed water samples for $\delta^{18}O$ and $\delta$ D collected till Aug. 2010. The results are shown in Fig. 2.

iii) Groundwater fluctuation data collected for the period 2003- 2006 when analyzed showed a significant fluctuation (Fig. 3). In order to examine the probable factors causing the fluctuation the following details were collected and analyzed.

   A. Rainfall data from 1970- to 2009 (Fig. 4)

   B. Change in Geomorphology (1987 and 2004) (Fig. 5)

   C. Change in cropping pattern (1980- 2008) (Fig 6 to 8)

In order to identify the isotopic characteristics of surface water (rain and river water) & deeper aquifers the following action has been taken.

1. Eight new rainfall sampling locations were established (during July 2010) making the total thirteen rainfall sampling sites (5 in Kandi and 8 in Plains) (Fig. 9)
2. In the month of July 2010, eleven river water sampling sites were established five each on river Beas and Sutlej and one at the confluence of the rivers (at Harike) (Fig. 10)
3. In the month of Aug. 2010, four sampling sites (2 in each river) were established to study the river water-groundwater interaction in the study area (Fig. 11)
4. Fourteen deep tube wells (above 100m depth) were identified for isotopic characterization of pre- and post monsoon of deeper aquifer (Fig. 12)

In addition to the above, a workshop entitled "Water availability and management in Punjab (WAMIP-2010)" in the Punjab region is planned to be organized on 13$^{th}$ to 15$^{th}$ Dec. 2010. The workshop brochure is circulated (Email and Postal services) to various state and central organizations, NGOs and academic institutions.

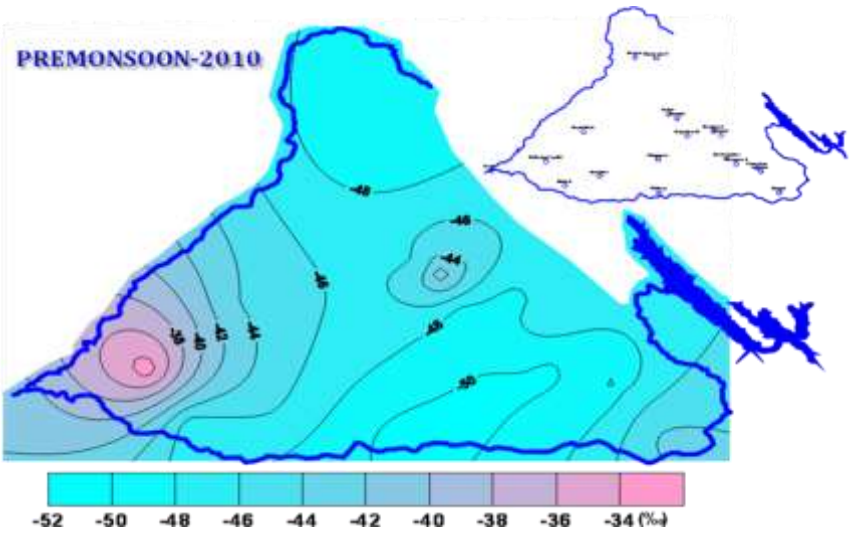



**Fig. 1 Isotopic variation of groundwater in deep aquifer (TW & Pz)**

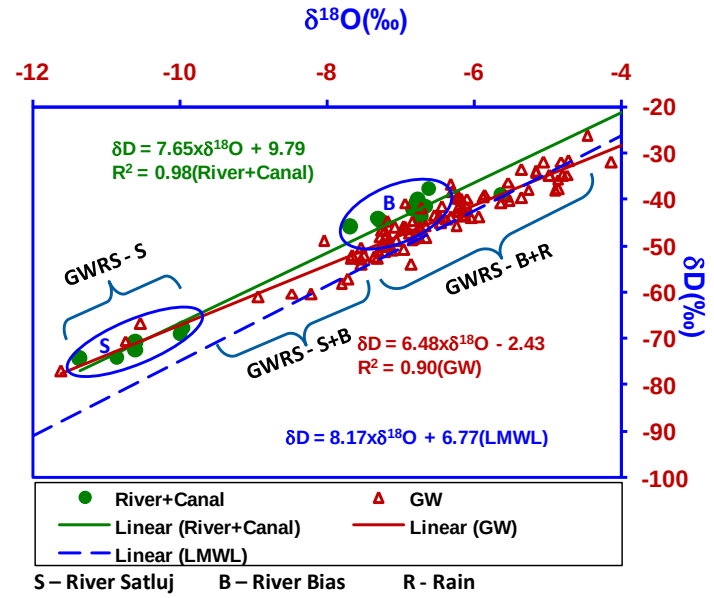



**Fig. 2 Isotopic indexing of groundwater recharge sources (GWRS)**

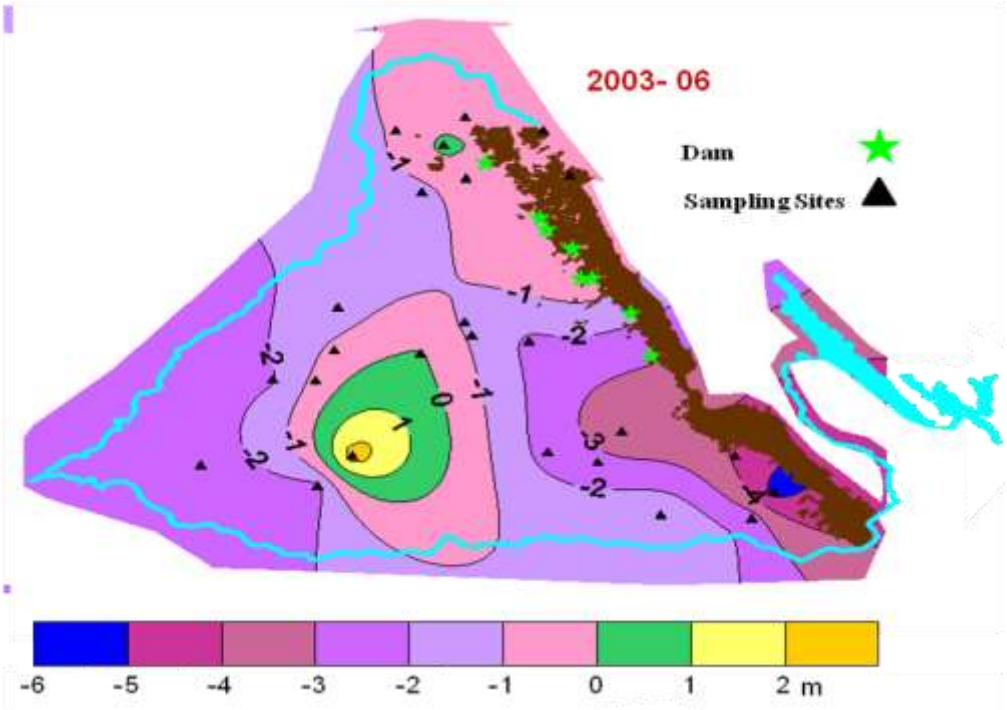



**Fig. 3 Groundwater rise/fall in Bist-Doab region**

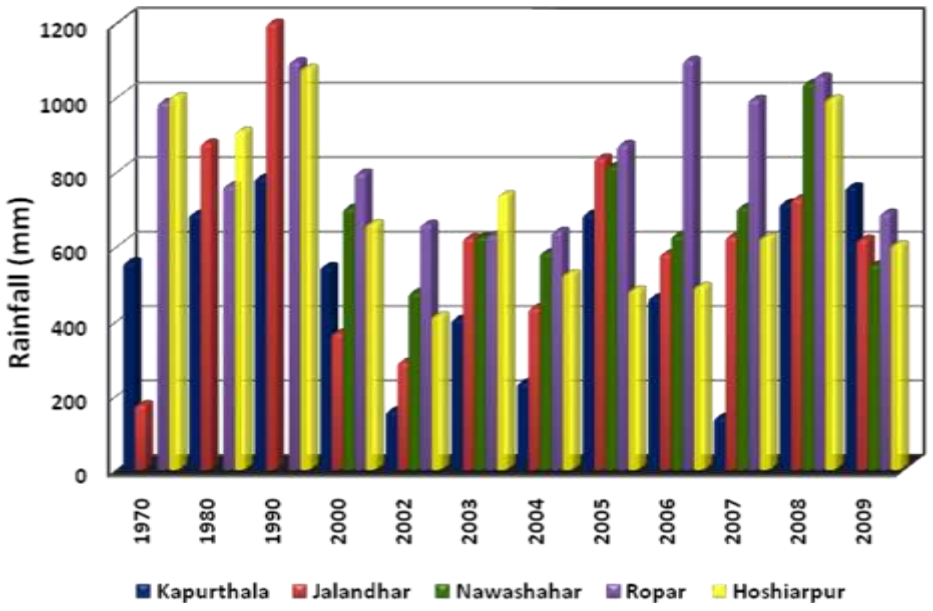



**Fig. 4 Change in Rainfall in the region**

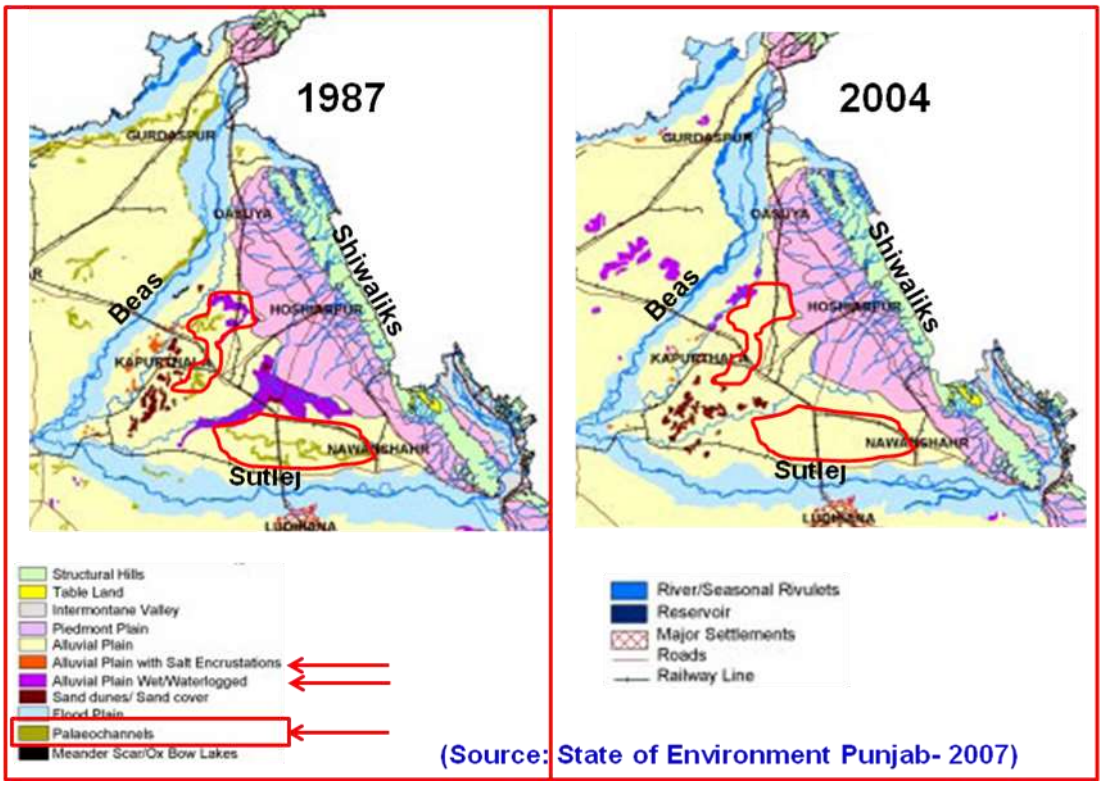



**Fig. 5 Change in geomorphology in the region**

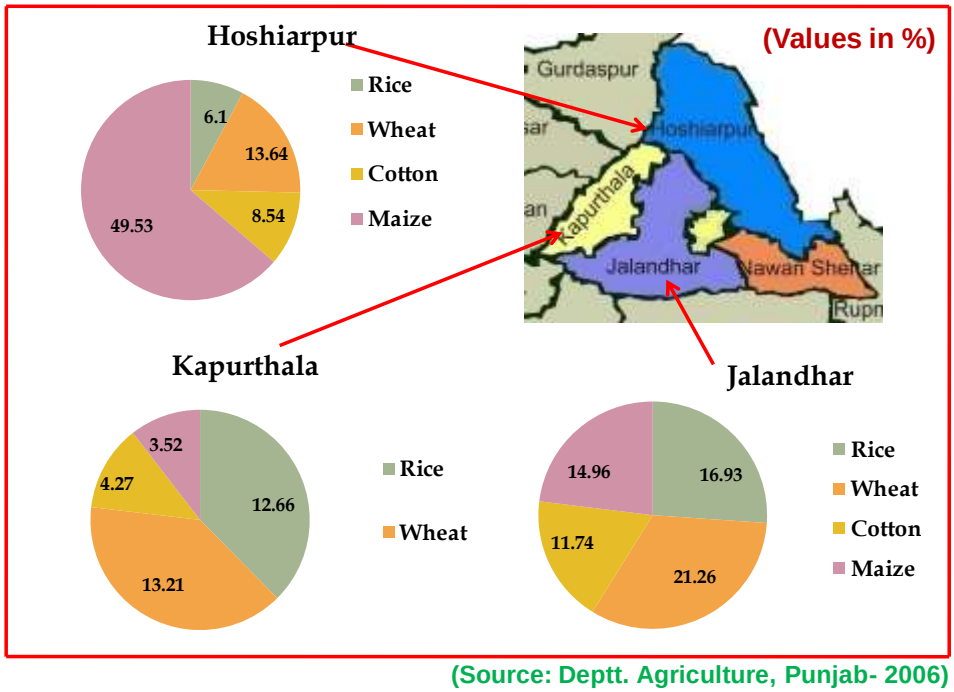



**Fig. 6 Crop distribution in Bist-Doab region**

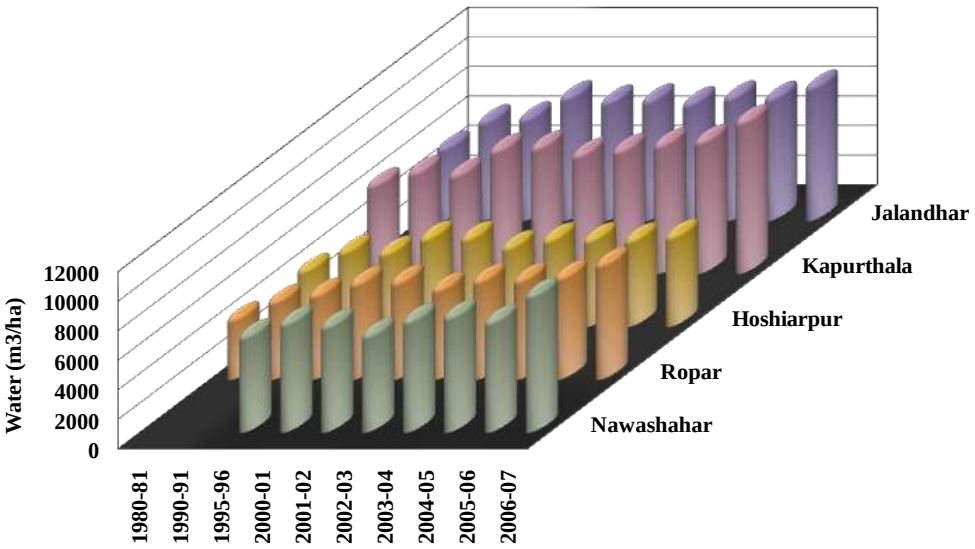



**Fig. 7 Water utilized/ unit area for irrigation in Bist Doab region**

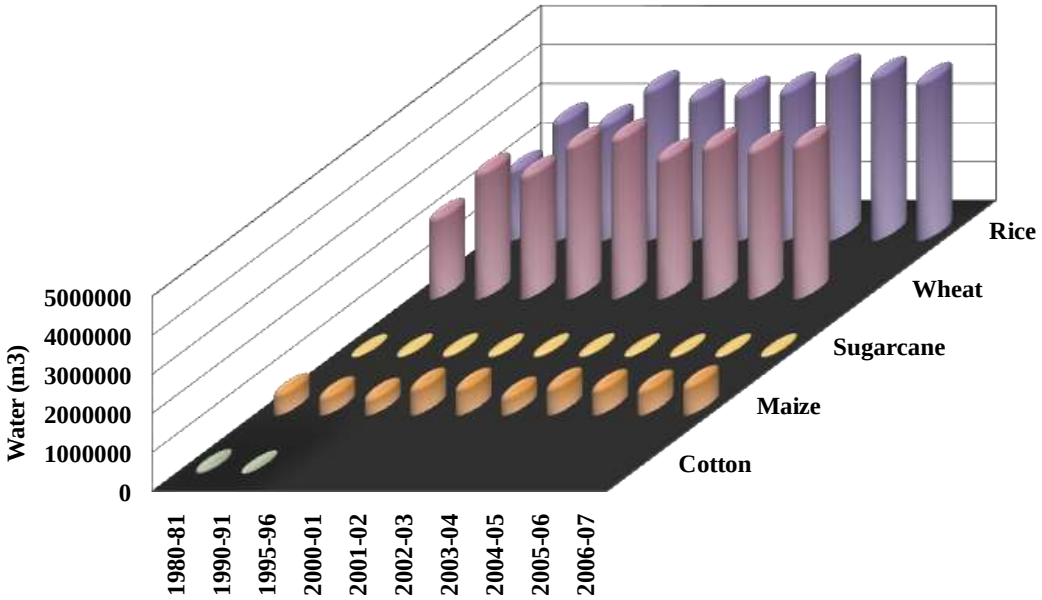



**Fig. 8 Water utilized for various crops in Bist-Doab region ($m^3$)**

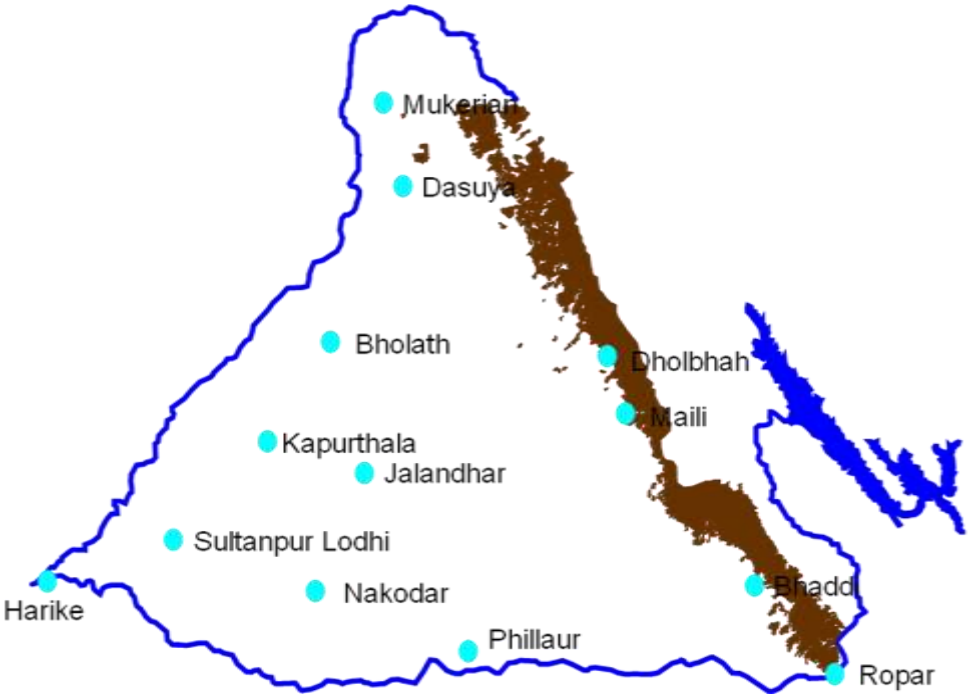



**Fig. 9: Established 13 rainfall collection stations**

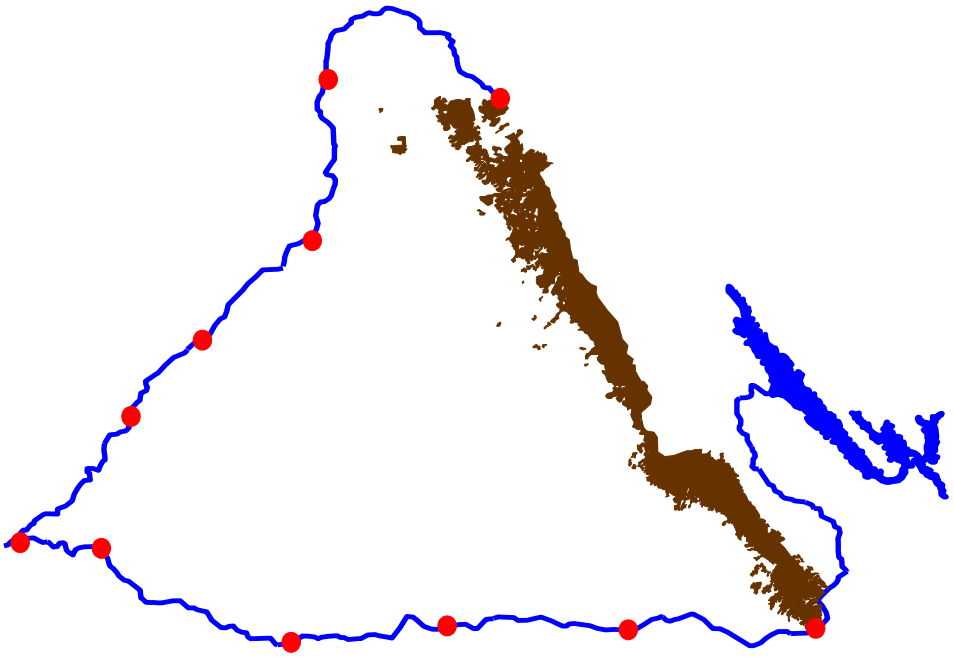


**Fig. 10: Sampling sites - river water**

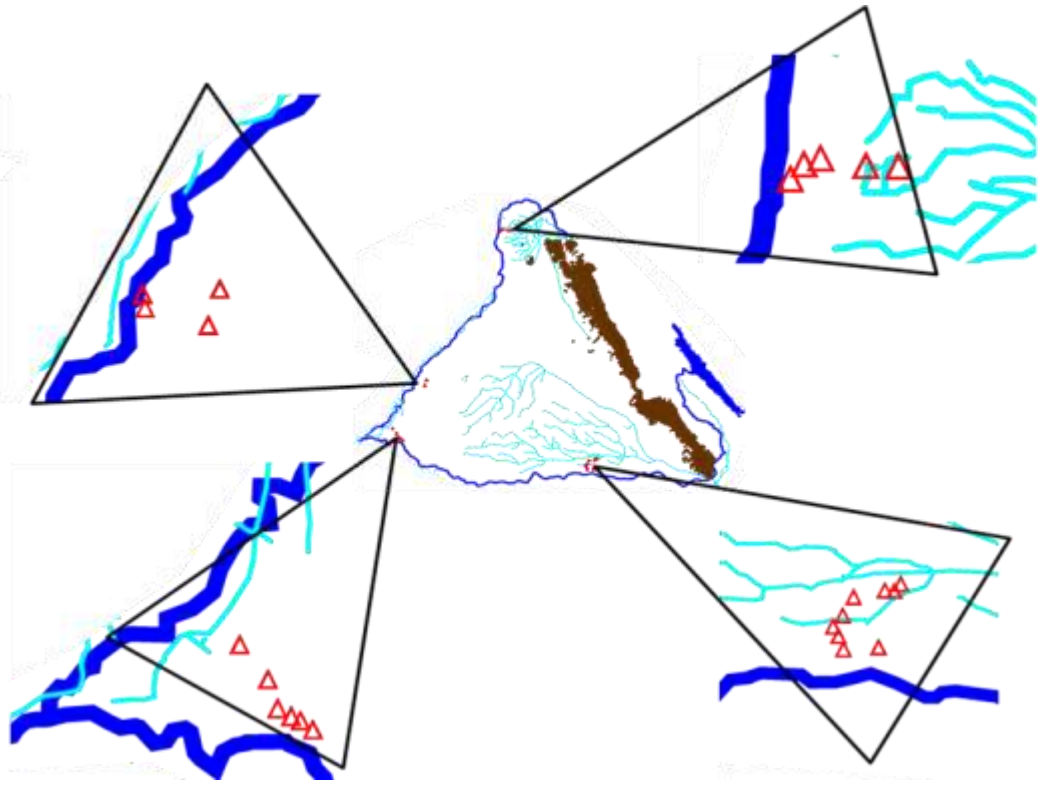


**Fig. 11: Sampling sites – flood-plain (shallow aquifer)**

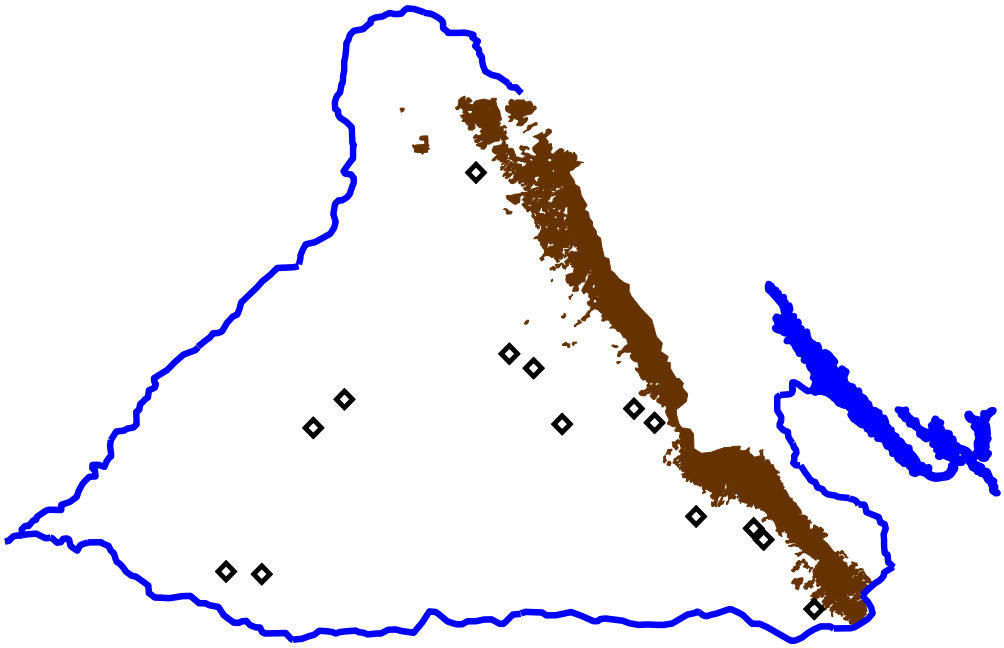


**Fig. 12: Sampling sites – tubewell water (out of 52, only 14 locations are shown)**

**EXPECTED DATE OF COMPELETION**: SEPTEMBER, 2012

**4. PROJECT REFERENCE CODE : NIH/HID/HP-II/08-12**

| | | |
|---|---|---|
| **TITLE** | **:** | **GROUNDWATER MANAGEMENT IN OVER-EXPLOITED BLOCKS OF CHITRADURGA AND TUMKUR DISTRICTS OF KARNATAKA** |
| **STUDY GROUP** | **:** | Dr. Sudhir Kumar (PI), Dr. JV Tyagi, Dr. Vijay Kumar and Dr. B.K. Purandara |
| **DATE OF START** | **:** | July 2009 (July, 2009- June, 2012) |
| **DURATION** | **:** | 3 years. |
| **FUNDING** | **:** | MOWR (PDS under HP-II) |

**Objectives of the Study:**

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.

**PROGRESS / PRESENT STATUS**

✓ Two watersheds have been identified in the Tumkur and Chitradurga districts for carrying out groundwater management studies.

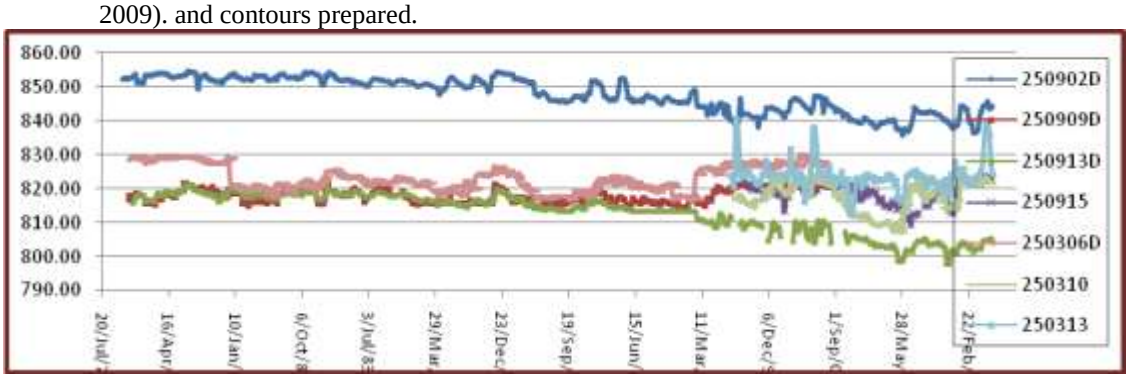
**Location Map of**
**Chitradurga and Tumkur Watersheds, Karnataka**

✓ A visit was made during the April / May 2010 to Bangluru, Chitradurga and Tumkur districts for installing instruments and conduct field experiments.

✓ Hydrometeorological Instruments (Evaporation pan, Soil moisture sensors and Rain gauge) have been installed in the field.

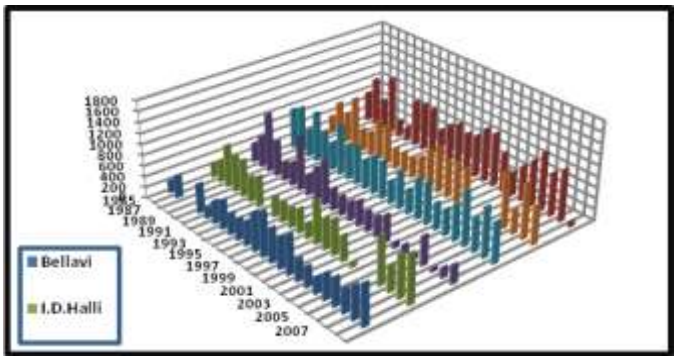
✓ Infiltration tests conducted at 16 locations in both the watersheds

- ✓ GIS Database has been prepared for both the watersheds including Base map, Drainage map, Road map and Water storage structures maps etc.
- ✓ 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.




**Water Level fluctuation in Tumkur District**

- ✓ 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.




**Rainfall data of Tumkur District**

- ✓ Water Quality data have also been collected for 13 observation wells for Chitradurga watershed (2009) and 20 for Tumkur watershed (from 1997 onwards).
- ✓ About 15 groundwater samples from Chitradurga and Tumkur watershed have been collected from different wells for Stable isotopic analysis.

**EXPECTED DATE OF COMPLETION:** June, 2012

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

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

**STUDY GROUP :** S.P. Rai, Bhishm Kumar, J. V. Tyagi (NIH) and Rajeev Tiwari (FRI)

**DATE OF START :** March 2008

**DURATION :** 5 Yrs (March, 2008- February, 2013)

**FUNDING** **:** Rs. 3.5 lac, Forest Research Institute, Dehradun

**Objectives of the Study:**

1. Impact of forest cover on stream discharge pattern.
2. To separate surface runoff & ground water components in the stream discharge using conventional and isotopic technique
3. Soil erosion under different forest cover.
4. Identification of recharge zone of stream & springs using isotopic techniques
5. To define the role of forest on hydrological regime

**BRIEF METHODOLOGY:**

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

**PROGRESS / PRESENT STATUS:**

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

The compound weir ($120^0$ 'V' Notch and rectangular) and automatic water level stage recorder have been installed in these watersheds for monitoring the continuous stream discharge. Meteorological observatories have been installed near the outlet of each watershed for monitoring the rainfall, temperature, humidity and evaporation etc. The continuous data have been recorded since June 2008 onwards. For isotopic characterization of rain and streams, water samples have been collected for measuring $^{18}O$ and D analysis and also for $^{3}H$ analysis.

The average air temperature varies between $15.5^0$C (minimum) and $25^0$C (maximum) in degraded watershed and $18^0$C to $22^0$C in forested watershed. The relative humidity is observed minimum in summer months and maximum in rainy months. The evaporation rate varied from minimum 2.5 mm/day in rainy months to maximum 6 mm/day in summer months.

Collection of discharge data of both the watershed started from April 2008. The discharge data have been analysed from April 08 to July 2010. The results reveals that monthly average discharge in degraded watershed (i.e., Bansigad) vary between 0.01$m^3$/sec (minimum) in the month of November and 0.59 $m^3$/sec (maximum) in the month August. Bansigad stream was dried in the months of April, May and June during the 2008 and 2009 and it was dry for during winter and summer months of the year 2010. However, forested watershed, it vary between 0.03 $m^3$/sec in the month of May and 0.56 $m^3$/sec in the month of August. It remains perennial throughout the year.

Hydrograph shown below reveals that rainfall response on stream discharge of both watersheds is very quick. However, comparatively slow recession of hydrograph ia observed in dense forest stream. The discharge decline slowly in Arnigad stream during post monsoon month while it decline at faster rate in Bansigad stream and stream become dry up in summer months. The preliminary observations reveal that the stream flowing through dense forest

sustains during non-monsoon months due input from the delayed subsurface flow.

Total rainfall received during 1st year (i.e., April 2008 to March 2009) in the Arnigad and Bansigad micro watersheds are 2905 mm and 2958 mm respectively. During the second year 1701mm and 1932 mm rainfall is recorded from Arnigad and Bansigad watershed respectively, which is comparatively less than that of first year. This amount of rainfall is generating runoff from Arnigad and Bansigad watersheds 1627 mm and 1932 mm during first year and 996 mm and 326 mm during second year, respectively. Monthly distributions of runoff in the both the micro watersheds vary significantly. During the monsoon period from June to September of first year both the watersheds receive about 80-88% of the total rainfall while runoff percentage during June to September is 32% to 36% in Arnigad and 17% to 46% in Bansigad to the total rainfall. Runoff variation is more in the degraded Bansigad (degraded) micro watersheds. This reflects the impact of forest on runoff.

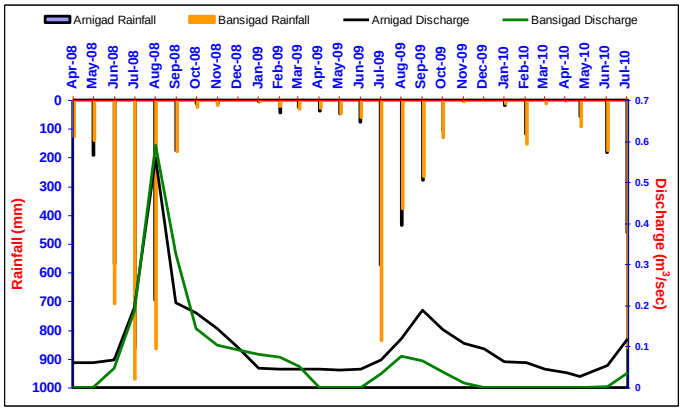



**Fig: Rainfall-runoff relationship on monthly basis from Arnigad and Bansigad micro-watersheds**.

During the period, from October 2008 to March 2009, both watershed received rainfall approximately 3% of the total rainfall received during the year. Runoff during the same period is 545mm from the Arnigad (dense) and 361mm from the Bansigad (degraded). Standard deviation of daily discharge is 20% higher in Bansigad (0.19 m3/s) than Arnigad (0.15 m3/s). These results indicate that runoff is more uniform in case of dense forests. During post monsoon months, stream discharge from the degraded watershed reduces drastically. Discharge in Arnigad stream becomes higher than the Bansigad stream (Fig. 1).

The steady rate of infiltration in Bansigad watershed was found to be 28.90, 8.1 and 30.30 cm/hr in agricultural land, degraded forest and dense forest respectively, while in Arnigad watershed the rates were observed to be 12.69, 32.20 and 24.57 cm/hr in respective land uses.

**Isotopic Composition of Rain and Stream Discharge**

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

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

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

Slope and the intercept of the best fit line of both watershed are close to those of local meteoric water line for the Bhagirathi River basin ($\delta D = (8.0) * \delta^{18}O + (11.5)$, $r^2 = 0.98$). Seasonal and storm-wise variation has been also recorded, which will be useful in hydrograph separation.

In stream discharge, $\delta^{18}O$ varies from -12.9 ‰ in the month of August to -7.5 ‰ in the month of June in Bansigad watershed while it varies from -9.9 ‰ in the month of August to -7.56 ‰ in the month of May in Arnigad watershed. The depleted isotopic signature of stream discharge during the rainy months and enriched values during the pre-monsoon months reveal the seasonal variations due to change in source of contribution. During the monsoon months, stream discharge dominates by surface runoff while during non rainy months, subsurface flow dominates. The stable isotopic signatures of stream discharge in the watersheds depict the following relations.

$\delta D = (7.91) * \delta^{18}O + 11.93$ $r^2 = 0.80$ (Bansigad Watershed)
$\delta D = (7.90) * \delta^{18}O + 11.55$ $r^2 = 0.98$ (Arnigad Watershed)

Slope and the intercept of the best fit line of stream discharge of both the watershed are close to local meteoric water line, which indicates that source of stream discharge is only local precipitation. Monthly weighted value of $\delta^{18}O$ rain and discharge have been analysed for hydrograph separation. Variations are shown in figure 2. The baseflow and runoff components have been computed on the basis of conventional and isotopic techniques.

$\delta D$ and $\delta^{18}O$ analysis of five springs have been carried out. On the basis of isotopic signatures of the springs, recharge zones of two springs have been identified. The sediment delivery from both the watersheds has been measured on the basis of daily sampling during monsoon period. The suspended concentration in stream water discharged through V notch in the forested watershed has been found varying from 2 mg/l during summer months to 8170 mg/l during rainy period while it was recorded from 2 mg/l to 5860 mg/l in the degraded watershed of Bansigad. Further analysis of sediment data is in progress.

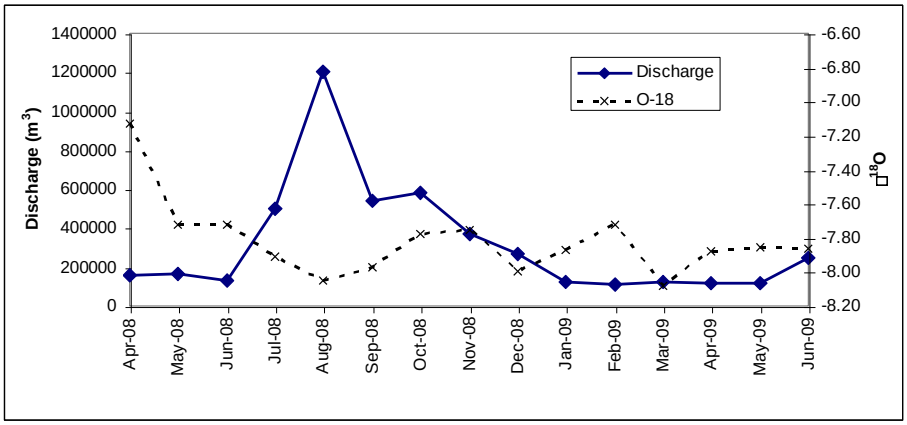



**Fig Variation of $\delta^{18}O$ with Discharge in Arnigad watershed**

**EXPECTED DATE OF COMPLETION**: March, 2013

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

**TITLE : ASSESSMENT OF GROUNDWATER RESOURCES & DEVELOPMENT POTENTIAL OF YAMUNA FLOOD PLAIN, NCT DELHI**

**STUDY GROUP :** Dr. Sudhir Kumar, NIH (PI) and Investigators from CGWB, CWC, IIT Delhi, DU, NRL, and DJB

**DATE OF START :** April, 2010

**DURATION :** 1 year (April, 2010-march, 2011)

**FUNDING :** Delhi Jal Board, Total: Rs.36.267 lac (NIH Component: Rs.26.594 lac)

**Objectives of the Study:**
:

(a) Estimation of groundwater resources in the Yamuna floodplains.
(b) Estimation of groundwater development potential in space and time through ground water simulation studies.
(c) Assessment of the impact of groundwater extraction from floodplains on hydrological regime.

(d) Assessment of groundwater quality vis-a-vis availability of drinking water.

The following scope has been envisaged under the proposed study:

i. To decipher the disposition of aquifer system within and adjacent to floodplain.
ii. To ascertain the groundwater flow direction in reference to river Yamuna.
iii. To assess the total groundwater resources within the floodplains.
iv. To delineate groundwater contaminated areas and evolve strategy for development of potable ground water
v. To investigate impact of ground water development on hydrological regime.
vi. To explore the possibility of augmentation of ground water in the floodplain using flood water of river Yamuna.

**PROGRESS/PRESENT STATUS:**

- All available data with CGWB have been collected related to bore-wells (lithologs), pump tests and water levels.
- Litholog data have been analysed and aquifer geometry of the YFP finalized
- Groundwater levels are been monitored every month.
- Samples for groundwater quality and isotopic analysis collected and analysed.
- Infiltration tests conducted in the Yamuna flood plain
- 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
- Development of Conceptual model completed
- Calibration of model is under progress

**EXPECTED DATE OF COMPLETION**: March, 2011

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

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

**STUDY GROUP :** Dr. S. P. Rai (PI); Dr. Manohar Arora, Dr. Bhishm Kumar, Dr. Rakesh Kumar and Nareh Saini

**DATE OF START:** April 2010

**DURATION :** 3 years (April, 2010- March, 2013)

**FUNDING :** Internal

**Objectives of the Study :**

(i) Isotopic characterization of melt water near snout.
(ii) Isotopic characterization of Snow, Glacier and Rain near snout.
(iii) Estimation of snow and Glacier melt using two component model

**BRIEF METHODOLOGY:**

- Stable isotopes of oxygen and hydrogen, environmental radioisotopes like H-3 and artificial radioisotope like Cs-137 will be used for the characterization.
- Chemical analysis (major cation and anion) of collected samples
- Discharge and meteorological data will be used for analysis of isotopic data.

**PROGRESS / PRESENT STATUS:**
Sample collection for the ablation period of 2010 has been started at the site established by NIH, near Gangotri snout. Water sample of river and precipitation (rain/snow) have been collected on daily basis for analysis of stable isotopes ($\delta D$ and $\delta^{18}O$) and tritium. The analyses of the samples are in progress.

River, precipitation and few snow and ice samples near Gaumukh snout have been collected during the previous years 2005, 2008 and 2007. The $\delta D$ and $\delta^{18}O$ values of snow, glacier and river (i.e. meltwater) are discussed below.

**Isotopic composition of Snow and Ice**
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 Gaumukh snout are presented in Table 1.

**Table 1: $\delta^{18}O$ values of snow measured under present study**

| Type of sample | Altitude (m) | $\delta^{18}O$ (‰) |
|---|---|---|
| Snow near Gaumukh | 3800 | -11.6 |
| | 3800 | -13.9 |
| | 3800 | -9.7 |
| | 3800 | -10.1 |
| | 3800 | -11.7 |
| | 3800 | -4.0 |
| | 3800 | -14.0 |
| **Ice samples** | 4000 | -18.5 |
| | 4000 | -13.37 |
| | 4000 | -18.1 |
| | 4000 | -14.5 |
| | 4000 | -13.5 |
| | 4000 | -15.0 |
| | 4000 | -14.4 |

The results clearly indicate that the fresh snow bears more enriched isotopic signature than the glacier.

**Isotopic composition ($\delta D$ and $\delta^{18}O$) of River**
The $\delta^{18}O$ values of river water during pre-monsoon (April to June) found between -12‰ and -13‰. The $\delta^{18}O$ values further depletes slowly in the month of July. The depleted $\delta^{18}O$ signatures continue in the remaining months of August and September with slight enrichment. The abrupt depletion of $\delta^{18}O$ in July, August and September is triggered with a heavy rainfall event. It has been observed that the isotopic values of river initially follow the $\delta^{18}O$ values of snow as shown in Table 1 (-4.0‰ to -14.4‰ for samples collected in the month of May and June). It suggests that snowmelt dominates in the river discharge at initial stage (during May and June). The depleted value of $\delta^{18}O$ in the months of July, August indicated more contribution from ice melt.

**EXPECTED DATE OF COMPLETION**: March, 2013

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

| | | |
|---|---|---|
| **TITLE** | **:** | **DEVELOPMENT OF SPRING SANCTURIES IN AN URBAN AND RURAL WATERSHED IN DISTRICT PAURI GARHWAL, UTTARAKHAND** |
| **STUDY GROUP** | **:** | Dr. S. P. Rai (PI)<br>Dr. Bhishm Kumar, Dr. Sudhir Kumar, Dr. Suhas Khobragade and Pankaj Garg |
| **COLLABORATING ORGANISATION** | **:** | Srinagar Regional Centre of GBPIHED, Almora |
| **DATE OF START** | **:** | April 2010 |
| **DURATION** | **:** | 3 years (April, 2010- March, 2013) |
| **FUNDING** | **:** | Partly by G B Pant Institute of Himalayan Environment & Development, Almora |

**Objectives of the Study:**

To decipher the recharge zone of springs falling in the study area.

(ii) To analyze the relationship between rainfall, evaporation, landuse/land cover and ecological factors with spring discharge.

(iii) To implement spring sanctuary strategy in the identified recharge area in order to enhance the discharge

**BRIEF METHODOLOGY**:

Methodology has been discussed in brief.

i) Detailed Geological Mapping
   Delineation of lithological units
   Analysis of trends or patterns of structures
ii) Geomorphological Investigations
   Morphometric analysis along with slope analysis
iii) Isotopic Investigations
   Spring/ groundwater
   Precipitation
iv) Measures to Rejuvenate Springs

Designing and locations for developing engineering structures such as infiltration trenches, water storage tanks and bunds etc for rejuvenation of springs including biological measures.

**PROGRESS / PRESENT STATUS:**

Two watersheds have been identified for the study of spring sanctuaries which are facing with acute water scarcity. One water shed is in Pauri urban area and second one in the rural area i.e. Dugargad watershed. In Pauri watershed eight springs have selected at different part of the watershed to collect the water samples for stable isotopes (δD and $\delta^{18}O$) radioactive isotope ($^{3}H$) analysis. A meteorological observatory in the watershed has been installed to monitor the variation in meteorological parameters. The discharge of the springs has been measured on the daily basis. Total 67 samples on weekly basis have been collected for δD and $\delta^{18}O$ analysis and 16 samples for $^{3}H$ analysis from the Pauri watershed.

In Dugargad watershed, 3 springs have been identified for stable isotopes (δD and $\delta^{18}O$) radioactive isotope ($^{3}H$) analysis. Discharge of two springs have been measured on daily basis during monsoon period. Total 24 samples on weekly basis have been collected for δD and $\delta^{18}O$ analysis and 6 samples for $^{3}H$ analysis from Pauri watershed.

Rainfall samples have been collected at four additional sites in order to estimate the altitude effect in the study area. Rainfall samples have been collected on daily basis from all the six sites. The total number of samples collected for

$\delta D$ and $\delta^{18}O$ analysis are 119 upto the month of July 2010 and 12 for $^{3}H$ analysis. The isotopic analyses of these samples are under progress.

The literatures related to spring study have been collected. The geological and geomorphological details of the area have been collected.

**EXPECTED DATE OF COMPLETION:** March, 2013.

**9. PROJECT REFERENCE CODE: NIH/HID/INT/10-13**

| | | |
|---|---|---|
| **TITLE OF THE STUDY** | **:** | **IDENTIFICATION OF RECHARGE ZONES OF SOME SELECTED SPRINGS OF UTTARAKHAND USING ISOTOPES** |
| **STUDY GROUP** | **:** | Dr**.** S. D. Khobragade **(P.I.), Dr.** Bhishm Kumar, Dr. Sudheer Kumar, Dr. S. P. Rai and Pankaj Garg |
| **DATE OF START** | **:** | APRIL, 2010 |
| **DURATION** | **:** | 2 YEARS (APRIL, 2010 TO MARCH, 2012) |
| **FUNDING:** | | Internal |
| **COLLABORATING ORGANISATION:** | | Uttarakhand Jalsansthan, Dehradun |

**Objectives of the Study:**

(i) To identify recharge areas of some selected springs of Uttrakahand, and

(ii) To suggest remedial measures for rejuvenation of these springs

**BRIEF BACKGROUND:**

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.

**BRIEF METHODOLOGY:**

Water samples are to be collected from various sources such as precipitation, ground water, spring water etc. The samples are to be collected on weakly basis during the non-monsoon season and on daily basis during the monsoon season. The samples would be analyzed for environmental isotopes. Meteoric water line and altitude effect will be established for the study area to determine the recharge zones. Isotopic data will be correlated with the hydro-geological and geo-chemistry data. Based on the analysis of the data, recharge sources of the springs would be identified and accordingly remedial measures for the rejuvenation of the springs would be suggested.

**PROGRESS / PRESENT STATUS**

- Some relevant Literature has been collected.
- Field visits were made during the month of June and September 2010.
- Study area has been finalized in consultation with the Uttarakhand Jalsansthan, Deharadun. The selected springs are Moli, Ratoli, Gothiyara and Kanda Dhangi lying in the Jakhnidhar block of district Tehri Garhwal.
- Required equipment such as rain-gauges, temperature-humidity meter, digital thermometer etc have been purchased.

- 3 rain-gauges have been installed at the study site.
- Data observers have been appointed for collection of water samples and data such as spring discharges, rainfall, air temperature, humidity, water temperature, and water samples of precipitation, spring and groundwater.
- Water samples are being collected at the required interval from different sources at the desired interval.
- The collected samples are being analysed for isotopic composition.
- Results will be presented during the working group meeting.

**EXPECTED DATE OF COMPLETION**: March, 2012.

# GROUNDWATER HYDROLOGY DIVISION

**1. 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 (PI), Mr. C. P. Kumar, Dr. Anupma Sharma<br>Mr. Rajan Vatsa |
| **Date of Start** | **:** | April 01, 2009 |
| **Duration of the Study &** | **:** | Three years (2009-2012), March-2012 |
| **expected Date of Completion** | | |
| **Whether externally funded** | **:** | No |

**Objectives of the Study :**

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

**Brief Methodology:**

The technical program of the proposed study comprises the following:

- 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.

**Progress/Present status:**

1. *Data collection* –Various meteorological data from IMD were collected. Soil samples from 12 locations of the Sonar basin were collected and the testing of these samples in laboratory for soil-moisture characteristics data and grain-size analysis is in progress.
2. *Database Preparation:* The database preparation for downscaling of rainfall and temperature as well as HELP model for estimation of groundwater recharge has been completed.
3. *Analysis* – Statistical analysis of rainfall and temperature for future trend has been completed. Downscaling of rainfall and temperature for the year 2039, 3069 and 2099 and estimation of recharge rates is in progress.

**Expected date of completion:** March 2012

**2. Title of the study** : **Coastal Groundwater Dynamics and Management in the Saurashtra Region, Gujarat.**

**Date of start** : Oct. 26, 2009

**Duration of the study** : Oct. 26, 2009 - June 31, 2012

**Whether externally funded or not:** 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

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

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

1. Analyses of the physico-chemical mechanism of mixing of freshwater-saltwater and other hydrogeochemical processes in the limestone coastal aquifer system of Porbandar region, Coastal Saurashtra.
2. Simulation of the transport of saltwater in the coastal aquifer system through numerical modeling and study impact of existing aquifer management practices on the groundwater regime.
3. Development of a trade-off model for planning sustainable groundwater development program for different management strategies in order to check the saline water ingress.
4. Guidelines for design of possible remedial measures such as suitable artificial recharge techniques and optimal pumping policy.
5. Evaluating 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.

**Progress/Present status:**

1. Identification of study area – Minsar river basin in Porbandar District of Coastal Saurashtra.
2. Literature review – Relevant literature review under progress.
3. Data collection – Two field visits to the study area undertaken since April 2010. During the visits, data pertaining to water quality recorded from open wells and piezometers, lithologs, pump tests, groundwater draft, rainfall, reservoirs, recharge structures, land use, relevant reports and maps collected.
4. Field experiments – Experiments using double ring infiltrometer at 12 sites and Guelph permeameter at 11 sites carried out in Minsar Basin. From the field, 15 soil samples collected for lab analyses. To carry out isotope analyses, 10 water samples collected from different water bodies.
5. Data monitoring – Water level and water quality data monitoring on quarterly basis in 40 wells and on monthly basis in 26 wells.
6. Database preparation – Digitization of drainage network and other water bodies, administrative boundaries, and elevation contours completed. DEM of Minsar basin developed. Database development on GIS under progress.
7. Data analysis – Analysis of litholog, pump test, landuse, water table and water quality data under progress.
8. Groundwater balance – Estimation of groundwater balance components under progress.

**Date of completion of project:** June 2012

**3. 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** |
| **Duration** | **:** | November 2009 – February, 2011 ( 1 year 6 month) |
| **Funding** | **:** | Ground Water Department, Govt. of Rajasthan. |
| **Project cost** | **:** | Rs. 24.52 lacs |
| **Study team** | **:** | N. C. Ghosh, Sc. F (PI) ; Sudhir Kumar, Sc. E2; Anupma Sharma, Sc. C; Surjeet Singh, Sc. C; Rajan Vasta, Sc. B; Shoba Ram, PRA; Sanjay Mittal, SRA; Ram Chander, RA. |
| **Consultant** | **:** | Prof.(Retd.) G. C. Mishra |

**Objective of the study:**

(i) Identification of cause(s) of rising ground water levels in Jodhpur city.
(ii) 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:**

(i) An interim report has been submitted to the GWD, Jodhpur on 31st March, 2010,

(ii) Two more field trips in between April and September, 2010 by scientists and assisting staffs to conduct pumping tests, to measure city's sewerage outflows at three distinct outlet locations, to collect data/information had been taken place. The city's sewerage outflows had been got measured by engaging a local agency, and the measurements were taken for continuous 7 days in each location from morning 6 A.M. to evening 7 P.M. The rating curve making uses of available measured data have been developed for each location. These rating curves are being used for water balance study of the Jodhpur city area,

(iii) Aquifer characterization and stratification of geological formations have been completed making use of 93 borewelllog data in ROCKWORKS software,

(iv) The study area measuring about 116 sq. km. has been discritized into 107 x 113 number grids of each size 100 m x 100m along x-y direction; in vertical direction, it has been divided into 6 layers of different depths, in accordance with the geological formations. Visual MODFLOW is being used as the tool for groundwater flow simulation,

(v) Transmissivity and storativity values of the aquifer are being estimated from the pumping test data. Necessary program in Fortran language has been developed,

(vi) Boundary conditions for different simulation period are being conceptualized and assigned in accordance with the field conditions. Water level situation prevailed in the month of January, 2005 is being considered as the initial condition for simulation,

(vii) Different layer dataand thematic maps including input stresses are being prepared. It is expected to complete the calibration task of the conceptualize programme by November, 2010,

(viii) Writes up on respective elemental work are progressing simultaneously,

(ix) Water balance of the Kailana and Takhatsagar reservoir having known inflow and all outflow components except the groundwater seepage component is being carried out separately to estimate the seepage component,

(x) After getting the conceptualized model calibrated and validated, it will be extended to develop scenarios for different remedial options.

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

**Date of start :** April 1, 2010

**Duration of the study :** Two years (2010 – 2012)

**Whether externally funded or not:** Internal funding with manpower and logistic support from local non-governmental agencies and beneficiaries of the study.

**Study Group :** Dr. Anupma Sharma (Sc. C), Mr. C.P. Kumar (Sc. F), Dr. N.C. Ghosh (Sc. F & Head), Dr. Sudhir Kumar (Sc. EII) , Shri Rajan Vatsa (Sc. B, Shri Shobha Ram (PRA) Shri Sanjay Mittal (SRA)

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

**Brief methodology:**

The technical program of the proposed 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.

**Progress/Present status:**

1. Field visits – One visit undertaken since April 2010.
2. 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.
3. Data analysis under progress.

**Milestones & expected outcome/output:** With increased adoption of rainwater harvesting technologies, it is important to have pro-active knowledge on hydrological consequences of upscaling at basin scale. The study would aid in assessing the impact of rainwater harvesting schemes on groundwater availability for given basin characteristics.

**Proposed date of completion**: March 2012

# ENVIRONMENTAL HYDROLOGY DIVISION

**1. Title of the study:** **Assessment of Ground Water Quality in 25 Class I Cities of India – 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)

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

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

**Duration of the study :** Phase II: 2010-11 (Thirteen Cities)

**Weather externally funded or not:** Yes, CPCB, Delhi

**Point wise objectives:**

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

**Brief methodology:**

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

**Progress/Present Status:**

- First round of sampling (Pre-monsoon) from the eleven class - I cities (Panjim, Gandhinagar, Ranchi, Thiruvananthapuram, Imphal, Pondicherry, Kavaratti, Daman, Silvassa, Ratlam, Bilaspur) has been completed (30 samples from each city, Total number of Samples 330).
- Information related to the study area of 11 Class- I cities covering physiography and soil type, geography, surface and subsurface hydrology, potential of ground water, depth of shallow and deep aquifers, climate, geology, population, industries, bulk storage of petroleum production, water supply, water treatment plants, waste disposal sites etc. collected and are being compiled.
- Physico-chemical and bacteriological analysis completed.
- Digestion/concentration of the samples (Pre-monsoon) for metal analysis is in progress.
- Processing of data is under progress as per BIS standards for the first round of sampling.

**Expected date of completion:** March 2011

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

**Study Group :** M K Sharma, Scientist 'B', V K Choubey, Scientist 'F', A K Keshari, Associate Professor, IIT, Delhi

**Date of start :** October 2007

**Duration of the Study :** Thee Years

**Weather externally funded or not:** Internally funded

**Problem Definition and Study Area :**

Metropolitan city Vadodara witnessed a sudden spurt in industrial activity with the establishment of Gujarat Refinery, Indian Oil Corporation. Metropolitan city of Vadodara is the industrial nucleus of the Gujarat State. During the recent study carried out by NIH, very high concentration of pesticide lindane was observed in ground water of metropolitan city Vadodara. Therefore there is a need to study the lindane migration pattern in the ground water of metropolitan city Vadodara from future projections.

**Objectives of the Study:**

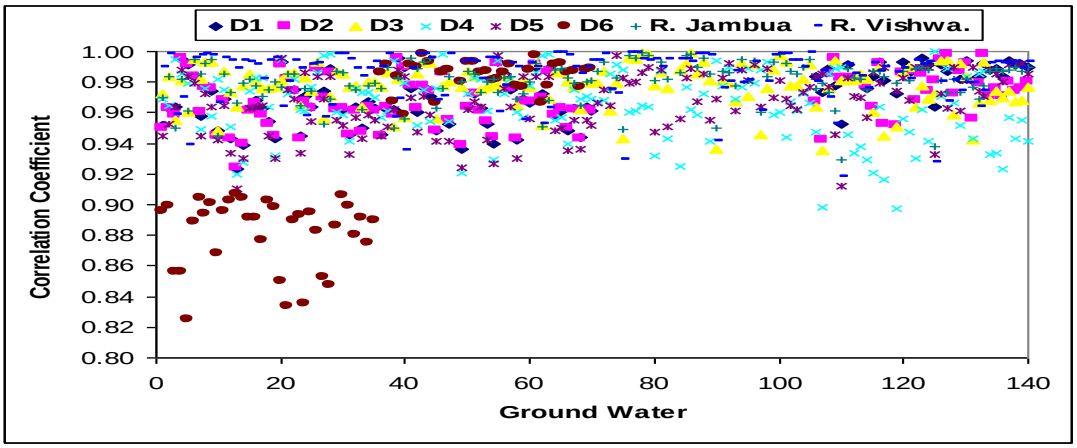
- To develop a contaminant source identification model from point source
- To study and characterize the contaminant (pesticide) migration pattern in the ground water in space and time for prediction purposes

**Brief Methodology:**

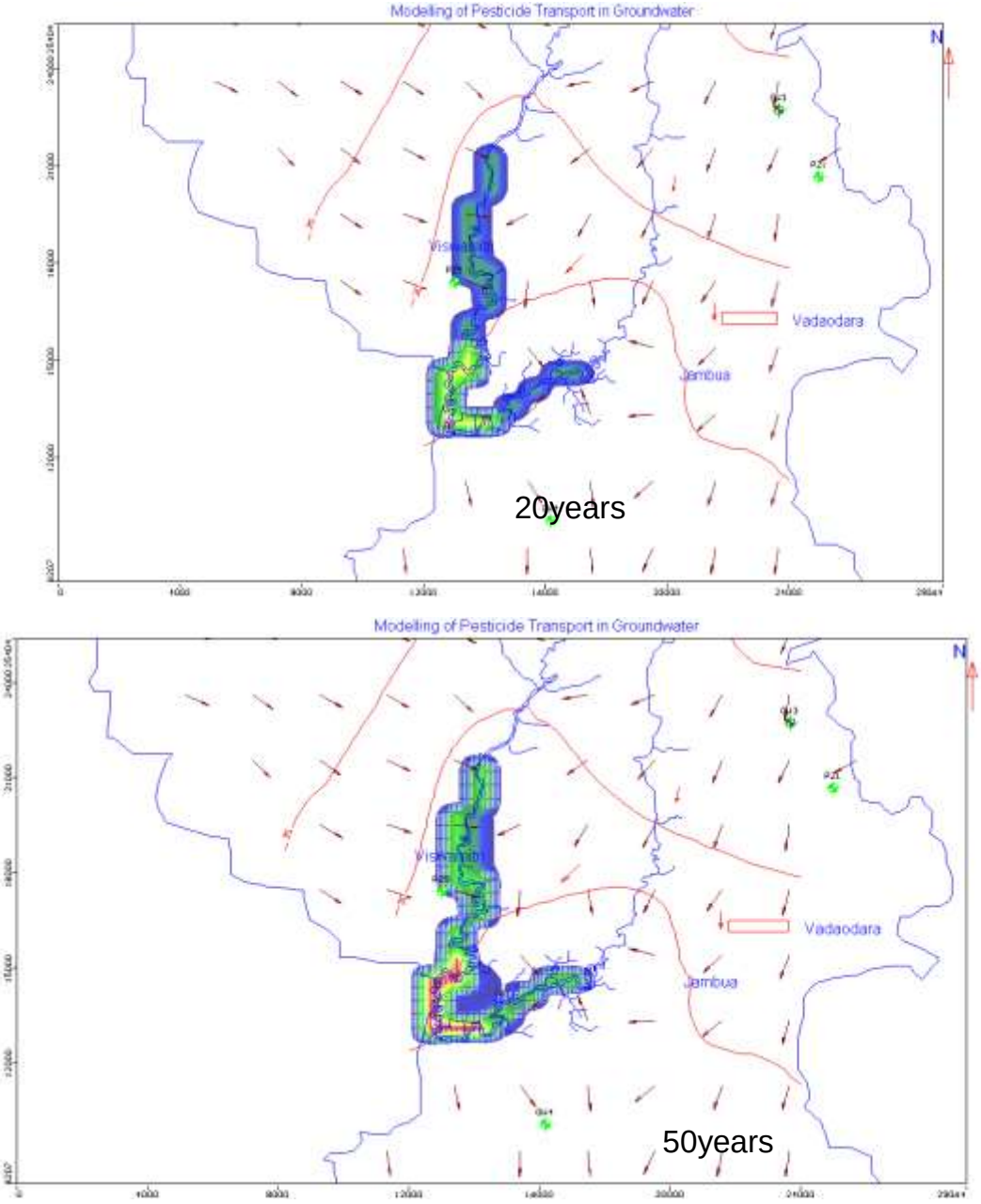
- Methodology will involve flow and transport of organo-chloro pesticide (Lindane) through column study (experimental) in unsaturated zone and modelling flow and transport using MODFLOW & MT3D in saturated zone. Initially, the model will be calibrated using data collected along space & time for a period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

**Results achieved with Progress/Present Status:**

i) Contaminant sources using chemographs of point sources and ground water at different locations were identified. River Vishwamitri and river Jambua are the main contaminant sources of ground water of Vadodara city.



ii) For Ground water flow modeling in saturated zone, Model MODFLOW was calibrated using the field data of vadodara city. For contaminant transport modeling, the test run of model MT3D was carried out for TDS for future projections along space & time for a period upto 50 years.




**Expected Outcome/Output :**

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

**Expected date of completion :** September 2010

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

**Study Group :** Dr V K Choubey, Scientist 'F,' Dr. R.P. Pandey, Scientist 'E1, Shri Omkar Singh, Scientist 'E1, Shri D.G. Durbude, Scientist 'C', Dr. M.K. Sharma, Scientist 'C', I & PHE Dept., Shimla (H.P.), NICD, New Delhi

**Date of start :** April, 1st,.2009

**Duration of the Study:** 3 years (upto 31.3.2012)

**Weather externally funded or not:** yes, HP-II

**Objectives of the Study :**

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

**Brief Methodology:**

**Analysis of basin characteristics of Shimla City.**

i. Digitizing & generation of basin characteristics maps using ILWIS.
   a. Analysis of spatial and temporal variation of rainfall data using statistical methods by collecting historical data.
   b. Assessment of water availability of Shimla City using hydrological and collecting demographic data.

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

iii. Study of existing sewerage network efficacy and sewage disposal practices in the City using SEWERCAD Software

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

v. Dissemination of knowledge, findings and application of the developed model to field engineers and common people through preparation of Reports/lecture notes and organizing trainings/workshops.

**Results achieved with Progress/Present Status:**

- Review of relevant literature of the STPs, WTPs, and Sewage Network Designing etc.
- Delineation of watershed & digitizing of drainage map of Shimla lying under Yamuna Basin has been completed and same for Satluj Basin is under process.
- Pre-monsoon Sampling of water sample from the study area was done and Analysis of the sample was completed.
- Field visit at Shimla was performed during 28 June-1st July, 2010. Collection of surface water samples from open drains, STPs, and water supply source and water distribution points was carried out. I&PHE officers accompanied the field visit for sampling.
- 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.).

- Example Run for the given data of Bentley SewerCAD software was performed to understand the functioning of Sewer CAD. Request was made to I&PHE Dept. Shimla to provide all data for the SewerCAD software.
- Three days Training course on "Water quality and its management" was organised during 28 Jun-1 July., 2010 at HIPA, Shimla" for field engineers.
- Two days Training on SPSS was organised for project personnel and supporting staff during 2-3 Aug 2010 at NIH, Roorkee by IBM SPSS.

Expected date of completion : March, 2012

**4. Title of the Study: Environmental Flow Requirement: A case study of river**

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

**Date of start:** 1.10.2009

**Duration of the Study:** 3 years

**Weather externally funded or not:** Internal

**Objectives of the Study :**

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

**Brief Methodology:**

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

**Progress/present status:**

- Field visit was conducted jointly with Karnataka Power Corporation Limited (KPCL), Bangalore for reconnaissance survey at the proposed site for construction of weir as a part of Shivanasamudram Seasonal Power Scheme of KPCL, Bangalore. The stream gauging station located at Kollegal was visited to investigate the water spread area and catchment characteristics. The catchment area of cauvery river upstream of Shivasamudram proposed site was also visited. Water Resources Development Organisation, Bangalore office was also visited in connection with data availability for nearer stream gauging station.
- Based on the critical review of literature, it is found that the Modified Tennant method is found suitable for environmental flow estimation. Hence, this method will used for estimating the environmental flow requirement.
- The study area details, maps, stream flow data for 100 years (1901-1999) at Kollegal gauging station were collected from KPCL, Bangalore. The collected data of stream flow and maps were computerised/scanned for further processing.
- The procurement of stream flow data for other gauging sites from WRDO, Bangalore is under process.

**Expected date of completion : 30.9.2012**

**5. Title : Impact of Kumbha Mela 2010 on water quality of surface water and ground water resources in and around Hardwar City**

**Study Group :** V K Choubey, Scientist 'F', M K Sharma, Scientist' C', Omkar Singh- Scientist' E1', D.G. Durbude, Scientist' C'

**Date of start:** January, 2010

**Duration of the study:** One year

**Weather externally funded or not:** Internal

**Objectives of the Study:**

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

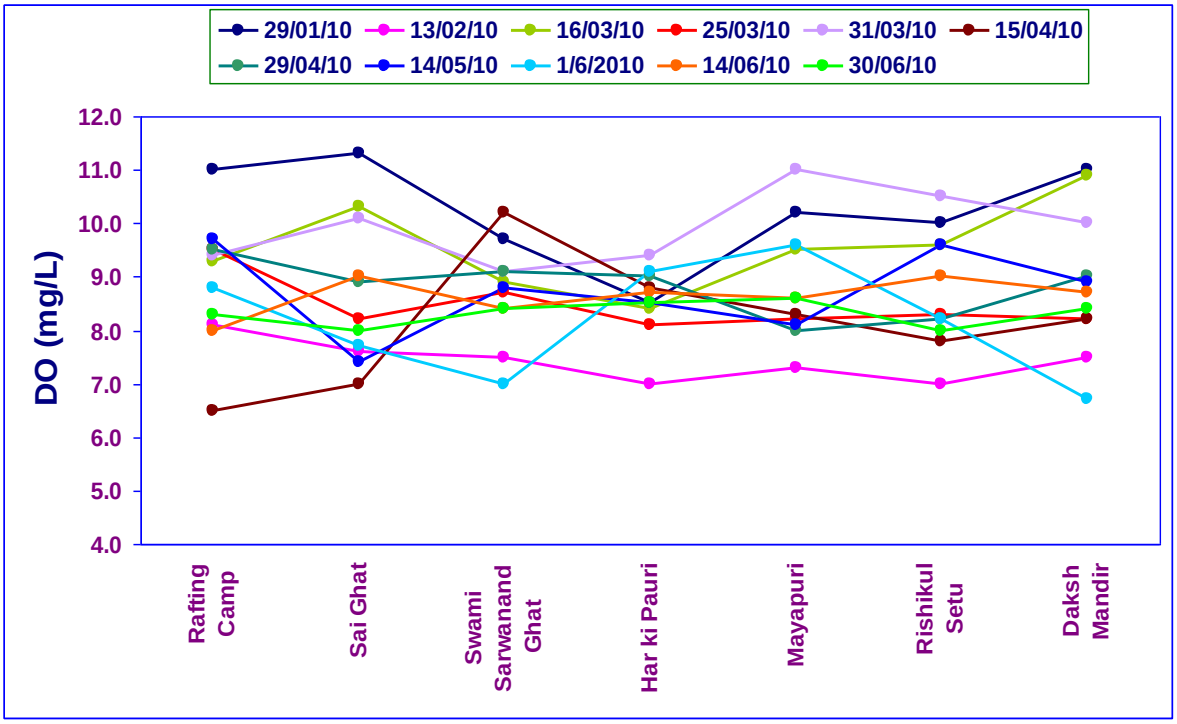
ii) To examine the suitability of surface water and ground water resources in and around Hardwar City for various designated uses

**Brief methodology:**

- 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.
- Determination of hydrological soil properties (infiltration, hydraulic conductivity, texture, etc.) around along River Ganga (Rishikesh to Hardwar) through field and laboratory works.

**Results achieved with Progress/Present Status:**

- 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).
- The collected samples were analysed for Physico-chemical parameters, Bacteriological parameters and metal concentrations.
- All the physico-chemical parameters analysed, were found with in the limit prescribed for drinking water by Bureau of Indian Standards (BIS, 1991), however, very high bacteriological contamination (TC>2400) was observed in the river Ganga/canal water and in few ground water samples in the month of January, April, May and June 2010.




- All metal concentration were observed with in the maximum permissible limit prescribed for drinking purpose.

**Expected outcomes:**

- Report on the impact of Kumbh Mela-2010 on surface and ground water quality of Hardwar

**Expected date of completion:** March, 2011

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

**Study Group :** Omkar Singh, Scientist' E1, V K Choubey, Scientist 'F', Vijay Kumar, Scientist' E1, D.G. Durbude, Scientist' C' , M K Sharma, Scientist' C'

**Date of start :** April, 2010

**Duration of the study:** 1 year

**Weather externally funded or not:** Internal

**Objectives of the Study:**

- To study spatial variability of groundwater quality in Kandi (Bhawar), Sirowal (Terai) and Shiwalik belts of Jammu Region
- To suggest improvement of existing water quality monitoring network in the study area
- To prioritize existing ground water quality parameters for long term regular monitoring of dominant water

quality parameters in the study area

- To prepare Hydro-chemical facies for classification of ground water quality in the study area

**Brief methodology:**

Management of groundwater is very important to meet the increasing demand of water for domestic, agricultural and industrial uses. The information on the spatial and temporal variability of groundwater quality is useful for proper planning and management of groundwater resources. The spatial dependence between observations can be expressed by the semi variance, which is a measure of the average similarity between observations at a given distance apart. This has led to considerable interest in design of investigative studies and monitoring programs to describe groundwater quality over various sizes of areas. 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.

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).

**Progress/Present Status:**

- Review of relevant literature pertaining to application of geo-statistical techniques in spatial data bases
- Collection & preparation of existing ground water quality data sets for Kandi, sirowal (Terai) and Shiwalik belts of Jammu, Kathua and Udhampur districts for spatial variability analysis using GEO-EAS (Geo-statistical Environmental Assessment Software, USEPA).
- Data processing was under progress for spatial variability analysis of ground water quality data of Kandi belt for different parameters viz., pH, EC, total hardness, alkalinity, chloride, nitrate, sulphate, calcium, magnesium, sodium, potassium, phosphate, etc.
- Preparation of existing ground water quality data for classification of ground water quality and hydro-chemical facies analysis
- Interaction with CGWB for additional ground water quality data of the recent years.

**Expected date of completion:** March, 2011

## Agenda Item 33.4

# ANNEXURE - D

# PROPOSED NEW STUDIES FOR THE YEAR 2010-2011

# WATER RESOURCES SYSTEM DIVISION

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

| | | |
|---|---|---|
| **Title of the study** | **:** | **Climatic variability analysis and its \ impact on Himalayan watershed in Uttarakhand.** |
| **Study Group** | **:** | Dr. Avinash Agarwal, Sc E2, Manohar Arora Sc C, R K Nema (SRA) |
| **Date of start** | **:** | Nov. 2010 |
| **Duration of study** | **:** | 3 years **(**Nov. 2010 to Oct. 2013) |
| **Funding** | **:** | Internal |

**Objectives of the Study:**

- Detailed hydrological monitoring, collection of data at watershed scale and creation of a centralized database for watershed for the benefit of the users.
- Development of implementable technology for water availability analysis.
- Interaction and transfer of developed implementable technology to users.

**Brief methodology:**

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.

**Study Area:**

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

**Chandrabhaga and Danda watersheds**

Chandrabhaga watershed is located geographically between $30^{0}$ 18' N to $30^{0}$ 19' N and $78^{0}$ 35' E to and $78^{0}$ 36' E, and Danda between 30° 14' N to 30° 16' N and 78° 37' E to 78° 39' E Jakhnidhar block of Tehri-Garhwal district (Uttarakhand). It is sub-humid with moderate rainfall with annual average of 900 mm.

**Mile stones and expected outcome/output:**

- Creation of a centralized database for Himalayan watershed for the benefit of the users.
- Water availability plans for villagers in the watershed area.
- Interaction and transfer of implementable technology to users and create awareness.

**Expected date of competition:** Oct**. 2013**

**Quarterly schedule for year 2010-13**

Continuous monitoring of watersheds (Chandrabhaga, Danda) with the help of existing instrumentation from starting to end of the project for Rainfall (10 locations), runoff (4 locations), suspended sediment (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 of data and updating the data hub.

| 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 | |

# HYDROLOGICAL INVESTIGATIONS DIVISION

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

**TITLE : Hydrogeological Studies of Jhamarkotra Mines, Udaipur, Rajasthan**

**STUDY GROUP :** Dr. Sudhir Kumar, Scientist E2 (PI), Dr. MS Rao, Scientist C, Sh. SK Verma, Scientist C, Sh. Pankaj Garg, Scientist B

**DATE OF START :** 1st July 2010

**DURATION :** 1 ½ years (July 2010 to Dec 2011)

**FUNDING :** RSMML, Udaipur. Amount: `13.17 Lakh

**BRIEF BACKGROUND:**

The Jhamarkotra deposit of rock phosphate, the country's only known mine, has an estimated reserved of 80 million tons (of the rock phosphate). It is the most modern and scientifically laid out mines in the country and is the largest open cast in the country outside the steel and coal sectors.

The top surface level in the mine area was about 600 m above mean sea level (MSL) and mine working has gone to a depth of up to 405 m and 425 m above MSL in D & E block respectively. Further, RSMM Ltd. plans to excavate the deposit up to 320 m above MSL. Groundwater level contours indicate that present water level in the mining area is about 402 m and 421m above MSL (for D & E block respectively) and the groundwater flow direction is from NW to SE. As the water level is very near to the bottom of the mining pit, it is not possible to excavate to further depth unless the water table is lowered. The fractures and solution cavities within the dolomitic limestone provide paths for the movement of the groundwater and under the present condition of water level the mine is facing the threat of closure. Therefore, RSMML has awarded a consultancy project to NIH.

**Objectives of the Study:**

- 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

**BRIEF METHODOLOGY:**

The tasks and methodology to be adopted for the study are given in Table below:

| S. No. | Methodology | Task to be accomplished |
|---|---|---|
| **1.** | ***Field investigations***: for collection of water samples and estimation of aquifer parameters etc. | Water quality and isotopic studies |
| 2. | ***Rockworks software,*** using the data of available lithologs of the borings available in the area. | Figuring out the disposition of aquifer system |
| 3. | ***Groundwater dating approach***, by determining the age of groundwater at different location. | Ascertaining the groundwater flow direction<br>Demarcation of the recharge and discharge areas |
| 4. | ***Isotopic approach,*** by determining the stable isotopic composition of waters of different aquifers | Interaction between different aquifers<br>Demarcation of the recharge and discharge areas |
| 5. | ***Mathematical modelling***: Using 3D groundwater modelling software MODFLOW | Dewatering Plan for the mines Investigating the impact of mine dewatering on nearby groundwater regime<br>GW quantity assessment for supply to Udaipur city |
| 6. | ***Water Balance approach*** | Water accumulation and pumping from mining pit |

**MILE STONES AND EXPECTED OUTCOME/OUTPUT:**

The study will provide a dewatering plan for the operation of the only phosphorite mine in India.

**EXPECTED DATE OF COMPLETION:** December 2011

**ACTIVITY SCHEDULE**

| SN | Activities | Target Date |
|---|---|---|
| **1.0** | **PREPARATORY WORK** | |
| 1.1 | Recruitment of project staff | Aug'10 |
| 1.2 | Collection and Compilation of available data | Sep'10 |
| 1.3 | Identification of Data Gaps | Oct'10 |
| **2.0** | **FIELD WORK** | |
| 2.1 | Identification of wells for water sampling | Aug'10 |
| 2.2 | Establishment of raingauge station | Aug'10 |
| 2.3 | Infiltration tests to determine Infiltration rates | Nov'10 |
| 2.4 | Groundwater level monitoring in and around Mine | Sep'10 to Oct'11 |
| 2.5 | Pump Tests to determine Sp. yield and Hyd. Cond. (by RSMML) | Dec'10 |
| 2.6 | Estimation of groundwater draft | Jan'11 |

| SN | Activities | Target Date |
|---|---|---|
| 2.7 | Collection of SW and GW samples for water quality analysis | Oct'10 & Jan'11 |
| 2.8 | Collection of SW and GW samples for isotopic analysis | Sep'10 to Sep'11 |
| 2.9 | Collection of samples for groundwater dating | Nov'10 & Apr'11 |
| **3.0** | **LABORATORY WORK** | |
| 3.1 | Analysis of Lithologs and development of Aquifer | Dec'10 |
| 3.2 | Analysis of Water Quality of SW and GW samples | Nov'10 & Feb'11 |
| 3.3 | Analysis of stable isotopes ($\delta D$ and $\delta^{18}O$) of SW and GW samples | Sep'10 to Nov'11 |
| **4.0** | **GROUNDWATER STUDIES** | |
| 4.1 | Estimation of Natural Recharge to groundwater | Feb'11 |
| 4.2 | Feasibility of dewatering of monsoon water from the pit in shortest possible time | Mar'11 |
| 4.3 | Determination of groundwater flow direction | Apr'11 |
| 4.4 | Identification of the source of GW in blocks D & E of mines | May'11 |
| 4.5 | Measures for protection of groundwater quality in nearby wells | Jul'11 |
| **5.0** | **GROUNDWATER MODELLING** | |
| 5.1 | Creation of GIS data base for GW modelling | Oct'10 |
| 5.2 | Development of Conceptual model | Jan'11 |
| 5.3 | Calibration of Model | Apr'11 |
| 5.4 | Development of mine dewatering Plan | Jul'11 |
| 5.5 | Simulation of impact of dewatering on water levels | Oct'11 |
| 5.6 | Assessment of availability of GW for supply to Udaipur city | Oct'11 |
| **6.0** | **REPORT FINALISATION** | Dec'11 |

# ENVIRONMENTAL HYDROLOGY DIVISION

**PROJECT REFERENCE CODE: NIH/EHD/INT/10-11**

**Title** : **Impact of Kumbha Mela 2010 on water quality of surface water and ground water resources in and around Hardwar City**

**Study Group** : V. K. Choubey, Scientist 'F' , M K Sharma, Scientist' C', Omkar Singh, Scientist' E1' D.G. Durbude, Scientist' C'

**Date of start** : January, 2010

**Duration of the Study** : One year

**Funding** : Internal

**Point wise 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

**Brief methodology:**

- 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.
- Determination of hydrological soil properties (infiltration, hydraulic conductivity, texture, etc.) around along River Ganga (Rishikesh to Hardwar) through field and laboratory works.

**Expected outcomes:**

- Report on the impact of Kumbh Mela-2010 on surface and ground water quality of Hardwar

**Expected date of completion: March, 2011**