AGENDA AND AGENDA NOTES

68th MEETING OF THE TECHNICAL ADVISORY COMMITTEE (TAC) OF NIH

JULY 21, 2015

AT 1100 HRS

IN CENTRAL WATER COMMISSION
CONFERENCE ROOM [525(S)]
SEWA BHAWAN, R K PURAM

NEW DELHI

NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE-247667

AGENDA AND AGENDA NOTES FOR THE 68th MEETING OF THE TAC OF NIH

AGENDA ITEMS

List of Appendices

ITEM NO. 68.1 Opening Remarks by the Chairman

ITEM NO. 68.2 Confirmation of the minutes of 67th meeting of the TAC

The 67th meeting of the TAC was held at New Delhi on July 15, 2014. The minutes of the meeting were circulated to all the members and invitees vide letter No. NIH/RCMU/TAC/34/11 dated July 22, 2014. A copy of the minutes of the 67th meeting of TAC is given in **Appendix-68.2.1(Page #36).** Since no comments were received from the members on the circulated minutes, the minutes may please be confirmed.

ITEM NO. 68.3: Action taken on the decisions/ recommendations in the previous meeting

During the 67th meeting of the TAC, the following recommendations/ suggestions had been made by the members. The actions taken on the recommendations/ suggestions are as follows:

Item #	**Recommendations/suggestions**	**Action Taken**
67.4	The Chairman opined that the local line departments and stakeholders should be invited in the Working Group meetings when the completed internal studies are being presented.	Noted.
67.4	Mr N N Rai suggested that the methodology for assessment of environmental flow in rivers should be standardized, and offered to provide the methodology adopted by CWC for such studies for various basins in north-eastern region. The Chairman suggested that if available in public domain, the approach adopted by CWC in the Kishanganga project should also be looked into. He stressed that the required field data in the habitat modeling studies should be used from the authorized field organizations such as Zoological Survey of India, Botanical Survey of India, CIFRI, etc.	Noted.

ITEM NO. 68.4: Status and progress of the work programme for the year 2014-2015

The approved Work Programme of the Divisions at the Headquarters and RC/CFMS of the Institute for the year 2014-15 is given in the tables below, and details are provided in **Appendix 68.4.1(Page # 53):**

1. Environmental Hydrology Division
2. Ground Water Hydrology Division
3. Hydrological Investigation Division
4. Surface Water Hydrology Division
5. Water Resources System Division
6. Research Management & Outreach Division (RMOD)
7. Regional Centre, Belgaum
8. Regional Centre, Jammu
9. Regional Centre, Bhopal
10. Regional Centre, Kakinada
11. Centre for Flood Management Studies, Guwahati
12. Centre for Flood Management Studies, Patna

ENVIRONMENTAL HYDROLOGY DIVISION
2014-2015

S.No.	Study	Study Team	Duration	Status
Internal Studies				
1.	Water Quality Modelling using Soft Computing Techniques (Najafgarh, Mehrauli, City and Shahadara Blocks of NCR Delhi)	Rama Mehta (PI) C. K. Jain Anju Cjoudhary	2 Years (04/14-03/16)	Ongoing
2.	Environmental Flow Assessment of Hemavathi River in Karnataka	D. G. Durbude (PI) C. K. Jain	2 Years (04/13-03/15)	Discontinued
3.	Himalayan River Water Quality Assessment in a Stretch from Gangotri to Haridwar	Rajesh Singh (PI) C. K. Jain D. G. Durbude M. K. Sharma S. P. Rai Renoj J. Thayyan J. P. Patra	3 Years (06/14-03/17)	Ongoing
Sponsored Projects				
1.	Ionic Enrichment Dynamics of Glacial Sediment and Melt water of Gangotri Glacier	M. K. Sharma (PI) C. K. Jain Renoj Thayyan Manohar Arora Naresh Saini Jatin Malhotra Rakesh Goyal	3 Years (04/14-03/17) DST Sponsored.	Ongoing
2.	Low Cost Technology for Purification of Arsenic and Microbes Contaminated Water using Nanotechnology	Vijaya Aggarwala, IITR (PI) Rama Mehta, NIH (Co-PI)	2 Years (04/14-03/16) DST Sponsored.	Ongoing

GROUND WATER HYDROLOGY DIVISION
2014-15

S. No. & Reference Code	Project	Project Team	Duration	Funding Source	Status
1. NIH/GWD /NIH/13-14	Estimation of specific yield and storage coefficient of aquifers	Surjeet Singh (PI) N.C. Ghosh (Co-PI) Sumant Kumar	1 year (04/13 – 0/14)	NIH	Completed
Sponsored Studies					
2. EU-sponsored Project no. 282911	Saph Pani - Enhancement of natural water systems and treatment methods for safe and sustainable water supply in India"	Project Coordinator & P.I. : N. C. Ghosh Other Team Members V. C. Goyal, C. K. Jain, Sudhir Kumar, B. Chakravorty, A. K. Lohani Anupma Sharma, Surjeet Singh, Sumant Kumar Shashi Poonam Indwar	36 months (Oct., 2011-Sept.,2014)	European Union under 7th - Framework Programme	Completed
3. NIH/GWD /NIH/11-14	Management of Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)	Sumant Kumar (PI) Rajan Vatsa, N.C. Ghosh, C.P. Kumar, Surjeet Singh, Sanjay Mittal	3 years (04/11 – 3/15)	Saph Pani Project, after Sept., 2014 NIH's internal funding.	Completed
4. EU-sponsored Project no. 282911	Flow and Contaminant Transport Modeling of Riverbank Filtration	Shashi Poonam Indwar (PI), N.C. Ghosh, Anupma Sharma, Rajan Vatsa, Sanjay Mittal	2 ½ years (04/12 – 9/14)	Saph Pani Project, after Sept., 2014 NIH's internal funding.	Completed

HYDROLOGICL INVESTIGATION DIVISION
2014-2015

S.No.	Study	Team	Duration	Status
INTERNAL STUDIES				
1	Water Quality, Hydrogeology and Isotopic Investigations in SW Punjab	M. S. Rao (PI) C. P. Kumar Gopal Krishan	3 years (07/12-06/15)	Completed
2	Water Availability Studies for Sukhna Lake, Chandigarh	S. D. Khobragade (PI) C. P. Kumar Sudhir Kumar A. R. Senthil Kumar P. K. Garg V. K. Agarwal	2 years (04/13-03/15)	Completed
3	Isotope Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains	Sudhir Kumar (PI) C. K. Jain S. P. Rai S. D. Khobragade P. K. Garg B. C. Joshi (CGWB) Tejdeep Singh (CGWB)	2 years (07/13-06/15)	Ongoing
4	Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes	S. K. Verma (PI) S. P. Rai (Co-PI) M. S. Rao C. P. Kumar Mohar Singh	2 years (10/13-09/15)	Ongoing
5	Sub-marine Groundwater Discharge and Sea-water Intrusion in Coastal Aquifers of East Coast, India	M. S. Rao (PI)	2 years (06/14-05/16)	To start from April, 2015
6	Monitoring Isotopes in Air Moisture in Parts of Himalayas (Himachal Pradesh & Uttarakhand) for investigating the Cloud Condensation	M. S. Rao (PI) C. P. Kumar Gopal Krishan	2 years (06/14-05/16)	To start from April, 2015
SPONSORED PROJECTS				
7	The Structure and Dynamics of Groundwater Systems in Northwestern India under Past, Present and Future Climates	S. P. Rai (PI) M. S. Rao Surjeet Singh S. K. Verma C. P. Kumar Sudhir Kumar V. K. Agarwal Rajeev Gupta S. L. Srivastava Vishal Gupta Mohar Singh	3 years (06/12-05/15)	Ongoing
8	The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India	M. S. Rao (PI) C. P. Kumar S. P. Rai	3 years (09/12-08/15)	Ongoing

S.No.	Study	Team	Duration	Status
9	Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques	S. P. Rai (PI) R. V. Kale M. S. Rao C. P. Kumar Sudhir Kumar V. K. Agarwal Vishal Gupta Mohar Singh	3 years (10/12-09/15)	Ongoing
10	Review of Groundwater Resources in the Indo-Gangetic Basin: A Case Study on Resilience of Groundwater in the Punjab to Withdrawal and Environmental Change	M. S. Rao (PI) C. P. Kumar Gopal Krishan	One year 8 months (02/13-09/14)	Completed
11	Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains	Sudhir Kumar (PI) S. P. Rai S. D. Khobragade C. K. Jain P. K. Garg	2 years (05/13-04/15)	Ongoing

SURFACE WATER HYDROLOGY DIVISION
2014-2015

S. No. & Ref. Code	Title	Study Team	Duration	Status
Internal Studies				
1. NIH/SWD/NIH/ 12-15	Sedimentation Studies for Pong Reservoir, Himachal Pradesh	A. R. Senthil kumar Manohar Arora Suhas D Khobragade Avinash Agarwal Sanjay Jain	3 years (April 2012 to March 2015)	Extended uptoSept.2015
2. NIH/SWD/NIH/ 12-15	Study Of Hydro-Meteorological Droughts For Chitrakoot Bundelkhand Region In India	R.P. Pandey	3 years (April 2012 to March 2015)	Completed
3. NIH/SWD/NIH/ 13-16	Quantitative assessment of uncertainties in river discharge estimation	Sanjay Kumar Sharad Jain	3 Years (April 2013 to March 2016)	Ongoing
4. NIH/SWD/NIH/ 13-16	Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills.	Avinash Agarwal Manohar Arora RK Nema	3 Years (November 2013 to October 2016)	Ongoing
5. NIH/SWD/NIH/ 14-15	Estimation of Water Balance for Integrated Water Resources Management in Yerrakalva Pilot Basin, A.P.	J.V.Tyagi YRS Rao,	1 year (April 2014 to March 2015)	Extended upto Sept.2015
6. NIH/SWD/NIH/ 14-15	Status Report on “Impact of Anthropogenic and Climate Change on Sediment Load of Rivers”	Archana Sarkar	1 year (April 2014 to March 2015)	Completed
7. NIH/SWD/NIH/ 14-16	Study of Rainfall Patterns and Comparison of Rainfall Data from different Sources for Uttarakhand State	Archana Sarkar N.K. Bhatnagar Vaibhav Garg (IIRS) Rakesh Kumar	2 years (April 2014 to March 2016)	Ongoing
8. NIH/SWD/NIH/ 14-17	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora Rakesh Kumar	3years (May 2014 to March 2017)	Ongoing
9. NIH/SWD/NIH/ 14-17	Effect of climate change on evaporation at point scale	Digambar Singh A. R. Senthil kumar Manohar Arora	3years (June 2014 to March 2017)	Ongoing
10. NIH/SWD/NIH/ 14-17	Hydrological Modelling of Brahmani Baitarani River Basin using eWater Source Platform	J.P.Patra Rakesh Kumar Pankaj Mani	3years (April 2014 to March 2017)	Ongoing
11. NIH/SWD/NIH /13-15	Application of DSS(P) for Integrated Water Resources Development and Management	A.K. Lohani Surjeet Singh Rahul Jaiswal	2 year (April 13-March 15)	Extended upto Oct. 2015

WATER RESOURCES SYSTEM DIVISION
2014-2015

S. N.	Title	Study Team	Duration	Funding	Status
Ongoing Internal Studies					
1.	Trend and variability analysis of rainfall and temperature in Himalayan region	L. N. Thakural Sanjay Kumar Sanjay K. Jain Sharad K. Jain Tanvear Ahmed	3 years (10/11-09/14)	NIH	Completed
2.	NIH_Basin – A WINDOWS based model for water resources assessment in a river basin	M. K. Goel Sharad K. Jain Deepa Chalisgaonkar Prabhash K. Mishra	2 Years (04/13-03/15)	NIH	Extended upto 3/16
3.	Web GIS based snow cover information system for the Indus Basin	D. S. Rathore Deepa Chalisgaonkar L. N. Thakural Tanvear Ahmed	2 Years (04/13-03/15)	NIH	Completed
4.	Assessment of Water Footprint of the National Capital Territory (NCT) of India	Deepa Chalisgaonkar Sharad K. Jain M. K. Nema P. K. Mishra	2 Years (04/13-03/15)	NIH	Completed
5.	Impact of Climate and Land Use Change on Floods of Various Return Periods	P. K. Bhunya Sanjay Kumar D S Rathore	2 Years (04/13-03/15)	NIH	Discontinued
6.	Assessing climate change impact across KBK region of Odisha	P. K. Mishra Sharad K. Jain Sanjay K. Jain P. K. Bhunya	2 Years (04/13-03/15)	NIH	Extended upto 3/16
7.	Glacier change and glacier runoff variation in the upper Satluj river basin	Sanjay K. Jain Sharad K. Jain Renoj J. Theyyan	2.5 Years (10/13-03/16)	NIH	Ongoing
8.	Variability of the Hydro-climatic variables in Punjab Plains of lower Satluj	M. K. Nema Sharad K. Jain	2 Years (11/13-10/15)	NIH	Ongoing
Sponsored Studies					
1.	Glaciological studies of Phuche Glacier, Ladakh Range, India	Renoj J. Theyyan M K Goel S P Rai	5 Years 1/10-12/14	DST	Completed
2.	Ganga River Basin Environment Management Plan	Sharad K Jain N. C. Ghosh Sanjay K. Jain M. K. Goel	2 Years 07/12-06/14	IIT Kanpur	Completed
3.	Assessment of Environmental flow for Himalayan River	Sharad K. Jain Pradeep Kumar P. K. Agarwal P. K. Mishra	1 Year 10/14-10/15	MOES	Ongoing
New Internal Studies					
1.	Hydrologic Modelling of a part of Satluj Basin using SWAT Model	P. K. Agarwal Sharad K. Jain M. K. Goel Sanjay K. Jain MK Nema Tanvear Ahmed	2 -3/4 Years (06/14-3/17)	NIH	Ongoing
2.	Decision Support System for Water Resources Planning in Upper Bhima basin, Maharashtra	D. S. Rathore M. K. Goel, R.P. Pandey Sanjay Kumar Surjeet Singh	2 years (07/14-06/16)	NIH	Ongoing
3.	Catchment scale evaluation of cold-arid cryospheric system Hydrology, Ganglass catchment, Ladakh	Renoj J. Theyyan S P Rai	3 years (04/14-03/17)	NIH	Ongoing

RESEARCH MANAGEMENT AND OUTREACH DIVISION
2014-2015

S.No.	Study	Team	Duration	Status
		Internal Studies		
1.	Participatory development of structure for IWRM Framework in identified sub-basins under Pilot Basin Studies (PBS) program **(New Study)**	V C Goyal (PI) Omkar Singh R V Kale	DOS: July 2014 DOC: June 2015	Completed
2.	Water Conservation and Management in Ibrahimpur Masahi Village of Haridwar District (Uttarakhand) **(Ongoing Study)**	Omkar Singh (PI), V.C. Goyal, C.K. Jain, J.V. Tyagi and Sanjay Kr. Jain **Scientific/Technical Staff** Subhash Kichlu, Yatvir Singh, Rajesh Agarwal, Rakesh Goyal, N.K. Lakhera and C.S. Chowhan	DOS: Apr 2013 DOC: Mar 2015	Extended upto March, 2016
		Sponsored Studies		
3.	Customization of WEAP model for application in Ur river watershed in Tikamgarh district of Bundelkhand region. **(Under TIFAC Project) (New Study)**	R V Kale (PI) T Thomas- RC Bhopal Jyoti Patil Rajesh Agarwal	DOS: Apr 2014 DOC: Sep 2015	Ongoing

Sponsored Projects

1. Integrating hydrology, climate change and IWRM with livelihood issues: Development of methodology and a DSS for water-scarce Bundelkhand region in India, **Funded by TIFAC, Government of India under INDIA-IIASA Programme of TIFAC**
   Period: Aug 2013-Dec 2016 (30 months)   Budget: Rs 56.64 lakh

   Team from NIH:
   V C Goyal (PI), T Thomas (Co-PI), R V Kale (Co-PI)
   Nodal Coordinators from other partners:
   Dr (Mrs) K Vijaya Lakshmi, DA, New Delhi
   Dr Sandeep Goyal, MAPCOST, Govt. of MP (India)
   International Collaborators: IIASA, Austria

2. Development of a DSS for Hydrology and Watershed Management in Neeranchal Project, **To be funded by Dept. of Land Resources (GoI) under a World Bank supported project**
   Period: Jun/Jul 2014-May 2019   Budget: Rs 30 Crore approx.
   Partners: NIH; IIT Delhi; WTC Delhi; NRSC Hyderabad

REGIONAL CENTRE, BELGAUM
2014-2015

No.	Title of the Study	Study Group	Duration	Funding	Status
1	Waterlogging and Salinity Studies in NagarjunaSagar Right Bank Canal Command	NV, BKP	2 years (Aug2012 - Jul2014)	COMPLETED (Report will be submitted soon)	Completed
2	Integrated Water Resources Management (IWRM) on a Pilot Basin – Zuari River Basin, Goa	CMT, BKP, VCG	3 years (Apr2013 - Mar2016)	Internal (PBS)	Ongoing
3	Comparative Analysis of Various Rainfall-Runoff Models for Rivers of Western Ghats	BV, CK & MKJ	3 years (Apr2013 - Mar2016)	Internal	Ongoing
4	Studies on Spring flows and estimation of Groundwater Recharge in Ghataprabha Sub-basin	BKP, NV, SK,RV	2 years (Apr2013 - Mar2015)	Internal	Ongoing
5	Application of Geostatistical methods for analyzing sedimentation pattern in river basins of Kerala State	MKJ, and CM	2 years (Oct2014-Sep2016)	Internal	Ongoing
6	Modeling of Sediment Yield From River Basins of Kerala & Goa, Using SWAT Model	CMT & BV	2 years (Oct2014-Sep2016)	Internal	Ongoing
7	Runoff estimation in a catchment using GIS and WEB based tools: A case study	MKJ and BV	1 year (Oct2014-Sep2015)	Internal	Ongoing
8	Impact of Land use/Land cover Changes on Ground water – A Case Study	BKP, BV and NV	2 years (Oct2014-Sep2016)	Internal	Ongoing
9	Impact of Urbanization on Surface and Ground water Quality and Quantity – A Case Study	BKP, SK and NV	2 years (Oct2014-Sep2016)	Internal	Ongoing

SK : Sudhir Kumar, Scientist G
BV : B.Venkatesh, Scientist F
CMT : Chandramohan T., Scientist D
RV : Rajan Vats Scientist B
CK : ChandraKumar S., SRA
VCG : V. C. Goyal, Scientist F
BKP : Purandara, Scientist E
MKJ : Mathew K. Jose, Scientist D
NV : N Varadarajan,SRA

REGIONAL CENTRE, JAMMU
2014-2015

S. N.	Study	Team	Duration	Funding	Status
1	Impact of land use changes on flow regime and sustenance of environmental flows of Tawi river at Jammu	Pradeep Kumar M. K. Nema	Nov 2011 to Oct 2014 (03 Years)	NIH	Extended upto Dec.2015
2.	Climate Change Effects on Hydrology of the Tawi Basin in Western Himalaya	M. K. Nema Pradeep Kumar	Nov 2011 to Oct 2014 (03 Years)	NIH	Extended upto Dec.2015
3.	PBS: Integrated Water Resources Management (IWRM) Study in Tawi River Basin, JK	Pradeep Kumar M. K. Nema	Apr 2012 to Mar 2017 (05 Years)	NIH	Ongoing
4.	Automation of Hydro-Meteorological Network in Jhelum Basin for Flood Forecasting	Pradeep Kumar R. J. Thayyen M. K. Goel Sharad K. Jain	Sep 2013 to Mar 2016 (02 Years 07 Months)	NIH	Discontinued

REGIONAL CENTRE, BHOPAL
2014-2015

S. N.	Study	Study Group	Starting and ending date	Duration	Status
1.	Surface and ground water modeling for conjunctive use (Pilot Basin Studies: IWRM in Bina River Basin in Bundelkhand Region in M.P.)	T. R. Nayak T. Thomas Ravi Galkate R.K. Jaiswal	April 2012 to March 2017	5 Years	Extended upto Dec.2015
2.	Applications of Decision Support System (DSS) in Shipra river basin of MP	Ravi Galkate T. R. Nayak R.K. Jaiswal T. Thomas	June 2013 to May 2016	3 Years	Ongoing
3.	Integrating hydrology, climate change and IWRM with livelihood issues: Development of methodology and a DSS for water-scarce Bundelkhand region in India	V. C. Goyal T. Thomas R. V. Kale S. Goyal K. Vijay-lakshmi	May 2013 to October 2015	2½ Years	Ongoing
4.	Integrated Assessment of Drought Vulnerability for Water Resources Management in Bina basin	T. Thomas T. R. Nayak R.K. Jaiswal Ravi Galkate	July 2014 to June 2016	2 Years	Ongoing
5.	Irrigation Planning and Management in the Harsi project Command of a Water Resource Project	R.K. Jaiswal T. Thomas Ravi Galkate T. R. Nayak	May 2013 to April 2015	2 Years	Extended upto Oct.2015

REGIONAL CENTRE, KAKINADA
2014–2015

S. No.	Project	Project Team	Duration	Status
1	Runoff estimation of Tammileru ungauged basin, Andhra Pradesh.	V.S. Jeyakanthan, Scientist 'D' (P.I.) J.V.Tyagi, Scientist 'G' R.Venkata Ramana, Scientist 'C'	April 2013 to March 2015	Completed
2	Statistical downscaling and assessment of climate change impact on hydrology of Mahanadi river basin	P.C.Nayak, Scientist 'D' (P.I.) Y.R.Satyaji Rao, Scientist 'F' B. Venkatesh, Scientist 'F' T. Thomas, Scientist 'D'	April 2013 to March 2015	Extended upto March 2016
3	Analysis of high frequency ground water levels data in the coastal aquifers of Andhra Pradesh	B.Krishna, Scientist 'C' (P.I.) Y.R.Satyaji Rao, Scientist 'F' R.Venkata Ramana, Scientist 'C'	April 2013 to March 2015	Completed
4	Evaluation of urban storm water network in Hyderabad using SWMM	R.Venkata Ramana, Scientist 'C' (P.I.) Y.R.Satyaji Rao, Scientist 'F' S.V.Vijayakumar, Scientist 'F' V.S. Jeyakanthan, Scientist 'D'	April 2013 to March 2016	Ongoing
5	IWRM Studies (2013-2017): Surface water and Ground water Interaction study in the Y- drain of lower Yerrakalva basin	S.V.Vijayakumar, Scientist 'F' (P.I.) Y.R.Satyaji Rao, Scientist 'F' R.Venkata Ramana, Scientist 'C' B. Krishna, Scientist 'C'	April 2014 to March 2015	Completed
6	IWRM Studies (2013-2017) : Assessment of water availability in the upper Yerrakalva basin	Y.R.Satyaji Rao, Scientist 'F' (P.I) S.V.Vijayakumar, Scientist 'F' J.V.Tyagi, Scientist 'G' R.Venkata Ramana, Scientist 'C' B.Krishna, Scientist 'C'	April 2014 to March 2015	Extended upto March 2016
7	Identification of submarine groundwater discharge and sea water intrusion zones in Godavari delta using integrated approach	Y.R.Satyaji Rao, Scientist 'F' (P.I) M.S.Rao, Scientist 'D' R.Venkata Ramana, Sc'C'	August 2014 to March 2017	Ongoing

CFMS, GUWAHATI
2014-2015

Study No.	Title of the study	Study Team	Duration	Status
NIH/CFMS-G/13-15/	Risk Assessment of Heavy Metal Pollution in Surface Soils of Kulsi River Basin (Assam / Meghalaya)	C. K. Jain S. K. Sharma G. Tirkey B. Sharma	07/13-03/15	Ongoing
NIH/CFMS-G/13-15/	Short Term Flood Forecasting Using Bootstrap based Artificial Neural Networks within Kulsi River Basin (Assam / Meghalaya) – I	S. K. Sharma G. Tirkey	07/13-03/15	Ongoing
NIH/CFMS-G/13-15/	Application of the Arc – SWAT model for the prediction of runoff within Kulsi River Basin (Assam/Meghalaya)	G. Tirkey S. K. Sharma	07/13-03/15	Ongoing
NIH/CFMS-G/13-15/	Status Report on Soil Erosion and Sedimentation of River Brahmaputra in North-East Region	G. Tirkey	07/13-03/15	Ongoing

CFMS, PATNA
2014-2015

SN	Title of the Project/Study	Study Group	Duration	Funding	Status
1.	Pilot Basin Studies (PBS) for Mahi River Basin in Ghaghra-Gandak Composite Basin	B Chakravorty, NG Pandey P. Mani	04/12-03/17	NIH	Ongoing
2.	Development of flood forecasting system based on rainfall information obtained from satellite data	Pankaj Mani Rakesh Kumar	3 year (Started in 2013-14)	NIH	Ongoing
3	Trend and Variability Analysis of Rainfall using Mann-Kendall Test and Sen's Slope Estimates for the Districts of Bihar under Climate Change Scenarios.	SR Kumar	1 year (Started in 2013-14)	NIH	Completed
4.	Spatial and Temporal Distribution of Geochemical Characteristics and Environmental Stable Isotopes in Groundwater of North Bengal using GIS and its Assessment with the help of Water Quality Index (WQI) and Existing Classification Systems	SR Kumar, MS Rao and SWID (West Bengal)	2 year (Started in 2012-14)	NIH	completed
5.	Time Series analysis of Monthly Rainfall in Mahi Basin	NG Pandey B Chakravorty Sanjay Kumar	2 year (2014-2016)	NIH	Ongoing

The list of research papers published by the scientists and scientific staff of the Institute during April, 2014 - March, 2015 & April 2015 to May, 2015 is given in **Appendix 68.4.2 (page # 325)**. The list of workshops/training courses/seminar/symposia organized during April, 2014 - March, 2015 & April, 2015 to May, 2015 is given in **Appendix 68.4.3 (page # 341)**. The progress of laboratory work done during April, 2014 - May, 2015 is given in **Appendix 68.4.4 (page # 344)**.

Various activities carried out under Information, Education and Communications (IEC) programme, to create mass awareness among the people regarding water conservation, harvesting, quality of water, etc., is is given in **Appendix 68.4.5 (page # 347)**.

The TAC may please consider the progress and status of the Work Programme of the Divisions and RC/CFMS of NIH for the year 2014-2015.

ITEM NO. 68.5: Report the proceedings of the Working Group meeting

The 41st & 42nd meeting of the Working Group of NIH was held at NIH, Roorkee, during November 26-27, 2014 and March 19-20, 2015, respectively, under the Chairmanship of Director, NIH. The Working Group considered the status of the work programme of the year 2014-15 and also the proposed work programme for the year 2015-16 under two categories: (i) internally funded projects, and (ii) sponsored/consultancy projects.

The approved minutes of the 41st & 42nd meeting of the NIH Working Group are given in **Appendix 68.5.1 & 68.5.2 (page # 349 &376)**.

The TAC may please note the proceedings of the meeting of the Working Group.

ITEM NO. 68.6: Work programme for the year 2015-2016

The proposed Work Programme of the Divisions at the Headquarters and RC/CFMS of the Institute for the year 2015-16 is given in the tables below.

1. Environmental Hydrology Division
2. Ground Water Hydrology Division
3. Hydrological Investigation Division
4. Surface Water Hydrology Division
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6. Research Management & Outreach Division (RMOD)
7. Regional Centre, Belgaum
8. Regional Centre, Jammu
9. Regional Centre, Bhopal
10. Regional Centre, Kakinada
11. Centre for Flood Management Studies, Guwahati
12. Centre for Flood Management Studies, Patna

ENVIRONMENTAL HYDROLOGY DIVISION
WORK PROGRAM FOR 2015-16

S.N.	Code	Study	Study Team	Duration
Internal Studies				
1.	EH/2015/TS-1	Water Quality Modelling using Soft Computing Techniques	Rama Mehta (PI) C. K. Jain	**2 Years (05/14-05/16)**
2.	EH/2015/TS-2	Himalayan River Water Quality Assessment in a Stretch from Gangotri to Hardwar	Rajesh Singh (PI) C. K. Jain M. K. Sharma S. P. Rai Renoj J. Thayyan J. P. Patra	**3 Years (07/14-06/17)**
Sponsored Projects				
1.	EH/2015/SR-1	Ionic Enrichment Dynamics of Glacial Sediment and Melt water of Gangotri Glacier **(DST)**	M. K. Sharma (PI) C. K. Jain Renoj Thayyan Manohar Arora Naresh Saini Jatin Malhotra Rakesh Goyal Karan Jamwal	**3 Years (04/14-03/17)**
2.	EH/2015/SR-2	Low Cost Technology for Purification of Arsenic and Microbes Contaminated Water using Nanotechnology **(DST)**	Vijaya Aggarwala, IITR (PI) Rama Mehta, NIH (Co-PI)	**2 Years (04/14-03/16)**

GROUND WATER HYDROLOGY DIVISION
WORK PROGRAM FOR 2015-16

S. No.	Code	Study	Study Team	Duration & Status
1.	GWH/2015/TS-1	Flow and Contaminant Transport Modeling of Riverbank Filtration	Shashi P. Indwar (PI) N.C. Ghosh Anupma Sharma Rajan Vatsa	3 ½ years (04/12 – 09/15) Status: In progress
2.	GWH/2015/TS-2	Management of Water Resources for Quantity and Quality in Yamuna-Hindon Inter-basin	Anupma Sharma (PI) Deepak Kashyap, CED, IITR (Technical Advisor) N. C. Ghosh M K Sharma R.P. Singh Sumant Kumar Shashi P. Indwar	3 years (12/14 – 11/17) Status: In progress
3.	GWH/2015/TS-3	Development of Website and e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*"	N. C. Ghosh (Coordinator) C. P. Kumar (PI) Anupma Sharma Shashi P. Indwar Sanjay Mittal	2.5 years (04/15 – 9/17) Status: New
4.	GWH/2015/TS-4	Diagnosis Survey and Selection of Suitable Sites for Development of Riverbank Filtration Demonstration Schemes in Different States	Surjeet Singh (PI) N.C. Ghosh C. P. Kumar Sumant Kumar Sanjay Mittal	1 year (04/15 – 3/16) Status: New
5.	GWH/2015/TS-5	Alternate Water Supply Management Strategies in Arsenic Affected/ Vulnerable Areas: Mapping of Arsenic Affected Zones/ Regions in Eastern U.P.	Sumant Kumar (PI) & Shashi P. Indwar (PI) N. C. Ghosh R. P. Singh Rajesh Singh S. L. Srivastava	1 year (04/15 – 3/16) Status: New

HYDROLOGICAL INVESTIGATIONS DIVISION
WORK PROGRAM FOR 2015-2016

S. N.	Code	Study	Team	Duration/ Status
	Ongoing Internal Studies			
1.	HI/2015/TS-1	Isotopic Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains	Sudhir Kumar (PI) C. K. Jain S. P. Rai S. D. Khobragade P. K. Garg CGWB, Lucknow CGWB, Chandigarh	**2 years** (07/13-06/15)
2.	HI/2015/TS-2	Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes	S. K. Verma (PI) S. P. Rai (Co-PI) M. S. Rao C. P. Kumar Mohar Singh	**2 years** (10/13-09/15)
3.	HI/2015/TS-3	Interaction between groundwater and seawater along the northern part of east coast of India	M. S. Rao (PI), Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16)
4.	HI/2015/TS-4	Isotopic investigation of benchmark Himalayan glaciers.	M. S. Rao (PI) S.P. Rai, Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16)
5.	HI/2015/TS-5	Assessment of dissolved radon concentration for groundwater investigations in Haridwar district	Pankaj Garg (PI) Sudhir Kumar, M. Someshwar Rao	**1 year** (01/15 – 12/15)
	New Internal Studies			
6.	HI/2015/TS-6	Status Report on Rewalsar Lake, Himachal Pradesh	SD Khobragade (PI) Sudhir Kumar, C. K. Jain	**1 year** (04/15 – 03/16)
7.	HI/2015/TS-7	Lake-Groundwater Interaction Studies for Sukhna Lake, Chandigarh	SD Khobragade (PI) Sudhir Kumar, Senthil Kumar, Pankaj Garg	**3 year** (04/15 – 03/18)
	Sponsored Projects			
8.	HI/2015/SR-1	The Structure and Dynamics of Groundwater Systems in Northwestern India under Past, Present and Future Climates **(MoES)**	S. P. Rai (PI) M. S. Rao Surjeet Singh S. K. Verma C. P. Kumar Sudhir Kumar V. K. Agarwal Rajeev Gupta S. L. Srivastava Vishal Gupta Mohar Singh	**3 years** (06/12-03/16) **Continuing Study**

S. N.	Code	Study	Team	Duration/ Status
9.	HI/2015/SR-2	The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India **(IAEA)**	M. S. Rao (PI) C. P. Kumar S. P. Rai	**3 years** (09/12-08/15) **Continuing Study**
10.	HI/2015/SR-3	Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques **(IAEA)**	S. P. Rai (PI) R. V. Kale M. S. Rao C. P. Kumar Sudhir Kumar V. K. Agarwal Vishal Gupta Mohar Singh	**3 years** (10/12-09/15) **Continuing Study**
11.	HI/2015/SR-4	Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains **(IAEA)**	Sudhir Kumar (PI) S. P. Rai S. D. Khobragade C. K. Jain P. K. Garg	**2 years** (05/13-04/15) **Continuing Study**
12	HI/2015/SR-5	Understanding of hydrological processes in Upper Ganga basin by using isotopic techniques **(DST)**	Dr. S. P. Rai (PI) Dr. Sudhir Kumar Rajesh Singh S. D. Khobragade Dr. M. Arora Dr. R. J. Thayyen Sh. P. K. Garg	**5 years** **(4/15 – 3/20)** **New Study**

SURFACE WATER HYDROLOGY DIVISION
WORK PROGRAM FOR 2015-16

S.N.	Code	Study	Study Team	Duration
	Ongoing Internal Studies			
1.	SWH/2015/TS-1	Application of DSS (P) for Integrated Water Resources Development & Management	A.K. Lohani Surjeet Singh Rahul Jaiswal D K Sonkusale Akilesh Verma	2 years (April 2013 to Sept. 2015)
2.	SWH/2015/TS-2	Estimation of Water Balance for Integrated Water Resources Management in Yerrakalva Pilot Basin, A.P.	J.V.Tyagi YRS Rao,	1 year (April 2014 to Sept. 2015)
3.	SWH/2015/TS-3	Study of Rainfall Patterns and Comparison of Rainfall Data from different Sources for Uttarakhand State	Archana Sarkar Vaibhav Garg, IIRS Rakesh Kumar N.K. Bhatnagar	2 years (April 2014 to Sept. 2017)
4.	SWH/2015/TS-4	Quantitative assessment of uncertainties in river discharge estimation	Sanjay Kumar Sharad Jain	3 Years (April 2013 to March 2016)
5.	SWH/2015/TS-5	Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills.	Avinash Agarwal Manohar Arora RK Nema	3 Years (Nov 2013 to Oct 2016)
6.	SWH/2015/TS-6	Effect of climate change on evaporation at point scale	Digambar Singh A. R. Senthil kumar Manohar Arora	3years (June 2014 to March 2017)
7.	SWH/2015/TS-7	Hydrological modelling, water availability analysis	J.P.Patra Rakesh Kumar Pankaj Mani	3years (April 2014 to March 2017)
	Ongoing Sponsored Projects			
1.	SWH/2015/SR-1	Modeling of Gangotri Glacier melt runoff and simulation of stream flow variation under different climate scenarios	Manohar Arora Rakesh Kumar	3years (May 2014 to March 2017)
	New Internal Studies			
1.	SWH/2015/TS-8	Flood and Sediment studies in Himalayan basin using MIKE-11 Model	A.K. Lohani	3 years (April 2015 to March 2018)
2.	SWH/2015/TS-9	Snowmelt Runoff Modelling and Study of the Impact of Climate Change in Sharda River Basin	Archana Sarkar T. Thomas Vaibhav Garg	3 years (April 2015 to March 2018)
3.	SWH/2015/TS-10	Study on effect of climate change on sediment yield to Pong reservoir	A. R. Senthil Kumar J. V. Tyagi Avinash Agarwal Suhas Khobragade Manohar Arora	3 years (April 2015 to March 2018)
4.	SWH/2015/TS-11	Study of regional drought characteristics and long term changes in supplemental irrigation water requirement in Seonath Basin in Chhattisgarh	R.P. Pandey Rakesh Kumar	2 years (April 2015 to March 2017)

WATER RESOURCES SYSTEMS DIVISION
WORK PROGRAM FOR 2015-2016

SN	Code	Study	Study Team	Duration
	Ongoing Internal Studies			
1.	WRS/2015/TS-1	NIH_Basin – A WINDOWS based model for water resources assessment in a river basin	M. K. Goel Deepa Chalisgaonkar Sharad K. Jain Prabhash K. Mishra	3 Years (04/13-03/16)
2.	WRS/2015/TS-2	Assessing climate change impact across KBK region of Odisha	P. K. Mishra Sharad K. Jain Sanjay K. Jain	3 Years (04/13-03/16)
3.	WRS/2015/TS-3	Glacier change and glacier runoff variation in the upper Satluj river basin	Sanjay K. Jain Sharad K. Jain Renoj J. Thayyen	2.5 Years (10/13-03/16)
4.	WRS/2015/TS-4	Variability of the Hydro-climatic variables in Punjab Plains of Lower Satluj	M. K. Nema Sharad K. Jain	2 Years (11/13-10/15)
5.	WRS/2015/TS-5	Catchment scale evaluation of cold-arid cryospheric system Hydrology, Ganglass catchment, Ladakh	Renoj J. Thayyen S. P. Rai Sanjay K Jain Sudhir Kumar	3 years (04/14-03/17)
6.	WRS/2015/TS-6	Hydrologic Modelling of a part of Satluj Basin using SWAT Model	P. K. Agarwal Sharad K. Jain M. K. Goel Sanjay K. Jain M. K. Nema Tanvear Ahmed	2 -3/4 Years (06/14-3/17)
7.	WRS/2015/TS-7	Decision Support System for Water Resources Planning in Upper Bhima basin, Maharashtra	D. S. Rathore M. K. Goel, R.P. Pandey Sanjay Kumar Surjeet Singh	2 years (07/14-06/16)
8.	WRS/2015/TS-8	Modeling of Narmada basin by using the GWAVA model	Sanjay K. Jain Sharad K. Jain T. Thomas (RC-Bhopal) P. K. Mishra P. K. Agarwal M. K. Nema	2.25 years Dec. 2014 – Mar 2017
9.	WRS/2015/TS-9	Runoff modeling of Shyok River, Karakorum Range	Renoj J.Thayyen Sanjay K.Jain	3 years Dec-2014 to Nov-2017
10.	WRS/2015/TS-10	Hydrological process and characterization of Lesser Himalayan Catchments	M. K. Nema Sharad K. Jain Sanjay K. Jain Renoj J.Thayyen P. K. Mishra P. K. Agarwal	5 Years 12/14-12/19
	Ongoing Sponsored Studies			
1.	WRS/2015/SR-1	Glaciological studies of Phuche Glacier, Ladakh Range, India (DST)	Renoj J. Thayyen M K Goel S P Rai	5 Years 1/10-06/15

2.	WRS/2015/SR-2	Assessment of Environmental flow for Himalayan River (MOES)	Sharad K. Jain Pradeep Kumar P. K. Agarwal P. K. Mishra	1 Year 07/14-07/15
	New Internal Studies			
1.	WRS/2015/TS-11	Development of Ganga Information Portal	Deepa Chalisgaonkar Sharad K. Jain D. S. Rathore Sanjay K. Jain Sudhir Kumar P. K. Mishra P. K. Agarwal M. K. Nema Furquan Ullah	3 years (04/15-03/18)
2.	WRS/2015/TS-12	Study of Hydrological Changes in selected watersheds in view of Climate Change in India	L. N. Thakural D. S. Rathore Surjeet Singh Tanvear Ahmed Sanjay K. Jain Sharad K. Jain	3 years (04/15-03/18)

RESEARCH MANAGEMENT AND OUTREACH DIVISION
WORK PROGRAM FOR 2015-2016

SN	Code	Title of Project/Study, Study Team	Duration
	Ongoing Internal Study		
1.	RMO/2015/TS-1	Participatory development of structure for IWRM Framework in identified sub-basins under Pilot Basin Studies (PBS) program **Team:** V C Goyal (PI), Omkar Singh and R V Kale	DOS: July 2014 DOC: June 2015
2.	RMO/2015/TS-2	Water Conservation and Management in Ibrahimpur Masahi Village of Hardwar District (Uttarakhand) **Team:** Omkar Singh, V.C. Goyal, C.K. Jain, and Rajesh Singh	DOS: Apr 2013 DOC: March 2016
	New Internal Study		
3.	RMO/2015/TS-3	WEAP Model set up for four sub-basins under Pilot Basin Studies (PBS) Programme, jointly with the RCs/CFMSs **NIH HQs:** V C Goyal (PBS Leader), Jyoti Patil and R V Kale **Co-investigators from NIH RCs/CFMSs:** Chandramohan T (RC-Belgaum), Y R S Rao (RC-Kakinada), T R Nayak (RC-Bhopal), B Chakravorty (CFMS-Patna)	DOS: Apr 2015 DOC: Mar 2017
	Sponsored Project		
1.	RMO/2015/SR-1	Customization of WEAP model for application in Ur river watershed in Tikamgarh district of Bundelkhand region. **(Under TIFAC Project)** **Team:** R V Kale (PI), T Thomas- RC Bhopal, Jyoti Patil, Rajesh Agarwal	DOS: Apr 2014 DOC: Sep 2015 (**Ongoing study)**

Proposed Technical Transfer & Outreach Activities during 2015-2016

S N	Code	Activity
1	RMO/2015/OR-1	Outreach activities (IITF-2015, IWW, other exhibitions)
2	RMO/2015/TW-1	5-day Workshop on “Citizen science in hydrology and water resources”
3	RMO/2015/TW-2	Orientation training of newly appointed scientists
4	RMO/2015/OR-2	Science-Policy interface, IPR issues, and technical meetings
5	RMO/2015/OR-3	Establishment of “Water Activity Centre”
6	RMO/2015/LCU	Operational expenses of LCU-Delhi

REGIONAL CENTRE, BELGAUM

Proposed Work Program for the Year 2015-2016

No.	Title of the Study	Study Group	Duration	Funding	Status
1	Waterlogging and Salinity Studies in NagarjunaSagar Right Bank Canal Command	NV, BKP	2 years (Aug 2012 - Jul 2014) **Report will be submitted by 30th Sept 2015**	Internal	Continued
1	Integrated Water Resources Management (IWRM) on a Pilot Basin – Zuari River Basin, Goa	CMT, BKP, VCG	3 years (Apr 2013 - Mar 2016)	Internal (PBS)	Continued
2	Comparative Analysis of Various Rainfall-Runoff Models for Rivers of Western Ghats	BV, CK & MKJ	3 years (Apr 2013 - Mar 2016)	Internal	Continued
3	Studies on Spring flows and estimation of Groundwater Recharge in Ghataprabha Sub-basin	BKP, NV, SK, RV	2 years (Apr 2013 - Mar 2015) **Extended for one year upto March 2016**	Internal	Continued
4	Application of Geostatistical methods for analyzing sedimentation pattern in river basins of Kerala State	MKJ, and CM	2 years (Sep 2014 – Mar 2016)	Internal	Continued
5	Modeling of sediment yield from river basins of Kerala and Goa, using SWAT model	CMT & BV	2 years (Sep 2014 – Mar 2016)	Internal	Continued
6	Runoff estimation in a catchment using GIS and WEB based tools: A case study	MKJ and BV	1 year (Sep 2014- Aug 2015)	Internal	Continued
7	Impact of Land use/Land cover Changes on Ground water – A Case Study	BKP, BV, SKJ and NV	2 years (Sep 2014 – Mar 2016)	Submitted to MoES for Funding	Continued
8	Impact of Urbanization on Surface and Ground water Quality and Quantity – A Case Study	BKP, SK and NV	2 years (Sep 2014 – Mar 2016)	Internal	Continued

SKJ : Sharad K. Jain
VCG : V. C. Goyal, Scientist F
BKP : Purandara, Scientist E
MKJ : Mathew K. Jose, Scientist D
NV : N. Varadarajan, SRA
SK : Sudhir Kumar, Scientist G
BV : B. Venkatesh, Scientist F
CMT : Chandramohan T., Scientist D
RV : Rajan Vats Scientist B
CK : ChandraKumar S., SRA

REGIONAL CENTRE, JAMMU
Proposed Work Program for the Year 2015-2016

S. No.	Title of the Study	Study Team	Duration	Funding
Ongoing Projects				
1	Impact of land use changes on environmental flows of Tawi river at Jammu	P. Kumar M. K. Nema	03 years (11/2011-10/2014) under extension upto 12/2015	NIH
2	Climate change effects on hydrology of the Tawi basin in Western Himalaya	M. K. Nema P. Kumar R. J. Thayyen	03 years (11/2011-10/2014) Under extension upto 12/2015	NIH
3	PBS: Integrated Water Resources Management (IWRM) Study in Tawi River Basin, JK	P. Kumar S. S. Rawat	05 years (4/2012-3/2017)	NIH
New Projects				
4	Estimation of sediment yield and identification of areas vulnerable to soil erosion and deposition in a western Himalayan catchment	S. S. Rawat P. Kumar	01 year 11 months (5/2015-3/2017)	NIH
5	Hydrological Investigation of Natural Water Springs of Baan Ganga watershed in Jammu & Kashmir State	S. S. Rawat P. Kumar	02 years 11 months (5/2015-3/2018)	NIH
6	Cryospheric processes in an alpine regime; a case study of Thajwas catchment, Sind sub-basin, Kashmir Valley, India	P. G. Jose R.J. Tahyyen S.P. Rai	02 years 11 months (5/2015-3/2018)	NIH
7	Hydrological Assessment of the floods in the Jhelum river during Sep 2015	P. Kumar S. S. Rawat	02 years 11 months (5/2015-3/2018)	NIH

REGIONAL CENTRE, BHOPAL
Proposed Work Program for the Year 2015-2016

Sl. no	Name of the project	Duration	Starting and ending date	Status
1.	Surface and ground water modeling for conju-ncttive use (under Pilot Basin Studies in Bina River Basin in Bundelkhand Region in M.P.)	1¾ years	April 2014 to Dec. 2015	Ongoing Project
2.	Development of DSS for Bina River Basin in Bundelkand Region in M.P. using WEAP Model (under PBS)	2 years	April 2015 to March 2017	New Project
3.	Development of Decision Support System (DSS) Model for Shipra River Basin of MP	3 years	June 2013 to May 2016	Ongoing Project
4.	Integrating hydrology, climate change and IWRM with livelihood issues: Development of methodology and a DSS for water-scarce Bundelkhand region in India	2½ years	May 2013 to Oct. 2015	Ongoing R&D Project
5.	Integrated Drought Vulnerability Assessment for Water Resources Management of the Bina Basin	2 Years	July 2014 to June 2016	New Project
6.	Irrigation Planning and Management for the Command of Harsi Reservoir in Madhya Pradesh	2 ½ years	May 2013 to Oct. 2015	Ongoing Project
7.	Estimation of Revised Capacities of Reservoirs in Chhattisgarh state using Digital Image Processing technique	2 Years	April 2015 to March 2017	New Project

REGIONAL CENTRE, KAKINADA

Approved Work Programme for the Year 2015 – 2016

S. No.	Project	Project Team	Duration	Status/Funding
1	Evaluation of urban storm water network in Hyderabad using SWMM	R.Venkata Ramana, Scientist 'C' (P.I.) Y.R.Satyaji Rao, Scientist 'F' S.V.Vijayakumar, Scientist 'F' V.S. Jeyakanthan, Scientist 'D'	April 2013 to March 2016	Ongoing/ Internal
2	Statistical downscaling and assessment of climate change impact on hydrology of Mahanadi river basin	P.C.Nayak, Scientist 'D' (P.I.) Y.R.Satyaji Rao, Scientist 'F' B. Venkatesh, Scientist 'F' T. Thomas, Scientist 'D'	April 2013 to March 2016	Ongoing/ Internal.
3	IWRM Studies (2013-2017): Assessment of water availability in the upper Yerrakalva Basin	Y.R.Satyaji Rao, Scientist 'F' (P.I) S.V.Vijayakumar, Scientist 'F' J.V.Tyagi, Scientist 'G' R.Venkata Ramana, Scientist 'C' B. Krishna, Scientist 'C'	April 2014 to March 2016	Ongoing/ Internal.
4	Identification of submarine groundwater discharge and sea water intrusion zones in Godavari Delta using integrated approach	Y.R.Satyaji Rao, Scientist 'F' (P.I) M.S.Rao, Scientist 'D' R.Venkata Ramana, Scientist 'C'	August 2014 to March 2017	Ongoing /Internal
5	Identification of Ground Water Recharge zones in Vaippar Basin, Tamilnadu using Remote Sensing and GIS techniques	V.S. Jeyakanthan, Scientist 'D'(P.I) J.V. Tyagi, Scientist 'G' R Venkata Ramana, Scientist 'C'	April, 2015 to March, 2017	New /Internal
6	IWRM Studies (2013-2017): Development of hydrological management practice plans for IWRM in the Lower Yerrakalva Basin	S.V.Vijaya Kumar, Scientist 'F' (P.I) Y.R.Satyaji Rao, Scientist 'F' V.S.Jeyakanthan, Scientist 'D'	April, 2015 to March, 2017	New /Internal
7	Development of groundwater level forecasting model using high frequency groundwater level data in the Srikakulam District of Andhra Pradesh	B. Krishna, Scientist 'C' (P.I) Y.R.Satyaji Rao, Scientist 'F' R Venkata Ramana, Scientist 'C'	April, 2015 to March, 2016	New /Internal

CFMS, GUWAHATI
Proposed Work Programme for the Year 2015 – 2016

Study No.	Title of the study	Study Team	Duration
NIH/CFMS-G/15-17/	Estimation of Runoff for Kulsi River Basin using SCS Curve Number and Geographic Information System (GIS)	S. K. Sharma G. Tirkey	07/15-03/16 (New Study)
NIH/CFMS-G/15-17/	Application of USLE model for estimation of soil loss in Kulsi River Basin using remote sensing and geographic information system	G. Tirkey S. K. Sharma	07/15 - 03/16 (New Study)

CFMS, PATNA
WORK PROGRAMME THE YEAR 2015-2016

Sl	Title of the study	Study Team	Duration
1.	Pilot Basin Studies (PBS) for Mahi River Basin in Ghaghra-Gandak Composite Basin	B Chakravorty NG Pandey Pankaj Mani	04/12-03/17 (XII Plan Year)
2.	Development of flood forecasting system based on rainfall information obtained from satellite data	Pankaj Mani Rakesh Kumar	3 year (Started in 2013-14) (4/2013-3/2014)
3.	Time Series analysis of Monthly Rainfall in Mahi Basin	NG Pandey B Chakravorty Sanjay Kumar	2 year (2014-2016) (4/2014-3/2016)
4.	Demonstration scheme on Riverbank Filtration in Gagatic plain of Bihar	B Chakravorty NG Pandey	2 year (2015-17) (4/2015-3/2017)
5.	Spatial and Temporal Distribution of Geochemical Characteristics and Environmental Stable Isotopes in Groundwater of North Bengal	SR Kumar, MS Rao and SWID	1 year (2015-16) (4/2015-3/2016)

ITEM NO. 68.7: Reporting Items

List of Recently completed/ On-going Consultancy Projects

SN	Title of Project	Consultancy No.	Sponsoring Agency	Total Cost (in Rs)	Date of start	Duration	Status
1	Hydr-geological study for 4000MW Vadarevu Thermal Power Plant near Kanuparthi Village, Naguluppalapadu Mandal, Prakasam Dist., A.P.	CS-15/2011-12/NIH (DRC-Kakinada)	APGENCO Ltd., Hyderabad	18,57,452	Aug 2011	Six months	Ongoing
2	Hydrological Study for Rural Drinking Water Supply Options in part of Bundelkhand Region of, U.P	CS- 17/2012- 12/ NIH (SWHD)	SWSM, DODW Govt. of U.P	26,28,449	May 2012	Eight Months	Ongoing
3	Area Drainage Study for Plant and Ash Dyke for Gajmara Super Thermal Power Project (4 x 800 MW) Sponsored by NTPC Ltd, New Delhi.	CS-21/2012-12/NIH/ (SWHD)	NTPC, Ltd. NOIDA	12,93,000	Aug 2011	3year 6 months	Completed
4	Site Specific Area Drainage study for plant and Ash Dyke for Khargone Super Thermal Power Project (2x660 MW)	CS-23/2011-11/NIH (SWHD)	NTPC, Ltd. NOIDA	12,93,000	Aug 2011	Five Months	Completed
5	Environmental flow Assessment For HEO 240 MW, Arunachal Pardesh	CS-28/2012-2012/NIH (SWHD)	VELCAN Energy, New Delhi	4,43,825/-	Sept 2012	Two Months	Completed
6	Dam Break Analysis and Preparation of Emergency action Plan for Nagarjuna Sagar dam	CS-30/2012-12/NIH/ (SWHD)	Irrigation and CAD Dept., Govt. of Andhara Pradesh	10,60,000/-	Jan 2012	Twelve Months	Ongoing
7	Dam Break Analysis for Indira Sagar Polavaram Project	CS-31/2012-12/NIH (SWHD)	Irrigation and CAD Dept., Govt. of Andhara Pradesh	14,51,310	Dec 2012	Six Months	Ongoing
8	Hydro-Geological studies for the proposed Kothagudem Thermal Power Station Stage VII (1x800 MW), Polancha, Distt.	CS-33/2012-13/NIH (Kakinada)	APGENCO, Hyderabad	23,93,268	Jan 2013	Six months	Ongoing

	Khammam, (Andhra Pradesh)						
9	Hydro-Geological studies for the proposed Dr. Narla Tata Rao Thermal Power Station Stage V (1x800 MW), Ibrahimpatnam, Distt. Krishna, (Andhra Pradesh)	CS-34/2012-13/NIH (Kakinada)	APGENCO, Hyderabad	23,93,268	Jan 2013	Six months	Ongoing
10	Cumulative Impact Assessment of Alaknanda and Bhagirathi Including Tributaries	CS-35/2012-13/NIH (WRSD)	Uttarakhand Jalvidhyut Nigam, Dehradun	60,62,103	Feb 2013	Twelve months	Ongoing
11	Hydro-geological study for 800 MW expansion unit under stage II for Sri Damadram Sanjeevaiah Thermal Power Station Nelatur, village, Muthukar Mandal, Distt. Nellore (AP)	CS-36-2013-2013-NIH (Kakinada)	APPDCL, Hyderabad	28,37,090	Mar 2013	Six months	Ongoing
12	Cumulative Environmental Impact Assessment (CEIA) study of Yamuna River Basin with special reference to HEPs	CS-38/2013-14/NIH(WRS)	Uttarakhand Jalvidhyut Nigam, Dehradun	15,68,827	Ap 2013	Ten months	Ongoing
13	Integrated Hydrological Investigations of Sukhna Lake for its conservation and Management	CS-39/2011-13/NIH(HID)	Deptt of forest & wildlife, Chandigarh Administration, Chandigarh	22,00,485	July 2011	Two years	Ongoing
14	Pre-Dredging and Post-Dredging Bathymetric Surveys of Ramgarh Taal, Gorakhpur (UP)	Cs40-2012-13/NIH(HID)	AHEC, IIT Roorkee	9,40,000 + 12.36% service Tax	Nov 2012	Two spells of six months	Ongoing
15	Area Drainage Studies for Power Projects of NTPC-SAIL Power Company Pvt Ltd at Jagdishpur SAIL unit in Distt Sultanpur (UP)	CS42-2013-2013/NIH(SWHD)	NSPCL Delhi	11,75,342	Jan 2013	Five months	Completed
16	Estimation of Design basis flood and safe grade elevation for Mahi-Banswara Power Project	CS43-2012-2014/NIH(SWHD)	NPCILMumbai	59,44,293	Dec 2012	Eighteen months	Ongoing
17	Dam Break Analysis for Sharavathi and	CS-44/2013-14/NIH/(HR	KPCL	21,41,300	May 2013	Nine months	Ongoing

	Varhi Basin Dams	RC, Belgaum)					
18	Hydrological Studies for dewatering of Jamarkotra Mines, Udaipur, Rajasthan	CS-45/2013-16/NIH(HID)	Rajasthan state Mines & Minerals Ltd. Udaipur	22,55,680	July 2013	Three Years	Ongoing
19	Study of Hydrological & Hydro-geological aspect of Korba power project in Chhatisgarh (MP) to assess water source sustainability	CS-48/2013-13/NIH(GWHD)	Korba power corporation ltd. Gurgaon	24,71,920	Sept 2013	Three months	Ongoing
20	Study of Hydrological & Hydro-geological aspect of Jhabua power project in Chhatisgarh (MP) to assess water source sustainability	CS-49/2013-13/NIH(GWHD)	Jhabua power corporation ltd. Gurgaon	24,71,920	Sept 2013	Three months	Ongoing
21	Drainage Analysis and Design for Proposed Kakinada SEZ (KSEZ) Area in AP	CS-50/2013-14/NIH(DRC, Kakinada)	Kakinada SEZ, GMR Group, Hyderabad	21,40,458	Sept 2013	Six months	Ongoing
22	Hydrological study of limestone mining area for integrated green field cement project near Mundwa, in Nagpur district of Rajasthan	CS-51/2013-15/NIH(SWHD)	Ambuja Cements Ltd	28,09,000	Oct 2013	Six months	Completed
23	Estimation of Sediment rate at proposed Jalleru Reservoir, Andhra Pradesh	CS- 53/2013-14 NIH/ RC/Kakinada	Gayatri Projects Limited Hyderabad	21,77,000	Jan 2014	Six months	Ongoing
24	Hydrological Area Drainage Studies & design of drainage system for GHAVP-1 to 4	CS54-2013-2015/NIH(SWHD)	NPCIL Mumbai	34,98,890	Jan 2014	Two years	Completed
25	Identification of Source and location of Seepage/Leekage from Kaushalya Dam Haryana	CS-55/2013-14/NIH(HID)	Irrigation Department, Govt of Haryana	20,22,480	Apr 2013	six months	Completed
26	Impact Assessment of Ash Pond on the Groundwater Quality un the surrounding villages of NTPC Simhadri through stable isotopic studies	CS-56/2013-15/NIH(HID)	NEERI Nagpur	10,11,240	Jan 2014	Two Years	Ongoing

27	Estimation of Design Basis Flood and safe grade elevation for nuclear power project site at Narora	CS57-2013-2015/NIH(SWHD)	NPCIL Mumbai	67,22,386	Mar 2014	Two years	Ongoing
28	Environmental flow study of Nakthan HEP (520 MW) Project in Himachal Pradesh	CS-58/2014-2014/NIH (SWHD)	HPPCL. Bhunter, Himachal Pradesh	10,39,330	Apr 2014	Six Months	Ongoing
29	Yield Study of Yettinahole Project Kakinad	CS-59/2014-2014/NIH (SWHD)	Karnataka Neervari Nigam	5,62,8560	May 2014	Two Months	Ongoing
30	Hydraulic Modelling for Brahmaputra Riverfront Development ProjectFor Guwahati	CS-60/2013-2015/NIH (SWHD)	Guwahati Metropolitan Dev Authority	83,42,730	May 2014	Two years	Ongoing
31	Isotopic Characterization of Groundwater of Distt Raigarh	CS-61/2014-15/NIH(HID)	Chhatisgarhcouncil for Science & Technology Raipur	4,94,384	July 2014	6 months	Ongoing
32	Hydrogeological study for Ash Pond of 2x525 MW Maithon Power Ltd and an abandoned coal mine, Distt Dhanbad, Jharkhand	CS-62/2014-15/NIH(HID)	Maithon Power Ltd	16,15,175	July 2014	One & half months	Ongoing
33	Design Flood Estimate for Pagal Nallah, leh	CS-63/2014-15/NIH (WRSD)	DGBR Leh	5,39,328	Aug 2014	Six months	Ongoing
34	Desk Study of Dam Break Analysis for Kudgi STPP, Stage-I	CS-64/2014-15/NIH (SWHD)	NTPC Noida	20,14,053	Sept 2014	Three months	Ongoing
35	Water Safety Impact Assessment through Sanitary Improvement of India Mark 2 Hand Pumps in Moradabad, UP	CS-65/2014-15/NIH (EHD)	UNICEF, UP	12,02,000	Sept 2014	Sixmonths	Ongoing
36	Environmental flow study of Surgani-Sundla HEP in Distt Chamba (HP)	CS-66/2014-15/NIH (EHD)	HPPCL, Hamirpur	8,00,003	Sep 2014	Six months	Ongoing
37	Possible Impact of Construction Actiivties in Kansal Area (Mohali) on Water Flow to Sukhna Lake in Chandigarh	CS-67-2014-15/NIH(HID)	Tata Housing Development Company, New Delhi	3,25,000	Nov 2014	Two months	Ongoing
38	Water Availability Studies for Chulka Lake	CS-68-2014-2016/NIH(SWHD)	NPCIL Mumbai	40,05,072	Nov 2014	Two years	Ongoing

39	Area Drainage Study including hydrological designof site area drainage for chutka lake	CS-69-2014-2016/NIH(SWHD)	NPCIL Mumbai	40,05,072	Nov 2014	Two years	Ongoing
40	EFR of Shongtong Karchhum	CS-70/2014-15/NIH(SWHD)	HPPCL Kinnau	4,19,140	Dec 2014	Two months	Ongoing
41	Ganga Aquifer Management for Ecosystems Services (GAMES)	*CS-71/2014-15/NIH (WRSD)*	IWMI Srilanka	16,91,000	June 2014	One year	Ongoing
42	Project wise water availability and integrated operation analysis of major projects in Krishna Basin	*CS-72/2015-15/NIH(WRSD)*	Irrigation & CAD Department, Govt of Andhra Pradesh	95,67,454.00	Feb 2015	10 months	Ongoing
43	GIS Map for the entire catchment of Sapta Kosi High dam Multipurose Project and Sun Kosi Storage-cum-diversion Schem, Nepal	*CS-73/ 2015-15/NIH(WRSD)*	Project Manager, JPO-SKSKO, Nepal	5,26,000.00	March 2015	3 months	Ongoing

68.8 Any other item with permission of the Chair

APPENDICES

APPENDIX-68.1.1

REVISED COMPOSITION OF TECHNICAL ADVISORY COMMITTEE (with effect from May 2015)

1.	Chairman, Central Water Commission Sewa Bhawan, R.K. Puram New Delhi-110066	Chairman
2.	Member (D&R), Central Water Commission Sewa Bhawan, R.K. Puram NEW DELHI-110066	Member
3.	Chief Engineer (HSO), Central Water Commission Sewa Bhawan, R.K. Puram NEW DELHI-110066	Member
4.	Director National Institute of Hydrology Roorkee-247667	Member
5.	Chairman, Central Ground Water Board Jam Nagar House, New Delhi	Member
6.	DDGM (Hydromet), India Meteorological Department Mausam Bhawan, Lodhi Road, New Delhi-110001	Member
7.	Dr. N K Goel Professor, Deptt. Of Hydrology IIT, Roorkee	Member
8.	Prof. K P Sudheer Department of Civil Engineering IIT Madras IIT P.O. Chennai – 600 036	Member
9.	Prof. K V Jayakumar Department of Civil Engineering National Institute of Technology Warangal – 506 004 (A.P.)	Member
10.	Director Water Technology Centre IARI, Delhi	Member
11.	Dr. N G Srivastava, AGM Pollution Control Research Institute BHEL, Haridwar, Uttarakhand	Member
12.	Prof. Rohit Goyal Department of Civil Engineering MNIT, Jaipur-302017	Member
13.	Office of the Superintending Engineer State Water Data Center Nr WALMI Campus Sector-8, Gandhinagar Gujarat-382008	Member
14.	Dr. Himanshu Kulkarni Advanced Centre for Water Resources Developement and Management (ACWDAM) Plot 4 Lenyadri society, Sus Road Pashan, Pune-411021	Member
15.	Commissioner (PP), Ministry of Water Resources Shram Shakti Bhawan, Rafi Marg, New Delhi-110001	Member
16.	Dr V C Goyal, Scientist F National Institute of Hydrology, Roorkee	Member-Secretary

APPENDIX – 68.2.1

MINUTES OF THE 67th MEETING OF TAC OF NIH

MINUTES OF 67th MEETING OF
TECHNICAL ADVISORY COMMITTEE OF
NATIONAL INSTITUTE OF HYDROLOGY
HELD ON JULY 15, 2014 AT NEW DELHI

The 67th meeting of the Technical Advisory Committee (TAC) of the National Institute of Hydrology, Roorkee was held in the Central Water Commission, New Delhi on July 15, 2014. The meeting was chaired by Sh. A.B. Pandya, Chairman, CWC. The list of the participants is given in Appendix -I.

Chairman in his opening remarks welcomed the members and the invitees. He appreciated the works being carried out by NIH, and urged that the Institute should gear up to handle new challenges, such as impact of climate change on water resources. He then requested the Member-Secretary to take up the agenda.

Dr V C Goyal, Member-Secretary, also welcomed the Chairman, members and invitees. He then took up the agenda items.

ITEM NO. 67.2: Confirmation of the Minutes of 66th Meeting of TAC

The Member-Secretary informed that the minutes of the 66th meeting of the TAC, held on July 29, 2013 at New Delhi, was circulated vide letter no. NIH/RCMU/TAC/34/11 dated July 31, 2013. Since no comments were received from the members, the Minutes were confirmed by the TAC.

ITEM NO. 67.3: Action Taken on the Decisions/Recommendations in the Previous Meeting

The Member-Secretary informed that the change of name of the RC-Bhopal is being processed with the GB of NIH. On the issue of initiating few self-supporting short-term courses, he informed that the modalities of initiating such courses are being worked out.

ITEM NO. 67.4: Status of the Work Programme for the Year 2013-2014

The Member-Secretary briefed about the studies carried out by the Institute during the year 2013-2014. He informed that 192 research papers have been published by the Institute and 9 research papers have been accepted for publication during April 2013-March 2014 & April-June 2014. He further informed that 38 training courses/workshops/symposia were organized during this period. Members appreciated the number of publications brought out by the Institute and number of training/workshop/symposium organized by the Institute.

Prof Patra suggested that the study group for studies of applied nature may include officers from academic and field organizations of the concerned region. The Chairman opined that the local line departments and stakeholders should be invited in the Working Group meetings when the completed internal studies are being presented.

With reference to the study entitled "*Assessment of Environmental flow for Himalayan river*", Mr N N Rai suggested that the methodology for assessment of environmental flow in rivers should be standardized, and offered to provide the methodology adopted by CWC for such studies for various basins in north-eastern region. The Chairman suggested that if available in public domain, the approach adopted by CWC in the Kishanganga project should also be looked into. He stressed that the required field data in the habitat modeling studies should be used from the authorized field organizations such as Zoological Survey of India, Botanical Survey of India, CIFRI, etc. CE (HSO) advised to be careful in such assessment for the rivers in the Indus basin as there are international implications.

The following studies completed during 2013-2014 were presented during the meeting:

1. Coastal Groundwater Dynamics and Management in the Saurashtra Region, Gujarat (Dr. Anupma Sharma, Sc. D, NIH).
2. National Program on Isotope Fingerprinting of Waters of India (IWIN) (Dr. M. S. Rao, Sc. D, NIH).
3. Cryospheric system studies and runoff modeling of Ganglass catchment, Leh, ladakh Range (Dr. Renoj J. Thayyan, Sc. D, NIH).
4. Monitoring and Modelling of the Streamflow for the Gangotri Glacier (Dr. Manohar Arora, Sc. D, NIH).
5. Development of Low Cost Media for Fluoride Removal from Drinking Water of Fluoride Affected Areas (Dr. Rajesh Singh, Sc. B, NIH).

During presentation of the study “Coastal Groundwater Dynamics and Management in the Saurashtra Region, Gujarat”, Dr Gurunadha Rao enquired about the submarine discharge and presence of limestone cavities in the region. He suggested illustrating the 3D conceptualization in vertical 2D cross-section as well. Dr Pandian enquired on the quantification of change in cropping pattern and the economic returns as a result of project interventions. The Chairman enquired about the bunds and tidal regulators in the study area and the possibility of artificial recharge of deep aquifers, which was replied by Dr Anupma Sharma.

During presentation on the completed study entitled *“Cryospheric system studies and runoff modeling of Ganglass catchment, Leh, Ladakh Range”*, the Chairman remarked that the melting of permafrost might trigger increased movement of sediments in rivers and enhance the vulnerability of landslides in the area. He suggested that permafrost studies are in preliminary stages in our country and need greater focus in future.

ITEM NO. 67.5: Report the Proceedings of the Working Group Meetings

The Member-Secretary briefed about the 39th and 40th meetings of the Working Group of NIH, which were held at NIH, Roorkee, during October 21-22, 2013 and June 4-5, 2014, respectively. During these meetings, the Working Group members reviewed the progress of studies for the year 2013-2014 and also discussed the proposed work programme for the year 2014-2015. He presented the major recommendations of the working group.

TAC noted the proceedings of the Working Group meetings.

ITEM NO. 67.6: Work Programme for the Year 2014-2015

The Member-Secretary briefed about the proposed work programme of the Institute for the year 2014-2015, which was discussed during the 40th Working Group meeting of NIH. Director, NIH, informed that due to some administrative reasons, the RCC meetings for most of the Regional Centres could not take place. However, the proposed work programme of the Regional Centres were placed before the TAC. The TAC suggested that the proposed work programme of these Regional Centres may be considered by the respective RCCs and their recommendation should be placed before the TAC during it s next meeting.

The TAC approved the proposed work programme of the Institute for the year 2014-2015. The list of studies approved by the TAC for the year 2014-2015 is given in Appendix-II.

ITEM NO. 67.7: Reporting Items

1. Details of the consultancy projects carried out by NIH during the year 2013-2014 were noted by the TAC.
2. Details of the international R&D projects submitted/ awarded during the year 2013-2014 were noted by the TAC.
3. Dr V C Goyal, Head, RMO Division, made a presentation on the Project "Development of a DSS for Hydrology and watershed Management in Neeranchal Project", which is to be funded by Dept. of Land Resources (GoI) under a World Bank supported project. The TAC appreciated and approved taking up the sponsored project by the NIH.

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

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Appendix– I: List of Participants
Appendix– II: Proposed Work Programme for the Year 2014-2015

Appendix-I

LIST OF PARTICIPANTS OF THE 67th TAC MEETING OF NIH

1.	Sh. A.B. Pandya Chairman, CWC New Delhi	In Chair
2.	Sh. Vinay Kumar Chief Engineer (HSO) CWC, New Delhi	Member
3.	Sh. R.D. Singh Director, NIH Roorkee	Member
4.	Sh. K.C. Naik Member (TT&WQ), CGWB, New Delhi	Representing Chairman CGWB
5.	Sh. S.B. Tyagi IMD, New Delhi	Representing DDGM (H) IMD
6.	Prof. K.C. Patra Dept. of Civil Engineering NIT Rourkela-769008, Orissa	Member
7.	Dr. B.J. Pandian Director i/c, Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore - 641003.	Member
8.	Dr V V S Gurunadha Rao Scientist G (Retd.), NGRI, Hyderabad	Member
9.	Dr V C Goyal Scientist F, NIH, Roorkee	Member-Secretary

INVITEES

1. Dr. Rakesh Kumar, Head, SWHD, NIH
2. Er. C P Kumar, Head, HID, NIH
3. Dr. C.K. Jain, Head, EHD, NIH
4. Dr. J.V.Tyagi, SWHD, NIH
5. Dr. M.K. Goel, WRSD, NIH
6. Er. Omkar Singh, RMOD, NIH
7. Dr. M.Someshwar Rao, HID, NIH
8. Dr. Anupama Sharma, GWHD, NIH
9. Dr. Renoj J.Thayyan, WRSD, NIH
10. Dr. Manohar Arora, SWHD, NIH
11. Dr. Rajesh Singh, EHD, NIH
12. Sh. M.Raghuram, Director Hyd. (DSR), CWC
13. Sh. G.L.Bansal, Director, Hyd.(N), CWC
14. Sh. N.N. Rai, Director, Hyd.(NE), CWC

Appendix-II

APPROVED WORK PROGRAMME FOR THE YEAR 2014-2015

ENVIRONMENTAL HYDROLOGY DIVISION
2014-2015

S.No.	Study	Study Team	Duration
Internal Studies			
1.	Water Quality Modelling using Soft Computing Techniques (Najafgarh, Mehrauli, City and Shahadara Blocks of NCR Delhi)	Rama Mehta (PI) C. K. Jain Anju Cjoudhary	2 Years (04/14-03/16)
2.	Environmental Flow Assessment of Hemavathi River in Karnataka	D. G. Durbude (PI) C. K. Jain	2 Years (04/13-03/15)
3.	Himalayan River Water Quality Assessment in a Stretch from Gangotri to Haridwar	Rajesh Singh (PI) C. K. Jain D. G. Durbude M. K. Sharma S. P. Rai Renoj J. Thayyan J. P. Patra	3 Years (06/14-03/17)
Sponsored Projects			
1.	Ionic Enrichment Dynamics of Glacial Sediment and Melt water of Gangotri Glacier	M. K. Sharma (PI) C. K. Jain Renoj Thayyan Manohar Arora Naresh Saini Jatin Malhotra Rakesh Goyal	3 Years (04/14-03/17) DST Sponsored.
2.	Low Cost Technology for Purification of Arsenic and Microbes Contaminated Water using Nanotechnology	Vijaya Aggarwala, IITR (PI) Rama Mehta, NIH (Co-PI)	2 Years (04/14-03/16) DST Sponsored.

GROUND WATER HYDROLOGY DIVISION
2014-15

S. No. & Reference Code	Project	Project Team	Duration & Status	Funding Source
1. NIH/GWD/ NIH/13-14	Estimation of specific yield and storage coefficient of aquifers	Surjeet Singh (PI) N.C. Ghosh (Co-PI) Sumant Kumar	1 year (04/13 – 10/14) **Status**: Continuing, & extended for six months.	NIH
Sponsored Studies				
2. EU-sponsored Project no. 282911	Saph Pani - Enhancement of natural water systems and treatment methods for safe and sustainable water supply in India"	Project Coordinator & P.I. : N. C. Ghosh Other Team Members V. C. Goyal, C. K. Jain, Sudhir Kumar, B. Chakravorty, A. K. Lohani Anupma Sharma, Surjeet Singh, Sumant Kumar Shashi Poonam Indwar	36 months (Oct., 2011-Sept.,2014) **Status:** Continuing & expected to be completed by 30th September, 2014.	European Union under 7th - Framework Programme
3. NIH/GWD/ NIH/11-14	Management of Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)	Sumant Kumar (PI) Rajan Vatsa, N.C. Ghosh, C.P. Kumar, Surjeet Singh, Sanjay Mittal	3 years (04/11 – 03/15) **Status:** Second phase will Continue	Saph Pani Project, after Sept., 2014 NIH's internal funding.
4. EU-sponsored Project no. 282911	Flow and Contaminant Transport Modeling of Riverbank Filtration	Shashi Poonam Indwar (PI), N.C. Ghosh, Anupma Sharma, Rajan Vatsa, Sanjay Mittal	2 ½ years (04/12 – 09/14) **Status:** Continuing	Saph Pani Project, after Sept., 2014 NIH's internal funding.

HYDROLOGICL INVESTIGATION DIVISION
2014-2015

S.No.	Study	Team	Duration/ Status
INTERNAL STUDIES			
1	Water Quality, Hydrogeology and Isotopic Investigations in SW Punjab	M. S. Rao (PI) C. P. Kumar Gopal Krishan	3 years (07/12-06/15) Continuing Study
2	Water Availability Studies for Sukhna Lake, Chandigarh	S. D. Khobragade (PI) C. P. Kumar Sudhir Kumar A. R. Senthil Kumar P. K. Garg V. K. Agarwal	2 years (04/13-03/15) Continuing Study
3	Isotope Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains	Sudhir Kumar (PI) C. K. Jain S. P. Rai S. D. Khobragade P. K. Garg B. C. Joshi (CGWB) Tejdeep Singh (CGWB)	2 years (07/13-06/15) Continuing Study
4	Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes	S. K. Verma (PI) S. P. Rai (Co-PI) M. S. Rao C. P. Kumar Mohar Singh	2 years (10/13-09/15) Continuing Study
5	Sub-marine Groundwater Discharge and Sea-water Intrusion in Coastal Aquifers of East Coast, India	M. S. Rao (PI)	2 years (06/14-05/16) New Study
6	Monitoring Isotopes in Air Moisture in Parts of Himalayas (Himachal Pradesh & Uttarakhand) for investigating the Cloud Condensation	M. S. Rao (PI) C. P. Kumar Gopal Krishan	2 years (06/14-05/16) New Study
SPONSORED PROJECTS			
7	The Structure and Dynamics of Groundwater Systems in Northwestern India under Past, Present and Future Climates	S. P. Rai (PI) M. S. Rao Surjeet Singh S. K. Verma C. P. Kumar Sudhir Kumar V. K. Agarwal Rajeev Gupta S. L. Srivastava Vishal Gupta Mohar Singh	3 years (06/12-05/15) Continuing Study
8	The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India	M. S. Rao (PI) C. P. Kumar S. P. Rai	3 years (09/12-08/15) Continuing Study

S.No.	Study	Team	Duration/ Status
9	Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques	S. P. Rai (PI) R. V. Kale M. S. Rao C. P. Kumar Sudhir Kumar V. K. Agarwal Vishal Gupta Mohar Singh	3 years (10/12-09/15) Continuing Study
10	Review of Groundwater Resources in the Indo-Gangetic Basin: A Case Study on Resilience of Groundwater in the Punjab to Withdrawal and Environmental Change	M. S. Rao (PI) C. P. Kumar Gopal Krishan	One year 8 months (02/13-09/14) Continuing Study
11	Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains	Sudhir Kumar (PI) S. P. Rai S. D. Khobragade C. K. Jain P. K. Garg	2 years (05/13-04/15) Continuing Study

SURFACE WATER HYDROLOGY DIVISION
2014-2015

S. No. & Ref. Code	Title	Study Team	Duration
Internal Studies			
1. NIH/SWD/NIH/12-15	Sedimentation Studies for Pong Reservoir, Himachal Pradesh	A. R. Senthil kumar Manohar Arora Suhas D Khobragade Avinash Agarwal Sanjay Jain	3 years (April 2012 to March 2015)
2. NIH/SWD/NIH/12-15	Study Of Hydro-Meteorological Droughts For Chitrakoot Bundelkhand Region In India	R.P. Pandey	3 years (April 2012 to March 2015)
3. NIH/SWD/NIH/13-16	Quantitative assessment of uncertainties in river discharge estimation	Sanjay Kumar Sharad Jain	3 Years (April 2013 to March 2016)
4. NIH/SWD/NIH/13-16	Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills.	Avinash Agarwal Manohar Arora RK Nema	3 Years (November 2013 to October 2016)
5. NIH/SWD/NIH/14-15	Estimation of Water Balance for Integrated Water Resources Management in Yerrakalva Pilot Basin, A.P.	J.V.Tyagi YRS Rao,	1 year (April 2014 to March 2015)
6. NIH/SWD/NIH/14-15	Status Report on “Impact of Anthropogenic and Climate Change on Sediment Load of Rivers”	Archana Sarkar	1 year (April 2014 to March 2015)
7. NIH/SWD/NIH/14-16	Study of Rainfall Patterns and Comparison of Rainfall Data from different Sources for Uttarakhand State	Archana Sarkar N.K. Bhatnagar Vaibhav Garg (IIRS) Rakesh Kumar	2 years (April 2014 to March 2016)
8. NIH/SWD/NIH/14-17	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora Rakesh Kumar	3years (May 2014 to March 2017)
9. NIH/SWD/NIH/14-17	Effect of climate change on evaporation at point scale	Digambar Singh A. R. Senthil kumar Manohar Arora	3years (June 2014 to March 2017)
10. NIH/SWD/NIH/14-17	Hydrological Modelling of Brahmani Baitarani River Basin using eWater Source Platform	J.P.Patra Rakesh Kumar Pankaj Mani	3years (April 2014 to March 2017)
11. NIH/SWD/NIH/13-15	Application of DSS(P) for Integrated Water Resources Development and Management	A.K. Lohani Surjeet Singh Rahul Jaiswal	2 year (April 13- March 15)

WATER RESOURCES SYSTEM DIVISION
2014-2015

S. N.	Title	Study Team	Duration	Funding (Rs. Lakh)
Ongoing Internal Studies				
1.	Trend and variability analysis of rainfall and temperature in Himalayan region	L. N. Thakural Sanjay Kumar Sanjay K. Jain Sharad K. Jain Tanvear Ahmed	3 years (10/11-09/14)	NIH
2.	NIH_Basin – A WINDOWS based model for water resources assessment in a river basin	M. K. Goel Sharad K. Jain Deepa Chalisgaonkar Prabhash K. Mishra	2 Years (04/13-03/15)	NIH
3.	Web GIS based snow cover information system for the Indus Basin	D. S. Rathore Deepa Chalisgaonkar L. N. Thakural Tanvear Ahmed	2 Years (04/13-03/15)	NIH
4.	Assessment of Water Footprint of the National Capital Territory (NCT) of India	Deepa Chalisgaonkar Sharad K. Jain M. K. Nema P. K. Mishra	2 Years (04/13-03/15)	NIH
5.	Impact of Climate and Land Use Change on Floods of Various Return Periods	P. K. Bhunya Sanjay Kumar D S Rathore	2 Years (04/13-03/15)	NIH
6.	Assessing climate change impact across KBK region of Odisha	P. K. Mishra Sharad K. Jain Sanjay K. Jain P. K. Bhunya	2 Years (04/13-03/15)	NIH
7.	Glacier change and glacier runoff variation in the upper Satluj river basin	Sanjay K. Jain Sharad K. Jain Renoj J. Theyyan	2.5 Years (10/13-03/16)	NIH
8.	Variability of the Hydro-climatic variables in Punjab Plains of lower Satluj	M. K. Nema Sharad K. Jain	2 Years (11/13-10/15)	NIH (11.34)
Sponsored Studies				
1.	Glaciological studies of Phuche Glacier, Ladakh Range, India	Renoj J. Theyyan M K Goel S P Rai	5 Years 1/10-12/14	DST (56.00)
2.	Ganga River Basin Environment Management Plan	Sharad K Jain N. C. Ghosh Sanjay K. Jain M. K. Goel	2 Years 07/12-06/14	IIT Kanpur (12.00)
3.	Assessment of Environmental flow for Himalayan River	Sharad K. Jain Pradeep Kumar P. K. Agarwal P. K. Mishra	1 Year 07/14-07/15	MOES (9.95) (Funds are expected shortly)
New Internal Studies				
1.	Hydrologic Modelling of a part of Satluj Basin using SWAT Model	P. K. Agarwal Sharad K. Jain M. K. Goel Sanjay K. Jain MK Nema	2 -3/4 Years (06/14-3/17)	NIH (23.00)

		Tanvear Ahmed		
2.	Decision Support System for Water Resources Planning in Upper Bhima basin, Maharashtra	D. S. Rathore M. K. Goel, R.P. Pandey Sanjay Kumar Surjeet Singh	2 years (07/14-06/16)	NIH (34.00)
3.	Catchment scale evaluation of cold-arid cryospheric system Hydrology, Ganglass catchment, Ladakh	Renoj J. Theyyan S P Rai	3 years (04/14-03/17)	NIH (20.00)

RESEARCH MANAGEMENT AND OUTREACH DIVISION
2014-2015

S.No.	Study	Team	Duration
		Internal Studies	
1.	Participatory development of structure for IWRM Framework in identified sub-basins under Pilot Basin Studies (PBS) program **(New Study)**	V C Goyal (PI) Omkar Singh R V Kale	DOS: July 2014 DOC: June 2015
2.	Water Conservation and Management in Ibrahimpur Masahi Village of Haridwar District (Uttarakhand) **(Ongoing Study)**	Omkar Singh (PI), V.C. Goyal, C.K. Jain, J.V. Tyagi and Sanjay Kr. Jain **Scientific/Technical Staff** Subhash Kichlu, Yatvir Singh, Rajesh Agarwal, Rakesh Goyal, N.K. Lakhera and C.S. Chowhan	DOS: Apr 2013 DOC: Mar 2015
		Sponsored Studies	
3.	Customization of WEAP model for application in Ur river watershed in Tikamgarh district of Bundelkhand region. **(Under TIFAC Project) (New Study)**	R V Kale (PI) T Thomas- RC Bhopal Jyoti Patil Rajesh Agarwal	DOS: Apr 2014 DOC: Sep 2015

Sponsored Projects

3. Integrating hydrology, climate change and IWRM with livelihood issues: Development of methodology and a DSS for water-scarce Bundelkhand region in India, **Funded by TIFAC, Government of India under INDIA-IIASA Programme of TIFAC**
Period: Aug 2013-Dec 2016 (30 months) Budget: Rs 56.64 lakh

Team from NIH:
V C Goyal (PI), T Thomas (Co-PI), R V Kale (Co-PI)
Nodal Coordinators from other partners:
Dr (Mrs) K Vijaya Lakshmi, DA, New Delhi
Dr Sandeep Goyal, MAPCOST, Govt. of MP (India)
International Collaborators: IIASA, Austria

4. Development of a DSS for Hydrology and Watershed Management in Neeranchal Project, **To be funded by Dept. of Land Resources (GoI) under a World Bank supported project**
Period: Jun/Jul 2014-May 2019 Budget: Rs 30 Crore approx.
Partners: NIH; IIT Delhi; WTC Delhi; NRSC Hyderabad

REGIONAL CENTRE, BELGAUM
2014-2015*

S N	Title of the Study	PI	Duration
1	Effectiveness of Storage Tanks for Groundwater Recharging in North Karnataka Region	M. K. Jose	2 years (August 2012 to July 2014) On Going
2	Effect of Sand Mining on River and Groundwater Regime in Hard Rock Areas: A Case Study from Andhra Pradesh	M. K. Jose	2 years (August 2012 to July 2014) On Going
3	Waterlogging and Salinity Studies in NagarjunaSagar Right Bank Canal Command	N. Varadarajan	2 years (August 2012 to July 2014) On Going
4	Integrated Water Resources Management (IWRM) on a Pilot Basin – Zuari River Basin, Goa	T. Chandramohan	3 years (April 2013 to March 2016) On Going
5	Comparative Analysis of Various Rainfall-Runoff Models for Rivers of Western Ghats	B. Venkatesh	3 years (April 2013 to March 2016) On Going
6	Application of Isotopes for Estimation of Groundwater Recharge under Different Land Covers/ Land Uses in Sindhudurg District, Maharashtra	B. K. Purandara	2 years (April 2013 to March 2015) On Going
7	Dam Break Analysis of Sharavathi and Varahi river basins	B. Venkatesh	9 months On Going
8	Development of DSS(P) Application for conjunctive use of surface and groundwater in Tungabhadra Command	B. Venkatesh	3 years (August 2013 to July 2016) On Going

*To be considered by the RCC

REGIONAL CENTRE, JAMMU
2014-2015*

S. N.	Study	Team	Duration	Funding/ Remarks
1	Impact of land use changes on flow regime and sustenance of environmental flows of Tawi river at Jammu	Pradeep Kumar M. K. Nema	Nov 2011 to Oct 2014 (03 Years)	NIH
2.	Climate Change Effects on Hydrology of the Tawi Basin in Western Himalaya	M. K. Nema Pradeep Kumar	Nov 2011 to Oct 2014 (03 Years)	NIH
3.	PBS: Integrated Water Resources Management (IWRM) Study in Tawi River Basin, JK	Pradeep Kumar M. K. Nema	Apr 2012 to Mar 2017 (05 Years)	NIH
4.	Automation of Hydro-Meteorological Network in Jhelum Basin for Flood Forecasting	Pradeep Kumar R. J. Thayyen M. K. Goel Sharad K. Jain	Sep 2013 to Mar 2016 (02 Years 07 Months)	NIH

*To be considered by the RCC

REGIONAL CENTRE, BHOPAL
2014-2015

S. N.	Study	Duration	Starting and ending date	Status/ Study Group
1.	Surface and ground water modeling for conjunctive use (Pilot Basin Studies: IWRM in Bina River Basin in Bundelkhand Region in M.P.)	5 Years	April 2012 to March 2017	T. R. Nayak T. Thomas Ravi Galkate R.K. Jaiswal
2.	Applications of Decision Support System (DSS) in Shipra river basin of MP	3 Years	June 2013 to May 2016	Ravi Galkate T. R. Nayak R.K. Jaiswal T. Thomas
3.	Integrating hydrology, climate change and IWRM with livelihood issues: Development of methodology and a DSS for water-scarce Bundelkhand region in India	2½ Years	May 2013 to October 2015	V. C. Goyal T. Thomas R. V. Kale S. Goyal K. Vijay-lakshmi
4.	Integrated Assessment of Drought Vulnerability for Water Resources Management in Bina basin	2 Years	July 2014 to June 2016	T. Thomas T. R. Nayak R.K. Jaiswal Ravi Galkate
5.	Irrigation Planning and Management in the Harsi project Command of a Water Resource Project	2 Years	May 2013 to April 2015	R.K. Jaiswal T. Thomas Ravi Galkate T. R. Nayak

REGIONAL CENTRE, KAKINADA
2014–2015*

S. N.	Study	Team	Duration	Status/Funding
1	Surface water and Ground water interaction study in the Y drain of lower Yerrakalva basin as part of pilot basin studies for IWRM	S.V.Vijayakumar (P.I.) Y.R.Satyaji Rao R.Venkata Ramana B. Krishna	April 2014 to March 2015	New/Internal (Basin Suggested by Govt., of A.P)
2	Water availability: IWRM studies in the Yerrakalva River Basin, Andhra Pradesh	Y.R. Satyaji Rao (PI) B.V.Ramana	April 2014 to March 2015	New/Internal (Basin Suggested by Govt., of A.P)
3	Runoff estimation of Tammileru ungauged basin Andhra Pradesh using SWAT model	V.S. Jeyakanthan (P.I.) J.V.Tyagi R.Venkata Ramana	May 2013 to March 2015	Continuing from previous year/Internal
4	Assessment of climate change impact on hydrology of Mahanadhi basin	P.C.Nayak (P.I.) Y.R.Satyaji Rao B. Venkatesh T. Thomas	April 2013 to March 2015	Continuing from previous year /Internal
5	Hydrological modeling of time series data Analysis of high frequency Ground water	B.Krishna (P.I.) Y.R.Satyaji Rao R.Venkata Ramana	May 2013 to March 2015	Continuing from previous year /Internal

S. N.	Study	Team	Duration	Status/Funding
	levels data in the Coastal aquifers of A.P			
6	Evaluation of urban storm water network in Hyderabad using SWMM	R.Venkata Ramana (P.I.) Y.R.Satyaji Rao S.V.Vijayakumar V.S. Jeyakanthan	May 2013 to March 2016	Continuing from previous year /Internal
7	Identification of submarine discharge zones and sea water intrusion modeling in Godavari Delta using integrated approach	Y.R. Satyaji Rao (PI) M.S.Rao B.V.Ramana	July 2014 to March 2017	New/ Internal (in collaboration with NIO, NGRI)

*To be considered by the RCC

CFMS, GUWAHATI
2014-2015*

Study No.	Title of the study	Study Team	Duration
	Continuing Studies		
NIH/CFMS-G/13-15/	Risk Assessment of Heavy Metal Pollution in Surface Soils of Kulsi River Basin (Assam / Meghalaya)	C. K. Jain S. K. Sharma G. Tirkey B. Sharma	07/13-03/15 (On Going)
NIH/CFMS-G/13-15/	Short Term Flood Forecasting Using Bootstrap based Artificial Neural Networks within Kulsi River Basin (Assam / Meghalaya)	S. K. Sharma G. Tirkey C. K. Jain	07/13 - 03/15 (On Going)
NIH/CFMS-G/13-15/	Application of the Arc – SWAT model for the prediction of runoff within Kulsi River Basin (Assam/Meghalaya)	G. Tirkey S. K. Sharma C. K. Jain	07/13 - 03/15 (On Going)
	New Proposed Studies		
NIH/CFMS-G/14-16/	Estimation of Runoff for Kulsi River Basin using SCS Curve Number and Geographic Information System (GIS)	S. K. Sharma G. Tirkey C. K. Jain	07/14-03/16 (New Study)
NIH/CFMS-G/14-16/	Application of USLE model for estimation of soil loss in Kulsi River Basin using remote sensing and geographic information system	G. Tirkey S. K. Sharma C. K. Jain	07/14 - 03/16 (New Study)

*To be considered by the RCC

CFMS, PATNA
2014-2015*

S. N.	Title of the study	Study Team	Duration	Funding
1.	Pilot Basin Studies (PBS) for Mahi River Basin in Ghaghra-Gandak Composite Basin	CFMS, Patna	April 2012-March 2017 (XII Plan Year)	NIH
2.	Development of flood forecasting system based on rainfall information obtained from satellite data (***Continue study from previous year*** started in 2012-13)	Pankaj Mani Rakesh Kumar	1 year (2014-2015)	NIH
3.	Preparation of Groundwater Quality Atlas using GIS for Varanasi City situated on the bank of River Ganga	SR Kumar and MS Rao	2 year (2014-2016)	NIH
4.	Study of drought in Bihar districts	SR Kumar and DS Rathore	2 year (2014-2016)	NIH
5.	Spatial and Temporal Distribution of Geochemical Characteristics and Environmental Stable Isotopes in Groundwater of North Bengal using GIS and its Assessment with the help of Water Quality Index (WQI) and Existing Classification Systems (***Continue study from previous year***)	SR Kumar and MS Rao	2nd year (2014-2015): **Part-II:** Environmental Stable Isotopes, WQI, Classification Systems and Trends in Water Quality Parameters	NIH
6.	Time Series analysis of Monthly Rainfall in Mahi Basin	NG Pandey B Chakravorty SR Kumar	2 year (2014-2016)	NIH
7.	Monthly Rainfall Prediction of Bihar Districts	SR Kumar, RV Raman, NG Pandey, B Chakravorty	2 year (2014-2016)	NIH
8.	Development of Relationships Between Reference Evapotranspiration of Penman-Monteith and other Climatological methods for Bihar under Middle Ganga Basin	SR Kumar NG Pandey B Chakravorty RV Raman	3 year (2014-2017)	NIH

*To be considered by the RCC

APPENDIX-68.4.1

WORK PROGRAMME OF THE DIVISIONS AT THE H.Q. AND RC/CFMS OF THE INSTITUTE FOR THE YEARS 2014-15 & 2015–2016

ENVIRONMENTAL HYDROLOGY DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr. C K Jain	Scientist G & Head
2	Dr. (Mrs.) Rama Mehta	Scientist D
3	Dr. M K Sharma	Scientist D
4	Dr. Rajesh Singh	Scientist C
5	Smt. Babita Sharma	RA
6	Smt. Bina Prasad	RA

Progress of Work Program for the Year 2014-15

S.No.	Study	Study Team	Duration
Internal Studies			
1.	Water Quality Modelling using Soft Computing Techniques	Rama Mehta (PI) C. K. Jain	2 Years (05/14-05/16)
2.	Himalayan River Water Quality Assessment in a Stretch from Gangotri to Hardwar	Rajesh Singh (PI) C. K. Jain M. K. Sharma S. P. Rai Renoj J. Thayyan J. P. Patra	3 Years (07/14-06/17)
Sponsored Projects			
1.	Ionic Enrichment Dynamics of Glacial Sediment and Melt water of Gangotri Glacier	M. K. Sharma (PI) C. K. Jain Renoj Thayyan Manohar Arora Naresh Saini Jatin Malhotra Rakesh Goyal Karan Jamwal	3 Years (04/14-03/17) Sponsored by DST, New Delhi
2.	Low Cost Technology for Purification of Arsenic and Microbes Contaminated Water using Nanotechnology	Vijaya Aggarwala, IITR (PI) Rama Mehta, NIH (Co-PI)	2 Years (04/14-03/16) Sponsored by DST, New Delhi
Consultancy Project			
1.	Water Safety Impact Assessment through Sanitary Improvement of India Mark 2 Hand Pumps in Moradabad Division, Uttar Pradesh	C. K. Jain (PI) Babita Sharma Rakesh Goyal Daya Nand	6 Months (10/14 – 03/15) Sponsored by: UNICEF Office for Uttar Pradesh Amount: 12 Lakh

Training Course Organized during 2014-15

S.No.	Topic	Sponsored by	Venue	Period
1.	Water Quality and its Management	NIH and CSMRS	NIH, Roorkee	1-5 September 2014
2.	Monitoring of Non-point Source (NPS) Pollution in a riverine system	CPCB, Delhi	NIH, Roorkee	13-15 October, 2014
3.	Advanced Soft Computing Techniques in Hydrology and its Applications (ASCTHA-2014).	Paid Course	NIH, Roorkee.	27th November to 02 December, 2014
4.	One Awareness program for Teachers about Water Conservation	NIH, Roorkee with Education department, Uttarakhand	NIH, Roorkee	06 December, 2014
5.	Advanced Instrumentation Technique and Preventive Maintenance	CPCB, Delhi	NIH, Roorkee	8-10 December, 2014
6.	Hands on Advanced Instruments of Water Quality Testing” sponsored by during	WQAA, MoWR, RD & GR, New Delhi	NIH, Roorkee	12-16 January, 2015

Study – 1 (Internal Research Project)

1. **Title of the Study:** Water Quality Modeling using Soft Computing Techniques

2. **Study Group:**

Project Investigator Dr. Rama Mehta, Sc. 'D'
Co-Investigator Dr. C. K. Jain, Sc. 'G'
Scientific/Technical Staff Ms. Anju Chowdhary, SRA

3. **Type of Study:** Internal

4. **Nature of Study:** Applied Research

5. **Date of start:** May 2014

6. **Scheduled date of completion:** May 2016

7. **Duration of the Study:** Two years

8. **Study Objectives:**

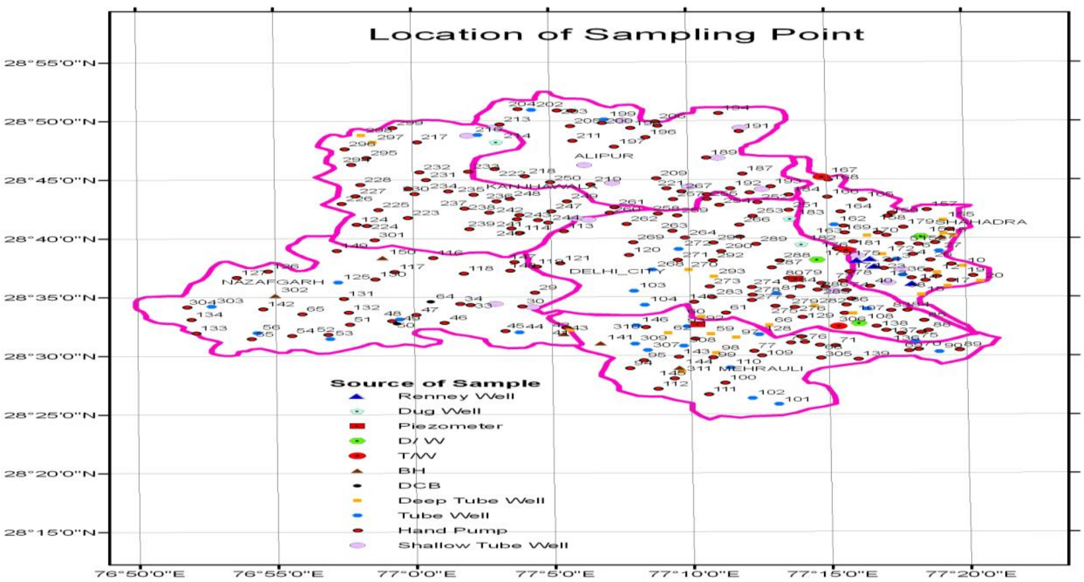
To develop the models for assessment of the quality of water with its quality parameters for Najafgarh, Mehrauli, Delhi City and Shahdara blocks of NCR using conventional and soft computing techniques.

9. **Statement of the Problem:**

The quality of ground water within National Capital Region (NCR) Delhi varies from place to place along with the depth of water table. The kind and concentration of dissolved salts depend on their source and nature of sub surface environment.

Various methods are discussed in literature on drinking water quality criteria and decision-making. But most of the reports on the water quality revealed that deterministic approach in decision making by comparing values of parameters of water quality with prescribed limits provided by different regulatory bodies is used without considering uncertainties involved at various steps throughout the entire procedure. To overcome the difficulties of complex ground water quality there has been a need to develop techniques that can help to find meaningful solutions. Soft computing techniques are relatively new emerging techniques used in hydrologic and water resources systems. Fuzzy logic technique used in uncertainties in water resources system arises not only due to randomness of hydrological variable but also due to imprecision, subjectivity, vagueness associated with decision making and lack of adequate data. Such uncertainties are best addressed through fuzzy logic technique. Therefore, new emerging techniques as Neuro-Fuzzy techniques and ANN are frequently used to develop the models. Fuzzy_Mamdani Inference technique has been used during the study.

The NCT of Delhi having Six administrative blocks namely Alipur, Kanjhawala, Najafgharh, Mehrauli, City and Shahdara. The ground water sampling locations have been depicted as below (Fig. 1):



Water quality Modeling for two administrative blocks viz. Delhi City & Shahdara have been done with three different techniques and results have been analyzed with empirical techniques for Water Quality Index during this year. Data analysis and modeling for other two blocks is in progress.

10. Approved Action Plan / Methodology:

Water quality indices (WQI) giving a single value to the water quality of a source, which translates the list of constitutes and their concentrations present in a sample in a single value. One can compare different samples for quality on the basis of the index value of each sample. The use of WQI has been strongly advocated by agencies responsible for water supply and control of water pollution.

Following methods have been employed to calculate the water quality index:

- Empirical Method
- Soft Computing Techniques (SCT)-Mamdani_ Fuzzy Inference System (M_FIS)
- Canadian Water Quality Guidelines

11. Timeline:

Activities	2014-15				2015-16			
	1st Qr.	2nd Qr.	3rd Qr.	4th Qr.	1st Qr.	2nd Qr.	3rd Qr.	4th Qr.
Data collection for four administrative blocks	■	■						
Model Development with application of Empirical method & CCME-WQI technique for all four blocks.		■	■					
Model Development with			■	■	■			

application of soft computing method as M_FIS technique.								
Testing, evaluation, and comparison with conventional method.								
Result analysis & Report writing								

12. Objectives and achievement during last six months:

Objectives	Achievements
i) Model Development with application of soft computing methods. ii) Data analysis for other two blocks as Najafgarh & Mehrauli. iii) Model development for other two blocks.	i) Three models (Each model with Empirical method, CCME_ WQIG and Fuzzy Inference Technique) have been developed for Shahdara block. ii) Data analysis for other two blocks as Najafgarh & Mehrauli has been completed. iii) Model development for other two blocks is under progress.
Testing, Evaluation and comparison with conventional method.	Results via Fuzzy model have been compared with conventional method and Canadian formula (CCME) For Delhi city block. Results via Fuzzy model have been compared with conventional method and Canadian formula (CCME) For Shahdara block. Comparative results have shown through graphs and performance indices.

13. Recommendation / Suggestion:

Recommendation / Suggestion	Action Taken
Results are appriciated by members. Dr. N.C. Ghosh suggested that the Water quality Index should be analyzed for other uses of water as for irrigation purpose etc. Dr. V.K. Sharma, Director, GSI, Dehradun, suggested that all sample locations can be presented in GIS map could be related with the soil & geology of the land of that block.	Proper actions as per suggestions are considered in the study.

14. Analysis & Results:

- The ground water quality of the City & Shahdara Block has been assessed with all three methods as Empirical method, CCME Water Quality Index guidelines (CCME_WQI) and Fuzzy Inference method.
- Comparative graphs with all results have been drawn.

15. **End Users / Beneficiaries of the study:** Hydrologist, Public, & Water agencies working for NCR region

16. **Deliverables:** Technical report, research papers and manual

17. **Major items of equipment procured:** None

18. **Lab facilities used during the study:** None

19. **Data procured or generated during the study:** None

20. **Study Benefits / Impacts:**

Measurable indicators	Achievements
Model development for block Delhi City & Shahdara with new emerging techniques to get the Water Quality Index for specific use of ground water	Completed for two blocks
Solution of identified problem	Completed for two blocks

21. **Involvement of end users/beneficiaries:** Local people of the NCR region.

22. **Specific linkage with Institution and /or end users/beneficiaries:** Nil

23. **Shortcoming/Difficulties:** No

24. **Future Plan:** Models can be developed for other two administrative blocks of NCR as Najafgarh and Mehrauli using same techniques.

PROFORMA FOR SUBMITTING INTERNAL RESEARCH PROJECTS

1. Thrust Area under XII Five Year Plan: Water quality monitoring and modeling

2. Project Team

- **a. Project Investigator :** Dr. Rama Mehta, Sc. D, EHD
- **b. Project Co-investigator :** Dr. C. K. Jain, Sc. G, EHD
- **c. Technical staff :** Anju Chowdhary, SRA

3. Title of the Project: Assessment of Water Quality Index for two administrative blocks of NCT Delhi using Soft Computing technique (**DOS:** May 2014, **DOC:** May 2016)

4. Objectives:

To develop the models for assessment of the water quality index with its quality parameters for four blocks viz. Delhi City & Shahdara, Najafgarh & Mehrauli of NCR region using conventional and soft computing techniques.

5. Present state-of-art: annex 1

6. Methodology:

Following methods have been employed to calculate the water quality index.

- ➢ Empirical Method
- ➢ Soft Computing Techniques (SCT) -Mamdani_ Fuzzy Inference System (M_FIS)
- ➢ Canadian Council of Ministry of Environment Water Quality Index Guidelines

7. Research Outcome from the Project:

a. Developed models with new emerging techniques as M-FIS and CCME- WQIG.
b. GIS presentation of water quality of different samples with respect to the outcomes of the models.
c. Technical report and papers.

8. Work Schedule:

a. Probable date of commencement of the project: May 2016
b. Duration of the project: Two Years.
c. Stages of work and milestone: The modeling and analysis for two blocks viz. Najafgarh & Mehrauli has to be done during year 2015-16.

Sl. No.	Work Element	First Quarter	Second quarter	Third quarter	Forth quarter
1	Data Analysis	***			
2	Modeling		***	***	
3	Result analysis & Report Writing.			***	***

Study -2 (Internal Research Project)

1. **Title of the Study:** Himalayan river water quality assessment in a stretch from Gangotri to Haridwar.

2. **Study Group:**

Project Investigator Dr. Rajesh Singh, Sc. 'B'
Project Co-investigator Dr. C. K. Jain, Sc. 'G', EHD Dr. M. K. Sharma, Sc. D, EHD Dr. S. P. Rai, Sc. E, HID Dr. Renoj J. Thayyan, Sc. D, WRSD Dr. J. P. Patra, Sc. B, SWHD
Scientific/Technical Staff Shri Rakesh Goyal, Tech. Gr. I Shri Dayanand, Tech. Gr. II

3. **Type of Study:** Internal

4. **Nature of Study:** Applied Research

5. **Date of start:** 01.07.2014

6. **Scheduled date of completion:** 30.06.2017

7. **Duration of the Study:** 3 Years

8. **Study Objectives:**

    i) Catchment characterization affecting river water quality
    ii) River water quality assessment for different designated uses
    iii) Decipher the different sources of solutes controlling the river water quality
    iv) Nutrient loading due to anthropogenic activity
    v) CO_2 consumption during chemical weathering

9. **Statement of the Problem:**

The purity and sanctity of Himalayan Rivers is challenged now by the technological development and growing financial strength of the nation. Construction of plethora of roads along the fragile mountain slopes facilitated movement of more men and material to the fragile Himalaya. Tourist activities in this region have increased many folds in recent years. More land is being brought under cultivation and more and more fertilisers and pesticides are being used to manage the crop productivity. As a by product of these developmental activities, the pristine rivers of the Himalaya are getting polluted more and more. Moreover, the increase in temperature and CO_2 in atmosphere will results in change in the pattern of chemical weathering and transport of solute through these rivers.

Therefore, there is a need for water quality assessment of Himalayan Rivers to understand the multifold impact of urbanization, tourist influx, and climate change on water quality of rivers.

10. Approved Action Plan / Methodology:

i) Collection of river water, suspended sediments, and bed sediment samples from Gangotri to Haridwar on monthly basis.
ii) Analysis of river water samples for physico-chemical, isotopic, and bacteriological composition.
iii) Analysis of river bed sediments for elemental and mineral composition.
iv) Processing the data to understand the contamination of water and consumption of CO_2 during the weathering process.

11. Timeline:

Sr. No.	Major Activities	2014-15			2015-16				2016-17				17-18
		2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.
1	Literature Survey												
2	Field Investigation												
3	Sample Collection and Analysis												
4	Data Collection and Interpretation												
5	Status Report												
6	Interim Report												
7	Final Report												

12. Objectives and achievement during last six months:

Objectives	Achievements
Literature Survey	• Literature survey completed.
Field investigation, Sample Collection & Analysis	• Field investigation completed. • Samples were collected in Dec. 2014. Analysis is under progress.

13. Recommendation / Suggestion:

Recommendation / Suggestion	Action Taken
1. No Specific comments	

14. Analysis & Results:

- Geo-spatial map showing sampling locations prepared.
- Samples collected in December 2014.
- Physico-chemical, bacteriological, and isotopic (δO^{18} & δD) analysis of samples completed.

15. End Users / Beneficiaries of the study: State Govt. Planners

16. **Deliverables:** Technical report & research papers

17. **Major items of equipment procured:** None

18. **Lab facilities used during the study:** Water Quality Laboratory (NIH)

19. **Data procured or generated during the study:** None

20. **Study Benefits / Impacts:**

Measurable indicators	Achievements
River water quality assessment	Under progress
Nutrient loading	Under progress

21. **Involvement of end users/beneficiaries:** -----

22. **Specific linkage with Institution and /or end users/beneficiaries:** Nil

23. **Shortcoming/Difficulties:** No

24. **Future Plan:**

- Sampling and analysis of river water, suspended sediments, and bed sediments on bi-monthly basis.
- Processing the data to understand the contamination of water and consumption of CO_2 during the weathering process.

PROFORMA FOR SUBMITTING INTERNAL RESEARCH PROJECT

1. Thrust Area under XII Five Year Plan: Surface, ground, and wastewater quality monitoring and modelling

2. Project Team :

a. Project Investigator : Dr. Rajesh Singh, Sc. B, EHD

b. Project Co-investigator : Dr. C. K. Jain, Sc. F, EHD
Dr. M. K. Sharma, Sc. C, EHD
Dr. S. P. Rai, Sc. D, HID
Dr. Renoj J. Thayyan, Sc. D, WRSD
Dr. J. P. Patra, Sc. B, SWHD

3. Title of the Project : Himalayan River Water Quality Assessment in a Stretch from Gangotri to Haridwar

4. Objectives :

i) Catchment characterization affecting river water quality
ii) River water quality assessment for different designated uses
iii) Decipher the different sources of solutes controlling the river water quality
iv) Nutrient loading due to anthropogenic activity
v) CO_2 consumption during chemical weathering

5. Present state-of-art :

Water of sound quality is the key for vital socio-economic functions on Earth. Most users of water depend on adequate levels of water quality. When these levels are not met, these water users must either pay an additional cost for water treatment or incur at least increased risks of damage or loss. As populations and economies grow, more pollutants are generated and degradation of water resources has become one of the most pressing global concerns currently facing mankind. Increasingly, the major efforts and costs involved in water management are devoted to water quality protection and management. Conflicts among various users of water are increasingly over issues involving water quality as well as water quantity. Evidently, there is a need for effective management efforts, where one possible action is to focus on minimizing pollutant load from pollutant-producing areas to water resource areas. In September 2000, the European Union (EU) passed a new water framework directive (WFD) with the goal of increasing and establishing a good ecological status on a long-term basis. Groundwater, surface waters and coastal waters are affected by this regulation making extensive management of rivers and their catchment areas indispensable. River basin management consists of coordinating all activities which can affect the water resources with the goal of maintaining good quality of water. The management decisions for improving the health of the water bodies can be possible with the help of modeling techniques.

Generally, water quality is the process to determine the chemical, physical and biological characteristics of water bodies and identifying the source of any possible pollution or contamination which might cause degradation of the water quality. Chemical weathering of the rocks leads to introduction of dissolved solids in the river water and conversely stream chemistry provides information on chemical erosion processes (Chetelat et al., 2008). Chemical weathering is a chemical reaction; therefore it requires a “substrate” and “reacting agents” for it to occur. The substrates on the earth surface are the minerals in rocks and the reacting agents are acids, such as, carbonic acid (HCO^-_3 derived from dissolution of CO_2); sulfuric acid (H_2SO_4 derived from pyrite oxidative weathering and a number of organic acids (oxalic, acetic and humic), which liberate protons to weather the minerals. In addition to these acids, H_2O also acts an agent in dissolving evaporite minerals. Among the various acids, H_2CO_3 is the dominant source of protons for chemical weathering reactions and a regulator of atmospheric CO_2. In addition to H_2CO_3, weathering through organic acids and H_2SO_4 may also be important on local and regional scales (Galy and France- Lanord, 2001). Globally, rivers carry about 2130 x 10^6 tons/yr dissolved material from weathering of rocks (Gaillardet et al., 1999) and transport it to sea. In India, the stream erosion study in Himalayan region dates back to 1970 (Raymahasay, 1970) followed by geochemical characterization of River Ganga water (Handa, 1972). Afterwards, Abbas and Subramanian (1984) described the erosion and sediment transport pattern in the Ganga basin. In a pioneering study, Sarin and Krishnaswami (1984) reported major ion chemistry of Ganga River, which was followed by a number of studies related to geochemistry of Himalayan Rivers in India and abroad (Harris, 1995; Jain et al., 1998; Pierson-Wickmann et al., 1998; France-Lanord and Galy, 1999; Jain, 2002; Semwal and Akolkar, 2006; Singh and Singh, 2007; Trivedi et al., 2010; Singh et al., 2012; Tyagi et al., 2013).

Our main interest is to analyze the river water sample for physico-chemical and bacteriological parameters to understand the different sources of solutes controlling the river water quality. We will also model the pollutant load reaching the river and its behavior in a river stretch.

6. Methodology :

i) Collection of river water, suspended sediments, and bed sediment samples from Gangotri to Haridwar on monthly basis.
ii) Analysis of river water samples for physico-chemical, isotopic, and bacteriological composition.
iii) Analysis of river bed sediments for elemental and mineral composition.
iv) Processing the data to understand the contamination of water and consumption of CO_2 during the weathering process.

7. Research Outcome from the Project :

i) Geo-spatial data base of river water quality
ii) Annual dissolved and suspended solid flux in the river
iii) CO_2 consumption due to chemical weathering
iv) Technical report and papers

8. Work Schedule

a. Probable date of commencement of the project : July 2014
b. Duration of the project : 3 Years
c. Stages of work & milestone

Sr. No.	Major Activities	2014-15			2015-16				2016-17				17-18
		2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.
1	Literature Survey												
2	Field Investigation												
3	Sample Collection and Analysis												
4	Data Collection and Interpretation												
5	Status Report												
6	Interim Report												
7	Final Report												

Study -3 (sponsored Project)

1. **Title of the Study:** Ionic Enrichment Dynamics of Glacial Sediment and Melt water of Gangotri Glacier

2. **Study Group:**

Project Investigator Dr. M. K. Sharma, Sc. 'D'
Co-Investigator Dr. C. K. Jain, Sc. 'G' Dr. Renoj Thayyan, Sc. 'D' Dr. Manohar Arora, Sc. 'D'
Scientific/Technical Staff Sri. Naresh Saini, PRA Sri. Jatin Malhotra, SRA Sri. Rakesh Goyal, Tech. Gr. I Sri. Dayanand, Tech. Gr. II Sri Karan Jamwal, JRF

3. **Type of Study:** Sponsored project by DST, New Delhi, **Budget: Rs 30.60 lacs**

4. **Nature of Study:** Applied Research

5. **Date of start:** April 2014

6. **Scheduled date of completion:** March 2017

7. **Duration of the Study:** 3 Years

8. **Study Objectives:**

   i) To characterize the seasonal variability of the major-ion chemistry of glacial meltwater.
   ii) Chemical characterization of the suspended sediment of Gangotri glacial system
   iii) To study Ionic enrichment dynamics of meltwater-glacial sediment interaction
   iv) To investigate open and closed system low temperature ionic enrichment process

9. **Statement of the Problem:**

Higher level of pollutant load in the lower reaches of River Ganges is as an unresolved problem for the past many decades. There were number of projects launched by the Government of India to address this issue, but failed to achieve the desired result during the past two decades. Contribution of Himalaya rivers originating from snow and glacier fields of higher Himalaya spread across India, Nepal and Tibet, play an important role in controlling the solutes levels in the River Ganges. As these mountain waters with significant amount of snow, glacier meltwaters and rainfall is characterised by low ionic concentrations and play a major role in diluting the high solute load emanating from Ganga plain catchments. Hence any change in the quality and quantity of the Himalayan tributaries of River Ganga under the climate change regime will impact the quality parameters of River Ganga. Understanding of low temperature solute acquisition processes is therefore very important for assessing the solute acquisition and pollutant loading further downstream. Higher sediment load in the glacier fed streams play a significant role in solute acquisition by its interaction with dilute glacial and snow melt waters. Further downstream, higher sediment load due to anthropogenic activities added another dimension to the problem. As Gangotri glacier is the biggest glacier in the region as well as the source of River Ganga, it is imperative to study the dynamics of solute acquisition by dilute glacier waters in interaction with freshly grinded glacier sediments. Hence this study is conceptualised to build the existing knowledge gap on solute acquisition of glacier melt waters during its transit with high sediment load under prevailing low temperature conditions close to the glacier.

10. Approved Action Plan/Methodology:

i) Literature survey through international publications (research papers/ reports)
ii) Reconnaissance survey of Gangotri glacier catchment for site selection.
iii) Collection Suspended sediment samples and meltwater samples from selected sites seasonally.
iv) Chemical analysis for major cations, anions and trace metals in the collected suspended sediment and meltwater.
v) Geochemical analysis of suspended sediments
vi) Study of closed system characteristics and open system dynamics
vii) Dissolution experiments of glacial meltwater-suspended sediment interaction

11. Timeline:

Activity	2014-15				2015-16				2016-17			
	1^{st} Qr.	2^{nd} Qr.	3^{rd} Qr.	4^{th} Qr.	1^{st} Qr.	2^{nd} Qr.	3^{rd} Qr.	4^{th} Qr.	1^{st} Qr.	2^{nd} Qr.	3^{rd} Qr.	4^{th} Qr.
Literature survey												
Reconnaissance Survey												
Collection of SS and meltwater samples												
Chemical analysis of SS and meltwater samples												
Geochemical analysis of SS												
Open and close system study												
Dissolution experiments of glacial meltwater -SS interaction												
Interim Report Writing												
Final Report Writing												

12. Objectives and achievement during last six months:

Objectives	Achievements
Chemical analysis of SS and meltwater samples	• Measurement of suspended sediment concentration is completed. • Physico-chemical analysis of unfiltered meltwater samples is completed.

13. **Recommendation / Suggestion:** None

Recommendation / Suggestion	Action Taken
None	None

14. **Analysis & Results:**
    - i) Processing of measurement of suspended sediment concentration for the suspended sediment samples collected from Gomukh, Bhojwasa and Gangotri completed for the ablation period of year 2014 has been completed.
    - ii) Physico-chemical analysis of unfiltered meltwater sample collected from Gomukh, Bhojwasa and Gangotri completed.
    - iii) Sieving of bed sediment samples collected from Gomukh, Bhojwasa and Gangotri completed and digestion of the samples is under progress.
    - iv) Processing of hydro-chemical data is under progress.

15. **End Users / Beneficiaries of the Study:** Policy makers and planners of State/Central Government Organizations
16. **Deliverables:** Technical report and research papers
17. **Major items of equipment procured:** i) Low Temperature pH Meter ii) Low Temperature EC Meter iii) Temperature probe with data logging iv) Deep Freezer
18. **Lab facilities used during the study:** Water Quality Laboratory (NIH)
19. **Data procured or generated during the study:** Hydro-chemical data of Gangotri Glacier
20. **Study Benefits / Impacts:**

- Study of low temperature ionic enrichment during interaction between glacial sediment and melt water especially for glaciers with huge supraglacial debris cover.
- Ionic enrichment dynamics of meltwater-glacial sediment interaction under open and close system.
- Provide a strong basis extending studies of solute variability and sediment and pollutant loading further downstream.

21. **Involvement of end users/beneficiaries:** Local people
22. **Specific linkage with Institution and /or end users / beneficiaries**: None
23. **Shortcoming/Difficulties:** No
24. **Future Plan:**

- Collection Suspended sediment samples and meltwater samples from selected sites for the ablation period of year 2015.
- Study of closed system characteristics and open system dynamics
- Geochemical analysis of suspended sediment
- Processing of hydro-chemical data.

PROPOSED WORK PROGRAMME OF ENVIRONMENTAL HYDROLOGY DIVISION FOR THE YEAR 2015-16

S.No.	Study	Study Team	Duration
Internal Studies			
1.	Water Quality Modelling using Soft Computing Techniques	Rama Mehta (PI) C. K. Jain	2 Years (05/14-05/16)
2.	Himalayan River Water Quality Assessment in a Stretch from Gangotri to Hardwar	Rajesh Singh (PI) C. K. Jain M. K. Sharma S. P. Rai Renoj J. Thayyan J. P. Patra	3 Years (07/14-06/17)
Sponsored Projects			
1.	Ionic Enrichment Dynamics of Glacial Sediment and Melt water of Gangotri Glacier	M. K. Sharma (PI) C. K. Jain Renoj Thayyan Manohar Arora Naresh Saini Jatin Malhotra Rakesh Goyal Karan Jamwal	3 Years (04/14-03/17) Sponsored by DST, New Delhi
2.	Low Cost Technology for Purification of Arsenic and Microbes Contaminated Water using Nanotechnology	Vijaya Aggarwala, IITR (PI) Rama Mehta, NIH (Co-PI)	2 Years (04/14-03/16) Sponsored by DST, New Delhi

PROPOSALS FOR ORGANISING TRAINING WORKSHOPS/SEMINARS/ SYMPOSIA/ MASS AWARENESS PROGRAMME ETC. DURING THE YEAR 2015-16

TRAINING WORKSHOP - 1

PROFORMA FOR SUBMITTING PROPOSALS FOR ORGANISING TRAINING WORKSHOPS/SEMINARS/SYMPOSIA/MASS AWARENESS PROGRAMME ETC.

1. **Thrust Area under XII five year Plan :**
2. **Topic of Training Workshops/Seminars/Symposia/Mass Awareness Program etc :** Advanced Soft Computing Techniques in Hydrology and its Applications (ASCTHA-15)
3. **Convener :** Dr. Rama Mehta
4. **Co-ordinator :** Dr. A.K. Lohani
5. **Co Co-ordinator (S)/ Co-Organising Secretary (ies):**
6. **Faculty:** From NIH & IITR
7. **Duration of the programme :** One Week
8. **Tentative Schedule :** November, 2015
9. **Place at which Programme would be organized:** NIH, Roorkee
10. **No of Participants Expected:** 30-40

TRAINING WORKSHOP - 2

PROFORMA FOR SUBMITTING PROPOSALS FOR ORGANISING TRAINING WORKSHOPS/SEMINARS/SYMPOSIA/MASS AWARENESS PROGRAMME ETC.

1	**Thrust Area under XII five year Plan**	Water Quality
2	**Topic of Training Workshops/ ~~Seminars/Symposia/~~ ~~Mass Awareness Programmes~~ etc.**	**Water Quality Monitoring and Assessment**
3	**Convener**	Dr. C. K. Jain, Sc. G & Head, EHD
4	**Coordinator/ Organising Secretary**	Dr. M. K. Sharma, Sc. D, EHD
5	**Co-coordinator/ Co-organising Secretary**	Dr. Rajesh Singh, Sc. B, EHD
6	**Faculty**	From NIH, IITR, JNU and CPCB
7	**Duration of the programme**	5 days
8	**Tentative schedule**	December 2015
9	**Place at which Programme would be organized**	NIH Roorkee
10	**Number of participants expected**	30

TRAINING WORKSHOP - 3

PROFORMA FOR SUBMITTING PROPOSALS FOR ORGANISING TRAINING WORKSHOPS/SEMINARS/SYMPOSIA/MASS AWARENESS PROGRAMME ETC.

1	**Thrust Area under XII five year Plan**	Water Quality
2	**Topic of Training Workshops/ ~~Seminars/Symposia/Mass Awareness Programmes~~ etc.**	Design, Operation, and Maintenance of STPs and CETPs
3	**Convener**	Dr. C. K. Jain, Sc. G & Head, EHD
4	**Coordinator/ Organising Secretary**	Dr. Rajesh Singh, Sc. B, EHD
5	**Co-coordinator/ Co-organising Secretary**	Dr. M. K. Sharma, Sc. D, EHD Dr. Sumant Kumar, Sc. B, GWHD
6	**Faculty**	Annexure ‘A’
7	**Duration of the programme**	5 days
8	**Tentative schedule**	Annexure ‘B’
9	**Place at which Programme would be organized**	NIH Roorkee
10	**Number of participants expected**	25
11	**Budget Estimate**	Annexure ‘C’

Annexure ‘A’

DETAILS OF FACULTY MEMBERS

S.No.	Name	Designation	Qualification	Experience (Years)
1.	Er. R. D. Singh	Director	M. Tech.	33
2.	Dr. C. K. Jain	Sc. ‘G’	Ph.D.	30
3.	Dr. M. K. Sharma	Sc. ‘D’	Ph.D.	20
5.	Dr. Rajesh Singh	Sc. ‘B’	Ph.D.	13
6.	Er. Sumant Kumar	Sc. ‘B’	M. Tech.	7
7.	Dr. I. M. Mishra	Professor, IITR	Ph.D.	35
8.	Dr. A. A. Kazmi	Professor, IITR	Ph.D.	15
9.	Dr. Sudipta Sarkar	Asst. Professor, IITR	Ph.D.	18
10.	Dr. R. C. Trivedi	Chief Consultant, DHI	Ph.D.	35
11	Dr. R. M. Bhardwaj	Scientist ‘D’, CPCB	Ph.D.	25

Annexure 'B'

TENTATIVE SCHEDULE

Day 1, Monday		**Faculty**
0930 – 1030	Registration	-
1030 – 1130	Inauguration	-
1130 – 1200	Inaugural Tea	-
1200 – 1300	Status and Strategies for Management of Water Resources in India	Er. R. D. Singh
1300 – 1400	Lunch	-
1400 – 1500	Status of Water Supply, Wastewater Generation, & Treatment in India	Dr. R. C. Trivedi
1500 – 1600	Status of Sewage Treatment Plants in India	Dr. R. M. Bhardwaj
1600 – 1630	Tea	-
1630 – 1730	Water Quality Issues in India	Dr. C. K. Jain
Day 2, Tuesday		
0930 – 1030	General Principals of Wastewater Treatment – Chemistry & Wastewater Analyses	Dr. C. K. Jain
1030 – 1130	Basic Principles of Aerobic Digestion	Dr. Rajesh Singh
1130 – 1200	Tea	-
1200 – 1300	Sizing calculation for Aerobic Reactors	Dr. Rajesh Singh
1300 – 1400	Lunch	-
1400 – 1500	Operational issues related to CETPs	Dr. Sumant Kumar
1500 – 1600	Life cycle assessment of Treatment Plants	Dr. Sumant Kumar
1600 – 1630	Tea	-
1630 – 1730	Advanced instruments for Water Quality Monitoring	Dr. M. K. Sharma
Day 3, Wednesday		
0930 – 1030	Basic Principles of Anaerobic Digestion	Dr. Rajesh Singh
1030 – 1130	Sizing calculation for Anaerobic Reactors	Dr. I. M. Mishra
1130 – 1200	Tea	-
1200 – 1300	Operational Issues Related to Aerobic / Anaerobic Treatment Plants	Dr. Rajesh Singh
1300 – 1400	Lunch	-
1400 – 1500	Membrane Bioreactor - Basic Principles & Sizing Calculations	Dr. Rajesh Singh
1500 – 1600	Membrane Bioreactor - Operational Issues	Dr. Rajesh Singh
1600 – 1630	Tea	-
1630 – 1730	Tutorial	Dr. Rajesh Singh / Dr. M. K. Sharma
Day 4, Thursday	**Field Visit**	
Day 5, Friday		
0930 – 1030	Sequencing Batch Reactor – Basic Principles & Sizing Calculations	Dr. A. A. Kazmi
1030 – 1130	Sequencing Batch Reactor – Operational Issues	Dr. A. A. Kazmi
1130 – 1200	Tea	-
1200 – 1300	Bio-medical Waste Handling Practices in India	Dr. Sudipta Sarkar
1300 – 1400	Lunch	-
1400 – 1500	Health & Safety Aspects of Operating Treatment Plants	Dr. Rajesh Singh
1500 – 1600	Presentation by Participants on Sewage Treatment Plants & Panel Discussion	Dr. C. K. Jain / Dr. Rajesh Singh
1600 – 1700	Valedictory	-
1700 – 1730	Valedictory Tea	

GROUND WATER HYDROLOGY DIVISION

Scientific Manpower

S N	Name	Designation
1.	Dr. N C Ghosh	Scientist G & Head
2.	Er. C P Kumar	Scientist F
3.	Dr. Anupma Sharma	Scientist D
4.	Dr. Surjeet Singh	Scientist D
5.	Sri Sumant Kumar	Scientist C
6.	Ms. Shashi Poonam Indwar	Scientist B
7.	Sri Sanjay Mittal	SRA
8.	Sri S L Srivastava	SRA
9.	Sri Ram Chandra	RA

APPROVED WORK PROGRAMME OF THE DIVISION FOR THE YEAR 2014-15

S. No.	Project	Project Team	Duration & Status	Funding Source
1. NIH/GW D/NIH/1 1-14	Management of Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)	Sumant Kumar (PI) Rajan Vatsa N. C. Ghosh C. P. Kumar Surjeet Singh Sanjay Mittal	4 years (04/11 – 03/15) **Status: Completed**	Saph Pani Project/ extended period as internal funding
2.	Flow and Contaminant Transport Modeling of Riverbank Filtration	Shashi P. Indwar (PI) N.C. Ghosh Anupma Sharma Rajan Vatsa	3 ½ years (04/12 – 09/15) **Status: In progress**	Extended period as internal funding
3. NIH/GW D/NIH/14 -17	Management of Water Resources for Quantity and Quality in Yamuna-Hindon Inter-basin	Anupma Sharma (PI) N. C. Ghosh Other NIH study team members Collaborating Institute: CED, IIT-Roorkee	3 years (12/14 – 11/17) Status: **In progress**	Internal Funding
4.	Ganges Aquifer Management for Ecosystems services (GAMES)	Sharad Kumar Jain (PI) N. C. Ghosh Sudhir Kumar Sanjay Kumar Jain M. K. Goel Anupma Sharma Surjeet Singh	1 year (06/14 – 05/15) **Status**: **In progress**	IWMI, Hyderabad
Proposed New Studies				
5. NIH/GW D/NIH/15 -18	Development of Website and e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*"	C. P. Kumar (PI) Anupma Sharma Shashi P. Indwar Sanjay Mittal	2.5 years (04/15 – 9/17) **Status**: **New**	Internal Funding
6. NIH/GW D/NIH/15 -16	Diagnosis Survey and Selection of Suitable Sites for Development of Riverbank Filtration Demonstration Schemes in Different States	Surjeet Singh (PI) N.C. Ghosh C. P. Kumar Sumant Kumar Sanjay Mittal	1 year (04/15 – 3/16) **Status: New**	Internal Funding
7. NIH/GW D/NIH/15 -16	Alternate Water Supply Management Strategies in Arsenic Affected/Vulnerable Areas: Mapping of Arsenic Affected Zones/Regions in Eastern U.P.	Sumant Kumar (PI) & S. P. Indwar (PI) N. C. Ghosh R. P. Singh Rajesh Singh S. L. Srivastava	1 year (04/15 – 3/16) **Status: New**	Internal Funding

The detailed status of the studies is given in Annexure-I.

Staff Strength and Facilities Available

Scientists : 7 (Dr. N. C. Ghosh, Sc.-G; Mr. C. P. Kumar, Sc.-F; Dr. Anupma Sharma, Sc.-D; Dr. Surjeet Singh, Sc.-D; Mr. Rajan Vatsa, Sc.-B; Mr. Sumant Kumar, Sc.-B; Ms. Shashi Poonam Indwar, Sc.-B)

Scientific Staff: 8 (SRA-2, RA-1; Tech-3; PS-1; MTS-1)
Resource Person -1

Soil-Water Laboratory is functioning under the division.

The division is in the process of establishing the '*Centre of Excellence for Advanced Groundwater Research*".

Status of Outreach Activities Carried Out During the Year 2014-2015

1. Organized a one-week training course on "*Groundwater Modeling using MODFLOW and MIKESHE*" during 02-06 February, 2015.

2. Scientists of the division published/accepted 8 papers in international journals, 8 papers in national journals and 2 papers in international conferences.

3. Scientists/scientific staff delivered 16 lectures/tutorials in different training courses and workshops.

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

Title: **Managed Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)**

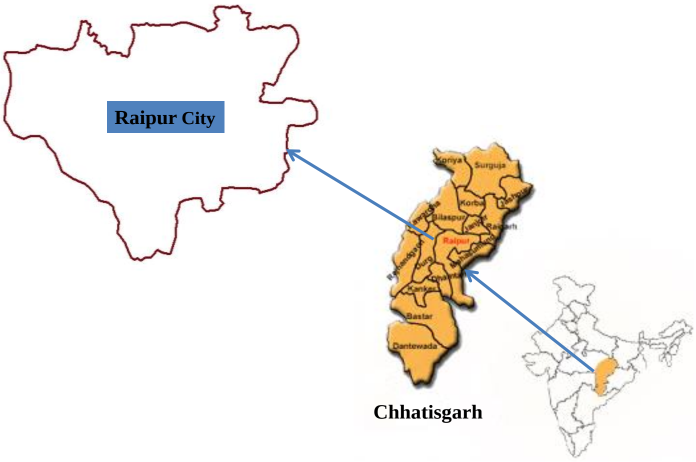
Team members : 1) Mr. Sumant Kumar - PI
2) Mr. Rajan Vatsa - Co-PI
3) Dr. N. C. Ghosh
4) Mr. C. P. Kumar
5) Dr. Surjeet Singh
6) Mr. Sanjay Mittal
7) Dr. R. P. Singh

Type of study : Internal under the framework of “Saph Pani” Project.

Date of start : April, 2011

Scheduled date of completion : March, 2015 (with 1 year extension)

Location map Raipur Municipal boundary forms the study area which lies between 21°10’and 21°21’ N latitudes and 81°32’ to 81°44’E longitudes. Raipur is the capital of Chhattisgarh state.



Objectives
1) To identify the potential recharge sites for groundwater resources augmentation,
2) To model and analyze aquifer responses due to the recharge from the identified potential recharge sites,
3) To manage the augmented groundwater resources for subsequent potential uses.

Statement of the problem, end users/beneficiaries of the study:
Raipur city has 154 small and large water bodies. These water bodies are natural and manmade, locally called “talab”. These talabs are connected by storm water channels and hence specific catchment area. Out of the 154 talabs, 85 talabs are in place, remaining talabs have lost their entity because of the developmental activities. Most of the existing talabs face deteriorating water quality due to disposal of municipal wastes both solid and liquid.

Raipur area also faces problem of depleting groundwater levels due to its excessive withdrawal. To overcome these problems, a Managed Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR) scheme has been envisaged, as a pilot study with objectives to enhance groundwater recharge from Teliabandha talab through aquifer storage treatment. It has been found out that recharge is very less through the talab. Therefore, we are attempting to study other talabs so that we can make possible best use of surface water from these water bodies.

Approved action plan

- Literature review
- Field investigation and data collection
- Determination of availability of surface water and groundwater
- Recharge site identification
- Estimation of groundwater recharge and simulation of aquifer response
- Analysing water supply and demand Pattern
- Demand management

Objectives & Achievements

To identify the potential recharge site for groundwater augmentation	Recharge site (Teliabanda lake) has been identified.
To model & analyze aquifer response due to the recharge from the identified potential recharge site	Semi-analytical model has been developed to estimate recharge.
To manage the augmented GW resources for subsequent potential uses	It has been estimated that recharge from selected recharge site (Teliabandha lake) is very less due to hydro-geological condition and water quality is also bad. Other prominent talabs have also been assessed for water quality to make best possible uses of surface water. Studied the feasibility of joint optimal surface water and groundwater uses for sustainability of groundwater potential.

Analysis and Results

A comprehensive analysis of hydrological, hydrogeological and water quality aspects of Teliabandha lake and its catchment has been carried out. The analysis of hydrological components included: rainfall-runoff modelling, evaporation rate and lake water quality assessment. The hydrogeological components included: aquifer characterization, aquifer parameters estimation, groundwater level and quality analysis. The groundwater recharge rates for variable inflows and outflows to/from the lake have been quantified by developing a semi-analytical model integrating Hantush's (1967) analytical expression for water table rise due to recharge from a rectangular spreading basin into the basic water balance equation of the lake. The basic concept followed in estimating the unsteady groundwater recharge consequent from variable inflows and outflows is water balance of the lake. The groundwater recharge rate has been found very low varying between 3.75 mm/day and 4.82 mm/day for depth of water in the lake ranging between 2.5 m and 3.36 m. The geological formation of thick limestone formation for the site poses constraints - a limiting factor for MAR-ASTR proposition. The lake water quality data analysis show that the turbidity and chemical oxygen demand exceed the permissible limits mentioned in BIS (10500-2012) guidelines for drinking water. In addition to this, the presence of fecal coliform and total coliform have been found in the lake water.

MAR and ASTR are not feasible due to hydrogeological conditions and bad water quality of Teliabandha lake. Therefore, it is proposed to study other prominent lakes for management of surface water. The reduced level of lake bed has been measured using DGPS. Using the lake bed R.L., critical path for the connectivity of different water sources has been studied but it is found that it is not a feasible option due to densely populated habitation and also there are topographical mounds in between the lakes. To assess the suitability of surface water and groundwater for different purposes, water samples were collected from both the sources. The chemical water quality data of twenty seven prominent lakes and 8 groundwater samples have been analyzed, classified and studied for their suitability for drinking and irrigation purposes.

The water samples were collected and analyzed for pH, Turbidity, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Alkalinity, Hardness, Sodium (Na^+), Potassium (K^+), Calcium (Ca^{++}), Magnesium (Mg^{++}), Bicarbonate ($HCO3^-$), Sulphate (SO_4^{2-}), Nitrate (NO_3^-), Fluoride(F^-), Chloride (Cl^-), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Total Coliform (TC) and Fecal Coliform (FC). There are variations for pH (6.59-8.29), EC (382-2330 µS/cm), Turbidity (1-232 NTU), TDS (244-1491 mg/L), Alkalinity (120-600 mg/L), Hardness (66-330 mg/L), Na^+(37-430 mg/L), K^+ (8-253 mg/L), Ca^{++} (9-90 mg/L), Mg^{++}(3-26 mg/L), SO_4^{2-} (5-200 mg/L), NO_3^-(0-19 mg/L), F^-(0.18-1.41 mg/L) and Cl^- (46-388 mg/L), DO(1-8.6 mg/L), BOD (0.1-11.3 mg/L), COD (8-118 mg/L), Total Coliform (15-3600 MPN/100ml) and Fecal Coliform (4-240 MPN/100 ml). The results have been compared with the drinking water standard prescribed by Bureau of Indian Standards (BIS). All the physio-chemical parameters are within the prescribed limit except turbidity, fecal and total coliform. The Sodium Adsorption Ratio (SAR), salinity hazards have been studied to classify the water for irrigation uses. It is found that lake water is suitable for irrigation purposes. It may be concluded that solid and liquid wastes of any kind should not be discharged in the lakes. The solid wastes deposited on the lake bottom should be dredged out to enhance the recharge.

2. PROJECT REFERENCE CODE: EU-sponsored Project no. 282911

Title of the study: Flow and Contaminant Transport Modeling of Riverbank Filtration.

Name of PI: Mrs. Shashi Poonam Indwar, Sc-B

Co-PI: Dr. N. C. Ghosh, Sc-G
Team Members: Dr. Anupma Sharma, Sc-D
Mr. Rajan Vatsa, Sc-B
Mr. Sanjay Mittal, SRA

Type of study: Internal under the framework of 'Saph Pani' Project

Nature of study: Technology or technique development

Date of start: April 2012

Scheduled date of completion: September 2015 (with extension)

Location map
India

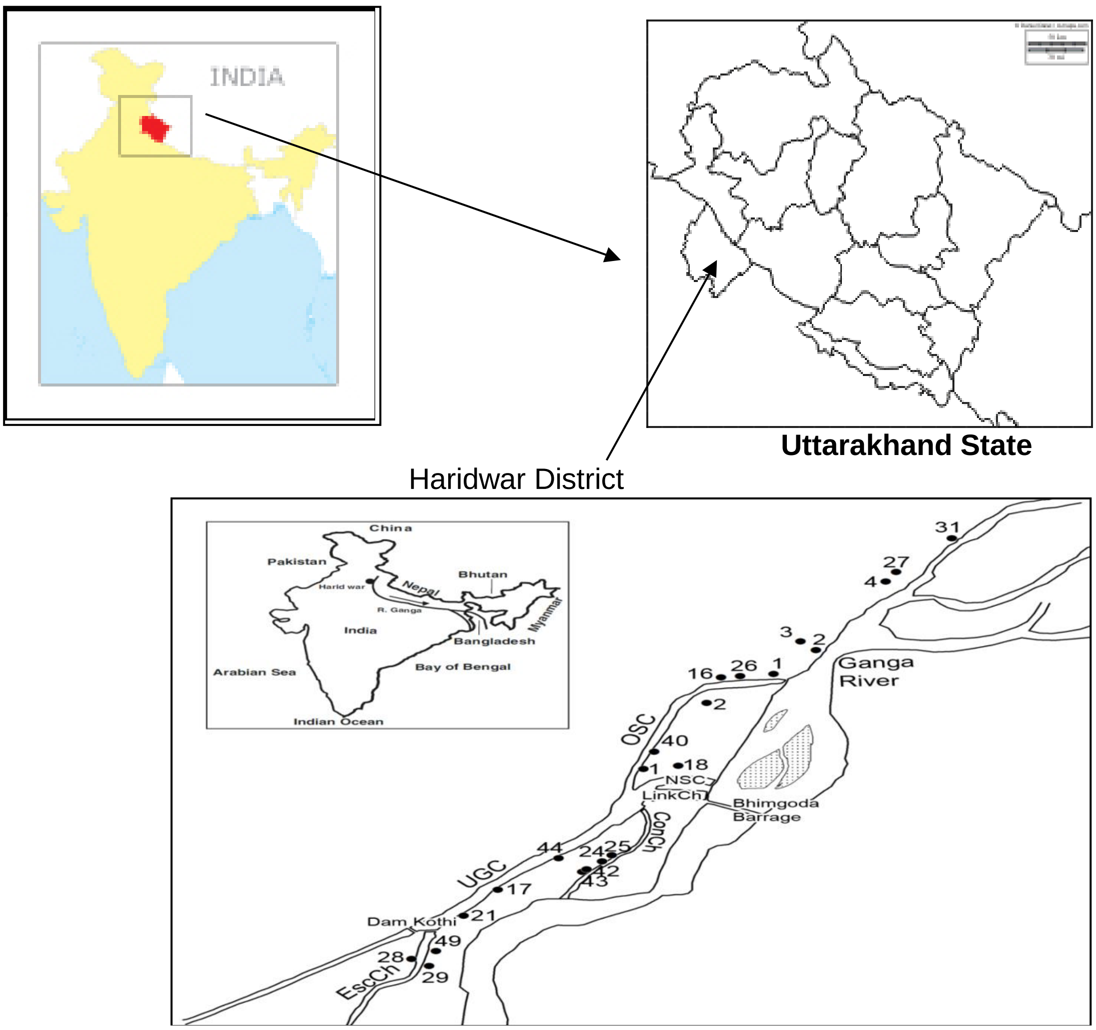


Figure1. Study area of the riverbank filtration site with 22 Infiltration wells in Haridwar, India

Study objectives:

(i) To analyze and model the flow paths and travel times of the existing bank filtration sites along the bank of Ganga river in Haridwar,
(ii) To model and evaluate removal performance of organic pollutants, coliform bacteria and other pathogens by bank filtration.

Statement of the problem:

Uttarakhand Jal Sansthan, Haridwar has installed 22 infiltration wells along the bank of Ganga river. These wells are operated to supply drinking water to the nearby areas in the Haridwar City with post treatment. During monsoon period, as post treatment, sodium hypochlorite is used in the well as disinfection. These wells are located at varying distances (50-495m) from the river centerline and have been constructed at varying depths (7-10m) below ground surface. It is considered that due to bank filtration and mixing of nearby groundwater, these wells are producing good quality of water, to the extent of permissible limit, and removing the pathogenic loads satisfactorily.

The present study is intended to analyze and model the flow paths, travel times of bank filtrate water from river to the well for the given hydrogeological setups and varying flow conditions in the river. It would further be attempted to develop a flow and contaminant transport model based on the existing scenario.

Approved action plan:

- Data collection and base data computerization
- Conceptualization of the problem, model setup, model data preparation
- Part-I report preparation - model calibration, validation and analysis
- Contaminant transport modeling and analysis etc.
- Final report preparation

Action plan for the years (2012-2015)

Review of literature	Completed
Reconnaissance survey of study sites	Completed
Data collection and base data analysis	Completed
Analysis of field data (conceptualization of the problem, model setup, model data preparation)	Completed
Contaminant transport modeling and analysis	Under progress

Objectives and Achievements:

Objectives	Achievements
• To analyze and model the flow paths and travel times of the existing bank filtration sites along the bank of Ganga river in Haridwar	• The baseline data for flow and contaminant transport modelling has been collected and assimilation of various other data related to flow modelling is complete. • The conceptual framework for the flow model has been prepared. Steady-state modelling of bank filtrate travel-time and flow path is complete.
• To model and evaluate removal	• Will be followed up after first objective

performance of organic pollutants, coliform bacteria and other pathogens by bank filtration	

Analysis and Results:

To determine the water quality improvement of riverbank filtrate, samples of groundwater, surface water and RBF wells water were collected once a month. Comparison of water quality parameters for surface water, groundwater and infiltration wells enables in assessment of natural treatment process of riverbank filtrate as it moves in the subsurface. Analysing major ions such as Na^{2+}, K^{+}, $Ca^{2+,}$ Mg^{2+} SO_4^{2-} NO_3^{-} which are essential elements enables to assess the mineralization process of water during the subsurface passage. Concentration graph showing the major ions present in surface water, groundwater and infiltration wells has been plotted to depict the same for Bhupatwala, Pantdweep and Beragi Camp area. Ferrous and Manganese are essential dietary elements present in water and according to WHO (2011), the recommended health based limit values for Fe^{2+} and Mn^{2+} are 2 mg/L and 0.4 mg/L, respectively. Concentration plot for Ferrous and Manganese present in river and nearby RBF wells for Bhupatwala, Pantdweep and Bairagi camp depict that surface water is having higher concentration of Ferrous and Manganese ranging from 2.1 to 5.5 mg/L and from 1.9 to 6.7 mg/L, respectively during monsoon, as higher discharge and flow velocities cause erosion of Fe^{2+} and Mn^{2+} which is accumulated in riverbed during low flow in river. Turbidity is the measure of relative clarity of a liquid. The turbidity of Ganga river (upstream and downstream of Bhimgoda barrage) is 2 to 15 times more in monsoon season due to high flow velocities, high runoff and erosion of soil and riverbed materials respectively. The turbidity of the abstracted water is below the Indian Standard limit of 5 NTU (IS 10500, 1993) during monsoon and non-monsoon.

Analysis of field data (conceptualization of the problem, model setup, model data preparation): The conceptualization of the flow model has been completed. DEM (Digital Elevation Model) for the study area using ASTER data has been generated. Aquifer characterization is complete and various hydrogeological and hydraulic data for setting up the flow model completed. Modelling of bank filtrate flow-path in steady state condition for existing bank filtration sites in Haridwar is completed. Modelling of bank filtrate travel time and calibration is under progress.

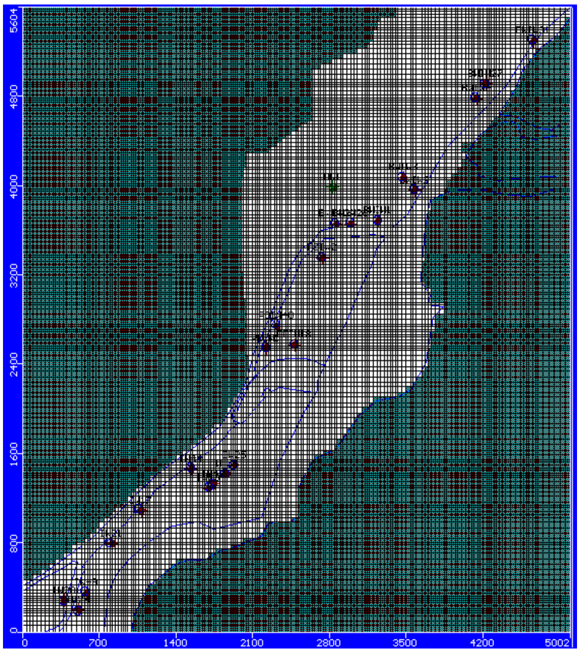


Figure 2. Discretized setup of MODFLOW domain: red circles - pumping wells; green circles - observation points. Total of 50*60 grids, each of size 100m*93.3m, refined by 2 i.e 12.5m*11.6m grid size

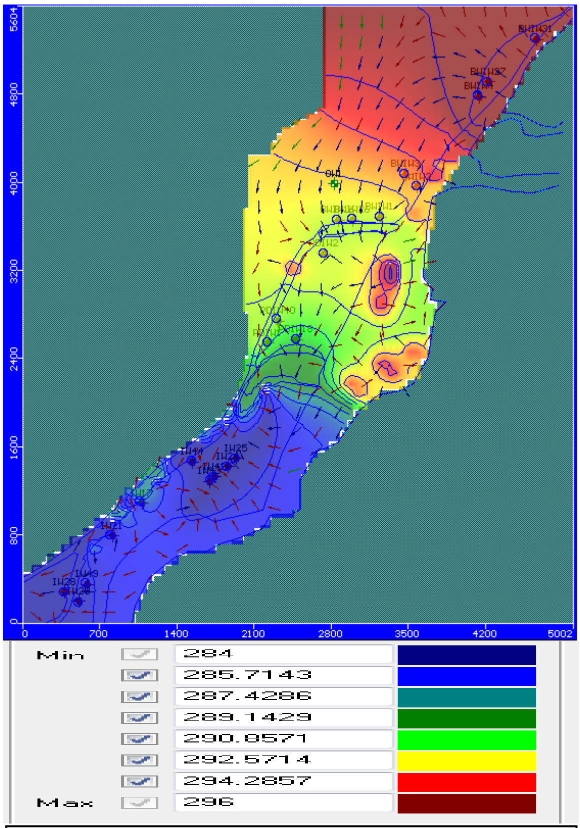


Figure 3. Flow path generated for pumping wells, Ganga river and canal in steady state condition under monsoon period (23.08.12)

List of deliverables: Technical Reports, training programmes, user's interaction workshop and papers

3. PROJECT REFERENCE CODE: NIH/GWD/INT/14-17

Title of the study: **Management of Water Resources for Quantity and Quality in Yamuna-Hindon Inter-basin**

Study team:

- Coordinator : Dr. N. C. Ghosh, Scientist-G, GWH Div.
- PI : Dr. Anupma Sharma, Scientist-D, GWH Div.
- Study Group : Groundwater Hydrology division in collaboration with study group from IIT Roorkee

Type of study (sponsored/consultancy/referred/internal): Internal (at present)

Date of start: December 2014

Duration of study: Three years

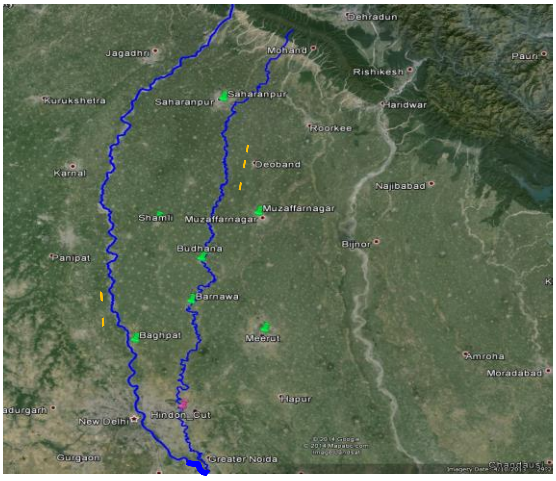
Study objectives:

1. Numerical modeling for optimal management of surface water and groundwater in Yamuna-Hindon inter-basin
2. Strategies for groundwater management associated with climate variability events
3. Assessment of surface water and groundwater quality degradation due to disposal of municipal and industrial effluents and impact on groundwater pumpage

Need for study and Specific linkages with Institutions and/or end-users/beneficiaries:

Severe water quality degradation issues have affected domestic and irrigation water supply in the fertile Yamuna-Hindon inter-basin. Need to develop strategies for conjunctive management of water resources in the region.

Location map:



Objectives vis-à-vis Achievements:

Objectives	Achievements
Literature review	Completed till date
Data collection	Collection of historical data groundwater levels, river stage data, crop cultivation, irrigation schemes, relevant reports and maps,

	meteorological data, data collection during field visit
Field experiments and Laboratory investigations	- Soil samples collected - Soil sample analyses in laboratory for soil moisture characteristics
Database preparation	DEM, Fence diagram, Land use, Water balance (under progress)
Data analysis	Analysis of water table and water quality data, satellite data, land use, Analysis of soil samples and data for infiltration and saturated hydraulic conductivity

Adopters of the results of the study and their feedback: Study yet to be completed

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

1. Reports
2. Research Papers

Lab facilities used during the study:

1. Soil and Groundwater Lab, NIH
2. Water Quality Lab, NIH

Future plan:

1. Field surveys and data collection
2. Groundwater and surface water quality analysis to continue
3. Numerical simulations

4. PROJECT REFERENCE CODE: NIH/GWD/INT/15-18

Thrust Area under XII five year Plan: Technology Transfer and Outreach Activities

1. Project team:

a) Project Investigator — Mr. C. P. Kumar

b) Project Co-Investigator(s) — Dr. Anupma Sharma
Ms. Shashi Poonam Indwar
Mr. Sanjay Mittal

2. Title of the Project: Development of Website and e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*"

3. Objectives:

- To develop website and e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*".
- Information dissemination as well as gathering responses and opinions through e-Portal.

4. Present state-of-art

Presently, no website/e-Portal exists in India where information related to mitigation and remedy of arsenic menace in India is disseminated and responses and opinions are gathered.

5. Methodology

- Presentation by NIC empanelled vendors on suitable designs of website/e-Portal on "Mitigation and Remedy of Arsenic Menace in India" and/or Brain Storming Session to finalize the requirements of website/e-Portal
- Registration of domain name (gov.in)
- Procurement of server (to be hosted in Computer Centre of NIH, Roorkee) and other necessary hardware and software
- Development of website and e-Portal on "Mitigation and Remedy of Arsenic Menace in India"
- Release of website/e-Portal and Brain Storming Session to discuss the relevant issues
- Information dissemination, gathering responses and opinions through e-Portal
- Maintaining and updating the website/e-Portal

6. Research outcome from the project

Website/e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*" and responses/opinions on related issues.

7. Work Schedule:

a) Probable date of commencement of the project: April 2015

b) Duration of the project: 2.5 Years (April 2015 to Sept. 2017)

c) Stages of work and milestone:

S. No.	Work Element	First Year	Second Year	Third Year
1.	Presentation by NIC empanelled vendors on suitable designs of website/e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*" and/or Brain Storming Session to finalize the requirements of website/e-Portal			
2.	Registration of domain name (gov.in)			

S. No.	Work Element	First Year	Second Year	Third Year
3.	Procurement of server (to be hosted in Computer Centre of NIH, Roorkee) and other necessary hardware and software			
4.	Development of website and e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*"			
5.	Release of website/e-Portal and Brain Storming Session to discuss the relevant issues			
6.	Information dissemination, gathering responses and opinions through e-Portal			
7.	Maintaining and updating the website/e-Portal *(to be continued beyond the project period)*			

5. PROJECT REFERENCE CODE: NIH/GWD/INT/15-16

Thrust Area under XII five year Plan: Sustainable Management of Surface and Groundwater.

1. Project team:

a. Project Investigator — Dr. Surjeet Singh

b. Project Co-Investigator(s) — Dr. N.C. Ghosh
Mr. C. P. Kumar
Mr. Sumant Kumar
Mr. Sanjay Mittal

2. Title of the Project: Diagnosis Survey and Selection of Suitable Sites for Development of Riverbank Filtration Demonstration Schemes in Different States.

3. Objectives:

i. Baseline data collection and database generation for selected river bank filtration demonstration schemes,
ii. Preliminary analysis of data and selection of suitable sites for development of riverbank filtration scheme.

4. Present state-of-art

Based on the successful demonstration of “Saph Pani” (Saph Pani, 2011-2014) results on “Bank Filtration (BF)” and recommendations of the final conference of the project, as follow up action on promotion of bank filtration technique in India for different hydrogeological settings to attain drinking water security, Secretary (WR, RD & GR) in the 75th meeting of Governing Body of NIH held on 19th January, 2015 desired that NIH should develop 6 (six) pilot demonstrate schemes on BF in different feasible locations particularly in the Ganga basin as implementable R & D project and submit the project proposal in the Ministry of Water Resources, River Development and Ganga Rejuvenation, Govt. of India for financial support. The primary purpose of Ministry of WR, RD & GR in developing pilot study schemes in different locations is to demonstrate drinking water department about effectiveness of BF technique in supply of safe drinking water in peri-urban and rural areas.

NIH together with a number of other organizations (IIT Roorkee; Uttarakhand Jal Santhan, and University of Applied Sciences Dresden (HTWD), Germany) had carried out 3 years extensive studies on various aspects of ‘Riverbank Filtration (RBF)’ technique based on the schemes developed at Haridwar, Srinagar and Nainital in Uttarakhand and in Delhi region. The performance and results of those schemes reported in the final Conference and reports of the project showed promising potential of extending the technique in other parts of the Country.

The Institute is proposing to develop 6 pilot riverbank filtration (RBF) schemes at different places namely; one site at Laksar area in Uttarakhand; two sites in Uttar Pradesh, one at Mathura area and other one at Agra, one site in Bhojpur area in Bihar; one site in Sahebganj area in Jharkhand; and one site in at Visakhapatnam area in Andhra Pradesh.

5. Methodology

- Literature survey on the guidelines and pre-requisites for the selection of river bank filtration sites.
- GIS database development.
- Collection of exiting river flows and groundwater related data including water quality.
- Field visits and collection of water samples and analysis.
- Collection of hydro-meteorological and hydro-geological data and processing.
- Identification of suitable RBF sites.

6. Research outcome from the project

The outcome of the study will help in development of the demonstration sites for the riverbank filtration.

7. Work Schedule:

a. Probable date of commencement of the project: April 2015
b. Duration of the project: 1 Year (April 2015 to March 2016)
c. Stages of work and milestone:

Sl. No.	Work Element	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1	Literature survey				
2	GIS database development				
3	Collection and procurement of meteorological & Hydro-geological data				
4	Field visit and collection of data & information				
5	Data analysis				
6	Collection of water samples and analysis				
7	Identification of suitable RBF sites and dissemination workshop with line departments				
8	Preparation of final report				

5. PROJECT REFERENCE CODE: NIH/GWD/INT/15-16

Thrust Area under XII five year Plan: Groundwater Contamination-remediation Modeling

1. **Project team:**
   a. **Project Investigators:** Sumant Kumar Sc-B and Shashi Poonam Indwar Sc-B, GWHD
   b. **Project Co-Investigator(s):** Dr. N.C.Ghosh Sc-G, GWHD
      Dr. R.P. Singh, SRP, GWHD
      Dr. Rajesh Singh, Sc-B, EHD
      Sri S.L. Srivastava, S.R.A, GWHD

2. **Title of the Project:** Alternate Water Supply Management Strategies in Arsenic Affected/Vulnerable Areas: Mapping of Arsenic Affected Zones/Regions in Eastern U.P.

3. **Objectives:**
   (i) Diagnosis survey of the area affected by and vulnerable to arsenic contamination.
   (ii) Baseline data collection from arsenic affected areas and analyses for arsenic risk mapping.
   (iii) Characterization of hydrogeological units in respect of arsenic toxicity in groundwater.
   (iv) Groundwater quality sampling campaign and assessment for affirmation and validation of databases.

4. **Present state-of-art: Selected demand driven R & Ds on "Arsenic Mitigation"**

Occurrence of arsenic in groundwater, in excess to the permissible limit of 50 µg/L in the Ganges-Brahmaputra fluvial plains in India covering 10 states namely West Bengal, Jharkhand, Bihar, Uttar Pradesh in flood plains of Ganga river; Assam and Manipur in flood plain of Brahmaputra and Imphal rivers and Rajnandgoan village in Chhattisgarh state, is one such large scale groundwater quality disaster, described internationally as the World biggest natural groundwater calamity to the mankind after Bangladesh. These fluvial plains represent Holocene aquifers of recent alluvial sediments and have the routes originated from the Himalayan region. Since the groundwater arsenic contamination first surfaced in 1983 from nearly 33 villages in 4 districts in West Bengal, up till 2008; 9 districts covering 3417 villages in 111 blocks in West Bengal, 15 districts covering 68 villages in 3 blocks in Jharkhand, 3 districts covering 9 blocks in Assam, 4 districts in Manipur, and 1 district covering 4 villages in 1 block in Chhattisgarh have been detected for groundwater arsenic contamination. With every new survey, new arsenic affected villages and people suffering from arsenic related diseases are being reported and the problem resolving issues are getting complicated by a number of unknown factors. Further to those, Arsenic groundwater contamination has far-reaching consequences including its ingestion through food chain, which are in the form of social disorders, health hazards and socio-economic dissolution besides its sprawling with movement, and exploitation of groundwater. Whether the knowledgebase, understandings and technological options available are adequate to resolve the issues or, there are further needs of more investigations and studies to strengthen understanding of geochemical processes to mitigate and remediate arsenic from groundwater, are some of the concerns to be addressed for attaining sustainability in supply of arsenic safe groundwater to affected areas.

Groundwater arsenic contamination in UP was first exposed in 2003 by SOES from survey of 25 villages in Ballia district. Thereafter, with continued survey two more districts, Gazipur and Varanasi were detected for arsenic groundwater contamination. As of 2008, 3 districts covering 69 villages in 7 blocks in Uttar Pradesh were found affected by arsenic groundwater contamination and people suffering from arsenical skin lesions. They used to drink water of hand pump operated tube wells. All those tube wells tap groundwater from shallow aquifer below 20-30 m. All the arsenic affected districts in UP and 12 districts in Bihar are aligned along the linear track of the Ganga river. The Ganga alluvium is divided into (i) older alluvium of middle to late Pleistocene age and (ii) newer alluvium of Holocene age. The results of studies carried out by different agencies/researchers have one commonality that the concentration of arsenic (As^{3+}) more than permissible limit of 50 µg/l occurs in the groundwater from newer alluvium of Holocene age and the groundwater occurring in the older alluvium. This suggests that the arsenic contamination is of geogenic nature. The proposed study focuses on mapping and zoning the arsenic concentration and hence the methodology is devised with the central idea to map the geographical spread and vertical continuity of older and newer alluvium both.

The proposed study has been undertaken in light of the recommendation given by Inter-Ministerial Group (IMG) on “Arsenic Mitigation” constituted by Ministry of Water Resources, River development & Ganga Rejuvenation and Public Accounts Committee (PAC, eighth report, 16th Lok Sabha) on ‘Water Pollution in India’. PAC recommended under Groundwater Pollution: “Alternate sustainable programmes be launched for ensuring supply of arsenic-free water through conjunctive use of surface water and in situ groundwater after thorough scientific studies”. The proposed study will be a step forward in understanding the root causes and magnitude of arsenic contamination in eastern U.P. and for attaining sustainable supply of arsenic safe groundwater to affected areas.

5. Methodology

- Compilation of available literature on arsenic contamination in the area.
- Data acquisition on hydrogeology (lithologs, historical data on water level, aquifer parameters and well characteristic etc.), hydrochemistry, health effects due to arsenic contamination and arsenic removal technologies.
- Preparation of fence diagrams showing the lateral and vertical extensions of older alluvium and newer alluvium and correlating the arsenic concentration with geology.
- Collection of groundwater samples from eastern U.P. (Kushi Nagar, Deoria, Ballia, Ghazipur, Chandauli, Sonbhadra, Maharajganj, Gorakhpur, Azamgarh, Mau, Varanasi and Mirzapur). Analyzing the samples with an emphasis on arsenic speciation.
- Data analysis and interpretation to understand the source of contamination.
- Preparation of the arsenic speciation zone maps in the GIS environment.

6. Research Outcome from the Project :

a. Geo-spatial data base of arsenic contamination
b. Correlation of arsenic concentration with geology
c. Technical report and papers

7. Work Schedule

a. Probable date of commencement of the project : April, 2015
b. Duration of the project : 1 Year
c. Stages of work & milestone

S.No.	Major Activities	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
1	Literature Survey				
2	Field Investigation				
3	Sample Collection and Analysis				
4	Data Collection and Interpretation				
5	Final Report				

PROPOSED WORK PROGRAM OF GROUND WATER HYDROLOGY DIVISION FOR THE YEAR 2015-16

S. No.	Project	Project Team	Duration & Status	Funding Source
1.	Flow and Contaminant Transport Modeling of Riverbank Filtration	Shashi P. Indwar (PI) N.C. Ghosh Anupma Sharma Rajan Vatsa	3 ½ years (04/12 – 09/15) **Status: In progress**	Extended period as internal funding
2. NIH/GWD/NIH/14-17	Management of Water Resources for Quantity and Quality in Yamuna-Hindon Inter-basin	Anupma Sharma (PI) N. C. Ghosh Other NIH study team members Collaborating Institute: CED, IIT-Roorkee	3 years (12/14 – 11/17) Status: **In progress**	Internal Funding
3.	Ganges Aquifer Management for Ecosystems services (GAMES)	Sharad Kumar Jain (PI) N. C. Ghosh Sudhir Kumar Sanjay Kumar Jain M. K. Goel Anupma Sharma Surjeet Singh	1 year (06/14 – 05/15) **Status**: **In progress**	IWMI, Hyderabad
4. NIH/GWD/NIH/15-18	Development of Website and e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*"	C. P. Kumar (PI) Anupma Sharma Shashi P. Indwar Sanjay Mittal	2.5 years (04/15 – 9/17) **Status**: **New**	Internal Funding
5. NIH/GWD/NIH/15-16	Diagnosis Survey and Selection of Suitable Sites for Development of Riverbank Filtration Demonstration Schemes in Different States	Surjeet Singh (PI) N.C. Ghosh C. P. Kumar Sumant Kumar Sanjay Mittal	1 year (04/15 – 3/16) **Status: New**	Internal Funding
6. NIH/GWD/NIH/15-16	Alternate Water Supply Management Strategies in Arsenic Affected/ Vulnerable Areas: Mapping of Arsenic Affected Zones/ Regions in Eastern U.P.	Sumant Kumar (PI) & S. P. Indwar (PI) N. C. Ghosh R. P. Singh Rajesh Singh S. L. Srivastava	1 year (04/15 – 3/16) **Status: New**	Internal Funding

HYDROLOGICAL INVESTIGATION DIVISION

Scientific Manpower

S N	Name	Designation
1.	Dr. Sudhir Kumar	Scientist G & Head
2.	Dr. S D Khobragade	Scientist E
3.	Dr. S P Rai	Scientist E
4.	Dr. M S Rao	Scientist D
5.	Sri S K Verma	Scientist D
6.	Sri P K Garg	Scientist B
7.	Sri Rajeev Gupta	SRA
8.	Sri U K Singh	SRA
9.	Sri V K Agarwal	SRA
10.	Sri Jameel Ahmed	SRA
11.	Sri Raju Juyal	RA
12.	Sri Vishal Gupta	RA

APPROVED WORK PROGRAMME OF HYDROLOGICAL INVESTIGATIONS DIVISION FOR THE YEAR 2014-2015

S. No	Study	Team	Duration/ Status
	INTERNAL STUDIES		
1.	Water Quality, Hydrogeology and Isotopic Investigations in SW Punjab	M. S. Rao (PI), C. P. Kumar Gopal Krishan	**3 years** (07/12-06/15) **Completed**
2.	Water Availability Studies for Sukhna Lake, Chandigarh	S. D. Khobragade (PI) C. P. Kumar Sudhir Kumar A. R. Senthil Kumar P. K. Garg V. K. Agarwal	**2 years** (04/13-03/15) **Continuing Study**
3.	Isotopic Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains	Sudhir Kumar (PI) C. K. Jain S. P. Rai S. D. Khobragade P. K. Garg Two officers each from Lucknow and Chandigarh office of CGWB)	**2 years** (07/13-06/15) **Continuing Study**
4.	Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes	S. K. Verma (PI) S. P. Rai (Co-PI) M. S. Rao C. P. Kumar Mohar Singh	**2 years** (10/13-09/15) **Continuing Study**
5.	Interaction between groundwater and seawater along the northern part of east coast of India	M. S. Rao (PI), Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16) **New Study**
6.	Isotopic investigation of benchmark Himalayan glaciers.	M. S. Rao (PI), S.P. Rai, Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16) **New Study**
7.	Assessment of dissolved radon concentration for groundwater investigations in Haridwar district	Pankaj Garg (PI), Sudhir Kumar, M. Someshwar Rao	**1 year** (01/15 – 12/15) **New Study**
	SPONSORED PROJECTS		
8.	Review of Groundwater Resources in the Indo-Gangetic Basin: A Case Study on Resilience of Groundwater in the Punjab to Withdrawal and Environmental Change	M. S. Rao (PI) C. P. Kumar, Gopal Krishan	**One year 8 months** (02/13-09/14) **Completed**
9.	The Structure and Dynamics of Groundwater Systems in Northwestern India under Past, Present and Future Climates	S. P. Rai (PI) M. S. Rao, Surjeet Singh, S. K. Verma C. P. Kumar, Sudhir Kumar, V. K. Agarwal Rajeev Gupta, S. L. Srivastava, Vishal Gupta, Mohar Singh	**3 years** (06/12-05/15) **Continuing Study**

S. No	Study	Team	Duration/ Status
10.	The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India	M. S. Rao (PI) C. P. Kumar S. P. Rai	**3 years** (09/12-08/15) **Continuing Study**
11.	Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques	S. P. Rai (PI) R. V. Kale, M. S. Rao C. P. Kumar, Sudhir Kumar, V. K. Agarwal Vishal Gupta, Mohar Singh	**3 years** (10/12-09/15) **Continuing Study**
12.	Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains	Sudhir Kumar (PI) S. P. Rai, S. D. Khobragade, C. K. Jain P. K. Garg	**2 years** (05/13-12/15)* **Continuing Study** ***Extended by IAEA***
CONSULTANCY PROJECTS			
13.	Integrated Hydrological Investigations of Sukhna Lake, Chandigarh for its Conservation and Management	Suhas Khobragade (PI)	**Initially 2 years** (7/11-12/13) **Completed**
14.	Hydrogeological Study for Dewatering of Jhamarkotra Mines, Distt. Udaipur	Sudhir Kumar (PI)	**3 years** (05/13-04/16) **Continuing Study**
15.	Impact Assessment of Ash Pond on the Groundwater Quality in the Surrounding Villages of NTPC Simhdri through Stable Isotopic Studies	Sudhir Kumar (PI)	**1 year** (07/13-06/14) **Completed**
16.	Isotopic Characterization of Groundwater of District Raigarh, Chhattisgarh	S. P. Rai (PI)	**6 months** (04/14-09/14) **Completed**
17.	Hydrogeological Studies for Ash Pond of 2 X 525 MW Maithon Power Limited and an Abandoned Coal Mine, District Dhanbad, Jharkhand	Sudhir Kumar (PI)	**3 months** (06/14-8/14) **Completed**
18.	Possible impact of construction activities in Kansal area (Mohali, Punjab) on water flow to Sukhna lake in Chandigarh	Suhas Khobragade (PI)	**2 months** (9/14-11/14) **Completed**

Type of study/Project	*Completed in FY 2014-15*	*To be Continued in FY 2015-16*	*Total as per approved program*
Internal Studies	2	5	7
Sponsored Projects	1	4	5
Consultancy Projects	5	1	6
Total	8	10	18

The progress and the results of the internal studies and the sponsored projects is given below:

INTERNAL STUDIES:

1. *PROJECT REFERENCE CODE: NIH/HID/INT/2012-14/2*

Thrust Area under XII five year Plan:

Water Quality and Health

Title of the Study:

Water Quality, Hydrogeology and Isotopic Investigations in SW Punjab

Status: *Study completed and presented in 41st Working Group Meeting held on 26-27 November, 2014*

2. PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/1

Thrust Area under XII five year Plan:

Hydrology for watershed management (Hydrology of lakes & other water bodies)

Title of the Study:

Water Availability Studies for Sukhna Lake, Chandigarh

Project Team :

(a) Project Investigator: S. D. Khobragade (PI)
(b) Project Co-Investigator(s): Sudhir Kumar, C. P. Kumar, A. R. Senthil Kumar, P. K. Garg, V. K. Agarwal

Duration : April 2013 to March 2015

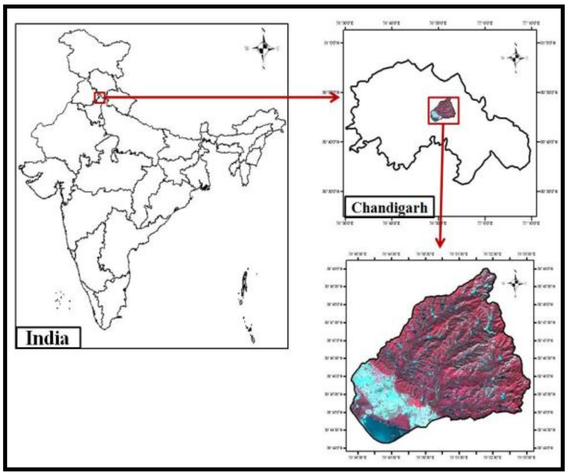
Statement of the Problem

Sukhna Lake in Chandigarh is a popular destination for recreation and tourism. However, the lake is in limelight in recent years due to various problems being faced by it. One of the serious problems of the lake is declining water availability in recent years. Water availability analysis has already been carried out based on limited available data, under a consultancy project for the lake carried out by NIH. Further detailed investigations are required on this aspect. The present study has therefore been proposed as Phase-II of the investigation being carried out on Sukhna Lake by the Institute.

Objectives

1. To study inflow regime of the lake
2. To study seepage losses from the lake
3. To analyze long term trends in rainfall and evaporation
4. To study the impact of aquatic weeds on lake evaporation, and
5. To study water availability in the lake

Study Area



Objectives vis-à-vis Achèvements:

Objectives	Achievements
To study inflow regime of the lake	Inflow has been estimated using water balance approach for 2011, 2012, 2013 and 2014
To study seepage losses from the lake	Seepage has been estimated using water balance approach and based on analysis of long term of lake water levels
To analyze long term trends in rainfall and evaporation	Analysis has been completed using trend line method and statistical tests.
To study the impact of aquatic weeds on lake evaporation	In view of the fact that after the complete drying of the lake in 2012 summer and subsequent dredging, the weeds have vanished from the lake for the time being. So this objective has been dropped.
To study water availability in the lake	Water balance has been completed for the years 2011-12, 2012-13, and 2013-14.

Analysis and Results

Following observations have been made based on the water balance of the lake:

(i) Depending upon the rainfall characteristics, the lake can get a total inflow of about 200 Ham to 700 Ham in a water year (July to June), including direct rainfall over it and through surface runoff from the catchment. The contribution of direct rainfall may vary from 120 Ham to 200 Ham while the contribution by surface runoff from catchment may vary from 80 Ham to 500 Ham. During deficit rainfall years, the contribution from direct rainfall over the lake may be more than the runoff from the catchment.

(ii) Depending upon the rainfall characteristics, during monsoon season (July to September), the lake can receive about 200 Ham to 560 Ham of total inflow. The contribution of direct rainfall may vary from 100-150 Ham while the contribution of runoff from catchment may vary from 100-410 Ham.

(iii) Depending upon the water received by the lake during monsoon, the total losses from the lake in a water year (July to -June) may vary from 300 Ham - 450 Ham.

(iv) Depending upon the water levels of the lake, the seepage losses from the lake in a water year (July-June) can vary from 0 (zero) to 175 Ham. The seepage losses may vary from 0-60 Ham during monsoon (July-September) and 0-150 Ham during the post monsoon months (October-June). Higher is the post monsoon water level reached by the lake, more would be the seepage losses. At levels of 1956.3 m and below, the losses would be almost zero or negligibly small.

(v) Depending upon the water available in the lake, evaporation losses in a water year can be upto 300 Ham. The water losses due to evaporation during monsoon can be upto 80 Ham. As far as post monsoon season of October to June is concerned, the evaporation losses may vary from about 150 Ham- 220 Ham.

(vi) Inflow to lake in post monsoon season is almost 100% by rainfall falling directly over the lake.

(vii) In deficit rainfall years when the water levels are significantly low, evaporation is the single most important factor determining water losses from the lake with contribution above 90%, (if the water level is below 1156.3 ft level). Evaporation is always the important cause of water loss in summer irrespective of the water availability in lakes.

(viii) Seepage losses are very significant during monsoon months and during the months immediately succeeding the monsoon months till the water levels come down to the below critical mark. If the water levels are above the critical mark, then in the winter months, when evaporation rates are generally very low, seepage is a dominant factor in deciding the decline in water level.

Status: Study has been completed.

3. ***PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/3***

Thrust Area under XII five year Plan

Dynamics of deeper aquifers

Title of the Study:

Isotope Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains

Project Team:

(a) Project Investigator: Sudhir Kumar (PI)

(b) Project Co-Investigator(s): C. K. Jain, S. P. Rai, S. D. Khobragade, P. K. Garg, Two officers each from Lucknow and Chandigarh Regional Offices of CGWB

Duration : July 2013 to June 2015

Study Objectives: Objectives of the study are

i. To identify the various aquifers present in alluvial tract of the Upper Yamuna Plains.
ii. To identify the source of recharge of different aquifers, and the interaction between various aquifers.
iii. To investigate the continuity of aquifers on both the sides of the river Yamuna,
iv. To determine the groundwater dynamics in different identified aquifers, and
v. To estimate the groundwater velocity and replenishment potential of the deeper aquifers

Details are given under sponsored project "Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains"

4. PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/4

Thrust Area under XII five year Plan: Water Quality and Health

Project team:

a) Project Investigator: S. K. Verma
b) Project Co-Investigator(s): S. P. Rai, M. S. Rao, C. P. Kumar, Mohar Singh

Title of the Project:

Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes

Objectives:

i. To measure radon concentration in water
ii. To identify paleo-groundwater in the study area

Present state-of-art:

A National Working Group IGCP-571 has been constituted by GSI, Govt. of India to study the radon concentration in different materials. NIH is entrusted to study the radon concentration in waters. Radon is a decay product of Uranium with a half-life of 3.8 days. It can cause serious disease like lung cancer. In USA more than 25,000 deaths occur every year due to high radon concentration in water as well as in air. High concentrations of Radon has been observed in certain parts of India.

Groundwater from deeper aquifers is being withdrawal without the knowledge of groundwater dynamics in aquifer. Some of the deeper aquifers may have paleo water which may not serve the needs for water supply for longer time. Therefore, there is a need to map the paleo-waters to avoid huge investments on other industrial and/or urbanizational developments in such areas.

Methodology:

In order to study the radon contamination in the study area at different locations, groundwater samples from intermediate/deep aquifers will be collected for in-situ radon concentration measurement. Spatial and temporal variation of radon concentration in groundwater samples will be studied. The groundwater samples from intermediate/deep aquifers for existing tube wells will also be collected for tritium and ^{14}C measurement. The hydro-geological data will also be collected for the study area in order to study the hydro-geological features to be linked with the radon concentration in waters and paleo-groundwater.

Research outcome from the project:

i. Generation of data base for radon concentration & groundwater age
ii. Publication of report and research papers

Work Schedule:

d. Date of commencement of the project: Oct. 2013
e. Duration of the project: Oct. 2013 to Sept. 2015 (2 years)
f. Stages of work and milestone:

Sl. No.	Work Element	Apr-Jun, 2015	July-Sep, 2015
1.	Monitoring of radon concentration	*	
2.	Identification of paleo-groundwater		*

Analysis and Results

- The analysis of radon concentration in groundwater has been carried out for a total of 20 groundwater samples collected from intermediate/deep aquifers using tube wells for drinking water supply from different locations in the study area.
- It is found that the radon concentration in water varies from 1 Bq/litre to 14 Bq/litre in Nawanshahar district, from 5.5 Bq/litre to 24 Bq/litre in district Hoshiarpur and from 0 Bq/l to 4 Bq/l in district Ropar. These values fall under the safe limit recommended by the World Health Organization (WHO) for drinking water i.e. 100 Bq/litre.
- The electrical conductivity of groundwater samples has been measured at 20 locations at the time of sampling which varies from 250 µS/cm to 470 µS/cm in the study area.
- In addition to above, a total of 20 ground water samples were collected from intermediate/deep aquifers using tube wells for drinking water supply each from 20 locations. These samples are being analysed for tritium dating using Tritium Enrichment unit and Quantulus available in Nuclear Hydrology laboratory.

Future Plan: As per activity chart

PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/3

Thrust Area under XII five year Plan:

Water Management in Coastal and Hard rock aquifers

Project team:

a) Project Investigator: Dr. M. Someshwar Rao
b) Project Co-Investigator(s): Dr. Sudhir Kumar, & Sh. SK Verma
c) Technical Collaborators:
   i. Sh. Niladri Naha, Additional Director, SWID, Kolkata
   ii. Dr. Abhijit Chakraborty, Asstt. Prof., IIT, Kharagpur

Title of the Project:

Interaction between groundwater and seawater along the parts of east coast of India

Objectives: The study the following objectives:

i. Mapping the salinity variation and stable isotopic composition in the coastal groundwater
ii. Mapping the dissolved radon in groundwater and its implication to fresh groundwater discharge to sea or sea-water intrusion
iii. Mapping the groundwater-seawater interaction regions vis-à-vis the operating hydrological process (SGD/Seawater intrusion)

Present state-of-art

In the coastal aquifer, the difference in hydrostatic pressure between groundwater and sea water results into fresh groundwater discharge into the sea as submarine groundwater discharge (SGD) or inflow of seawater into groundwater system as seawater intrusion. SGD and seawater intrusion (SI) are the pathways of interaction between groundwater and sea. Seawater intrusion and SGD are the issues of global importance. The change in sea level (due to climate change or tidal effects) and groundwater levels (due to excess withdrawal, land use change, climate change etc) influence both SGD and SI. While SGD is the direct loss of freshwater to sea, the seawater intrusion causes groundwater salinization thereby reducing the available freshwater volume. It is also known that SGD causes loading of nutrient and release of contaminant near shore line causing the increased biological activity at the location of SGD. India has over 2000 km length of shore line. Therefore, for development of water resource potential of coastal groundwater it is important to delineate zones of groundwater falling in SGD or seawater intrusion process. With the increasing population and the demand of freshwater such maps are important to formulate management practices to safeguard the fresh water and for sustainability of fresh groundwater resources.

Although submarine springs and seeps have been known since Roman period, the scientific investigation of SGD started in sixties (Kohout, 1964). In India, saltwater contamination due to seawater intrusion, saltpan deposit and mining activities have been reported through major ion analysis of groundwater (see for example, Chandrasekar et al, 2014). However, results of such studies need to be taken carefully as seawater-groundwater interaction involve cation-exchange interaction which may not result from a direct flow of water mass from sea to groundwater or vise-a-versa. In a combined geophysical and geochemical investigation of coastal groundwater in Godawari Basin (Gurunadh Rao et al. 2011) it was shown that TDS and Chloride concentrations are the simplest indicators for assessment of salinization process. In the study they observed that salinity is mainly due to dissolved salts of marine clays left out during the recession of sea and not due to the lateral movement of sea water from Bay of Bengal and the interpretation was supported by groundwater level contours which showed groundwater flow direction towards the sea and also by ERT data. In an isotopic investigation of groundwater in the west coast of India near Mangalore, Lambs et al., (2011) observed a difference in isotopic composition and d-excess of groundwater in the summer and winter periods, with a predominantly lighter isotopes in the latter periods. Use of radon for studying the seawater-groundwater interaction started with the work of BARC team SGD in the west coast region of India near Thiruvananthpuram (Jacob et al,

2009) who successfully employed radon for estimating the SGD component. However, other than few such studies not much work has been reported on use of isotopes in integration with the conventional techniques to examine and map the zones of seawater-groundwater interaction regions in accordance with the operating processes SI/SGD.

Methodology

In the present project it is proposed to map the safe zones, vulnerable zone and potential risk zones for groundwater withdrawal by delineating areas of SI and SGD using EC, stable isotope, radon and water level data in parts of east coast falling in the south-east coastal region of West Bengal and north-east coastal region of Odisha. As a part of the study, literature survey will be on the conventional and isotope techniques available to investigate the SI/SGD zones in the coastal aquifers. For the study, groundwater samples will be collected in pre- & post monsoon seasons. In-situ analysis will be done for EC, temperature and radon (^{222}Rn) concentration. Select number of samples will be collected and analyzed for stable isotope composition at NIH, Roorkee. As these parameters (EC, Temp, stable isotope composition, ^{222}Rn concentration) are expected to change during monsoon and non-monsoon season, samples will be collected in two seasons: before and after the monsoon for both the years 2015 and 2016. Long term data on water table will be collected to examine the seasonal dependency of groundwater flow conditions. Rainfall data will also be collected to interpret the results. Technical support from state groundwater department will be taken in groundwater sampling and for collating the archival data. The knowledge that will be gained by the study will be published in journals and conferences and also will be disseminated through training programmes.

Research outcome from the project:

- Thematic maps of variation of (i) stable isotopic composition, (ii) salinity, (iii) major ions, and (iv) radon in groundwater during pre & post monsoon periods. Interpretation of the above data with respect to the changing groundwater levels before and after the monsoon periods.
- Mapping the areas of safe groundwater, vulnerable and potential risk zone according to SI & SGD operating process
- Knowledge dissemination in terms of publications (report, papers in journals and conferences etc) and training programs etc.

Work Schedule:

a) Probable date of commencement of the project: April, 2015
b) Duration of the project: 2 years
c) Stages of work and milestone:

Year 2015-16

Sl. No.	Work Element	First Qr	Second Qr	Third Qr	Fourth Qr
1	Literature collection	✓	✓		
2	Field work for water sampling and data collection	✓		✓	
3	Sample analysis		✓	✓	
4	Data interpretation, interim report, publications				✓
5	Training programme/workshop				✓

Year 2016-17

Sl. No.	Work Element	First Qr	Second Qr	Third Qr	Fourth Qr
2	Field work for water sampling and data collection	✓	✓	✓	
3	Sample analysis	✓	✓	✓	✓
4	Data interpretation, Final report, publications	✓	✓	✓	✓

6. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/3

Thrust Area under XII five year Plan: ***Himalayan ecosystem***

Project team:

a. Project Investigator: Dr. M. S. Rao
b. Project Co-Investigator(s): Dr Sudhir Kumar
Technical Collaboration: Prof. A. L. Ramanathan, JNU

Title of the Project: ***Isotopic investigation of benchmark Himalayan glaciers***

Objectives

The objectives of the project are:

(i) Generating the isotope data base on snow & glaciers of benchmark Himalayan glaciers distributed between Uttarakhand to Ladakh
(ii) Assessment of spatial variability in isotopic & chemical characteristic of glacial environment
(iii) Use of isotope technique to understand the accumulation and ablation processes of (Himalayan) glaciers

Present state-of-art

Himalayan glaciers are the major sources of fresh water for the livelihood of population of northern India and it exerts strong influence over the river flow of several major rivers like River Ganga, River Yamuna, River Indus, River Brahamaputra and their tributaries by storing and releasing water in accordance with the climate of this region. Climate change (e.g. temperature and precipitation) results into advancement/ recession, of these glaciers. Therefore, the glaciers are considered to be as a sensitive indicators of climate change. Globally, climate change has been projected to cause major changes in glacier, snow and their melt contribution to streamflow.

Stable isotopic composition of precipitation reflects the integrated effect of source of origin of air-moisture and the local weather conditions during the precipitation. During accumulation period, isotopic variations resulted from changing weather pattern get locked in the glaciers and the locked information may be retrieved by raising and analyzing the glacial cores for isotopic details. The isotopic composition of precipitation, in general, also depletes with increasing altitude of precipitation (‘altitude effect’). The information of precipitation at different altitude can be investigated by investigating and analyzing snow or surface ice along altitude gradient. During ablation, snow and ice melting contributes to stream discharge. A continuous melting of snow/ice may result into progressive enrichment in isotopic composition of snow/glacial melt and therefore, evaporation and melting can be investigated by isotopic details of snow melt discharge. However, process such as integrated discharge from snow melt from multiple altitudes, percolation of snow melt, ice erosion etc can complicate the data interpretation. Thus, isotopic analysis of snow, ice, glacial core and their melt may provide useful information on accumulation, ablation and climate change. Chemical analysis of glacial & snow melt components may further be used in resolving englacial and subglacial components and thereby hydrograph separation. Tritium dating of glacial core and meltwater can further provide immense information on origin of melting water as from modern snow or old ice.

A major problem in most of the conventional studies comes from the fact that these are based on the glacial data which is non-continuous for discharge data, sediment data or precipitation data (including snow). Therefore, interpretation on glacial advance, retreat, mass balance, correlation with river discharge data etc., derived using the non-continuous data has limited scope for modelling or for future prediction. In-fact, in several glaciers of Himalaya, glacier mass balance has been found to show an inverse-relation with the monsoon precipitation which is an intriguing factor.

From the existing literature it can be seen that there are very few studies conducted in Himalayan glaciers on combined stable isotope, environmental tritium & chemical aspects of glacial layers. A study based on multi-parameter approach provides immense information to characterize the glacier and its vulnerability to climate change and its implication to water resources for future prediction. The present project is intended to provide a first-hand data on stable isotope, chemical and environmental tritium data on Himalayan glaciers and its interpretation to glacial ablation and accumulation due to climate variability.

Methodology

A detailed literature survey will be conducted to get the details on glacial cover extent, its temporal variation, hydrometerological details of the area, snow melt and river data etc Study area map will be prepared using survey of India toposheet and remote sensing data. Snow, rain, air-moisture and river discharge samples will be collected from sites wherever possible. Ice core will be raised from multiple locations. The collected samples will be analyzed for stable isotopic composition, tritium dating and chemical quality details. Air temperature and humidity recorders will be installed at suitable places or the data will be collected from the nearby stations. The isotope details will be transformed into air-temperature by comparing with the instrumental meteorological data. Snow density and tritium data will be used to estimate annual snow accumulation rate. Radon survey will be done at suitable sites. In the project, JNU will support in getting snow, glacier core and melt water samples, and in getting the hydrometerological data. The collected samples will be analyzed for water chemistry and isotopic details in NIH Roorkee. Wherever possible, NIH will install air-moisture sampling units to get the dynamic changes in isotopic composition of atmospheric vapour. The knowledge dissemination will be done jointly with JNU.

Research outcome from the project

The present project will provide first ever use of combined techniques: tritium, stable isotope, radon and chemical data in survey of some of the important glaciers of Himalaya. Further, as stated in the literature survey, the only stable isotope measurements made on Uttarakhand glaciers (core samples) is that by PRL group (Nijampurkar et al., 1984). Stable isotope variability over 3 decades since the study by PRL will provide changes if anything occurred since then.
The present project is also important in the sense that it is purely field based study in the area where there is a big paucity data. The survey that will be conducted will provide a base for developing several new projects in the Himalayan region in the future.
The results will be disseminated through publications in journals and conferences and through trainings.

Work Schedule:

a. Probable date of commencement of the project : April 2015
b. Duration of the project : 2 years
c. Stages of work and milestone:

Year 2015-16

Sl. No.	Work Element	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	Literature collection & data survey	✓	✓		
	Purchase of equipments and items for study, hiring of project staff etc	✓	✓		
2	Field work for water sampling, installation		✓	✓	✓

	of equipment (precipitation, air-moisture, snow & snow melt, river water, groundwater and spring water etc)				
3	Sample analysis		✓	✓	✓
4	Data interpretation, interim report, publications				✓

Year 2016-17

Sl. No.	Work Element	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	Field work for water sampling	✓	✓		
2	Sample analysis	✓	✓	✓	
3	Data interpretation, publications	✓	✓	✓	
4	Training programme/workshop, Final report				

7. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/3

Thrust Area under XII five year Plan: ***Water Quality and Health***

Project team:

a. Project Investigator: Sh. P.K. Garg, Sc. 'B'
b. Project Co-Investigator(s): Dr. Sudhir Kumar, Sc. 'G', Dr. M.S. Rao, Sc. 'D'

Title of the Project:

Assessment of dissolved radon concentration for groundwater investigations in Haridwar district

Objectives:

(i) Mapping the spatial distribution and temporal fluctuation in radon levels in groundwater in Haridwar district
(ii) To investigate the effect of seasonal groundwater levels fluctuations on radon levels.

Present state-of-art

Radon in groundwater originates due to decay of parent radioactive member radon-226 which is derived from the decay of the ultimate parent source uranium-238. The uranium-238 is present in groundwater as uranyl complex or is present in the host aquifer matrix as radioactive contaminant. Solubility of parent members of radon (radium and uranium) in groundwater depends upon geochemical conditions and temperature of groundwater. Radon-222 concentration in groundwater is a function of radioactivity concentration of radium (and hence uranium) in aquifer matrix, aquifer porosity (dry pores may lead to escape of radon) and physico-chemical condition of groundwater. During rainfall recharge, moisture filled pores in the vadose zone may slow down the escape rate of radon and also rise in groundwater levels due to rainfall induced groundwater recharge may dilute the radon levels in the groundwater. Thus, radon concentration in groundwater at a given location depends on the local hydrogeology, groundwater fluctuation and soil moisture conditions. Thus, a temporal variation in dissolved radon concentration in groundwater may provide a new way to look into the aquifer system and recharge conditions. Due to the short half-life of radium & radon isotopes compared to timescales at which groundwater levels and soil moisture fluctuation take place; the variation of these hydrological parameters may get recorded in the radon signals.

Methodology

In order to study the radon contamination in the study area at different locations, groundwater samples from shallow as well as deeper aquifers for pre and post monsoon seasons will be collected for in-situ radon measurement for studying the spatial and temporal variation of radon concentration. The hydro-geological data will also be collected for the study area in order to study the hydro-geological features to be linked with the radon concentration in pre and post monsoon season groundwater samples.

Research outcome from the project

Spatial and temporal distribution of radon groundwater in Haridwar area

Work Schedule:

a. Date of commencement of the project: April, 2015
b. Duration of the project: 1 year
c. Stages of work and milestone:

Sl. No.	Work Element	First Qr	Second Qr	Third Qr	Fourth Qr
1	Review of literature	√	√		
2	Site selection	√			

3	Collection and compilation of data		√		
4	Field work, sample collection and analysis of water samples	√	√	√	
5	Data interpretation		√	√	
6	Project report & publications			√	

SPONSORED PROJECTS

8. PROJECT REFERENCE CODE: NIH/HID/MOES/2012-15

Title of the Study : **The Structure and Dynamics of Groundwater Systems in Northwestern India under Past, Present and Future Climates**

Study Team : S. P. Rai (PI), S. K. Verma, S. Khobragade, Surjeet Singh, Sudhir Kumar, V. K. Agarwal, Rajeev Gupta, S. L. Srivastava, Vishal Gupta, Mohar Singh

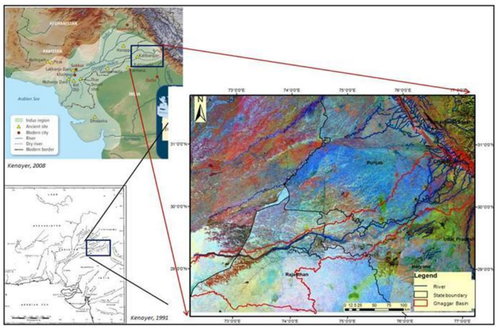
Funding Agency : MoES, Government of India

Budget : Rs. 210 Lakh (NIH component Rs. 35 lacs)

Date of Start : June 2012

Date of Completion : May 2015 (extend to March 2016 by MOES, Govt. of India)

Study Area



The study area covers the North Western India. However, Ghaghar basin has been selected to carry out detailed investigations, which covers the states of Himachal Pradesh, Punjab, Haryana and Rajasthan.

Land use: Agriculture dominated

Major problem of the area is declining of groundwater levels at a very fast rate, but at few places groundwater level is raising also.

Study Objectives

1. Isotopic characterization ($\delta^{18}O$ and $\delta^{2}H$) of groundwater, stream and rain water
2. Groundwater dating using Tritium and Carbon-14
3. Delineation of flow direction and recharge zones
4. Identification of recharge source and zones of groundwater in the study area

Statement of the Problem

India is largest agricultural user of groundwater in the world. The last 40 years have seen a revolutionary shift from large scale surface water management to widespread groundwater abstraction, particularly in the northwestern states of Punjab, Haryana and Rajasthan. As a result of this, groundwater depletion of this region has become under the vulnerable condition and a hotspot for groundwater management. The groundwater depletion rates in the states of northwestern India are reported highest in the world. This unmanaged use of groundwater becomes more challenging due to increasing demands from population and industrial developments under the climate change scenario. There is a major task to replenish the groundwater depletion through rainfall recharge. Therefore, this study is proposed to study groundwater dynamics in the region.

Action Plan

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th
Selection of study area	♦															
Literature survey	♦	♦	♦	♦	♦											
Collection of previous years data	♦	♦	♦	♦	♦											
Identification of data gaps	♦	♦	♦													
Selection of sites for stable isotope ($\delta^{2}H$ and $\delta^{18}O$) analysis	♦	♦	♦													
Selection of sites for radio- isotope (^{3}H and ^{14}C) analysis	♦	♦	♦													
Site selection and installation of raingauges	♦	♦	♦													
Measurement of $\delta^{2}H$ and $\delta^{18}O$ of rain, river and groundwater		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦			
Sample collection and Measurement of ^{3}H activity of groundwater, rain and river		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		
Sample collection and measurement of ^{14}C activity of groundwater										♦	♦	♦	♦	♦	♦	
Preparation of geological and hydrogeological maps				♦	♦	♦	♦	♦								
Preparation of water table and flow direction map		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦			
Interpretation of isotopic data					♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		
Estimation of natural recharge to groundwater												♦	♦	♦	♦	
Impact of climate change on groundwater										♦	♦	♦	♦	♦	♦	
Identification of recharge zones									♦	♦	♦	♦	♦	♦	♦	
First Draft Report				♦												
Second Draft Report										♦						
Final Report																♦

Objectives vis-à-vis Achievements

Objectives	Achievements
Isotopic characterization ($\delta^{18}O$ and δ^2H) of groundwater, stream and rain water	Pre-monsoon & post-monsoon samples of groundwater, river and canal have been collected and laboratory analysis completed.
Groundwater dating using tritium and Carbon-14	To date the groundwater, enrichment of about 40 samples has been completed and further analysis of 40 samples is in progress. For carbon dating, a proposal was submitted at NERC, UK for funding, NERC has been agreed to support for carbon-14 dating of 25 groundwater samples.
Delineation of flow direction and recharge zones	Water level data and tritium data are used to delineate the flow direction and recharge zones of groundwater.
Identification of recharge source and zones of groundwater in the study area.	$\delta^{18}O$, δ^2H and tritium data of groundwater and other sources have been analysed and source identification of the groundwater is in progress

Analysis and Results:

Variation of Groundwater Level Data

Groundwater level data of last 30 years of Ghaghar basin were analysed to study the groundwater fluctuation. Water level data show dramatic decline in groundwater level by 12-18 meters during this period. The initial trend between 1974 and 1998 is much gentler compared to a steep decline between 1998 and 2010 as observed on time series plots. Southwest part of the study area show rise in groundwater level varying from 10-18 meters during this period.

Isotopic Composition of Rainfall, River and Canal Water

The stable isotope data of precipitation of study area and surrounding are used to characterize the isotopic composition of precipitation. The $\delta^{18}O$ varies from -19.4‰ (minimum) to 9.8‰ (maximum) and δ^2H from -150.1‰ (minimum) to 59.1‰ (maximum). The local meteoric water line is

$$\delta^2H = 7.9 * \delta^{18}O + 5.4,\ r^2 = 0.98,\ n = 148$$

Ghaggar river samples have been collected from its origin near to Nahan in Himachal Pradesh to downstream upto Siras in Haryana. The $\delta^{18}O$ of river varies from -7.3‰ to -5.3‰ and δ^2H vary between -50.6‰ to -43.8‰. The $\delta^{18}O$ in origin area (between Nahan to Panchkula) varies between -7.3‰ and -6.7‰ for $\delta^{18}O$ and between -50.6‰ and -46.4‰ for δ^2H. Near Patiala and Sirsa isotopic composition of river is found -6.1‰ and -5.3‰ for $\delta^{18}O$ and -49.8‰ to -43.8‰ for δ^2H respectively. The canal water samples were collected from various sites in the catchment. The isotopic variation of canal water are found between -12.1‰ and -11.5‰ for $\delta^{18}O$ and -80.9‰ and -74.9‰ for δ^2H. The isotopic composition of canal water is depleted in comparison to Ghaggar River and local precipitation. Since, the source of canal water is Bhakara dam, which is on Satluj River.

The spatial variation of $\delta^{18}O$ values of groundwater of shallow depth show that $\delta^{18}O$ varying between -4‰ and -12‰. The enriched $\delta^{18}O$ values are found in the upper part of the catchment while depleted values in the middle and lower part of the catchment. The depleted isotopic signature of groundwater in the middle and lower part indicates recharge to groundwater from canal water. The environmental tritium activity has been measured for groundwater at different locations and it is found to vary between 0.3 TU and 8 TU. The tritium value of groundwater samples collected from shallow depths near Chandigarh and Rajpura area are varying from 5.2 TU to 6.1 TU and near Patiala and Samana it is about 4.2 TU.

The electrical conductivity (EC) of Ghaghar river and canal water is found in the range of 400 µS/cm to 450 µS/cm and 200 µS/cm to 220 µS/cm, respectively. The canal and river water samples show low salt values than the desirable value of Indian & WHO Standards (782 µS/cm). EC of groundwater ranges between 230 µS/cm and 10500 µS/cm in shallow aquifer, 260 µS/cm to 3900 µS/cm in middle aquifer and 420 µS/cm to 9500 µS/cm in deep aquifer, respectively. In shallow aquifer, EC ranges 250 µS/cm to 2000 µS/cm in upper reaches of study area, 500 µS/cm to 1000 µS/cm in middle part of study area and 1000 µS/cm to 10500 µS/cm in lower part of study area. The southern part of the basin is more saline. This is reason that groundwater level is raising upwards in southern part of the study area.

There is marked variation in isotopic and chemical composition of groundwater which indicates complex system of recharge.

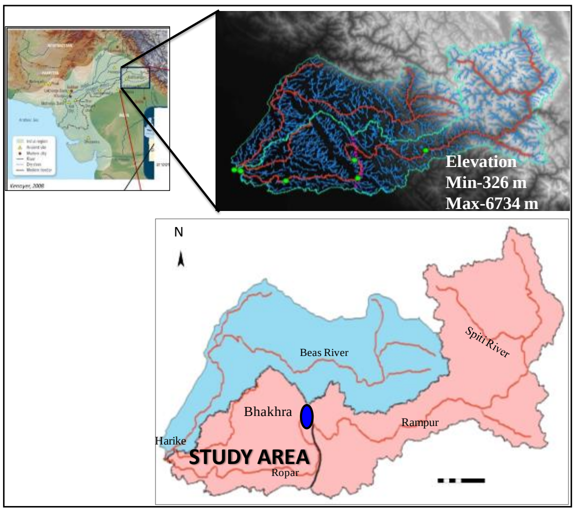
Future Plan

- Pre-monsoon sampling of groundwater for stable and radio isotope measurements
- Estimation of volume of water withdrawn due to pumping
- Preparation of canal map of the study area
- Sampling for stable isotope for estimation of canal recharge to groundwater

9. *PROJECT REFERENCE CODE: NIH/HID/IAEA-2/2012-15*

Title of the Study	:	**Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques**
Study Team	**:**	S. P. Rai (PI), R. V. Kale, M. S. Rao, C. P. Kumar, Sudhir Kumar, V. K. Agarwal, Vishal Gupta, Mohar Singh
Funding Agency	:	IAEA, Vienna
Budget	:	15000 Euro per year
Duration	:	Three years (October 2012 to September 2015)

Study Area



The study area falls in the Punjab state of India. Groundwater levels in Punjab have reached to most critical condition. As per report of Central Ground Water Board, Government of India (2009), 80% area of Punjab state falls under over-exploited zone. With onset of Green Revolution during 1960s, the state rapidly adopted the green revolution technology and resulted in increased demand for irrigation water. The requirement of irrigation was met through development of irrigation canal network and development of tube wells. Between 1960 and 1999, the food grain production of Punjab increased from 3.16 to 22.22 million tones. During this period, number of tube wells increased from 0.60 million to 1.1 million, leading to over-exploitation of groundwater in most parts of the state. The concentrated pumping has affected the natural groundwater conditions and flow regime.

Study Objectives

1. To develop thematic maps based on isotope and related information relevant to the evaluation and assessment of the quality of surface water
2. Comparative study of recession characteristics of Satluj River with conceptual and isotopic model
3. To assess the potential and limitations of the tracer techniques for routine application in hydrological studies

Statement of the Problem

The importance of Satluj river in Indian context is better understood from the fact that it continues to play a major role in the socio-economic development of north-western part of the country. The dependency of the states of Himachal Pradesh, Punjab, Haryana and Rajasthan on the resources of Satluj river for the sustenance and growth of agricultural and hydroelectric power sector is ever growing. In addition to several micro and mini projects, several mega projects are under way, particularly in the upper part of Satluj Basin. The runoff of Satluj river receives major contribution from snow/glacier, rainfall-runoff and groundwater/baseflow. The assessment of rainfall derived runoff and snow and glacier melt runoff have been carried out. However, contribution of the baseflow to river flow was overlooked and no major attempt has been made to assess the impact of baseflow contribution on discharge and quality of the river. Therefore, this study will be a first approach to understand the groundwater and river interaction in this part of the Satluj catchment.

Action Plan

Activity Schedule (Quarterwise: 2012-13, 2013-2014 and 2014-2015)

Activity	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
Selection of study area			♦									
Literature survey			♦	♦	♦							
Collection of previous years' data				♦	♦							
Identification of data gaps				♦								
Selection of sites for stable isotope (δ^2H and $\delta^{18}O$) analysis					♦	♦	♦	♦				
Selection of sites for radio- isotope (^3H and ^{14}C) analysis			♦	♦	♦	♦	♦	♦	♦	♦		
Site selection and installation of raingauges			♦	♦	♦	♦						
Measurement of δ^2H and $\delta^{18}O$ of rain, river and groundwater				♦	♦	♦	♦	♦	♦	♦		
Measurement of ^3H and ^{14}C activity of groundwater, rain & river				♦	♦	♦	♦	♦	♦	♦		
Preparation of geological & hydro geological maps of the study area				♦	♦	♦	♦	♦				
Preparation of water table and flow direction map				♦	♦	♦						
Interpretation of isotopic data					♦	♦	♦	♦	♦	♦	♦	
Application of conceptual model					♦	♦	♦	♦	♦	♦	♦	
Report Finalisation											♦	♦

Objectives vis-à-vis Achievements

Objectives	Achievements
To develop thematic maps based on isotope and related information relevant to the evaluation and assessment of the quality of surface water	Following tasks have been completed 1. Isotopic characterization ($d^{18}O$ and d^2H) of groundwater, stream and rain water 2. Groundwater dating using tritium 3. Delineation of flow direction and recharge zones using water level and tritium data
Comparative study of recession characteristics of Satluj River with conceptual and isotopic model	Isotopic technique has been used to separate out different component of hydrograph Modelling approach has been attempted to separate out the baseflow component of stream discharge Comparison of both study is under progress

To assess the potential and limitations of the tracer techniques for routine application in hydrological studies	Assessment of potential of tracer techniques are under progress

Analysis and Results

Isotopic Composition of Precipitation

The isotopic composition of precipitation in study are varies from -19.4‰ to 9.8‰ for $\delta^{18}O$ and -150.1‰ to 59.1‰ for $\delta^{2}H$. The $\delta^{18}O$- $\delta^{2}H$ bi plot of precipitation in the study area shows similarity with GMWL (Rozanski *et al.* 1993) and Indian Meteoric Water Line for the north region (IMWL-North) (Kumar *et al.* 2010). The slightly lower intercept may be due to local climate.

LMWL: $\delta^{2}H = 7.9 \times \delta^{18}O + 5.4$; $R^2 = 0.97$, n = 119 (eq. 1)

IMWL- North: $\delta^{2}H = 8.15 \times \delta^{18}O + 9.55$; $R^2 = 0.99$ (eq. 2)

GMWL: $\delta^{2}H = 8.17 \times \delta^{18}O + 11.27$; $R^2 = 0.99$ (eq. 3)

Isotopic Composition of River

The $\delta^{18}O$ of Rivers Satluj varies between -12.7‰ to -6.8‰ and $\delta^{2}H$ from -87.9‰ to -48.5‰. The isotopic composition of river gets enriched as water move from Ropar to Harike (downstream). The depleted isotopic composition of Satluj River at Ropar is due to major contribution from the higher Himalayas. As river move downstream, enrichment of $\delta^{18}O$ of river water is observed which may be due to the contribution from groundwater. The regression lines derived for the river water is given below:

$\delta^{2}H = 6.7 \times \delta^{18}O – 3.2$; $R^2 = 0.99$, n = 98 (eq. 4)

Isotopic Composition of Groundwater

The groundwater samples were collected from existing dug well, hand pump and tube wells. The depth of dug well, handpumps and tube wells represents to different depth of water level. The depth of open well, dugwell, hand-pumps and tubewells were collected from the sampling sites. The overall depth data indicate that handpumps are bored up to depth of 80 m and tubwells below the 80 m depth.

Open well and Handpump = <80 m
Tubewell of private farmers and Government = > 100 m

The oxygen isotope ratio ($\delta^{18}O$) of groundwater up to depth of 80 m varied from -12.4‰ (minimum) to -4.7‰ (maximum) and hydrogen isotopic ratio ($\delta^{2}H$) from -85.1‰ (minimum) to -32.4‰ (maximum). The $\delta^{18}O$ of groundwater below the depth of 100 m varied from -11.3‰ (minimum) to -5.4‰ (maximum) and $\delta^{2}H$ -81.6‰ (minimum) to -35.2‰ (maximum).

The $\delta^{18}O$ and $\delta^{2}H$ relationship for groundwater collected upto depth zone of <80 m and >100 m depth has been developed. The regression analysis between $\delta^{18}O$ and $\delta^{2}H$ of the data of different depth gives the best fit line (BFL) as:

$\delta^{2}H = 6.7 * \delta^{18}O – 1.5$ (n = 96, $r^2 = 0.98$) (< 80 m) (eq. 5)

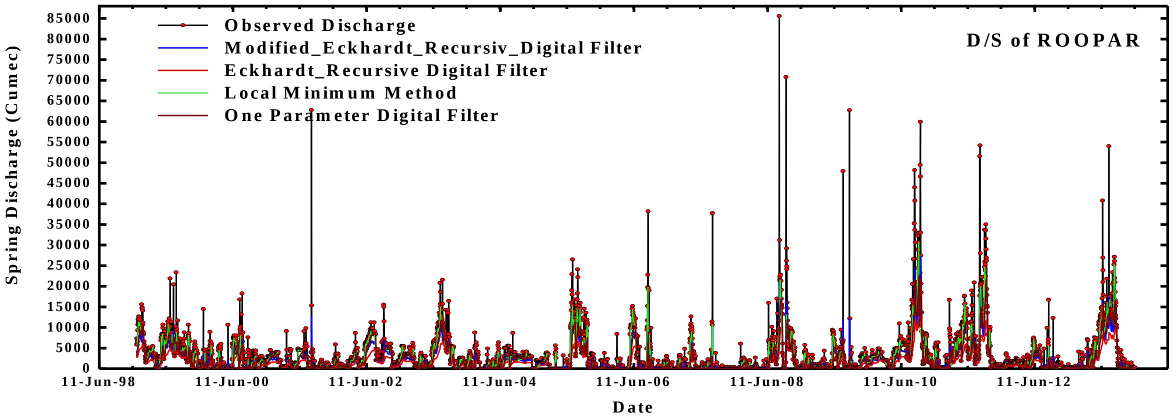
$\delta^{2}H = 7.6 * \delta^{18}O + 4.9$ (n = 76, $r^2 = 0.92$) (>100 m) (eq. 6)

Generally, shallow groundwater show enriched $\delta^{18}O$ and $\delta^{2}H$ values in the study area. However at few locations depleted value (more than -9‰) are also found due to possible recharge through river/canal. The deep aquifer shows almost similar isotopic composition throughout the study area which resembles the isotopic composition of precipitation.

In the present study, baseflow separation has been carried out using following non-tracer based methods, (i) Local Minimum Method, (ii) One Parameter Digital Filter, (iii) Eckhardt Digital, and (iv) Modified Eckhardt Digital Filter

The results of baseflow separation hydrograph obtained using filter methods are shown in Figure along with observed discharge hydrograph.

Figure: Estimated vs observed discharge by various separation methods.



The partitioning of stream flow has been carried out using the isotopic modeling techniques. The results as well as their analysis will be presented in more details during WG meeting.

Future Plan

Hydrochemical characteristics of groundwater and river

Identification of groundwater discharge and recharge zones to Satluj river.

10. *PROJECT REFERENCE CODE: NIH/HID/IAEA-1/2012-15*

Title of the Study : **The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India**

Study Team : M. S. Rao (PI), C. P. Kumar and S. P. Rai

Funding Agency : IAEA, Vienna

Budget : Euros 15,000

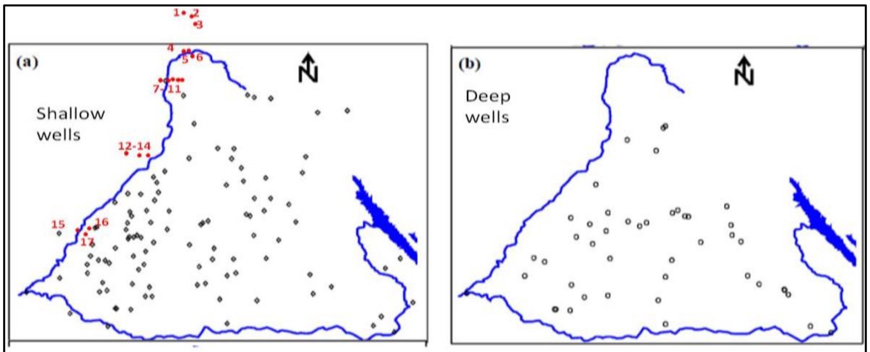
Date of Start : September 2012

Date of Completion : August 2015

Study Objectives

1. Assessment of depleting groundwater conditions in north-eastern parts of Punjab.
2. Identifying the regions where groundwater use has caused changes in chemical, stable isotopic composition and age of groundwater.
3. Identifying the areas where deep aquifers are getting modern recharge through their shallow aquifers.
4. Groundwater recharge/return-flow to the Beas River and Satluj River due to river waterand groundwater interaction.
5. Assessment of artificial recharge measures.

Location Map



Locations	Dhaki	Tangu	Dam -tal	Kath-garh	Mir-thal	Beas near Mirthal	Jagatpur Kalan	Naushera pattan	Kalaut Harsha/ Leachpur
Loc. No.	1	2	3	4	5	6	7	8	9

Locations	Bahadur pur	Mushaib pur	Ghuman	Mache rai	Hargovind-pur	Fattu-dinga	Amritpur	Mundi Mode
Loc. No.	10	11	12	13	14	15	16	17

Statement of the Problem

As per report of CGWB, 80% area of Punjab falls under over-exploited zone. The concentrated pumping has affected the natural groundwater conditions and flow regime. The falling water table has brought the agricultural productivity and economic conditions of the state to a plateau. Recent isotopic hydrological investigations have provided some clues on recharge conditions of groundwater diminishing zone in Bist doab. However, most of the isotope data in the earlier study was based on top aquifer and few data from a second aquifer, while the wells getting developed for irrigation and drinking needs have been entering into the deeper aquifers. The doab region is underlain by hundreds of meters of thick alluvium. However, detailed study of groundwater age of deeper aquifer is yet to be mapped using ^{14}C dating. The present study is intended to assess the mid and long term sustainability of groundwater resources, especially in aquifers that have been providing large quantities of water over last few decades. The study region is an extended part of Bist doab region where groundwater is getting over-exploited.

Action Plan

After carefully examining the overall progress report for the period ending in November 2014, IAEA has assigned the following work programme for the remaining period of the project (to be completed before 9th December 2015):

1. Collection of rainwater, groundwater and surface water samples and there analysis for stable isotope, radiometric dating and water quality
2. Data interpretation in terms of recharge characteristic, dynamics of aquifer system and use towards sustainability of aquifers
3. Evaluation of changes in water quality and quantity aspects due to extensive exploitation and identifying the parameters (isotopic, chemical and hydrological) that can be used as indicators for the intensive exploitation for the study area
4. Providing remedial cost effective & environmentally suitable strategies along with a conceptual groundwater model for improving the current groundwater situation.
5. Publications of papers
6. Submission of final report to IAEA as per IAEA's TECDOC format

Work Progress from December 2014 onwards:

During the progress period, as per the objectives assigned by the IAEA, water samples (rainfall, groundwater, river water samples) that were collected in the last quarter of the year 2014 are being analyzed for chemical constituents, tritium dating and stable isotope analysis. A field work is proposed in the month of March for collecting fresh set of water samples from the study region. During the progress period, water level data from 520 villages for the period 1998 to 2011 in the Bist Doab region has been collected. After carefully scrutinizing the data, the data of 520 villages falling in 36 blocks of 5 districts have been separated for trend analysis. Further work is in progress.

Future Plan

- As per the assigned tasks, water samples from the study area will be collected till July 2015.
- The data generated from the analysis of the samples over the 3 years project period will be processed to examine variation in various parameters in response to the over exploitation and from the results indicator for intensive exploitation will be identified.
- Using groundwater age, regions where groundwater surface water interactions is taking place and from the identified effective recharge sources cost effective and environmentally suitable strategies to improve the current groundwater situation will be suggested. A conceptual groundwater model will be provided to explain the observed facts.
- Final report will be submitted and efforts will be put to publish papers in high impact journals.

11. PROJECT REFERENCE CODE: NIH/HID/IAEA-3/2013-15

Title of the Study : **Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains**

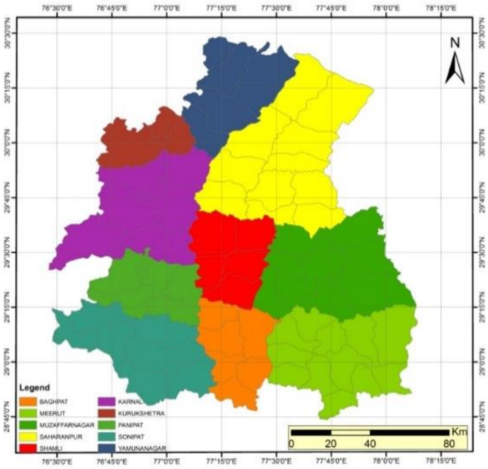
Study Team : Sudhir Kumar (PI), S. P. Rai, Suhas Khobragade, C. K. Jain, P. K. Garg

Funding Agency : IAEA, Vienna

Budget : 28,500 Euro

Duration : May 2013 to April, 2015

Location Map:



Study Objectives: Objectives of the study are

i. To identify the various aquifers present in alluvial tract of the Upper Yamuna Plains.
ii. To identify the source of recharge of different aquifers, and the interaction between various aquifers.
iii. To investigate the continuity of aquifers on both the sides of the river Yamuna,
iv. To determine the groundwater dynamics in different identified aquifers, and
v. To estimate the groundwater velocity and replenishment potential of the deeper aquifers.

Statement of the Problem:

Central Ground Water Board, Government of India has started a program for mapping the aquifers in India. This programme is designed to make a significant step forward in groundwater resource management by identifying and mapping aquifers, quantifying the available groundwater resources potential and proposing plans appropriate to the scale of demand, aquifer characteristics and the institutional arrangements for management. This work will be systematically implemented in the country, by involving organisations / institutions across India.
Alluvial aquifers are primarily composed of thick unconsolidated Quaternary deposits made up of alternating sequences of sand, silt and clay in various proportions. The major part of water demand in these areas is catered from groundwater which is by and large copiously available because of potential nature of aquifers as well as adequate recharge from rainfall. Western part of the Upper Yamuna Plains has a good irrigation canal network of Western Yamuna Canal, which originates from Hathnikund Barrage in Yamunanagar District of Haryana. The unconfined aquifers in the study area are expected to be recharged by the seepage from canal network and irrigation return flow apart from the rainfall, which is the major source of recharge. The canal water originates at higher altitudes in the Himalayas has different isotopic composition ($\delta^{18}O$ and δD) as compared to the groundwater locally generated in the Upper Yamuna Plains.

Deeper aquifers in the area are supposed to be recharged from the Bhabhar zone, the coarse material deposited as alluvial fans on the margin of Himalayas. Groundwater velocity in the deeper aquifers is expected to be very slow, thus groundwater dating (^{14}C) should give an idea about the groundwater flow direction as well as groundwater velocity in the deeper Aquifers. If there is vertical recharge through the semi-confining layers, the same should be easily detected by Tritium dating.

Thus, isotope based investigations can help understanding the surface water and groundwater interactions, aquifer-aquifer interactions, groundwater dynamics and identification of recharge sources and recharge areas of deeper aquifers for taking better management strategies**.**

Action Plan: The action plan is given below:

Activity	May, 2013 – April,2014				May, 2014 – April,2015			
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Collection of available literature and data from CGWB and State Groundwater Departments	*							
Identification of wells for groundwater sampling	*							
Construction of Aquifer Geometry based on available Data / Information		*						
Collection of groundwater and River /Canal/Rainfall samples for Chemical and Stable isotope analysis		*	*		*			
Chemical and stable Isotopic Analysis of samples		*	*		*	*		
Tritium samples analysis and Dating		*	*	*	*	*		
Collection of Samples for ^{3}H-He dating					*			
^{3}H-He sample analysis at IAEA					*	*		
Collection of Samples for ^{14}C dating		*	*		*			
^{14}C samples analysis at IAEA designated laboratory			*	*	*	*		
Interpretation of Data			*	*	*	*	*	
Interim Report and Discussion of Results during the meeting to be hosted by IAEA				*				
Workshop				*			*	
Final draft report and discussion on outcome during the meeting to be hosted by IAEA + final report submission								*

Objectives vis-à-vis Achievements:

S. No.	Objective	Achievement
1	To identify the various aquifers present in alluvial tract of the Upper Yamuna Plains.	The aquifers have been identified
2	To identify the source of recharge of different aquifers, and the interaction between various aquifers.	Partially achieved
3	To investigate the continuity of aquifers on both the sides of the river Yamuna,	Not yet established
4	To determine the groundwater dynamics in different identified aquifers, and	Partially achieved
5	To estimate the groundwater velocity and replenishment potential of the deeper aquifers.	Not yet established

Present Status

1. Most of the data available with CGWB has been collected.
2. Groundwater sampling from 21 wells ranging in depth from 100-420 m have been collected from UP side. 28 samples from shallow wells tapping the Ist aquifer have also been collected.
3. Analysis of groundwater and river/canal/rainfall samples for chemical and stable isotope analysis is under progress.
4. Carbon-14 and carbon-13 analysis of 14 samples has been completed
5. Noble gas analysis for 12 samples has been completed
6. Thirty One samples locations from Haryana have been collected which includes 10 locations for IIIrd aquifer, 6 locations from IInd aquifer and 15 locations from Ist aquifer
7. Construction of aquifer geometry based on available data / information has been completed

The results achieved shall be presented during the working group meeting.

Future Plan

1. Collection of remaining samples from Haryana from the identified locations
2. Analysis of samples for stable isotopes
3. Analysis of physico-chemical parameters
4. Dating of deeper groundwater

ITEM NO. 42.5 PROPOSED WORK PROGRAM OF THE DIVISION FOR THE YEAR 2015-16

As per the approved work program of the Hydrological Investigations Division for the FY 2014-15, 5 Internal studied, 4 sponsored projects and 1 consultancy project shall continue during the FY 2015-16. Moreover, it is proposed to start four new studies (2 internal, 1 sponsored, and 1 consultancy Project) w.e.f 01.04.2015.The proposed work program of the division during FY 2015-16 is given at Annexure-II.

Type of study/Project	*Continuing in Studies*	*New studies proposed*	*Total*
Internal Studies	5	2	7
Sponsored Projects	4	1	5
Consultancy Projects	1	1	2
Total	10	4	14

The details of the proposed new internal studies and the sponsored projects under taken during the FY 2015-16 is given below:

INTERNAL STUDIES:

PROJECT REFERENCE CODE: NIH/HID/INT/2015-16/1

Thrust Area under XII five year Plan : Hydrology of Lakes and other water bodies

Project team:

(a) Project Investigator: **Dr. Suhas Khobragade**
(b) Project Co-Investigator(s): Dr. Sudhir Kumar, Dr. C. K. Jain
Staff: Sh. V. K. Agrawal, and Sh. Satya Prakash

Title of the Project:

Hydrological Aspects of Rewalsar Lake, Himachal Pradesh (Status Report)

Objectives:

(a) To determine the environmental status of the lake
(b) To identify major problems of the lake
(c) To identify major management issues of the lake
(d) To review current research status and research needs for lake
(e) To review the data availability scenario and identify data gaps vis-a-vis identified research needs

Present state-of-art

The Rewalsar Lake is situated at an altitude of 1400 m, 16 km from the city of Mandi in the state Himachal Pradesh. The shallow lake has the maximum depth of 6.5 m. The lake is significant from religious, cultural and tourism purposes.

Water quality degradation has been reported for the lake. Due to pollution the nature of water has turned acidic (Tribune India, May 11, 2010). The poor sewerage system of Rewalsar town is further increasing the problem as contaminated water directly flows into the lake (Tribune India, May 11, 2010). According to the news published in the Tribune (May 14, 2014), more than 700 fish died during May 2014 at Rewalsar Lake. The death of fish is a regular feature of the lake but no systematic studies have been reported for the lake. However, a few scattered references on the lake are available. Das and Gaye-Haake (2003) studied the geochemistry of Rewalsar Lake sediment and analysed its implications for source-area weathering. Das and Dhiman (2003) studied the chemical characteristics of the lake. Das and Dhiman (2003) also reported the sediment chemistry of the lake. The state Pollution Control Board analysed the dissolved oxygen level in the lake in 2010 and it was found to be low. No hydrological studies have been reported for the lake so far.

Methodology

The envisaged objectives will be achieved through –

a) Collection, processing and analysis of the available data
b) Review of literature
c) Field survey
d) Interaction with management authorities and local people
e) Collection and laboratory analysis for water sample/sediment samples for water quality and isotopic characteristics

Research outcome from the project

The output of the study would be in the form of a comprehensive report wherein all data, maps, information and analysis would be included. The report would also contain major identified problems of the lake, current research status of the lake, identified data gaps. Major management issues related to the lake would be discussed and possible approaches to deal with them would be suggested.

Work Schedule:

a) Probable date of commencement of the project: 1st April, 2015
b) Duration of the project: 1 Year
c) Stages of work and milestone:

Sl. No.	Work Element	First quarter	Second quarter	Third quarter	Fourth quarter
	Literature Review	√	√		√
	Collection and compilation of all available data/information	√			
	Purchase of instruments	√			
	Preparation of study area maps		√		
	Procurement of data	√			
	Collection of water samples for water quality analysis	√	√		
	Collection of sediment samples	√			
	Lab. Analysis of water and sediment samples for Water Quality	√			
	Water quality assessment of the lake		√	√	
	Identification major problems, data gaps and research gaps				√
	Preparation of interim report	√	√		
	Preparation of final report				√

1. ***PROJECT REFERENCE CODE: NIH/HID/INT/2015-18/1***

Thrust Area under XII five year Plan : ***Hydrology of Lakes and other water bodies***

Project team:

a. Project Investigator: **Dr. Suhas Khobragade**

b. Project Co-Investigator(s): Dr. Sudhir Kumar, Dr. Senthil Kumar, Sh. P Garg,
Staff: Sh. V. K. Agrawal and Sh. Satya Prakash

Title of the Project

Lake-Groundwater Interaction Studies for Sukhna Lake, Chandigarh

Objectives:

(i) To understand lake-ground water interaction regime of the lake and to identify the zones of lake-water interaction

(ii) To determine seepage losses from the lake

(iii) To determine the relative significance of seepage losses in overall water balance of the lake

Present state-of-art

Although an accurate estimate of groundwater and lake water interaction is very significant and fundamental for reliable applications, not many studies have been reported on this aspect. The interaction between lake water and groundwater may be characterized by high degree of variability, and may be difficult to estimate at times, in view of inability of adequate data. However, in the context of lake water budget, it is crucial to understand and quantify exchange processes between groundwater and lake water. In most of the lake water budget studies, the relationship of ground water to lakes has been a minor part of the hydrologic studies, and it remains the least studied and least understood aspect of Lake Hydrology. This may, in many cases, lead to vague and incorrect estimation of actual groundwater proportions of the total water available in the lake.

A number of studies, particularly using the isotopes have been reported for understanding of the lake-groundwater interaction. Nachiappan et al. (2002) estimated subsurface components in the water balance of Lake Nainital using environmental isotopes. The results were verified using the environmental isotope mass balance method and chloride mass balance method. Schuster et al. (2003) studied ground water movement in the littoral zone of Williams Lake using isotope techniques. Temperature measurements can be analyzed for recharge and discharge rates. Anderson (2005) reviewed works related to heat as a groundwater tracer. Kraemer (2005) measured radium isotopes as indicators of inflow and mixing processes in lake and tributary water of Cayuga Lake, New York. Kalbus et al. (2006) provided an overview of the methods for estimating fluxes at the groundwater – surface water interface. As per the conclusions of the review, a multi-scale approach combining multiple measuring methods may considerably constrain estimates of fluxes between groundwater and surface water. Raanan et al. (2009) investigated the Ra isotope quartet in order to quantify the discharge of saline groundwater into a freshwater lake. Kidmose et al. (2010) investigated spatial distribution of seepage for a flow-through lake in western Denmark at multiple scales with an integrated use of; seepage meter, lake- groundwater gradients, stable isotope fractionation ($\delta^{18}O$), CFC apparent ages, land-based and off-shore geophysical surveys, and lake bed coring. Stets et al. (2010) studied surface water and groundwater flows to open- and closed-basin lakes in a headwaters watershed using a descriptive oxygen stable isotope model. Roningen et al. (2012) studied hydro-geologic control on lake level at Mountain Lake (USA) to understand the hydro-geological factors that influence lake level changes using a daily water balance, electrical resistivity, water sampling and geochemical analysis and well logging.

Sukhna Lake in Chandigarh faces water scarcity problems especially during the deficit rainfall years. No studies on the interaction of the lake with surrounding groundwater have been reported so far except for the preliminary investigations carried out by NIH. Studies on water balance carried out by NIH do indicate that seepage may be a significant factor determining the water availability in the lake. A careful and detailed studies on this aspect is however needed to understand and establish the lake -groundwater interaction and seepage losses from the lake.

Methodology

The envisaged objectives will be achieved through –

a. Collection, processing and analysis of the available hydro-meteorological, ground water and isotopic data
b. Generation of additional hydro-meteorological and groundwater data.
c. Field investigations including, piezometer installation and monitoring, resistivity survey, bathymetric survey and infiltration tests
d. Sample collection and laboratory analysis for isotopic investigations Isotopic investigations of water and soil/sediment samples

Research outcome from the project

The output of the study would be in the form of a comprehensive report. The report would contain all isotopic and ground water data of the lake and surrounding area. It would provide identified of zones of lake-ground water interaction, seepage rates from the lake, its relative contribution in overall water budget of the lake as well as its role in water scarcity problem of the lake.

Work Schedule:

a. Probable date of commencement of the project: **April, 2015.**
b. Duration of the project: **3 years**
c. Stages of work and milestone:

Sl. No.	Work Element	First Year	Second Year	Third Year
1.	Recruitment of project staff	√		
2.	Literature Review	√	√	√
3.	Collection and compilation of all available data/information	√		
4.	Procurement of instruments	√		
5.	Preparation of study area maps	√		
6.	Procurement of data	√		
7.	Identification of locations for installation of piezometers	√		
8.	Installation of piezometers	√		
9.	Collection of water samples for water quality analysis	√	√	√
10.	Collection of water samples for isotope analysis	√	√	√
11.	Infiltration tests to determine Infiltration rates	√		
12.	Measurement/estimation of discharge	√	√	
13.	Bathymetric Survey	√		
14.	Generation of field data such as water levels of lakes & GW, meteorological data etc	√		
15.	Analysis of water samples for Water Quality	√		
16.	Analysis of samples for isotopes	√	√	√
17.	Isotopic characterization of water in and around the lake	√	√	√
18.	Resistivity Survey	√		
19.	Identification of lake-groundwater interaction zones			√
20.	Determination of Seepage rates		√	√
21.	Determination of Water Balance components	√	√	
22.	Preparation of interim report	√	√	
23.	Preparation of final report			√

SPONSORED PROJECT

PROJECT REFERENCE CODE: NIH/HID/SPON/12-15

Title of the Study:	**Understanding of hydrological processes in Upper Ganga basin by using isotopic techniques**
Study Group:	**PI and Co-PI:** Dr. S. P. Rai, Dr. Sudhir Kumar, Rajesh Singh, S. D. Khobragade, Dr. M. Arora, Dr. R. J. Thayyen, and Mr. P. K. Garg
Staff:	Mr. Vipin Agrawal, Rajeev Gupta, Raju Juyal, Mr. Vishal Gupta, Mr. Mohar Singh
Type of Study	**To be s**ponsored from DST, Govt. of India (Under Process)
Nature of Study	Application of isotope to understand hydrological processes of Upper Ganga Basin
Duration:	5 Years
Date of Start:	April 2015
Date of Completion	March 2020

Study Objectives:

- **a)** Isotopic characterisation of precipitation and identification of sources of vapour
- **b)** Runoff generation processes in headwater region of Ganga using isotope and modeling
- **c)** Spatial and temporal variation of snow and glacier melt in Ganga and its major tributaries.
- **d)** Contribution of transient groundwater and its role in sustainable flow of Ganga.
- **e)** Groundwater dynamics in mountainous area including identification of recharge sources and zones of major springs

Statement of the Problem:

The Himalayan mountain system is the source of one of the world's largest supplies of fresh water which is under threat due to serious environmental degradation and climate change. Continuing climate change is predicted to lead to major changes in the strength and timing of the Asian monsoon, inner Asian high pressure systems, and winter westerlies – the main systems affecting the climate of the Himalayan region. The impacts on river flows, groundwater recharge, natural hazards, and the ecosystem, as well as on people and their livelihoods, could be dramatic affected, although not the same in terms of rate, intensity, or direction in all parts of the region. Therefore, a thorough understanding of hydrological processes operating all along the Himalayan region is a fundamental requirement.

Studies conducted worldwide during last few decades have established that stable oxygen and hydrogen isotope ratios provide useful tools for hydrological investigations in mountainous area. Classical approach used to study the hydrological processes can be strengthened through tracing isotopic signature of water molecules. Since, primary input of water on land is precipitation. The isotopic signatures of source and subsequent partitioning into stream flow, subsurface flow, spring/groundwater recharge processes, etc., though occurring on a local scale and over small time intervals get integrated both temporally and spatially as water from different parts of the catchment originating at different times accumulate and mix through operative hydrological processes, provide valuable information about different hydrological processes. Therefore, isotopes of well-mixed environmental reservoirs, such as the atmosphere, glacial melt, streams and aquifers, often represent an integration of source inputs to the system that extend over large spatial scales. Thus, isotopes indicate, record, integrate and trace water movement and hydrological process from small geographic scales (meters to hectares) and short temporal scales (minutes to hours) to large spatial scales (regions and the globe) and long temporal scales (decades to centuries). The partitioning of the different component of stream runoff can be done. Therefore, isotopic data on water sources at different spatial and temporal scales can be used to calibrate hydrological models, to provide internal quantitative check on the assumptions of various hydrological models.

It can be achieved through investigating stable isotopic composition (oxygen isotopes - ^{16}O and ^{18}O; and hydrogen isotopes-^{1}H and ^{2}H or D) of water molecules in different components of hydrological cycle in conjunction with volume and flux data. Environmental radio tracers (^{3}H, & ^{14}C etc) will be use to trace the residence time, flow velocity and age of the groundwater along with stable isotopes also. Study area for the present study will be upto Rishikesh

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

Study Area: Study area covers upper Ganga basin up to Rishikesh

Methodology:
- Field investigations of the study area
- Hydrogeological investigations of the study area using the past data
- Stable isotopic analysis of precipitation, glacier, river and groundwater
- Tritium and Carbon-14 dating to determine the age of the groundwater
- Delineation of drainage and preparation DEM using remote sensing and GIS
- Application of SNOWMOD and SRM models
- Analysis of the results

Action plan & time line: (Quarter wise, for 2015-2020)

Activities	**1st year**		**2nd year**		**3rd year**		**4th year**		**5th year**	
	I	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**
Appointment of Project staff	√									
Procurement of instruments	√	√								
Literature Collection	√	√	√							
Sample collection and analysis of sample for stable and radio isotope		√	√	√	√	√	√	√		
Compilation of data, interpretation and analysis					√	√	√	√	√	
Organisation of training course and workshop				√		√		√		
Preparation of final report										√

Data requirement & Expected source:
Meteorological data (i.e., rainfall, maximum minimum temperature, sunshine hours, relative humidity, solar radiation etc), Discharge data and hydrogeological data are required. Meteorological data would be purchased from IMD. The geological information's will be collected from the GSI/CGWB and state groundwater cell. The discharge data will be collected from CWC. Isotope and other related data will be generated in the field and lab.

List of deliverables:
Reports and papers will be delivered on following aspects
1. Understanding of Runoff generation processes in head water region of Ganga basin.

2. Assessment and snow/glacier melt contribution in mountainous region of Ganga basin with time and space
3. Role of groundwater contribution in sustaining the discharge of Ganga river and its tributaries.
4. Development of methodology for the sustainable development of springs through understanding the mechanism of recharge and discharge processes of the springs
5. Identification of source of precipitation

IPR potential and issues: NIL

Involvement of End Users/beneficiaries:
The beneficiaries of the study would be the water resource planners and managers of water resources of the study area apart from the academicians.

Specific linkages envisaged with Institutions and/or other NGOs: Sharing of data with central and state government organization and NGOs of the study area

Major items of equipment needed: None

PROPOSED WORK PROGRAMME OF HYDROLOGICAL INVESTIGATIONS DIVISION FOR THE YEAR 2015 - 16

S. No.	Study	Team	Duration/ Status
INTERNAL STUDIES			
1.	Isotopic Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains	Sudhir Kumar (PI) C. K. Jain S. P. Rai S. D. Khobragade P. K. Garg CGWB, Lucknow CGWB, Chandigarh	**2 years** (07/13-06/15) **Continuing Study**
2.	Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes	S. K. Verma (PI) S. P. Rai (Co-PI) M. S. Rao C. P. Kumar Mohar Singh	**2 years** (10/13-09/15) **Continuing Study**
3.	Interaction between groundwater and seawater along the northern part of east coast of India	M. S. Rao (PI), Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16) **Continuing Study**
4.	Isotopic investigation of benchmark Himalayan glaciers.	M. S. Rao (PI) S.P. Rai, Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16) **Continuing Study**
5.	Assessment of dissolved radon concentration for groundwater investigations in Haridwar district	Pankaj Garg (PI) Sudhir Kumar, M. Someshwar Rao	**1 year** (01/15 – 12/15) **Continuing Study**
6.	Status Report on Rewalsar Lake, Himachal Pradesh	SD Khobragade (PI) Sudhir Kumar, C. K. Jain	**1 year** (04/15 – 03/16) **New Study**
7.	Lake-Groundwater Interaction Studies for Sukhna Lake, Chandigarh	SD Khobragade (PI) Sudhir Kumar, Senthil Kumar, Pankaj Garg	**3 year** (04/15 – 03/18) **New Study**
SPONSORED PROJECTS			
8.	The Structure and Dynamics of Groundwater Systems in Northwestern India under Past, Present and Future Climates	S. P. Rai (PI) M. S. Rao Surjeet Singh S. K. Verma C. P. Kumar Sudhir Kumar V. K. Agarwal Rajeev Gupta S. L. Srivastava Vishal Gupta Mohar Singh	**3 years** (06/12-03/16) **Continuing Study**
9.	The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India	M. S. Rao (PI) C. P. Kumar S. P. Rai	**3 years** (09/12-08/15) **Continuing Study**

S. No.	Study	Team	Duration/ Status
10.	Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques	S. P. Rai (PI) R. V. Kale M. S. Rao C. P. Kumar Sudhir Kumar V. K. Agarwal Vishal Gupta Mohar Singh	**3 years** (10/12-09/15) **Continuing Study**
11.	Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains	Sudhir Kumar (PI) S. P. Rai S. D. Khobragade C. K. Jain P. K. Garg	**2 years** (05/13-04/15) **Continuing Study**
12	Understanding of hydrological processes in Upper Ganga basin by using isotopic techniques	Dr. S. P. Rai (PI) Dr. Sudhir Kumar Rajesh Singh S. D. Khobragade Dr. M. Arora Dr. R. J. Thayyen Sh. P. K. Garg	**5 years** **(4/15 – 3/20)** **New Study**
CONSULTANCY PROJECTS			
13.	Hydrogeological Study for Dewatering of Jhamarkotra Mines, Distt. Udaipur	Sudhir Kumar (PI)	**3 years** (05/13-04/16) **Continuing Study**
14.	Estimation of canal seepage and groundwater recharge using isotopic techniques in the Chajlet block, Moradabad district, Uttar Pradesh	Sudhir Kumar (PI) SP Rai SK Verma	**1 years** (03/15-02/16) **New Study**

SURFACE WATER HYDROLOGY DIVISION

Scientific Manpower

S N	Name	Designation
1.	Dr. Rakesh Kumar	Scientist G & Head
2.	Dr. J V Tyagi	Scientist G
3.	Dr. Avinash Agarwal	Scientist F
4.	Dr. S K Singh	Scientist F
5.	Dr. R P Pandey	Scientist F
6.	Dr. A K Lohani	Scientist F
7.	Dr. Senthil Kumar	Scientist E
8.	Dr. Sanjay Kumar	Scientist D
9.	Smt. Archana Sarkar	Scientist D
10.	Dr. Manohar Arora	Scientist D
11.	Sri Digambar Singh	Scientist C
12.	Sri J P Patra	Scientist C
13.	Sri Naresh Kumar	PRA
14.	Sri N K Bhatnagar	PRA
15.	Sri R K Neema	PRA
16.	Sri Hukum Singh	PRA
17.	Sri Om Prakash	SRA
18.	Sri Jatin Malhotra	SRA
19.	Sri T R Sapra	RA

NATIONAL INSTITUTE OF HYDROLOGY

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WORK PROGRAMME OF SURFACE WATER HYDROLOGY DIVISION FOR THE YEAR 2014-15

S.No. & Ref. Code	Title	Study Team	Duration
1. NIH/SWD/NIH/12-15	Sedimentation Studies for Pong Reservoir, Himachal Pradesh	A. R. Senthil kumar Manohar Arora Suhas D Khobragade Avinash Agarwal Sanjay Jain	3 years (April 2012 to March 2015)
2. NIH/SWD/NIH/12-15	Study of Hydro-Meteorological Droughts For Chitrakoot Bundelkhand Region In India	R.P. Pandey Rakesh Kumar	3 years (April 2012 to March 2015)
3. NIH/SWD/NIH/13-15	Application of DSS (P) for Integrated Water Resources Development & Management	A.K. Lohani Surjeet Singh Rahul Jaiswal D K Sonkusale Akilesh Verma	2 years (April 2013 to March 2015)
4. NIH/SWD/NIH/14-15	Estimation of Water Balance for Integrated Water Resources Management in Yerrakalva Pilot Basin, A.P.	J.V.Tyagi YRS Rao,	1 year (April 2014 to March 2015)
5. NIH/SWD/NIH/14-15	Systematic treatment and analytical solutions for surges and bores in rectangular channels (research study)	S.K. Singh	1 year (April 2014 to March 2015)
6. NIH/SWD/NIH/14-15	Status Report on "Impact of Anthropogenic and Climate Change on Sediment Load of Rivers"	Archana Sarkar	1 year (April 2014 to March 2015)
7. NIH/SWD/NIH/14-16	Study of Rainfall Patterns and Comparison of Rainfall Data from different Sources for Uttarakhand State	Archana Sarkar Vaibhav Garg, Sc C, IIRS, Dehradun Rakesh Kumar N.K. Bhatnagar	2 years (April 2014 to March 2016)
8. NIH/SWD/NIH/13-16	Quantitative assessment of uncertainties in river discharge estimation	Sanjay Kumar Sharad Jain	3 years (April 2013 to March 2016)
9. NIH/SWD/NIH/13-16	Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills.	Avinash Agarwal Manohar Arora RK Nema	3 years (November 2013 to October 2016)
10. NIH/SWD/NIH/14-17	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora Rakesh Kumar	3 years (May 2014 to March 2017)
11. NIH/SWD/NIH/14-17	Effect of climate change on evaporation at point scale	Digambar Singh A. R. Senthil kumar Manohar Arora	3 years (June 2014 to March 2017)
12. NIH/SWD/NIH/14-17	Hydrological modelling, water availability analysis	J.P.Patra Rakesh Kumar Pankaj Mani	3 years (April 2014 to March 2017)

1. Sedimentation Studies for Pong Reservoir, Himachal Pradesh

1. Title of the study:

Sedimentation Studies for Pong Reservoir, Himachal Pradesh

2. Study Group:

Dr. A. R. Senthil kumar Sc E, SWHD
Dr. Manohar Arora, Sc D, SWHD
Dr. Suhas D Khobragade, Sc E, HID
Dr. Avinash Agarwal, Sc, F, SWHD
Dr. Sanjay Jain, Sc F, WRSD

3. Date of start: 1 April 2012

4. Duration of the study: 3 Years

5. Whether externally funded or not: No

6. OBJECTIVES OF THE STUDY:

i. To develop a sediment yield model for the catchment area
ii. To generate rainfall and runoff series for the future periods
iii. To compute the sediment yield based on the generated rainfall and runoff series
iv. To predict elevation-area-capacity curve

7. BRIEF METHODOLOGY:

Sediment yield model

Multiple Linear regression (MLR) and ANN models are developed to simulate the sediment yield for the catchment of Beas river up to Pong reservoir based on the historical data of rainfall, runoff and sediment yield

Generation of rainfall and runoff series

The data of rainfall and runoff for future 25, 50, 75 and 100 years are generated by the time series modelling with available data of rainfall and runoff series.

Computation of sediment yield and consolidated sediment volume

The developed sediment yield model is applied to compute the sediment volume for future 25, 50, 75 and 100 years. The unit weight of deposited sediment in the reservoir is computed from particle size distribution of suspended sediment concentration, hydrographic survey and porosity of uniformly distributed sediment in the reservoir. The consolidated unit weights of the sediment are arrived at by empirical equation as well as statistical methods. The consolidated unit weights computed by different methods are used to compute the possible range of sediment volume expected to be deposited in the reservoir for the future 25, 50, 75 and 100 years.

Revision of elevation-area-capacity table

The computed sediment volume for future periods is distributed in the reservoir by empirical area reduction method.

8. Results achieved with progress/present status

The monthly rainfall at Dehra Gopipur, Haripur, Nangal Chowk and Pong dam and monthly flow volume and sediment yield at Jwala Mukhi from 1987 to 2009 are used to develop ANN model to simulate the sediment load. The feed forward ANN is trained with input vector selected from the data as mentioned above. The monthly data from 1987 to 2007 are considered for the training of the model and data from 2008 to 2009 are considered for the validation of the model. The ANN model with input vector of flowvol(t), raindehra(t), rainhari(t), rainnangch(t), rainpondam(t) and the structure of 5-2-1 is the best model among the all. The monthly rainfall at Dehra Gopipur, Haripur, Nangal Chowk and Pong dam and monthly flow volume at Jwala Mukhi for future 25, 50, 75 and 100 years are generated by using time series modelling. The best ANN model is used to simulate the sediment load for future 25, 50, 75 and 100 years using the generated series of rainfall and flow volume. The uncertainty in the simulated series of sediment load is addressed by generating ensembles of input series and determining the sufficient number of parameter sets of the model by boots trap method.

The uncertainty analysis of generated data series of rainfall at Dehra Gopipur, Haripur, Nangal Chowk and Pong dam, flow volume at Jwala Mukhi for future 25, 50, 75 and 100 years is carried out. The uncertainty in the generated data series is determined by finding bandwidth of probable values of a particular series. The 1000 ensembles of rainfall at Dehra Gopipur, Haripur, Nangal Chowk and Pong dam, flow volume at Jwala Mukhi for 25, 50, 75 and 100 years are generated by changing the seed of uniformly distributed random number. The 10, 50 and 90 percent probable generated series of rainfall and flow volume is found from the ensembles of the series. These values address the uncertainty in the generated data. The uncertainty in the model is addressed by developing ANN ensembles by boots trap method. 200 ANN ensembles were generated with available 276 patterns of historical data. The average probable sediment yield from the ANN ensembles were simulated from 10, 50 and 90 percent probable generated series of rainfall and flow volume. The consolidated unit weight of sediment by different methods such as particle size distribution of suspended sediment concentration, hydrographic survey and porosity of uniformly distributed sediment have been computed. The expected life of the reservoir is found to be 340 years from plot of cumulative sediment yield on y-axis and time on x-axis. The consolidated unit weight of sediment by frequency analysis of unit weight of sediment computed from suspended sediment concentration and empirical formula is being done. The estimation of consolidated sediment volume by consolidated unit weight of sediment and estimation of elevation-area-capacity curve for future periods from consolidated sediment volume is being carried out. The simulation of sediment yield from data of each ensemble is being carried out with ANN ensembles.

9. Expected date of completion: 31 March 2015

2. STUDY OF HYDRO-METEOROLOGICAL DROUGHTS FOR CHITRAKOOT BUNDELKHAND REGION IN INDIA

Name of PI: **Dr. R.P. Pandey, Scientist F**; Surface Water Div., NIH Roorkee

Type of study: **Internally Funded**

Project Duration: **3-years**

Date of start: **April 2012**

Scheduled Date of Completion: **March. 2015**

OBJECTIVES OF THE STUDY:

Major objective of the study is to quantify water scarcity during droughts and to identify possible options for augmenting water supply and minimizing crop loss due to droughts. The specific objectives of this project are to:

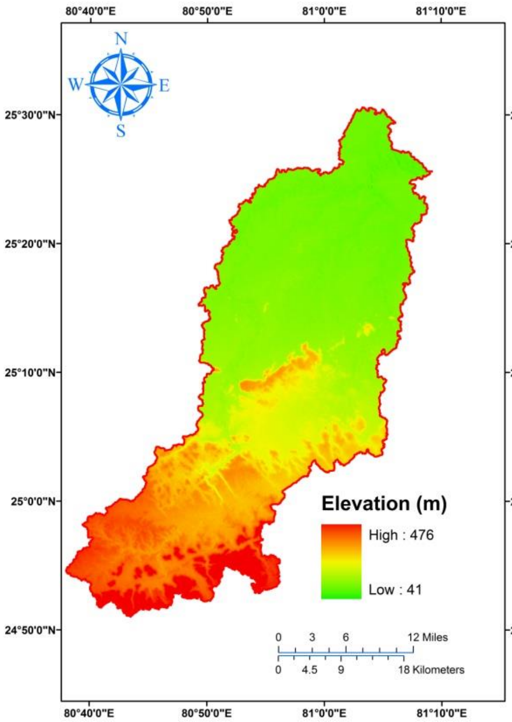
a) Assessment of drought frequency, duration and severity in Bubdelkhand.
b) Quantification of surface water and groundwater availability.
c) Assessment of total water demands for domestic, industries and agriculture.
d) Assessment of supplemental irrigation to minimize crop loss due to dryspells and droughts.
e) Delineation of zones vulnerable to different degree of drought severity.
f) To suggest an area specific plan for water management in Paisuni Basin,

Study Area : <u>Paisuni (Mandakini) Basin in Chitrakoot District</u>
Study area belongs to the part of Bundelkhand region in India (Fig. 1). Mean annual rainfall in the basin is about 1039 mm and mean annual potential evapotranspiration is about 1950 mm. Statement of problems of the study area is as follows:

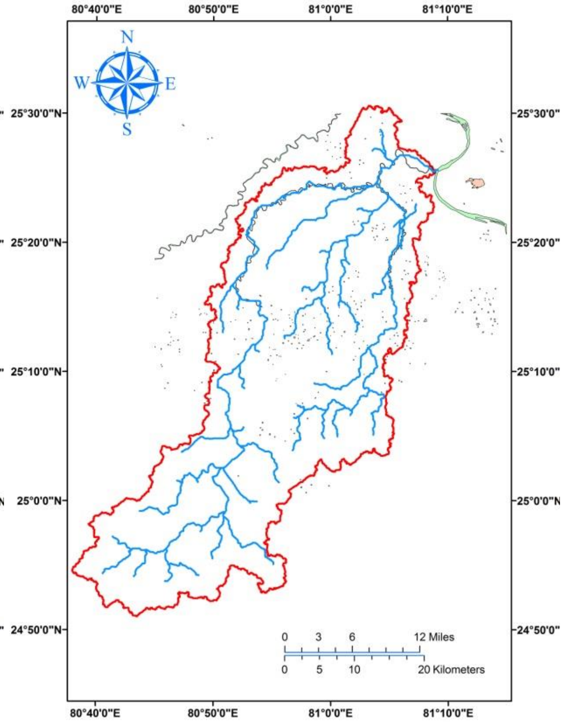
- Paisuni basin in Chitrakoot faces recurrent droughts of with average frequency of once in five years (greater severity).
- Frequent failures of crops are reported in the basin due to droughts.
- Present sources of drinking water supply are not sufficient to meet the demand during summer. Sever water shortages emerge during drought period
- In recent past during 2004- 2008 and 2010, it experienced acute water scarcity due to persistent drought situation in the basin.
- Ground water availability in Manikpur, Pahari and Chitrakoot blocks are limited and it does not meet the demands. The Manikpur block appears to be more vulnerable to water shortages in summer months.

PROGRESS OF PROPOSED STUDY:

- Collected data/information from various sources and conducted field investigations in the study areas.
- Prepared base maps of drainage, land-use, DEM, ground water aspect map etc. using GIS.
- Analyzed rainfall data to determine frequency and severity of droughts in past decades and their impacts reported in administrative documented.
- Applied and compared SPI and EDI with A New Methodology (named as SDI, simple drought index) to assess attributes of drought events.
- Analyzed critical dry spell fro past 50 year data and estimated supplemental irrigation requirement for crop saving during CDS and drought.
- Prepared map for demarcation water deficit zones in study area in the form of different clusters of villages for water supply planning.



DEM Map



Drainage Map

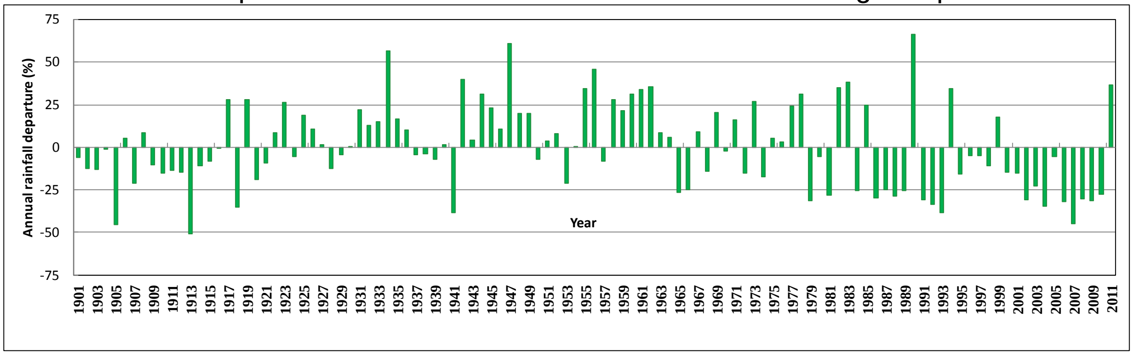


Table : Results of Critical Dry Spell Analysis in Paisuni basin covering Chitrakoot distt. UP and Part of Satna distt. MP

S. No	Station	Ist Critical Dry Spell			IInd Critical Dry Spell			IIIrd Critical Dry Spell			Longest duration of CDS
		Start mean date	End Mean Date	Duration	Start Mean Date	End Mean Date	Duration	Start Mean Date	End Mean Date	duration	
	1	2	3		4	5		6	7		8
1	Mau	17 July	3 Aug	18	12 Aug	23 Aug	11	5 Sep	21 Sep	17	45 (1983)
2	Karwi	18 July	2 Aug	16	9 Aug	26 Aug	18	-	-		28 (2002)
3	Satna	22 July	4 Aug	17	4 Aug	19 Aug	16	27 Aug	7 Sep	11	26 (1974)

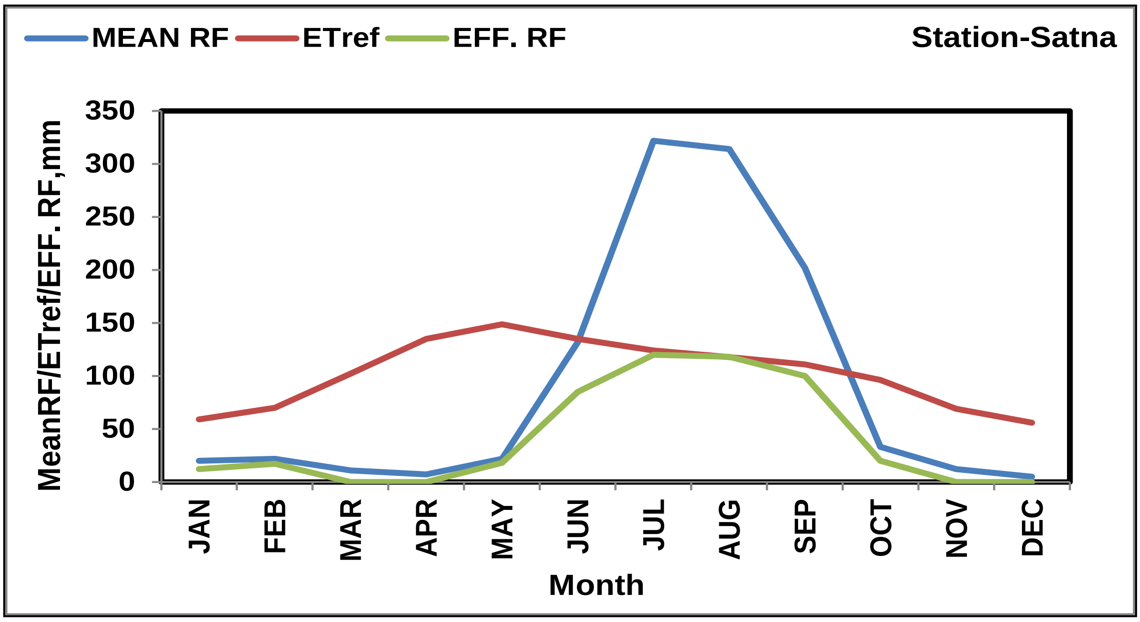


Fig: Distribution of monthly rainfall and Evapotranspiration

Table :Estimation of Crop Water Requirement

S. No.	Name of crop	Crop duration	Sowing time	Total Crop Water requirement (mm)
	1	2	3	4
1	Paddy (Kharif)	97 days	1-Jul	487
2	Soybean (Kharif)	110 days	30-Jun	411
3	Maize (Kharif)	110days	1-Jul	348
4	Wheat (Rabi)	120days	5-Nov	342

Table: Comparison of results of SDI with SPI and EDI

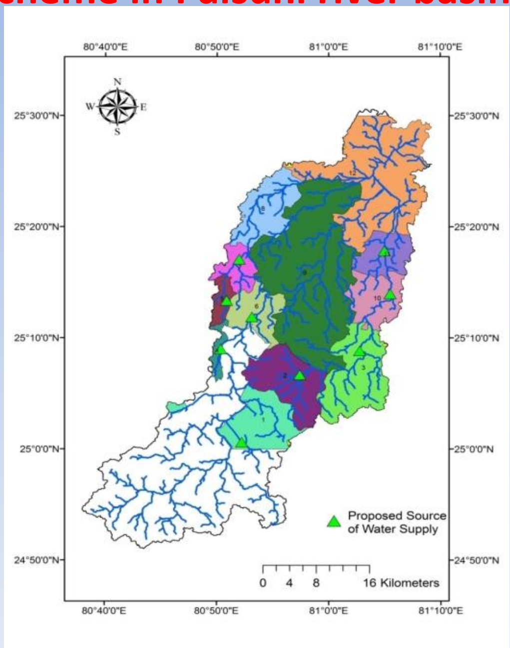
Year	Month	Rainfall	Monthly Av. RF	SDI-Identification	Weighted Departure	SPI 3 Month	EDI Monthly
2006	Jan	0	20	Drought-50	-2.13	-1.99	0.57
2006	Feb	20	22	Drought-2m	-0.21	-0.43	0.48
2006	Mar	34.2	11	1	2.47	0.31	0.85
2006	Apr	23.8	7	1	1.79	1.17	1.18
2006	May	25	22	1	0.32	1.19	0.62
2006	Jun	42.5	132	Drought-50	-9.54	-0.4	-0.69
2006	Jul	435.6	322	1	12.11	0.27	0.37
2006	Aug	171.5	314	1	-15.19	-0.39	-0.63

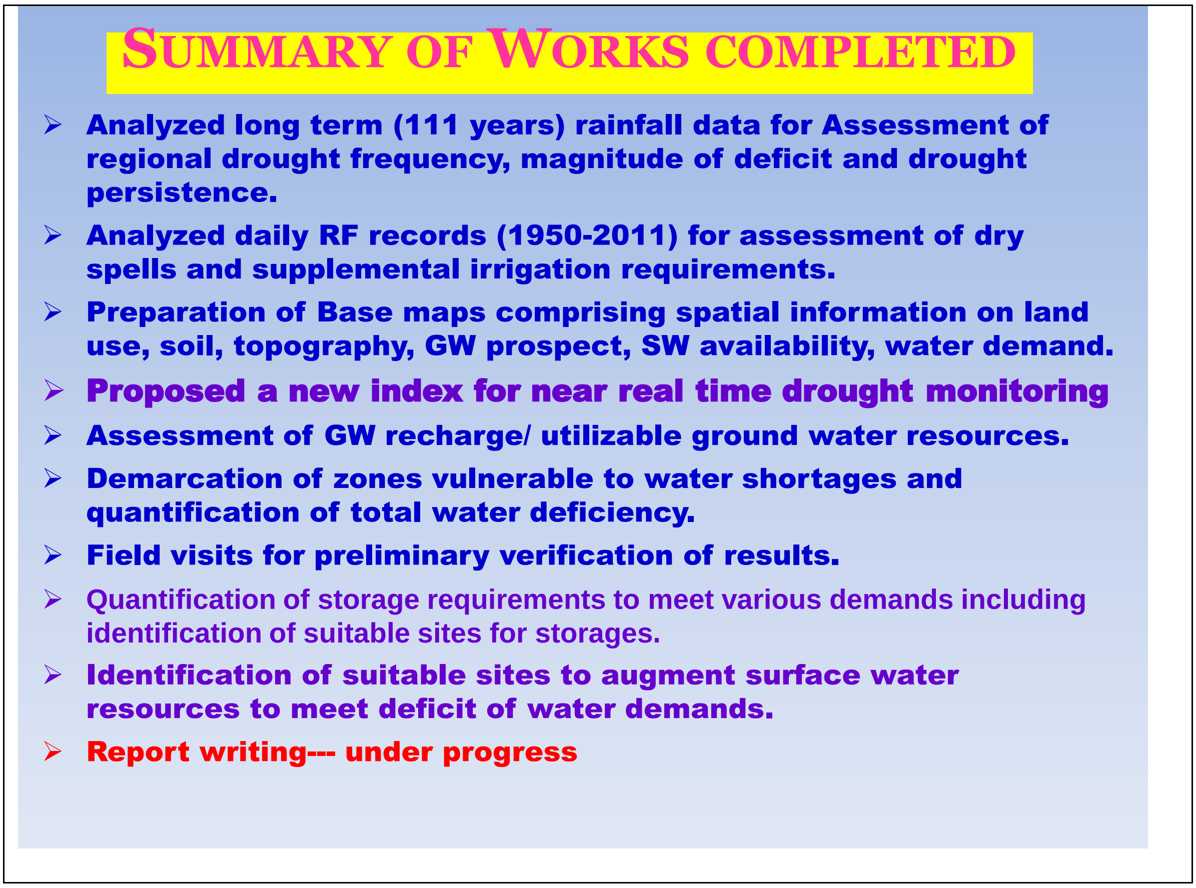
2006	Sep	44.9	202	Drought-50	-16.75	-0.64	-1.29
2006	Oct	11.5	33	Drought-50	-2.29	-1.57	-1.31
2006	Nov	0.6	12	Drought-2m	-1.22	-1.71	-1.46
2006	Dec	0	5	Drought-2m	-0.53	-0.86	-1.44
2007	Jan	0	20	Drought-50	-2.13	-1.74	-1.78
2007	Feb	71.2	22	1	5.25	0.75	-0.67
2007	Mar	25	11	1	1.49	1.04	-0.5
2007	Apr	1.8	7	1	-0.55	1.52	-0.67
2007	May	2.9	22	Drought-50	-2.04	0.08	-0.87

Map showing the clusters of villages for water supply scheme in Paisuni river basin

Based on following

- Topography
- Water Demand
- GW availability/potential
- SW storage potential





The study is expected to be completed by March 31st 2015.

3. APPLICATION OF DSS (P) FOR INTEGRATED WATER RESOURCES DEVELOPMENT AND MANAGEMENT

1. **Title of the Project:** Application of DSS (P) for Integrated Water Resources Development and Management

2. **Study Group:**
   Dr. A.K. Lohani, Scientist 'F' Surface Water Hydrology Division, PI
   Data Collection, Data Processing, Data Analysis, Simulation, Interpretation of results etc.
   Dr. Surjeet , Scientist 'D', Ground Water Hydrology Division, Co-PI
   Data Collection, Data Processing, Simulation
   Rahul Jaiswal, Scientist 'C' & Ganga Plains Regional Centre, Bhopal, Co-PI
   Data Collection, Data Processing, Simulation
   Officers from Water Resources Department, Chhattisgarh
   D. K. Sonkusale, *Water Resources Department, Raipur- Data Collection*
   Akilesh Verma*, Water Resources Department, Raipur- Data Collection*

3. **Type of study: Internal**
4. **Date of Start: April 1, 2013**
5. **Date of Completion: March 31, 2015**
6. **Type of Study: Internal**
7. **Statement of Problem**

The management of water resources requires integration of large volumes of disparate information from diverse sources. An efficient and easy to use framework is required to couple this information with hydrological modelling tools for assessment and evaluation that allow broad, interactive participation in water resources planning and decision making process and effective methods of communicating results to a broader audience. Better and useful information needs to be made available to a larger number of participants in more open and participatory decision making and this information is to be effectively integrated into decision making processes. It is a challenge to integrate new information technologies with traditional methods of analysis and to put these tools to work in practice. A Decision Support System (DSS) helps in attaining this objective. DSS (planning) developed under Hydrology Project-II pertains to a decision support system for integrated water resources development and management. The proposed study will demonstrate the implementation steps and applicability of the DSS(P) for a selected basin.

8. Objectives:

- To collect and process hydrological time series data and spatial data
- To carry out rainfall-runoff modelling using NAM
- To implement Mike basin in the study area
- To generate scenarios for integrated water resources management

9. The Study Area

The Seonath River Originates near village Panabaras in the Rajnandgaon District. The Basin is located between latitude 20^0 16' N to 22^0 41' N and Longitude 80^0 25' E to $82^0$35' E. The Basin area of river up to confluence with the Mahanadi River is 30,860 Sq Km . The river traverses a length of 380 Km. The main tributaries of Seonath river are Tandula, Kharun, Arpa, Hamp, Agar and Maniyari Rivers. The mean annual rainfall in the basin varies from 1005 mm to 1255 mm.

10. Analysis and Results:

Converted the MIKE-11 data files for Mike Hydro software. Using the NAM model rainfall runoff modeling of Arpa basin has been carried out. Figure 1 indicates that the observed and simulated values of the runoff and it shows a good match.

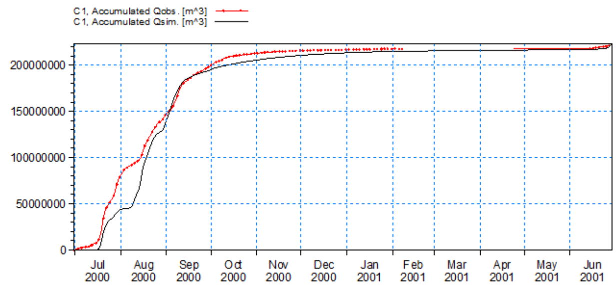


Figure 1: Observed and simulated accumulated runoff: Calibration results of NAM-MIKE-11 Model (2000-2001)

Furthermore, a model for Arpa basin has been setup in Mike Hydro software. Some of the data required to fine tuning of the model parameters for calibration are required. We have requested the Officers of the Water Resources Department, Chhattisgarh progress (Figure 3).

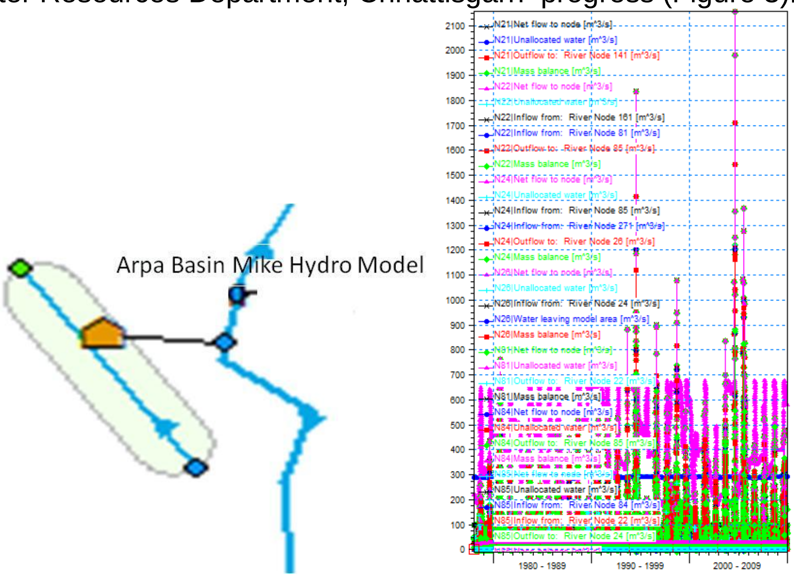


Figure 3: Mike Hydro Model setup for Arpa Basin

11. Action Plan

Task	**Apr. -Sep. 2013**	**Oct.-Mar. 2013**	**Apr.-Sep. 2014**	**Oct. 2013-Mar. 2014**	**Status**
Identification of the study basin					**Identifying the basin in consultation with Chhattisgarh WRD**
Data Collection & Processing					**Completed**
Rainfall-Runoff Modelling using NAM					**Completed**
Implementation of Mike Basin					**In progress**
Scenario generation using DSS(P)					**In progress**

12. Deliverables

Reports and research papers

4. ESTIMATION OF WATER BALANCES FOR INTEGRATED WATER RESOURCES MANAGEMENT IN YERRAKALVA PILOT BASIN, A.P.

1. Title of the Project: **Estimation of Water Balance for Integrated Water Resources Management in Yerrakalva Pilot Basin, A.P.**

2. Thrust Area under XII five year Plan: Integrated Water Resources Development & Management

3. Project Team: Dr. J.V.Tyagi, Sc 'G', SWH Div. (PI)
Dr. YRS Rao, Sc 'F', DRC, Kakinada (Co-PI)

4. Objectives of the study:

(i) To calibrate and validate SWAT model on Yerrakalva pilot basin
(ii) To compute water balance components of the hydrologic cycle for the basin

5. Statement of the problem:

Under 12th five-year plan program, NIH has taken up Pilot Basin Studies (PBS) for Integrated Water Resources Management (IWRM) in Yerrakalva river basin in coastal Andhra Pradesh. The program involves detailed studies on various components of the hydrologic cycle including water balance study of the basin. A water balance study quantifies the components of the hydrologic cycle at the catchment scale. The components of water balance of a basin are influenced by climate, the physical characteristics of the watershed such as morphology, land use and soil. Therefore, understanding the relationship between these physical parameters and hydrological components are very essential for integrated water resources management. This provides the most fundamental information about the hydrology of a watershed and is necessary to assess the importance of climate and land cover in determining water availability. In addition to providing a baseline understanding of the hydrologic processes occurring within a catchment, the water balance components can be compared over long periods of time to track the hydrologic response of a catchment to climatic and land cover variability. Therefore, the present study has been taken up for estimation of water balance and water yield in Yerrakalva river catchment which is critical to long term sustainable management of water resources in the basin.

6. Study area:

The Yerrakalva river rises in the eastern slopes of the eastern ghats at the boarder of West Godavari and Khammam districts. It enters into West Godavari district after 6.4 km run in Khammam district and runs in West Godavari district for about 180 km and joins the Upputeru river, which takes off from the Kolleru lake and falls into Bay of Bengal. Yerrakalva enters the Godavari western delta near Nandamuru aquiduct of Tadepalligudem Mandal. The catchment area of the river is 2725.03 Sq km of which 2330.10 Sq km spreads in upland and 394.93 Sq km in delta (Fig. 1). The study area gets rain during both Southwest and Northeast monsoons. The annual normal rainfall in the basin is around 1078mm.

7. Present state of art:

Major hydrological processes can be quantified with the help of water balance equations. Since the hydrologic processes are very complex, watershed models are widely used for proper comprehension of water balance components. The models based on explicit catchment water balance modelling are numbered in the hundreds and new models are still being presented. The watershed models partition rainfall into various hydrological processes such as surface runoff, evapotranspiration, percolation, lateral flow and base flow etc. with the constraint to account for all water entering, leaving and being stored in a catchment. This adaptation of the principle of conservation of mass constrains the potential for error.

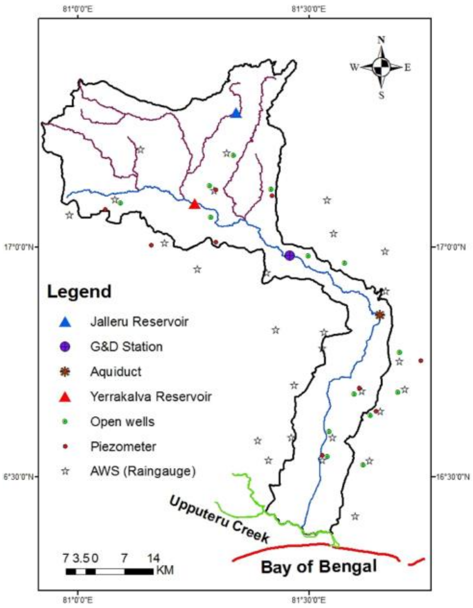


Fig. 1: study area

8. Methodology

SWAT, one of the most recent models developed by the USDA, will be used to analyse and quantify the water balance of the Yerrakalva river basin. The model has been chosen as SWAT is an integrated river basin scale, physically based, continuous-time, long-term simulation, distributed watershed model. Also, its suitability to different parts of the world has been well established. The SWAT model uses physically based inputs such as weather variables, soil properties, topography, land use characteristics and land-management practices occurring in the catchment. In SWAT, a basin is delineated into sub-basins, which are then further subdivided into HRUs based on the homogeneous land use, soil types and topographical characteristics. The major components of SWAT can be grouped into two categories (i) land phase of the hydrologic cycle that controls the amount of water, sediment, nutrient and pesticide loadings to the main channel in each sub-basin, and (ii) routing phase of the hydrologic cycle that defines the movement of water, sediments, etc. through the channel network of the watershed to the outlet. The physical processes associated with water flow, sediment transport, crop growth, nutrient cycling, etc. are directly modelled by SWAT. The hydrologic cycle as simulated by SWAT is based on the water balance equation. Model outputs all water balance components (surface runoff, evaporation, lateral flow, recharge, percolation, sediment yield, etc.) at the level of each watershed and are available at daily, monthly or annual time steps.

9. Work schedule:

(a) Date of commencement of the project: April 2014
(b) Duration of the project: One year (Extension for six months i.e. up to Sept. 2015 is required).
(c) Stages of work and milestone:

S. No.	Work Element	1st Qtr 2014	2nd Qtr 2014	3rd Qtr 2014	4th Qtr 2014	Status
1.	Collection of daily hydro-meteorological data & Processing					Completed
2.	Field experiments, collection of soil samples and lab analysis					Completed
3.	Preparation of spatial data base for SWAT viz. DEM, soil map and land use map					Completed

4.	Preparation of attribute data base					Completed
5.	Setting up of SWAT model					Completed
6.	Calibration and validation of model					To be done
7.	Analysis of model output and water balance					To be done
8.	Report preparation					To be done

Progress

The daily rainfall data of the study area have been collected. Soil samples have been collected from the field and are analyzed in the lab for determination of soil texture. Spatial maps viz. DEM, soil map and land use map have been prepared for the study area. Preparation of attribute data for the SWAT model is completed. Model has been set up on the study basin. However, the hydrologic design details of Yerrakalva reservoir and other data such as elevation-area-capacity curve, reservoir outflows etc. are yet to be obtained from the reservoir authorities that are required for calibration and validation of the model. The working Group may consider for extension of study period for six months i.e. up to September 2015.

10. Research Outcome from the project:

(i) Quantification of water balance components of the catchment
(ii) Long term average estimates of catchment water yield
(iii) Technical publications in the form of report and research paper

6. PROJECT REFERENCE CODE: NIH/SWD/NIH/14-15

Title of the Study: Status Report on "Impact of Anthropogenic and Climate Change on Sediment Load of Rivers"

Name of the PI Dr Archana Sarkar, Sc C, SWHD

Type of Study : Internal

Date of Start : 1 April 2014

Scheduled Date of Completion: 31 March 2015

Study Objectives

1. Literature review
2. Preparation of status report

Statement of the Problem

The sediment load of a river represents a key component of its hydrology, and in turn exerts an important influence on its aquatic ecology, its morphology and the exploitation of its water resources. Changes in the sediment loads of rivers can therefore have wide-ranging environmental and social and economic implications. There is growing evidence (reported by various authors for different rivers of the world) that the sediment loads of many rivers of the world, especially Asian rivers have changed significantly in recent years due to many reasons, including anthropogenic as well as climate change impact). Therefore, it is required to carry out a comprehensive up to date review of all such studies and prepare a status report.

APPROVED ACTION PLAN AND TIMELINE

Year	April - June	July-Sept	Oct-Dec	Jan-March
2014-15	Literature Review	Literature Review	Literature Review	Preparation of status report

PROGRESS

Objectives	Achievements
April 2014- October 2014	
1 Literature Review	Completed
Nov2014- March 2015	
1 Literature Review	Completed
2 Preparation of Final Report	In Progess (to be completed by end of March, 2015)

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

Refer a status report on Sediment Erosion completed by the division earlier.

ANALYSIS AND RESULTS

Extensive review of literature from research papers, reports and books. Preparation of status report is in progress.

EXPECTED ADOPTERS: State Water Resources Dept and other agencies.

DELIVERABLES: Status report

7. PROJECT REFERENCE CODE: NIH/SWD/NIH/14-16

Thrust Area under XII five year Plan

1. Project team:

a. Project Investigator: **Dr ARCHANA SARKAR, Sc 'D', SWHD**
Project Co-Investigator(s):
Dr Rakesh Kumar, Sc G & Head, SWHD
Dr. Vaibhav Garg, Sc C, IIRS, Dehradun
Staff: Sh. N.K. Bhatnagar, PRA, SWHD

2. Title of the Project

Study of Rainfall Patterns and Comparison of Rainfall Data from different Sources for Uttarakhand State

3. Objectives:

i. Procurement of additional rainfall data of the available rain gauge stations in Uttarakhand State from various agencies and processing of rainfall data.
ii. Spatio-temporal trend analysis of historical rainfall data.
iii. Downloading and processing of rainfall data (same location as that of rain gauge stations) from TRMM satellite data as well as high resolution gridded re-analysis rainfall data from APHRODITE.
iv. Comparison of rainfall data from various sources.

4. Present state-of-art

Uttarakhand is a state in the northern part of India. It is often referred to as the "Land of the Gods" due to the many holy Hindu temples and pilgrimage centres found throughout the state. Uttarakhand is known for its natural beauty of the Himalayas, the Bhabhar and theTerai. It borders the Tibet Autonomous Region on the north; the Mahakali Zone of the Far-Western Region, Nepal on the east; and the Indian states of Uttar Pradesh to the south and Himachal Pradesh to the northwest. The state is divided into two divisions, Garhwal and Kumaon, with a total of 13 districts. Two of the most important rivers in Hinduism originate in the region, the Ganga at Gangotri and the Yamuna at Yamunotri. Uttarakhand has a total area of 53,484 km², of which 93% is mountainous and 65% is covered by forest. Most of the northern part of the state is covered by high Himalayan peaks and glaciers. Uttarakhand lies on the southern slope of the Himalaya range, and the climate and vegetation vary greatly with elevation, from glaciers at the highest elevations to subtropical forests at the lower elevations.

Study of rainfall based on an integrated perspective of its attributes like spatio-temporal variation, persistence, trends, periodicities etc is very essential for understanding the nature of weather and climate patterns. A good knowledge of local rainfall-regime is crucial for planning and management of domestic, urban as well as industrial water use, irrigation and crop practices besides forecasting and management of extreme events like floods and droughts. In view of the recent flood disaster in the Uttarakhand state, it becomes all the more important to carry out a scientific analysis of the rainfall regime of the region.

Rainfall observations are an essential element of studies related to hydrological processes. They are utilized both for a better understanding of these processes and as input in hydrological simulation models indispensable to a correct territorial planning and to an adequate management of water resources system. Rain gauges, radars, satellite sensors, forecasts from high resolution numerical weather prediction models and high resolution gridded re-analysis rainfall data are a part of precipitation monitoring networks/data sources. These data sources provide rainfall data that are further provided to hydrological models to produce forecasts, therefore, their comparative accuracy assessment is of prime importance.

Methodology

Trend analysis of historical rainfall data

The objective of a trend analysis is to find out whether a given time series shows an increasing or decreasing tendency over a given period of observation. Confirmatory method of data analysis detects the trends present in a time series and also estimates the rate of the identified trends. Both parametric and non-parametric methods of statistical trend analysis have been extensively used for detection of linear trends in climatic data series. However, form of test and the underlying sample distribution assumptions vary according to the objective of trend analysis. In the present study, linear trends will be estimated using the three methods: linear regression, Mann-Kendall test and Sen's slope estimator considering the advantages and disadvantages of the three methods.

Comparison of rainfall data from different sources

Comparison of rainfall data from two different sources, viz TRMM satellite data products and APHRODITE high resolution gridded re-analysis data will be carried out considering observed rain gauge data as base data.

5. Research outcome from the project

The output of the study would be in the form of a comprehensive report. It is envisaged that the information generated out of this study will add substantially towards better planning, design, development and management of water resources of the basin. It will be useful for the Water Resources Department in particular and people at large in general.

6. Work Schedule:

a. Probable date of commencement of the project: **April 1, 2014.**
b. Duration of the project: **2.5 years**
c. Stages of work and milestone:

S. No.	Work Element	First Year				Second Year				Third Year	
		Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2
1	Additional rainfall data procurement, data processing										
2	Trend Analysis of historical rainfall data (Annual and seasonal)										
3	Downloading of APHRODITE daily rainfall data, its processing and trend analysis (Annual and seasonal)										
4	**Interpretation of Results, Preparation & Submission of Interim Report-I**										
5	Trend Analysis of historical rainfall data (different rainfall										

	intensity series)										
6	Downloading of TRMM satellite data and processing of the downloaded data										
7	Analysis and comparison of rainfall data from different sources using statistical parameters										
8	Preparation & Submission of **Interim Report-II**										
9	comparison of rainfall data from different sources using a hydrological model										
10	Preparation & Submission of **Final Report**										

Progress (2014-15)

- Procurement of additional rainfall data, processing of missing data and annual and seasonal rainfall series generation
- Downloading of APHRODITE daily rainfall data and its processing
- Trend Analysis of historical rainfall data (annual and seasonal)

Preparation of Interim report (under progress)

8. PROJECT REFERENCE CODE : NIH/SWD/NIH/13-16

1. Thrust Area under XII five year Plan: Water Resources Development and Management

2. Title of Study: Quantitative assessment of uncertainties in river discharge estimation.

3. Study Group : Sanjay Kumar, Sc-D, PI
Sharad Jain, Sc-F, Co-PI

4. Objectives of the study:

The objectives of the study are:

1. To estimate uncertainty in river discharge observations.
2. To estimate uncertainty in the stage-discharge (rating) relationship.
3. To estimate uncertainty in stage- discharge relationship using slope as a parameter (back water effects).

5. Statement of the problem:

The uncertainty in the river discharge measurement and estimation is caused by different sources of errors. These mainly includes uncertainty in (a) observations of river stage and discharge used to parameterize the rating curve, (b) presence of unsteady flow conditions, and (c) interpolation and extrapolation errors of the rating curves. The study will provide a framework for analyzing and quantifying the uncertainty in the (i) river flow data (ii) stage-discharge relationship and (iii) stage-slope-discharge relations (for backwater effects) based on the ISO documents GUM (Guides to the expression of Uncertainty in Measurement), HUG (Hydrometric Uncertainty Guidance), ISO 773, 5168, 7066 and 768. The study will also examine various hydraulic factors controlling the flow at a cross section in the river and provides an understanding of independent variables that describes relations among stage, discharge and other parameters specifically discharge measurement under back water effects.

6. Methodology:

Statistical methods/tools and the procedures described in various ISO documents (GUM, HUG) will be used for the estimation of river discharge uncertainties. The uncertainty in discharge measurement (assuming velocity area method) will be quantified as per the ISO 748 which provides the magnitude of these errors at 95% confidence level. The GUM defines the law of propagation of errors for combining uncertainties from several sources and HUG described it for different types of mathematical expressions generally used in hydrometry. This is illustrated by considering the quantity Q as a function of several measured quantities x, y, z . The error δQ in Q due to errors δx, δy, δz…. in x, y, z…., respectively, is given by

$$\delta Q = \frac{\partial Q}{\partial x}\delta x + \frac{\partial Q}{\partial y}\delta y + \frac{\partial Q}{\partial z}\delta z + \cdots$$

The uncertainty of a discharge measurement determined from a stage-fall-discharge rating function (as opposed to a gauged discharge which is determined from a current meter) shall be evaluated using statistical equations based on law of propagation of errors described above. Let X_{rd} be the uncertainty in the recorded discharge, the above error equation is then modified for uncertainty in discharge compution using stage-fall-discharge relationship as

$X_{rd}=\pm(X_{\alpha}{}^{2} + \beta^2 X^2\ h_{u/s\text{-}h0} + \gamma\ ^2X^2{}_{hu/s\text{-}hd/s})^{1/2}$

In practice, X_{α} is the standard error of the mean relation ($S_{mr).}$ $Xh_{u/s\text{-}h0}$ is the standard error of upstream gauge and $X_{h\ u/s\text{-}h\ d/s}$ is the standard error of fall between the u/s and d/s gauges.

7. Deliverables: Revised ISO document**,** Research papers and Report

8. Action plan and timeline and progress:

S.N.	Major Activities	1st Year	2nd Year	3rd Year
1	**Literature review including related various ISO standards**			
2	**Estimation of uncertainty in river discharge measurements (Interim Report-1)**			
3	**Estimation of uncertainty in stage-discharge (rating) relationship using slope as a parameter (back water effects) (Interim Report-2)**			
4	**Estimation of uncertainty in stage-discharge (rating) relationship. (Interim Report-3)**			
5	**Preparation of final report**			

Progress:

(i) As required by ISO/BIS the NWIP and the working draft of the revised ISO 9123 with updated uncertainty clause has been submitted to BIS/ISO for consideration.

(ii) The working draft of the ISO 9123 has been circulated to SC1 members bodies for call of experts.

(iii) The review comments from experts has been resolved.

(iv) The review comments from member bodies has been received and currently being resolved.

9. PROJECT REFERENCE CODE: NIH/SWD/NIH/14-15

Title of the study	Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills.
Name of PI, Co-PI, & their affiliation	Dr. Avinash Agarwal (PI), Dr. Manohar Arora (Co PI), RK Nema (PRA)
Type of study	Internal funded
Date of start	Nov. 2013
Schedule date of completion	Nov. 2013 to Oct. 2016 (3 Years)

Role of team members

Dr. Avinash Agarwal (PI): Field visits, collection of electronic data, processing and plotting of data. Analysis of rainfall, runoff spring flow data. Development of implement-able technology for water availability and transfer. Progress, presentation and final reporting.

Dr. Manohar Arora (Co PI): Field visits. Assessing in collection of electronic data and in development of implement able technology for water availability analysis. Presenting the progress of work when required. Transfer of technology

Sh. R K Nema (PRA): Field visits. Collection of tabulated data. Keeping the record of skilled and unskilled daily wages. Proper running of all field instrument and observatory. Visits of the sites for its proper up date. Assessing in transfer of technology

Location of study area

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 respectively for Chandrabhaga and Danda watersheds (Uttarakhand). Reliable source of water in the watersheds is only the existing springs in the watersheds.

Objectives of the study:

- Identification and development of river gauging sites. Installation of equipments for long term data base.
- Development of rainfall-runoff-suspended sediment yield model using satellite and general soil information.
- Classification of short and long term springs and development of spring flow model using topographic, hydrologic information such as hydraulic conductivity and effective porosity along with the recession characteristics of fractured soil media.
- Rejuvenation of few selected springs through woven wire check dams/infiltration tanks and to study changes in flow.
- Impact of climatic variability on runoff and spring flows.

Statement of the problem:

The monitoring continued with a network of instrumentation for watersheds (Chandrabhaga, Danda) with Rainfall (08 locations), runoff (3 locations), AWS One location for rainfall, temperature, humidity, wind speed & direction incoming radiation, pan evaporation and soil moisture (different depths), soil temperature (two depths). Daily spring flow of around twenty locations in each watershed is measured. The spring flow models will be developed considering topographic and hydrologic information. A long term spring flow record for springs is developed for climatic variability of the springs and for evaluation of spring flow with time.

Recommendation and suggestions in previous meeting of working group

Discussions were held with following comment/recommendation.	
▪ It was advised by the group that the tracer technique must be adopted to exactly identify the points/s of recharge to springs before taking any rejuvenation activity. ▪ The impact of rejuvenation must be reported	▪ PI accepted the suggestions and informed that full weight age will be given to suggestions when the rejuvenation activities will be taken up. ▪ The results will be given as suggested.

Analysis of results

(a) Maintenance and up keeping of installed equipments and data collection.

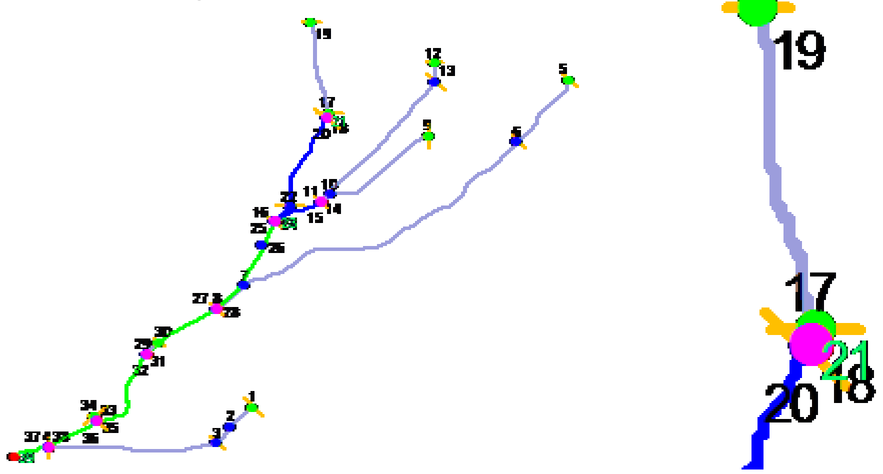
(b) Spring classification on the bases of spring discharge using Meinzer's classification.

(c) Relative performance of springs by four methods viz. (1) Based on spring flow variability, (2) Based on normalized mass spring flow, (3) Based on rainfall spring flow lag and (4) Based on spring flow gradient.

(d) Spring-shed for the springs of watersheds are defined and the spring-shed area has been estimated.

(e) Under Development of runoff, sediment transport model aCCH1D (National Center for Computational Hydro Science and Engineering) flow model is being applied. The input channel geometry, bed sediment, bank sediment, sediment classification are created and given to the model. The river geometry has been defined below as;

Geometry



Results in brief

1. The flow at each input green node is being estimated by SWAT.
2. SWAT inputs files (soil, land use, weather input) have been developed.

List of deliverables	Hydro-meteorological data, papers and report for small watershed of Uttarakhand.
Major items of equipment procured	Nil
Lab facilities used during the study	Nil
Data procured and /or generated	Soil data of UP and Uttarakhand (being procured) Spring flow (generated)

Study benefits/impacts	Hill habitat, State Government and other agencies.
Specific linkage with institutions and/or end-users/ beneficiaries	Village wise interactive work shops in the watershed are proposed
Shot comings/ difficulties	Nil
Future plan	Model development

10. PROJECT REFERENCE CODE: NIH/SWD/NIH/14-17

Title of the Study: Monitoring and modelling of streamflow for the Gangotri Glacier

Study Group : Dr Manohar Arora Sc 'C'
Dr Rakesh Kumar Sc 'F'

Role of Team Members:

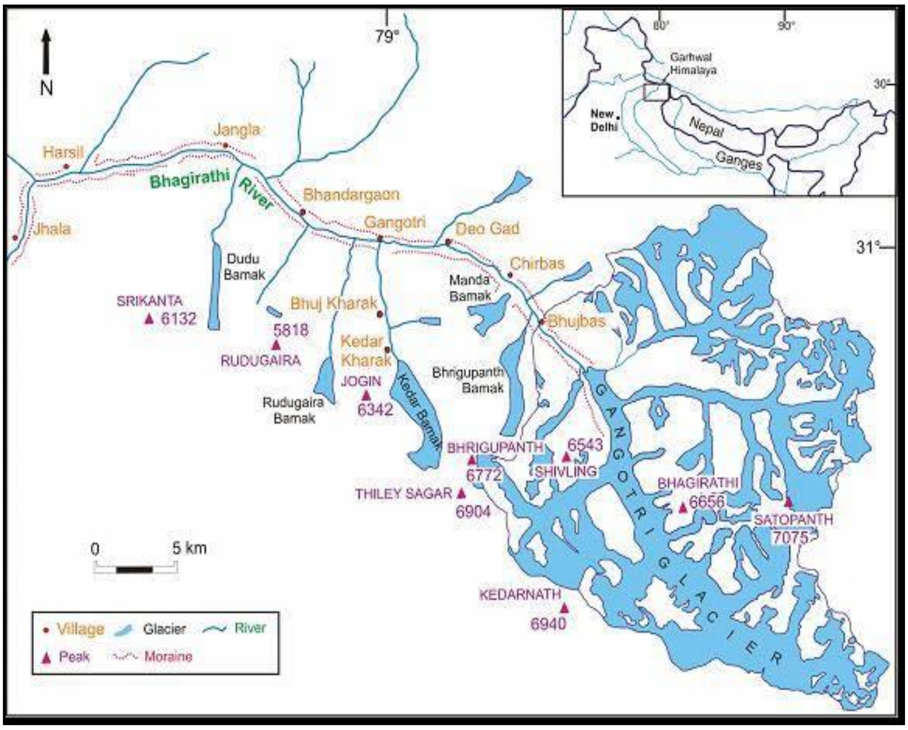
1. **Dr . Manohar Arora, Scientist C& PI:** Conduction field investigations, analyzing data/information, report preparation and overall responsible for the study completion.
2. **Dr Rakesh Kumar, Scientist F &** Co-PI: Guidance in development of methodology, modelling and structuring of report.

Type of Study : Sponsored

Date of start : 01.5. 2014

Scheduled date of completion : 31.03.2017

Location Map:



Objectives: The objective of this study includes:

- Continuous observations of meteorological, hydrological and suspended sediment data for the melt season to determine monthly and seasonal specific water and sediment yield from the study glacier.
- To study the melt water storage and drainage characteristics of the glacier and to simulate daily streamflow using a conceptual hydrological model using observed meteorological and hydrological data.
- Modeling the role of glacier in catchment runoff variation.
- Modeling the catchment runoff variation under different climatic scenarios.

Statement of the problem : The study involves collection and analysis of hydro-meteorological and discharge data of the glacier site. The second step is to develop and apply a snow melt model for streamflow generation and identification of different runoff components. The third step is to model role of glacier in catchment runoff variation and catchment runoff variation under different scenarios.

Approved action plan:

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

Objectives vis a vis Achievements:

Objectives	Achivements
Continuous monitoring of meteorological and hydrological data for monthly and seasonal specific water yield and its variability from the year to year	The data collection and field investigations for the summer 2014 have been collected. The team had returned successfully on 17th October 2014
To study the melt water storage and drainage characteristics of the glacier and to simulate daily streamflow using a conceptual hydrological model using observed meteorological and hydrological data.	The data has been analyzed for the ablation season 2014. It is observed that the Maximum Temperature ranged between 21.2°C to 7.1°C. The standard deviation was 2.6. The Minimum Temperature ranged between 13.4°C to -4.3°C. The standard deviation was 3.2. The Mean Temperature varied between 15.1°C to 3.4°C. The standard deviation was 2.4. The total rainfall observed was 193 mm and the maximum rainfall was 28.8mm. The discharge varied between 199 m^3/s to 3.8 m^3/s. The mean suspended sediment concentration was 1265 mg/l and the suspended sediment load was 12421 tonnes. The melt water storage and drainage characteristics for this season is under progress. The estimation of snow cover area for the modeling is also in progress. The climatic scenarios are being generated in collaboration with IIT Delhi.

Recommendations of Working Group/TAC/GB:
The study may be continued for long term to link with climate change.

Analysis and Results:
The Department of Science and Technology has sponsored this study. This is the first year and the investigations were started on 17th May 2014.

Adopters of the results of the study and their feedback:
The study is a sponsored study and the results will be disseminated by DST.

List of deliverables:

Major items of equipment procured: Nil

Lab facilities during the study: Analysis of suspended sediment samples will be carried out in Soil Lab.

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

Study Benefits/Impact: The study is being sponsored by DST. The meteorological and discharge data would be utilised in studying the characteristics of the Gangotri glacier under changing climate.

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

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

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

11. PROJECT REFERENCE CODE: NIH/SWD/NIH/14-17

Title of the study: **Effect of climate change on evaporation at point scale**

Study Group:

Sh. Digambar Singh, Sc B, SWHD
Dr. A. R. Senthil kumar Sc E, SWHD
Dr. Manohar Arora, Sc D, SWHD

Date of start: 1 June 2014

Duration of the study: 3 Years

Whether externally funded or not: No

Objectives of the study:

v. To develop evaporation model by empirical and soft computing techniques
vi. To downscale the data of temperature, rainfall and humidity from GCM model
vii. To determine the effect of climate variables on evaporation by using the downscaled data

Brief Methodology:

Evaporation model

Multiple Linear regression (MLR) and soft computing techniques would be applied to model the evaporation with rainfall, temperature and humidity as input vectors.

Development of climate scenarios

The prediction of rainfall, minimum and maximum temperature and humidity for future is possible by considering the statistical properties of the time series. The weather generators, considering the future carbon emissions, radiation and effects of green house gases, have been developed to generate the time series by fitting a distribution to the times series and by using the properties of distribution of the times series. The different scenarios of climatic conditions such as A1F1, B1 and baseline can be obtained from SDSM (**Statistical DownScaling Model)** from UK/PRECIS from IITM, Pune. The best models developed by soft computing techniques to simulate the evaporation from historical values of rainfall, maximum and minimum temperature and humidity at the site can be utilized to generate the evaporation from the generated values of rainfall and maximum and minimum temperature and humidity for different climatic scenarios as mentioned above. The falling and rising values of evaporation from the different climate scenarios would give an idea to the official dealing with the planning of cropping pattern.

Results achieved with progress/present status

The literatures related to statistical downscaling from GCM have been reviewed from renowned international journals. The daily data of rainfall, temperature, relative humidity, wind speed and evaporation at NIH observatory are available from 1987 to 2014 and the data have been analyzed for gaps and errors and the same have been removed. The empirical method, modified Penman method, is used to compute the evaporation from the available data.

Meteorological data have been categorized in five series such as pre monsoon, monsoon, post monsoon, winter and annual. The characteristics of Meteorological data are being studied in detail to finalize the significant independent variables to model the evaporation. ANN model for simulating evaporation has been developed using Meteorological data such as rainfall, maximum temperature, minimum temperature and humidity as input data. Results of the different combinations of ANN model are presented in the following table.

Results of ANN model during calibration and validation

Model No	Input Combination	ANN Structure	Calibration			Validation		
			CORR	RMSE	EFF%	CORR	RMSE	EFF%
ANNEVAP1	R (t-1), maxt(t), mint(t), hum(t-1)	4-1-1	0.8753	1.0462	0.7662	0.8852	1.0245	0.7743
ANNEVAP2	“	4-2-1	0.8792	1.0310	0.7730	0.8883	1.0064	0.7822
ANNEVAP3	“	4-3-1	0.8810	1.0236	0.7762	0.8890	1.0082	0.7814
ANNEVAP4	“	4-4-1	0.8831	1.0151	0.7800	0.8897	1.0045	0.7830
ANNEVAP5	“	4-5-1	0.8829	1.0161	0.7745	0.8888	1.0023	0.7840
ANNEVAP6	“	4-6-1	0.8838	1.0125	0.7811	0.8897	1.0057	0.7825
ANNEVAP7	“	4-7-1	0.8851	1.0070	0.7835	0.8846	1.0051	0.7827
ANNEVAP8	“	4-8-1	0.8843	1.0102	0.7820	0.8903	1.0017	0.7842
ANNEVAP9	“	4-9-1	0.8864	1.0016	0.7857	0.8894	1.0052	0.7827
ANNEVAP10	“	4-10-1	0.8836	1.0134	0.7807	0.8910	0.9976	0.7860

The model ANNEVAP4 with ANN structure 4-4-1 is best among all the structure, because the performance of the structure in terms of all the statistical parameters is best among all ANN structures. Though the performance of ANN structure 4-10-1 is better than other models considered the difference between the results during calibration and validation are negligible. After increasing the number of hidden neurons more than 4 the performance of the model is fluctuating (decreasing and then it is increasing) and it might have led to over fitting of the model parameters and a large ANN structure. Correlation between meteorological and evaporation data is being studied.

Action plan and timeline

Year	April - June	July-Sept	Oct-Dec	Jan-March
2014-15	Literature review, Data collection and compilation	Literature review, Data collection, compilation and processing	Development of model for evaporation by empirical and soft computing techniques	Development of model for evaporation by empirical and soft computing techniques
2015-16	Development of model for evaporation by empirical and soft computing techniques	Development of climate scenarios from SDSM/PRECIS	Development of climate scenarios from SDSM/PRECIS	Development of climate scenarios from SDSM/PRECIS
2016-17	Simulation of evaporation by considering the climate scenarios	Simulation of evaporation by considering the climate scenarios	Simulation of evaporation by considering the climate scenarios	Writing of final report

Expected date of completion: 31 March 2017

12. PROJECT REFERENCE CODE: NIH/SWD/NIH/14-17

1. Thrust area under XII five year Plan

Hydrological modelling, water availability analysis

2. Project team:

- **a.** Project Investigator: J.P.Patra, Sc. – B, SWHD
- **b.** Project Co-Investigator (s): Dr. Rakesh Kumar, Sc. – G & Head SWHD; Pankaj Mani, Sc – D, CFMS Patna

3. Title of the Project

Hydrological modelling of Brahmani Baitarani river basin using eWater Source platform.

4. Objectives

- **a.** Statistical and trend analysis of rainfall and river discharge in Brahmani Baitarani river basin.
- **b.** Development of rainfall runoff model for Brahmani Baitarani river basin using eWater source platform.
- **c.** Investigation of implications of different rainfall inputs on rainfall–runoff simulation.
- **d.** Test the applicability of the eWater source modelling platform in Brahmani Baitarani river basin by generating hydrological time series.

5. Present state-of-art

The eWater source is Australia's first national river basin scale water modelling system. The source modelling platform has been developed to take a holistic approach to water management including human and ecological impacts. This includes integrating policy, addressing water savings and sharing for a whole river and connected groundwater systems including cities, agricultural and environmental demands.

In the India-Australia Water Science and Technology Partnership programme, Australia is collaborating with the Ministry of Water Resources to pilot the source river basin modelling platform in India. The MoWR, GOI is planning to develop an Integrated Water Resources Management (IWRM) plan for Brahmani Baitarani basin using the source river basin modelling platform. Hence, the present study has been formulated to develop a rainfall runoff model for Brahmani Baitarani river basin in source platform and test its applicability by generating hydrological time series.

6. Methodology

The Brahmani Baitarni basin (Fig. 1) extends over states of Odisha, Jharkhand and Chhattisgarh with catchment area of about 51,822 km^2. The basin is bounded by the Chhotanagpur Plateau on the north, by the ridge separating it from Mahanadi basin on the west and the south and by the Bay of Bengal on the east. The Brahmani known as South Koel in its upper reaches rises near Nagri village of Jharkhand at an elevation of about 600 m and has length of about 800 km. In its tail reach, the river is known as Maipura. The Baitarni raises near Dumuria village in the hill ranges of Kendujhar district of Odisha at an elevation of about 900 m and has a length of about 355 km. The river is known as Dhamra in its lower reaches. Brahmani and Baitarni form common delta area before falling into the Bay of Bengal. The lower reaches of the basin near the deltaic area are subject to floods. Moreover Mahanadi, Brahmani and Baitarani are interconnected near their delta, worst flood occur when there is simultaneous heavy rains in all the three catchments. Floods are also caused from cyclonic storms since the coastal areas of the basin are cyclone-prone. The industrial development potential of this basin is very high due to its rich mineral resources (iron ore, copper, bauxite etc.) and power potential (548 MW at 60% load factor). Rourkela is an important industrial centre located in this basin. There various other industries (Iron and steel, Thermal power plant, fertilizers etc) existing the basin and more than 50 small to large industries are planned to set up in the upper and middle reaches of the basin. Hence, in future there will be very high water demands from industrial sectors.

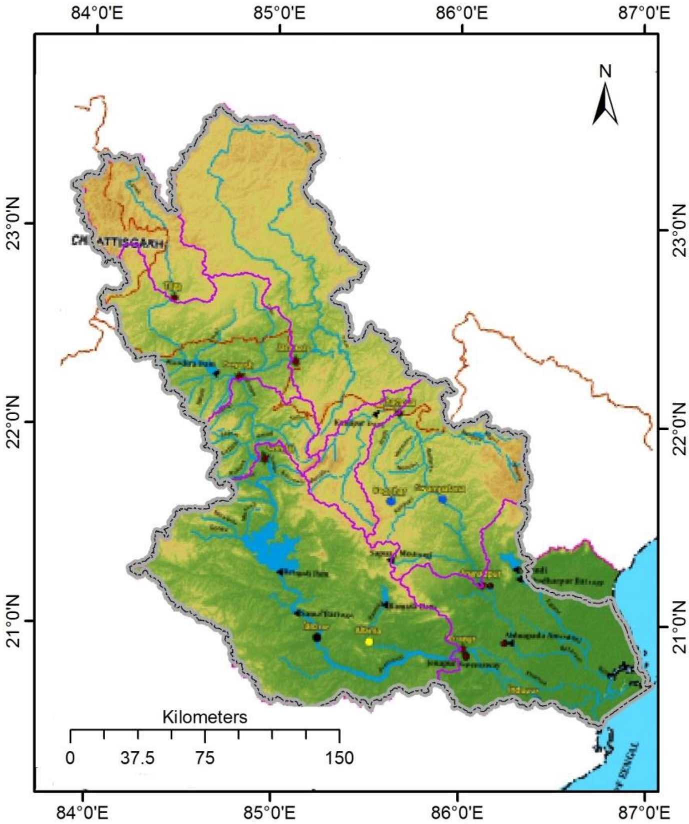


Fig. 1: Index map of study area

Historical rainfall and flow data of the Brahmani Baitarani river basin will be collected and time series of monthly, seasonal and annual values of rainfall and discharge will be analyzed using statistical methods. Trend analysis will be performed to determine whether or not there have been any significant changes in rainfall and discharge over this catchment. The analogue year's plots will be used to identify years with near normal, above normal and below normal conditions, using the long term mean of the variables.

Rainfall runoff models are used to derive runoff for a particular area from inputs of rainfall and potential evapotranspiration. All rainfall runoff models in source are conceptual models that represent catchment hydrological response to rainfall as a series of mathematical relationships. They provide runoff output from each functional unit as total discharge, which is split into quick flow (surface flow) and slow flow (baseflow) proportions. The rainfall-runoff models presently available in source are: Sacramento (sixteen parameters), SIMHYD (7 parameter), SMARG, GR4J (modèle du Génie Rural à 4 paramètres Journalier) (four parameters), IHACRES (six parameters), AWBM (3 parameter), SURM. These models will be configured to run the rainfall-runoff models at the catchment scale.

Different methods are available to obtain the daily rainfall time series for conceptual rainfall–runoff models, depending on data availability, time constraints etc. The implications of different rainfall inputs on the calibration and simulation of rainfall–runoff models will be analysed. First, the simulated runoff resulting from single lumped daily rainfall series for each catchment obtained from three methods: single rainfall station, thiessen average, and average of interpolated rainfall surface will be compared. Secondly, runoff generated from catchment modelling using daily/monthly rainfall series and modelling with smaller functional units within a sub catchment will be compared. The source platform includes set of optimisation tools for calibration of various model parameters. These high-level optimisation features include: Shuffled Complex Evolution (SCE-UA), multi-objective complex evolution (MOCOM-UA), Rosenbrock and other optimisation algorithms; predefined and user defined custom objective functions; option for custom optimisation problems such as regional calibration. Some of these techniques will be applied to calibrate the model. Finally, the calibrated model will be used to simulate hydrological time series for various time periods and will be compared with observed time series to test the applicability of the eWater source modelling platform in Brahmani Baitarani river basin.

7. Research outcome of the project

- Trends of rainfall and stream flow in the Brahmani Baitarani river basin.
- Calibration and validation of various model parameters of eWater source modelling platform for Brahmani Baitarani river basin.
- Water availability at various rivers reaches and sub catchments.
- Quantify rainfall-driven runoff in the catchment under present conditions and alterations made to runoff by climate variability, different land uses etc.
- Applicability of the eWater source modelling platform in Brahmani Baitarani river basin.
- The rainfall runoff modelling setup will help in development of IWRM plan in Brahmani Baitarani river basin.
- Research papers and reports.

8. Work Schedule:

a. **Probable date of commencement of the project:** April 2014

b. **Duration of the project:** 3 Years

c. **Stages of work and milestone:**

Sl. No.	Work Element	First Year	Second Year	Third Year
1	Literature Review and detailed formulation of research approach			
2	Collection of hydro meteorological data, satellite images, thematic maps etc.			
3	Compilation, statistical and trend analysis of rainfall and river discharge			
4	Rainfall runoff model set up in eWater Source platform			
5	Implications of different rainfall inputs and sub catchment size			
6	Calibration and parameter estimation			
7	Model performance evaluation with in various time periods			
8	Reporting	1st Interim report	2nd Interim report	Final report

Results achieved with progress/present status

During the past one year the major time was devoted for literature review, collection of hydro meteorological data, satellite images, thematic maps etc. and compilation of rainfall and river discharge data. The details of data collected are given in a separate heading. The rainfall and discharge data are analysed for missing value and various statistical properties are calculated. Both parametric and non parametric trend analysis for some of rainfall and river discharge data has been carried out and the rainfall runoff model setup for Brahmani Baitarani river basin using eWater source platform is under progress.

Action taken on comments of previous working group meeting

There were no specific comments.

New Studies

13. PROJECT REFERENCE CODE: NIH/SWD/NIH/15-18

1. **Thrust Area under XII five year Plan**
   Flood & Sediment Modelling
2. **Project team:**
   i. Project Investigator: Dr. A.K. Lohani
   ii. Project Co-Investigator(s):

3. **Title of the Project: Flood and Sediment studies in Himalayan basin using MIKE-11 Model**

4. **Objectives**
   To model the floods generated due to cloud burst events.
   To develop discharge-sediment relationship.
   To assess sediment dynamics in the river system.

5. **Present state-of-art**
   In upper Himalayan basins, several water resources projects are under operation and many more are coming up to harness the water resources. These projects are of considerable national and local importance in terms of hydropower generation, irrigation, flood control and subsequent socio-economic development of the region. In the recent past various cloud burst events have been observed in the Himalayan region. Therefore, it is important to analyze the cloud burst generated floods in the basin. Furthermore, the Himalayan rivers carry very high sediment load. Therefore, keeping in view the upcoming projects and development in the Himalayan region modeling of the sediment dynamics in a river system is need of the day.

6. **Methodology**
   a) Analysis of available precipitation data for different return period for the identified sub basin.
   b) Historical study of cloud bursts in the Himalayan Region.
   c) Study of phenomenon of cloud bursts
   d) Quantification of cloud burst phenomenon into flood hydrograph at the critical section in the river stream.
   e) Flood routing of cloud burst flood.
   f) Development of MIKE-11 based sediment model to assess the sediment dynamics of the river system.

7. **Research outcome from the project**
   The research outcome will be in the form of technical report, research papers. Development of methodology for the cloud burse flood modeling and sediment modeling.

8. **Work Schedule:**
   a. Probable date of commencement of the project
   b. Duration of the project
   c. Stages of work and milestone:

Sl. No.	Work Element	2015-16	2016-17	2017-18
1	Data Collection	✓		
2	Procurement of Mike-11 Software	✓		

3	Analysis of available precipitation data for different return period for the identified sub basin	✓✓✓	✓	
	Historical study of cloud bursts in the Himalayan region.	✓✓✓	✓	
	Study of phenomenon of cloud bursts	✓✓	✓	
	Quantification of cloud burst phenomenon into flood hydrograph at the critical section in the river stream		✓✓	
	Flood routing of cloud burst flood.		✓✓	
	Development of MIKE-11 based sediment model to assess the sediment dynamics of the river system.		✓✓✓✓	✓✓✓✓
	Report writing			✓✓

14. PROJECT REFERENCE CODE: NIH/SWD/NIH/15-18

1. Thrust Area under XII five year Plan

2. Project team:

Project Investigator: **Dr ARCHANA SARKAR, Sc 'D', SWHD**
Project Co-Investigator(s):
Er. T. Thomas, Sc D, Regional Centre, Bhopal
Dr. Vaibhav Garg, Sc C, IIRS, Dehradun
Staff: Sh. N.K. Bhatnagar, PRA, SWHD

3. Title of the Project

Snowmelt Runoff Modelling and Study of the Impact of Climate Change in Sharda River Basin

4. Objectives:

i. Preparation of basin maps including DEM and estimation of snow cover area using remote sensing data
ii. Calibration of conceptual snowmelt runoff models namely, SRM and SNOWMOD for Sharda River basin upto Tanakpur.
iii. Development and training of black-box models (ANN models) for simulation of runoff including snowmelt runoff of the Sharda River basin upto Tanakpur.
iv. Inter-comparison of various models.
v. Investigation of the impact of likely future changes in climate on stream flow using downscaled GCM scenarios in the study area.

5. Present state-of-art

The Sharda Valley in Uttrakhand has a vast potential for Water Resources Development, which was not tapped at all during the initial three decades of planned development. The region is mythological abode of Gods; the pilgrim route to Holy Mansarover passes along the Sarda Valley. The river Sharda (or Kali) form the international boundary between India and Nepal, towards the north, from a point called Bramhadeo, about 5 km upstream of Tanakpur. River Sharda originates in the region of Higher Himalayas, near Indo-Tibetan border, from the Glacier of Zaskara range, at about 5250 M. In the upper reaches, in the hills, it is called Mahakali. The river emerges into plains at Bramhadeo and it is called Sharda. The study area extends between 29°0'–30°38'N and 79°28 – 81°7'E covering an area of about 15280 Sqkm, with elevation ranging from 250 to 7000m above msl. About 1732 Sqkm of the total area of the basin is under glacier landscape. The Main River generally flows in north-south direction and is met with by a number of major tributaries from Indian side, namely, Dhauliganga, Goriganga, Sarju and Ladhia. The major tributary from the Nepal side is Chameliya. The Sharda river finally joins the Ghaghra (Karnali) River as its right-bank tributary in Uttar Pradesh. The Sharda Valley in Uttrakhand has a vast potential for Water Resources Development. The Tanakpur Hydroelectric Project (120MW) was commissioned in 1992 by the NHPC with a barrage on the Sharda River near the town of Tanakpur in the district of Champawat. Mahakali (Sharda in India) is one of the five major river basins of Nepal which is shared with India and of which about 34 per cent of total basin area lies in Nepal. The hydroelectric potential of the valley on the Indian side of the river as assessed by UP Irrigation Department is over 3000 MW; and the power potential of the main Sharda river is assessed as 2000 MW. Therefore, accurate estimation of the basin runoff (including snowmelt runoff) is of extreme importance.

Rainfall-runoff models are of prime importance in the decision making process of water resources planning, design, development and management activities. Such models are used, for example, in the design and operation of hydraulic structures, for flood forecasting, and for evaluating possible impact of land use land cover changes as well as climate changes over a catchment. However, due to the interrelated character of driving factors, i.e., physiographic and climatic factors, the rainfall-runoff process becomes highly complex to understand and also extremely difficult to model. Further, in Himalayan region, like the Sharda River, snowmelt is a governing factor for runoff generation. So, for snow-fed basins, snowmelt runoff component is also required to be incorporated in the modelling approach. It is, therefore required to apply a suitable methodology for modelling the runoff in the Sharda river basin.

Potential climate change and its unfavourable impacts on hydrologic systems pose a threat to water resources throughout the world. The effect of climate on hydrology in tropical Asia has many facets. The Himalayas, which act as a mountain barrier on the earth, where polar, tropical and Mediterranean influences interact, play an important role in maintaining and controlling the monsoon system over the Asian continent. In the Himalayas, the storage of precipitation in the form of snow and ice (in glaciers) over a long period provides a large water reservoir that regulates annual water distribution. The majority of rivers originating in the Himalayas have their upper catchments in snow covered areas and flow through steep mountains. If there is any climatic variability in the Himalayas, the impacts could be felt in regions downstream. Therefore, besides reasonably accurate estimation of the runoff, there is an imperative need to study the impact of climate change on the runoff regime of the Sharda basin in view of its huge water resources potential including uses for hydropower, irrigation etc.

6. Methodology

Generation of Base Maps and Snow Cover Maps

- The Shuttle Radar Topography Mission (SRTM) elevation data at 90 m resolution (3-arc SRTM) will be used in this study which consists of a specially modified radar system that flew onboard the Space Shuttle Endeavour during an 11-day mission in February of 2000. All SRTM data are freely available at the USGS ftp site: http://seamless.usgs.gov/.
- Snow cover area (SCA) is one of the important input parameters in modelling. In the Himalayan region, due to cloud cover it is very difficult to get cloud free satellite data for most part of the year. Therefore, snow covered area in the basin would be determined from Moderate Resolution Imaging Spectro radiometer (MODIS – a NASA space satellite) in the form of eight day composite snow cover data (MODIS/Terra-MOD10A2 products). The chances of getting cloud-free scenes in case of MODIS are higher due to higher temporal resolution. Besides, MODIS has an automated snow-mapping algorithm, which reduces the time and errors incorporated during processing satellite data manually.

Hydrological Modelling for Simulation Runoff including Snowmelt Runoff and Inter-comparison of Models

Two types of modeling approaches would be applied, viz, conceptual modeling approach and black-box modeling approach with two types of models (SRM & SNOWMOD) in the former approach as explained below:

- SRM is a conceptual, deterministic, degree day hydrologic model used to simulate daily runoff resulting from snowmelt and rainfall in mountainous regions where snowmelt is a major runoff factor. It is the most popular temperature index method developed by Martinec for small European basins originally and has been applied in over 100 basins ranging in surface area from 0.8 Sq.km to 917,444 Sq.km in 29 different countries. SRM requires daily temperature, precipitation and daily snow covered area values as input parameters.
- The snowmelt model (SNOWMOD) is designed to simulate daily stream flow for mountainous basins receiving input from both snowmelt and rainfall. It is a semi-distributed model in which division of the basin is carried out into a number of elevation zones and evaluation of different hydrological processes related to snowmelt and rainfall runoff is done zone-wise. At each time

step, the model achieves three operations. The first one is the extrapolation of the available meteorological data at different elevation zones. Thereafter, the rate of snowmelt is calculated at each time step. Finally, the snowmelt runoff generated from SCA is integrated with runoff generated due to rainfall from SFA (snow-free area), and these components are routed separately to the outlet of the basin with proper accounting of base flow. The model optimizes the parameters used in routing of the snowmelt runoff and rainfall runoff.

- Artificial Neural Networks (ANNs) have been proposed as efficient tools in developing nonlinear systems theoretic models of the rainfall-runoff process. In the present study, multi-layer feed forward ANN technique will be applied for developing runoff models for the Sharda basin using available data.
- All the runoff simulation models will be calibrated/trained for the same period and with similar input data so that a comparison can be made.

<u>Impact of Climate Change on Runoff</u>

- Investigation of the impact of likely future changes in climate on stream flow will be carried out using downscaled GCM scenarios.

7. Research outcome from the project

The output of the study would be in the form of a comprehensive report. It is envisaged that the information generated out of this study will add substantially towards better planning, design, development and management of water resources of the basin. The climate impact study aims to provide information for planning of climate change adaptation strategies for the study basin.

8. Work Schedule:

a) Probable date of commencement of the project: **April 1, 2015.**
b) Duration of the project: **3 years**
c) Stages of work and milestone:

S. No.	Work Element	First Year				Second Year				Third Year			
		Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q4
1	Collection of information and Hydro-meteorological Data												
2	Preparation of base maps												
3	Downloading MODerate resolution Image Spectral radiometer (MODIS) snowcover data products for for the study area												
4	Analysis and interpretation of weekly MODIS snowcover data and preparation of snow cover maps												
5	**Preparation & Submission of Interim Report-I**												
6	Input data preparation for SRM Model												
7	Calibration and Validation of SRM Model												
8	Input data preparation for SNOWMOD Model												
9	Calibration and Validation of SNOWMOD Model												
10	Input data preparation for ANN Models												
11	Training and Validation of ANN												

	Models												
12	Preparation & Submission of **Interim Report-II**												
13	Inter-comparison of Models												
14	Downscaling of GCM outputs for the study basin												
15	Preparation of Input data for conceptual model for changed climate scenarios												
16	Simulation of conceptual snowmelt runoff model with changed climate scenarios												
17	Preparation & Submission of Final Report												

15. PROJECT REFERENCE CODE: NIH/SWD/NIH/15-18

1. Thrust Area under XII five year Plan

2. Project team:

a. Project Investigator: **Dr A. R. SENTHIL KUMAR, Sc "E" SWHD**
b. Project Co-Investigator(s):
Dr. J. V. Tyagi, Sc "G", SWHD
Dr Avinash Agarwal, Sc "F", SWHD
Dr. Suhas Khobragade, Sc "E", HID
Dr Manohar Arora, Sc "D", SWHD

Staff: Sh. R. K. Nema, PRA, SWHD and Sh. Omprakash, SRA, SWHD

3. Title of the Project

"Study on effect of climate change on sediment yield to Pong reservoir"

4. Objectives:

a) To model sediment yield at Pong dam.
b) To investigate the impact of likely future changes in climate on sediment yield up to Pong dam using future climatic scenarios.
c) To assess the life of the reservoir for the likely sediment yield under the projected different climatic scenarios.

5. Present state-of-art

The developmental activities in the catchment area contribute high sediment load which affects the expected performance of the reservoir. Increase of anthropogenic emissions of green house gases will aggravate climate change and thus average temperature of atmosphere, no of extreme events of rainfall and intensity will increase. In Himalayan region, the increase in high intensity rainfall will contribute more sediment to the reservoir. It is important to estimate the change in sediment yield under the projected different climatic scenarios to assess the performance of the Pong reservoir.

The sedimentation in the reservoir is a continuous process and it reduces the performance of the reservoir slowly in meeting the demands over the time during the life of the reservoir (Morris and Fan, 1997). Survey of Indian reservoirs shows that sediment yield from the catchment due to unpredicted land use changes has been many fold than the sediment inflow considered during the design of the reservoirs (Tejwani, 1984). Consideration of sediment yield from the catchment area over the life period of the reservoir in view of the high sediment inflow has become important to evolve future operating policy to maximize the benefits from the water releases for various sectors.

The recent IPPC's summary report for policymakers confirms the human interference with the climate system based on the data of anthropogenic emissions of green house gases observed for many decades (IPCC WGII AR5, 2014). Increased level of green house gases in the atmosphere has increased average surface temperature of the earth and it will continue to increase in the 21st century. Increased average surface temperature results in extreme events and high intensity of precipitation. The high intensity rainfall will dislodge the sediment and generate more sediment from the catchment and the sediment will get deposited in the reservoir in due course. So it is imperative to estimate the sediment yield at the upstream of Pong reservoir under different future climate scenarios considered by the IPCC summary report and the elevation-area-capacity will be revised by considering the increased sediment yield.

6. Methodology

The sediment yield up to Pong reservoir is to be modeled by Soil and Water Assessment Tool (SWAT). SWAT is a physically based semi distributed continuous time model developed by USDA Agricultural Research Centre (ARS) of Texas A&M university, USA to predict the impact of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land use and management conditions over long periods of time (Soil and Water Assessment Tool Theoretical Documentation, 2011). SWAT requires specific information about weather, soil properties, topography, vegetation and land management practices occurring in the watershed. The physical processes associated with water movement, sediment movement, crop growth, nutrient cycling etc. are directly modeled by these inputs. The sediment yield is modeled by modified USLE (universal Soil Loss Equation) (Parajuli et al., 2009).

The different CGMs (Global Climate Models) are available by the research team worldwide based on the reports published by IPCC from time to time. GCMs have been evolved from the Atmospheric General Circulation Models (AGCMs) widely used for daily weather prediction. GCMs have been used for a range of applications, including investigating interactions between processes of the climate system, simulating evolution of the climate system, and providing projections of future climate states under scenarios that might alter the evolution of the climate system. The most widely recognized application is the projection of future climate states under various scenarios of increasing atmospheric carbon dioxide (CO2). The different scenarios of climatic conditions such as RCP2.6 and RCP8.5 are to be obtained from CMIP5 models available from different institutes.

The parameters of the SWAT are to be calibrated using the historical hydro-meteorological data. The future sediment yield are to be simulated using SWAT with the data of different climatic scenarios. The impact of likely future changes in climate on stream sediment yield up to Pong is to be analyzed by the output of SWAT for future climate scenarios. The elevation-area-capacity curve of Pong reservoir will be revised based on the future sediment yield and the life of the reservoir will be projected.

7. Research outcome from the project

The output of the study would be in the form of a comprehensive report. The output of the study will give an idea of increased sediment yield from the future climatic scenarios to the state department officials for managing the various demands based on the available storage in the reservoir on priority basis.

9. Work Schedule:

a) Probable date of commencement of the project: **April, 2015.**
b) Duration of the project: **3 years**
c) Stages of work and milestone:

Sl. No.	Work Element	First Year	Second Year	Third Year
1	Recruitment of project staff	√		
2	Literature Review	√	√	√
3	Collection and processing of Hydrometeorological data and purchase of satellite imagery and soil maps	√		

4	Data preparation for SWAT	√		
5	Simulation of Sediment yield by SWAT	√	√	
6	Downscaling of data from GCM Models	√	√	
7	Simulation of sediment yield with the data from future climatic scenarios		√	√
8	Revision of elevation-area-capacity table of the reservoir by using the future projected sediment yield		√	√
9	Preparation of interim report	√	√	
10	Preparation of final report			√

References

1. Climate Change 2014: Impacts, Adaptation and Vulnerability: Summary for policy makers, IPPC WGII AR5 Phase I report, March 2014.
2. Morris, G. L., and Fan, J. (1997). Reservoir sedimentation handbook – Design and Management of Dams, Reservoirs, and Watersheds for Sustainable Use, McGraw-Hill, New Delhi.
3. Parajuli, P. B., Nelson, N. O., Frees, L. D., and Mankin, K. R. (2009). "Comparison of AnnAGNPS and SWAT model simulation results in USDA-CEAP agricultural watersheds in south-central Kansas." *Hydrolog. Precess*. 23(5), 748-763.
4. Soil and Water Assessment Tool Theoretical Documentation, Version 2009. (2011). TR-406, Texas A&M University, USA.
5. Tejwani, K.G. (1984). "Reservoir sedimentation in India-Its causes, Control, and Future course of action." *Water International*, 9, 150-154.

16. PROJECT REFERENCE CODE: NIH/SWD/NIH/15-17

1. Thrust Area under XII five year Plan :
   Study of Hydrologic extremes

2. Project team:
   b. Project Investigator: Dr. R.P. Pandey, Scientist F
   c. Project Co-Investigator(s): Dr. Rakesh Kumar, Scientist G

3. Title of the Project
   Study of regional drought characteristics and long term changes in supplemental irrigation water requirement in Seonath Basin in Chhattisgarh

4. Objectives

The main objectives in this study will be as follows:

(1) To analyse long-term rainfall and streamflow data for assessment of regional drought characteristics
(2) To assess the climatic variability in terms of long term trend in climatic variables.
(3) To assess long-term changes in evapotranspiration and sensitivity analysis of ET to different climatic variables.
(4) Estimation of Crop Water Requirement (CWR) and net irrigation requirement (NIR) using suitable method.
(5) To analysis Long Term Trend in NIR to estimate the change in total Irrigation Water Demand (IWD).

5. Present state-of-art

Any change in meteorological variables adversely affects the crop productivity and thereby the regional economy. Thus assessment of the regional level irrigation water demand is necessary for developing strategies for its mitigation. A number of researchers perceive the trend analysis of different climatic variables and parameters which leads to the change in IWD. The literature pertaining to this is given below:

Elgaali et.al, (2007) reported an increase in Irrigation Water Demand for HAD and CCC climate change scenarios for Arkansas River Basin in southeastern Colorado. Elnesr et al. (2010) studied changes in the ETo of 27 weather stations from the period of 1980-2008 in Arabian Peninsula. The increasing trends prevailed during most of the year except in the winter months from October to January. During winter months, significant decreasing trends were observed for only four stations. In general, most of stations showed an increasing trend especially in the Northern parts of KSA (Kingdom of Saudi Arabia). Liang et al. (2010) analyzed monthly ETo at 15 stations during 1961–2005 in the Taoer River basin in China. The long term persistence of the trends for growing season and annual ETo showed the same spatial patterns, high positive values in the west study area in the upper reach and negative values in the Southeast study area in the lower reach was noticed.

Dinpanshoh et al., (2011) analyzed trend in reference crop ET over Iran. The result showed both statistically significant increasing and decreasing trends in the annual and monthly ETo. The increasing trends in ETo were more pronounced than the decreasing trends. In annual time scale, the strong positive (negative) trend in ETo over Iran of the magnitude of about 186 (-65) mm/year per decade was observed. In monthly time scale there was greater number of increasing trends than that of the decreasing trends in most of the warm months. The most strong positive (negative) trend magnitude was found in April (July) with Theil–Sen's slope. Wind speed was found to be the most dominant variable influencing ETo in all the months except the winter months in Iran. Shamsuddin Shahid (2011) reported that there will be no appreciable changes in total irrigation water requirement due to climate change in

Bangladesh. However, there will be an increase in daily use of water for irrigation. As groundwater is the main source of irrigation in northwest Bangladesh, higher daily pumping rate in dry season may aggravate the situation of groundwater scarcity in the region.

Tabari et al., (2011) analyzed annual, seasonal and monthly trends in the Penman–Monteith ETo at 20 meteorological stations during 1966–2005 in the western half of Iran. The result indicated significant positive trends magnitude in annual ETo varied from 11.28 to 2.30 mm/year. On the seasonal scale, stronger increasing trends were identified in ETo data in winter and summer compared with those in autumn and spring. The highest numbers of stations with significant trends were found in the monthly ETo series in February, while the lowest numbers of stations with significant trends were observed in November. Analysis of the impact of climatic variables on the significant increasing trend in ETo showed that the increasing trend was mainly caused by a significant increase in air temperature during the study period.

Tabari et al., (2011) analyzed the impacts of meteorological variables on the temporal trends of ETo indicated that the increasing trend of ETo was most likely due to a significant increase in minimum air temperature, while decreasing trend of ETo was mainly caused by a significant decrease in wind speed. Tang et al. (2011) analyzed variations in ETo over 58 years (1950–2007) at 34 stations in the Haihe river basin China. The results showed that ETo gradually decreased in the whole basin over the entire study period. On the monthly scale temperature had positive impact on ETo and while solar radiation and wind speed had negative effect on it. Whereas changes in air temperature were found to produce a large increase in derivative of ETo, changes in other key variables each reduced rates, resulting in an overall negative trend in ETo. Wang et al. (2011) studied the spatial and temporal patterns of trends for ETo at 34 meteorological stations during 1957-2007 in the Haihe River basin, China using the Mann-Kendall (MK) test and the Sen's method. The basin is subjected to significant decreasing trend in annual ETo, which is observed at most stations in the eastern and southern areas of the basin.

6. Methodology

For determination in variability of climatic factors and the long term changes in IWD, the methodology would include the following:

- The determination the monotonic linear trends in metrological time series (Temperature, Rainfall, Relative Humidity, Wind Speed and Sunshine Hours) using the Mann Kendall's test.
- Estimation of the slopes of trend lines of metrological variables using the Theil–Sen's slope estimator.
- Determination of the step change/ detect the abrupt changes in the time series using cumulative deviation test and distribution free CUSUM test.
- Determination of the percentage variability of metrological series by Coefficient of Variation (CV) over entire Seonath river basin.
- Estimation of ET using suitable method and the application of the Partial Relative Correlation Method to investigate the correlation between ETo and meteorological variables.
- Estimation of CWR and NIR and subsequently assessment of changes in the total Irrigation Water Demand in different seasons.
- Long term Trend Analysis of Net Irrigation Requirement and determination of trend in ET and NIR using Mann Kendall's test and Thiel's Sen's Slope Estimator will be use to estimate the trend magnitude.
- Thus the study will lead to assess changes in irrigation water demand over past 50-years in the context of long term changes in climatic variables.

Proposed Study Area: The study is proposed to be carried out for the Seonath river basin in Chattisgarh. The Seonath river basin is the longest tributary of the Mahanadi basin draining three districts of Chhattisgarh namely Durg, Rajandgaon and Bilaspur. The Basin is located between latitude $20^0$16' N to 22^0 41' N and Longitude $80^0$25' E to $82^0$35' E. The drainage area of the Seonath river basin is 30,860 Sq km. The mean annual rainfall in the basin varies from 1005 mm to 1255 mm. Seonath river basin comprises 25% of the upper catchment of the Mahanadi basin

7. Research outcome from the project

i. The study would be able to reveal long term trend and changes in different meteorological variables in the study basin
ii. The long-term changes in CWR and NIR in the study will be estimate and the prediction of changes in total irrigation water demand will be obtained.
iii. The study will lead to assess long-term changes in supplemental water need to save seasonal crops during drought and to enhance crop yield in good years.

This research will provide updated information on the effect of climatic variability on irrigation water in the study area. Such knowledge is vital for proper planning and management of water resources for future use.

8. Work Schedule:

a. Probable date of commencement of the project: **April 1, 2015**
b. Duration of the project : **Two Years**
c. Stages of work and milestone:

Sl. No.	Work Element	First Year				Second Year			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	Collection of information and Hydro-meteorological Data								
2	Preparation of base maps								
3	Analysis of long-term rainfall and stream flow records to assess regional drought characteristics								
4	Analysis of long-term trends of climatic variables and determination of slope of trend lines and step change etc.								
5	**Preparation & Submission of Interim Report-I**								
6	Estimation of ET_o and sensitivity analysis of climatic factor								
7	Estimation of CWR and NIR for various crops in rabi and kharif season								
8	Determination of Critical Dry spells and assessment of water requirement and irrigation water requirement								
9	Determination of long-term changes in Irrigation water requirement								
10	Preparation & Submission of Final Report								

PROPOSED WORK PROGRAMME OF SURFACE WATER HYDROLOGY DIVISION FOR THE YEAR 2015-16

S.No. & Ref. Code	Title	Study Team	Duration
1. NIH/SWD/NIH/14-16	Study of Rainfall Patterns and Comparison of Rainfall Data from different Sources for Uttarakhand State	Archana Sarkar Vaibhav Garg, Sc C, IIRS, Dehradun Rakesh Kumar N.K. Bhatnagar	2 years (April 2014 to March 2016)
2. NIH/SWD/NIH/13-16	Quantitative assessment of uncertainties in river discharge estimation	Sanjay Kumar Sharad Jain	3 Years (April 2013 to March 2016)
3. NIH/SWD/NIH/13-16	Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills.	Avinash Agarwal Manohar Arora RK Nema	3 Years (November 2013 to October 2016)
4. NIH/SWD/NIH/14-17	Monitoring and modelling of streamflow for the Gangotri Glacier	Manohar Arora Rakesh Kumar	3years (May 2014 to March 2017)
5. NIH/SWD/NIH/14-17	Effect of climate change on evaporation at point scale	Digambar Singh A. R. Senthil kumar Manohar Arora	3years (June 2014 to March 2017)
6. NIH/SWD/NIH/14-17	Hydrological modelling, water availability analysis	J.P.Patra Dr. Rakesh Kumar Pankaj Mani	3years (April 2014 to March 2017)
NEW STUDIES			
7. NIH/SWD/NIH/15-18	Flood and Sediment studies in Himalayan basin using MIKE-11 Model	Dr. A.K. Lohani	3 years (April 2015 to March 2018)
8. NIH/SWD/NIH/15-18	Snowmelt Runoff Modelling and Study of the Impact of Climate Change in Sharda River Basin	Dr Achana Sarkar Er. T. Thomas Dr. Vaibhav Garg	3 years (April 2015 to March 2018)
9. NIH/SWD/NIH/15-18	Study on effect of climate change on sediment yield to Pong reservoir	Dr A. R. Senthil Kumar Dr. J. V. Tyagi Dr Avinash Agarwal Dr. Suhas Khobragade Dr Manohar Arora	3 years (April 2015 to March 2018)
10. NIH/SWD/NIH/15-17	Study of regional drought characteristics and long term changes in supplemental irrigation water requirement in Seonath Basin in Chhattisgarh	Dr. R.P. Pandey Dr. Rakesh Kumar	2 years (April 2015 to March 2017)

WATER RESOURCES SYSTEM DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr. S K Jain	Scientist G & Head
3	Mrs. Deepa Chalisgaonkar	Scientist F
4	Dr. Sanjay K Jain	Scientist F
5	Dr. M K Goel	Scientist F
6	Sri D S Rathore	Scientist F
	Dr. Renoj Thayyen	Scientist D
8	Sri L N Thakural	Scientist C
	Sri. Manish Nrma	Scientist C
9	Sri P K Mishra	Scientist B
10	Sri Tanvear Ahmed	Scientist B
11	Sri P K Agarwal	Scientist B
12	Sri Yatvear Singh	PRA

WORK PROGRAMME FOR THE YEAR 2014-2015 &2015-16

WORK PROGRAMME FOR THE YEAR 2014-2015				
SN	**Title**	**Study Team**	**Duration**	**Funding (Rs. in Lakhs)**
		Completed Internal Studies		
1.	Trend and variability analysis of rainfall and temperature in Himalayan region	L. N. Thakural Sanjay Kumar Sanjay K. Jain Sharad K. Jain Tanvear Ahmed	3 years (10/11-09/14)	NIH
2.	Web GIS based snow cover information system for the Indus Basin	D. S. Rathore Deepa Chalisgaonkar L. N. Thakural Tanvear Ahmed	2 Years (04/13-03/15)	NIH
3.	Assessment of Water Footprint of the National Capital Territory (NCT) of India	Deepa Chalisgaonkar Sharad K. Jain M. K. Nema P. K. Mishra	2 Years (04/13-03/15)	NIH
		Ongoing Internal Studies		
1.	NIH_Basin – A WINDOWS based model for water resources assessment in a river basin	M. K. Goel Sharad K. Jain Deepa Chalisgaonkar Prabhash K. Mishra	3 Years (04/13-03/16)	NIH (16)
2.	Assessing climate change impact across KBK region of Odisha	P. K. Mishra Sharad K. Jain Sanjay K. Jain	3 Years (04/13-03/16)	NIH (28)
3.	Glacier change and glacier runoff variation in the upper Satluj river basin	Sanjay K. Jain Sharad K. Jain Renoj J. Thayyen	2.5 Years (10/13-03/16)	NIH (12)
4.	Variability of the Hydro-climatic variables in Punjab Plains of Lower Satluj	M. K. Nema Sharad K. Jain	2 Years (11/13-10/15)	NIH (11.34)
5.	Catchment scale evaluation of cold-arid cryospheric system Hydrology, Ganglass catchment, Ladakh	Renoj J. Thayyen S. P. Rai Sanjay K Jain Sudhir Kumar	3 years (04/14-03/17)	NIH (48)
6.	Hydrologic Modelling of a part of Satluj Basin using SWAT Model	P. K. Agarwal Sharad K. Jain Tanvear Ahmed M. K. Goel Sanjay K. Jain M. K. Nema	2 -3/4 Years (06/14-3/17)	NIH (23)
7.	Decision Support System for Water Resources Planning in Upper Bhima basin, Maharashtra	D. S. Rathore M. K. Goel, R.P. Pandey Sanjay Kumar Surjeet Singh	2 years (07/14-06/16)	NIH (34)
8.	Modeling of Narmada basin by using the GWAVA model	Sanjay K. Jain Sharad K. Jain T. Thomas (RC-Bhopal) P. K. Mishra P. K. Agarwal	2.25 years Dec. 2014 – Mar 2017	NIH

		M. K. Nema		
9.	Runoff modeling of Shyok River, Karakorum Range	Renoj J.Thayyen Sanjay K.Jain	3 years Dec-2014 to Nov.2017	NIH (38)
10.	Hydrological process and characterization of Lesser Himalayan Catchments	M. K. Nema Sharad K. Jain Sanjay K. Jain Renoj J.Thayyen P. K. Mishra P. K. Agarwal	5 Years 12/14-12/19	NIH+
		Ongoing Sponsored Studies		
1.	Glaciological studies of Phuche Glacier, Ladakh Range, India	Renoj J. Thayyen M K Goel S P Rai	5 Years 1/10-06/15	DST (56)
2.	Assessment of Environmental flow for Himalayan River	Sharad K. Jain Pradeep Kumar P. K. Agarwal P. K. Mishra	1 Year 07/14-07/15	MOES (8.61)
		Proposed New Internal Studies for the year 2015-2016		
1.	Development of Ganga Information Portal	Deepa Chalisgaonkar Sharad K. Jain D. S. Rathore Sanjay K. Jain Sudhir Kumar P. K. Mishra P. K. Agarwal M. K. Nema	3 years (04/15-03/18)	MoWR (107.88)
2.	Integrated approach for hydrological changes in selected catchments for IWRM in view of climate change in India	L. N. Thakural D. S. Rathore Surjeet Singh Tanvear Ahmed Sanjay K. Jain Sharad K. Jain	3 years (04/15-03/18)	MoWR (44.30)

COMPLETED STUDIES
INTERNAL RESEARCH PROJECT: NIH/WRS/2015/01

1. Thrust Area under XII five year Plan

2. Project team:

a. Project Investigator	Mr. L. N. Thakural, Sc-B, PI
b. Co-PIProject Co-Investigator(s)	Dr. Sanjay Kumar, Sc-D,
	Dr. Sanjay Kumar Jain, Sc-F, Co-PI
	Dr. Sharad Kumar Jain, Sc-G, Co-PI
	Mr. Tanveer Ahmed, Sc-B, Co-PI

3. Title of the Project - Trend and variability analysis of Rainfall and Temperature in Himalayan region

4. Objectives-

1. To create database for hydrological parameters (Rainfall and Temperature) for the Himalayan region.
2. To estimate temporal and spatial characteristics of the rainfall and temperature time series.
3. To carry out trend and variability analysis of rainfall and temperature.

5. Present state-of-art

Interest in climate variations has experienced a significant increase in recent years due to the important economic and social consequences connected with extreme weather events. Most of the studies regarding climate change only seek to detect potential trends or fluctuations in the long term mean of climatic signals, but the study of variability changes and extreme event behaviour is also essential. In the present study statistical analysis, trend and climatic variability changes in climatic variables namely temperature and rainfall will be carried out in Himalayan region, India. The parametric and non-parametric approaches will be used to determine the trends in the time series data of these meteorological parameters

6. Methodology

Statistical techniques/tools will be used to evaluate the temporal and spatial characteristics of the rainfall and temperature time series (statistical distribution, temporal correlation, spatial correlations). As meteorological data in the Himalayan region is scarce the rainfall data from APHRODITE would also be used in the study. A comparison of rainfall from APHRODITE with the ground based stations will also be carried out. The trends and variability analysis of rainfall and temperature time series would be evaluated using the following statistical techniques for various time scales.

1. Parametric approach for trend and variability.
2. Mann-Kendall test and Sens's estimator of slope method (non-parametric) for trend and variability.

7. Research outcome from the project

The changes in temperature, precipitation, and other climatic variables are likely to influence the amount and distribution of runoff in all river systems globally. The detection of trends and magnitude of variations due to climatic changes in hydro climatic data, particularly temperature and precipitation is essential for the assessment of impacts of climate variability and change on the water resources of a region. The results will be useful for the runoff and climate change studies.

8. Work schedule

Sr. No.	Major Activities	1st Year	2nd Year	3rd Year
1	Literature review			
2	Data collection & preparation for analysis			
3	Temporal and Spatial characteristics of the rainfall and temperature time series and their statistical distribution.			
4	Analysis using parametric approach			
5	Analysis using non-parametric approach			
6	Preparation of report**		Part-1	Part-2 Part-3

9. Analysis and Results

HIMALAYAN REGION

The trends for the rainfall data has been carried using the rainfall data derived from the APHRODIE. The location map of stations considered is shown in Figure 1

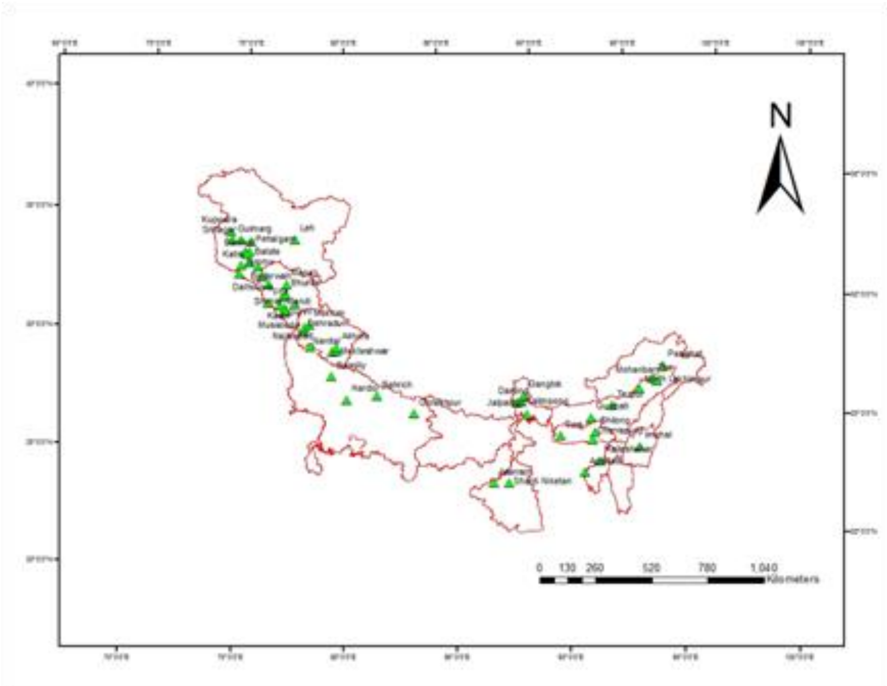


Figure 1: Location map of study area.

Trends in Rainfall

The magnitude of the trends in the annual mean rainfall time series on seasonal and annual time scale is determined using the Sen's slope estimator is given in Table 3. The Man-Kendall test was applied to this time series to ascertain the significance of trends (Table1).

Table 1: Sen's estimator of slope (^{0}C/year) for rainfall

Stations	pre-monsoon	monsoon	post-monsoon	winter	annual

	Z statistic	Sen slope	Z statistic	Sen slope	Z statistic	Sen slope	Z statistic	Sen slope	Z statistic	Sen slope
Agartala	**0.23**	0.566	0.78	3.64	1.05	1.11	0	0.184	0.86	6.16
Almora	0.12	0.067	-1.11	-3.93	-0.78	-0.309	0.67	0.599	-0.54	-2.89
Asansol	1.1	0.87	0.78	3.24	0.23	0.42	0.01	0.005	0.75	2.917
Baderwah	**-0.89**	-2.53	-1.62	-6.65	0.78	0.6	-0.26	-0.71	-1.4	-8.03
Bahrich	**1.46**	0.85	-1.21	-4.3	-0.67	-0.26	0.99	0.56	-42	-2.21
Bareilly	**1.27**	0.84	0.5	2.33	-1.16	-0.3	0.97	0.53	0.61	3.15
Batote	**-1.1**	-3.14	-1.05	-2.26	0.26	0.08	-0.67	-1.17	-1.33	-6.32
Bhuntar	**-1.14**	-1.66	0.91	3.29	-0.61	-0.24	-1.73	-2.46	-0.29	-1.06
Bilaspur	**1.1**	0.48	-0.34	-0.69	-0.01	-0.02	0.59	0.24	-0.26	-0.96
Dalhousie	**-1.14**	-1.77	-1.08	-7.73	0.06	0.03	-0.12	-0.23	-0.68	-5.31
Darjeeling	**1.51**	2.68	1.78	8.2	-0.23	-0.41	1.62	0.84	1.31	14.71
Deradun/Mussorie	**0.18**	0.37	0.4	2.38	-1.48	-0.82	0.07	0.04	0.31	3.87
Dharamsala	**0**	0.01	-0.69	-12.39	-0.78	-0.63	-0.48	-1.01	-0.91	-15.38
Gangtok	**1.08**	4.61	0.85	14.75	0.5	0.55	**2.98**	1.32	1.16	20.38
Gulmarg	**-0.56**	-1.17	-180	-1.17	0.23	0.09	-0.59	-0.98	-1.27	-4.54
Guwahati	**1.76**	3.04	-0.04	-0.26	0.83	0.82	0.03	-0.12	1.73	5.88
Hardoi	**0.74**	0.34	-1.76	-5.1	-0.56	-0.23	1.68	0.66	-1.27	-4.03
Imphal	**1.51**	3.19	-0.18	-0.66	0.23	0.43	0.86	0.53	1.05	4.61
Jalpaiguri	**1.36**	4.68	1.05	6.88	0	0	1.84	0.75	1.21	12.63
Jammu	**-0.74**	-0.17	0.12	0.5	1.29	0.61	0.48	0.62	0.15	0.83
Kaliashahr	**0.07**	0.41	1.45	6.25	-0.42	-0.65	-0.04	-0.02	1.24	7.35
Kasol	**0.48**	0.22	-0.07	-0.12	-0.8	-0.34	0.42	0.76	-0.12	-0.73
Kukernag	**-1.24**	-3.34	-0.59	-1.28	0.64	0.54	-0.62	-0.39	-1.39	-3.42
Kupwara	**-0.53**	-1.53	-1.4	-1.56	-0.1	-0.14	-0.31	-0.86	-1.19	-5.26
Leh	**-0.18**	-0.04	0.31	-0.25	0.45	0.07	**-0.94**	-0.35	0.09	0
Manali	**-2.13**	-4.49	-0.8	-1.81	-1.81	-0.87	-3.18	-8.57	-1.87	-13.13
Mandi	**0.03**	-1.08	0.89	3.8	-0.23	-0.13	-0.31	-0.46	0.23	1.5
Mohanbari	**0.86**	2.85	-0.75	-4.42	-0.4	-0.56	0.86	0.53	-0.12	-0.91
Mukhim	**0.01**	0.12	0.83	5.13	-1.68	-0.63	-0.42	-0.4	0.69	4.46

*Bold indicates statistical significance at 95% confidence level as per with Mann-Kendall test (+ for increasing and – for decreasing)

The rainfall analysis of the stations located in Himalayan region shows a mixed (increasing/decreasing) in the trends both at seasonal and annual scale. Gangtok and Leh are showing the decreasing trend in rainfall during winter season which are statistically significant also.

COMPLETED STUDIES
INTERNAL RESEARCH PROJECT: NIH/WRS/2015/02

1. **Thrust Area under XII five year Plan:** Hydrological information

2. **Project team:**
   a. Project Investigator: D.S. Rathore, Sc F
   b. Project Co-Investigator(s): Deepa Chalisgaonkar, Sc F
   L.N. Thakural, Sc B
   Tanveer Ahmad, Sc B

3. **Title of the Project:** Web GIS based snow cover information system from Indus basin

4. **Objectives:**
   a. To publish snow cover information on web as an OGC web service for Indus basin

5. **Present state-of-art**
   NSIDC has prepared snow cover maps using MODS bands 2, 4 and 6, cloud mask and temperature screen. The methodology utilizes masking, thresholding and spectral space partitioning techniques with NDSI, NDVI, individual band values to delineate snow in swath product. Multiple temporal and spatial resolution products are generated from swath products. Snow cover maps for Himalaya are also prepared by ICIMOD through post processing of NSIDC snow maps. The maps are also visualized through web GIS application.

6. **Methodology**
   MODIS data mosaicing, subsetting (spectral and spatial), reprojecting and conversion of format for the data was carried out in MODIS Reprojection Tool (MRT). Basins were delineated using SRTM250 data. Indus basin boundary was reshaped based on ICIMOD basin vector data. The basin extent within India was obtained by overlay with Indian geographical extent. Snow was delineated using NDSI and MODIS band-2 reflectance. Snow statistics was computed. Snow raster were polygonized and morphologically cleaned. Snow vector maps were published using Geoserver software as WMS layers. Web application was developed utilizing these maps.

7. **Research outcome from the project**
   a. Sub basin wide snow statistics: Snow cover maps were prepared for years 2007-08, 2010-2012.
   b. Web application for snow cover maps: Web application was prepared for visualization of snow cover maps.

8. **Work Schedule:**
   Project to be completed by March 2015

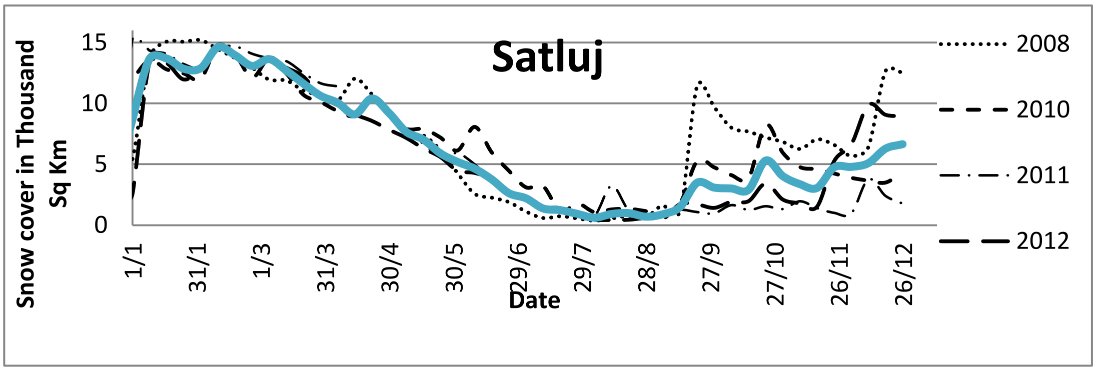


Fig Snow extent for Satluj basin

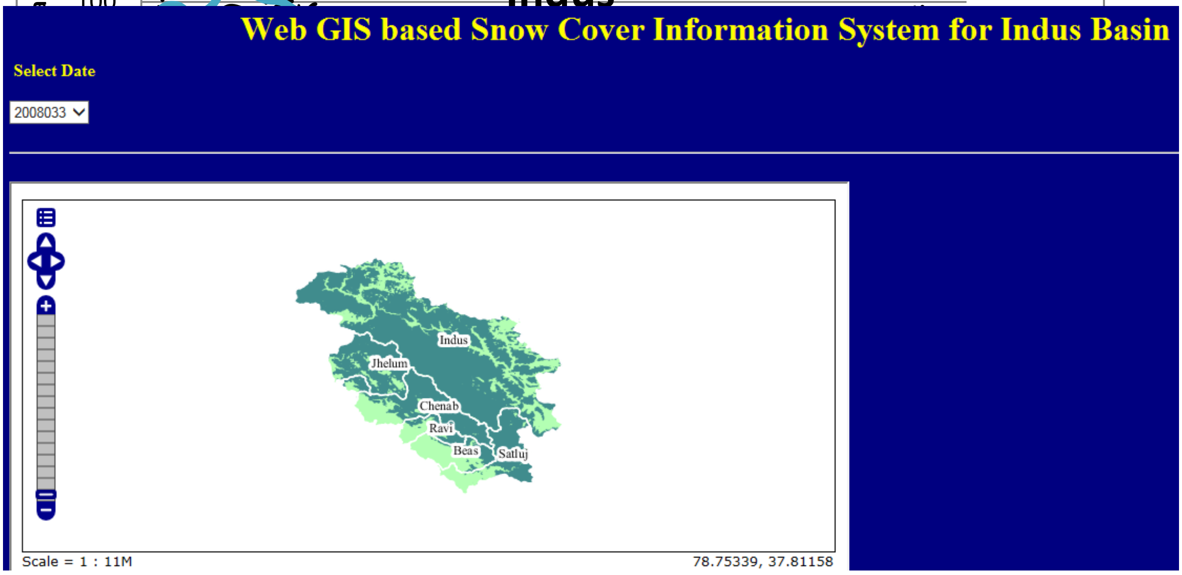


Fig. Snow extent for Indus basin

Fig. Web application for snow cover in Indus basin

COMPLETED STUDIES
INTERNAL RESEARCH PROJECT: NIH/WRS/2015/03

Title of Study	-	**Assessment of Water Footprint of the National Capital Territory (NCT) of India**
Study Group	-	D. Chalisgaonkar Dr. S. K. Jain Manish Nema Prabhash K. Mishra
Type of Study	-	Internal
Start Date	-	April 01, 2013
Target date of completion	-	31st March, 2015

Objectives
The objective of this study is to estimate the water footprints of NCT Delhi from both a supply and consumption perspective by quantifying green, blue and grey water footprints. Additionally, the aim is to understand how the water resources of NCT Delhi are being utilized for water consumption.

Methodology
The methodology used in this study is largely based on earlier studies supported by Water Footprint Network (www.waterfootprint.org). There are three components of water footprint.

Blue Water Footprint:
It is the volume of surface water and groundwater consumed (i.e. evaporated or incorporated into the product) during production processes.

Green Water Footprint
It is the volume of rainwater consumed (i.e. evaporated or incorporated into the product) by the product; and

Grey Water Footprint
It is the amount of freshwater required to mix pollutants and maintain water quality according to agreed water quality standards.

In the present study, the previous methodologies are integrated and upgraded where possible. The main upgrades are the incorporation and assessment of green, blue and grey water resources.

The study of existing water management schemes of water supply and sewage treatment of NCT Delhi reveals the following activities influence the water use within the city boundary:

- Sources of Water in NCT Delhi
- Consumption of water for various purposes
- Processing at a sewage treatment plant

The water footprints thus consist of two components: consumptive water use and wastewater pollution. The impact of water pollution is being assessed by quantifying the dilution water volumes required to dilute waste flows to such extent that the quality of the water remains below agreed water quality standards. The water footprint of NCT Delhi is being assessed for three major sectors i.e. domestic, agriculture and industrial.

The WF of the NCT Delhi is being computed based on the data for the period 2006-2010 collected from various sources, published reports from various departments of government of NCT Delhi and from some other important websites. The virtual water content related data is available at country level not at NCT Delhi level, so it is being used for NCT Delhi as well. The data which was not available has been assumed.

The WF is being computed based on the available data of direct (real) and indirect (virtual) water consumption of NCT Delhi. As the computation of grey water footprint includes the amount of freshwater required for mixing pollutants and maintaining water quality according to agreed water quality standards, the water quality criterion of Central Pollution Control Board ('C' Class water), given below, has been taken as the water quality standards for the computation of dilution water requirement.

'C' CLASS WATER QUALITY NORMS

Drinking water source after conventional treatment and disinfection	• Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less

Progress of the Study:

The assessment of the domestic water footprint has been done as a first step during 2013-14. It has been done by computing the environmental pressure exerted by the population of NCT Delhi in terms of the water it uses directly and indirectly. Presently the assessment of agriculture water footprint and industrial water footprint are being done.

For the computation of crop water requirement, CROPWAT software is being used. It uses precipitation data, crop growth inputs, and soil data to calculate crop water requirements. After all yields and variables in the CROPWAT program are accounted for, the blue and green water footprints can be determined.

Green water use by crop = min (crop water requirement, effective precipitation)
Blue water use by crop = min (irrigation requirement, effective irrigation)

The grey water component assessment has been done based on the application of nitrogen (N) fertilizer to the crop fields. Only the nitrogen fertilizer use has been incorporated into the grey water footprint, because the grey component is expressed as a dilution water requirement. This means only the most critical pollutant with the greatest application rate need be considered.

Virtual water import component has also being considered for the computation of agriculture water footprint as lot of agriculture related products are brought in Delhi for consumption.

Benefits of the Study:

- Economic benefits: better water management and better water use have positive impacts on water costs;
- Environmental benefits: better water quality and more efficient water consumption have lower impacts on ecosystem;
- Social benefits: better quality of water means better quality of life;
- An Indian approach on water use: definition of common strategies on water footprint will contribute to promote transnational awareness on domestic water management, saving and innovations.

ONGOING STUDIES
INTERNAL RESEARCH PROJECT: NIH/WRS/2015/01

1. **Thrust Area under XII five year Plan:** Integrated Water Resources Development & Management

2. **Project team:**

a. Project Investigator: Dr. M. K. Goel, Sc. "F"
b. Project Co-Investigator(s): Dr. Sharad K. Jain, Sc. "G"
Smt. D. Chalisgaonkar, Sc. "F"
Mr. P. K. Mishra, Sc. "B"

3. **Title of the Project** NIH_Basin – A WINDOWS based model for water resource assessment in a river basin

4. **Objectives**

Envisaged objective of the study is to develop a WINDOWS interface (named as NIH_Basin – NIH_Basin-Simulation) of a model developed for assessment of water resources in a river basin for easy application by the user groups. It is also proposed to carry out a number of modifications in the model (developed in earlier study) for comprehensive analysis of water resources at basin scale.

5. **Present state-of-art**

Effective management of water and related environment in a river basin requires an integrated and co-ordinated planning within the basin. In the present approach of water availability estimation in a river basin, it is difficult to account for the effect of various developmental activities and climate sensitive parameters on the water resources scenario in a river basin. Groundwater is not given enough attention in the assessment of total water resources in the basin and the water requirement for different purposes is not precisely estimated. Discharge is considered as the basic unit for water availability estimations which may be affected by a number of basin parameters and developmental activities. A number of basin scale models, like RIBASIM, MIKE BASIN etc. have been reported but there is no Indian model which can cater, particularly, to the Indian conditions. Further, spatial variability of water related variables and parameters are not considered in such models.

With this need in view, a detailed spatially distributed model has been developed to assess various components of the hydrological cycle in a river basin. In this model, focus is given to incorporate spatial variation of land-use, soil type, rainfall, evapo-transpiration, physiographic characteristics, cropping pattern, irrigation development, groundwater conditions, river network and hydraulic structures in a river basin. GIS is employed to link the spatial data with the simulation model and to project the model results in map form for easy visualization. The basin is divided into grids of uniform size (~ 1 km) and model computes various components of hydrologic cycle such as actual evapo-transpiration, overland flow, groundwater recharge, and residual soil water content at monthly time step for each grid. The model brings out total water availability in the basin; water consumed by different uses; and water storage in different hydraulic structures, in soil water zone, and in groundwater aquifer in a river basin. By taking repeated runs of the model for longer time periods, sustainability of various water resources management plans can be examined. The model can be used to: a) visualize the effect of land use change, cropping pattern change, climate change (in terms of rainfall and its distribution, temperature, humidity etc.), and population and industrial growth on the basin water resources, and b) analyze various management options like inter-basin transfer of water, development of new water resources projects etc.

The model is in continuous phase of development. Some of the present limitations of the model which are planned to be addressed include: i) specification of EAC tables or corresponding relationships for various storage structures, ii) rule-curve based operation of reservoirs so that different operation policies of the system can be simulated, iii) option of hydropower simulation in the basin, iv) continuous long-term simulation, and v) simplified representation of groundwater simulation. It is proposed to prepare input data files through user-interactive forms.

6. Methodology

For approximating the EAC relationships for a reservoir, the approach developed by J. Mohammadzadeh-Habili et. al (2009) has been adopted, avoiding the necessity of specifying EAC tables for various reservoirs in the river basin. The method has been programmed within the FORTRAN code of the model. The previous option of assuming a triangular distribution has also been retained.

Rule-curve based approach has been added in the FORTRAN code for simulating the reservoir operation as per specified operation policy. Earlier, reservoir operation was simulated only with standard linear operation policy (SLOP) only. The option of hydropower simulation of a reservoir has also been added and eight different methods of supply of water through the power plants have been considered. Tail water elevation is also considered as a function of discharge.

Model is planned to work in two modes: a) monthly mode (in which the simulation is carried out at daily time step for a month and then the spatial recharge and discharge pattern are externally used to find the revised water table in the basin with some groundwater simulation model, say Visual MODFLOW, and the revised groundwater table is used for the subsequent month), and b) continuous mode (in which the simulation is carried out at daily time step for the complete period for which hydro-meteorological data are available). In the second mode, grid-wise pumping and recharge estimations are accumulated over each sub-basin and then divided by the S_y of sub-basin to convert water withdrawal/ recharge to corresponding change in groundwater level which can be applied to initial groundwater surface to find the revised surface in the sub-basin, thus avoiding the necessity of detailed groundwater simulation. For each sub-basin, average groundwater depth is computed from data of a large number of observation wells (a procedure, defined by DHI, Denmark has been adopted for converting irregular observations in different wells in a sub-basin) has been programmed and is being added as a module in the software.

In WINDOWS interface of the model, various data input forms are being developed. The layout plan of the software for various activities is shown in Figure - 1. Four important modules of the software include:

a) Database preparation
b) GIS analysis
c) Model execution
d) Analysis of results

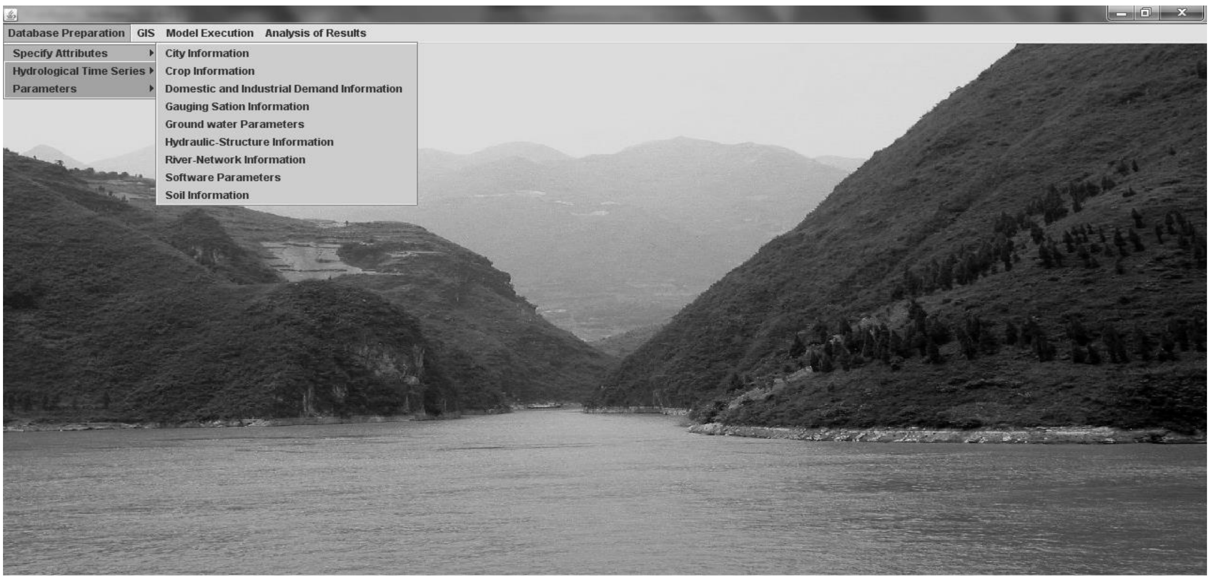


Figure – 1: Layout plan of *NIH Basin*

The "Database Preparation" module is planned to include forms for the entry of attribute and temporal data of hydrological variables and model parameters. In the "GIS Analysis" module, it is planned to link the free domain GIS (ILWIS system) for creating and processing geo-spatial data. This module will also contain provisions for converting raster data to ASCII format. In the "Model Execution" module, various sub-models which are run for aggregating spatial information will be provided. In addition, the main Basin model will also be provided in this module. In the "Analysis of Results" module, provision will be made to view spatial and hydrological results of the model.

7. Research outcome from the project

Research outcome from the project is a WINDOWS based spatially distributed river basin planning and management model for integrated water resources assessment and management at basin scale. The study can help water resources departments and river basin authorities in the analysis at river basin scale. It can also help in assessing the impact of various natural and anthropogenic activities on various components of the hydrological cycle at basin scale.

8. Work Schedule:

a. Probable date of commencement of the project: April 01, 2013
b. Duration of the project: 2.5 years
c. Stages of work and milestone:

S. No.	Work Element	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Year 2013 - 14					
1.	Modification in model methodology and source code				
Year 2014 - 15					
2.	Modification in model methodology and source code				
3.	Development of data forms & WINDOWS interface				
Year 2015 - 16					
4.	Development of data forms & WINDOWS interface				
5.	Model testing and refinement				
6.	Report writing and User Manual preparation				

9. Present Progress:

A number of modifications have been made in the model methodology and the source code for making it more practicable and realistic. Some of these modifications include:

a) Number of landuse classes has been increased from 6 to 60 for more detailed representation.
b) As suggested in last WG, option has been included to consider industrial demands separately (earlier, it was merged with domestic demands) and the same has been linked to city attributes.
c) Date of commissioning of hydraulic structures has been included and in the long-term simulation, their effects are considered only after their commissioning.
d) Now, variable GW development is considered (which was constant initially) by specifying the parameters of a 2nd order equation.
e) Provision of observed EAC table specification for a hydraulic structure has been added.
f) Baseflow computation is now made depending on the actual GW storage in upstream basin above a gauging site.

g) Rather than considering constant population for human and cattle population, population growth is considered as per defined rate and for long-term simulation, revised population is estimated at the beginning of each year.
h) In the command area of hydraulic structures which are commissioned in intermediate stages during long-term simulation, option has been included for considering the revised cropping pattern while computing irrigation demands.

These modification required changes in the input data. Therefore, it was decided to first complete the model modifications and then develop the WINDOWS based forms for database preparation. The program development is nearing completion but interface development needs considerable time. It is suggested to increase the time period of this study by 6 months.

ONGOING STUDIES
INTERNAL RESEARCH PROJECT: NIH/WRS/2015/02

1. Thrust Area under XII five year plan: Impact of climate change on water resources

2. Project team:

a. Project Investigator: Shri P. K. Mishra, Sc 'B'

b. Project Co-Investigator(s): Dr. Sharad K. Jain, SC 'G' & Head
Dr. Sanjay K. Jain, Sc 'F'

3. Title of the Project: Assessing Climate Change Impact across KBK (Kalahandi-Bolangir-Koraput) region of Odisha

4. Objectives:

1. To analyze long-term historical climatic data to determine trend
2. To analyze the future climate in the region based on downscaled GCM data
3. To assess the current potential and utilization gap of water resources in the region to develop management plan

5. Present state-of-art

The proposed study envisages assessing the climate change effects in one of the poorest region in the country (KBK region, Odisha) regularly facing drought, water scarcity, and flood as well. The region is neglected with poor connectivity, resulting in increased Naxalite activities. With large-scale Govt. funding and concerted efforts, KBK region can be developed. Further, climate change and its impact on the water resources is also inevitable. The situation may aggravate in future. Therefore, a timely holistic study considering all the three undivided districts is essential to study the water resources problem in the region considering climate change.

6. Methodology

The study requires creation of a large database collected from primary and secondary sources and generated through Remote sensing and GIS. The study commences with findings standard statistical characteristics for rainfall and temperature such as mean (μ), standard deviation (σ), skewness (Sk), kurtosis (Kk), and coefficient of variation (Cv) for monthly, seasonal and annual temporal scale. The seasonal assessment will include Pre-monsoon (April-May), Monsoon (June-September), Post-Monsoon (October-November) and Winter (December-March) period.

The long-term historic data is analyzed for detecting trend utilizing parametric (5-year moving average) and non-parametric tests (Mann-Kendall test; Sen's slope estimator). Unlike parametric test, the non-parametric tests are robust in nature and do not affected by outliers but certainly by randomness. Hence, the series of data were tried for detecting outliers and randomness before performing any test for trend detection. Standard Normal Homogeneity Test (SNHT) and Pettitt's Test are utilized to find the most probable year where the rainfall and temperature trend has been shifted considerably.

The downloaded large-scale daily predictors of Hadley Center's GCM (HadCM3) for HadCM3 A2 and B2 future scenarios for 139 years (1961–2099) on 3.750 latitude x 3.750 longitude grid-scale (http://www.cics.uvic.ca/scenarios/sdsm/select.cgi) is downscaled using Statistical Downscaling Model (SDSM). The Statistical Downscaling Model (SDSM) is a multiple regression-based tool, introduced by Wilby et al. (2002), for generating future scenarios to assess the impact of climate change. HadCM3 is a coupled atmosphere-ocean GCM developed at the Hadley Centre of the United Kingdom's National Meteorological Service. HadCM3 has been chosen because of its' wider acceptance in many climate change impact studies. Further, it provides daily predictor variables, which can be exclusively used for the SDSM model. Water resources availability and utilization will be made using primary and secondary data collected through field visit and from different multiple sources. It is planned to utilize SWAT model to assess the water resources.

7. Research outcome from the project

a. Long-term trend of climatic variables viz. rainfall, temperature and potential evapotranspiration for the region
b. Future climatic scenario for the region
c. Water availability at present and in the future scenario vis-à-vis its present utilization

8. Work Schedule

a. Probable date of commencement of the project: April 01, 2013
b. Duration of the project: 3 years
c. Stages of work and milestone:

Sl. No.	Work Element	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Year 2013 - 14					
1.	Data procurement & Review of literature				
2.	Trend analysis				
3.	1st Interim report				
Year 2014 - 15					
4.	Downscaling				
5.	Inputs for SWAT model set-up				
6.	2nd Interim report				
Year 2015 - 16					
7.	Water resources assessment				
8.	Final report				

9. Progress till date:

The study started with three objectives as given in item 4. Already trends in long-term climatic data, i.e., rainfall (110 years), temperature (102years), and potential evapotranspiration (102 years) have been investigated on monthly, seasonal and annual series in eight districts spread over in the KBK region in the western part of Odisha, India. The trends are generated using both parametric (linear regression method) and non-parametric (Mann-Kendall test and Sen's Slope estimates).

As per the second objective of the study i.e. to analyze the future climate in the region based on downscaled GCM data, future rainfall in the KBK region has been downscaled from HadCM3 A2 and HadCM3 B2 GCM data utilizing SDSM model and presented in the 41st Working Group. The study has been carried out using SDSM tool version 4.2.9.

In the present Working Group, future temperature scenario in the KBK region has been downscaled from HadCM3 A2 and HadCM3 B2 GCM data utilizing SDSM model. Further, to assess the water availability and utilization, input data for two basins in the KBK region viz. Tel basin (sub-basin to Mahanadi basin) and Sarbari basin (sub-basin to Godavari basin) is under preparation to run SWAT model. In view of the work volume, it is requested to extend the project period for one year.

ONGOING STUDIES
INTERNAL RESEARCH PROJECT: NIH/WRS/2015/03

1. Thrust Area under XII five year plan: Impact of climate change on water resources

2. Project team:

a. Project Investigator: Dr. Sanjay K. Jain, Sc "F"

b. Project Co-Investigator(s): Dr. Sharad K. Jain, Sc 'G' & Head
Dr. Renoj Theyyan, Sc "D"

3. Title of the Project: Glacier change and glacier runoff variation in the upper Satluj river basin

4. Objectives:

A major goal of the proposed study is to obtain broader understanding of glacier change (spatial and temporal), reasons and their impact on glacier melt runoff. The objectives of the proposed study are as follows:

- Collection and processing of historical data
- Future climate projections will be applied to see the changes in meteorological variables.
- Assessment of changes in glacier cover area using satellite data
- Modelling of glacier melt runoff.
- Glacier mass balance
- Changes in glacier mass balance will be used to investigate glacier melt contributions.

5. Present state-of-art

Glacier runoff contributions to streamflow provide critical water supply in many mountainous regions. These glacier runoff contributions are highly sensitive to changes in temperature. The change in glacier cover area results in significant changes to both total annual and summer streamflow downstream. Warmer temperatures cause increased glacial melt but as glaciers recede; their potential contributions to water supplies are also affected. In Western Himalayan basins, several water resources projects are under operation and many more are coming up in near future to harness the available potential. These projects are of paramount importance in terms of drinking water, irrigation, hydropower generation, flood control and subsequent socio-economic development of the region. The availability of stream flow for glacier melt for these projects throughout the year is very important.

6. Methodology

- Creation of data base of the study area(s)
- Glacier inventory and glacier change occurring in the study area.
- Trend analysis of past and future metrological data
- Glacier mass balance study
- Modeling of glacier melt runoff
- Projection of temperature change
- Assessment of changes in glacier melt runoff vis-à-vis glacier change/change in meteorological inputs

7. Research outcome from the project

The glacier inventory and change in the glacier of the study area. Expected runoff in future and changes in hydropower potential.

8. Work Schedule

a. Probable date of commencement of the project: October 2013
b. Duration of the project: 3 years
c. Stages of work and milestone:

1st. Interim report	2nd. Interim report	Final report
April 2014	April 2015	March 2016

9. Progress:

In the present study three sub basins of Satluj basin has been taken and they are Baspa, Tirunglhad and Spiti (shown in Figure 1). In these three basins glacier change have been computed using glacier map obtained from Topographical maps (1966) and satellite data (2000, 2006 and 2011). It was observed that the glacier areas in these basins have been receding. Discharge data of three sites (Sangla, Thangi and Khab), temperature data (Raksham, Kaza, Kalpa) as well as snow water equivalent (SWE) have been collected. The field data have been processed. The correlation of this data with the glacier change obtained using image processing has been investigated.

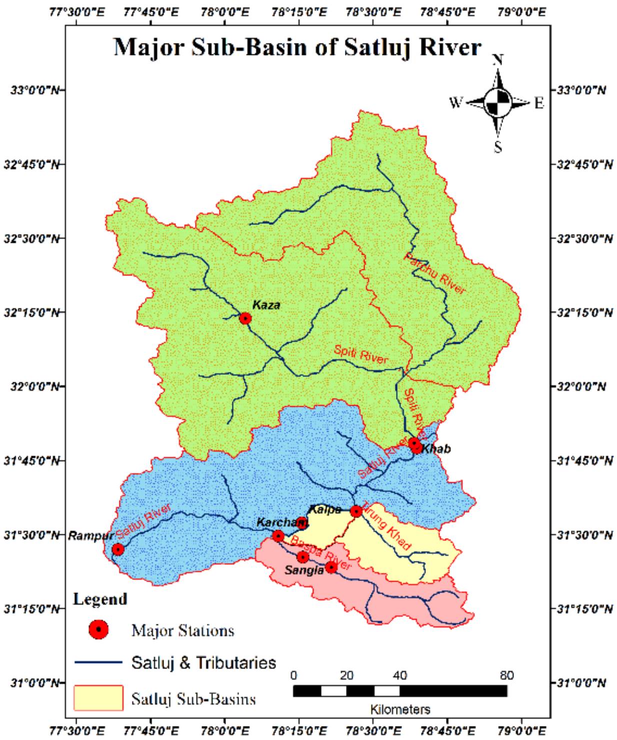


Fig. 1 Study area

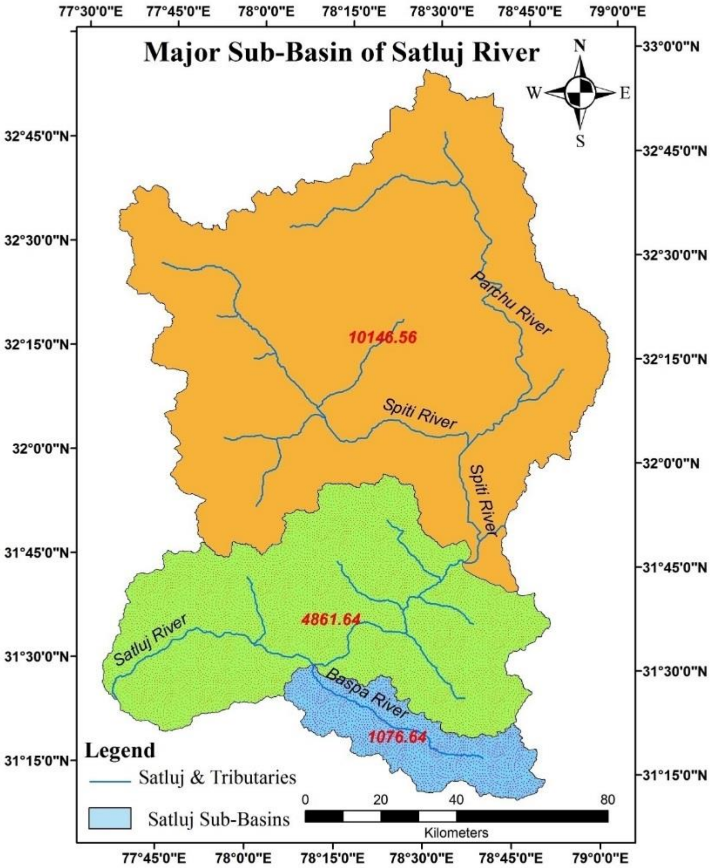


Fig. 2 Major sub-basins of Satluj River

ONGOING STUDIES
INTERNAL RESEARCH PROJECT: NIH/WRS/2015/04

1. Thrust Area under XII five year plan: Sustainable water systems management: Adaptation of hydro-system to climate change

2. Project team:

a. Project Investigator: Manish Kumar Nema, Sc 'B'

b. Project Co-Investigator(s): Dr. Sharad K. Jain, Sc 'G' & Head

3. Title of the Project: Variability of the Hydro-climatic variables in Punjab Plains of lower Sutlej

4. Objectives:

a. To collect/procure/computerize long-term hydrological and climatic data of study area
b. To create an integrated hydrological database of lower Sutlej
c. To analyze recorded hydro-climatic data for trends or changes in Punjab Plains of lower Sutlej
d. To evaluate monthly/seasonal/annual hydrology of the region

5. Present state-of-art

The most of the hydrologic and climatic datasets varies with time and space. The assessment of trends in climatology and hydrology still is a matter of debate. Capturing typical properties of time series, like trends, is highly relevant for the discussion of potential impacts of global warming or flood / drought occurrences. The majority of the Indian agriculture is dependent on the southwest monsoon, which brings about 80% of the total precipitation over the country which is critical for the availability of freshwater for drinking and irrigation. Changes in climatic variable over the Indian region, particularly the SW monsoon, would have a significant impact on agricultural production, water resources management and overall economy of the country. A pre-information regarding the changes can be ascertained by the analyzing the trend of these variables. Considering their importance, this study is proposed to understand the variability of the Hydro-climatic variables in Punjab plains of lower Satluj basin by performing standard trend analysis. The Punjab plain of lower Satluj basin up to Harike Barrage has been selected for the study in views of its important contribution in agricultural production for the country. The land surface of Punjab is one of the most fertile plains of India. The Satluj, Ravi and Beas are the major rivers flowing through the Punjab. The Satluj and its tributary Beas enters Punjab near Nangal and Talwara respectively. After moving about 450 km in the plains of Punjab, these two confluences at Harike before crossing over to Pakistan. On micro regional basis the Punjab plains may be divided into the Bari Doab (be-tween the Beas and the Ravi) and the Bist Doab (between the Beas and the Satluj).

6. Methodology

Data Acquisition:

All possible hydro-climatic data and other related information shall be acquired, purchased, collected from various state and central agencies mainly includes Indian Meteorology Department (IMD); Central Water Commission (CWC); Bhakra Beas Management Board (BBMB); Ground Water Department, Govt. of Punjab; etc.

Processing of Acquired Hydrological data:

Integrated hydrological data base will be created in GIS environment after data pre-processing like identification and removal the data gaps, outliers etc.

Linear Regression and Mann–Kendall Test for Trend Analysis:

Prior to perform linear regression test data series shall be standardized by subtracting the mean and diving by their standard deviations. To test for randomness against trend in hydrology and climatology the widely used Kendall's τ statistic will be applied

Magnitude of the Trends: The magnitude of the trend in a time series will be determined using a non-parametric method known as Sen's Slope Estimator.

7. Research outcome from the project

Research Papers and Reports. Comprehensive database of the lower Sutlej in Punjab plains for the end users/beneficiaries from the relevant Sectors

8. Work Schedule

a. Probable date of commencement of the project: 01/11/2013
b. Duration of the project: 2 years
c. Stages of work and milestone:

S N	Work Element	First Year				Second Year			
		Q1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4
1.	Literature survey, Data collection/Monitoring/Field & Lab Investigation								
2.	Processing of Acquired Hydrological data								
3.	Linear Regression and Mann–Kendall Test for Trend Analysis and Magnitude of the Trends								
4.	Analysis & Interpretation of data using computer program/model output								
5.	Preparation of Papers/ Report								

9. Progress till date:

The trend and magnitude of trend analysis has been performed for the monthly rainfall, maximum and minimum temperature data series for the 9 districts which fall under the study area. The results has also been presented in the previous working group meetings. While analyzing the discharge data of the lower Sutlej at Harike and Ropar, it has been observed that most of the discharge is highly regulated and even many a times there are flow breaks in the data. Therefore, it has been felt that the application of MK and Sen's slope may not be very fruitful for understanding the trends. While discussing the issue during the internal review meeting it has been decided to drop the trend component of discharge for the study and also to shorten the period of study from three to two years.
In the last five months the groundwater level data from observation wells and piezometers present in the study area has been collected and being analyzed for identification of trends and their magnitude in the ground water levels using the same methods used in case of rainfall data. The groundwater data has been categorized in to pre-monsoon (i.e. Month of June) and post monsoon (i.e. Month of October) for the available datasets. Average pre-monsoon water table depth of the study area various from 5.32 - 26.87 meters below ground level. The ground water level over the study area are showing a falling trend yet the reason for fall has to be investigated as both groundwater withdrawals are significantly rising in the Punjab and rainfall is also showing decreasing trends.

ONGOING STUDIES
INTERNAL RESEARCH PROJECT: NIH/WRS/2015/05

1. **Thrust Area** : Himalayan Cryosphere and Climate Change

2. **Project team** : Dr. R.J Thayyen, Dr.S.P Rai, Dr. Sanjay Jain, Dr. Sudhir Kumar

3. **Title of the project** : Catchment scale evaluation of cold-arid cryospheric system Hydrology, Ganglass catchment, Ladakh.

4. **Objective**
   1. To improve the understanding of the climate forcing on cold-arid cryospheric system and Hydrology.
   2. To improve the understanding of the melt water generation process and the role of permafrost.
   3. To study the temporal variations in isotopic characteristics of winter base flow and summer flow of the perennial reach and its cryospheric linkages.

5. **Present state of the art:**
   Himalayan and trans- Himalayan regions of the country have many hydrological regimes. Role of the Himalayan cryospheric systems to the downstream river flow varies across these hydrological regimes. However, lack of data and research in these areas limit our understanding of these systems and thereby our ability to manage these system under the changing climate. Cold-arid cryospheric system of the Ladakh is unique hydrological regime of the Himalayan system. The first phase of the project entitled "Cryospheric system studies and runoff modeling of Ganglass catchment, Leh, Ladakh Range" has revealed many unknown facets of the hydrology of the cold-arid cryospheric system such as catchment specific runoff of nival/glacier system, very high temperature lapse rate under cold-arid climate, Low contribution of glacier melt and significant contribution from frozen ground etc. While the earlier project has concentrated on the high altitude Nival/glacier system with catchment outlet at 4700 m a.s.l., the present project (Phase-II) has aimed to expand the research preview to the foothill zones of the mountain to achieve a more comprehensive understanding of the cold-arid system hydrological processes with a view to assist people in managing these scarce resources.

6. **Methodology**

   a) Monitoring of weather parameters by AWS at 3500 m a.s.l., 4700 m a.s.l. and 5600 m a.s.l. for studying the orographic forcing
   b) Monitoring discharge and Electrical conductivity at 4700 m a.s.l & 3500 m a.s.l.
   c) Measuring ground temperature for permafrost studies
   d) Geophysical investigation of potential permafrost zones
   e) Isotope studies of stream discharge at 4700m a.s.l. and 3500 m a.s.l.
   f) Runoff modeling by SNOWMOD by incorporating the new SELR concept

7. **Research Outcome from the Project:** The project is aimed at quantifying various hydrological components in the catchment and its seasonal responses. Such an understanding is essential for managing the water resources of the region effectively. Better understanding of the lean season winter outflow from the groundwater system is intended to bridge the critical knowledge gap of the mountain groundwater resources and its linkages with the surface water. Understanding of the orographic processes and mountain climate at the nival/glacier systems to decipher the climate change impact on the cold-arid cryospheric system better.

8. Work Schedule

S. No.	Work Element	First Year				Second Year				Third Year			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1.	**Monitoring weather**	■	■	■	■	■	■	■	■	■	■	■	■
2.	**Monitoring Q**		■	■			■	■			■	■	
3.	**Permafrost temp.**				■	■	■	■	■	■	■	■	■
4.	Geophysics-permafrost			■				■					
5.	Isotope studies	■	■	■	■	■	■	■	■	■	■	■	■

9. Analysis and result

This is a new study initiated in July 2014 in continuation of the studies of past 05 years in the Ladakh region. In view of the expanded research preview, a new discharge and meteorological station are established at 3700 m a.s.l. at Gonpa area. This discharge station at the perennial stretch of the interrupted stream is established with a view to gather hydrological information throughout the water year, which may provide some insight on surface water – ground water interaction and information of possible permafrost degradation/seasonally frozen ground in the catchment. Discharge measurement at 3700m a.s.l. continued during the reporting period and the samples for isotopic analysis were collected. Meteorological data being generated from 3700, 4700 and 5600 m a..s.l. and analysed. Discharge data from 4700m a.s.l is analysed. This data shows significant snow melt during the July and August months constituting 67% of the catchment discharge in summer. Isotope samples collected during the 2014 summer months is also being analysed.

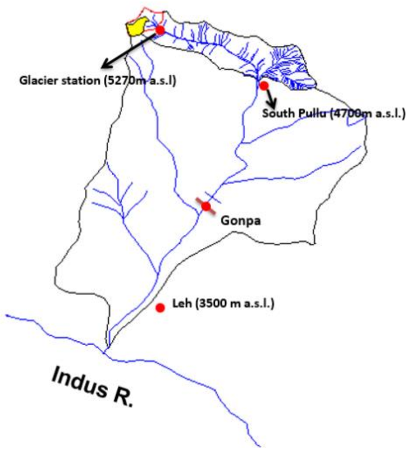


Figure 1 Study area showing South Pullu and Gonpa discharge stations and weather stations

ONGOING STUDIES
INTERNAL RESEARCH PROJECT: NIH/WRS/2015/06

1. Thrust Area under XII five year plan: Integrated water resources management/ watershed hydrology

2. Project team:

a. Project Investigator: P. K. Agarwal, Sc 'B'

b. Project Co-Investigator(s): Dr Sanjay K. Jain, Scientist 'F'
Shri Tanvear Ahmed, Scientist "B"
Dr. M. K. Goel, Scientist "F"
Dr. Sharad K. Jain, Scientist "G"

3. Title of the Project: Hydrological modeling of a part of Satluj basin using SWAT Model

4. Objectives:

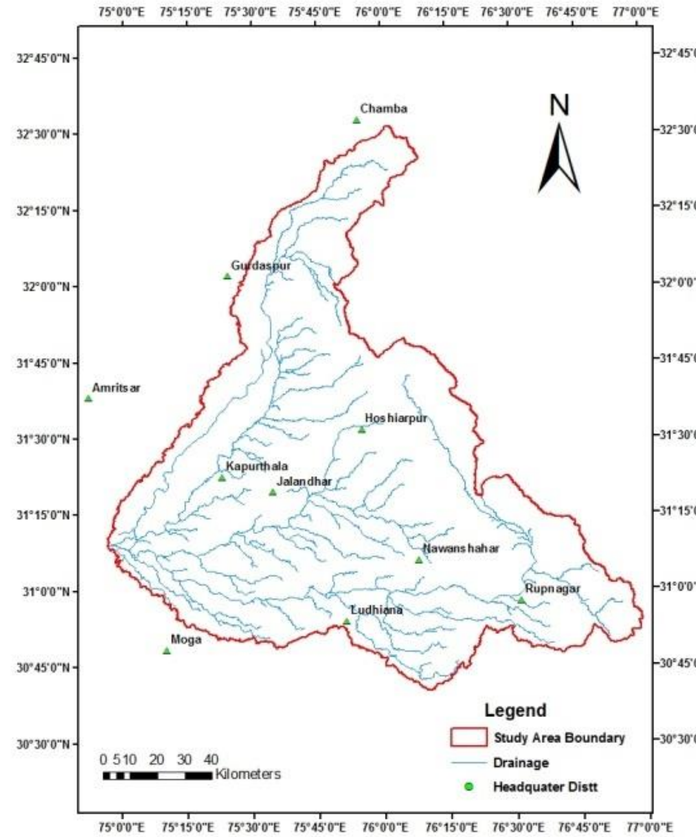
i. To develop the data base of a part of Satluj river basin (between Ropar D/s of Bhakra dam to Harike) and

ii. To carry out Hydrological modeling of the basin using ArcSWAT model to find out water balance components e.g. Actual evapo-transpiration etc.

5. Present state-of-art

The Soil and Water Assessment Tool (SWAT) model is a river basin or watershed scale model developed by the USDA Agricultural Research Service. SWAT is a spatially distributed, continuous time model that operates on a daily time step. SWAT was developed to predict the impact of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land use and management conditions over long periods of time. It can incorporate the effects of tanks and the reservoirs/check dams off-stream as well as on-stream. SWAT requires specific input about weather, soil properties, topography, vegetation, and land management practices to model hydrology and water quality in a watershed. The model allows a basin to be subdivided into sub-basins or watersheds which is particularly beneficial when different areas of the macro-watershed are dominated by land uses or soils different enough in properties to have different impacts on the hydrological response. Within SWAT the input information for each watershed is grouped and is called hydrologic response units or HRUs. The major advantage of the model is that unlike the other conventional conceptual simulation models it does not require much calibration and therefore can be used on ungauged watersheds. Model outputs include all water balance components (surface runoff, evaporation, lateral flow, recharge, percolation, sediment yield, etc.) at the level of each watershed and are available at daily, monthly or annual time steps.

Study Area selected Satluj river basin (between Ropar D/s of Bhakra dam to Harike) as given figure



6. Methodology

In the present study, the following methodology will be adopted:

- Data base preparation in ArcGIS (DEM, Land use, soil map)
- Collection of metrological data (rainfall, temperature, wind, solar radiation, humidity)
- Setup of SWAT model using Acr-GIS.
- Calibration and validation of SWAT model
- To carry out the effect of land use & other changes on stream flow.

7. Research Outcome from the Project

- Stream flow from the study area
- Water balance components (runoff, evaporation, lateral flow etc) for the sub-basin.

8. Work Schedule

a. Probable date of commencement of work June 2014
b. Duration of Work 2-3/4 Years
c. Stage of work and Milestone

SN	Work Element	First Year (2014-15)			Second Year (2015-16)				Third Year (2016-17)			
		Jun-Sep	Oct-Dec	Jan-mar	April-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jen	Jul-Sep	Oct-Dec	Jan-Mar
1	**Literature Review**											

	& Data Collection										
2	**Development of data base for a river basin for SWAT model**										
3	**Application of SWAT model**										
4	**Analysis of Results**										
5	**Preparation of Report**										

9. Progress made between Dec 2014-Feb 2015

- SRTM DEM (90 meter) has been downloaded and study area and drainage etc. have been generated.
- Literature review in progress;
- Meteorological data has been collected;
- The preparation of data base required for SWAT is under progress
- Preparation of land use map & Soil map are in the final stage of completion;
- In SWAT HRU analysis work just has been started;

ONGOING STUDIES
INTERNAL RESEARCH PROJECT: NIH/WRS/2015/07

1. **Thrust Area under XII five year Plan**: Integrated Water Resources Development and Management

2. **Project team**:
   a. **Project Investigator**: D.S. Rathore, Sc F
   b. **Project Co-Investigator(s)**: M.K. Goel, Sc F
   R.P. Pandey, Sc F
   Sanjay Kumar, Sc D
   Surjeet Singh, Sc D

3. **Title of the Project**: Decision support system for water resources planning in Upper Bhima basin, Maharashtra

4. **Objectives**:
   a. Rainfall- runoff modeling and estimation of water availability in the basin
   b. Multi-reservoir operation in the basin for project complexes
   c. Drought prediction
   d. Water quality modeling in the basin
   e. Conjunctive use operation in command area
   f. Rainfall- runoff modeling and river basin simulation for climatic change scenarios

5. **Present state-of-art**

A Decision Support System (Planning) has been developed under Hydrology Project - II for State and Central implementing agencies. The project has two components, namely DSS platform and modelling systems. For modelling system, MIKE HYDRO Basin model was chosen in the project. The model is a water allocation model which also has conceptual lumped rainfall- runoff model NAM in built for generation of long term runoff time series. The platform has GIS, spreadsheet, scenario, script, time series and dashboard (for web applications) managers. On the platform, data and model scenarios may be handled. The scenarios are run with available MIKE HYDRO Basin engine.

6. **Methodology**

MIKE HYDRO Basin will be used and database for the Upper Bhima basin up to Ujjani dam developed in HP-II project will be transferred to the new system. Rainfall- runoff modelling will be done using NAM for finding different hydrological components at sub-basins scale. Rule curves would be developed for various project complexes and multi reservoir operation would be carried out to optimize the water use in the basin. Meteorological and hydrological drought indices would be computed using rainfall and hydrological data. Conjunctive use scenario in canal command areas will be run. River water quality modelling will be carried out. Web-interfaces through Dashboards would be developed for dissemination of input and results of simulation in DSS (Planning). Downscaling will be done for climatic scenario. Downscaled climate data will be utilized and model runs would be taken to find their impact on the water availability and allocation in the basin.

7. **Research outcome from the project**
   a. Water availability in various sub-basins in present and changed future climate.
   b. Reservoir operation rules for existing and future climatic scenarios: Model was set up for reservoir operation and optimization in Khadakwasla complex.
   c. Meteorological and hydrological drought indices: Data preparation was done for computing meteorological drought indices.
   d. Conjunctive use in canal command areas.

e. River water quality modeling in river reaches and impact of climate change: Water quality model was set up.
f. Interfaces for decision support.

8. Work Schedule:

a. Probable date of commencement of the project: Continuing
b. Duration of the project: 2 years
c. Stages of work and milestone:

Sl. No.	Work Element	First	Second	Third
1	Water availability	Data processing	Rainfall- runoff modeling- current	Rainfall- runoff modeling- future
2	Reservoir operation rules	Data preparation, Model set up	Rule curves- current	Rule curves- future
3	Drought indices	Data preparation	Meteorological	Hydrological
4	Conjunctive use	Model set up	Current scenario	Future scenario
5	Water quality modeling	Model set up	Current scenario	Future scenario
6	Interfaces	Application-1	Application-2	Application-3

ONGOING STUDIES
INTERNAL RESEARCH PROJECT: NIH/WRS/2015/08

1. Thrust Area under XII five year plan: Hydrology for sustainability of water resources

2. Project team:

a. Project Investigator: Dr. Sanjay K. Jain, Sc "F"
b. Project Co-Investigator(s): Dr. Sharad K. Jain, Sc "G"
Er. T. Thomas, Sc 'C'
Er. P K Mishra, Sc 'B'
Er. Manish Neema, Sc 'B'
Er. P.K.Agarwal, Sc 'B'

3. Title of the Project: Modelling of Narmada Basin Using GWAVA Model

4. Objectives:

A major goal of the proposed study is to do hydrologic modeling of the basin. The objectives of the proposed study are as follows:

- Collection and processing of historical data
- Future climate projections will be applied to see the changes in meteorological variables.
- Modelling of rainfall runoff.
- Impact of changes on stream flow in the basin.

5. Present state-of-art

Accurate water resources assessment and re-assessment is need of the hour in view of the altered water demand and utilization scenario world-wide. This requires robust hydrological model to accurately assess the water availability at present and in the future. Narmada basin is one of the highly regulated basins in India. Several water resources projects are being implemented, under construction and proposed in the basin. Since last few decades, urbanization and population growth has also driven additional water requirement in the basin. This requires revisiting water resources assessment in the Narmada basin.

6. Methodology

Study area: Narmada basin up to Hoshangabad including Tawa basin (D/s of confluence with Tawa)

GWAVA is a hydrological model which incorporates additional water resource components such as reservoirs, abstractions, and water transfers that modify water quantity and flow regime. It was developed with funding from DFID (UK Department for International Development). The model typically operates on 0.5 or 0.1 degree latitude-longitude grid. The choice of grid size is a compromise between that needed to represent spatial variability and the availability of suitable data. The model outputs include simulated monthly flows and a cell-by-cell comparison of water availability. GWAVA can be used to examine scenarios of change, both for climate and water demands.

Inputs for first tier GWAVA application

- Spatially and temporally explicit inputs
  - Rainfall, temperature (at least daily resolution)
  - Potential evapotranspiration or wind speed + relative humidity + solar radiation (at least daily resolution)
  - If the modelled area does not include some upstream areas: River discharges into the modelled area
- Spatially explicit inputs
  - Elevation or flow direction grid

- Coverage by different irrigated crop types
    - map of rivers and other water bodies
    - Soil texture
    - Land cover
    - Lake, reservoir and wetland parameters (areal cover, maximum water volume, vertical shape, type of reservoir)
    - Urban and rural water demand per capita
    - industrial water demand
    - Rural population
    - Total population
    - Cattle, sheep and goat population
- Temporally explicit inputs
    - Gauged river discharge
- Parameters (constants)
    - Per capita water demand for sheep, goats, and cattle
    - Irrigation efficiency
    - % Leakage from urban and rural water supply systems
    - % return flow
    - Crop characteristics and growth stage durations for individual irrigated crop types, and the start and end of their growing season

Once the database data base of the study area(s) is collected and/or procured, model set up will be done. Then model will be calibrated and validated before going for sensitivity analysis.

7. Research Outcome from the Project

- Stream flow from the study area
- Water balance components (runoff, evaporation, lateral flow etc) for the sub-basin.

8. Work Schedule

a. Probable date of commencement of work November 2014
b. Duration of Work 2-3/4 Years
c. Stage of work and Milestone

1st. Interim report	2nd. Interim report	Final report
April 2015	April 2016	March 2017

9. Progress

The catchment of the study basin (Narmada) has been created in GIS. The hydromet data of the basin is collected. Processing of the data is in progress. A training course on the application of GWAVA is proposed in the first week of March, 2015. After that model set up for basin will be taken up.

ONGOING STUDIES
INTERNAL RESEARCH PROJECT: NIH/WRS/2015/09

1. **Thrust Area under XII five Year Plan**: Himalayan Cryosphere and Climate Change

2. **Project Team:**
   Project Investigator: Dr. R.J Thayyen, Sci-D
   Project Co-Investigators: Dr. Sanjay Jain, Sci'F'

3. **Title of the Project:** Runoff modelling of Shyok River, Karakorum Range

4. **Objectives:**

1. To generate runoff data at Km 150 for BRO-HIMANK
2. To develop a baseline runoff and meteorological data of Shyok basin
3. Runoff modelling of Shyok River at KM 150 & Shyok village

5. Present state-of-art

Shyok Basin lie in the northern most part of our country sharing its boundary with China and Pakistan. The upper Indus basin has the largest glacier reserve in the Himalaya with 5211 glaciers and 29119 km^2 of glacier cover. Within the upper Indus region, the Shyok basin has the largest number of glaciers enumerated at 2454 covering a 10810km^2. Comparing to this, the Indian Himalayan region contributing to Ganga-Brahmaputra river system only have 1578 glaciers covering just 3787km^2 of glacier cover (Data Source Raina& Srivastava,2008 sourced from GSI glacier inventory 2009). However, glaciers and cryospheric system in this region is not received the due attention till date. Discharge of Shyok river is not monitored and its hydrological characteristics and resource potential is not known. The border roads organisation, HIMANK project is in urgent need of discharge data of Shyok river for strategic purpose and the present project is planned to fulfill this requirement for BRO.

Shyok river fed by the glaciers of Karakorum range. It is well accepted that the Karakorum glaciers are gaining mass in the recent past. Long –term monitoring of River Shyok will provide valuable information on river flow response of a glacier fed river under positive mass balance regime. Being a trans-boundary river this information will be very useful different national agencies. The automatic weather station proposed in the study will be the first comprehensive weather station in the region and will provide crucial input to the armed forces and data required for snowmelt runoff model. The ongoing study in the Ladakh range south of the Karakoram in the cold-arid system has shown that the glaciers are losing it mass. The proposed will be provide a interesting comparison between two contrasting glacier systems in the Himalaya.

Head water region of the Shyok river originating from the Remo glacier has couple of surging glaciers such as Chonh Kumdan, Kichik Kumdan and Aktash glacier. Under the mass gain these glaciers are potential to surge. The Kumdan floods during 1929 to 1932 due to bursting of a 16 km long lake formed by blocking of River Shyok by the surging Kumdan glacier was devastated the Shyok basin. Hence monitoring of Shyok river is necessary for civilian and defense perspective. Hence the proposed study is being taken up by the above objectives.

6. **Methodology**
   1. Monitoring of weather parameters and discharge by AWS at Km 150 (5600 m a.s.l.) for generating climate data for runoff modeling.
   2. Generation of snow cover depletion curves through melt season
   3. Runoff modeling by SNOWMOD and Win SRM at this two stations

7. **Research Outcome from the project:** Discharge & Meteorological data, Research papers and project reports and better understanding of the Cryospheric response of the Karakorum mountains.

8. Work Schedule

S. No.	Work Element	First Year				Second Year				Third Year			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1.	**Monitoring weather**												
2.	**Monitoring Q**												
4.	Runoff modeling												

9. Analysis and result

During the reporting period, a discharge station is set up at km 150 at Durbuk-DBO road axis with the help of Border Road organisation in the month of October 2014 and discharge data is being collected. This data will be downloaded in the month of June/ July months when roads open after the winter.

ONGOING STUDIES
INTERNAL RESEARCH PROJECT: NIH/WRS/2015/10

1. **Thrust Area under XII five Year Plan**: Sustainable water systems management: Adaptation of hydro-system to climate change

2. **Project Team:**
   a. Project Investigator: Manish Kumar Nema, Scientist 'B'
   b. Project Co-Investigators: Dr S. K. Jain, Scientist 'G'/ Head, WRSD,
   Dr Sanjay K Jain, Scientist 'F'
   Dr Renoj J. Thayyen, Scientist 'D' and
   Mr PK Mishra, Scientist 'B'

3. **Title of the Project:** Hydrological Processes and Characterization of Lesser Himalayan Catchments

4. **Objectives:**
   a. To establish an instrumentation and experimental setup to measure various hydrological and meteorological variables in a watershed in the upper Ganga basin within the state of Uttarakhand for better understanding of their behavior and to study the dynamic linkages between the two.
   b. Analysis and comparison of estimated Evapotranspiration (ET) by different methods like RS/SEBAL, FAO56 method and actual field measurements
   c. To study the various water balance components in the watershed

5. **Present state-of-art**

Watershed is supposed to be the basic unit at which the hydrologic processes are studied and is central to most of the concepts in hydrology. Managing agricultural or forested watersheds for water quality and quantity improvement and productivity requires a detailed understanding of functional linkages between ecohydrological processes and management practices. Various watershed studies are being conducted to understand the fundamental hydrologic and biogeochemical processes and their linkages with soils, vegetation, topography, climate, and management practices worldwide. These studies mainly involve modelling the natural processes but the vibrancy of experimental hydrology broadly across the areas of subsurface and surface hydrology and hydrometeorology still have a unique place of importance and no alternative.

In view of the state of affairs of existing models and studies addressing the problems of watershed hydrology, the major limitations might be characterized as mainly twofold. First, study basin designs have been limited by the black box concept and many misconceptions (e.g., the linearity, non-heterogeneity, additivity of hydrologic systems etc.). Second, operation has been substantially bounded by the hydraulic conception of these watersheds as isolated hydrological systems (Wei-Zu et al. 2013). Most of the watershed studies monitor only total runoff at the stream-outlet and the subsurface responses of the watershed are only estimated by hydrograph separation, etc. These characteristics undermine the formulation of a unified theory of watershed hydrology (Sivapalan et al. 2005) and the development of watershed models (Kirchner, 2006; Mcdonnell et al., 2007). There is a clear need to move beyond the status quo and expand from this narrow hydrological perspective to generate hypotheses governing general behavior across places and scales, with the ultimate aim to advance the science of hydrology.

6. **Methodology**

(A) Study Area:

A small Himalayan hilly watershed Hinval up to Jijli in the upper Ganga basin in the state of Uttarakhand is proposed for the study. This study area is a paired watershed of two kinds. One of them is a forested catchment (undisturbed) and other one is an agricultural watershed with anthropogenic interventions including an urban habitat at Chamba (Uttarakhand). The geographical extent of the study area is from $30^0$17’N–$30^0$26’N latitude and $78^0$16’E–$78^0$25’E longitude. This area is a typical representative of a combination of lesser Himalayan hilly temperate climatic conditions with average annual rainfall range of 1200-1800 mm. The Himalayan subtropical forests yield to a belt of temperate broad leaf and mixed forest mainly comprises of pine forest. The total area under study is of 120 km^2 approximately (20 km^2 forested catchment and 100 km^2 the other one) with an elevation range of 999-2676 m. The location map of the watershed and their digital elevation model from SRTM is given in the figure 1.0 for reference. The stream in the forested sub-catchment is the source of drinking water for 87 nearby villages. This stream is being pumped 24x7 by the state authorities at its outlet at Dev Nagar. A study of the topography and land use of the proposed watershed shows that the watershed is representative of the surrounding areas.

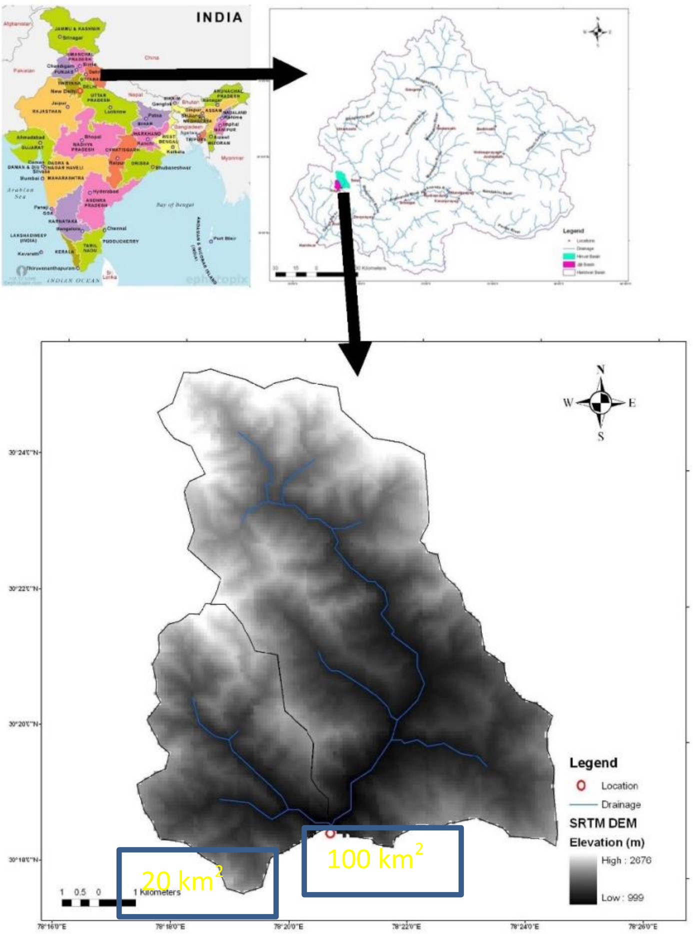


Fig. 1.0 Location of the Hinval watershed up to Jijli within India

(B) Experimental setup

Variables and parameters to be observed: They were organized into four categories, that is, hydrological and ecological variables, atmospheric forcing variables, vegetation parameters, and soil parameters.

(C) Soil Heat Flux

Soil heat flux represents the amount of radiant energy absorbed or released at the soil surface during a given time period. Many field studies in topics such as microclimatology, and hydrology require reliable measurements of the soil surface flux (Payero et al 2005; Oladosu et al 2007). Soil heat flux, as a component of available energy, is a necessary input for many evaporation measurement and prediction techniques. Evaporation measured with the Bowen ratio energy approach is dependent on an accurate value for the available energy (net radiation-heat flux). One of the objective of this study is to estimate soil heat flux using soil temperature collected at various soil depths. It is also intended to study the diurnal variation of soil heat flux in winter, Pre-monsoon, SW monsoon and NE monsoon seasons.

(D) Evapotranspiration (ET)

At the watershed scale, ET represents the largest water flux next to precipitation, but it is the most challenging variable to measure at this scale due to the heterogeneity of the landscape. Accurate estimates of ET are needed for numerous agricultural and natural resource management tasks, hydrological modelling and to project changes in hydrological cycles due to potential climate change. Crop coefficients are developed to determine crop water needs based on the estimated evapotranspiration (ET) of a reference crop under a given set of meteorological conditions as followed in Penman–Monteith equation, as presented in the FAO-56 manual on crop evapotranspiration. Starting in the 1980s, crop coefficients developed through lysimeter studies or set by expert opinion began to be supplemented by remotely sensed vegetation indices (VI) that measured the actual status of the crop on a field-by-field basis. VIs measure the density of green foliage based on the reflectance of visible and near infrared (NIR) light from the canopy, and are highly correlated with plant physiological processes that depend on light absorption by a canopy such as ET and photosynthesis (Glenn et al., 2011). After that many studies have been reported for the estimation of ET and water balance using remote sensing techniques (Senay et al., 2011; Raghuveer et al., 2011; Vinukollu et al., 2011; Elhag et al., 2011; Allen et al. 2011). In the present study, the estimates of ET from various sources will be compared with the actual field observations.

(E) Soil Moisture

Soil moisture in the uppermost 1–2 m of the earth's surface is recognized as a key variable in many environmental studies, including those related to meteorology, hydrology, agriculture and climate change. This thin layer of soil controls the success of agriculture and regulates partitioning of precipitation into runoff and sub-surface water storage. An understanding of the soil moisture variability is necessary to characterize the linkages between a region's hydrology, ecology and physiography (Jackson, 1993). In the changing climate and land use scenario, it is important to evaluate the impacts of these changes on regional hydrology. The proposed objectives under this theme are to understand spatio-temporal variability of soil water potential and soil moisture content under different land covers in the temperate lesser Himalayan region and to evaluate differences, if any in spatial and temporal patterns of soil moisture content as influenced by nature of land cover. We propose to establish sampling points for measuring the soil moisture content under different land covers in selected watersheds. These points shall be spread spatially across the watersheds so as to cover topographic highs and lows. Soil matric potential measurements are proposed using resistance-type probes. At each sampling point, probes will be installed at different depths. A roving instrument (handheld read-out unit) shall be used to record matric potential (kPa). Measurements shall be made at suitable time steps (Venkatesh et al., 2010)

(F) Hydrologic Modelling

Soil and Water Assessment Tool (SWAT) Model

For hydrologic modelling, a robust model, which incorporates most of the study variable sand parameter is needed. The model used at a later stage in the study will be calibrated and validated on the generated data from the experimental setup. For hydrology modelling, SWAT model will be applied. SWAT is a semi-distributed, continuous watershed modelling system, which simulates different hydrologic responses using process- based equations. The model computes the water balance considering a range of hydrologic processes such as evapotranspiration, snow accumulation, snowmelt, infiltration and generation of surface and subsurface flow components. Spatial variability within a watershed is represented by dividing the area into multiple sub-watersheds, which are further subdivided into hydrologic response units (HRUs) based on soil, land cover and slope characteristics. SWAT uses a temperature-index approach to estimate snow accumulation and melt. Snowmelt is calculated as a linear function of the difference between average snowpack maximum temperature and threshold temperature for snowmelt. Snowmelt is included with rainfall in the calculation of infiltration and runoff. SWAT does not include an explicit module to handle snow melt processes in the frozen soil, but includes a provision for adjusting infiltration and estimating runoff when the soil is frozen (Neitsch et al., 2005). Despite this limitation, SWAT was considered to be the most appropriate integrated model currently available for application in cold regions environment. SWAT computes actual soil water evaporation using an exponential function of soil depth and water content. The model generates surface runoff using a modified Soil Conservation Service (SCS) curve number method based on local land use, soil type, and antecedent moisture conditions. Groundwater flow contribution to total stream flow is simulated by routing the shallow aquifer storage component to the stream. Runoff is routed through the channel network using the variable storage routing method or the Muskingum method (Neitsch et al., 2005). For snowmelt runoff modelling, another model, SNOWMOD model, after proper training and validation, will be forced with climate scenarios to generate future projections of timing and magnitude of snow and glacial melt discharge.

Variable Infiltration Capacity (VIC) Model

The VIC [Liang et al., 1994] model is a macroscale hydrological model that simulates hydrologic fluxes (such as runoff and evapotranspiration) and moisture storage in response to input climate variability. As a semi-distributed macroscale hydrological model, VIC balances both the water and surface energy budgets within the grid cell, and its sub-grid variations are captured statistically. Distinguishing characteristics of the VIC model include: subgrid variability in land surface vegetation classes; subgrid variability in the soil moisture storage capacity; drainage from the lower soil moisture zone (base flow) as a nonlinear recession; inclusion of topography that allows for orographic precipitation and temperature lapse rates resulting in more realistic hydrology in mountainous regions. It is applied to grid cells, with typical spatial dimensions from 1/80 to 20 latitude by longitude. VIC represents multiple vegetation classes as fractions within a grid cell and uses two or more soil layers to calculate the energy and water balance while considering sub grid spatial variability of precipitation and infiltration [Liang et al., 1996]. The upper soil layer represents the dynamic response of soil moisture to rainfall events and the lower layers represent the seasonal soil moisture storage. Most of the applications use three layers (e.g. Bowling et al., 2003a, Maurer et al., 2001, Wood et al., 2002).

The VIC model represents surface runoff processes via the variable infiltration curve. This curve represents the relationship between the fractional area that is assumed to be saturated in any given time step and the infiltration capacity for the remaining unsaturated portion of the grid cell. During rain events, surface runoff is produced from the saturated fraction. The base flow is specified as a function of soil moisture in the lowest soil layer. This relationship is nonlinear at high soil moisture contents thereby producing rapid base flow response in wet conditions. Below a user specified value of soil moisture, the function becomes linear thereby reducing the responsiveness of base flow in dry conditions. It is proposed to apply above models once sufficient data have been collected.

7. Research Outcome from the project:

Development of a world class field hydrological laboratory in the lesser Himalaya. Development of better understanding of monsoon forcing on regional hydrology under changing climate for the end users/beneficiaries from the relevant Sectors. Research Papers and Reports.

8. Work Schedule:

- **a.** Probable date of commencement of the project: 01.01.2015
- **b.** Duration of the project: 5 years
- **c.** Stages of work and milestones:

SNo.	Description of Activity	2015				2016				2017				2018				2019			
		J	**A**	**J**	**O**	**J**	**A**	**J**	**O**	**J**	**A**	**J**	**O**	**J**	**A**	**J**	**O**	**J**	**A**	**J**	**O**
1.	Development of Procedure for scientific work																				
2.	Recruitment and deployment of Project Personnel																				
3.	Purchase of instruments and experimental setup																				
4.	Data generation and acquisition																				
5.	Data analysis and modelling																				
6.	Final Reporting																				

9. Progress till date:

The project has recently started and the study team members has visited the study area on 06.02.2014 and assessment and identification of the discharge gauging sites and location for automatic weather stations has been done. Soon the construction of the gauging structure has to be started and procurement of instruments and man power deployment are the immediate targets of the project.

SPONSORED STUDIES
EXTERNAL RESEARCH PROJECT: NIH/WRS/2015/01

1. **Thrust Area:** Himalayan Cryosphere and Climate Change

2. **Project team:** Dr. R.J Thayyen, Dr. S.P Rai & Dr. M.K Goel

3. **Title of the project:** Glaciological studies of Phuche Glacier, Ladakh Range.

4. **Objectives**
   1. Winter & Summer Mass Balance studies by glaciological method
   2. Runoff measurements
   3. Collection and standardization of meteorological parameters by AWS
   4. Mass Balance & Runoff modeling
   5. To study the composition of stable isotopes $\delta^{18}O/\delta D$ in the winter snow, summer snow/rainfall and separate snow, rain and glacier melt components in the glacier discharge and its temporal and seasonal variations.

5. Present state of the art

Most of the glacier mass balance research in the Himalaya is concentrated in the monsoon regimes of Uttarakhand and Himachal Pradesh. Response of small glaciers in the Cold-Arid climate system of the Trans-Himalaya to the prevailing climate is not yet known, leading to a huge knowledge gap in our understanding of factors influencing glacier response to the climate change and its consequences. As people fully depend on glacier streams of the region for their sustenance, as the glacier melt feeds into a dry regime, study of these glaciers have greater societal importance.

6. Methodology

a) Procurement and installation of equipments
b) Yearly winter and summer mass balance measurement
c) Glacier runoff measurements
d) Year round monitoring of meteorological parameters and standardization
e) Mass balance & runoff modeling
f) Stable isotope characterization of winter snow pack, summer rain/snow and stream flow
g) Hydrograph separation by isotope method.

7. Research outcome: Glacier mass balance data inclusive of winter and summer mass balance of two glaciers in the Ladakh Himalaya. Assessment of prevailing climate and its orographic controls. Isotope based assessment of stream flow components and its seasonal variations. All these insights will be useful for managing the scarce water reserve of the Ladakh region.

8. Cost estimate :

a. Total cost of the project: Rs. 56 lakhs
b. Source of funding: DST

9. Analysis and Result

Glacier response to prevailing weather is influenced by many factors like regional/local climate, aspect, altitude, Debris cover, dust/soot deposits etc. How to achieve a region specific understanding of glacier response – climate relationship by resolving these various forcing factors is a challenging question. Glacier melt contribution to the catchment runoff across the Himalaya under various glacio-hydrological regimes are also not well understood. This knowledge gap is primarily because of the standard practice in

India to estimate only the annual glacier mass balance leaving aside the melting snow accumulated in winter and summer precipitation contributions. Under this project, winter and summer mass balance of Phuche and Khardung glaciers were studied. These wo glaciers are part of Khardung glacier complex in the cold-arid climate and situated just 2.5 Km apart on the Ladakh Range near Leh. These glaciers are being monitored for winter and summer mass balance since 2010 by glaciological method. Both these glaciers have same NE aspect but have different wind regime as the Khardung glacier is situated on the northern slopes of the Ladakh range feeding to the Nubra valley and the Phuche glacier is in the Ganglass valley feeding to the River Indus. During the four years of study (2010-2013), Phuche glacier experienced two slightly positive mass balance years interspersed with two significant negative mass balance years. While Khadung glacier experienced consistent mass loss with a remarkable cumulative mass loss of (-)2690 mm w.e. during these four years. Cumulative mass loss of Phuche glacier was significantly less at (-)670 mm w.e. during the same period. Winter mass balance of Phuche glacier ranged between 660 to 590mm w.e and annual mass exchange from the glacier range between 630 to 835mm w.e. Winter mass balance of Khardung glacier range between 690 to 567mm w.e and annual mass exchange from Khardung glacier ranged between 1140 to 770mm w.e. These values gives the first information on mass exchange on a Himalayan glacier and suggest that the winter snow accumulation on the glacier is many fold than the precipitation monitored at the valley bottom at Leh at 3500m a.s.l. Lack of precipitation data from glacier accumulation area is proved to be one of the key factors restraining our understanding on the glacier contribution to the stream flow and catchment/basin water balance. This study provide a firm basis for a reliable water balance estimate of the headwater catchments of the cold-arid system. This study also provided the first unequivocal evidence of mass loss of Ladakh glaciers in response to prevailing weather and suggests that the southern extent of the ‘Karakorum anomaly’ did not reach the Ladakh range.

During the reporting period summer mass balance measurements were continued in the Phuche and Khardung glaciers. The weather parameters were monitored and the weather data is being analysed to study the seasonal variations of meteorological variables and resultant glacier melt. Modelling of glacier melt is attempted through the degree-day approach and energy balance components were prepared modelling. Analysis of isotope data is also in progress.

SPONSORED STUDIES
EXTERNAL RESEARCH PROJECT: NIH-E/WRS/2015/02

1. **Thrust Area:**

2. **Project Team:**
   a. Project Investigator: Dr. Sharad K. Jain, Scientist 'G'/ Head, WRSD
   b. Project Co-Investigators: Dr. Pradeep Kumar, Scientist 'B', WHRC
   Shri P. K. Agarwal, Scientist 'B'
   Shri P. K. Mishra, Scientist 'B'

3. **Title of the Project:** Assessment of Environmental flow for Himalayan River

4. **Type of Study** - MOES Sponsored

5. **Amount** - 8.61 Lakhs

6. **Start Date** - Nov., 2014

7. **Scheduled date of completion** - Nov., 2015

8. **Status:**
   A project proposal for carrying out work to create baseline database and estimate environmental flows for a few Himalayan rivers was submitted to the Ministry of Earth Sciences and the same has been approved. Formal orders have been issued and funds have been received recently.
   Two Research Associates have been recruited recently. One is working from WHRC, Jammu and other is posted at HO, Roorkee. In the meantime work has started to collect the data and create the database.

NEW STUDIES
EXTERNAL RESEARCH PROJECT: NIH-E/WRS/2015/01

1. **Thrust Area under XII five year Plan** : Hydrological information

2. **Project team:**
   a. Project Investigator: Deepa Chalisgaonkar, Sc F
   b. Project Co-Investigator(s): Dr. Sharad K. Jain, Sc G
   Sri D. S. Rathore, Sc F
   Dr. Sanjay K. Jain, Sc F
   Dr Sudhir Kumar. Sc 'G'
   Sri P.K. Mishra, Sc B
   Sri P K Agarwal, Sc B
   Sri Manish Nema, Sc 'B'

3. **Title of the Project :** Development of Ganga Information Portal

4. **Objectives**

Ganga Information Portal is envisaged to provide a unique platform comprising multisource data and information on Ganga basin. The major objective for developing such a portal is:

- To develop a knowledge/ information e-portal (Ganga Information Portal) with updated information on Ganga basin
- To provide a world class platform as resource centre for data sharing, retrieving pertaining to Ganga basin
- To operate and maintain the e-portal on 24x7 basis

5. **Present state-of-art**

The Ganga is the most sacred as well as one of the most exploited rivers of India. With a vast geographical extent, varied climate, land use land cover, wildlife, demography and socio-economic situation in the entire Ganga Basin, tapping information for resource planning, R&D activities is a difficult task. There are lot of information on Ganga basin collected, collated, and compiled by different institutions/ organizations and agencies of both State and Central Governments. Many NGOs are also involved in different activities related to Ganga basin with possession of valuable information. There are also a number of books, journal papers, reports on Ganga basin. But this information is scattered, fragmented and unavailable on one platform to cater the need of multiple users.

Recently, the Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR, RD&GR) is emphasizing to restore the rivers into 'Nirmal' and 'Aviral' including Ganga. In addition to this, the government has launched the ambitious 'Namami Gange' an Integrated Ganga Conservation Mission with activities related with conservation and rejuvenation of the Ganga. Recognizing the multi-sectoral, multi-dimensional and multi-stakeholder nature of information in the Ganga basin, it is need of the hour to develop a web-based platform where different types of data/ information (facts; publications; data; maps; photographs; etc.) related to Ganga basin is available at one place. 'Ganga Information Portal' (GIP) is a step in this direction to develop a web-based information portal where variety of information on Ganga basin will be uploaded and maintained at National Institute of Hydrology, Roorkee.

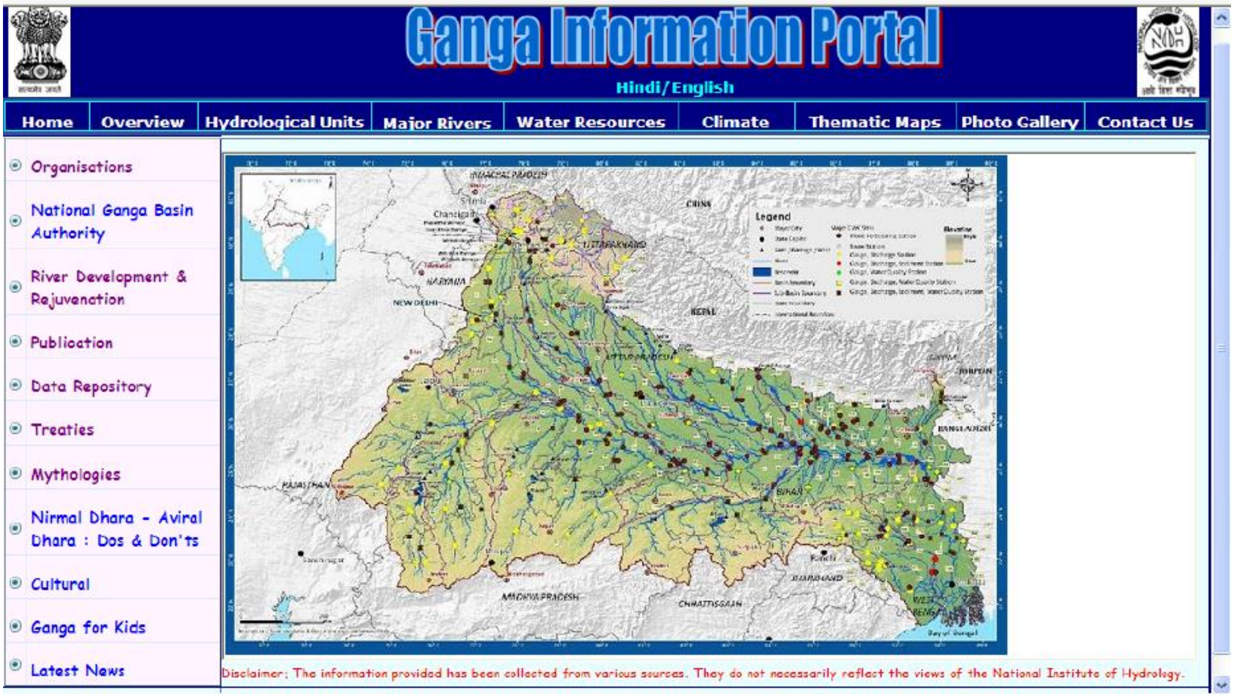
6. **Methodology**

The GIP will be developed using World Wide Web (*WWW*) technology. The *WWW* technology is based on an open unstructured distributed hypermedia information system. It consists of non-linear, flexibly linked HTML (Hyper Text Media Language) documents, in which different types of *WWW* objects can be embedded. This allows interactive components to be integrated, besides multi-media objects like images, videos and audio sequence. In this way, the *WWW* provides new possibilities and features for information presentation, documentation and exchange and sharing.

The system will be developed in HTML and java script language. Users can use the software with the help of a web browser. The main and drop down menus allow the user to interact with the system very easily. The information relating to the Ganga will be collected from many different sources, agencies and organizations and will be arranged between the time-spaces, and it will be possible to share, to search, to display, and to output (print) it. The main screen of the proposed software is shown in Fig.1. It will use "Point and Click" navigation to navigate around the site. A list of the states is provided for easy geographic access to spatial data.

7. Research outcome from the project

A portal as shown in fig.1 will be developed which will support quick and timely access of the information related to Ganga, anytime and from anywhere in the world.



8. Work Schedule:

a. Probable date of commencement of the project : April 1, 2015
b. Duration of the project : 3 years, however, GIP is an integrated information portal which requires continuous efforts in upgradation and maintenance.
c. Stages of work and milestone:

Sl.No	Item/Activity	Timeframe
i.	Creation/ Establishment of Infrastructures	2 months
ii.	Collection and procurement of different types of data/ information from different stakeholders on Ganga basin	3 months & beyond
iii.	Collation and compilation of information before uploading for end users	4 months & beyond
iv.	Portal development and management	4 months & beyond
v.	Launching of portal	
	(i) Initially for limited users for feed-back & comments	6 months
	(ii) Public domain	8 months
vi.	Operation and maintenance of GIP on 24x7 basis	8 months & beyond
vii.	Retrieving critics, comments and feedback from different users	On regular basis

NEW STUDIES
EXTERNAL RESEARCH PROJECT: NIH-E/WRS/2015/02

1. Thrust Area under XII five year Plan

2. Project team:

a. Project Investigator	Mr. L. N. Thakural, Sc-B, PI
b. Co-PI Project Co-Investigator(s)	Mr. D. S. Rathore, Sc-F Dr. Surjeet Singh, Sc-D Mr. Tanvear Ahmad¸ Sc-B Dr. Sanjay Kumar Jain, Sc-F, Dr. Sharad Kumar Jain, Sc-G

3. Title of the Project - Integrated approach for hydrological changes in selected catchments for IWRM in view of climate change in India

4. Objectives-

- Development of database related to hydro-meteorological data.
- Long-term spatio-temporal analysis of hydro-meteorological variables.
- Assessment of variation in surface water and groundwater availability.
- Spatial variation of Ground water levels.
- Drought characterization.
- Climate change scenarios/analysis.
- Inter-comparison of water resources variability in selected basins and suggestions for IWRM.

5. Present state-of-art

The climate of earth has never been stable for any extended period but varying naturally on all time scales. Climate change has greatly affected the characteristics of climatic variables globally. These changes are not uniform but vary from place to place or region to region. Probable climate change and its perilous impacts on the hydrologic system pose a threat to global fresh water resources and aquatic ecosystems worldwide. The present study is envisaged in this context to take up the study on the assessment of hydrological changes in different watersheds in India under changing environment.

6. Methodology

- Literature survey on the guidelines and pre-requisites for the selection of watersheds.
- GIS database development.
- Field visits for ground truth and data collection of exiting hydro-meteorological and groundwater related data and processing of data.
- Spatio-temporal analysis of hydro-meteorological data using parametric and non-parametric approaches.
- Application of lumped conceptual rainfall-runoff model (NAM) for assessment of surface and ground water availability.
- Computation of SPI, hydrological drought indices, analysis of change in rainy days.
- Downscaling of meteorological data, generation of climatic scenarios based on IPCC-SRES using actual data
- Impact of climate change on streamflow using statistically downscaled data for each catchment
- Inter-comparison of watersheds and suggestion for irrigation water management.

7. Research outcome from the project

The outcome of the study will help in assessment of water resources availability and impact of climate change at basin scale.

8. Work Schedule:

a. Probable date of commencement of the project: April 2015
b. Duration of the project: 3 Years (April 2015 to March 2018)
c. Stages of work and milestone:

S. No.	Work Element	First Year	Second Year	Third Year
1.	Literature survey and Data collection, selection of watersheds	*		
2.	Processing and analysis of hydrometereological data, GIS database development,	*	*	
3.	Assessment of variation in surface water		*	
4.	Ground water variation, Drought characterization		*	
6.	Climate change, Inter-comparison of water resources variability in selected basins and suggestions for IWRM.		*	*
7.	Preparation of Final report			*

RESEARCH MANAGEMENT AND OUTREACH DIVISION

Scientific Manpower

S N	Name	Designation
1	Dr. V C Goyal	Scientist F & Head
2	Sri Omkar Singh	Scientist E
3	Dr. R V Kale	Scientist C
4	Sri Subhash Kichlu	PRA
5	Sri Rajesh Agarwal	SRA

RESEARCH MANAGEMENT AND OUTREACH DIVISION (RMOD)

WORK PROGRAMME FOR YEAR 2014-2015

SN	Title of Project/Study, Study Team	Duration
1.	Pilot Basin Studies (PBS) at six identified sites, jointly with the RCs and CFMSs (**Joint Study)** **NIH HQs:** V C Goyal (Leader), Omkar Singh, R V Kale **NIH RCs/CFMSs:** RC-Belgaum, RC-Jammu, RC-Kakinada, RC-Sagar, CFMS-Guwahati, CFMS-Patna	DOS: Apr 2012 DOC: Mar 2015
2.	Water Conservation and Management in Ibrahimpur Masahi Village of Hardwar District (Uttarakhand) **Team:** Omkar Singh, V.C. Goyal, C.K. Jain, J.V. Tyagi and Sanjay Jain	DOS: Apr 2013 DOC: March 2015
3.	Participatory development of structure for IWRM Framework in identified sub-basins under Pilot Basin Studies (PBS) program **Team:** V C Goyal (PI), Omkar Singh and R V Kale	DOS: July 2014 DOC: June 2015
4.	Customization of WEAP model for application in Ur river watershed in Tikamgarh district of Bundelkhand region. **(Under TIFAC Project)** **Team:** R V Kale (PI), T Thomas- RC Bhopal, Jyoti Patil, Rajesh Agarwal	DOS: Apr 2014 DOC: Sep 2015

Sponsored Projects

5. Integrating hydrology, climate change and IWRM with livelihood issues: Development of methodology and a DSS for water-scarce Bundelkhand region in India, **Funded by TIFAC, Government of India under INDIA-IIASA Programme of TIFAC**
   Period: Aug 2013-Dec 2016 (30 months) Budget: Rs 56.64 lakh
   Team from NIH:
   V C Goyal (PI), T Thomas (Co-PI), R V Kale (Co-PI)
   Nodal Coordinators from other partners:
   Dr (Mrs) K Vijaya Lakshmi, DA, New Delhi
   Dr Sandeep Goyal, MAPCOST, Govt. of MP (India)
   International Collaborators: IIASA, Austria
6. Development of a DSS for Hydrology and Watershed Management in Neeranchal Project, **To be funded by Dept. of Land Resources (GoI) under a World Bank supported project**
   Period: Jun/Jul 2014-May 2019 Budget: Rs 30 Crore approx.
   Partners: NIH; IIT Delhi; WTC Delhi; NRSC Hyderabad

WORK PROGRAMME FOR YEAR 2015-2016

SN	Title of Project/Study, Study Team	Duration
1	Participatory development of structure for IWRM Framework in identified sub-basins under Pilot Basin Studies (PBS) program **Team:** V C Goyal (PI), Omkar Singh and R V Kale	DOS: July 2014 DOC: June 2015 (**Ongoing study)**
2	Customization of WEAP model for application in Ur river watershed in Tikamgarh district of Bundelkhand region. **(Under TIFAC Project)** **Team:** R V Kale (PI), T Thomas- RC Bhopal, Jyoti Patil, Rajesh Agarwal	DOS: Apr 2014 DOC: Sep 2015 (**Ongoing study)**
3	Water Conservation and Management in Ibrahimpur Masahi Village of Hardwar District (Uttarakhand) **Team:** Omkar Singh, V.C. Goyal, C.K. Jain, and Rajesh Singh	DOS: Apr 2013 DOC: March 2016 (**Ongoing study- extension being sought)**
4	WEAP Model set up for four sub-basins under Pilot Basin Studies (PBS) Programme, jointly with the RCs/CFMSs **NIH HQs:** V C Goyal (PBS Leader), Jyoti Patil and R V Kale **Co-investigators from NIH RCs/CFMSs:** Chandramohan T (RC-Belgaum), Y R S Rao (RC-Kakinada), T R Nayak (RC-Bhopal), B Chakravorty (CFMS-Patna)	DOS: Apr 2015 DOC: Mar 2016 (**New study)**

Sponsored Projects

1. Integrating hydrology, climate change and IWRM with livelihood issues: Development of methodology and a DSS for water-scarce Bundelkhand region in India, **Funded by TIFAC, Government of India under INDIA-IIASA Programme of TIFAC**
   Period: Aug 2013-Jan 2016 (30 months) Budget: Rs 56.64 lakh
   Team from NIH:
   V C Goyal (PI), T Thomas (Co-PI), R V Kale (Co-PI)
   Nodal Coordinators from other partners:
   Dr (Mrs) K Vijaya Lakshmi, DA, New Delhi
   Dr Sandeep Goyal, MAPCOST, Govt. of MP (India)
   International Collaborators: IIASA, Austria
2. Development of a DSS for Hydrology and Watershed Management in Neeranchal Project, **To be funded by Dept. of Land Resources (GoI) under a World Bank supported project**
   Period: Apr 2015-May 2020 Budget: Rs 30 Crore approx.
   Partners: NIH; IIT Delhi; WTC Delhi; NRSC Hyderabad

Study- 1 (RMOD/2015-16/TS-1)

1. **Thrust Area under XII five year Plan**: Integrated Water Resources Management (IWRM)- PBS

2. **Project team:**
   a) Project Investigator: Dr V C Goyal, Sc F
   b) Project Co-Investigator(s): Er Omkar Singh, Sc E and Dr R V Kale, Sc B

3. **Title of the Project:** Participatory development of structure for IWRM Framework in identified sub-basins under Pilot Basin Studies (PBS) program

4. **Objectives :**
   The objective of the study is to prepare an IWRM Framework document outlining the availability of water and related natural resources, and the strategy to share, use, manage and protect the basin's resources in an equitable and acceptable way.

5. **Present state-of-art:**

6. **Methodology**
   Through the proposed study, a document will be prepared which will provide the structure of IWRM Framework to be used for each of the six sub-basins of the PBS Program. This document will have sections and reporting formats on the status of the basin, development trends, capacity development needs, and basin development strategy. Consultations will be held with the local stakeholders and the six sites. Professional organizations having specialized knowledge of IWRM issues (e.g. SaciWaters, Hyderabad) will be consulted/involved in preparation of the structure of the IWRM Framework document.

7. **Research outcome from the project:**

Contents of the Draft IWRM Framework Document

1.0 INTRODUCTION • Who is managing the water resources? • Who are water resources users? • Who is developing the water resources? • Water resources management problems and challenges • Why Integrated Water Resources Management (IWRM)?
2.0 WATER RESOURCES ASSESSMENT • Physical Setting and Climate • Surface Water Resources • Ground Water Resources • Water Balance Estimation • Water Quality
3.0 WATER RESOURCES ALLOCATION AND USE
4.0 PILOT BASIN MANAGEMENT PLAN
5.0 CAPACITY BUILDING MECHANISM
6.0 INSTITUTIONAL COORDINATION MECHANISM

8. **Work Schedule:**
   a) Duration of the project: July 2014- June 2015
   b) Stages of work and milestone:

S.N.	Activity	2014-15	2015-16

		Q1	Q2	Q3	Q4	Q1
1.	Compilation of IWRM Framework strategies					
2.	Preparation of draft IWRM Framework document for the PBS Program					
3.	Consultation with stakeholders on the draft document					
4.	Finalization of the IWRM Framework document					

Study- 2 (RMOD/2015-16/TS-2)

1. **Thrust Area under XII five year Plan**: Integrated Water Resources Management- DSS (Planning) Activities

2. **Project team**:
   a. **Project Investigator** **:** Dr. Ravindra V. Kale, Scientist 'B'
   b. **Project Co-Investigator:** Er. T Thomas (RC Bhopal), Dr. Jyoti Patil
   Staff: Mr. Rajesh Agarwal, SRA

3. **Title of the Project:** Customization of WEAP model for application in Ur river watershed in Tikamgarh district of Bundelkhand region.

4. **Objectives:**

The main object of the study is the customization of **W**ater **E**valuation **A**nd **P**lanning (WEAP) model for linking the Integrated Water Resource Management (IWRM) in Ur River catchment in Tikamgarh district of Madhya Pradesh (India). This main objective of the study can be accomplished with following sub-objectives:

1. To prepare the input data structure for WEAP model.
2. To test the ability of WEAP model to be used as a simulation tool to perform different types of scenario analysis studies

5. **Present State-of-Art:**

There are various hydrologic modelling tools which are designed to simulate water development and management policies in river basins. These models are applicable to wide variety of specific watershed or river basin conditions, water resource system configurations, institutional conditions, and management issues. Each of these modelling softwares are based on a node-link network representation of the water resource system being simulated. Some of the models include optimization that replaces a more detailed representation of operating policies. All contain menu-driven graphics-based interfaces that facilitate user interaction.

WEAP is a robust tool for assessment, management and planning of water resources where it simulates hydrologic pattern based on climatic input. WEAP uses precipitation, temperature, humidity, infiltration, and wind speed data to predict the amount of precipitation that falls into a particular area, discharge of streams, recharge of groundwater and/or evapotranspiration through vegetation. It allows to build a futuristic scenarios based on the baseline scenarios along with assumptions towards water demand, infrastructure and regulations. The assessment of the impact of all the anthropogenic activities on water resources management and livelihood issues could be possible in order to predict water shortage and water quality base on a model scenario. This software tool can be used to demonstrate the results of water demand quantity met during a month, the degree of potential water shortage, level of reservoir storage for future use and measurement of water quality. Further, it can be used to assess the adequacy of environmental flows, the level of hydropower generation capacity, the evaluation of soil moisture, evapotranspiration rates, volume of surface runoff, the rate of ground water recharge, agriculture water requirement, possible alternative to adapt cropping pattern to increase water use efficiency and maximize the income. Basically, WEAP has two main functions:

1. Simulation of natural hydrological processes (e.g. evapotranspiration, runoff and infiltration) to enable assessment of the availability of water resources within a catchment; and
2. Simulation of anthropogenic activities superimposed on the natural system to influence water resources and their allocation (e.g. consumptive and non-

consumptive water demands) to enable evaluation of the impact of human water use.

This study is undertaken with aim to prepare required input data structure to customize WEAP model for Ur River watershed falling in Tikamgarh district of Madhya Pradesh, India in order evaluate currently available water resources and management of demand and supply requirements of different socio-economic activities. Subsequently, customized WEAP model will be tested to assess its ability to be used as a simulation tool to perform different types of scenario analysis studies.

6. Methodology

This study intended to customize the Water evaluation and Planning (WEAP) model (Fig. 1) by linking the Integrated Water Resource Management (IWRM) and hydrological inputs with livelihood issues in Ur River catchment in Tikamgarh District (M.P.).

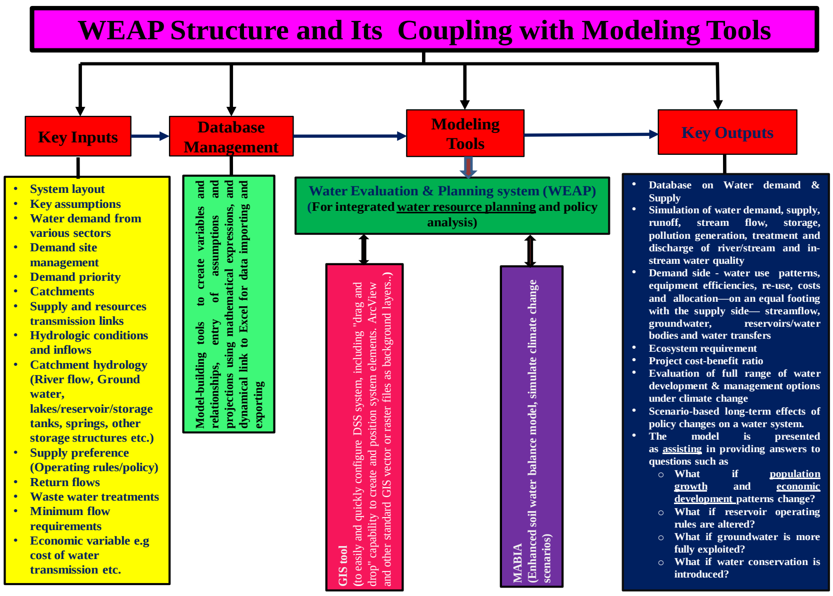


Figure 1. The WEAP model structure along with its coupling with other modeling tools to customize it for the Ur River catchment.

The WEAP model will be customized at sub-catchment scale in order to fulfill the requirements of the proposed DSS and output will be obtained on a daily/monthly scale. Prior to this, the hydrological processes occurring in the Ur River catchment will be modeled and and will be compared with the measured discharge time series. After, the proper calibration of the model, the demand sites will be added into a model framework and different scenarios will be generated to assess the gaps in the water demand and supply and water availability at different locations and at the different period of time.

7. Research outcome from the project

WEAP model will be customized for its application in Ur River watershed in Tikamgarh District (M.P.). Such model will be beneficial for the proper management of water resources in Ur River catchment and economic and social up-liftment of the area.

8. Work Schedule:

a. Duration of the project: April 2014- Sep 2015

b. Stages of work and milestone

Sl. No.	Work Element	2014-15				2015-16	
		Q1	Q2	Q3	Q4	Q1	Q2
1	Identification of site and Instrumentation at the identified site						
2	Collection of hydro meteorological data, satellite images, thematic maps etc.						
3	Compilation and verification of hydro-meteorological data, baseline survey data, census data and other qualitative data						
4	Preparation of input data for WEAP model						
5	Customization of WEAP for Ur River catchment and validation of model with observed data						
6	Report writing						
	Deliverable	**1st Interim Report**				**Final Report**	

Study- 3 (RMOD/2015-16/TS-3)

1. **Thrust Area under XII five year Plan**: IWRM- Hydrology for sustainability of water sources

2. **Project team:**
   a. Project Investigator: Omkar Singh
   b. Project Co-Investigator(s): V.C. Goyal, C.K. Jain, Rajesh Singh
   c. Supporting staff: Subhash Kichlu, Rajesh Agarwal, Rakesh Goyal

3. **Title of the Project:** Water Conservation And Management In Ibrahimpur Masahi Village Of Haridwar District (Uttarakhand)

4. **Objectives :**
   - Assessment of water demand in the study area
   - Assessment of water availability in the study area
   - Assessment of water quality status/Eutrophication of Ponds in the study area
   - Preparation of water conservation plan for the study area

5. **Present state-of-art:**

In our country, most of the traditional sources of water in villages are on the verge of disappearing/shrinking due to encroachment, siltation and water quality deterioration and witnessing severe eutrophication. The ponds located in the Haridwar District are also suffering from various hydrological problems and are at the verge of extinction, which require immediate intervention to restore for various uses. Rain water harvesting is a popular technique of developing surface water resources that can be used to provide water for livestock, domestic use and irrigation purposes. The purpose of rain water harvesting is to either augment existing water supplies or to provide water where other sources are not available. It also aims to provide water in sufficient quantity and of suitable quality for the intended use. Therefore, water conservation and its management of village ponds is essential for proper utilizing the water for beneficial use in the society. The water conservation and rain harvesting may be helpful for improving the livelihood of the peoples.

The present study has been taken for Ibrahimpur Masahi revenue village, lying under Shipla Nadi-Halzora Nadi watershed (a tributary of Solani River), District Haridwar (Uttarakhand). The area of Ibrahimpur Masahi revenue village is 14.26 km^2. The Ibrahimpur Masahi revenue village consists of 5 five sub-villages under its jurisdiction, namely- Ibrahimpur, Masahi, Belki, Inayatpur and Halzora.

6. **Methodology**
   - Estimation of Domestic Water Requirement (Human Needs)
   - Estimation Livestock Water Requirement
   - Estimation Crop Water Requirement
   - Probability Analysis of Rainfall Data & Water Availability
   - Planning of Rainwater Harvesting in the Village
   - Planning for Wastewater Management

The rainwater harvesting potential in the study area would be carried out as below:
   - Household Monthly Harvested Rainwater & Balance After Flushing
   - Household Monthly Harvested Rainwater & Balance After Flushing & Laundry (combined)
   - Rainwater Harvesting Potential of Village Ponds
   - Monthly Roof Top Water Harvesting Potential of Schools/Govt. Buildings

7. Research outcome from the project: Reports and papers

8. Work Schedule:

a. Probable date of commencement of the project: ongoing
b. Duration of the project: Apr 2013- Mar 2015 (extension being sought for 1 year, i.e. upto Mar 2016)
c. Stages of work and milestone:

S. N.	Major Activities	2013-14				2014-15				2015-16			
		1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
1	Review of literature												
2	Reconnaissance survey of the study area												
3	Procurement/Collection of necessary data for the study												
4	Field investigations (WQ, survey of ponds etc.)												
5	Analysis of data for assessment of water demand, availability, Water Quality, etc.												
6	Preparation of water conservation plan, in-situ wastewater management, sewage quality parameters & eutrophication of ponds												
7	Report (s) preparation												

Study- 4 (RMOD/2015-16/TS-4)

1. **Thrust Area under XII five year Plan**
   Integrated Water Resources Management (IWRM)- PBS

2. **Project team:**
   a. **Project Investigator**: V C Goyal (PBS Leader)
   b. **Project Co-Investigator(s):** Jyoti Patil and R V Kale (RMOD); Chandramohan T (RC-Belgaum), Y R S Rao (RC-Kakinada), T R Nayak (RC-Bhopal), B Chakravorty (CFMS-Patna)

3. **Title of the Project**: WEAP Model set up for four sub-basins under Pilot Basin Studies (PBS) Programme

4. **Objectives**
   The main objective of the study is to set up the WEAP model for 4 sub-basins under the PBS Programme (Bina in MP; Zuari in Goa; Yerakalva in AP and Mahi in Bihar).

5. **Present state-of-art**
   The Water Evaluation and Planning System (WEAP) contains components that allow the appraisal of water management strategies at basin level with economic values. It has been developed by the Stockholm Environmental Institute (SEI) as a decision support tool for water resources management (www.weap21.org). Currently, it is being applied particularly in regions, which are characterized by water scarcity and increasing demands, such as in the Middle East and North Africa. In many basins, the groundwater extractions exceed the natural recharge resulting in a deterioration of the water qualities and worsening the water shortage. The application of integrated water management strategies (IWRM), including water reuse, artificial ground water recharge, use of brackish water, storage of natural and reclaimed water, demand measures and improved water allocation among competing water uses, becomes increasingly necessary.

   The economic components of WEAP allow the calculation of costs for demand notes, transmission links, treatment plants and reservoirs. Moreover, the beneficial impacts of increases in water availability for different demand sites can be evaluated in economic terms. By creating suitable indicators the economic losses of unmet demands and the environmental costs of low river flows can be evaluated as well. WEAP offers the possibility to perform cost-benefit analyses of alternative measures to tackle water problems. For instance, the construction of a reservoir or of a new treatment technology at a demand node to mitigate water shortage can be compared in terms of net present values. The economic net benefits of investments on annual basis can be calculated for different demand nodes. These calculations methods serve to find out the most appropriate IWRM strategy at basin level. Furthermore, various financing options under different loan conditions and pricing policies can be considered.

   WEAP was applied successfully to model the hydrological features and water management strategies at many basins and it is being developed further. An example is the co-operation between the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD) and the German Federal Institute for Geosciences and Natural Resources (BGR) (www.acsad-bgr.org). A further example is the research project 'Integrated Water Resource Management in the Lower Jordan Rift Valley (SMART)', funded by the German Ministry of Education and Research (BMBF) (www.iwrm-smart.org).

6. **Methodology**
   WEAP is a robust tool for assessment, management and planning of water resources where it simulates hydrologic pattern based on climatic input. WEAP uses precipitation,

temperature, humidity, infiltration, and wind speed data to predict the amount of precipitation that falls into a particular area, discharge of streams, recharge of groundwater and/or evapotranspiration through vegetation. It allows to build a futuristic scenarios based on the baseline scenarios along with assumptions towards water demand, infrastructure and regulations. The assessment of the impact of all the anthropogenic activities on water resources management and livelihood issues could be possible in order to predict water shortage and water quality base on a model scenario. This software tool can be used to demonstrate the results of water demand quantity met during a month, the degree of potential water shortage, level of reservoir storage for future use and measurement of water quality. Further, it can be used to assess the adequacy of environmental flows, the level of hydropower generation capacity, the evaluation of soil moisture, evapotranspiration rates, volume of surface runoff, the rate of ground water recharge, agriculture water requirement, possible alternative to adapt cropping pattern to increase water use efficiency and maximize the income.

Customization of the WEAP model will be carried out for the respective sub-basins on a daily/monthly time step. First, a database will be prepared covering the required hydrologic, demographic and socio-cultural data, to be used with the model. Then, a draft schematic of the WEAP model will be prepared defining the demand and supply nodes, etc. The draft WEAP schematic will be discussed with the local stakeholders, and their views will be incorporated in the final model set up. Results from the WEAP model analysis will be used to prepare an integrated water management plan for the 4 sub-basins. Next, the integrated water management plan will be shared with the local stakeholders in the form of a training workshop.

7. Research outcome from the project

WEAP model will be set up for its application in the 4 sub-basins under the PBS Programme. This model will be useful in preparation of integrated water management plans for each sub-basin.

8. Work Schedule:

(i) Duration of the project: Apr 2015- Mar 2016
(ii) Stages of work and milestone:

S. N.	**Work Element/ Milestone**	**1st Qtr**	**2nd Qtr**	**3rd Qtr**	**4th Qtr**
1	Creation of database	√			
2	Draft WEAP model set up		√		
3	Stakeholders' meeting		√		
4	Finalization of WEAP model set up				√
5	Training workshop				√

TWSSM- 1 (RMOD/2015-16/TWSSM-1)

ORGANISING TRAINING WORKSHOPS/SEMINARS/ SYMPOSIA/MASS AWARENESS PROGRAMME, ETC

1. **Thrust Area under XII five year Plan:** Outreach Activities

2. **Topic of Training Workshops/Seminars/Symposia/Mass Awareness Programmes etc:** IITF-2015, IWW & Any Other Exhibition

3. **Convener:** Dr. V.C. Goyal, Head, RMO Division

4. **Co-ordinator/ Organising Secretary:** Mr. Omkar Singh, Sc E

5. **Co Co-ordinator (S)/ Co-Organising Secretary:** Mr Subhash Kichlu, PRA, Mr Rajesh Agrawal, SRA

6. **Faculty:** Internal Team of Exhibitors

7. **Duration of the programme:** Apr 2015- Mar 2016

8. **Tentative Schedule:** IITF (2 weeks), IWW (1 week), other exhibitions, NIH Foundation Day, World Water Day

9. **Place at which Programme would be organized:** New Delhi/ Roorkee/other places

10. **No of Participants Expected**: NA

Stages of Work:

S. N.	Work Element/ Milestone	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	IITF-2015			√	
2	IWW	√			
3	Other exhibitions				
4	NIH Foundation Day			√	
5	World Water Day				√

TWSSM- 2 (RMOD/2015-16/TWSSM-2)

PROFORMA FOR SUBMITTING PROPOSALS FOR ORGANISING TRAINING WORKSHOPS/SEMINARS/SYMPOSIA/MASS AWARENESS PROGRAMME ETC

1. **Thrust Area under XII five year Plan**
   Technology Transfer and Outreach Activities

2. **Topic of Training Workshops/Seminars/Symposia/Mass Awareness Programmes etc**
   Citizen Science in Hydrology and Water Resources Management

3. **Convener:** V C Goyal, Head, RMO Division

4. **Co-ordinator/ Organising Secretary**

5. Co Co-ordinator (S)/ Co-Organising Secretary (ies)

6. **Faculty**
   NIH, CGWB, IMD, ICAR, CSIR
   ATREE (Bangaluru), PSI (Dehradun), DA (Delhi), ARGHYAM (Bengaluru), ACWADAM (Pune), INREM (Hyderabad), TERI (Delhi)

7. **Duration of the programme :** 5 days

8. **Tentative Schedule**
   October 2015

- Lectures (1.5 days)
  a. Concepts of hydrologic analysis and data requirement
  b. Instrumentation and field monitoring
  c. Quality control
  d. Monitoring protocols and standards
  e. Database creation and management
- Tutorials (0.5 day)
  a. Preparation of field installation plan
  b. Selection of instrumentation
  c. Participatory water balance estimation
  d. Storage and retrieval of field data
- Field visit (2 days)
  a. Rain gauges
  b. Dug wells and piezometers
  c. Water level in streams, ponds/tanks
  d. Water quality
  e. Soil moisture, soil nutrients, landuse/landcover,
- Synthesis and Recommendations (1 day)
  a. Role and responsibility of actors
  b. Evolving water use plans
  c. Crowdsourcing hydrologic data and meta-data plans
  d. Virtual laboratories

9. **Place at which Programme would be organized:**
   Delhi
10. **No of Participants Expected**
    30

TWSSM- 3 (RMOD/2015-16/TWSSM-3)

PROFORMA FOR SUBMITTING PROPOSALS FOR ORGANISING TRAINING WORKSHOPS/SEMINARS/SYMPOSIA/MASS AWARENESS PROGRAMME ETC

1. **Thrust Area under XII five year Plan:** Induction Training Activities
2. **Topic of Training Workshops/Seminars/Symposia/Mass Awareness Programmes etc:** Orientation Training of Newly Appointed Scientists/Staff
3. **Convener:** Dr. V.C. Goyal, Head, RMO Division
4. **Co-ordinator/ Organising Secretary:** Mr. Omkar Singh, Sc E
5. **Co Co-ordinator (S)/ Co-Organising Secretary:**
6. **Faculty:** Internal
7. **Duration of the programme:** One week
8. **Tentative Schedule:** To be decided after joining of the new employees
9. **Place at which Programme would be organized:** NIH, Roorkee
10. **No of Participants Expected:** 20

TWSSM- 4 (RMOD/2015-16/TWSSM-4)

1. Thrust Area under XII five year Plan

Technical Transfer and Outreach Activities

2. Project team:

a. **Project Investigator:** Dr V C Goyal, Head, RMO Division

b. **Project Co-Investigator(s):** Sri Rajesh Agrawal, SRA

3. Title of the Project: Science-Policy Interface, IPR Issues in Hydrology & Water Resources, and Technical Meetings (TAC, WG)

4. Objectives

5. Present state-of-art

6. Methodology

7. Research outcome from the project

8. Work Schedule:

a. Duration of the project: Apr 2015- Mar 2016

b. Stages of work and milestone:

S. N.	Work Element/ Milestone	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	Science-Policy Interface- Publication of newsletter "Hydrology for People"	√		√	
2	IPR Issues in Hydrology & Water Resources- ISO surveillance audit ISO-related training course for staff		 √	 √	 √
3	Organization of technical meetings		WG		TAC, WG

Annexure-WAC

PROFORMA FOR SUBMITTING INTERNAL RESEARCH PROJECTS

1. Thrust Area under XII five year Plan

Major Facilities to be Created- 'Water Activity Centre'

2. Project team:

a. **Project Investigator**: Dr V C Goyal, Head, RMOD
b. **Project Co-Investigator(s):** Er Omkar Singh, Sc E; Sri Subhash Kichlu, PRA

3. Title of the Project: Establishment of 'Water Activity Centre'

4. Objectives

The Water Activity Centre would be an Information Centre covering various themes of water resources, its conservation and management, and many more. It would be a platform where most of the information on water resources can be gathered in a very interesting manner. Through its various programs, the Centre would attract a lot of visitors who would get informed on the issues and challenges of water resources.

5. Present state-of-art

6. Methodology

Components of Water Activity Centre

1. Live Diorama

This section would house working models on different themes, e.g. Rain Water Harvesting structures, groundwater recharge, Hydrologic Cycle, flood plain zoning, wastewater treatment. Understanding the concept of the working of the displayed models would motivate the visitors.

2. Audio Video Corner

This would be an extensive collection of documentary films made on the issues of water. It would also include the songs and *bhajans* sung on water. This would be an innovative way of teaching the visitors about the importance of water, water conservation, etc. A computer with a nice PA system shall be installed herein where a visitor can watch or listen to the audio video on water.

3. Knowledge Shelf

This would be the corner in the centre enabled with books from national and international publications pertaining to the issues of water and water conservation. This would include books in English and Hindi and would have reference guides, DIY Guides and many more.

4. Water Wall

This would be a room giving an amazing feeling to the visitor about water related issues. On its four walls different paintings denoting different issues would be put up.

5. Water on touch

This would be a Touch Screen portal covering important aspects of water, interactively discussing water-related problems and their solutions. This would establish a relationship of the visitor with water in a way so as to make him/her understand the various facets of water.

7. Research outcome from the project

The visitors visiting the Centre would be more informed on the issues of water resources and water conservation. They would be motivated to contribute considerably towards water conservation.

8. Work Schedule:

a. Duration of the project: Apr 2015- Mar 2016
b. Stages of work and milestone:

S. N.	Work Element/ Milestone	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	Live Diorama			√	
2	Audio Video Corner			√	
3	Knowledge Shelf			√	
4	Water Wall				√
5	Water on touch				√

Annexure- LCU

PROFORMA FOR SUBMITTING INTERNAL RESEARCH PROJECTS

1. Thrust Area under XII five year Plan
Major Facilities to be Created- LCU at Delhi

2. Project team:

a. **Project Investigator:** Dr V C Goyal, Head, RMOD
b. **Project Co-Investigator(s):** Dr Jyoti Patil, Sc B (LCU)

3. Title of the Project: Functioning of LCU at Delhi

4. Objectives
The basic intent of setting up a LCU has been to effective liaise and coordinate with the various government and non-government organizations in the NCR region on a regular basis. The LCU is expected to enhance interactions with policy makers, bureaucrats, and industrialists, who normally find it difficult to move out of Delhi.

5. Present state-of-art

6. Methodology

7. Research outcome from the project

8. Work Schedule:

a. Duration of the project: Apr 2015- Mar 2016
b. Stages of work and milestone:

S. N.	Work Element/ Milestone	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr

HARD ROCK REGIONAL CENTRE BELGAUM

Scientific Manpower

S N	Name	Designation
1	Dr.B.Venkatesh	Scientist F & Head
2	Dr.B.K.Purandara	Scientist E
3	Dr.Chandra Mohan T.	Scientist D
4	Dr.M K Jose	Scientist D
5	Dr.N. Varadarajan	SRA
6	Mr.Chandrakumar S	SRA

HRRC, BELGAUM
Work Program for 2014-2015

No.	Title of the Study	Study Group	Duration	Funding
1	Waterlogging and Salinity Studies in NagarjunaSagar Right Bank Canal Command	NV, BKP	2 years (Aug2012 - Jul2014)	COMPLETED (Report will be submitted soon)
2	Integrated Water Resources Management (IWRM) on a Pilot Basin – Zuari River Basin, Goa	CMT, BKP, VCG	3 years (Apr2013 - Mar2016)	Internal (PBS)
3	Comparative Analysis of Various Rainfall-Runoff Models for Rivers of Western Ghats	BV, CK & MKJ	3 years (Apr2013 - Mar2016)	Internal
4	Studies on Spring flows and estimation of Groundwater Recharge in Ghataprabha Sub-basin	BKP, NV, SK,RV	2 years (Apr2013 - Mar2015)	Internal
5	Application of Geostatistical methods for analyzing sedimentation pattern in river basins of Kerala State	MKJ, and CM	2 years (Oct2014-Sep2016)	Internal
6	Modeling of Sediment Yield From River Basins of Kerala & Goa, Using SWAT Model	CMT & BV	2 years (Oct2014-Sep2016)	Internal
7	Runoff estimation in a catchment using GIS and WEB based tools: A case study	MKJ and BV	1 year (Oct2014-Sep2015)	Internal
8	Impact of Land use/Land cover Changes on Ground water – A Case Study	BKP, BV and NV	2 years (Oct2014-Sep2016)	Internal
9	Impact of Urbanization on Surface and Ground water Quality and Quantity – A Case Study	BKP, SK and NV	2 years (Oct2014-Sep2016)	Internal

SK : Sudhir Kumar, Scientist G
BV : B.Venkatesh, Scientist F
CMT : Chandramohan T., Scientist D
RV : Rajan Vats Scientist B
CK : ChandraKumar S., SRA
VCG : V. C. Goyal, Scientist F
BKP : Purandara, Scientist E
MKJ : Mathew K. Jose, Scientist D
NV : N Varadarajan,SRA

Proposed Work Program for 2015-2016

No.	Title of the Study	Study Group	Duration	Funding
1	Integrated Water Resources Management (IWRM) on a Pilot Basin – Zuari River Basin, Goa	CMT, BKP, VCG	3 years (Apr 2013 – Mar 2016)	Internal (PBS)
2	Comparative Analysis of Various Rainfall-Runoff Models for Rivers of Western Ghats	BV, CK& MKJ	3 years (Apr 2013 – Mar 2016)	Internal
3	Studies on Spring flows and estimation of Groundwater Recharge in Ghataprabha Sub-basin	BKP, NV, SK, RV	2 years (Apr 2013 – Mar 2015)	Internal
4	Application of Geostatistical methods for analyzing sedimentation pattern in river basins of Kerala State	MKJ, and CM	2 years (Oct 2014 – Sep 2016)	Internal
5	Modeling of Sediment Yield From River Basins of Kerala & Goa, Using SWAT Model	CMT and BV	2 years (Oct 2014-Sep2016)	Internal
6	Runoff estimation in a catchment using GIS and WEB based tools: A case study	MKJ and BV	1 year (Sept 2014-August 2015)	Internal
7	Impact of Land use/Land cover Changes on Ground water – A Case Study	BKP, BV and NV	2 years (Oct 2014-Sep 2016)	Internal
8	Impact of Urbanization on Surface and Ground water Quality and Quantity – A Case Study	BKP, SK and NV	2 years (Oct 2014-Sep 2016)	Internal

SK : Sudhir Kumar, Scientist G
BV : B.Venkatesh, Scientist F
CMT : Chandramohan T., Scientist D
RV : Rajan Vats Scientist B
CK : ChandraKumar S., SRA
VCG : V. C. Goyal, Scientist F
BKP : Purandara, Scientist E
MKJ : Mathew K. Jose, Scientist D
NV : N Varadarajan,SRA

1.0 Integrated Water Resources Management (IWRM) on a Pilot Basin – Zuari River Basin, Goa

Study Group	: Chandramohan T., B. K. Purandara, V. C. Goyal
Date of start	: April 2013
Duration	: 3 years
Funding	: Internal

Objectives:

- Assessment of basin characteristics and its hydrology
- Working out an IWRM frame work for Zuari basin in consultation with WRD, Goa
- Instrumentation of the basin with the latest hydro-meteorological gauges
- Quantifying the soil hydraulic properties
- Water availability studies
- Hydrological studies such as flood frequency analyses, erosion and sediment transport studies, water quality assessment, etc.
- IWRM plan for equitable distribution of available water resources for different users in the catchment

Statement of the Problem:

IWRM provides the means of balancing and meeting the needs for use of water resources in such a way as to ensure the equitable and sustainable use of the water resource. It is based on the principle that, in order to maximise the benefits of the water resource and to ensure equitable use of water, needs of all the water users in the catchment must be balanced. The basis of IWRM is that different uses of water are interdependent. Additional benefits can be derived when different user groups are consulted in the planning and management of water management programs.

During the 12th 5-year plan period, National Institute of Hydrology (NIH) has proposed a project on Integrated Water Resources Management (IWRM) under Pilot Basin Study (PBS) at each of its Regional Centres. As per the discussions and deliberations held at various levels, NIH Regional Centre, Belgaum is collaborating with the Water Resources Department (WRD), Goa for carrying out the IWRM project in the Zuari River Basin. The need for the IWRM study for the Zuari Basin is important as;

- Data network is inadequate to represent the hydrology
- Lack of ET measurements within the forest areas affects the accuracy of water availability estimates
- Mining is a great threat to the general health of river and EIA studies are not carried out in a detailed manner
- Solutions have to formulated for the increased extent of salt water ingression into the upstream river reaches
- Limited coordination between agencies dealing with Water

Methodology:

Zuari River is the second largest river in the State of Goa and having many environmental and water resources related issues. There is a need for comprehensive analysis of these hydrological issues leading to evaluate quality & quantity of water, water-human relationship, socio-economics and institutional setup for managing water resources in the basin. Also, the Western Ghats mountain ranges located in the south-western part of India is undergoing substantial changes due to man’s activities, which hugely impacts the hydrological regime of this fragile ecosystem. Hence, it is important to conduct detailed hydrological analyses within a typical pilot basin which represents all types of hydrological complexities to provide a model for the hydrology of the region as well as representing the sensitive Western Ghat region. The various steps involved in the study:

- Identification of water related issues pertaining to Zuari basin by interaction with the people
- Identification of working partners who can be a part of the IWRM framework
- Preparation of an IWRM framework
- Design of an instrumentation strategy
- Field experiments for the evaluation of soil hydraulic properties
- Water availability studies – Surface Water & Groundwater
- Formulation of equitable water use strategy

Research outcome from the project:

The expected deliverables from this project are:

- A greater understanding of human-water relationships and to derive 'best practice" norms for better utilisation of the water resources in the region.
- Act as a model basin for detailed studies of hydrological processes in the Western Ghat region.
- Formulation of a set of recommendations regarding implementation and management policies of the water resources projects to the related departments.
- A greater understanding of human interference and water linkages in the catchment.
- Preparation of short briefing in non-technical language to spread the awareness about the best management practices of water and environment in the catchment.

Work Schedule for the year 2015-2016:

a. **Probable date of commencement of the project :** April 2013
b. **Duration of the project :** 3 years
c. **Stages of work and milestone:**

Sl. No.	Work Element	First	Second	Third	fourth
1	Identification of model and application				
2	Field experiments				
3	Other hydrological studies such as water balance, optimum allocation of water resources, etc.				
4	Analyzing the results				

2.0 Comparative Analysis of Various Rainfall-Runoff Models for Rivers of Western Ghats

Project team:

Project Investigator : B. Venkateh,
Project Co-Investigator(s) : S. Chandrakumar
: M. K. Jose

Objectives:

The main objective of this study is

1. To conduct catchment modeling for better understanding of hydrologic functioning and runoff generation mechanisms of basins in Western Ghats.
2. To compare and select the best conceptual rainfall-runoff model that can be used in simulating and forecasting the flow values, which an aid in carrying out of design, planning and management of water resources in basins of Western Ghats.

Present state-of-art: Development of mathematical models relating the precipitation incident upon a catchment to the stream emanating from the catchment has been a major focus of surface water hydrologist for decades. However, over the decades, the amount of effort and complexity of models seem to have increased continually with the expansion in available computing power. Most of the attention has been given to model the catchment behavior rather than identifying the model for catchment based on the hydrologic processes happening at the catchment level. Some of the work in this direction has been reported from the temperate zone where hydrological responses tend to be simpler. Whereas, the tropical zone such as in India, where the monsoon driven hydrologic cycle is prevailing, no such modeling activities has attempted. Moreover, in the recent times, this region is witnessing the implementation of newer project, without much of the hydrological analysis, due to lack of data and region specific methods. Therefore, in the present study, an attempt has been made to identify a best suited rainfall-runoff model for the catchments of Western Ghats.

Methodology:

The present study uses conceptual rainfall-runoff model such as Australian Water Balance Model (AWBM), SCAROMENTO Model, Soil Moisture Accounting Model (SMAR Model), Tank Model, SimHyd model and distributed model such as SWAT rainfall-runoff model. Also, it is envisaged to compare the results obtained through calibration for selecting the best suited model for the region.

Research outcome from the project: The present research would results in identifying a best suited rainfall-runoff model for Western Ghats region which is presently lacking for many of the river basins in India

Work Schedule for the year 2015-2016

a. Probable date of commencement of the project :
b. Duration of the project :
c. Stages of work and milestone:

Sl. No.	Work Element	First	Second	Third	fourth
1	Collection of Data				
2	Digitizing the basin Boundaries				
3	Calibration and Validation of model for selected basins				
4	Analyzing the results				

3.0 Studies on Spring flows and estimation of Groundwater Recharge in Ghataprabha Sub-basin

Study Group : B. K. Purandara, N. Varadarajan, Sudhir Kumar, C. P. Kumar, Rajan Vats
Date of start : April 2013
Duration : 2 years
Funding : Internal

A spring is a localized natural discharge of groundwater issuing on the land surface through well-defined outlets. The discharge may vary from a trickle to a stream. In the present study it is proposed to delineate areas into recharge and discharge from the zone of saturation in parts of Sindhudrug and Ghataprabha sub-basin. The objectives of the study includes

1. Demarcation of aquifers and areas of recharge and discharge based on hydrogeological and geophysical techniques
2. Estimation of groundwater recharge through different sources.
3. Estimation of Groundwater discharge and water availability in the region to understand the life of springs.
4. Assess the impact of land use/land cover changes on groundwater recharge and discharge**.**

The above study was proposed by the various members present in the RCC. Accordingly study is under progress in Ghataprabha representative basin. Relevant information has been collected for preliminary analysis. Detailed filed investigations are planned during monsoon and non-monsoon months of year 2014.

4.0 Application of Geostatistical methods for analyzing sedimentation pattern in river basins of Kerala State

Project team:

a. Project Investigator: Mathew K. Jose
b. Project Co-investigator: Chandra Mohan T

Objectives
Analysis of spatial and temporal distribution of sediment deposition in various catchments of Kerala State.

Present state-of-art
Spatial variability of sedimentation over basins have been studied using geostatistical methods by many investigators earlier (eg. Zhang etal 2014, Lessa al 2014, French et al 1995 etc). The spatial dependence and spatial correlation may be analysed using various tools like semi variogram analysis, kriging, and distribution simulations. Standard geostatistical tool kits can be used for the purpose. The proposed analysis will facilitate to bring about the spatial characteristics of the sediment distribution in the study area.

Methodology
In geostatistics, parameters concerned are analysed to reveal their spatial structure and inter-relationships. Processes like sedimentation have structural and random characteristics with variation in space and time. Thus, sedimentation is appropriately considered as a regionalized variable. Therefore, analysis of spatial correlation structure of sediment yield at various locations of different catchments may reveal the regional sedimentation characteristics. Evolving a sediment distribution relationship over the region, consisting of different catchments, may be useful in estimating / predicting sedimentation rates at non-sampling locations. The estimates based on geostatistical analyses would be better estimates of mass fluxes compared to those obtained through conventional statistical methods.

Research outcome from the project
Regional spatial/temporal structure of sedimentation in various catchments of the state of Kerala.

Work Schedule:
a. Date of commencement of the project
October 2014
b. Duration of the project
2 Years
c. Stages of work and milestone

Sl. No.	Work Element	First	Second	Third
1		- Collection of Data - Field Visits - Processing of data - Interim Report	- Analyses - Report preparation	NA
	Deliverables	**First Interim Report**	**Second Interim Report**	**Final Report**
2		October 2015	-	October 2106

5.0 Modeling of Sediment Yield from River Basins of Kerala and Goa, Using SWAT Model

Project team:

a. Project Investigator — Chandramohan T
b. Project Co-investigator — Venkatesh B

Objectives:

- to test the performance of SWAT model in predicting sediment yield by acquiring the most sensitive sediment parameters in the river basins
- to develop calibrated sediment parameters so that the model can be used in ungauged watersheds for prediction of sediment yield.

Present state-of-art:
Soil erosion and related degradation of land resources are highly significant spatio-temporal phenomena in many countries. Soil erosion, generally associated with agricultural practices, leads to decline in soil fertility, brings on a series of negative impacts of environmental problems, and has become a threat to sustainable agricultural production and water quality in the region. It has been estimated that in India about 5334 m-tons of soil are being removed annually due to various reasons. Often, a quantitative assessment is needed to infer the extent and magnitude of soil erosion problems so that effective management strategies can be resorted to. But, the complexity of the variables makes precise estimation or prediction of erosion difficult. Many empirical and conceptual methodologies have been formulated for the prediction of erosion and sediment yield. However, majority of them are site specific and cannot be used for other regions.

The emergence of soil erosion models have enabled the study of soil erosion, especially for conservation purposes, in an effective and acceptable level of accuracy. For this purpose, several available empirical, physically based, or conceptual models could be used. The latest advances in spatial information technology such as GIS, have augmented the existing methods and have provided efficient methods of monitoring, analysis and management of earth resources.

Methodology:
In this study, the physically based SWAT model will be applied to undisturbed river basins of Kerala and Goa State for the prediction of soil erosion and sediment yield. SWAT model is a watershed scale, continuous, long-term, distributed model designed to predict the impact of land management practices on the hydrology, sediment, and contaminant transport in agricultural watersheds. SWAT subdivides a watershed into different subbasins connected by a stream network, and further into hydrological response units (HRUs). The SWAT system is embedded within geographic information system (GIS) and can integrate various spatial environmental data including soil, land cover, climate and topographic features.

Research outcome from the project:
Reliable predictions of the quantity and rate of runoff and sediment transport from land surface into streams, rivers, and water bodies are needed. Predictions of runoff and sediment yield, support decision makers in developing watershed management plans for better soil and water conservation measures.

This study is aimed at calibrating the SWAT model by identifying major sediment related parameters pertaining to west flowing rivers originating from Western Ghat Region. This calibrated model can be used to predict sediment yield from ungauged river basins of the region.

Work Schedule:
a. Date of commencement of the project — October 2014
b. Duration of the project — 2 years
c. Stages of work and milestone:

Sl. No.	Work Element	First	Second	Third	fourth
1	Collection of satellite data and analyses Other data such as rainfall, etc				
2	Calibration of model parameters and Testing of SWAT model for gauged basin				
4	Application to ungauged basin				

6.0 Runoff estimation in a catchment using GIS and WEB based tools: A case study

Project team:

a. Project Investigator: Mathew K. Jose
b. Project Co-investigator: B. Venkatesh

Objectives

Estimation of runoff from the R Manjirasub basin, a tributary of R Godavari using application of GIS techniques.

Present state-of-art

GIS techniques have been proved to be advantageous over other methods when the study area is large,many, alternative landcover scenarios are explored, or digital database already exists for the study area. In literature there are examples of many investigations of rainfall runoff and changes in land use scenario carried out using GIS techniques

Methodology

Geographic information systems (GIS) have been used for various analyses of spatially distributed data. The power of a GIS lies in its ability to reference features to a geographic location just as a conventional map does. However, a GIS has the ability to easily manipulate and combine different data sets in many ways that a map cannot. To employ a GIS for an analysis, the user must determine the objectives which will then define the data necessary for the project. Each data set has to be geo-referenced so that each model has a common map projection and scale to ensure that one coordinate represents the same location in each model. The proposed study is to demonstrate the applicability of GIS and web based tools in accomplishing hydrological analyses like runoff estimation from a catchment. The ArcGIS program can be used for this study along with web applications like GoogleEarth and other public domains where data is shared freely. Hydrologic analysis shall be performed using the above tools to estimate the runoff from the R Manjirasub basin, a major tributary of R Godavari.

Research outcome from the project

Application of GIS tools for hydrological applications in a sub-basin of R Godavari basin.

Work Schedule:

a. Probable date of commencement of the project: October 2014
b. Duration of the project: 1 Year
c. Stages of work and milestone

Sl. No.	Work Element	First	Second	Third
1		- Collection of Data - Field Visits - Procurement of Software - Processing of data - Interim Reports - Analyses - Report preparation	NA	NA
	Deliverables	**First Interim Report**	**Second Interim Report**	**Final Report**
2		May 2105	-	October 2105

7.0 Impact of Land use/Land cover Changes on Ground water – A Case Study

Project team:

a. Project Investigator   B. K. Purandara
b. Project Co-investigator   B. Venkatesh

Present State of Art

Impacts of LU/LC change on atmospheric components of the hydrologic cycle (regional and global climate) are increasingly recognized (Pitman et al., 2004). However, impacts of LU/LC change on subsurface components of the hydrologic cycle are less recognized, particularly groundwater recharge. The potential scale of subsurface impacts is large. Groundwater is Earth's largest freshwater resource. Reduced reliability of surface water supplies in the western US with projected climate change during the next century may result in increased reliance on groundwater. Widespread changes in LU/LC have occurred as a result of agricultural expansion. Groundwater is one of the major components of the hydrological cycle. One of the predominant factors, which affect the movement of water over and into the ground surface is the vegetation cover of the watershed. There could be several types of covers or the land uses on the soil surface, for example forests, grass, agriculture, barren land etc. Different land use will have different kinds of effect on movement of water over and under the ground surface. In the presence of forest, water movement and water action are different because of the canopy, forest flow and distinctive soils. Due to forest deep rooting system and added contribution to organic matter content of the soil have been generally found to improve the soil structure resulting in better surface recharge conditions. On the other hand, the evapo-transpiration requirements of the forest have been found relatively higher than other land uses. Therefore, the net effect of forest on ground water regime becomes an important issue for investigation by hydrologist which in turn will be useful for water resources planner and environmentalist. In this connection, it is proposed to carry out following investigations in parts of Uttarakannada, district of Karnataka.

Objectives

- To understand the relationship between rainfall-runoff and groundwater recharge under different forest types
- To estimate evapo-transpiration under different forest covers/land covers
- To determine the in-situ soil hydraulic properties (such as infiltration, saturated and unsaturated hydraulic conductivity, soil moisture retention characteristics
- To estimate the groundwater recharge under different land use/land covers as well as based on field and laboratory methods, numerical solutions and also using tracer techniques
- To develop a conceptual groundwater model based on detailed hydrogeology, soil and land use pattern

Methodology

- Groundwater level monitoring in selected watersheds in parts of North Kanara district
- Soil moisture monitoring using moisture probes and estimation of ET using the soil moisture data
- In-situ determination of soil hydraulic properties and determination of aquifer parameters across an array of land use/land covers
- Surface and groundwater balance estimates of selected watershed
- Numerical modeling using Visual Modflow/GWM systems

Research outcome from the project

- an understanding of the relative impacts of the forest/land-cover changes in the selected watersheds across an array of climate and soils.

- Development of a conceptual model which will help in greater understanding of the runoff processes and ground water response to changes in physical parameter.

Work Schedule:

a. Date of commencement of the project October 2014
b. Duration of the project 2 years
c. Stages of work and milestone:

Sl No.	1st Year (April'15 to June'15)	July 15 to Sept'15	Oct'15 to Dec.'15	Jan 16 to March'16
1	Monitoring and In-situ determination of soil hydraulic parameters Literature Survey	Collection of Secondary data from State and central Government Organizations	Setting up of the model in GIS environment & Calibration of the model	Application of VISUAL MODFLOW/GWM & Report preparation

8.0 Impact of Urbanization on Surface and Ground water Quality and Quantity – A Case Study

Project team:

a. Project Investigator B. K. Purandara
b. Project Co-investigator Sudhir Kumar& N. Varadarajan

Present State of Art

Population growth and urban development dramatically alter the natural watershed ecosystem structure and functions and stress water resources. Anthropogenic activities are of a major force in changing the hydrological cycle as well as the climate. Assessing the impacts of human activities on hydrological environments is becoming a wide-focused topic. In the present study an attempt will be made to link the urbanization, agricultural development, and the subsequent water resources exploitation with the change of water environments in Belgaum and adjoining areas and evaluate the impacts of human activities on the regional hydrological cycle and water quality. According to the historical records, the depth of the water table was shallow. After the 1970s, the increase of groundwater pumping began to result in the fall of the groundwater level at a rate of 0.1 to 0.5 m $year^{-1}$. Further, there is a close relationship exists between urbanization and water pollution. Urban areas with ever growing population stress and lack of facilities to dispose the domestic and industrial wastes in proper scientific manner resulted in both surface and ground water pollution. Fortunately, in most urban area pollutants are of a point source nature and are controlled by discharge regulations.

However, in urbanized areas, the land is altered to meet the needs of the people who live there. This alteration of the land accelerates nonpoint source pollution because it changes the way water moves, increases surface runoff, and causes erosion. Moving with the water, eroded soil from agriculture areas are the other pollutants, which cause numerous water quality problems in a city and its adjoining parts.

Therefore, in the present study, it is proposed to investigate the impacts of urban growth on groundwater quality and quantity in a two tier city like Belgaum which is known as the second capital of Karnataka. Belgaum has a large number of floating population due to army and Air force establishments. Therefore, city is under pressure to provide basic amenities to the citizen such as adequate drinking water and sanitation facilities. The water supply and sanitation systems in the city and is typically characterized by following issues:

- Raw water is transported from distant source
- Energy use in raw water transport is rising.
- Surface water source such as a river is exploited to such an extent that it cannot meet ecological flow demand at downstream reach.
- Wastewater is discharged untreated due to lack or inadequate treatment capacity thereby polluting groundwater and eutrophication of surface water body.
- Management of solid waste has become an environmental challenge.
- Groundwater pollution from on-site sanitation

Objectives

Considering the above issues, the district administration has raised some of the issues related to solid waste management, sanitation and water quality issues related to both surface and ground water. Therefore, the present study has been proposed for Belgaum city with the following objectives.

1. Ground water availability studies of Belgaum City and adjoining areas (proposed for the inclusion under BCC)
2. Surface and Ground water quality investigations in Belgaum city and adjoining areas

3. Issues of Solid waste management and its impact on water quality
4. Water quality impact on health aspects of the residents in parts of Belgaum city.

Methodology

- Groundwater level monitoring and collection surface and ground water samples for analysis
- Laboratory analysis of Water samples for chemical and biological parameters
- Data Analysis
- Preparation of report

Research outcome from the project

- an understanding of the relative impacts of the forest/land-cover changes in the selected watersheds across an array of climate and soils.
- Development of a conceptual model which will help in greater understanding of the runoff processes and ground water response to changes in physical parameter.

Work Schedule:

a. Date of commencement of the project October 2014
b. Duration of the project 1 year
c. Stages of work and milestone:

Sl No.	1st Year (April'15 to June'15)	July 15 to Sept'15	Oct'15 to Dec.'15	Jan 16 to March'16
1	Estimation of Surface and Ground water balance with respect change in land covers of Belgaum city (Pre-monsoon, 2015)	Analysis of water quality parameters with special emphasis on health aspects (microorganisms	Estimation of Surface and Ground water balance with respect change in land covers of Belgaum city	Estimation of Surface and Ground water balance with respect change in land covers of Belgaum city

WESTERN HIMALAYAN REGIONAL CENTRE JAMMU

Scientific Manpower

S N	Name	Designation
1	Dr. S S Rawat	Scientist D
2	Dr P G Jose	Scientist D
3	Dr. Pradeep Kumar	Scientist C

NATIONAL INSTITUTE OF HYDROLOGY

राष्ट्रीय जल विज्ञान संस्थान

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WORK PROGRAMME FOR 2014-15

S. N.	Study	Team	Duration	Funding/ Remarks
1	Impact of land use changes on flow regime and sustenance of environmental flows of Tawi river at Jammu	Pradeep Kumar M. K. Nema	Nov 2011 to Oct 2014 (03 Years)	NIH
2.	Climate Change Effects on Hydrology of the Tawi Basin in Western Himalaya	M. K. Nema Pradeep Kumar	Nov 2011 to Oct 2014 (03 Years)	NIH
3.	PBS: Integrated Water Resources Management (IWRM) Study in Tawi River Basin, JK	Pradeep Kumar M. K. Nema	Apr 2012 to Mar 2017 (05 Years)	NIH
4.	Automation of Hydro-Meteorological Network in Jhelum Basin for Flood Forecasting	Pradeep Kumar R. J. Thayyen M. K. Goel Sharad K. Jain	Sep 2013 to Mar 2016 (02 Years 07 Months)	NIH

PROPOSED WORK PROGRAMME FOR 2015-16

S. No.	Title of the Study	Study Team	Duration	Funding
	Ongoing Projects			
1	Impact of land use changes on environmental flows of Tawi river at Jammu	P. Kumar M. K. Nema	03 years	NIH
2	Climate change effects on hydrology of the Tawi basin in Western Himalaya	M. K. Nema P. Kumar R. J. Thayyen	03 years	NIH
3	PBS: Integrated Water Resources Management (IWRM) Study in Tawi River Basin, JK	P. Kumar S. S. Rawat	05 years	NIH
4	Automation of Hydro-Meteorological Network in Jhelum Basin for Flood Forecasting	P. Kumar R. J. Thayyen M. K. Goel Sharad K. Jain	02 years 07 months	NIH
	New Projects			
5	Estimation of sediment yield and identification of areas vulnerable to soil erosion and deposition in a western Himalayan catchment	S. S. Rawat P. Kumar	02 years	NIH
6	Hydrological Investigation of Natural Water Springs of Baan Ganga watershed in Jammu & Kashmir State	S. S. Rawat P. Kumar	03 years	NIH
7	Cryospheric processes in an alpine regime; a case study of Thajwas catchment, Sind sub-basin, Kashmir Valley, India	P. G. Jose R.J. Tahyyen S.P. Rai	03 years	NIH
8	Hydrological Assessment of the floods in the Jhelum river during Sep 2015	P. Kumar S. S. Rawat	02 years	NIH

Ongoing-project

1. Thrust Area under XII five year Plan:

Integrated Water Resources Management – Pilot Basin Studies (IWRM-PBS)

2. Project team:

a) Project Investigator : Dr. Pradeep Kumar, Sc. 'B'

b) Project Co-Investigator(s) : Dr. Soban Singh Rawat, Sc. 'D'

3. Title of the Project :

PBS: Integrated Water Resources Management (IWRM) Study in Tawi River Basin, JK

4. Objectives :

a) Assessment of water resources availability and demand under the present condition

b) Assessment of water resources availability and demand under the future scenarios of land use changes / climate changes

c) Preparation of water resources management plan for the Tawi basin

d) To carry out capacity building and mass awareness

e) To formulate the institutional coordination mechanism

5. Present state-of-art

Under the 12^{th} Five Year Plan, NIH has proposed to initiate few Pilot Basin Studies (PBS) across India. As part of the IWRM studies taken up from different regional centres of NIH on different sub-basins, WHRC has identified the Tawi basin for its first PBS study. The selection of basin was based on a number of factors viz. Accessibility, High societal impact, Easy to ensure continuity of long-term study etc.

The river Tawi is endowed with vast water resources with irrigation, domestic water and hydropower potential which are yet to be assessed in details. Since last four decades, few minor schemes for irrigation, hydropower and domestic water supply have come up. Tawi river is the major source of water supply to the Jammu and Udhampur cities. Recently, one project for recreational activity is also coming up on Tawi river at Jammu. The increasing demand of the development of Tawi river for beneficial uses of the population of Jammu, Udhampur and Doda districts calls for the systematic hydrological studies for the river.

Pollution Influx at Udhampur and Jammu City is causing alarming shift or total elimination of sensitive biotic community from the river. As the human population continues to grow, it will contribute significantly towards the process of river biodegradation. The presence of some pollution indicator species directly points to the shifting status of the Tawi river from non-polluted to polluted.

All these issues point towards an integrated hydrological approach, but, the lack of an Integrated Water Resources Management Plan is hampering the development and management of water resources of Tawi river. In this connection, the present study has been envisaged to carry out in-depth analysis required for preparation of Water Resources Management Plan of Tawi basin.

Study area

Tawi river is a major left bank tributary of river Chenab. The river originates from the Kailash Kund and adjoining area south-west of Bhadarwah in Doda District. Tawi river catchment is delineated by latitude 32^0 35' - 33^0 5' N and longitude 74^0 35' - 75^0 45' E. The catchment area of the river up to Indian border is 2168 km², and falls within the districts of Jammu, Udhampur and a small part of Doda. The river covers about 141km length before entering Pakistan. The river in general flows through steep hills on either side excepting the lower reach for about 35 km. Width of the river at Jammu is about 300 m at the bridge site. The upper part of the basin is covered by hard granite intrusive rocks and the lower part by loose and soft Shiwalik rocks. The average height of the basin is 2200m varying from 300m to 4000m above mean sea level. The slope of the basin is from East to West in upper part, while North-East to South-East in the lower part. In the Tawi basin, July and August are generally the wettest months with about 55% rainfall and November is the least rainy month with about 2-3% of total rainfall. Tawi experiences heavy floods in July and August. Monsoon starts from 1st July with heavy thunder showers and continues upto mid September. Normal annual rainfall varies from 111 cm to 150 cm within the basin. Its upper part is snow fed while the lower part is predominantly rainfed.

6. Methodology

Assessment of water availability and demand

Secondary data collected through different agencies regarding the hydro-meteorology, land-use, soil, population etc. will be used to assess the present state of water availability and demand scenario. The area under different crops will be assessed by using the secondary data available with state government and also by using the imageries.

Water resources allocations

Considering the present state of water availability and demand scenario as the baseline, different future scenarios will be generated and corresponding water resource allocations will be worked out using Water Evaluation and Planning (WEAP) Model.

7. Research outcome from the project

Water resources management plans for different water availability and demand scenarios and formulating the inter-institutional mechanism for coordination

8. Work Schedule:

a) Date of commencement of the project: 1st Apr 2012
b) Duration of the project: 5 years
c) Stages of work and milestone:

Work Element	1st year (2012-13)				2nd year (2013-14)				3rd year (2014-15)				4th year (2015-16)				5th year (2016-17)			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Identification of the basin for IWRM-PBS through consultation with state govt.	■	■																		
Preparation of Status Report on the present knowledge base of the selected basin	■	■	■	■																
Organizing Stakeholders' Brainstorming Session				■	■															
Appointment of Nodal Officer (from I&FC Deptt., J&K Govt.)						■	■													

Recruitment of Resource Persons (Junior)																				
Collection of Literature and secondary data																				
Field work for collecting ground information																				
Data processing and analysis																				
Synthesis and report writing																				

New project

1. Thrust Area under XII five year Plan : Surface Water Hydrology

2. Project team

a) Project Investigator : Dr. Soban Singh Rawat, Sc. 'D'
b) Project Co-Investigator(s) : Dr. Pradeep Kumar, Sc. 'B'

3. Title of the Project

"Estimation of sediment yield and identification of areas vulnerable to soil erosion and deposition in a western Himalayan catchment"

4. Objectives

a. To prepare comprehensive digital geo-database of study area.
b. To develop a grid based spatially distributed sediment yield model for better understanding of the sediment flow through complex slop of the hills
c. To categorize the catchment on the basis of soil erosion and deposition prone areas for prioritizing the watershed treatment measures.

5. Present state-of-art

Eighty percent of the sediment material delivered to the world's oceans each year comes from Asian rivers, and amongst these, Himalayan rivers are the major contributors (Stoddart 1969). The Himalayan and Tibetan regions cover only about 5% of the earth's land surface but supply about 25% of the dissolved load to the world ocean (Raymo and Ruddiman 1992). The Himalayas is the youngest mountain range on the earth, and it is the origin of world's three major river systems viz. the Indus, the Ganges, and the Bhrahmaputra. In spite of the hydrological importance of the region, a few studies have been reported on rainfall induced soil erosion/sediment yield modelling. Depending on the model algorithms which describe erosion, transportation processes, and the data requirement, several models ranging from simple empirical to complex physically based have been developed. Simple popular empirical models such as USLE and its derivatives perform very well at the plot scale. However, there use at catchment scale is problematic. Therefore various physically based models such as Water Erosion Prediction Project (WEPP) (Nearing at al., 1989), Areal Non-point Source Watershed Environment Response Simulation (ANSWERS) (Beasley and Huggins, 1980), Agricultural Nonpoint Source Pollution Model (AGNPS) (Young et al., 1989), and Soil and Water Assessment Tool (SWAT) (Arnold et al., 1993), and many others have been developed and theses have proved very useful as research tools. However, these are of limited use in field, especially in developing countries, because they require skill and large amount of data. Therefore, an emphasis should be given to develop models that are less complex than the physically based models but yield precise results compared to those due to USLE or its derivatives (Aksoy et al., 2005).

In developing country like India, where rural population is often more than 65%, assessment of erosion focuses mainly towards on-site effects of erosion. On site erosion strongly affects crop yield, undermines the long term sustainability of farming system, and repeat a major threat to the livelihood of the farmers and rural communities. In the present era of industrialization, more attention is being paid to the society at large, viz., in flood prevention, water reservoir preservation, and water pollution control (Garen et al., 1999). Whether the main concern of soil and water conservation planning is towards prevention of on-site or off-site effects of erosion, there is a growing need for tools that enable to define the spatial distribution of erosion within a catchment, i.e. to identify sources of sediment erosion. Indeed, the location of sediment sources and sinks is more important than the quantification of soil losses, as it is more cost effective than over-dimensioned erosion control measures. Therefore, modelling should be focused on spatial distribution of sediment within the watershed as well sediment yield at the outlet of the watershed.

River Tawi, a major River in Jammu region is the left bank tributary of river Chenab originating from the lapse of Kali Kundi glacier in Bhaderwah, flows through some parts of Doda district in Udhampur and then reaches Jammu from where it finally merges into Chenab in Pakistan.The length of Tawi river from its originating point to Jammu is about 150 km. The important role of Tawi River for sustaining the most populous cities in the region, Jammu and Udhampur has been considered while selecting the basin. The Tawi River has a very high social impact as it is the only major source of water for drinking, agricultural and industrial needs and serving to the almost 20% population of the whole J&K State. However, this heavy population load causes the ecological degradation (Change in the land use pattern, deforestation and low growth rate of vegetation, construction of new roads and bridges) which has accelerated the severe erosion in the catchment. Very high sediment yield has been experienced by the field engineers during monsoon season in Tawi river. This huge debris ultimately gets deposited in the surface of the river channel when Tawi enters in the plain area. Consequently, the channel capacity reduces significantly and river gets overflow. The flood of last September might be the result of this heavy sediment load deposition. Therefore, a study is being proposed hereby for accurate estimation of sediment yield in channel of Tawi river and also identify the sources of soil erosion and deposition in its catchment so that treatment measures can be prioritized accordingly.

6. Methodology

The methodology can be described in steps as follows:

- Discretize the Tawi catchment into sub-watersheds. The level of discretization will depend on the availability of desired information.
- Collect the spatially distributed land use features of the sub-watershed using remote sensing data and other data required.
- Development of a modelling framework suitable to mountainous catchments.
- Based on sediment yield computations, identify pockets/areas vulnerable to erosion for suggesting ameliorative measures.

7. Research outcome from the project

At present a little understanding is available on rainfall generated soil erosion and sediment yield mechanism especially for the western Himalayan catchments which are huge contributor to sediment yield in the world's ocean every year. The outcome from the present study will provide greater insight to the complex phenomenon of runoff and sediment yield generation from Himalayan catchments. The geo-database which will be developed in the project can be of immense significance in deciding the priority levels for implementation of the suitable measures (biological or engineering) for watershed treatment, and thus generated GIS maps may be useful for the various government departments, and NGO's.

8. Work Schedule:

a) Probable date of commencement of the project: 1st Apr 2015

b) Duration of the project: Two Years

c) Stages of work and milestone:

S. No.	Work Element	1st Year				2nd Second			
		I	II	III	IV	I	II	III	IV
1.	Collecting the input data from different sources and comprehensive field visits								
2.	Preparation of the digital database for the study area								
3.	Verification of geo-database from ground control points								
4.	Development of distributed sediment yield model for mountainous catchment and apply for Tawi catchment								
5.	Prioritization of Tawi catchment according to the areas prone to soil erosion/deposition								

New Project

1. Thrust Area under XII five year Plan

Ground Water Modeling and Management

2. Project team:

a) Project Investigator : Dr. Soban Singh Rawat, Sc. 'D'
b) Project Co-Investigator(s) : Dr. Pradeep Kumar, Sc. 'B'

3. Title of the Project

"Hydrological Investigation of Natural Water Springs of Baan Ganga watershed in Jammu & Kashmir State"

4. Objectives

a. To characterize the springs on basis of geomorphological and hydrological features prevailing in the study area.
b. To understand the discharge pattern of springs in relation to recharge zone characteristics and rainfall variation.
c. To study the storage characteristics and time of depletion of the springs irrespective of rainfall pattern.
d. To suggest a strategy for management and augmentation of spring discharge for making theses springs as sustainable drinking water source for the livelihood of the local people.

5. Present state-of-art

Surface water, flowing in the form of rivers, and subsurface water, occurring in the form of springs are two main sources of water supply in hilly areas of western Himalayan region. In the high altitude areas, the river flow in deep valley at the toe of slopes and rarely serve any purpose as far as domestic water supply and irrigation are concerned. Thus, in all hilly state of India and even mountainous part of countries such as Turkey, Spain, Greece etc., natural springs are the available major source of water. About 90 per cent of the rural population of this region depends upon natural springs for their water demands. That's why the villages in hills are clustered around the springs. There is hardly any settlement where there is no spring. These springs are locally called "*Chasma*" in Jammu and Kashmir and *"Naula"* and *"Dhara"* in Uttarakhand state of India.

It has been estimated that only less than 15 percent of the rainwater is able to percolate down through deforested slopes to recharge the catchment area of springs. The remaining flows down as runoff and cause floods in plains. In most of the springs in Himalayan area, the spring flow has decreased by 50 per cent within last 30 years and the piped drinking water in hill area are failing due to drying up of springs and has adversely affected the water supply in the irrigation channels. Under these circumstances, people will move wherever water moves. Studies indicates that deforestation, grazing and trampling by livestock, erosion of top fertile soil, forest fires and developmental activities (e.g. road cutting, mining, building construction etc.) in the recharge zone of the spring are the causes of the spring flow reduction. Almost negligible numbers of springs are being monitored presently for their flow and other hydrological parameters and hence no systematic study has been reported till today for developing these springs as dependable and sustainable sources of water for rural population of Himalayan region.

Baan Ganga, a small tributary of Chenab river, the legendary river associated with the miracles and legends of Mata. It is considered sacred and as is normal Hindu tradition, devotees like to bathe in it before preceding the journey of the holy shrine *Mata Vaishno devi.* This river is originated from the Trikuta hills and passes from the side of Katra town (main base camp for *Mata Vaishno Devi* journey). Baan Ganga travels 8 km up to Katra town and comprises 13 sq. km catchment area. Since, there is no glacier presented in the Baan Ganga catchment, hence springs are the only available sources to fulfil the water demand of the livelihood of the surrounding people and also to maintain the flow of the river Baan Ganga. However, due to ecological degradation in Trikuta mountain range, the discharge of theses springs has significantly reduced and some of the springs have dried-up. Consequently, people of the area are facing acute shortage of water for their livelihood and there is hardly any water flowing in Baan Ganga. The maps showing Baan Ganga watershed is presented in Figure 1.

Keeping in view the above points, there is urgent need to conduct a systematic study on the natural water springs of Baan Ganga catchment. The output of the study will be helpful for planning augmentation measures for theses springs and ultimately to rejuvenate the mythologically important Baan Ganga river.

Figure – 1: Map showing the Baan Ganga watershed and its drainage network

6. Methodology

The methodology can be described in steps as follows:

- Delineation of Baan Ganga watershed area from the corresponding toposheets and conduct compressive survey to identify all the springs emerges from this catchment
- Preparation of an inventory on the springs emerging from the Baan Ganga watershed which comprises the location and type of spring, characteristics of catchment such as slope, aspect, facing, geology, soil type, landuse, etc.
- Monitoring of hydro-meteorological data (spring Q, rainfall, temperature, RH, etc.)
- Delineation of the recharge zone of the springs
- Estimation of spring characteristics i.e., depletion time and find out the portion of rainfall contributed in spring's storage
- Estimation of household water consumption of the dependable village and accordingly the storage requirement for ensuring round the year uninterrupted water supply

7. Research outcome from the project

It is of common knowledge that the Himalayan catchments contribute significantly to the water resources of Northern India. Springs emerging from these regions are the life line of 90% of the rural population of the areas. Beside this, the water delivered from theses springs are the only sources to maintain the base flow of the rivers originated from the Himalaya, especially during the lean period. Hence, theses springs are the life line of the regional people as well as the people of downstream side. It is evident from the review of literature that only a few or negligible understanding is available on the flow behaviour of these natural water springs emerging from the Himalayan catchments. The present study is an attempt to provide greater insight for planning to make small flow of these springs as dependable source of water in the region, and thus, it is likely to be a significant contribution to water sector. The research outcome may be used by the different departments like Public Health Engineering, Soil and Water

Conservation, Forest Deptt. etc. and non-governmental organizations (NGOs) for effective execution of their developmental schemes.

8. Work Schedule:

a) Probable date of commencement of the project: 1st Apr 2015

b) Duration of the project: Three Years

c) Stages of work and milestone:

Work Element	1st Year				2nd year				3rd year			
	1	2	3	4	1	2	3	4	1	2	3	4
Identification of springs in catchment area												
Monitoring of Hydro-meteorological data												
Extract catchment characteristics												
Demarcation of Recharge zone												
Estimation of spring characteristics												
Development of water demand - supply relationship for selected springs												
Synthesis and report writing												

New Project

1. Thrust Area under XII five year Plan: Snow and Glaciers

2. Project team:

a) Project Investigator : Dr. Pottakkal George Jose, Sc. 'D'
b) Project Co-Investigator(s) : Dr. Renoj Thayyen, Sc. 'D'
: Dr. S.P. Rai, Sc. 'E'

3. Title of the Project :

Cryospheric processes in an alpine regime; a case study of Thajwas catchment, Sind sub-basin, Kashmir Valley, India

4. Objectives :

a) Mass balance monitoring and modeling of Thajwas Glacier.
b) Runoff modeling at the outlet of Thajwas catchment.
c) Delineate the climate-cryosphere-water resource linkages in this alpine catchment.
d) Quantify glacier melt, snow melt and base flow contribution to the discharge of Thajwas catchment by stable isotopes.

5. Present state-of-art

Glaciers and transient snow covers predominantly large proportion of the Himalayan landscape. The impact of these cryospheric components on the water resources of mountainous regions has been recognized globally, but not well understood in the Himalayan region in general and specifically in the Kashmir valley for various reasons. Glaciers in the Himalayas are receding at rates comparable to other glaciated regions in the world, and these include glaciers of Kashmir. A study on Kolhai Glacier conducted by remote sensing by the National Geophysical Research Institute, Hyderabad, revealed that its area has decreased from 19.34 Km^2 in 1992 to 17.23 Km^2 in 2001, a net decrease of 2.11 Km^2 in 10 years. A long term study on ChhotaShigri Glacier catchment, Chandra subbasin, in Himachal Himalaya (Wagnon et al, 2007; Azam et al, 2012; Vincent et al., 2013; Azam et al, 2014), has shed some light on the decadal behaviour of this glacier vis-à-vis the the changing climatic regime. In Dokriani Glacier catchment, Garhwal Himalaya, several studies suggested significant changes in the relative importance of glacier and snow melt as well as monsoonal precipitation in various altitudinal zones within the catchment itself (eg: Thayyen et al, 1999, Thayyen and Gergan, 2010). Seasonal snow covers 28% of Indus basin and accounts for 19% of Mean Annual Flow (Savoskul and Smakstin, 2013). Reportedly, Lidder and Sind basins snow cover has progressively declined over the years and glaciers have steadily vacated area over the last several years (eg; Thayyen et al, 2010). A recent study suggests that the interplay of summer air temperatures and the character of monsoonal precipitation on Chhota Shigri Glacier surface significantly alters the proglacial stream discharge (Pottakkal et al, 2015; *under communication*). Preliminary studies on the impact of deglaciation has been carried out for first time in the lower ablation zone of Gangotri glacier using tracer experiments suggesting significant role played by melt water streams entering the glacier body in accelerating the process (Pottakkal et al, 2014).

Study area

Thajwas glaciers are one of the most important tourist attractions in Sonamarg. These glaciers feed to Sind River, which is the one of the tributaries of the Jhelum river. There are three glaciers in the Thajwas catchment. First one could be seen from the main road and it is just above the camping site near the Mandakini point. The Thajwas-2 glacier lay ahead in the valley. Pavements and bridges were constructed by the tourism department to encourage the tourist to explore way inside of the valley. Thajwas-3 glacier lay further inside of the valley and is the main source of the Thajwas nalla.

Thajwas glaciers in the Sind sub-basin feed Thajwas nalla. Thajwas -1 glacier is the farthest in the catchment and can be approached from Sonamarg, a well known tourist destination in the Kashmir valley. Thajwas-1 glacier was spread over 2.34 km^2 area in 1978, which reduced to 1.97km^2 by 2005. Most of the shrinkage occurred around the frontal region constituting 76.9% of the total shrinkage. Snout of the glacier has shifted from 3620 m a.s.l. to 3800 m a.s.l. This glacier has receded 334 m in 27 years at an average rate of 12.4m/yr. Volume shrinkage of Thajwas -1 glacier during the past 27 years was calculated to be 29.8% from 86 x 106 m^3 in 1978 to 60.4 x 106 m^3 in 2005. The average specific balance calculated from the volume shrinkage of this glacier during the past 27 years was -0.44m w.e./yr, which is equivalent to 1.1% of annual degradation.

Tourism is one of the most important industries in Jammu and Kashmir and is crucial for the socio-economic integration of this sensitive border state of India. Thajwas Glacier catchment, although at the heart of Sonamarg, one of the most important tourist destinations in Kashmir Region, has not been studied for its glacier mass balance or snow cover changes and hence been chosen for this study.

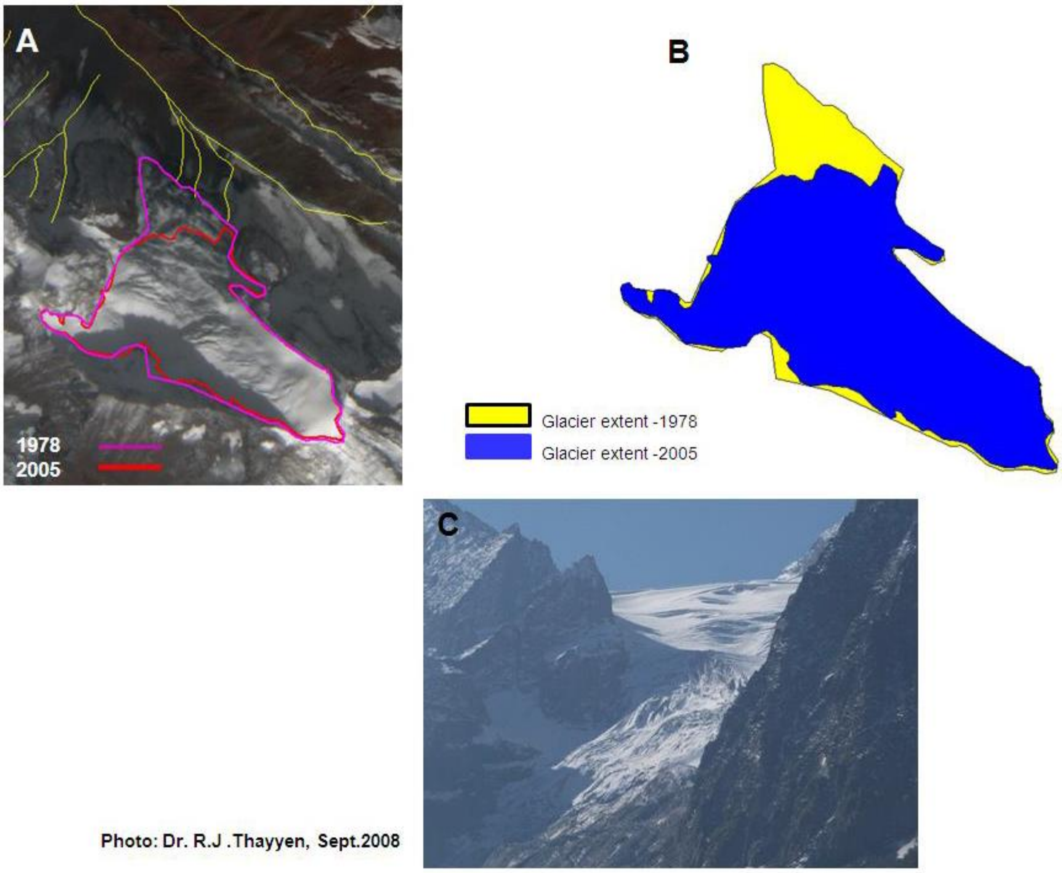

Figure - 1: Thajwas Glacier & area change between 1978 and 2005 (Thayyen et al, 2010)

The Thajwas-2 glacier lies on the west side of the Thajwas-1 glacier. Thajwas-2 glacier was spread over 1.08 km^2 area in 1978, which reduced to 0.71 km^2 by 2005. Shrinkage around the frontal region was around 50%. Snout of the glacier has been shifted from 3760 m a.s.l. to 3920 m a.s.l. This glacier has receded 240 m in 27 years at an average rate of 8.89 m/yr. Volume shrinkage of Thajwas-1 glacier during the past 27 years have been calculated to 43% from 27 x 106 m^3 in 1978 to 15 x 106 m^3 in 2005. Average specific balance calculated from the volume shrinkage of this glacier during the past 27 years was -0.48m w.e./yr, which is equivalent to 1.62% of annual degradation (Thayyen et al. 2010) as shown in Figure - 1.

6. Methodology

a) Mass balance monitoring and modeling of Thajwas Glacier by glaciological method for monitoring; degree–day and energy balance modeling.
b) Runoff modeling at the outlet of Thajwas catchment using discharge measurement at two sites and runoff modeling by Win SRM and SNOWMOD
c) Delineate the climate-cryosphere-water resource linkages in this alpine catchment.

Thajwas catchment has about 3.5 km^2 glacierised area with a very significant seasonal snow cover component. The cryospheric processes will be studied using an integrated approach, involving monitoring of seasonal snow cover, glacier mass balance, ice surface velocities and the proglacier and catchment discharges. The climate signals arriving on the glacier surface will be monitored using the AWS and the temperature gradient in the catchment will be computed using T-RH sensors to be installed at different altitude ranges within the catchment. The data collected from ablation stakes, snow stakes and pits will be used to measure the cryospheric response. Stream discharges measured at various points will be assessed along with tracer experiments to understand the en-glacial and sub-glacial processes that modify the climate signals within the glacier body and bring about changes in the stream discharges downstream.

d) Quantify glacier melt, snow melt and base flow contribution to the discharge of Thajwas catchment by stable isotopes
Sample Collection: Fresh snow, rain, snow-pit samples, meltwater stream and spring water samples will be collected at periodic intervals for various seasons.
Sample Analyses: Stable Isotopes will be analysed using IRMS at NIH Roorkee. Routine hydro-chemical parameters like pH, EC, will be measured in situ using a multi-parameter probe.

7. Research outcome from the project

Three years' annual and seasonal mass balances and model of Thajwas Glacier. Runoff at the outlet of Thajwas catchment will be developed. An understanding of the climate-cryosphere-water resource linkages in this alpine catchment as well as quantification of glacier melt, snow melt and base flow contribution to the discharge of Thajwas catchment by stable isotope, which can be used for water resources and ecohydrological planning for this region.

8. Work Schedule:

a) Probable date of commencement of the project: 1st Apr 2015
b) Duration of the project: 3 years
c) Stages of work and milestone:

Work Element	1st year				2nd year				3rd year			
	1	2	3	4	1	2	3	4	1	2	3	4
Recruitment/ Purchase & D.O. of equipments/constructing discharge site, installing stakes, collection of water samples	■	■										
Field/measuring stakes, install, test & standardise of AWS data, collect discharge data, dye tracer experiments, collect water samples, collecting AWS data, installing new stakes, processing data, etc.		■	■		■	■	■		■	■	■	
Collection of Literature, meteorological data/lab analysis, data processing, statistical analysis & interpretation of data,	■		■	■			■	■			■	■

Work Element	1st year				2nd year				3rd year			
	1	2	3	4	1	2	3	4	1	2	3	4
preparation of annual progress report, Submission of annual progress report	■		■	■			■	■			■	■
Field work for winter mass balance	■				■				■			
Presentation & Publication of work				■				■			■	■

New Project

1. **Thrust Area under XII five year Plan:** Hydrology of extremes

2. **Project team:**
   a) Project Investigator : Dr. Pradeep Kumar, Sc. 'B'
   b) Project Co-Investigator(s) : Dr. S. S. Rawat, Sc. 'D'

3. **Title of the Project :**
   Hydrological Assessment of the floods in the Jhelum River during Sep 2014

4. **Objectives :**

   a) Assessment of the peak discharges of the Jhelum river and derivation of hydrographs during the Sep 2014 floods
   b) To understand the role of lakes, flood diversion channel and other infrastructure development in the intensity and sustenance of floods

5. **Present state-of-art**

In September 2014, the Jammu & Kashmir state was hit by the heaviest recorded floods caused by torrential rainfall. The regions of Jammu and Kashmir in India, as well as Pak Occupied Kashmir, Gilgit-Baltistan and Punjab in Pakistan, were affected by these floods. The Jammu and Kashmir state and adjoining areas started receiving precipitation from 2 September 2014 onwards, during last stage of monsoon in India. From 2nd September onwards, the gauge and discharges of all the rivers of the J&K state (Jhelum, Chenab, Tawi and their tributaries) started rising. On 5 Sep nights, very heavy precipitation all over J&K state occurred. As the soil reservoir of all the basins were already saturated due to continuous precipitation since 2nd Sep, this very heavy precipitation caused flash floods in upper reaches in almost all the small tributaries of Jhelum, Chenab and Tawi rivers. According to the Home Ministry of India, several thousand villages across the state had been hit and 350 villages had been submerged. The impact was larger in Kashmir valley inundating almost whole of the Srinagar city, including the Civil Secretariat, Lal Chowk, High Court, Border Security Force (BSF) HQ in Santnagar and Army containment in Badamibagh.

As the storm starting from 2nd Sep continued, on Sep 3, the gauge at all the sites of Jhelum crossed the danger mark and on Sep 4, the gauge level at Sangam and Ram Munshi Bag sites of Jhelum river almost touched the highest flood level. From 4 Sep to 5th night, the gauge at Sangam gradually increased and crossed the HFL. As the Jhelum river breached the banks at few places, the gauge at Ram Munshi Bag didn't rise up till 5th evening. The gauge of Jhelum River at Sangam and Ram Munshi Bag started rising again very fast and crossed the HFL (32.6 and 22.6 ft respectively). As the water level kept on rising, the gauge at Sangam was fully submerged (highest level at gauge was at 35ft) and the flood water came in the National Highway. Jhelum river breached at many places on the left bank and caused submergence of almost whole Srinagar city on the left bank of Jhelum. As runoff from upper catchments keep on coming, the gauge kept on rising on 7th Sep also. On 7th Sep., the gauge at Ram Munshi Bag crossed 29ft (7ft above HFL). As a result, almost 80% of Srinagar city was submerged in flood water.

In the post-flood scenario, it remains a challenge to accurately estimate the peak gauges and discharges, flood hydrograph, causes and impact of these floods and preventive measures to be taken by the authorities to minimize the impact of such type of heavy floods in the Kashmir valley.

Study area

The Jhelum river originates in Verinag, shooting out from a spring. Verinag is located at lower Pir Panjal in Kashmir Valley approximately 80 km from Srinagar, by road, at an elevation of

1,876 m. The major tributaries of the Jhelum River in Kashmir valley are Rembiara Nala, Vishav Nala, Lidder Nala, Sindh Nala, etc. The drainage area of Jhelum in India is approx. 29500 km^2. The basin is dominated with the snow covers and glaciers contributing The basin falls in cold alpine hydrological regime. Average temperature ranges from -12 ^oC in January to 36 ^oC in July.

The River Jhelum starts from Kashmir, flows through a long stretch of Jammu before finally surrendering itself to the Indus River. Since the Jhelum River crosses both the regions of the state, it enjoys an immense importance among the various rivers & lakes of Jammu and Kashmir. Not only Jammu and Kashmir, the river flows through the state of Punjab and enters Pakistan also.

Over the years the Jhelum River has emerged as a major tourism attraction. The Jhelum River bifurcates the beautiful Srinagar city into two parts. The wonderful Dul lake of the city and Wullar lake are mostly fed by water from Jhelum. The River Jhelum in its path takes the form of a stream and act as lovely camping sites for campers and trekkers. The number of bridges over the river Jhelum in Srinagar city, which were built long ago, also serves as hot tourism sites.

6. Methodology

The study will be carried out in active collaboration with I & FC Deptt., Srinagar as they are not only maintaining the hourly gauges of the Jhelum river but also are the best witnesses of these floods. Geo-spatial database for the Jhelum river basin will be prepared so that a suitable hydrological model may be calibrated and validated for the basin. Using the hourly meteorological data and hourly gauge/discharge, the hydrographs at the selected locations of the Jhelum river will be prepared. Along with, the simulation of inundated areas corresponding to these flood hydrograph will also be carried out using the water elevation and digital elevation model (DEM) of the basin.

7. Research outcome from the project

Peak flood discharges and flood hydrographs for Jhelum river at Sangam, Ram Munshi Bag and Asham sites.

8. Work Schedule:

a) Date of commencement of the project: 1st Apr 2015
b) Duration of the project: 2 years
c) Stages of work and milestone:

Activity	1st year				2nd year			
Collecting the field information	■	■						
Procurement of secondary data		■	■					
Development of GIS database		■	■					
Data processing				■				
Model setup and analysis					■	■		
Synthesis and report writing							■	■

GANGA PLAINS SOUTH REGIONAL CENTRE BHOPAL

Scientific Manpower

S N	Name	Designation
1	Mr. Tej Ram Nayak	Scientist D
2	Mr. R V Galkate	Scientist D
3	Mr. T. Thomas	Scientist C
4	Mr. R K Jaiswal	Scientist C

WORK PROGRAMME FOR 2014-15

Sl. No.	Name of the project	Duration	Starting and ending date	Status
1.	Surface and Ground Water Modeling for Conjunctive Use (under Pilot Basin Studies in Bina River Basin in Bundelkhand Region in M.P.)	1¾ years	April 2014 to March 2015	Extended till Dec. 2015
2.	Applications of Decision Support System (DSS) in Shipra River Basin of MP	3 years	June 2013 to May 2016	Ongoing Project
3.	Integrating hydrology, climate change and IWRM with livelihood issues: Development of methodology and a DSS for water-scarce Bundelkhand region in India	2½ years	May 2013 to Oct. 2015	Ongoing Project
4.	Integrated Assessment of Drought Vulnerability for Water Resources Management in Bina Basin	2 years	July 2014 to June 2016	Ongoing Project
5.	Irrigation Planning and Management in the Command of Harsi Reservoir Project in Madhya Pradesh	2 ½ years	May 2013 to April 2015	Extended till Oct. 2015

PROPOSED WORK PROGRAMME FOR 2015-16

Sl. no	Name of the project	Duration	Starting and ending date	Status
1.	Surface and ground water modeling for conju-ncttive use (under Pilot Basin Studies in Bina River Basin in Bundelkhand Region in M.P.)	1¾ years	April 2014 to Dec. 2015	Ongoing Project
2.	Development of DSS for Bina River Basin in Bundelkand Region in M.P. using WEAP Model (under PBS)	2 years	April 2015 to March 2017	New Project
3.	Development of Decision Support System (DSS) Model for Shipra River Basin of MP	3 years	June 2013 to May 2016	Ongoing Project
4.	Integrating hydrology, climate change and IWRM with livelihood issues: Development of methodology and a DSS for water-scarce Bundelkhand region in India	2½ years	May 2013 to Oct. 2015	Ongoing R&D Project
5.	Integrated Drought Vulnerability Assessment for Water Resources Management of the Bina Basin	2 Years	July 2014 to June 2016	New Project
6.	Irrigation Planning and Management for the Command of Harsi Reservoir in Madhya Pradesh	2 ½ years	May 2013 to Oct. 2015	Ongoing Project
7.	Estimation of Revised Capacities of Reservoirs in Chhattisgarh state using Digital Image Processing technique	2 Years	April 2015 to March 2017	New Project

Study - I (Ongoing project)

1. Thrust area under XII five year plan:

Pilot Basin Studies: IWRM in Bina River Basin in Bundelkhand Region of Madhya Pradesh

2. Project Team:

a. **Project Investigator:** Dr. T.R. Nayak, Scientist E

b. **Project Co-Investigator(s):** Sh. T. Thomas, Scientist D
Sh. Ravi Galkate, Scientist D
Sh. R.K. Jaiswal, Scientist C

3. Title of the project:

Modelling for conjunctive use of surface and ground water in Bina river basin

4. Objectives:

- Interpolation of Pre and post monsoon groundwater level
- Estimation of groundwater recharge due to monsoon rainfall
- Water demand and supply (surface and ground water) assessment
- Groundwater modeling using MODFLOW for groundwater management
- Conjunctive use planning using MIKE Model (river management model)

5. Present State of Art:

Application of MODFLOW and MIKE Model for conjunctive use of surface and ground water resources

6. Methodology:

- Collection of meteorological and hydrological data
- Collection of pre monsoon and post monsoon ground water level data
- The depth of groundwater table below ground level for different periods have been converted into the RL above MSL
- Creation of point maps in GIS platform for groundwater level in different periods
- Preparation of raster maps for reduced levels (RL) of groundwater table using point interpolation by Ordinary Kriging method
- Development of contour maps of groundwater table at 1.0 m intervals from raster maps
- Analysis of rainfall and groundwater data assorted on seasonal basis for their long-term pattern to understand the dynamics of groundwater level and rainfall
- Development of MODFLOW groundwater model application for aquifer management
- Development of management plan for conjunctive use of surface and groundwater in MIKE

7. Research outcome from the project:

The study will also be used for identification of overexploited area, i.e. more draft than recharge of groundwater resource. Understanding the linkage between rainfall and natural groundwater recharge will be helpful in planning water harvesting structures in the critical areas and planning for conjunctive use of surface and groundwater resources.

8. Work Programme for the Second Year (2015-16):

Some more recent hydro-meteorological and groundwater level data will be collected from the CGWB, Bhopal and State Water Data Centre, WRD, Bhopal. The 3-D model for Bina river basin in MODFLOW will be developed to understand the groundwater flow and recharge/discharge from the shallow aquifer. The thematic maps showing location of observation wells, river/streams, surface water bodies created in ILWIS GIS platform and the same will be transferred in MODFLOW. Ground-water flow and storage changes, exchange of surface water with aquifers, discharge of water from aquifers and recharge from precipitation and irrigation will be estimated through modelling. Long-term effect of recent developmental activities in the river basin will be studied and MIKE application will be developed to prepare the management plan for conjunctive use of surface and ground water.

In order to develop the 3-D model of the Bina river basin, the litho-log data and aquifer parameters are required, for which CGWB, Bhopal and State Groundwater Department will be collaborated in the study.

Study – II (New project)

1. Thrust area under XII five year plan:

Pilot Basin Studies: IWRM in Bina River Basin in Bundelkhand Region of Madhya Pradesh

2. Project Team:

a. **Project Investigator:** Dr. T.R. Nayak, Scientist E

b. **Project Co-Investigator(s):** Sh. T. Thomas, Scientist D
Sh. R. Galkate, Scientist D
Sh. R.K. Jaiswal, Scientist C

3. Title of the project:

Development of Decision Support System (DSS) for Integrated Water Resources Management (IWRM) in Bina river basin in Bundelkand region of M.P.

4. Objectives:

Water Evaluation and Planning System (WEAP) is a PC based surface and groundwater resource simulation tool, based on water balance accounting principles, which can test alternative sets of conditions of both supply and demand. The user can project changes in water demand and supply over a long-term planning horizon to develop adaptive management strategies.

WEAP is designed as a comparative analysis tool. A base case is developed, and then alternative scenarios are created and compared to this base case. Developmental activities in water sector, changes in operating policies, and implications of changing supplies and demands can be economically evaluated.

Human activities related to land use influence the exchange of greenhouse gases between terrestrial ecosystems and the atmosphere and hence have an impact on climate change. The outcome also includes climate change projections for the study region, projection of scenarios for land-use and climate change, flow availability, sedimentation yield and groundwater recharge.

5. Present State of Art:

WEAP-MODFLOW DSS Applications for IWRM

6. Methodology:

- This project will develop a comprehensive list of external drivers based on the studies carried out by the researches, literature review and interaction with the major stakeholders. This list will then be put under a well designed priority and ranking criteria for identification of the key drivers contributing to the anticipated changes.
- On the basis of performance and field validation, appropriate models will be selected for studying the baseline conditions and effects of external drivers on water availability, demand, sediment yield, groundwater fluctuation.
- The WEAP model will be utilized to simulate the baseline and changed conditions in 2020, 2030 and 2050 in changing scenarios.
- On the basis of the anticipated impacts different adaptation strategies will be devised such as improvement of the land-use patterns, soil and water conservation methods, groundwater development and recharge augmentation.
- Policy implications on these strategies and a required governance structure will be also explored in a participatory way. The implications of water use policies in the realm of national water policies, agricultural policy, environment policy, disaster management policy, and climate change adaptation strategy and action plan (BCCSAP) will be particularly emphasized.

7. Research outcome from the project:

The study will be used for preparation of a comprehensive water resources management plan in line with Integrated Water Resources Management (IWRM) themes for sustainable development in the Bina river basin.

8. Work Programme for the First Year (2015-16)

Review of the existing model studies, literature, available data and collection of data w.r.t. hydrological modelling and research work carried out for water resources management in Bina river basin and Betwa river basin. Water Evaluation And Planning System (WEAP) model will be developed for assessing baseline hydrological conditions (may be 2010); setup, calibration and validation of Bina river basin model with the available field data. Extensive field visits and interaction meetings of the water related agencies and policymakers will be conducted to influence policymakers and stakeholders to adapt to anticipated changes in cropping pattern and water use.

9. Work Programme for the Second Year (2016-17)

Water Evaluation And Planning Process (WEAP) models will be used for assessing the impacts of land-use changes on river flow and groundwater recharge. MODLOW, MIKE and WEAP model will be utilized to simulate the baseline and projected conditions in 2020, 2030 and 2050. The implications of water use policies in the realm of national water policies, agricultural policy, environment policy, disaster management policy, and climate change adaptation strategy and action plan (BCCSAP) will be particularly emphasized. The output of this study is expected to be reflected in water use of local farmers and panchayats, water management by water related agencies and planning of the policymakers.

Study – III (Ongoing project)

1. Thrust area under XII five year plan:

DSS for Integrated Water Resources Management

2. Project Team:

a. Project Investigator: Sh. Ravi Galkate, Scientist D

b. Project Co-Investigator(s): Dr. T.R. Nayak, Scientist E
Sh. R.K. Jaiswal, Scientist C
Sh. T. Thomas, Scientist D

WRD, BODHI, Bhopal: Dr. Jitendra Jain, SE
Sh. Sanjeev Das, Ex. En.
Sh. Sanjay Gupta, Ex. En.

3. Title of the project:

Development of Decision Support System (DSS) Applications for Shipra River Basin of M.P.

4. Objectives:

- Development of river basin model for Shipra basin
- Rainfall runoff modeling
- Water availability assessment
- Supply demand analysis
- Surface and groundwater seasonal planning
- Dissemination of knowledge, findings and output

5. Present State of Art:

DSS developed for Wainganga basin of Madhya Pradesh under HP-II

6. Methodology:

- Assessment of water scarcity situation in Shipra basin
- Trend analysis of meteorological and hydrological data for assessment of climatic changes in the basin area
- Development of River Basin Model of Shipra using MIKE BASIN/ MIKE HYDRO software
- Rainfall runoff modeling using MIKE11 NAM Model
- Water availability study using flow duration curve technique under changing hydrological situation
- Development of applications for surface and groundwater seasonal planning using DSS(P) software
- Supply demand analysis for domestic water use for cities like Indore, Ujjain and Dewas
- Development of application for Khan river diversion
- Assessment of dwindling of lean period flow in Shipra (river has now become intermittent from its perennial nature) and possible plan for its rejuvenation
- Water resources planning under changing hydrological and climatic conditions

7. Research outcome from the project:

- Assessment of drought situation in Shipra basin for its mitigation planning.
- Assessment of climate change scenario which may affect the water resources planning in the basin.
- Development of rainfall runoff model and river basin model for Shipra basin so as to simulate various scenarios for water resources planning.
- Development of user friendly DSS interfaces, which could be the facilitating tool for decision makers to address water resources related issues, solve problem and make appropriate decisions.

- Various applications would be developed in DSS platform to address the issues like water availability, seasonal planning, demand supply, surplus deficit analysis, etc. under changing hydrological and climatic conditions.
- The output of this study would be helpful to the Madhya Pradesh state for optimal utilization of water resources and its future planning and management.

8. Work Programme for the Second Year 2015-16

The work for the second year (2015-16) will include discharge data collection from CWC(YB), Delhi and groundwater data from WRD, MP. The NAM Rainfall runoff model will be refined using daily observed discharge data. The developed NAM model will be used in river basin simulation. The MIKE BASIN model of Shipra basin will be refined using complete data and information on water transfer system of the basin. The further analysis will include trend analysis of meteorological and hydrological data, water availability assessment under changing hydrological situation. Development of applications for surface and groundwater seasonal planning using DSS(P) software. Supply demand analysis for domestic water use for cities like Indore, Ujjain and Dewas. Assessment of dwindling of lean flow in Shipra, reasons behind it and possible measures for its rejuvenation.

Study - IV (Ongoing project)

1. **Thrust Area under XII five year Plan**: Integrated Water Resources Management (Hydrology for sustainability of water resources/DSS (Planning) activities)

2. **Project team**:
   - a. **Project Investigator:** Dr. V. C. Goyal, Scientist 'F', NIH Roorkee.
   - b. **Project Co-Investigator:** Er. T. Thomas, Scientist 'D', NIH-RC Bhopal.
     Dr. Sandeep Goyal, Principal Scientist, MPCST
     Dr. K. Vijayalakshmi, VP, Development Alternatives
     Dr. R. V. Kale, Scientist 'B', NIH Roorkee.

3. **Title of the Project:**
   Integrating hydrology, climate change and IWRM with livelihood issues: Development of methodology and a DSS for water-scarce Bundelkhand region in India

4. **Objectives:**
   This project is an effort to conduct a rapid assessment of the current status of water and waste water management in the selected area of Bundelkhand region, and to develop a methodology for introducing an integrated approach of water management. The project essentially aims to evolve methodologies for effective water management by linking with the concept of livelihood. The main objectives of the study can be accomplished with following remaining sub-objectives:

   i. To test the ability of **W**ater **E**valuation **A**nd **Pl**anning (WEAP) model as a simulation tool to perform different types of scenario analysis studies.
   ii. Development decision support system (DSS) for linking the Integrated Water Resource Management (IWRM) and hydrology with livelihood.
   iii. Testing the developed DSS at selected project area.
   iv. Dissemination of the methodologies through involvement of the local community and line departments.

5. **Present State-of-Art:**
   There are various hydrologic modeling tools used as planning tools to simulate water resources management policies in river basins. Many of these are commercial software while few of them are available in public domain. Among the available models, WEAP is a robust tool for assessment, management and planning of water resources for the hydrologic simulation. WEAP uses a node-link mechanism whereby it simulates the natural hydrological processes (runoff and recharge) to enable assessment of the availability of water resources within a catchment based on the baseline period climatic data inputs. The futuristic scenarios along with assumptions towards water demand, infrastructure and regulations can be applied to assess their impacts on the supply-demand scenario. Therefore it is possible to simulate the impacts of anthropogenic activities superimposed on the natural system to influence water resources and their allocation (consumptive and non-consumptive water demands) to enable evaluation of the impact of human water use including the livelihood.

   The customized WEAP model will be tested to assess its ability to be used as a simulation tool to perform different types of scenario analysis.

6. **Methodology:**
   The WEAP model will be customized and hydrologic simulations performed at sub-catchment scale a daily time scale based on the calibrated model for which the instrumentation has been set up in the basin. Different scenarios will thereafter be generated to assess the gaps in the water demand and supply and water availability at

different locations for the baseline as well as future. The WEAP model will serve as a planning tool to assess the supply demand situation for alternative climate scenarios. Once the water availability and gaps in demand are ascertained, an IWRM plan will be prepared for the basin which shall include the location of the proposed structures along with the structural details. A web based DSS shall be designed based on the above inputs so that it can be assessed and used at the district/block level by the decision makers and concerned stakeholders. Simultaneously the technological demonstrations and interventions will be planned in one of the sub-watersheds and the DSS will be tested for the Ur watershed.

7. Research outcome from the project:

- Application of WEAP model as a planning and optimization tool in a drought prone region.
- Development of a Decision Support System, which shall be available for ready use by the decision makers and stakeholders.
- Technical reports, Interactive stakeholder workshops, Technology transfer and Research Papers

8. Results Achieved:

An Automatic Weather Station (AWS) has been installed at the Krishi Vigyan Kendra, Tikamgarh for monitoring the climatic data. Similarly discharge monitoring is being carried out at two locations on the Ur river and lake water levels are being monitored regularly in three major lakes located within the watershed since September 2014. The soil sampling has been carried out at ten locations based on the soil-crop combination during May 2014 along with the field experiments for infiltration capacity and saturated hydraulic conductivity. The report titled "Assessment of Supply Demand Scenario in Ur river basin using Detailed Water Balance Approach and Climate Change Scenarios" was completed and submitted for review. The discharge data for river Dhasan at Garauli has been collected from Central Water Commission, Yamuna basin, Agra. The water quality sampling has been carried out for the lake, river and observation wells located within the watershed. The high resolution data (Cartosat data) has been acquired from NRSC and 2.5 m × 2.5 m DEM has been prepared. The thematic layers corresponding to the population, soil texture, land use, livestock, infiltration, saturated hydraulic conductivity and other related data have been finalized during the period. Compilation and verification of the hydro-metrological data, baseline survey data, census data and other qualitative data has been completed. All these data layers form the input to the WEAP model which will used for the water resources planning and scenario based assessment of the supply demand situation in the watershed. The WEAP model has been setup (schematic view) by dividing the Ur watershed into 18 sub-watersheds. The given model inputs include climatic data for the baseline period, cropped areas in different seasons, cropping pattern, crop library, soil library, crop production (yield) and market price of crops. Similarly the domestic water demands have also been incorporated into the model. Various links such as rivers, demand sites, agricultural watersheds, ground water nodes and transmission links has been prepared. The initial model runs have been completed and the model is giving encouraging results. Various irrigation management scenarios have been prepared to analyze the different alternatives in irrigation water management. Some of the inputs which remain to be included in the model setup include stream flows and groundwater recharge components including the climate change scenarios into the future. The progress of the work is being monitored on a regular basis by the TIFAC.

9. Tasks to be taken up:

The non-availability of the stream flow data and storage details of the water bodies in the watershed has been one of the major shortcomings in the speedy execution of the simulation exercise. The bathymetric survey is planned to be carried out for some of the important lakes/tanks to estimate area-elevation-capacity details of these tanks/lakes. Thereafter the monthly storage data for the lakes/tanks during various months will be computed based on the water levels being monitored in some of the lakes. Since the basin is ungauged, the runoff has to be estimated by indirect means using the SCS-CN method or any other distributed hydrological model. Similarly the ground water recharge and storage capacity will be estimated for each of the sub-watersheds. The estimation of livestock and industrial demands data for each sub-watershed will be carried out. The climate change scenarios will be incorporated into the WEAP model for future supply-demand analysis and irrigation planning. Each of the alternative scenarios shall be linked to the livelihoods and alternate livelihood planning will also be carried out based on the supply demand situation into the future. All this information will form the basis for the development of a spatial decision support system, which will be useful tool to the decision makers and the concerned stakeholders.

Study – V (Ongoing Project)

1. Thrust Area under XII five year Plan:
Hydrology of Extremes (Drought Mitigation and Management)

2. Project team:

a. **Project Investigator :** Sh. T. Thomas, Scientist 'D'
b. **Project Co-Investigator :** Dr. T. R. Nayak, Scientist 'E'
Sh. R. K. Jaiswal, Scientist 'C'
Sh. Ravi Galkate, Scientist 'D'

3. Title of the Project:
Integrated Assessment of Drought Vulnerability for Water Resources Management in Bina Basin

4. Objectives:
The main object of the study is the development of a methodology for integrated assessment of drought vulnerability in Bina basin, which is also the basin selected for the Pilot Basin Studies (PBS) by RC Bhopal. The pilot basin has been selected in Bina basin, so as to represent the regular drought scenario in Bundelkhand region in Central India. The main objective of the study can be accomplished with following sub-objectives:

1. To assess the various types of droughts using the indicator based approaches.
2. Identification of areas vulnerable to drought on using spatially and temporally varying indicators

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5. Present State-of-Art:
The Bina basin located in the drought prone Bundelkhand region of Central India has been selected as the pilot basin and the major focus is towards providing effective solutions towards drought management solutions, which can subsequently be replicated to other basins in Bundelkhand. Looking into the looming climate change scenario and the predictions of higher climate variability and lesser number of rainy days, the future water availability scenario seems more uncertain with more water-related stresses as compared with the present times. It is rather imperative that all analysis pertaining to the evaluation of various types of drought and its characteristics be employed in the assessment of drought vulnerability, as it is crucial to know the most vulnerable areas for provision of adequate drought adaptation support.

Defining vulnerability to drought is complex and involves some measure of susceptibility and coping capacity. Vulnerability to drought varies spatially and is determined by natural factors, like the intensity and magnitude of drought hazard that leads to its susceptibility, and by social factors that lead to exposure, coping capacity and adaptive capacity. Subsequent droughts in the same region will have different effects, even if they are identical in intensity, duration, and spatial coverage, because societal characteristics evolve through time. Therefore there is a need to develop improved drought indicators and spatially variable warning thresholds, tailored to specific water users incorporating the various types of characteristics pertaining to meteorological, agricultural, hydrological and groundwater drought for assessment of drought vulnerability.

The study has been undertaken with an aim to develop a new methodology for assessment of areas vulnerable to drought for which the indicator based approaches will be employed. The various types of drought including the meteorological, hydrological and agricultural drought will be assessed on the basis of drought indicators. The spatially and temporally varying factors responsible for the drought vulnerability shall be used to identify vulnerable zones in the basin and suitable actions and recommendations shall be provided for tackling drought in these zones.

6. Methodology

The creation of an integrated database for drought characterization including the collection of available hydro-meteorological, hydrological, land use, soil type, demographic, and other related data from various agencies have been completed in the current year. The thematic maps on drainage network, geology, hydrogeology, road network, contour map, soil map and Digital Elevation Model (DEM) have been prepared. The land use classification will be carried out using the satellite data. The detailed investigations of the soils in the watershed for determination of soil-water properties viz., infiltration tests, and hydraulic conductivity need to be conducted at few test sites.

The evaluation of meteorological, hydrological and agricultural drought characteristics based on hydrological and climatic data will be carried out. A new methodology shall be developed for integrated assessment of drought vulnerability along with development of drought impact indicators and drought vulnerability index based on the available hydro-meteorological and hydrological database in the basin. The assessment of the areas vulnerable to drought will be helpful for focusing the concerted efforts towards drought mitigation in these areas.

7. Research outcome from the project

- The developed methodology can be effectively applied in identifying areas vulnerable to drought in other basins located in drought prone regions in Bundelkhand and Malwa regions of Madhya Pradesh and other states falling in the jurisdiction of the Centre including Rajasthan and Chhattisgarh.
- This information and data base will form a useful and vital input to the development of Decision Support System in Bina Basin using WEAP model, which shall be taken up as a separate project on completion of this study.
- Research outcome in the form of Technical Reports (Status Report-2015 & Final Report-2016) and few research papers in peer reviewed journals.

8. Results Achieved:

As a part of the work program during the first year, an integrated database has been created for drought characterization. The data pertaining to hydro-meteorology has ben collected from IMD and WRD, Data Centre, Bhopal. Also the hydrological data pertaining to stream flows for Bina at Rahatgarh G/D site have been collected from WRD, Data Centre, Bhopal. The statistical information on land use, sources of water, irrigated areas etc have been collected for the basin. The identification of existing land use pattern in the study area has been completed using the multi-date satellite data. Other thematic maps on soil texture, drainage network, geology, contours and Digital Elevation Model (DEM) have been prepared. The detailed investigations of the soils for determination of soil-water properties viz., infiltration tests, hydraulic conductivity etc. have been conducted at two sites and needs to be conducted further at few more sites based on the soil-crop combinations. The analysis of the hydrological and hydro-meteorological data has been carried out and the meteorological, hydrological and agricultural drought characteristics are being evaluated. The drought frequency varies between 1 in 4 years at Gairatganj, Rahatgarh and Kurwai to 1 in 5 years at Jaisinagar and Begumganj. The basin has been under widespread droughts during 1979-80, 1980-81, 1981-82, 2002-03 and 2007-08. The relative departure index (RDI) based on a weighting scheme depending on the drought severity has been developed for the basin and indicates the relative drought proneness of the development blocks. The higher RDI values have been observed for Begumganj, Khurai and Kurwai indicating that these areas are more prone to drought situations. A methodology has been evolved considering the separately the spatially varying and temporally varying indicators for drought vulnerability assessment and further improvements and refinement is in progress. The preparation of interim report is in progress.

9. Tasks to be taken up:

The initial methodology developed for vulnerability assessment needs to be fine tuned with the actual field conditions during drought. Also the aerial extent of the vulnerability analysis will be widened to include the command area as well along with the catchment area of Bina basin. One of the major difficulties in implementing this is the non-availability of hydrological data (stream flow) in the command area. Alternate methodology is being developed to incorporate the hydrological data into the vulnerability assessment in such situations of non-availability of stream flow data. A composite drought vulnerability index will be developed based on the various spatially and temporally varying indicators of drought vulnerability. The improved weighting scheme using the analytical hierarchical process (AHP) based on the operations research concept will also be applied for arriving at the weights of the indicators. The findings of the study will be very useful in the water resources planning and management especially during the drought scenario in the basin, which can subsequently be replicated to other basins of the region facing regular droughts.

Study – VII (New Project)

1. Thrust Area under XII five year Plan:
Surface Water, Reservoir Sedimentation

2. Project team:

a. Project Investigator : Sh. Rahul Kumar Jaiswal, Scientist –C

b. Project Co-Investigator(s) : Dr. T. R Nayak, Scientist -E
Sh. Ravi Galkate, Scientist -D
Sh. Thomas, Scientist -D
Dr. A. K. Lohani, Scientist -F

SWDC,WRD, Raipur : Sh. D. K. Sonkusale, Deputy Director
Sh. Akhilesh Verma, AE

3. Title of the Project:
Estimation of Revised Capacities in Reservoirs of Chhattisgarh state using Digital Image Processing technique

4. Objectives:

- Preparation of GIS based database for the study area
- Collection and analysis of reservoir details and other information
- Selection and digital image processing of remote sensing data
- Estimation of revised capacities of reservoirs and trend assessment in selected reservoirs
- Knowledge dissemination and development of awareness

5. Present state-of-art:
The catchment area which is the source of endowment for reservoir is generally overlooked resulting higher rate of erosion and sediment from catchment affecting the dead and live storage ultimately affects the intended benefits for which these projects are designed. In order to operate the reservoir in judicious manner, it is necessary to carry out sedimentation surveys at regular interval to determine the present status of storages in different zones of reservoir. The conventional method of reservoir sedimentation is costly, time consuming, risky and cannot be conducted regularly. It is therefore appropriate to carry out assessment of revised capacities using digital image processing techniques of remote sensing data. The newly born Chhattisgarh state is utilizing good potential of its water resources by constructing a large number of major dams and it is necessary to determine revised capacities and rate of sedimentation in these reservoirs for efficient reservoir operation. The revised capacities in Chhattisgarh state have been monitored in few reservoirs of the state and reservoirs are being operating considering the capacities computed during design of the project.

6. Methodology:
The methodology for the present study for the year will consists of:

- Development of GIS Based data base of reservoirs
- Collection of reservoir details including reservoir levels
- Selection and procurement of remote sensing data
- Estimation of revised capacities using digital image processing technique
- Estimation of average rate and trend of sedimentation in selected reservoir

7. Research outcome from the project:
The revised capacities of reservoirs estimated from the study will be helpful for efficient reservoir operation and modifying the releases considering present status of sedimentation. The average rate of sedimentation determined from the study can be used for designing the dead storages and gross capacities during design of future projects in the state. In the first year, two important reservoirs namely Ravishankar Sagar reservoir

and Tandula reservoir will be taken for estimation of revised capacities. In the second years, four more reservoirs namely Hasdeo, Sakasar, Kharang and Syam or some others will be selected for reservoir sedimentation studies with consultation of State Water Resources Deptt., Govt. of Chhattisgarh and data availability.

DELTAIC REGIONAL CENTRE KAKINADA

Scientific Manpower

S N	Name	Designation
1	Dr. YRS Rao	Scientist F & Head
2	Mr. S V Vijayakumar	Scientist F
3	Dr. V S Jayakanthan	Scientist D
4	Dr. P C Nayak	Scientist D
5	Mr. B. Krishna	Scientist C
6	Mr. R. Venkata Ramana	Scientist C

WORK PROGRAMME FOR 2014 - 2015

S. No.	Project	Project Team	Duration	Status/Funding
1	Runoff estimation of Tammileru ungauged basin, Andhra Pradesh.	V.S. Jeyakanthan, Scientist ‘D’ (P.I.) J.V.Tyagi, Scientist ‘G’ R.Venkata Ramana, Scientist ‘C’	April 2013 to March 2015	Completed/ Internal
2	Statistical downscaling and assessment of climate change impact on hydrology of Mahanadi river basin	P.C.Nayak, Scientist ‘D’ (P.I.) Y.R.Satyaji Rao, Scientist ‘F’ B. Venkatesh, Scientist ‘F’ T. Thomas, Scientist ‘D’	April 2013 to March 2015	Under Progress (Proposed to extend one more year)/Internal
3	Analysis of high frequency ground water levels data in the coastal aquifers of Andhra Pradesh	B.Krishna, Scientist ‘C’ (P.I.) Y.R.Satyaji Rao, Scientist ‘F’ R.Venkata Ramana, Scientist ‘C’	April 2013 to March 2015	Completed/ Internal
4	Evaluation of urban storm water network in Hyderabad using SWMM	R.Venkata Ramana, Scientist ‘C’ (P.I.) Y.R.Satyaji Rao, Scientist ‘F’ S.V.Vijayakumar, Scientist ‘F’ V.S. Jeyakanthan, Scientist ‘D’	April 2013 to March 2016	Ongoing/Internal
5	IWRM Studies (2013-2017): Surface water and Ground water Interaction study in the Y- drain of lower Yerrakalva basin	S.V.Vijayakumar, Scientist ‘F’ (P.I.) Y.R.Satyaji Rao, Scientist ‘F’ R.Venkata Ramana, Scientist ‘C’ B. Krishna, Scientist ‘C’	April 2014 to March 2015	Completed/ Internal
6	IWRM Studies (2013-2017) : Assessment of water availability in the upper Yerrakalva basin	Y.R.Satyaji Rao, Scientist ‘F’ (P.I) S.V.Vijayakumar, Scientist ‘F’ J.V.Tyagi, Scientist ‘G’ R.Venkata Ramana, Scientist ‘C’ B.Krishna, Scientist ’C’	April 2014 to March 2015	Under Progress (Proposed to extend one more year) /Internal
7	Identification of submarine groundwater discharge and sea water intrusion zones in Godavari delta using integrated approach	Y.R.Satyaji Rao, Scientist ‘F’ (P.I) M.S.Rao, Scientist ’D’ R.Venkata Ramana, Sc’C’	August 2014 to March 2017	Ongoing/Internal

PROPOSED WORK PROGRAMME FOR 2015 – 2016

S. No.	Project	Project Team	Duration	Status/Funding
1	Evaluation of urban storm water network in Hyderabad using SWMM	R.Venkata Ramana, Scientist 'C' (P.I.) Y.R.Satyaji Rao, Scientist 'F' S.V.Vijayakumar, Scientist 'F' V.S. Jeyakanthan, Scientist 'D'	April 2013 to March 2016	Ongoing/Internal
2	Statistical downscaling and assessment of climate change impact on hydrology of Mahanadi river basin	P.C.Nayak, Scientist 'D' (P.I.) Y.R.Satyaji Rao, Scientist 'F' B. Venkatesh, Scientist 'F' T. Thomas, Scientist 'D'	April 2013 to March 2015	Ongoing (Proposed to extend for one more year up to March, 2016)/ Internal.
3	IWRM Studies (2013-2017): Assessment of water availability in the upper Yerrakalva Basin	Y.R.Satyaji Rao, Scientist 'F' (P.I) S.V.Vijayakumar, Scientist 'F' J.V.Tyagi, Scientist 'G' R.Venkata Ramana, Scientist 'C' B. Krishna, Scientist 'C'	April 2014 to March 2015	Ongoing (Proposed to extend for one more year up to March, 2016)/ Internal.
4	Identification of submarine groundwater discharge and sea water intrusion zones in Godavari Delta using integrated approach	Y.R.Satyaji Rao, Scientist 'F' (P.I) M.S.Rao, Scientist 'D' R.Venkata Ramana, Scientist 'C'	August 2014 to March 2017	Ongoing /Internal
5	Identification of Ground Water Recharge zones in Vaippar Basin, Tamilnadu using Remote Sensing and GIS techniques	V.S. Jeyakanthan, Scientist 'D'(P.I) J.V. Tyagi, Scientist 'G' R Venkata Ramana, Scientist 'C'	April, 2015 to March, 2017	New /Internal
6	IWRM Studies (2013-2017) : Development of hydrological management practice plans for IWRM in the Lower Yerrakalva Basin	S.V.Vijaya Kumar, Scientist 'F' (P.I) Y.R.Satyaji Rao, Scientist 'F' V.S.Jeyakanthan, Scientist 'D'	April, 2015 to March, 2017	New /Internal
7	Spatio-temporal analysis of Hydro-climatic variables of East flowing rivers in North Coastal Andhra Pradesh	B. Krishna, Scientist 'C' (P.I) Y.R.Satyaji Rao, Scientist 'F' R Venkata Ramana, Scientist 'C'	April, 2015 to March, 2017	New /Internal

Evaluation of urban storm water network in Hyderabad using SWMM

1. ***Thrust area under XII five year Plan*** : Hydrology of Extremes (Urban flooding)

2. ***Project Team***
   a. Project Investigator : R. Venkata Ramana, Scientist 'C'
   b. Project Co-Investigator
   Y R Satyaji Rao, Scientist 'F'
   S V Vijay Kumar, Scientist 'F'
   V S Jeyakanthan, Scientist 'D'

3. ***Title of the Project***
   Evaluation of urban storm water network in Hyderabad using SWMM

4. ***Objectives***

- Adequacy verification of existing storm water drainage network to the design storm of various return periods.
- To develop the outfall hydrograph and water surface profiles along the drains.
- Design of the alternative drainage network.
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5. ***Present state-of-art***

Storm-water drainage systems in the past were designed for rainfall intensity of 12 – 20 mm/hr. These capacities have been getting very easily overwhelmed whenever rainfall of higher intensity has been experienced. Further, the systems very often do not work to the designed capacities because of very poor maintenance. Encroachments are also a major problem in many cities and towns. Natural streams and watercourses have formed over thousands of years due to the forces of flowing water in the respective watersheds. Habitations started growing into towns and cities alongside rivers and water courses. As a result of this, the flow of water has increased in proportion to the urbanization of the watersheds. Ideally, the natural drains should have been widened (similar to road widening for increased traffic) to accommodate the higher flows of storm-water. But on the contrary, there have been large scale encroachments on the natural drains and the river flood plains. Consequently the capacity of the natural drains has decreased, resulting in flooding. Improper disposal of solid waste, including domestic, commercial and industrial waste and dumping of construction debris into the drains also contributes significantly to reducing their capacities. It is imperative to take better operations and maintenance actions.

6. ***Methodology***

- Development of DEM of the catchment.
- Catchment delineation and its characteristics.
- Land use classification.
- Analysis of the storm drainage network.
- Identification of outfall and the problem of the conveyance system.
- Development of water surface profile along the channel and outfall hydrographs.
- Evaluation of the system.

7. ***Research outcome from the project***

- Water surface profiles along the channels
- Design floods for different return periods at various outlets
- Feasibility solutions for flood mitigation.

8. ***Work Schedule***
   a. Probable date of commencement of the project : May, 2013
   b. Duration of the project : 03 Years (Ongoing)
   (One year remaining)

c. Stage of work and milestone: 2013-2016 :

Sl. No.	Work Element/Quarterly	First Qr	Second Qr	Third Qr	Fourth Qr
2013-2014					
1	Identification area specific problems, historical floods and literature review	Completed			
2	Preparation base maps and identification of available data		Completed		
3	Procurement of satellite data and DEM			Completed	
4	First Interim report				Submitted
2014-2015					
1	Identification of specific zone in GHMC in consultation with GHMC	Completed			
2	Processing of rainfall data and development of IDF curves	Completed			
3	Delineation of sub watershed using DEM		Completed		
4	Preparation thematic maps (Land use, slope, soil)			Completed	
5	Collection of storm water drainage network details			Completed	
6	Second Interim Report				Under progress
2015-2016 (Proposed)					
1	Identification of locations and Installation of available instruments (AWLR and rain gauges)	↔			
2	Monitoring, processing and analysis of water levels and rainfall data	↔	↔		
3	Preparation of SWMM model input parameters and model setup		↔		
4	Model calibration/validation		↔	↔	
5	Identification flood prone area and its details			↔	
6	Final report and publications				↔

Statistical Downscaling and assessment of climate change impact on hydrology of Mahanadi river basin

1. ***Thrust area under XII five year Plan*** : R & D under National Water Mission (Projection of the impact of climate change on water resources)
2. ***Project Team:***
   a. Project Investigator : P.C. Nayak, Scientist 'D'
   b. Project Co-Investigator Y R Satyaji Rao, Scientist 'F'
   B Venkatesh, Scientist 'F'
   T Thomas, Scientist 'D'
3. ***Title of the Project***
   Statistical Downscaling and assessment of climate change impact on hydrology of Mahanadi river basin.

4. ***Objectives***

- To downscale the GCMs output
- Assessment of change in hydrological data by employing statistical significance testing to detect trends.
- To predict climatic projection for Mahanadi river Basin
- Hydrological assessment using WEAP/ SWAT model

5. ***Present state-of-art***
   The study is concerned with the assessment of climate change impacts on floods. The traditional way to address the problem is to develop climate scenarios from the GCMs and link the scenarios to a hydrological model from which peak flow values are extracted and analysed. It is recognized that existing methods for the assessment of climate change impacts are subject to various sources of uncertainty (choice of climate model, choice of emission scenario, course spatial and temporal scales, etc.). The main objective of the study is to investigate the climate change related uncertainty in the estimation of extreme flood flows for the Middle Mahanadi river basin using a wide range of climate model scenarios.

6. ***Methodology***
   Climate Change (CC) scenarios developed from Global Climate Models (GCMs) are the initial source of information for estimating possible future climate. However, for assessment of the future with the possible impacts of CC, the hydrological models can be driven with the output from the General Circulation Model (GCM). However, the resolutions of GCMs are currently constrained by computational and physical reasons to 200 KM for climate change predictions and are too course for hydrological modeling at basin scale. To identify trend in the climatic variables with reference to climate change, the Mann-Kendall, Cox–Stuart (CS) and Spearman Rank Correlation (SRC) tests has been proposed. In order to increase the spatial resolution of these predictions, one method used is 'statistical downscaling', which have been developed in the last decade. In the current investigation 'Change Factor Methodology' has been implemented for downscaling rainfall data. Uncertainty analysis has been proposed to evaluate the performance of the downscaling method in reproducing the mean and variability of the observed precipitation by comparing downscaled precipitation. It is also proposed to use hydrological model to assess the impact of climate change on water resources of Mahanadi river basin, in Odisha state.

7. ***Research outcome from the project :*** In the form of technical reports and papers
   a. Probable date of commencement of the project : April 2013
   b. Duration of the project : Two years
   (Proposed to extend one more Year)

c. Stage of work and milestone: 2013-2016

Sl. No.	Work Element	First Qr	Second Qr	Third Qr	Fourth Qr
	2013-2014				
1	Discharge Data Collection, Processing and literature review	Completed			
2	Rainfall Data Collection from IMD			Completed	
3	Trend analysis of rainfall and Runoff				Completed
4	Interim report				Submitted
	2014-2015				
1	Downscaling of rainfall from GCM data	Completed			
2	Spatiotemporal analysis of rainfall		Completed		
2	SWAT Model setup		Completed		
2	Uncertainty analysis and Hydrological modeling using SWAT			Under progress	
4	Details of Uncertainty analysis				Under progresses
4	Interim Report				Under progress
2015-2016 (Proposed for extension)					
1	Hydrological Modeling using SWAT & comparison with other models				
2	Scenario Development using Hydrological modeling				
3	Finalization projected scenarios				
4	Preparation of Final Report and technical paper				

IWRM Studies (2013-2017): Assessment of water availability in the upper Yerrakalva basin

1. ***Thrust area under XII five year Plan*** : IWRM studies.

2. ***Project Team:***
   a. Project Investigator : Y.R.Satyaji Rao, Scientist 'F'
   b. Project Co-Investigator S.V.Vijaya Kumar, Scientist 'F'
   J.V.Tyagi, Scientist 'G'
   R.Venkata Ramana, Scientist 'C'
   B.Krishna, Scientist 'C'

3. ***Title of the Project***
   Assessment of Water availability in the upper Yerrakalva basin.

4. ***Objectives***
   Assessment of water balance and water availability in the Upper Yerrakalva basin.

5. ***Present state-of-art***
   IWRM concept has strong necessity to make best efforts to manage surface water and groundwater in a comprehensive manner. In order to promote IWRM, few successful case studies are very much necessary. In this direction NIH has initiated hydrological interventions in the six pilot basins in the country. Yerrakalva is one among them. Very few studies have been carried out in India for preparing comprehensive IWRM plans for sustainable development and optimum utilization of water resources in the basin. Therefore, the present study is very important in the present context.

6. ***Methodology***
   The assessment of water balance would be taken up at sub basin level using SWAT model. Using the generated runoff series in each sub basin and observed runoff at catchment out let would be used for assessment of water availability. The groundwater utility in each sub basin is assessed using GEC norms. Future demands would be estimated using developmental activities and other proposed activities in the basin.

7. ***Research outcome from the project***
   Detailed hydrological investigations and IWRM plans for the basin.

8. ***Work Schedule***
   a. Probable date of commencement of the project : April 2014
   b. Duration of the project : One year (Proposed to extend for one more year)
   c. Stage of work and milestone: 2014-2016

Sl. No.	Work Element/Quarterly	First Qr	Second Qr	Third Qr	Fourth Qr
2014-2015					
1	Verification of CWC and APSGWD sub watershed classification	Completed			
2	Processing of histotical daily rainfall and discharge data		Completed		
3	Preparation of thematic maps (Landuse, Soil, DEM) and reservoir particulars		Completed		

4	Finalization of sub watersheds using SWAT model			Completed	
5	Stage of groundwater development as per APSGWD watersheds			Completed	
6	Preparation of Model input parameters for SWAT				In progress
7	Interim report				In progress
2015-2016 (Proposed for extension)					
1	Sub basin wise water balance components				
2	Sub basin wise water availability				
3	Stake holders present and future demand assessment				
4	Initiation of IWRM plans				
5	Preparation of Report				

Identification of submarine groundwater discharge and sea water intrusion zones in Godavari delta using integrated approach

1. ***Thrust area under XII five year Plan*** : Hydrology for watershed management (Water management in coastal aquifers)

2. ***Project Team:***
   a. Project Investigator : Y.R.Satyaji Rao, Scientist 'F'
   b. Project Co-Investigator : M.S.Rao, Scientist 'D'
   R.Venkata Ramana, Scientist 'C'

3. ***Title of the Project***

   Identification of submarine groundwater discharge and sea water intrusion zones in Godavari delta using integrated approach

4. ***Objectives***
   - To identify Submarine Groundwater Discharge zones (SGD) and Seawater Intrusion (SI) in Central Godavari delta
   - Aquifer characterization in Godavari delta
   - Geochemical and isotope characteristics of groundwater in Central Godavari Delta
   - Seawater Intrusion assessment using MODFLOW/SEAWAT model

5. ***Present state-of-art***

   In the coastal aquifer, the difference in hydrostatic pressure between groundwater and sea water results into fresh groundwater discharge into the sea as submarine groundwater discharge (SGD) or inflow of seawater into groundwater system as Seawater Intrusion (SI). SGD and seawater intrusion (SI) are the pathways of interaction between groundwater and sea. Seawater intrusion and SGD are the issues of global importance. The change in sea level (due to climate change or tidal effects) and groundwater levels (due to excess withdrawal, land use change, climate change etc) influence both SGD and SI. While SGD is the direct loss of freshwater to sea, the seawater intrusion causes groundwater salinization thereby reducing the available freshwater volume. It is also known that SGD causes loading of nutrient and release of contaminant near shore line. This rise of concentration of nutrients, nitrates, phosphates etc. above the concentration levels of the ambient seawater also results into increased biological activity at the location of SGD. Although, the SGD flow rates are very low but the total SGD flux to sea becomes significant considering the aerial extent of delta region and the depth over which the release of SGD occur. With the increasing population the demand of freshwater is growing accordingly, mapping the zones of SGD and SI for sustainable coastal groundwater management practices is becoming increasingly important at global scale.

6. ***Methodology***

   In the present project it is proposed to map the safe zones, vulnerable zones and potential risk zones for groundwater withdrawal by delineating areas of SI and SGD using EC, stable isotope, radon and water level data in the Godavari Delta. For the study, groundwater samples will be collected in pre- & post monsoon seasons. In-situ analysis will be done for EC, temperature and radon (^{222}Rn) concentration. Number of samples will be collected and analyzed for stable isotope composition at NIH, Roorkee. As these parameters (EC, Temp, stable isotope composition, ^{222}Rn concentration) are expected to change during monsoon and non-monsoon season, samples will be collected in two seasons: before and after the monsoon for both the years 2015 and 2016. Long term data on water table will be collected to examine the seasonal dependency of groundwater flow conditions. Rainfall data will also be collected to interpret the results. Technical support from state groundwater department will be taken in groundwater sampling and for collating the archival data.

7. ***Research outcome from the project***

- Thematic maps of variation of (i) stable isotopic composition, (ii) salinity, (iii) major ions, and (iv) radon in groundwater during pre & post monsoon periods. Interpretation of the above data with respect to the changing groundwater levels before and after the monsoon periods.
- Mapping the areas of safe groundwater, vulnerable and potential risk zone according to SI & SGD operating process
- Knowledge dissemination in terms of publications

8. ***Work Schedule***

a. Probable date of commencement of the project : August, 2014
b. Duration of the project : 2.5 years (Ongoing)
c. Stage of work and milestone : 2014 - 2017

Sl. No.	Work Element/Quarterly	First Qr	Second Qr	Third Qr	Fourth Qr
2014-2015					
1	Literature review on SGD/SI		Completed		
2	Identification of suitable methods for SGD			Completed	
3	Preparation of base maps of the study area			Completed	
4	Mapping of river, streams, and drains outlets to the sea				Completed
5	Analysis of LANDSAT thermal data				In progress
6	Interim report				In progress
2015-2016 (Proposed)					
1	Field work for water sampling and data collection	↔		↔	
2	Sample analysis		↔		↔
3	Data interpretation and preparation of maps				↔
4	Interim Report				↔
2016-2017 (Proposed)					
1	Field work for water sampling and data collection	↔		↔	
2	Sample analysis		↔		↔
3	Data interpretation and preparation of maps				↔
4	SI Modeling using MODFLOW			↔	↔
5	Report Preparation				↔

Identification of Ground Water Recharges zones in Vaippar Basin, Tamilnadu using Remote sensing and GIS techniques.

1. ***Thrust area under XII five year Plan*** : Regional Hydrology

2. ***Project Team:***
   a. Project Investigator : V.S. Jeyakanthan, Scientist 'D'
   b. Project Co-Investigator J.V. Tyagi, Scientist 'G'
   R. Venkata Ramana, Scientist 'C'

3. ***Title of the Project***
   Identification of Ground Water Recharges zones in Vaippar Basin, Tamilnadu using Remote sensing and GIS techniques

4. ***Objectives***
   The core objective of this project is to identify and map the ground water recharge zones using hydro-geomorphology and hydro-geology of the study area.

5. ***Present state-of-art***
   Groundwater is basically a renewable resource, but the volume of water actually in storage may vary greatly from place to place depending on climate, regional hydrogeology, utility of landuse/landcover, soil characteristics and rate of groundwater used for agriculture, industries and domestic purposes. In modern water resource development and hydro-geological study, GIS and remote sensing are playing a significant role. Using remote sensing technique hydrological investigations have got many advantages; one of these is its tendency to generate information in spatial and temporal domain which then goes to analysis, predication and validation respectively. It also provides multi-sensoral, multispectral and multi-temporal data. GIS technology is suitable alternative for providing an efficient management of large and complex data base.
   Different approaches to delineate various thematic information from the remote sensing digital data, such as maximum likelihood classification, minimum distance to mean classification and the band threshold method, adopt the per-pixel based methodology and assign a pixel to a single land cover type whereas in reality, a single pixel may contain more than one type of land cover (known as a mixed pixel). Mixed pixels are common, especially near the boundaries of two or more discrete classes. The per-pixel approaches are less intelligent in classifying the mixed pixels thereby producing inaccurate estimates of the landuse/lancover area. To compute the landuse/landcover area accurately, the sub-pixel based approach would be used in this study.

6. ***Methodology***
   Precipitation, landuse/landcover, lineament density, drainage pattern, water level, soil characteristics and slope data will be used to generate percolation, surface runoff and water capacity maps, which represent the recharging process of the study area. Sub-pixel methodology will be used for classifying landuse/landcover of the study area. Runoff will be estimated using SCS methodology. Hydro-geological and other above said input maps will be prepared from the satellite data. Remote sensing data will also be used for the identification of geological structure such as faults, joints, dikes etc that controls the groundwater flow pattern in the study area. Slope map will be prepared from DEM (Digital Elevation Model) obtained from satellite data. GIS platform will be used for analysis of spatio-temporal data. These maps and data will be combined and ranked to

produce a recharge potential index, from which ground water recharge zones in the study area will be identified.

7. ***Research outcome from the project***

To estimate the runoff of Vaippar basin on sub-watershed basis and to suggest the location of ground water recharge zones in the study area for water conservation purposes.

8. ***Work Schedule***

a. Probable date of commencement of the project : April, 2015

b. Duration of the project : Two years (New study)

c. Stage of work and milestone

Stage of work: 2015 – 2017

Sl	Work element\Quarterly	2015-16				2016-17			
		I	II	III	IV	I	II	III	IV
1	Literature review, Procurement of satellite data and other ancillary data								
2	Preparation of lineament, drainage density, landuse/lancover using sub-pixel classification approach, slope, water level maps and other inputs for SCS model								
3	Preparation of geological maps, soil characteristic maps, analysis spatio-temporal data using GIS and computation of runoff. Preparation of Interim Report								
4	Analysis all input maps & data and preparation of recharge potential maps using GIS								
5	Submission of Final report								

IWRM Studies (2013-2017): Development of hydrological management practice plans for IWRM in the Lower Yerrakalva Basin

1. ***Thrust area under XII five year Plan*** : IWRM (Water management in salinity affected areas)
2. ***Project Team:***
   a. Project Investigator : S.V.Vijaya Kumar, Scientist 'F'
   b. Project Co-Investigator : Y R Satyaji Rao, Scientist 'F'
   V S Jeyakanthan, Scientist 'D'
3. ***Title of the Project***
   IWRM Studies (2013-2017) : Development of hydrological management practice plans for IWRM in the Lower Yerrakalva Basin.

4. ***Objectives***
   - To estimate water requirement for various uses in the study area
   - To study water availability and suitability from different sources in the study area
   - To assess stake holders experiences on the supply and use in the study area
   - To develop suitable hydrological management practice plans for different uses

5. ***Present state-of-art***
   The lower Yerrakalva river basin, named as Yanamadurru drain area has not been studied scientifically to understand the inter relationship between water requirement for different uses and water availability from various sources in a planned manner. Whereas, the purpose of IWRM concept is to integrate appropriately the management of waters with from different resources. Thus, water resource is to be managed as a common pool community resource to achieve food security, support livelihood, and ensure equitable and sustainable development. There is strong necessity to make best efforts to manage surface water, groundwater, and other pertinent waters in a unified and comprehensive manner with due regard to the relationship between the river-basin or sub-basin and the aquifer. The line department like irrigation, groundwater, agriculture and fisheries department are engaged in delivery, operation, maintenance and utilization. There is necessity to study these aspects scientifically to develop proper hydrological management plans.

6. ***Methodology***
   In this study, it is proposed to estimate seasonal water availability from rainfall, river water, groundwater, canal water, pond water from an inventory keeping in view the demand for water for various uses. Assessment of available water resources in the basin and their temporal and spatial distribution is prerequisite for any hydrological study. The present and future water demand assessment is also equally important for sustainable development in the basin. Most recent scientific methods would be adopted in the assessment of water resources using conventional and detailed modeling. Also, water is not only essential for mankind but also for all living organisms. The timing, quantity and quality of river water has direct impact on the biological systems of the river basin, especially along the river corridor. Changes in flow regime impact the survival of the habitat and may damage the connectivity of freshwater ecosystem.
   It is proposed to study role of some hydrological management practices with the considered view of different stakeholders. Such an approach may help in proposing suitable action plans towards undertaking Integrated Water Resources Management in the lower Yerrakalva Basin.

7. ***Research outcome from the project***
   - Technical Reports and technical papers.

8. Work Schedule

a. Probable date of commencement of the project : April, 2015.

b. Duration of the project : 02 Years (New Study)

c. Stage of work and milestone : 2015 - 2017

Stage of work

Sl No	Work element\Quarterly	2015-16				2016-17			
		I	II	III	IV	I	II	III	IV
1	Planning and establishment including preparation of thematic maps	←	→						
2	Data collection and field investigations on water uses and supplies		←	—	—	—	—	→	
3	Stakeholders interaction		↔				↔		
4	Data analysis, verification, interpretation and reporting			←	→			←	→

Spatio-temporal analysis of Hydro-climatic variables of East flowing rivers in North Coastal Andhra Pradesh

1. ***Thrust area under XII five year Plan*** : R & D under National Water Mission
2. ***Project Team:***
   a. Project Investigator : B. Krishna, Scientist 'C'
   b. Project Co-Investigator : Y R Satyaji Rao, Scientist 'F'; R.Venkata Ramana, Scientist 'C'
3. ***Title of the Project***

   Spatio-temporal analysis of Hydro-climatic variables of East flowing rivers in North Coastal Andhra Pradesh.

4. ***Objectives***
   - Spatial and Temporal characteristics of the rainfall, temperature and stream flow time series and their statistical distribution by Parametric and Non-parametric approach
   - Analysis of RCM data for future hydro-climatic variables

5. ***Present state-of-art***

   Investigations of regional and global climatic changes and variabilities and their impacts on the society have received considerable attention in recent years. Changes in hydrological processes may in turn affect the overall availability and quality of water resources, and alter the spatiotemporal characteristics of hydrologic occurrences, such as the timing of flow events, and the frequency and severity of floods and droughts. The climate change is controlled by many factors, and there are many different scientific opinions regarding which of these factors is the most significant. There are also established linkages between hydro-climatic variables. Trend identification of hydro-climatic time series is one of the commonly used methods to detect the climate change. The detection and estimation of trends in the presence of noise, periodicities, or discontinuous patterns is important in hydrology and climate research studies. The basic idea of currently available trend estimation techniques (tests) is that the trends should be smooth and monotonic; however, hydro-climatologic variables contain multiple signals, and have segments of increasing and decreasing trends. As a result, estimating trends in time series of multiple signals is an essential and it is therefore important to continue developing the trend analysis. It includes the development of various signals of time series of Rainfall, Temperature and Stream flow by appropriate method. Estimate the trend and its spatio-temporal responses of Rainfall, Temperature and Stream flow.

   North Coastal Andhra Pradesh locally called as 'Uttar Andhra' consists of three districts namely Srikakulam, Vizianagaram and Visakha patnam districts. These districts were considered as backward areas of Andhra Pradesh due to lack of available water resources. This region has numerous rivers of comparatively smaller length such as Nagavali, Vamsadhara, Sarada etc. mostly originating from rich forests of the Eastern Ghats and flowing into the Bay of Bengal. Due to the presence of Eastern Ghats, there is a wide variability of hydroclimatic variables was taken place in this region. Thus there is a need to study the behaviour of trend particulars of hydroclimatc variables and its inter-relationship in this region.

6. ***Methodology***
   - Spatial and Temporal characteristics of the Rainfall, Temperature and Stream flow time series and their statistical distribution
   - Parametric approach for trend and variability
   - Non parametric approach for trend and variability
   - Development of time series of multiple signals of the variables

- Estimation of trend and variability of multiple signals of rainfall, Temperature and stream flow
- Preparation of RCM for north coastal A.P and projections of hydro-climatic variables

7. Research outcome from the project

This study of analysis of rainfall, temperature and stream flow has good potential for thorough understanding of the changes in the hydro-climatic variables due to climate change in North coastal Andhra Pradesh. The results from this study should be useful for Decision makers in proper utilisation and better management of available water resources in this region.

8. Work Schedule

a. Probable date of commencement of the project : April, 2015.
b. Duration of the project : 02 Years (New study)
c. Stage of work and milestone : 2015 – 2017

Stage of work

Sl No	Work element\Quarterly	2015-16				2016-17			
		I	II	III	IV	I	II	III	IV
1	Literature review, collection of historical data								
2	collection of historical data, data processing, and statistical analysis of data								
3	Parametric Analysis								
4	Non parametric analysis								
5	Multi resolution Analysis								
6	Draft and Final report								

PROPOSED TECHNOLOGY TRANSFER ACTIVITIES FOR THE YEAR 2015- 2016

PROPOSALS FOR ORGANISING TRAINING WORKSHOPS/ SEMINARS/ SYMPOSIA/ MASS AWARENESS PROGRAMME ETC

1.	*Thrust Area under XII five year Plan (Training Workshop)*	:	Technology Transfer activities
2.	*Topic of Training Workshops*	:	Groundwater monitoring, assessment and modelling.
3.	*Convener*	:	Y.R.Satyaji Rao, Scientist 'F'
4.	*Co-ordinator/ Organising Secretary*	:	S.V.Vijaya Kumar, Scientist 'F'
5.	*Co Co-ordinator (S)/ Co-Organising Secretary (ies)*	:	V.S.Jeyakanthan, Scientist 'D' P.C.Nayak, Scientist 'D' B. Krishna, Scientist 'C' R.V.Ramana, Scientist 'C'
6.	*Faculty*	:	NIH and its regional centre
7.	*Duration of the programme*	:	5-days
8.	*Tentative Schedule*	:	07-11 September 2015.
9.	*Place at which Programme would be organized*	:	Kakinada
10.	*No of Participants Expected*	:	30 Nos. and faculty /organisers: 50

CENTRE FOR FLOOD MANAGEMENT STUDIES GUWAHATI

Scientific Manpower

S N	Name	Designation
1	Dr. S K Sharma	Scientist B
2	Mr. Gulshan Tirkey	Scientist B

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

WORK PROGRAMME FOR 2014-15

Study No.	Title of the study	Study Team	Duration
NIH/CFMS-G/13-15/	Risk Assessment of Heavy Metal Pollution in Surface Soils of Kulsi River Basin (Assam / Meghalaya)	C. K. Jain S. K. Sharma G. Tirkey B. Sharma	07/13-03/15
NIH/CFMS-G/13-15/	Short Term Flood Forecasting Using Bootstrap based Artificial Neural Networks within Kulsi River Basin (Assam / Meghalaya) – I	S. K. Sharma G. Tirkey	07/13-03/15
NIH/CFMS-G/13-15/	Application of the Arc – SWAT model for the prediction of runoff within Kulsi River Basin (Assam/Meghalaya)	G. Tirkey S. K. Sharma	07/13-03/15
NIH/CFMS-G/13-15/	Status Report on Soil Erosion and Sedimentation of River Brahmaputra in North-East Region	G. Tirkey	07/13-03/15

PROPOSED WORK PROGRAMME FOR 2015-16

Study No.	Title of the study	Study Team	Duration	Funding
NIH/CFMS-G/15-17/	Estimation of Runoff for Kulsi River Basin using SCS Curve Number and Geographic Information System (GIS)	S. K. Sharma G. Tirkey	07/15-03/16 (New Study)	NIH
NIH/CFMS-G/15-17/	Application of USLE model for estimation of soil loss in Kulsi River Basin using remote sensing and geographic information system	G. Tirkey S. K. Sharma	07/15 - 03/16 (New Study)	NIH

Risk Assessment of Heavy Metal Pollution in Surface Soils of Kulsi River Basin (Assam / Meghalaya)

The study was undertaken with the objectives to i) investigate the distribution behavior of heavy metals between different physical and chemical fractions of the soil, ii) To investigate the chemical partitioning of heavy metal in such soils and to assess the bioavailability of heavy metals and iii) To investigate the distribution and fractionation of heavy metals to determine the eco-toxic potential of metal ions.

Fifty soil samples from Kulsi Basin were collected and analyzed for different matal ions (Fe, Mn, Cu, Ni, Cr, Pb, Cd, Zn, As, Hg, Ag, Al, Be, Ca, Co, Cs, Sr, U, Ti, Ba, K, Mg, CV and Se). The data is being processed for quantifying the degree of metal enrichment / pollution in surface soils. Various parameters like geo-accumulation index (I_{geo}), enrichment factor (EF), pollution index (PI) and integrated pollution index (IPI) are being developed to assess the extent of metal contamination in surface soils of Kulsi River Basin including floodplain areas of the Kulsi River. The report is under writing stage.

Short Term Flood Forecasting Using Bootstrap based Artificial Neural Networks within Kulsi River Basin (Assam/Meghalaya)

The project was undertaken to review the application of Bootstrap based Artificial Neural Networks (BANN) for prediction of hydrometerological parameters and to explore the estimation of precipitation at a discharge site using spatial distribution of selected weather stations.

Historical monthly rainfall data for 21 years (1990-2010) procured by the Centre from Indian Meteorological Department (IMD), Guwahati, Assam and Concurrent data from five weather stations i.e North Lakhimpur (S1), Mohanbari (S2), Guwahati (S3), Tezpur (S4) and Silchar (S5) from Assam and One weather station i.e. Shillong (S6) from Meghalaya were used in the study. The coordinates of weather stations were imported into the ArcGIS^{TM} Software. The descriptive statistics and inter-correlations among the stations were computed using statistical SPSSTM software. The pre-processing of rainfall data (S1 to S5) in Assam was carried out using Geostatistical Tool Box of ArcGIS software.

Interpolation of rainfall from weather stations (S1 – S5) in Assam was carried out using Inverse Distance Weighted model and Spline model inbuilt in the toolbox of ArcGISTM software. Weather station (S6) in Meghalaya was excluded from the analysis in order to validate the model. Trend lines were plotted between estimated and measured values of mean monthly rainfall corresponding to months of June to September. The trend lines depicted Spline model (R^2 = 0.676) to perform better than the inverse distance method (R^2 = 0.426) of interpolation. Selecting spline method of interpolation, the collinear values at Kulsi Bazzar (GDS II) monthly rainfall values for June to September were determined to be 308 mm, 339 mm, 289 mm and 176 mm respectively.

BANN models based on hierarchical combination of monthly rainfall lag (Jun - Sep) are being trained and validated for prediction of monthly runoff at Kulsi Bazzar Site. The best performing model will be used to simulate short term flood using an independent (rainfall-runoff) dataset.

Application of the Arc-SWAT model for the prediction of runoff within Kulsi River Basin (Assam/Meghalaya):

The project was undertaken with the objectives: (i) to perform sensitivity analysis of the different input parameters for estimation of runoff in Kulsi river basin, (ii) to calibrate and validate the Arc-SWAT model for the prediction of runoff in Kulsi river basin.

The Kulsi Basin, a part of the Brahmaputra sub-basin is situated on the south bank of the mighty River Brahmaputra. The Kulsi basin as a whole, receives a good amount of rainfall throughout the year. Apart from the rolling hill topography, faulty cultivation practices and deforestation within the basin results in huge loss of productive soil and water as surface runoff. Meteorological data of Guwahati and Shillong have procured from IMD. SRTM data was downloaded and basin maps and drainage network was created using Arc GIS. Soil map of the Kulsi river basin have downloaded from internet and digitized using Arc GIS. The LANDSAT imageries have downloaded and was processed using ERDAS. The SWAT model setup was carried out with Arc GIS interface. Sensitivity analysis is being carried out to examine the relative changes in the model output with respect to change in model input variables. Calibration and validation of Arc-SWAT model is going on for prediction of runoff in Kulsi river basin.

Status Report on Soil Erosion and Sedimentation of River Brahmaputra in North-East Region:

The project was undertaken with the objective: to prepare a status report on Soil Erosion and Sedimentation of River Brahmaputra in North-East Region and its effect on river basin.

The Brahmaputra is one of the biggest rivers of the world. The Brahmaputra basin covers an area of 5,80,000 Sq. Km of which 1,94,413 Sq. Km falls in India. In India, the basin lies in the states of Arunachal Pradesh, Assam, Nagaland, Meghalaya, Sikkim and West Bengal. Out of the numerous tributaries, 33 major tributaries lie within NE India with 20 of these coming from the north and another 13 from the south bank. Erosion by the Brahmaputra and its tributaries has been causing considerable damages each year. The extent of loss of damage due to erosion in the valley varies from year to year depending on the severity of floods. The Brahmaputra river is characterized by its exceedingly large flow, enormous volume of sediment load, continuous changes in channel morphology, rapid bed aggradations and bank line recession and erosion. After the great earthquake of 1950 erosion has been very severe due to excessive silt brought down by the river from the hill as a result of extensive landslides. The eroded soil in the catchment area and the debris of landslides pour in to the river during rains when the river carries not only enormous discharge but also excessive silt load. Under this condition the river tries to build steeper slope which in turn results in widening of bed and braiding of channels.

All necessary information/data regarding soil erosion and sedimentation of river Brahmaputra have been collected and an attempt has been made to review status of erosion and sedimentation of Brahmaputra River. The present study is under progress and final report will be submitted soon after compilation of information/data.

PROJECT REFERENCE CODE: NIH/CFMS-G/15-17

a. Title of Study:	Estimation of Runoff for Kulsi River Basin using SCS Curve Number and Geographic Information System (GIS)
b. Study Group:	S. K. Sharma and G. Tirkey
c. Date of Start:	July 2015
d. Duration of the Study:	Two years (July 2015 to March 2017)
e. Funding:	NIH

f. Objectives:

i) To estimate runoff from Kulsi River Basin using SCS CN Method
ii) To prepare runoff potential maps for Kulsi River Basin.

g. Brief Description/Methodology:

One of the major requirements for water resources development and management is analysis of rainfall runoff relationship and availability of water in the area, which vary with time and space. Knowing the amount of runoff from a catchment gains a vital importance particularly for planning the hydraulic structures and taking necessary erosion control measures, in catchments where there is no runoff observations. In catchments where agricultural lands are prevailing, American Soil Conservation Service (SCS) Runoff Curve Number Method is widely used for planning the structures aimed at water storage and, erosion and flood control. United States Department of Agriculture (USDA), Soil Conservation Service have developed a method to calculate runoff from agricultural catchments with different soil groups, vegetation covers and land uses by examining measured precipitation and runoff amounts, and named it as “SCS Curve Number Method”.

The SCS CN method requires numeric catchment characteristics which are the basis of catchment runoff determination. The objective of the method is to determine the right curve number of the catchment of interest that defines the runoff potential. Hydrologic soil group number, land use type, vegetation cover, soil conservation measures, antecedent soil moisture conditions are the basic catchment characteristics used for curve number calculations.

Keeping in view the above points, SCS-CN method will be used along with remote sensing and GIS datasets for simulation of rainfall runoff relationship for Kulsi River Basin. The study will also generate runoff potential maps for the Basin.

h. Expected Outcome:

Runoff Potential Maps for Kulsi River Basin, Assam/Meghalaya.

PROJECT REFERENCE CODE: NIH/CFMS-G/15-17

a. Title of Study:	Application of USLE model for estimation of soil loss in Kulsi River Basin using remote sensing and geographic information system
b. Study Group:	G. Tirkey and S. K. Sharma
c. Date of Start:	July 2015
d. Duration of the Study:	Two years (July 2015 to March 2017)
e. Funding:	NIH

f. Objectives:

i) To estimate soil loss using USLE model for Kulsi River Basin.
ii) To identify the critical erosion prone zones of Kulsi River Basin for conservation planning.

g. Brief Description/Methodology:

Soil erosion is a widespread problem in the developing countries. Serious soil erosion is occurring in most of the world's major agricultural regions and the problem is growing as more marginal land is brought into production. For maintaining and improving soil productivity, high priority should be given for conservation of soil resources by promoting optimum land use. Due to the complexity of the variables involved in erosion it becomes difficult to measure or predict the erosion in a precise manner. The latest advances in remote sensing technology have provided very useful methods of surveying, identifying, classifying and monitoring several forms of earth resources. Remote sensing data provide accurate, timely and real time information on various aspects of the watershed such as land use/cover, physiography, soil distribution, drainage characteristics etc. It also assists in identification of the existing or potential erosion prone areas and provides data inputs to many of the soil erosion models.

The USLE model applications with GIS would allow us to analyze soil erosion in much more detail since the process has a spatially distributed character. It is obviously more reasonable to use the USLE on a physical basis than to apply it to an entire watershed as a lumped model. A recent and emerging technology represented by GIS provides the tools to generate manipulate and spatially organize disparate data for sediment yield modeling. The GIS and Remote Sensing (RS) provide spatial input data to the model, while the Universal Soil Loss Equation (USLE) can be used to predict the sediment loss from the basin.

Keeping this in view, the present study will be taken up to estimate the magnitude and spatial distribution of soil erosion in Kulsi River Basin using USLE, GIS and RS, so that the critical areas, which need to be provided with adequate soil and water conservation measures can be identified.

h. Expected Outcome:

A quantitative assessment of soil loss will be obtained using USLE with a view to identify the critical erosion prone zones of study area for conservation planning.

CENTRE FOR FLOOD MANAGEMENT STUDIES PATNA

Scientific Manpower

S N	Name	Designation
1	Mr.Biswajit Chakravorty	Scientist F
2	Dr.Pankaj Mani	Scientist D
3	Mr. N G Pandey	Scientist D
4	Mr. S R Kumar	Scientist D
5	Mr. R Venkataraman	Scientist C

WORK PROGRAMME FOR 2014-2015

SN	Title of the Project/Study	Study Group	Duration	Funding
1.	Pilot Basin Studies (PBS) for Mahi River Basin in Ghaghra-Gandak Composite Basin	B Chakravorty, NG Pandey	04/12-03/17	NIH
2.	Development of flood forecasting system based on rainfall information obtained from satellite data	Pankaj Mani Rakesh Kumar	3 year (Started in 2012-13)	NIH
3	Trend and Variability Analysis of Rainfall using Mann-Kendall Test and Sen's Slope Estimates for the Districts of Bihar under Climate Change Scenarios.	SR Kumar	1 year (Started in 2013-14)	NIH
4.	Spatial and Temporal Distribution of Geochemical Characteristics and Environmental Stable Isotopes in Groundwater of North Bengal using GIS and its Assessment with the help of Water Quality Index (WQI) and Existing Classification Systems	SR Kumar, MS Rao and SWID	2 year (Started in 2012-14)	NIH
5.	Time Series analysis of Monthly Rainfall in Mahi Basin	NG Pandey B Chakravorty Sanjay Kumar	2 year (2014-2016)	NIH

WORK PROGRAMME FOR 2015-2016

Sl	Title of the study	Study Team	Duration
1.	Pilot Basin Studies (PBS) for Mahi River Basin in Ghaghra-Gandak Composite Basin	B Chakravorty NG Pandey Pankaj Mani	04/12-03/17 (XII Plan Year)
2.	Development of flood forecasting system based on rainfall information obtained from satellite data	Pankaj Mani Rakesh Kumar	3 year (Started in 2013-14)
3.	Time Series analysis of Monthly Rainfall in Mahi Basin	NG Pandey B Chakravorty Sanjay Kumar	2 year (2014-2016)
4.	Demonstration scheme on Riverbank Filtration in Gagatic plain of Bihar	B Chakravorty NG Pandey	2 year (2015-17)
5.	Spatial and Temporal Distribution of Geochemical Characteristics and Environmental Stable Isotopes in Groundwater of North Bengal	SR Kumar, MS Rao and SWID	1 year (2015-16)

Pilot Basin Studies (PBS) for Mahi River Basin in Ghaghra-Gandak Composite Basin

1. **Thrust Area under XII 5-year plan**: Integrated Watershed Management for Flood Control

2. **Project Team:** (a) Sri Biswajit Chakravorty, Sc 'F', CFMS, Patna (PI)
(b) Sri N. G. Pandey, Sc 'D', CFMS, Patna (Co-PI)

3. **Title of the Project:** Water balance study in Mahi basin under IWRM

4. **Objectives:**
   (i) Development of water balance model of Mahi basin and decision support system for increase in irrigated agriculture and productivity.
   (ii) Increase in livelihood and betterment of scio-economic condition of the inhabitants.

Statement of the problem: Under its 12th Plan program (2012-17), the Institute has been given the responsibility to take up PBS for Integrated Water Resources Management (IWRM) in different hydrological regions in the country. These PBS are expected to evolve a participatory model of addressing the water-related issues in the basin based on IWRM concept. The program will involve detailed studies on various components of the Hydrologic Cycle as well as on the identified water-related problems for a small basin through establishment of advanced instrumentation for data collection, storage, processing, and analyses using state-of-art models. The basin identified for this program would be studied in detail for a period of next five years, and the results and findings of the study would be shared with the State Government for their use in planning and effective management of water resources in the State.

Govt. of Bihar has approved and selected basin is Mahi basin falling under Gandak-Ghaghra composite basin for the above studies. Field visits were made and primary data through sampling is in progress and other secondary data from different sources are being collected.

Study area:

Mahi basin is a tributary to river Ganga that lies in the Gandak-Ghagra composite river basin. Mahi is surrounded by three major rivers- Ghagra in the West, Gandak in the East and Ganga in the South. The total catchment area is about 2700 sq. km. It is on the left bank of Ganga and about 50 km away from Patna. Mahi river originates from Kaimur chaur of Ajbinagar village at Baikanthapur in Gopalganj district of North Bihar at latitude 26° 28 '00"N and longitude 84° 25' 47" E. The catchment area of Mahi basin is about 2700 sq.km. and is bounded by Gandak basin in North and East, the Ghaghara basin in the West and river Ganga in the South. Total length of Mahi river is 91 km. It drains about 256 sq.km., excluding the drainage areas of its two tributaries namely Ghoghari and Gandaki. Mahi also functions as an escape channel of the Gandak canal system. It falls into Ganga near Nayagaon.

5. **Present state of art:**

For a river basin predominantly farmers are the target group and planning is mainly meant for their betterment. Presently this is done through water users association/farmers organizations in participatory mode. Farmer's interest is to get sustainable income growth. The socio-economic and political complexities always put barrier in their upliftment. Farmers seldom get fair price and the middle men engulf the cream. Mahi basin is situated in highly fertile tract of Gangetic plain of North Bihar. Where irrigation facility exists 3 crops per year can be grown but due to waterlogging and drainage congestions lower part of Mahi basin is without any crop.

6. **Methodology**

Water balance study is performed to assess the water surplus/water deficit areas. Planning is to be made for providing water through irrigation either surface or lift in water deficit areas. Similarly identifying the waterlogged pockets in the basin necessary drainage clearance is to be planned. Integrated approach involving agriculture, horticulture, cattle rearing, fish culture, duckery, goatery etc is to be encouraged making credits made available through farmers organization.

7. Work schedule:

(d) Date of commencement of the project: April 2013

(e) Duration of the project: 4 year.

(f) Stages of work and milestone:

SN.	Work Element	2014	2015	2016	2017	Status
1.	Literature review, meetings					Completed
2.	Pilot Basin selection					Completed
3.	Stake holders meetings					Completed
4.	Collection of hydrological meteorological data					Completed
5.	Collection of water/soil samples and in-situ hydraulic field tests in study area. Laboratory analysis					In progress
6.	Water balance studies					In progress
7.	Formation of farmers groups/associations					To be done
8.	Report preparation					To be done

Progress

Participatory Irrigation Management (PIM) concept and lesson learnt from Sone Irrigation Scheme in Paligunj distributary, Govt of Bihar was followed. Accordingly 3 field visits were made with the project authority dated 04 July, 2012, 20 December 2012 and 04 March 2014. A stake holders meet was organized at CFMS Patna on 21 December 2012. In this connection recently on 03-04 March 2015 PBS stake holders meet was organized in New Delhi and further work on water balance/water availability estimation was stressed. Three field visits for collection of soil samples and field tests through ring infiltrometer and Guelph permeameter were conducted during 18-21 Nov., 2014, 09-12 Dec., 2014 and 02-04 March 2015. So far 53 soil samples were collected and its laboratory tests are in progress. Water samples from tubewell (53 Nos) were also collected and analysis of groundwater water quality is to be started.

8. Research Outcome from the project:

(iv) Water balance study report-water deficit and water surplus area and planning productive utilization of water.

(v) Development of strategy and management plan for better livelihood.

Development of flood forecasting system based on rainfall information obtained from satellite data.

1. **Thrust area under XII five year plan:** Non Structural Measures of Flood Management

2. **Title of the Project:** **Development of flood forecasting system based on rainfall information obtained from satellite data**

3. **Project Team:**

Sri Pankaj Mani, Sc 'D', CFMS, Patna (PI)
Dr. Rakesh Kumar, Sc 'G', SWHD, NIH Roorkee (Co-PI)
Sri. Jagadish Prasad Patra, Sc 'B', SWHD, NIH Roorkee (Co-PI)

4. **Objectives of the study:**

(i) Development of IFAS for Bagmati basin which is partly in Nepal (majority of mountaneous catchment) for which rainfall data is limited.
(ii) Evaluation of Model performance wrt the observed discharge and water level of Bagmati river at various GD sites

Introduction: Floods are common natural hazards in the alluvial plains of Ganga which spread across the international boundaries and mountainous region. Accurate estimates of rainfall are needed in order to minimise the impacts of floods. In mountainous and transboundary areas of Bagmati basin, measuring stations are often sparse or data are unavailable for predicting rainfall derived floods. The first gauge data on Bagmati river is available at Dhen Bridge site when the river enters into India and the present practice of flood forecasting is based on the Guage to Guage correlation thus providing limited lead time. With the possibility of using satellite based rainfall estimates and also to estimate future rainfall, the accuracy and lead time of forecast will improve substantially.

Study area: Bagmati is an international and perennial river originating near Kathmandu from the shivpuri range of hills in Nepal at an elevation of 1500 m above MSL. It traverses nearly 195 Km in Nepal and rest 394 Km in Bihar and outfalls in the Kosi at Dumrighat and finally falls into the river Ganga at Krushela. It enters India in Sitamarhi district of Bihar about 2.5 Km north of Dheng railway station. The catchment area of Bagmati basin (including Adhwara) is 14,384 km^2, out of which 6,500 km^2 is in India and rest in Nepal. The main tributaries are; Lalbakeya(R), Lakhandei(L), Darbhanga-Bagmati(L), Old kamla(L), Hasanpur Bagmati(R).

5. **Present state of art:**

In India, Central Water Commission is mainly responsible for issuing flood forecast. The various flood forecasting centres are using different forecasting models, based on availability of hydrological and hydro-meteorological data, the basin characteristics, computational facilities available at forecasting centres, warning time required and purpose of forecast. However, some of the common methods being used by these centres are given below:

i). Simple correlation – based on stage-discharge data.
ii). Co-axial correlation – based on stage, discharge and rainfall data etc.
iii). Routing by Muskingum method and Successive routing through sub-reaches.

Recently, Flood Management Improvement Support Centre (FMISC), Water Resources Department, Government of Bihar has engaged DHI (India) Water & Environment to develop the Flood Forecast and Inundation Modeling System in Bagmati-Adhwara Basin. Hydrological modeling has been developed using NAM (Rainfall-Runoff) module of MIKE11 11 system. The NAM model computes catchment runoff from Nepal and Bihar. Model parameters are calibrated for both Bihar and Nepal catchments. Hydrodynamic Model is developed based upon the schematization of river network, river cross-section, model boundaries; cross-section extracted from DEM. DEM is developed from available LIDAR data for some area and SRTM data for the rest of the basin. The entire model has been designed to give a lead time of 72 hours along with the inundation maps showing depth, time of travel etc.

6. Methodology

It is proposed to develop the flood forecasting model for the study area using Integrated Flood Analysis System (IFAS) which a runoff calculation program conducting a distribution-model runoff analysis which uses “PWRI (Public Works Research Institute) distribution model as runoff analysis engine. The program uses on web based topographical and meteorological data. The performance of the model output at the observed GD site in Bagmati basin would be evaluated. Further, it is proposed to use HEC HMS of USACE, a physically based quasi-distributed model for rainfall runoff modeling. The results thus obtained would be compared with the Integrated Flood Analysis System (IFAS) model output.

Work schedule:

(a) Date of commencement of the project: April 2013
(b)Duration of the project: Three year.
(c)Stages of work and milestone:

S. No.	Work Element	2013 (6 M)	2013 (6 M)	2014 (6 M)	2014 (6 M)	2015 (6 M)	2015 (6 M)	Status
1.	Literature review							Completed
2.	Software downloading & learning							Completed
3.	Selection of study area							Completed
4.	Collection of hydrological meteorological data							Completed
5.	Development of GIS data base for study area							Completed
6.	IFAS model development and evaluation of its performance							In progress
7.	HEC HMS model setup and analysis & its result comparison							To be done
8.	Report preparation							To be done

Progress: The literature review has been carried out. The IFAS is downloaded and practiced. The hydrological and meteorological data for the study area have been collected. From the web site of GFAS, online data pertaining to terrain, land use and soil characteristics have been downloaded. The flow data for Hayaghat sites and rating curves for Hayaghat and Ekmighat sites has been collected. The Hourly data for 3 years (2007-2009) has been collected for Hayaghat and Ekmighat sites. The satellite based rainfall estimate has been downloaded. The landuse/ cover data is to be estimated using satellite imagery. The model development, model calibration and validation would be completed during the current year. IFAS simulation is in progress. Further, SRTM derived terrain analysis has been carried out.

7. Research Outcome from the project:

(i) Evaluation of satellite rainfall estimate for flood forecast
(ii) Development of HEC HMS model for Bagmati bain using satellite rainfall estimates.

Time Series analysis of Monthly Rainfall in Mahi Basin

1. **Thrust Area under XII five year plan**: Non Structural Measures of Flood Management

2. **Project Team:**

   (a) Sri N. G. Pandey, Sc 'D', CFMS, Patna (PI)
   (b) Sri. Biswajit Chakravorty, Sc 'F', CFMS, Patna (Co-PI)
   (c) Dr. Sanjay Kumar, Sc 'D', SWHD, NIH Roorkee (Co-PI)

3. **Title of the Project:** Time Series analysis of Monthly Rainfall in Mahi Basin

4. **Objectives of the study:**
   (i) The main objective is to investigate the annual and seasonal rainfall data and to make inferences regarding trends and postulating a model that fits these trends in the data.
   (ii) Development of relationship to convert monthly to daily rainfall and to find out the anomalies.

Statement of the problem: Time series analysis of rainfall data helps in identifying the trends in rainfall over the catchment. In this study the historical monthly rainfall records of IMD stations located in the districts of Chapra, Siwan and Gopalgunj of Mahi basin (a sub basin of Ghagra-Gandak composite basin) of North Bihar has been taken up for investigation. The annual and seasonal trends would be examined using available past rainfall data in the Mahi basin. The main objective is to investigate the annual and seasonal rainfall data and to make inferences regarding trends and postulating a model that fits these trends in the data. The statistical characteristics of the available annual and seasonal data have been evaluated and anomalies have been plotted to identify trends in the annual rainfall at some stations. Work is in progress to investigate these annual and seasonal trends at other stations.

Study area: Mahi basin is a tributary to river Ganga that lies in the Gandak-Ghagra composite river basin. Mahi is surrounded by three major rivers- Ghagra in the West, Gandak in the East and Ganga in the South. The total catchment area is about 2700 sq. km. It is on the left bank of Ganga and about 50 km away from Patna. Mahi river originates from Kaimur chaur of Ajbinagar village at Baikanthapur in Gopalganj district of North Bihar at latitude 26° 28 '00''N and longitude 84° 25' 47'' E. The catchment area of Mahi basin is about 2500 sq.km. and is bounded by Gandak basin in North and East, the Ghaghara basin in the West and river Ganga in the South. Total length of Mahi river is 91 km. It drains about 256 sq.km., excluding the drainage areas of its two tributaries namely Ghoghari and Gandaki. Mahi also functions as an escape channel of the Gandak canal system. It falls into Ganga near Nayagaon. Chapra, Siwan and Gopalgunj are the 3 districts where IMD monthly rainfall data were available for the past 100 years.

5. **Present state of art:**

   Monthly rainfall data is not useful in hydrological perspective. Rainfall-runoff models need daily rainfall records. Daily rainfall data for long duration is not available but a monthly record throughout the country is available from IMD.

   Time series analysis of rainfall data helps in identifying the pattern of rainfall over the catchment. The identified pattern is extrapolated or extended to forecast the future events with the assumption that the pattern identified from the historical record is continuous and prevails in future. To know the properties of the historical record the time series is broken up into individual components and then each component is analyzed separately to understand the mechanism of different components.

6. Methodology

In this study the historical monthly rainfall records of IMD stations located in the districts of Chapra, Siwan and Gopalgunj of Mahi basin (a sub basin of Ghagra-Gandak composite basin) of North Bihar has been taken up.

Analysis of monthly time series data is to understand the mechanism that generates the data so that the future sequences may be simulated or forecasted over a short period of time (forecasting). These are attempted by making inferences regarding the underlying laws of the stochastic process from the historical data and then by postulating a model that fits the data. ARIMA model will be used and effort will also be made to generate daily rainfall data from the monthly data by analyzing the daily rainfall trends.

7. Work schedule:

(a) Date of commencement of the project: April 2014

(b)Duration of the project: 2 year.

(c)Stages of work and milestone:

SN	Work Element	2014	2014	2015	2015	Status
1.	Literature review					Completed
2.	Software downloading & learning					Completed
3.	Selection of study area					Completed
4.	Collection of hydro-meteorological data					In progress
5.	Development of ARIMA model					To be done
6.	Validation and evaluation of its performance					To be done
7.	Report preparation					To be done

Progress

The literature review has been carried out. The meteorological data (monthly rainfall) for the study area have been collected from IMD, Pune. Collection of daily rainfall data of Chapra, Siwan and Gopalgunj are in progress. The model development, model calibration and validation would be completed during the current year.

8. Research outcome from the project:

(i) A relationship among the 3 rainfall stations would be developed after removing trend and seasonality taking previous time steps using ARIMA model. This relation will be used to forecast the future events for Mahi basin.

Demonstration scheme on Riverbank Filtration in Gagatic plain of Bihar
(Proposed study)

1. **Thrust Area under XII five year plan**: Water resources planning and management

2. **Project Team:**
   (a) Sri. Biswajit Chakravorty, Sc 'F', CFMS, Patna
   (b) Sri N. G. Pandey, Sc 'D', CFMS, Patna

3. **Title of the Project:** Riverbank Filtration in Gagatic plain of Bihar

4. **Objectives of the study:**

(i) Study and improve natural water treatment systems.
(ii) Popularize them among the various stakeholders.

Statement of the problem**:** Bank Filtration is a natural pre-treatment technology, which enables the utilisation of surface water sources such as lakes or rivers. The water passes through the natural porous sub-surface (aquifer) to the production well. The porous media serves as a natural filter and reduces the amount of suspended solids and pathogens. Bank filtrate from the production wells shows a significantly higher quality compared to water abstracted directly from surface or groundwater sources. BF is advantageous as a pre-treatment in order to reduce the necessary doses of chlorine prior to flocculation. Additional advantages of BF may also be seen during the monsoon season, principally in the removal of turbidity and pathogens, as well as in the removal of colour and dissolved organic carbon (DOC), UV absorbance, turbidity, and total thermo tolerant coliform counts.

NIH proposes to develop pilot demonstration schemes on BF for sustainable drinking water supply.

Study area: It is proposed to develop pilot demonstration schemes on BF on the right bank of Ganga river in and around Ara locality of Bihar for sustainable drinking water supply. The area is arsenic affected and therefore it is proposed to take up R&D study to see and improve natural water treatment systems.

5. **Present state of art:**

A collaborative European Union research project on river bank filtration under 'Saph Pani' started in October 2011 with duration of 36 months involving a consortium of 20 partners from India, European Union, Switzerland, Sri Lanka and Australia. Its full name is "Enhancement of natural water systems and treatment methods for safe and sustainable water supply in India" and it addresses the water challenges of the 21th century in India. The Saph Pani project aimed to study and improve natural water treatment systems such as bank filtration (BF), managed aquifer recharge (MAR) and constructed wetlands (CW) in India building Indian and European expertise in those fields. All the above three technologies have vast potential in the Indian context, and the objective under Saph Pani was to strengthen the scientific understanding of the technologies and their processes, and popularize them among the various stakeholders in India. The project focused on a set of specific case studies in India, and sustainability assessment was also performed for those case study sites, covering human health, environmental, economic, institutional and social aspects. Three thematic training courses, one each on the three technologies mentioned above, were also organized for the stakeholders in addition to practitioners' exposure tours. Water management plans for natural treatment systems were developed and suitable policy frameworks prepared.

6. Methodology

RBF is the influx of River water to the aquifer induced by a hydraulic gradient. Collector wells along banks in a certain distance from the river create a pressure head difference due to drawdown between the River and the well, which induces water from the river to flow through the porous media into the pumping wells. By this process, the water from the river passes through the porous material between the river and the well acting as a filtration media removing undesirable constituents from the river water. By applying this system of drinking water extraction, two different water resources are used namely surface water from the river percolating towards the well and the groundwater of the surrounding aquifer. It means the site selected for RBF is to be located where porous material is present between the River and the well to act as a filtration media to remove undesirable constituents from the River water. At the same time the yield of such well need to be reasonable high so that it caters the water supply need.

7. Work schedule:

(a) Date of commencement of the project: April 2015
(b) Duration of the project: 2 year.
(c) Stages of work and milestone:

S. No.	Work Element	2015	2015	2016	2016	Status
1.	Literature review					To be done
2.	Site selection					To be done
3.	Execution of demonstration well					To be done
4.	Performance of well					To be done
5.	Sampling and water quality analysis					To be done
6.	Report preparation					To be done

8. Research outcome from the project:

Study and improve natural water treatment systems through bank filtration and after successful implementation the effort would be to popularize them among the stakeholders and to other places.

Spatial and Temporal Distribution of Geochemical Characteristics and Environmental Stable Isotopes in Groundwater of North Bengal
(Proposed Study)

1. **Thrust Area under XII five year Plan:** Water quality assessment in specific areas and Application of modern techniques to provide the solution to hydrological problems.

2. **Project team:**
   a. Project Investigator: S.R. Kumar, Sc. 'D'
   b. Project Co-Investigator(s): Dr. M.S. Rao, Sc. 'D' and Officials from SWID

3. **Title of the Project:** Spatial and Temporal Distribution of Geochemical Characteristics and Environmental Stable Isotopes in Groundwater of North Bengal

4. **Objective:** To prepare spatial and temporal distribution maps to identify degraded WQ zones for taking remedial measures.
   Mapping the stable isotopic composition in the groundwater
   Mapping the dissolved radon in groundwater and its implication

5. **Present state-of-art:** People in the districts of north Bengal tend to use groundwater through dug wells, hand pumps and deep tube wells which led to recession in groundwater level and contamination by different pollutants. The groundwater is also being used for irrigation. The quality of groundwater is important to humans when used as a drinking water supply. There are pockets of high iron and fluoride contamination in the study area and comprehensive water quality study has not been attempted for quality assessment.

6. **Methodology:** In the present study it is proposed to map the safe zones, vulnerable zone and potential risk zones for groundwater quality by mapping the study area on GIS platform using EC, stable isotope, radon and water quality data in North Bengal region of West Bengal. For the study, groundwater samples will be collected in pre- & post monsoon seasons. In-situ analysis will be done for EC, temperature and radon concentration. Samples will be analyzed for stable isotope composition at HQ, NIH, Roorkee. As these parameters (EC, Temperature, stable isotope composition, Redon concentration) are expected to change during monsoon and non-monsoon season, samples will be collected on monthly basis for two seasons: before and after the monsoon. Long term data on water table will be collected to examine the seasonal dependency conditions. Rainfall data will also be collected to interpret the results. Technical support from SWID will be taken in groundwater sampling and for collating the archival data. Thematic maps (spatial and temporal) would also be generated using GIS. Isotopes and groundwater chemistry data would be used to identify the groundwater recharge source. Isotopic data will be processed as per IAEA criteria, ionic relationships would be developed and water types would be identified.

7. **Research outcome:**
   Thematic maps of variation of (i) stable isotopic composition (ii) major ions and (iii) radon in groundwater. Interpretation of the WQ data.
   Mapping the areas of safe groundwater, vulnerable and potential risk zone according to BIS and WQI.
   Knowledge dissemination in terms of publications (report, papers in journals and conferences etc.)
   The report would be of immense use to the planners, administrators and engineers concerned with the management and protection of groundwater quality in north Bengal.

8. Work Schedule:

a. Probable date of commencement of the project: April, 2015
b. Duration of the project: 1 years
c. Stages of work and milestone:

Year 2015-16

Sl. No.	Work Element	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	Literature collection	✓	✓		
2	Field work for water sampling and data collection	✓	✓	✓	✓
3	Sample analysis	✓	✓	✓	✓
4	Data interpretation, interim report, publications			✓	✓
5	Attending seminar/conf./symposia			✓	✓

APPENDIX 68.4.2

LIST OF PAPERS PUBLISHED/ ACCEPTED FOR PUBLICATION DURING JULY, 2014 – MARCH, 2015 & APRIL, 2015– MAY, 2015

LIST OF PAPERS PUBLISHDED/ACCEPTED FOR PUBLICATION

		July, 2014 – March, 2015		April, 2015 – May, 2015	
S.No.	**Item**	**Published**	**Accepted**	**Published**	**Accepted**
1.	International Journal	45	0	9	1
2.	National Journal	11	4	1	1
3.	International Conference/ Seminar/ Symposium	67	0	1	
4.	National Conference/ Seminar/ Symposium	38	0	2	
5.	Books/ Chapter published/ accepted	04	0	1	
	Total	165	4	14	2

Research Papers Published/ Accepted during July, 2014 to March, 2015

International Journal
Published

1. Jaiswal, R.K., Thomas, T. Galkate, R.V., Ghosh, N.C. and S.Singh (2014), "Reservoir operation & planning using MIKE BASIN in drought affected Bundelkhand region of M.P. India", Int. Jr. of Earth Sciences & Engineering, Vol.7, No.1, 349-355.
2. Bharatkar, P.S., R.Patel and D.G. Durbude (2014), "Novel Algorithm for RS image classification", J. Indian Soc. Remote Sensing, June 2014, 42(2), 435-437.
3. Jaiswal RK, Ghosh N C, Guru P, Devankant (2014) MIKE BASIN Based Decision Support Tool for Water Sharing and Irrigation Management in Rangwan Command of India, Int. J. Advances in Agriculture, http.//dx.doi.org/10.1155/2014/924948.
4. Nikam B R, Kumar P, Garg V, Thakur PK and Aggarwal SP. (2014). Comparative evaluation of different potential evapotranspiration estimation approaches. International Journal of Research in Engineering and Technology, Vol. - 03, Issue – 06.
5. Palmate, S.S., Pandey, A., Kumar Dheeraj, Pandey, R. P. and Mishra, S.K.(2014). Climate change impact on forest cover and vegetation in Betwa Basin,India. Applied Water Science. Published on line, July 2014 (*DOI 10.1007/s13201-014-0222-6)*.
6. Jain, Vinit Kumar; Manoj Kumar Jain, and Rajendra Prasad Pandey (2014). Effect of the Length of the Streamflow Record on Truncation Level for Assessment of Streamflow Drought Characteristics. Journal of Hydrologic Engineering, Vol. 19, No. 7, July 2014, pp.1361-1373,(*doi*: http://dx.*doi*.org/*10.1061*/(*ASCE*)*HE.1943-5584.0000922*).
7. Nayak, P. C., K. P. Sudheer, and S. K. Jain (2014). River flow forecasting through nonlinear local approximation in a fuzzy model. Neural Computing and Applications, DOI 10.1007/s00521-014-1684-z.
8. Arora, Manohar, Rakesh Kumar, R D Singh, Jatin Malhotra and Naresh Kumar (2014), Analysis of unusual meteorological conditions that led to recent floods in Bhagirathi Basin (Uttarakhand Himalayas). Hydrological Sciences Journal, DOI 10.1080/02626667.2014.951362. Online: 08 August 2014.
9. Kumar, S.R (2014), "Temperature and Rainfall Trends in Patna: An Analysis based on Records for the Period 1901-2002", (International Research Journal of Humanities and Environmental Issues (IRJHEI)) ISSN: 2277-9329 (Vol. III, Issue 4, July 2014, pp 1-7).
10. Krishan, Gopal, M.S. Rao, R.S. Loyal, A.K. Lohani, N.K. Tuli, K.S. Takshi, C.P. Kumar, P. Semwal and Sandeep Kumar, 'Groundwater level analyses of Punjab, India: a quantitative approach', Octa Journal of Environment Research. 2(3):123.

11. Mondal, A., Khare, D., Kundu, S., Meena, PK, Mishra, PK and Shukla, R. (2014). Impact of climate change on future soil erosion in different slope, land use, and soil-type conditions in a part of the Narmada River Basin, India, ASCE J. Hydrol. Eng, pp 1-11.
12. Arora, Manohar, Rakesh Kumar, Jatin Malhotra and Naresh Kumar (2014), 'Correlation of Streamflow and Climatic Variables for a large Glacierized basin', Journal of Water Resource and Protection.
13. Krishan, Gopal, M.S. Rao, B. Kumar, C.P. Kumar, S. Kumar, R.K. Jaiswal, YRS Rao, S. Tripathi, M. Kumar, P.K. Garg and P. Kumar, 'Monitoring of Southwest Monsoon using isotope analysis of ground level vapour (Glv) in Indian Sub-Continent', Journal of Earth Science and Climate Change. 5:8 http://dx.doi.org/10.4172 /2157-7617.1000224.
14. Jain Vinit, R.P.Pandey and M.K.Jain (2014), Spatio-Temporal Assessment of Vulnerability to Drought, Natural Hazards, Springer Publications, DOI 10.1007/s11069-014-1502-z, Published online in Nov. 2014.
15. Indwar, Shashi Poonam, Nilanchal Patel (2014), 'Classification accuracy analyses using Shannon's Entropy', International Journal of Engineering Research and Application . http://ijera.com/pages/v4no11(v4).html.
16. Thomas,T., S. S. Gunthe, N. C. Ghosh, and K P Sudheer (2014), 'Analysis of monsoon rainfall variability over Narmada basin in Central India : implication of climate change". In final proof correction stage', Journal of Water and Climate Change, IWA Publishing.
17. Thayyen, R.J. and A.P Dimri (2014): Factors controlling Slope Environmental Lapse Rate (SELR) of temperature in the monsoon and cold-arid glacio-hydrological regimes of the Himalaya, The Cryosphere Discuss,8, 5645-5686, doi:10.5194/tcd-8-5645-2014.
18. Rai, S P, Rajeev Saran Ahluwalia, S K Jain, D.P. Dobhal, 'Estimation of snow and glacier melt contribution in the upper part of the Beas River basin, Himachal Pradesh using conventional and SNOWMOD modeling approach', Accepted for publication in Journal of Water and Climate Change.
19. Krishan, Gopal, M.S. Rao, C.P. Kumar and Prabhat Semwal, 'Radon Concentration in Groundwater of East Coast of West Bengal, India', Journal of Radio analytical and Nuclear Chemistry.
20. Kasiviswanathan, K.S., Avinash Agarwal, A. R. Senthil Kumar (2014). "Radial Basis Function Neural Networks for Rainfall-Runoff Modeling". Journal of Water Resource Engineering and Management, Volume 1, Issue 2, ISSN: 2349 – 4336.
21. Sharma, M.K. & C.K. Jain, 'Hydrogeochemical studies of Groundwater in and around metropolitan Vadodara, Gujarat, India', Internal Journal of Engineering Research, Issue Special 3, pp.180-184.
22. Galkate, Ravi, 'Rainfall Runoff Model Development Under Regulated River Flow Condition. IJSET, 2014 (ISSN: 2277-1581).
23. Thomas, T., 'Comprehensive Evaluation of Changing Drought Characteristics in Bundelkhand Region of central India Meteorol Phys, published online, Springs, DOI 10.1007/S00703-014-0361-1.
24. Jaiswal, R.K., 'Trend Assessment For Extrem Rainfall Indices In The Upper Mahanadi With Reference To Climate Change IJSET, 2014 (ISSN : 2277-1581)
25. Thomas, T., 'Reservoir Modeling In Bearma Basin By Using Mike Basin 95 International Journal of Engineering Research ISSN:2319- 6890)(online),2347-5013(print).
26. Shanmugapriya S, Heltin Genitha C, Jeyakanthan, V.S., Sanjeevi S. (2014). 'Super resolution Mapping of Hypersepectral image for Estimating Water-spread area of Peechi reservoir, Southern India'. Internation Journal of Applied Remote Sensing, Vol.8, pp: 1-15.
27. Venkata Ramana, R., B Krishna,Y. R. S. Rao and V.S.Jayakanthan (2014) ' Urban Watershed Rainfall Forecast of Chennai City' published in International Journal of Engineering Research ISSN:2319-6890)(online) special issue 3, pp 252-257.
28. Krishna, B., Y.R.Satyaji Rao and R.Venkata Ramana (2014) 'Improved Neuro-Wavelet Model for Reservoir Inflow Forecast' published in International Journal of Engineering

Research ISSN:2319-6890)(online) special issue 3 on Hydraulics, Water Resources, Coastal and Environmental Engineering(HYDRO 2014 International), pp 118-121.

29. Khadanga, G. and B.Krishna (2014) ‘Hydrological Data Modelling Using Wavelet, Neural Network and AR Models’ published in International Journal of Engineering Research ISSN:2319-6890)(online) special issue 3 on Hydraulics, Water Resources, Coastal and Environmental Engineering(HYDRO 2014 International), pp 115- 118.
30. Kumar, Rakesh, Narendra K. Goel, Chandranath Chatterjee, Purna C. Nayak, “Regional Flood Frequency Analysis using Soft Computing Techniques”. Water Resources Management, DOI 10.1007/s11269-015-0922-1.
31. Jeyakanthan, V.S. (2014). “Estimation of reservoir capacity using remote sensing data - a soft classification approach”. International Journal of Earth Sciences and Engineering, Vol.7, No.3, pp 1158-1163.
32. Krishan Gopal, Rao, M.S. and Kumar C.P. (2014). Estimation of Radon concentration in groundwater of coastal area in Baleshwar district of Odisha, India. Indoor and Built Environment. DOI: 10.1177/1420326X14549979.
33. Nayak, P. C., Wardlaw, Robin and Kharya, A. K. (2015), “Water balance approach to study the effect of climate change on groundwater storage for Sirhind command area in India”, International Journal of River Basin Management, doi: 10.1080/15715124.2015.1012206
34. Thomas, T., Jaiswal, R.K., Nayak, P.C. and Ghosh, N.C. (2015) “Comprehensive evaluation of the changing drought characteristics in Bundelkhand region of Madhya Pradesh in central India” Meteorology and Applied Physics, doi: 10.1007/s00703-014-0361-1
35. Thomas, T., Nayak, P. C, and Ghosh, N. C. (2015) “Spatiotemporal Analysis of Drought Characteristics in Bundelkhand Region of Central India using Standardized Precipitation Index and Climate Change Implications” Journal of Hydrologic Engineering, doi: 10.1061/(ASCE)HE.1943-5584.0001189.
36. Kundu, S., Khare, D., Mondal, A. and Mishra, P.K. (2015) “Analysis of spatial and temporal variation in rainfall trend of Madhya Pradesh, India (1901-2011)”, Environmental Earth Sciences, DOI 10.1007/s12665-014-3978-y.
37. Kumar, C. P., Surjeet Singh (2015), Concepts and Modeling of Groundwater System, International Journal of Innovative Science, Engineering and Technology (IJISET), ISSN: 2348–7968, Volume 2, Issue 2, February 2015, pp. 262-271.
38. Kumar, Sumant, N C Ghosh, R P Singh, Mahesh M Sonkusare, S Singh, and S Mittal (2015), Assessment of water quality of lakes for drinking and irrigation purposes in Raipur City, Chhattisgarh, India, International Journal of Engineering Research and Applications (IJERA), Vol. 5, Issue 2, pp.42-49.
39. Ghosh, N. C., Sumant Kumar, GescheGrützmacher, Shakeel Ahmed, Surjeet Singh, ChristophSprenger, Raj Pal Singh, Biswajit Das, and TanviArora (2015), Semi-analytical model for estimation of unsteady seepage from a large water body influenced by variable flows, Jour. Water Resources Management, Springer, DOI: 10.1007/s11269-015-0985-z.
40. Gautam, Narayan P., M. Arora (2015), “Study of climate change using GCm Downscaling: Special Reference ti Indian Sub-Conrinent”, HYDRO NEPAL, issue no. 16, Jan. 2015, 36-39.
41. Singh, Dharamveer, R D gupta, Sanjay K. Jain, “Statistical analysis of long term spatial and temporal trends of temperature parameters over Satluj river basin, India”, Jr. of Earth System Science, Feb. 2015, Vol. 124, Issue 1, pp.17-35.
42. Nayak, T.R., S.K. Gupta, R.Galkate, “GIS based mapping of Groundwater Fluctrations in Bina Basin”, Aquatic Procedia (Elsevier), Vol. 4, pp.1469-1476.
43. Jaiswal, R.K., N.C. Ghosh, R.V. Galkate, T.Thomas, “Multi Criteria Decision Analysis (MCDA) for Watershed Prioritization”, Aquatic Procedia, Vol. 4, pp.1553-1560.

44. Chandramohan T, .Venkatesh B. and Balchand A.N, “Evaluation of Three Soil Erosion Models for Small Watersheds”, Aquatic Procedia 4 (2015) 1227 – 1234.
45. Venkatesh, B., LakshmanNandagiri and B.K.Purandara, “Analysis of Temporal Stability of Observed Soil Moisture under plantation forest in Western Ghats of India”, Aquatic Procedia 4 (2015) 601 – 608

National Journal
Published

1. Durbude, D.G., C.K.Jain, Omkar Singh (2014). Assessment of e-flows for a river in Southern India using Hydrological Index Methods, J.IWRS, Vol.34, No.3, July 2014, pp.26-34.
2. Krishan, G., Rao, M. S., Purushothaman, P., Rawat, Y. S., Kumar, C.P., Gupta, S., Bhatia, A.K., Marwah, S., Kaushik, Y.B., Angurala, M.P. and Singh, G.P., ‘Groundwater Resources in Bist-Doab Region, Punjab, India-an overview’, NDC-WWC Journal. 3 (2): 5-13.
3. Arora, Manohar, Rakesh Kumar and N K Varshney, ‘Downscaling Vidiyan Evam Jalvigyaniya Nidarshan Padhti (Hindi) (2014)’, Bhartiya Vaigyanik Evam Audyogik Anusandhan Patrika, Varsh 22 Ank 1 June 2014. Prasht 37-40.
4. Krishan, Gopal, A.K. Lohani, Sudhir Kumar, M.S. Rao, ‘Use of isotope techniques for hydrological analysis in hydro-power projects’, Water and Energy International.
5. Ahmed, Tanveer, Sanjay K Jain, P K Agarwal , D S Rathore (2014), “Application of water resources through use of remote sensing and GIS” NISCARE, Vol 22 No. 2 December 2014 PP 107-113.
6. Sharma, M.K., Babita Sharma, Rakesh Goel and Beena Prasad (2014), ‘Advanced techniqyes available for water purification’, Bhattiya Vaiganik avam Audhaugik Anusandhan Patrika, Varsh 22, Ank 2, December 2014, pp. 120-122.
7. Thomas, T.(2014), ‘Metrological & hydrological drought characteristic in Bearma Basin of Bundelkhand region in MP, Shikha Sachan, T. Thomas, R.M. Singh India Journal of Soil conservation No. 42, No. 2, pp235-242.
8. Singh, Ashutosh, Surjeet Singh, A. K. Nema, Gaurav Singh, Anshu Gangwar (2014), ‘Rainfall-Runoff Modeling using MIKE11 NAM Model for Vinyanakpur Intercepted Catchment, Chhattisgarh’, Indian Journal of Dryland Agricultural Research and Development, Vol. 29(2), pp: 01-07.
9. Nema, M.K. (2015). “नर्मदा : मध्यभारत की जीवन रेखा” a cover page article in Jal Chetna, a Hindi Technical Magazine of National Institute of Hydrology, Roorkee, vol. 4(1), PP 6-10.
10. Krishan, Gopal, Lohani, A.K. Kumar, S., Rao, M.S. (2015) Use of isotope techniques for hydrological analysis in hydro-power projects, IASH Journal-International Association for Small Hydro, International Association for Small Hydro (IASH) 4(1), pp. 33-37.
11. Guru, Poonam, R.K. Jaiswal, Devkant, K.L., Mishra, “Reservoir operation and irrigation management using MIKE Basin Model for Rangawan Reservoir”, Journal of IWRS, Vol. 34(4), pp.108.

Accepted

1. Singh, Omkar and Sharma, M.K. (2015). Measurement of Dissolved Oxygen and Biochemical Oxygen Demand for the Hindon River, India, Paper accepted for J of IWRS, Vol. 35, No.1.
2. Gupta, Parul, Anupma Sharma, and Namita Joshi, “Groundwater Quality Assessment for Irrigation Suitability in Salinity Affected Coastal River Basin of Gujarat”, Paper accepted in IWRS Journal.

3. Singh, Vikrant Vijay ,Anupma Sharma and P.C. Joshi, "Downscaling of Climatic Data Using Statistical Techniques in Coastal Saurashtra", Paper accepted in IWRS Journal.
4. Ghosh, Narayan C. , SarojKumariKhatania, ShashiPoonamIndwar, Cornelius S. S. Sandhu, C. K. Jain, Sanjay Mittal, and RakeshGoel, "Performance evaluation of riverbank filtration scheme – A case study from Haridwar, India", Paper accepted in 'Current Science' Journal.

International Conference/ Training/ Seminar/ Workshop
Published

1. Kumar, S.R. (2014), "Infiltration studies in Kulsi River basin of North Eastern Region of India to understand the effect of Landuse Change", Int. Geographical Union (IGU-2014) Conf. on Geohazards, Resource Sustainability and Mountain Response to Global Change, June 4-5, 2014, Organised by Dept. of Geography and Regional Development, Univ. of Kashmir, Srinagar-190006, Abstract Vol. pp.65.
2. Kumar, S.R. and S.Chakma (2014), "Groundwater Quality Mapping using Krigging Technique of GIS: A case study of Tezpur in Assam Valley of Brahmaputra Basiin", Int. Geographical Union (IGU-2014) Conf. on Geohazards, Resource Sustainability and Mountain Response to Global Change, June 4-5, 2014, Organised by Dept. of Geography and Regional Development, Univ. of Kashmir, Srinagar-190006, Abstract Vol. pp.170.
3. Qazi, N.Q. and S.P. Rai (2014), " Forest Influence on Baseflow from Paired Micro-Watersheds of Garhwal Himalayas, India, Poster presentation in 7th Scientific Conference on the Global Water and Energy Cycle held at Hauge, Netherland, organised by Forld Forum, Wageningen University, Netherlands, 14-17July 2014.
4. Joshi, Suneel, R. Sinha, S.P. Rai, Sanjeev Gupta, Alexander Densmore, Philippa Mason (2014), "Groundwater Structure and Dynamics in the Ghaggar basin in NW India using Hydrogeological and Isotopic Approach", Presented in CWC-NERC workshop held at Oxford, United Kingdom during 25-26 June, 2014.
5. Rai S.P., J. S. Rawat, C. P. Kumar and R.D. Singh (2014), 'Hydrological response of micro-watersheds under different landuse conditions: a case study of Lesser Himalaya, Uttarakhand, India', Proceeding of Asia Pacific Workshop "Forest Hydrology Water and Forests-Beyond Traditional Forest Hydrology", APAFRI, FRIM, Malaysia, 83-86 pp.
6. Qazi, N.Q., Rai S.P., M.P. Singh, J.V. Tiyagi and S.P.S. Rawat, 'Spatial and temporal variability of suspended sediment load of two oak micro-watersheds of the Lesser Himalayas', Proceeding of Asia Pacific Workshop "Forest Hydrology Water and Forests-Beyond Traditional Forest Hydrology", APAFRI, FRIM Malaysia, 77-78pp.
7. Tyagi, J. V., Rai S. P., Nuzhat Qazi, R. D. Singh, R. K. Tiwari and M. P. Singh, 'Effect of forest cover structures on soil moisture variation-A case study in Oak Forested Watersheds', Proceeding of Asia Pacific Workshop "Forest Hydrology Water and Forests-Beyond Traditional Forest Hydrology", APAFRI, FRIM, Malaysia, 102-104 pp.
8. Tarafdar, S., K. Kumar, Bhishm Kumar and Rai S. P, 'An insight into the subsurface aquifer characteristics through spring flow isotope Investigation in Pauri Urban Area', Proceeding of Asia Pacific Workshop "Forest Hydrology Water and Forests-Beyond Traditional Forest Hydrology", APAFRI, FRIM, Malaysia, 192-196 pp.
9. Tyagi, J.V., Nuzhat Qazi, Rai S.P. and M.P., 'Assessment of Hydrological response of Dense and Degraded Oak Forests Using SWAT published', Proceeding of Asia Pacific Workshop "Forest Hydrology Water and Forests-Beyond Traditional Forest Hydrology", APAFRI, FRIM, Malaysia, 178-180p.
10. Lapworth, D.J., G. Krishan, A.M. Macdonald, M.S. Rao, D.C. Gooddy & W.G. Darling (2014), 'Using Environmental Tracers To Understand The Response Of Groundwater

Resources In Nw India To Sustained Abstraction', IAH 2014*Groundwater: Challenges and Strategies* International Association of Hydrogeologists 41st International Congress At Marrakech Morocco Sep 18-19, 2014.

11. Macdonald, A.M., H.C. Bonsor, K. Gopal, M.S. Rao, K.M. Ahmed, R.G. Taylor, M. Shamsudduha, F. Van Steenbergen, A.A. Mackenzie, A. Dixit, M. Moench & J. Tucker (2014), 'Groundwater In The Indo-Gangetic Basin: Evolution Of Groundwater Typologies', IAH 2014 *Groundwater: Challenges and Strategies* International Association of Hydrogeologists 41st International Congress At Marrakech Morocco Sep 18-19, 2014.
12. Arora, Manohar, Rakesh Kumar, Naresh Kumar and Jatin Malhotra (2014), 'Hydrological modeling and streamflow characterization of Gangotri Glacier', International Conference "Geostatistical and Geospatial Approaches for the Characterization of Natural Resources in the Environment: Challenges, Processes and Strategies". 17-20 October 2014, Jawaharlal Nehru University, Delhi.
13. Patra, J.P., Rakesh Kumar and Pankaj Mani (2014), 'Spatiotemporal Characteristics of Drought in the Baitarani River Basin, India', International Conference "Geostatistical and Geospatial Approaches for the Characterization of Natural Resources in the Environment: Challenges, Processes and Strategies". 17-20 October 2014, Jawaharlal Nehru University, Delhi.
14. Krishan, Gopal, A.K. Lohani, M.S. Rao, C.P. Kumar and K.S. Takshi (2014), 'Groundwater fluctuation and trend in Amritsar, Punjab, India', In Proc. of 16th annual Conf. of the International Association for Mathematical Geosciences (IAMG-2014) on Geo-statistical and Geospatial approaches for the characterization of natural resources in the environment: challenges, processes and strategies during Oct. 17-20, 2014 at JNU, New Delhi. Pp.30.
15. Rai, S. P. & Bhishm Kumar,(2014). Identification of Recharge Sources And Zones of Springs Using Environmental Isotopes: Case Studies of Western Himalyan Region, Uttarakhand, India', IAMG2014 Organised by JNU, New Delhi During 17-20 Oct 2014.
16. Verma, S. K., S. P. Rai, M. S. Rao and C. P. Kumar (2014), 'Assessment of Groundwater Recharge due to Monsoon in Ozar Watershed of Maharashtra State using Isotopic Technique', 16th International Conference of International Association of Mathematical Geosciences (IAMG-2014) organized by J. N.U., New Delhi during Oct. 17-20, 2014.
17. Saxena, Shilpi, J. P. Shrivastava, S. K. Verma, C. P. Kumar and Bhishm Kumar (2014), 'Application of Environmental Isotopes as a Tool in Investigating of Groundwater Contamination', 16th International Conference of International Association of Mathematical Geosciences (IAMG-2014) organized by J. N.U., New Delhi during Oct. 17-20, 2014.
18. Singh, Rajesh, Sumant Kumar and Megha Garg (2014), Domestic waste water treatment using Tanfloc: A Tannin based coagulant, In. Geostatistical and Geospatial approaches for the characterization of Natural Resources in the Environment Challenges, Processes and Startegies (Ed. Raju, N. J.) ISBN 978-93-81891-25-4, Springer and Capital Publishing Company, New Delhi, pp.202-205, IAMG Conference, JNU, New Delhi.
19. Kumar, Sumant, N C ghosh, R P Singh, Rajesh Singh, Surjeet Singh (2014), Impact of canal recharge on Groundwater Quality of Kolayat Area, District Bikaner, India, In: Geostatistical and Geospatial approaches for the characterization of Natural Resources in the Environment Challenges, Processes and Startegies (Ed. Raju, N. J.) ISBN 978-93-81891-25-4, Springer and Capital Publishing Company, New Delhi, pp.198-201, IAMG Conference, JNU, New Delhi.
20. Kumar, S R (2014), 'Groundwater quality mapping using Krigging technique of GIS: A case study of Tezpur in Asaam valley of Brahmaputra basin (Chapter in book, pp:900-906), (Published by Allied Publishers, New Delhi, ISBN No: 978-81-8424-952-1), 4th International Conference on Hydrology and Watershed Management (ICHWAM-2014)

(29 Oct - 1 Nov, 2014).Org. by Centre for Water Resources, Jawaharlal Nehru Technological University, Hyderabad, Andhra Pradesh.

21. Kumar, S R (2014), 'Evaluation of groundwater corrosivity using the Larson-Skold Index and Baylis Curve methods (Chapter in book, pp:885-890), (Published by Allied Publishers, New Delhi, ISBN No: 978-81-8424-952-1), 4th International Conference on Hydrology and Watershed Management (ICHWAM-2014) (29 Oct - 1 Nov, 2014).Org. by Centre for Water Resources, Jawaharlal Nehru Technological University, Hyderabad, Andhra Pradesh.
22. Nayak, T.R. (2014), 'Remote Sensing and GIS Applications for Estimation of Runoff in an Un-gauged watershed', International Conference on "Hydrology and Watershed Management" during 29th Oct-1st Nov, 2014.
23. Satyaji. Rao, Y.R. (2014) "Potential of River bank Filtration in Andhra Pradesh, India". Published in the 4th International Conference on Hydrology and Watershed Management with a Focal Theme on "Ecosystem Resilience - Rural and Urban Water Requirements". Jawaharlal Nehru Technological University Hyderabad, 29th October - 1st November, Vol-I, pp 337-344.
24. Krishna, B., R. Venkata Ramana and Y. R. Satyaji. Rao (2014) "Wavelet Denoising Performance via ANN based Streamflow Forecasting Model". Published in the 4th International Conference on Hydrology and Watershed Management with a Focal Theme on "Ecosystem Resilience - Rural and Urban Water Requirements". Jawaharlal Nehru Technological University Hyderabad, 29th October - 1st November, 2014. Vol-II, pp 1125-1130.
25. Venkata Ramana, R., B. Krishna, Y. R. S. Rao and V. S. Jeyakanthan (2014) "Applications of hybrid wavelet–Artificial Intelligence models in rainfall forecast of Greater Hyderabad City". Published in 4th International Conference on Hydrology and Watershed Management with a Focal Theme on " Ecosystem Resilience - Rural and Urban Water Requirements". Jawaharlal Nehru Technological University Hyderabad, 29th October - 1st November, 2014. Vol-II, pp 1204-1215.
26. Jeyakanthan, V.S, Shanmuga Priya S, Heltin Genitha C and Sanjeevi S (2014) "Reservoir capacity estimation using remote sensing data – Per-pixel classification and super resolution mapping approaches". Published in the 4th International Conference on Hydrology and Watershed Management with a Focal Theme on "Ecosystem Resilience - Rural and Urban Water Requirements". Jawaharlal Nehru Technological University Hyderabad, 29th October - 1st November. Vol-I, pp 524-530.
27. Pandey, R.P.(2014), "A method for integrated assessment of vulnerability to drought", The 5th International Conference on Deserts, Drylands & Desertification, Ben-Gurion University of the Negev, 17-20 Nov. 2014, Sede Boqer, Israel, pp 92.
28. Singh, Vikrant Vijay, Anupma Sharma, P.C. Joshi (2014), 'Modelling current and futuristic runoff response in coastal watershed using SWAT: a case study in Saurashtra region, Gujarat, India', International Scientific Conference on Environmental Research: Issues, Challenges and Strategies for Sustainable Development and Livelihood Security', Lumbini, Nepal, November 1-3, 2014.
29. Gupta, Parul, Anupma Sharma, Namita Joshi (2014), 'Role of shelterbelt plantation as effective bioshields in saline coastal tracts of Gujarat', International Scientific Conference on Environmental Research: Issues, Challenges and Strategies for Sustainable Development and Livelihood Security', Lumbini, Nepal, November 1-3, 2014.
30. Krishan, Gopal, P.Garg, KS Takshi, A.K. Lohani, M.S. Rao, RS Loyal, CP Kumar, NK Tuli, M. Singh and P. Semwal (2014), 'Monitoring of Groundwater Fluctuations and Trend in Parts of Northern Punjab (vern. Majha), India', International conference on "Annual Water Resources Association 2014 AWRA" during 3-6 November, 2014 at Virginia, USA.
31. Amni, Pankaj, Rakesh Kumar, J.P. Patra (2014), 'Impact of DEM grid size on estimation of flood depth and flood level using 1D-2D coupled flow model', 19th International

conference on Hydraulics, Water Resources, Costal and Environmental Engineering (HYDRO 2014 International). 18-20 December, 2014, MANIT Bhopal.

32. Arora, Manohar, Rakesh Kumar, R D Singh, Jatin Malhotra and Naresh Kumar(2014), '. Investigation in observational rainfall characteristics in Gangotri glacier basin', 19th International conference on Hydraulics, Water Resources, Costal and Environmental Engineering (HYDRO 2014 International). 18-20 December, 2014, MANIT Bhopal.

33. Jain, C.K. (2014), 'Hydrogeochemical studies of groundwater in and around metropolitan Vadodara, Gujarat, India', 19th International conference on Hydraulics, Water Resources, Costal and Environmental Engineering (HYDRO 2014 International). 18-20 December, 2014, MANIT Bhopal.

34. Verma, S. K.(2014), 'Estimation of Groundwater Recharge due to Monsoon rains in Narsinghpur (M.P.), India using Isotopic Technique', 19th International Conference on Hydraulics, Water resources & Environmental Engineering (HYDRO-2014 INTERNATIONAL) organized by Maulana Azad National Institute of Technology, Bhopal (M.P.), India during Dec. 18-20, 2014.

35. Debnath, Palash, Abhijit Mukherjee, M.S. Rao and Gopal Krishan (2014), 'Stable isotope signature of groundwater-seawater interaction in a micro-tidal coast of the Bay of Bengal', AGU-2014, Fall Meeting, San Francisco, December 15-19, 2014.

36. Krishan, Gopal, M.S. Rao, A.K. Lohani, CP Kumar, KS Takshi, NK Tuli, RS Loyal, and G.S. Gill (2014), 'Assessment of groundwater level in southwest Punjab, India', International conference on "19th Conference on Hydraulics, Water resources & Environmental Engineering Hydro 2014" during 18-20 December, 2014 at MANIT, Bhopal, India.

37. Rai, S. P., S. Joshi, R. Sinha, S. Gupta, A. L. Densmore, Y.S. Rawat, S. Shekhar (2014), 'Sources and relative timing of groundwater recharge in northwest India using environmental isotopes', International conf. *AGU Fall Meeting* organized by Americal Geophysical Union from 15-19 Dec 2014.

38. Joshi, S., S. P. Rai, R. Sinha, S. Gupta, S. Shekhar, Y. S. Rawat, M. Yaduprami, P. J. Mason, A. L. Densmore, A. Singh, N. Nayak, and W. M. van Dijk (2014), 'Spatio-temporal Variations in Groundwater Levels in Northwest India and Implications for Future Groundwater Management', International conf. *AGU Fall Meeting* organized by Americal Geophysical Union from 15-19 Dec 2014.

39. Vam Dijk, W.M., A.L. Densmore, R. Sinha, S. Gupta, A. Singh, S. Yoshi, N. Nayak, M. Yaduprami, S. Shekhar, S.P. Rai, D. Kumar, and P.J. Mason (2014), 'Geomorphology and sedimentary architecture of the Sutlej-Yamuna plain, India, and implications for groundwater resources', International conf. *AGU Fall Meeting* organized by Americal Geophysical Union from 15-19 Dec 2014.

40. Thomas, T. (2014), 'Effective Drought Index Based Evaluation of Meteorological Drought Characteristics is Bundelkhand Region of Central India', ISH-HYDRO-2014 International.

41. Thomas, T. (2014), 'Groundwater Drought Scenario in Bundelkhand Region of Central India. A Case Study for Sonar Basin on Madhya Pradesh. ISH-HYDRO-2014 International.

42. Thomas, T., 'Change Detection In Land Use/Land Cover Using Remote Sensing And Gis – A Case Study For Ur Basin In Tikamgarh District.

43. Shivhare, V. and M. K. Goel (2014). "Simulation of surface runoff for upper Tapi sub-catchment area (Burhanpur Watershed) using SWAT", International Conference on "Operational RS Applications: Opportunities, Progress, and Challenges", organized by ISPRS Technical Commission during December 9 – 12, 2014 at Hyderabad.

44. Mishra, P.K., Jain, Sharad K., Jain, Sanjay K. and Nema, M.K. (2014) "Investigating regional trends for the KBK region of Odisha, India", proceeding of HYDRO 2014, 19th International Conference on Hydraulics, Water Resources, Coastal & Environmental Engineering during December 18-20, 2014 at Maulana Azad National Institute of Technology (MANIT), Bhopal.

45. Nema, M.K., Jain, Sharad K. and Mishra, P.K., (2014) “Spatial and temporal distribution of rainfall trends in Bist-Doab region of Punjab (1901-2010)”, proceeding of HYDRO 2014, 19th International Conference on Hydraulics, Water Resources, Coastal & Environmental Engineering during December 18-20, 2014 at Maulana Azad National Institute of Technology (MANIT), Bhopal.
46. Arora, Manohar, Rakesh Kumar, Naresh Kumar and Jatin Malhotra (2014) Study of Uttarakhand Floods 2013: Fats and Plausible causes at Third India Water week 2015. New Delhi. 13-17 January 2015.
47. Singh, Surjeet, N.C. Ghosh, R.K. Jasiwal, T. Thomas, T.R. Nayak and R.V. Galkate (2014), ‘*Planning of Hydrological Data Monitoring Network for Integrated Water Resources Management of Bina River Pilot Basin’* ,during 18-20, Dec 2014, 19th International Conference on Hydraulics, Water Resources & Environmental Engineering (HYDRO-2014) organized by Maulana Azad National Institute of Technology (MANIT), Bhopal 2014.
48. Jain, Anshul, SR Kumar, KDSR Prashant and J. Ravi Kiran (2014), ‘The Quality of Groundwater for Irrigation Use’, VIIIth WAC- International Conference 2014 on Balancing Development and Environment (20-21 Nov. 2014) Org. by Aqua Foundation, N. Delhi. (Published in the proceedings pp 117-124).
49. Pandey, N.G., B. Chakravorty, Sanjay Kumar and P. Mani (2014), ‘Simple Model to Estimate Soil Water Retention Limits of Chattisgarh State (published in Int. Jr. of Engineering Research (Issue special3) ISSN: 2319-6890 (online), 2347-5013(print) pp 227-230). 19th International Conference On “Hydraulics, Water Resources, Coastal & Environmental Engineering, HYDRO-2014, International” at Bhopal, M.P. (Dec 18-20, 2014). Org. by Civil Engg. Dept., MANIT, Bhopal, M.P. and NIH, Roorkee.
50. Chakravorty, B., N.G. Pandey and Sanjay Kumar (2014), ‘Effect of Conjunctive Use on Water- logging in Lower Gandak Basin of Bihar (published in Int. Jr. of Scientific Engineering and Technology (Issue special) ISSN 2277-1581, pp 298-303) 19th International Conference On “Hydraulics, Water Resources, Coastal & Environmental Engineering, HYDRO-2014, International” at Bhopal, M.P. (Dec 18-20, 2014). Org. by Civil Engg. Dept., MANIT, Bhopal, M.P. and NIH, Roorkee.
51. Lohani, A.K., Krishan, Gopal, Rao, M.S., Kumar, S. (2015) Groundwater Level Simulation Using Artificial Neural Network: A Case Study from Punjab, India. Proceedings of International conference “India Water Week 2015-Water Management for Sustainable Development" (IWW-2015), 13-17 January, 2015 at New Delhi, India, Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India, New Delhi, pp. 114.
52. Chhabra, A.S., Dwivedi, V.K., Lohani, A.K., Arora, N., Kar, A.K. (2015) Relationship between Rainfall Variability and Agricultural Crop Yield Over Brahmaputra Basin, India: An Assessment to Crop Insurance in Rural Areas of India, Proceedings of International conference “India Water Week 2015-Water Management for Sustainable Development" (IWW-2015), 13-17 January, 2015 at New Delhi, India, Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India, New Delhi, pp. 56.
53. Patra, J.P., Rakesh Kumar and Pankaj Mani (2015), “Flood inundation Assessment using coupled 1D and 2D hydrodynamic modeling” Proceedings of 3rd India Week 2015: Water management for sustainable development. pp. 142.
54. Kumar, Rakesh, J.P.Patra, and Pankaj Mani, “Some aspects of Integrated flood management” Proceedings of 3rd India Week 2015: Water management for sustainable development. pp. 145.
55. Pandey R.P., Jain Vinit, and Manoj Jain (2015), A new methodology for integrated assessment of vulnerability to drought using multiple factor’. Published in proceedings & presented in Session: S11–‘Preparedness and management of water related disasters’, 3rd India Water Week 2015, Water Management for Sustainable Development, 13-17 January, 2015, New Delhi, India, pp. 137(1-13).

56. Pandey R.P., Chakraborty Shiulee, Rakesh Kumar and Pramod Narayan (2015), Study of climatic variability and long-term changes of irrigation water requirement. Published in proceedings & presented in Session: 'S4 - Impact of climate change on water resources with special reference to agricultural water needs', 3rd India Water Week 2015, Water Management for Sustainable Development, 13-17 January, 2015, New Delhi, India, pp. 60(1-11).
57. Pandey R.P., Kale R.V., Singh Rajesh and Kharya Ashok (2015), Investigating rural drinking water supply options – a case study for parts of Chitrakoot District in Uttar Pradesh. Published in proceedings & presented in Session: 'S5 - Drinking Water Supply—Issues and Challenges', 3rd India Water Week 2015, Water Management for Sustainable Development, 13-17 January, 2015, New Delhi, India pp. 73(1-9).
58. Kumar Amrit, Pandey R.P. and Mishra S.K. (2015), Study of meteorological drought characteristics in North-Western India. Published in proceedings & presented in Session: 'S11 – 'Preparedness and management of water related disasters', 3rd India Water Week 2015, Water Management for Sustainable Development, 13-17 January, 2015, New Delhi, India, pp. 136 (1-10).
59. Galkate R.V., Pandey R.P., Thomas T., Jaiswal R.K., and Nayak T. R. (2015), 'Meteorological and hydrological droughts in Central India'. Published in proceedings & presented in Session: S11 – 'Preparedness and management of water related disasters', 3rd India Water Week 2015, Water Management for Sustainable Development, 13-17 January, 2015, New Delhi, India, pp. 138(1-11).
60. Sarkar, Archana (2015), "Analysis of Historical Rainfall trends in Uttarakhand Himalayas presented in India Water Week- 2015 on 15.01.15 at Pragati Maidan, New Delhi.
61. Krishan, Gopal, K.S. Takshi, M.S. Rao, Sudhir Kumar and A.K. Lohani (2015), 'Spatial Analysis of Ground Water level in Pubjab', India Water Week-2015, New Delhi, India.
62. Singh, O. and Goyal, V.C. (2015). Hydrological Assessment for Water Conservation Planning in Ibrahimpur Masahi Village of Haridwar District (Uttarakhand), Intl. conf. on "India Water Week-2015", 13-17 January, 2015 organized by MOWR, RD & GR, New Delhi.
63. Nayak, P.C., Kudupudi Chaitanya, Venkata Ravibabu Mandla and Venkatesh B. (2015) "Trend analysis and Rainfall-runoff modelling for assessing impacts of climate Change for Halia sub-basin", India Water Week-2015 on theme "Impact of climate change on water resources with special reference to agriculture water needs",organised between 13-18, January, 2015
64. Venkatesh.B., Jose, M.K and Nayak, P. C. (2015) "Comparison of Observed and Forecasted Values of Precipitation by a Regional Climate Model over Malaprabha Basin, Karnataka, India", India Water Week-2015 on theme "Impact of climate change on water resources with special reference to agriculture water needs", organised between 13-18, January, 2015
65. Thayyen, R.J. (2015), "Ground ice melt in the catchment runoff in the Himalayan cold-arid system, Glaciology in High Mountain Asia, International Glaciological Society, 1-6 March 2015, Kathmandu.
66. Agrawal, A., A.P. Dimri and R.J. Thayyen (2015), "Mass balance and runoff from Gangotri glacier using remote sensing methods, In International Symposium on Glaciology in High Mountain Asia, International Glaciological Society, 1-6 March 2015, Kathmandu.
67. Arora, M. (2015)' "Extreme hydro-meteorological events – A case study of two successive flash floods in the Central Himalayas", Workshop on Extreme Climate Events: From Physics to Solutions. Riederalp, Switzerland, March 24 - 28, 2015 .

National Conference/ Training/ Seminar/ Workshop
Published

1. Thomas, T., R.K. Jaiswal, R.V. Galkate and N.C. Ghosh (2014), "Drought vulnerability assessment in Bundelkhand region of Central India", Proc. Of the conference on Disaster risk and Vulnerability, DRVC-2014 held at Kerala University, Trivandrum during 24-26 April, 2014.
2. Jain, C.K., "Water quality issues for preserving rivers in India", Nat. Conf. on "Preserning Rivers in India" at PHD Chambers of Commerce and Industries, New Delhi on 25th June, 2014.
4. गोपाल कृष्ण' ,पंकज कुमार ,एमराव .एस., सीकुमार .पी., भीष्म कुमार, आरजयसवाल.के., वाईराव .एस.आर., शवम् त्रिपाठी, मनीश कुमार, रिनोज थायन, प्रदीप कुमार, "ग्राउंड लेवल वेपर)GLV) के समस्थानिक वश्लेषण द्वारा द क्षणी पश्चिम मानसून का अनुश्रवण", भारतीय उष्णदेशीय मौसम वज्ञान संस्थान (आईआईटीएम) में दिनांक 30-31 जुलाई को "जलवायु परिवर्तन, मानसून परिवर्तिता एवं पूर्वानुमान तथा जलवायु सेवाएं : वैज्ञानिक दृष्टिकोण" नामक वषय पर आयोजित संगोष्ठी
5. पकंज गर्ग, गोपाल कृष्ण*, राजेश अग्रवाल, एम0 एस0 राव, " उत्तर प्रदेश के सहारनपुर जिले मे वर्षा की प्रवृति का वशलेषण", भारतीय उष्णदेशीय मौसम वज्ञान संस्थान (आईआईटीएम) में दिनांक 30-31 जुलाई को "जलवायु परिवर्तन, मानसून परिवर्तिता एवं पूर्वानुमान तथा जलवायु सेवाएं : वैज्ञानिक दृष्टिकोण" नामक वषय पर आयोजित संगोष्ठी
6. Krishan, Gopal, P.Garg, K.S. Takshi, A.K. Lohani, M.S. Rao, R.S. Loyal, C.P. Kumar, N.K. Tuli, M. Singh, P. Semwal, "Monitoring of Groundwater Fluctuations and Trend in Parts of Northern Punjab (vern. Majha), India" has been accepted for ORAL PRESENTATION for the 2014 Annual Water Resources Conference to be held in Virginia, USA during November 3-6, 2014.
7. Krishan, Gopal, P.K. Garg, M.S. Rao, C.P. Kumar, 'Samsthanic va jaliya rasaynik vidhiyon dwara Punjab ke Jalandhar evam Kapurthala jile mein bhu-jal ka anveshan', National conf. "Rastriya Hindi Vigyan Sammelan-2014", during 01st – 2nd August 2014 at ABVHV Bhopal, India.
8. Garg, P.K., Gopal Krishan, Rajesh Agarwal and Pawan Kumar, 'Majuli Dweep Ka Astititva – Ek Jwalant Samasya', National conf. "Rastriya Hindi Vigyan Sammelan-2014", during 01st – 2nd August 2014 at ABVHV Bhopal, India.
9. Krishan, Gopal, A.K. Lohani, Sudhir Kumar and M.S. Rao, 'Hydrological analysis for planning, designing and operation of hydro-power project', National conference on Challenges and Barriers in Hydro-power development during September 18-19 at Shimla, HP.Pp:111-120.
10. Venkatesh, B., "Modeling of Potential Evaporation for a humid river basin located in western ghats india", in HYDRO 2014 International.
11. Chandramohan, T., B. K. Purandra, M.K. Jose, "Estimation of Soil Erosion Using Modified Universal Soil Loss Equation (MUSLE) in GIS Environment" in HYDRO 2014 International.
12. Jain, Anshul, S R Kumar, KDSR Prashant & J. Ravi Kiran, 'Review of Corrosivity Indices to Recognize The Corrosive Strength of Groundwater', National Conf. on Advances in Soil, Water and Environmental Engineering (ASWEE 2014), 10-11 Oct. 2014 (Org. by Centre for Advanced Research in Env. School of Civil Engineering, Shanmugha Arts, Science, Technology and Research Academy Tirumalaisamudram, Thanjavur, SASTRA Univ., Tamil Nadu), pp.161-172.
13. KDSR Prashant, S R Kumar, J. Ravi Kiran and Anshul Jain, 'An Overview on Suitability Evaluation of Groundwater for Irrigation', National Conf. on Advances in Soil, Water and

Environmental Engineering (ASWEE 2014), 10-11 Oct. 2014 (Org. by Centre for Advanced Research in Env. School of Civil Engineering, Shanmugha Arts, Science, Technology and Research Academy Tirumalaisamudram, Thanjavur, SASTRA Univ., Tamil Nadu), pp.116-128.

14. Ravi Kiran, J., SR Kumar, Anshul Jain and KDSR Prashant, 'Graphical Presentation and Classification for Assessment of Groundwater Quality: A Review', National Conf. on Advances in Soil, Water and Environmental Engineering (ASWEE 2014), 10-11 Oct. 2014 (Org. by Centre for Advanced Research in Env. School of Civil Engineering, Shanmugha Arts, Science, Technology and Research Academy Tirumalaisamudram, Thanjavur, SASTRA Univ., Tamil Nadu), pp.173-180.
15. Arora, Manohar, Rakesh Kumar, Naresh Kumar and Jatin Malhotra, 'Forecasting of monthly discharge for Gangotri Glacier melt stream using Time Series Analysis', National Conference on Glaciology. Shimla. October 30 - 31, 2014.
16. Thayyen, R.J., Winter and summer mass balance of Phuche glacier, Ladakh Range, National conference on Himalayan Glaciology, Shimla 30-31 October2014, SERB New Delhi.
17. Rai, S. P., Renoj J. Thayyen and Y.S. Rawat: Isotopic characterisation of precipitation at South pullu, Leh & Ladakh, J&K, National conference on Himalayan Glaciology, Shimla 30-31 October2014, SERB New Delhi.
18. Rai, S.P., Manohar Arora, Sudhir Kumar and R. D. Singh, 'Runoff Generation Process in Head Water Region of Ganga, Garhwal Himalayas, using Environmental Isotope', Expert Meets and Conf. on Climate Change and Environmental Sustainability: Records from Poles to Tropics, 9-10 Sept 2014 organised by Lucknow Univ., Lucknow.
19. Rai, S. P., Renoj J. Thayyen and Y.S. Rawat, 'Isotopic Characterisation of Precipitation at South Pullu, Leh & Ladakh, J&K', National Conference on Himalayan Glaciology (NCHG-2014) 30-31 October 2014 Shimla, Himachal Pradesh, India.
20. Kumar, Pradeep, 'Concept of Integrated Water Resources Management', In Compendium: Training course on "More Crop per Drop : Issues and Challenges within Jammu Region" organized by WMRC, SKUAST, Chatha, Jammu during 9-11 Oct 2014, Page 46-56.
21. Thayyen, R.J, Role of Cryosphere and Hydrologic extremes in the infrastructure development of Ladakh region. In: Geological & Geophysical problems due to Glaciers, glaciated Lakes and Cloudbursts on Infrastructure development in Ladakh Region organised by Border Roads Organisation (HIMANK), 11-12 November 2014 at HIMANK, Leh.
22. Krishan, Gopal, A.K. Lohani, M.S. Rao, KS Takshi, CP Kumar and Prabhat Semwal, 'Quantitative analysis of groundwater monitoring data in Malwa region of Punjab', National conference on Emerging Technology Trends in Agricultural Engineering (ETTAE 2014) during November 07–09, 2014 at NERIST, Nirjuli (Itanagar) Pp 386-393.
23. Khobragade, Suhas, Prabhat Semwal, Sudhir Kumar, A. R. Senthil Kumar and R. D. Singh, 'Prediction of water availability in Sukhna lake, Chandigarh for summer 2015', published in the proceedings of the National Conference on "Emerging Trends in Water Quantity & Quality Management (ETWQQM-2014)" to be organized by Purnima University, Jaipur at Jaipur during 19-20 December, 2014.
24. Patra, J.P., Rakesh Kumar and Pankaj Mani, 'Estimation of Design Flood for Bargi Dam of River Narmada', National Conference on Emerging Trends in Water Quantity and Quality Management (ETWQQM-2014) at Poornima University, Jaipur, during December 19-20, 2014.
25. Mani, Pankaj, Rakesh Kumar, R.P.Pandey, J.P.Patra, 'Remote Sensing and GIS Based Terrain Analysis to evaluate and improve the Surface Water Availability in Part of Nagaur District of Rajasthan', National Conference on Emerging Trends in Water Quantity and Quality Management (ETWQQM-2014) at Poornima University, Jaipur, during December 19-20, 2014.

26. Arora, Manohara, Rakesh Kumar,Jatin Malhotra and Naresh Kumar, ‘Characterization of suspended sediment in meltwater from Gangotri glacier. National Conference on Emerging Trends in Water Quantity and Quality Management’, National Conference on Emerging Trends in Water Quantity and Quality Management. Poornima University Jaipur. 19-20 December 2014.
27. Khobragade, Suhas, Prabhat Semwal, Sudhir Kumar, A. R. Senthil Kumar and R. D. Singh, ‘Prediction of water availability in Sukhna lake, Chandigarh for summer 2015’, National Conference on “Emerging Trends in Water Quantity & Quality Management (ETWQQM-2014)” organized by Purnima University, Jaipur at Jaipur during 19-20 December, 2014.
28. Satyaji Rao, Y.R. (2014). ‘Point source nitrate transport modeling in the coastal aquifers’. National Conference on “Emerging Trends in Water Quantity & Quality Management (ETWQQM-2014)” organized by Purnima University, Jaipur at Jaipur during 19-20 December, 2014.
29. Goyal, V.C. and J.P. Patil, ‘Sustainability aspects of Watershed Management Projects: Impacts of Check Dams’, DoLR Workshop on Construction & Desilting of Check Dams, New Delhi, 20-21 Nov 2014: Session 3.
30. Lohani, A.K., Sanjay K.Jain, Tanveer Ahmad, R.D.Singh, “Development of a Snowmelt Runoff Model for a Himalayan Basin Using Fuzzy Logic” National Conference on “Emerging Trends in Water Quantity & Quality Management (ETWQQM-2014)” organized by Purnima University, Jaipur at Jaipur during 19-20 December, 2014.
31. Lohani A.K. (2015) Conserve and Save Water to Protect the Water Environment, Invited Lecture in the Workshop on Water Conservation and Water Quality Management Using GIS/GPS”, Organized Jointly by Uttarakhand Science Education and Research Center (USERC), Dehradun and Uttarakhand Space Application Center (USAC), Dehradun on January 18, 2015 at MKVN Public School, Kalalghati, Kotdwara.
32. Kumar, Sudhir and BK Purandra (2015), “Water Management in Mining Areas”, National Seminar on Mining Environment and Water Resources Development, organised by Mining Engineers Association of India (Belgaum Chapter), held at KVK, Gadag, Karnataka during 22-23 March, 2015.
33. Kumar, Sudhir , Pradeep Kothari and Kumkum Mishra (2015), “Modern Techniques for Groundwater Management in Mines”, National Seminar on Mining Environment and Water Resources Development, organised by Mining Engineers Association of India (Belgaum Chapter), held at KVK, Gadag, Karnataka during 22-23 March, 2015.
34 Rawat, Soban Singh, Awani Kumar Singh, and Pradeep Kumar (2015), “Feasibility Study of Roof Top Rain Water Harvesting dependent Micro Irrigation System under Protected Environment”, Technology and Management of Micro Irrigation in Floriculture” organized by Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu during 19-20 March 2015.
35. Kumar, Pradeep, Neelam Patel (2015), “Yield Simulation of Potato under Sub-Surface Drip Irrigation System for varying water availability conditions”, Technology and Management of Micro Irrigation in Floriculture” organized by Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu during 19-20 March 2015.
36. Goyal, V.C., Sanghamitra Misra and Avanindra Kumar (2015), Participatory vulnerability and livelihood planning for water management in Bundelkhand region (Tikamgarh district, MP, India), FICCI-PMI Conference on Project Management Practices 2015, New Delhi, 10 March 2015.
37. Goyal, V.C., Promoting Citizen Science- an emerging concept with multidisciplinary focus on environmental issues in the Indian Himalayan region, 38th Indian Social Science Congress, Vishakhapatnam, 29 March-2 April 2015.
38. Nema, M.K. (2015), “lukewarmly Response of Micro-Irrigation Adaptation in India: Problems and Prospects. Proceedings of abstract of national seminar on ‘Technology and Management of Micro Irrigation in Floriculture’ organized by division of Agricultural

Engg. And Directorate of Extension Sher-e-Kashmir Univ. of Agricultural Sciences and Technology, Jammu from March 19-20, 2015.

Chapter in Book

1. Krishan, Gopal, A.K. Lohani, M.S. Rao, C.P. Kumar and K.S. Takshi, 'Groundwater fluctuation and trend in Amritsar, Punjab, India', In: Geo-statistical and Geospatial approaches for the characterization of natural resources in the environment: challenges, processes and strategies (Editor: N. Janardhana Raju). Capital Publishing House, New Delhi, Pp. 108-111. (ISBN. 978-93-81891-25-4).
2. Lohani, A. K., Jain, S. K., Singh, R. D. (2015) Assessment and Simulation of Glacial Lake Outburst Floods for Dhauliganga Basin in Northwestern Himalayan Region, Dynamics of Climate Change and Water Resources of Northwestern Himalaya, Editors: Rajesh Joshi, Kireet Kumar, Lok Man S Palni Springer International Publishing, ISBN: 978-3-319-13742-1 (Print) 978-3-319-13743-8 (Online), pp. 45-55.
3. Jain, S. K., Lohani, A. K, Singh, R. D. (2015) Identification of Glacial Lake and the Potentially Dangerous Glacial Lake in the Himalayan Basin, Dynamics of Climate Change and Water Resources of Northwestern Himalaya, Editors: Rajesh Joshi, Kireet Kumar, Lok Man S Palni Springer International Publishing, ISBN: 978-3-319-13742-1 (Print) 978-3-319-13743-8 (Online), pp. 35-44.
4. Singh, Omkar and Sharma, M.K. and Goyal, V.C. (2015). Hydrological Investigations for Conservation & Management of the Renuka Lake (H.P.), Paper accepted for a book entitled "Water Resource Management and Treatment Technologies" by USERC (Dept. Science & Technology, Govt. of Uttarakhand), Dehradun.

<u>Research Papers Published/ Accepted during April, 2015 to May, 2015</u>

International Journal
Published

1. Sharma, M. K., C. K. Jain, G. Tamma Rao & V. V. S. Gurunadha Rao (2015), 'Modelling of lindane transport in groundwater of metropolitan city Vadodara, Gujarat, India', Environmental Monitoring and Assessment. Volume 187, Number 5, April 2015
2. Dickson Adomako, Abass Gibrilla, Piotr Maloszewski, Samuel Yao Ganyaglo & S.P. Rai (2015), 'Tracing stable isotopes (δ2H and δ18O) from meteoric water to groundwater in the Densu River basin of Ghana', Environ Monit Assess (2015) 187:264DOI 10.1007/s10661-015-4498.
3. Ahluwalia, Rajeev Saran, S. P. Rai, S. K. Jain, D. P. Dobhal and Amit Kumar (2015), 'Estimation of snow/glacier melt contribution in the upper part of the Beas River basin, Himachal Pradesh using conventional and SNOWMOD modeling approach', Journal of Water and Climate Change, 2015 | doi:10.2166/wcc.2015.107.
4. Gupta, Ankush, Himanshu Singh, Fuzail Ahmed, Indu Mehrotra, Pradeep Kumar, Sudhir Kumar, Thomas Grischek, Cornelius Sandhu (2015), 'Lake bank filtration in landslide debris: irregular hydrology with effective filtration,' Sustainable Water Resources Management, DOI: 10.1007/s40899-015-0001-z, 2015 2015.
5. Jain, Sharad "Assessment of environmental flow requirements for hydropower projects in India", Current Science (published on-line).
6. Singh Rajesh, Bahukhandi Kanchan, Mondal Prasanjeet, Singh Satendra (2015), 'Water Quality Assessment of River Ganga Health Hazard Identification and Control,' International Journal of Scientific and Research Publications, Volume 5, Issue 5, May 2015, ISSN 2250-3153.
7. Singh, Anjali, Srivastav, S. K., Sudhir Kumar and G. J. Chakrapani (2015), 'A modified DRASTIC model (DRASTICA) for assessment of groundwater vulnerability to pollution in an urbanized environment in Lucknow, India,' Environmental Earth Science, May 2015 DOI: 10.1007/s12665-015-4558-5.

8. Allen, S.K., Rastner, P., Arora, M**.**, Huggel. C. and Stoffel M, International Journal on "Lake outburst and debris flow disaster at Kedarnath, June 2013: Hydro meteorological triggering, and topographic predisposition", Landslides Journal, DOI 10.1007/s10346-015-0584-3 May 2015.
9. Singh, A. K. and S. R. Kumar (2015), 'Quality assessment of groundwater for drinking and irrigation use in semi-urban area of Tripura, India', International Journal of Ecology, Environment & Conservation. (ISSN: 0971–765X). 21(1): 2015; pp. (97-108). EM International Pub., (SCOPUS - H Index – 9**,** NAAS Rating - 5.02)

Accepted

1. Jain Vinit, R.P.Pandey, M.K.Jain, and HiRyon Byun (2015). "Comparison of drought indices for appraisal of drought characteristics in the Ken river basin, Weather and Climate Extremes: ELSEWIER", Accepted May 2015.

National Journal
Published

1. Singh, Omkar and M. K. Sharma (2015), 'Measurement of dissolved oxygen and biochemical oxygen demand for the Hindon river, India,' Indian Water Resources Society, 35(1), 42-50.

Accepted

1. Ghosh, Narayan C., Saroj Kumari Khatania, Shashi Poonam Indwar, Cornelius S. S. Sandhu, C. K. Jain, Sanjay Mittal, and Rakesh Goel, "Determining distance of a bank filtration well, and performance evaluation of riverbank filtration scheme at Haridwar, India" accepted in Current Science Journal (authors).

International Conference/ Training/ Seminar/ Workshop
Published

1. Allen, S.K., Rastner, P., Arora, M., Huggel. C. and Stoffel M**.** (2015), 'Rainfall and snow-melt triggered glacial lake outburst: a systematic analysis of the Kedarnath (Uttarakhand, India), June 2013 disaster, Session CR4.5/NH8.6, EGU General Assembly 2015, 16 April 2015.

National Conference/ Training/ Seminar/ Workshop
Published

1. Jain, Anshul, SR Kumar, KDSR Prashant and J. Ravi Kiran (2015), 'Quality Valuation of Groundwater for Irrigation at Dhanbad', National Conference on Emerging Trends in Water Quantity and Quality Management at Jaipur, 19-20 Dec. 2014. ETWQQM-2014: Published in the Proceedings (Published by IJERT), pp. 59-63.
2. Krishan, Gopal, M.S. Rao, Sudhir Kumar and P.K. Garg (2015), 'Seasonal Variation in the Isotopic Composition of Ground Level Vapour (Glv) –An Implication in Studying Monsoon Dynamics', National seminar on "Recent development and challenges in geochemistry GEOCHEM-2015 at AU, Annamalai, Tamil Nadu 26-27 March, 2015.

Chapter in Book

1. C.P.Kumar published technical book on *Groundwater Assessment and Modelling*.Publisher: CreateSpace - An Amazon Company (Paperback) Amazon – Kindle Direct Publishing (Kindle). ISBN-10: 1511520493, ISBN-13: 978-1511520492, 332 pages.

APPENDIX 68.4.3

LIST OF WORKSHOPS/ TRAINING COURSES/ SYMPOSIA ORGANISED DURING JULY, 2014 – MARCH, 2015 & APRIL, 2015 – MAY, 2015

Orgainisation of Workshops/ Training Courses/ Seminars/ Symposia during July, 2014 to March, 2015

S.No.	Name of Course	Period	Place
1.	Brain Storming session on Major Hydrological issues of Central India	7 July, 2014	Bhopal
2.	Water Quality and its Management	Sept. 1-5, 2014	Roorkee
3.	Groundwater Management	Sept. 25, 2014	Belgaum
4.	Int. conf. on Natural Treatment Systems for Safe and Sustainable Water Supply in India: Results from the “Saph Pani Project”	18-19 Sep 2014	New Delhi
5.	Training Programme on Remote Sensing, GIS and Geospatial Techniques in Water Resources Management	22-27 Sept., 2014	Patna
6.	Training Programme on ‘Monitoring & Analysis Non-point source of Pollution (NPS) – Agriculture in a Riverine System	Oct 13-15, 2014	Roorkee
7.	Brainstorming session on “Assessment of impact of flood on river bank filtration sites in Uttarakhand”.	18 Oct 2014	Roorkee
8.	State level Geospatial Education & Training Workshop on “Management of Water Resources, Glaciers and Climate Change with special reference to Uttarakhand”	Nov. 1-3, 2014	Roorkee
9.	Training Program “Stress Management & Naturopathy”	Nov.6-7, 2014	Roorkee
10.	Training Course on ‘ILBM Approach for Conservation and Management of Lakes”	Nov. 10-14, 2014	Roorkee
11.	Training Course on ‘GIS applications in Watershed Management’	Nov. 17-21, 2014	Roorkee
12.	Flood Risk Mitigation & Management	19-21 Nov., 2014	Roorkee
13.	Training Course on “Advanced Soft Computing Applications in Hydrology & its Application	27 Nov.-2 Dec., 2014	Roorkee
14.	Training program on ‘Advanced Instrumentation Technique and Preventive Maintenance	Dec.8-10, 2014	Roorkee
15.	Brain Storming Session on R&D needs on Ganga River to ensure Aviral and Nirmal Dhara	16 Dec., 2014	Roorkee

16.	Workshop for Hindi language and its applications	Dec.18, 2014	Roorkee
17.	19th International Conference on Hydraulics, Water Resources, Coastal & Environmental Engineering (HYDRO-2014 International) in collaboration with MANIT, Bhopal	18-20 Dec., 2014	Bhopal
18.	National Conference on Emerging Trends in Water Quality and Quality Management (in collaboration with Purnima University, Jaipur)	19-20 Dec., 2014	Jaipur
19.	Training Programme on 'Hands on Advanced Instruments of Water Quality Testing'	Jan. 12-16, 2015	Roorkee
20.	Training course on "Project Hydrology"	Feb.2-6, 2015	Kakinada
21.	Training Course on" Groundwater Modelling using MODFLOW and MIKESHE	Feb.2-6, 2015	Roorkee
22.	Training Course on 'Integrated Catchment Modelling (ICMOD-2015)	Feb.9-13, 2015	Roorkee
23.	Training Course on "Application of Isotopes in Hydrological studies"	Feb 25-27, 2015	Roorkee
24.	Training course on DSS (Planning) for Integrated Water Resource Development Studies	Feb.23-27, 2015	Roorkee
25.	Training on GWAVA Model	March 2-3, 2015	Roorkee
26.	Workshop on WEAP Model Applications	March 3-4, 2015	Delhi
27.	Training Course on Basic Hydrology & Hydrological data processing & analysis	March 23-27, 2015	Kurukshetra

Orgainisation of Workshops/ Training Courses/ Seminars/ Symposia during April to May, 2015

S.No.	Name of Course	Period	Place
1	Training on "Advanced Techniques for Hydrological Investigations"	20-24 April, 2015	Roorkee
2	Basic Hydrology & Hydrological Data Processing and Analysis	April 27-May 01, 2015	HIRMI, Kurukshetra
3	Geospatial Education and Training Workshop on "Management of Water Resources, Glaciers and Climate Change with special reference to Uttarakhand"	24-26 May, 2015	Roorkee

APPENDIX 68.4.4

PROGRESS OF LABORATORY WORK
DURING THE PERIOD
JULY, 2014 – MAY, 2015

1. **Nuclear Hydrology Laboratory**
2. **Water Quality Laboratory**
3. **Soil-Water Laboratory**

Isotopic Analyses of Water Samples at Nuclear Hydrology Laboratory

(July 2014 to May 2015)

Sr. No.	Name of Division/Regional Centres/Other Institutions	^{3}H Analysis		Stable Isotope Analysis ^{18}O	Stable Isotope Analysis ^{2}H	Analysis of Major Cations & Anions
		No. of samples enriched	No. of samples analysed	No. of samples analysed	No. of samples analysed	No. of samples analysed
1.	H.I. Division & Other Divisions	-	-	8919	7140	150
2.	NIH Regional Centres Kakinada, Jammu etc.	-	-	688	674	-
3.	Other Organisations/ Institutions like BARC, IIT Roorkee, Delhi Univ. etc.	-	-	106	88	-
	Total	-	-	9713	7902	-

Chemical and Bacteriological Analysis of Water Samples in Water Quality Laboratory for the period between July, 2014 to May, 2015

	No. of samples of Different Divisions at NIH,Roorkee	No. of samples of Regional Centre	No. of samples of Outside Agencies on payment basis
Physico-chemical analysis	819	-	-
Bacteriological analysis	379	-	-
Metal analysis	80	-	-
Pesticide analysis	-	-	-
Total analysis	1278	-	-

Soil Water Laboratory
Laboratory Analysis carried out during the period April 2014 to May 2015.

Sl. No.	Name of the studies	No. of Samples	Parameters Measured
1.	Samples of Central Pulp and Paper Research Institute, Saharanpur(U.P.)	Eight	Particle size analysis of waste water samples(effluent samples)
2.	Soil Samples for M.Tech. student, IIT Roorkee (samples from Tehri District, Uttarakhand).	Eight Two	1. Soil moisture retention characteristics of Undisturbed soil samples. 2.Determination of soil texture using sieve shaker and laser based particle size analyser
3.	Sukhna Lake study of H.I. Division NIH , Roorkee.	Seven	Determination of soil texture using sieve shaker and laser based particle size analyser
4.	Kulsi Pilot Basin (Assam/Meghalaya)	Eleven	Determination of soil texture using laser based particle size analyser
5.	Yamuna – Hindon Inter basin.	One Two	Determination of soil texture using sieve shaker and laser based particle size analyser Determination of Permeability of soil.
6.	Modelling of Gangotri Glacier melt runoff and simulation of stream flow variation under different climatic scenario	Fifty One	Determination of sediment classification using laser based particle size analyser
7.	Minsar Basin of Saurashtra region ,Gujarat.	Eighteen No. Fourteen No.	Determination of soil moisture retention characteristics Determination pH and EC
8.	Tammileru ungauged basin Andhra Pradesh.	Fifteen	Determination of Permeability of soil.
9.	Training to Ten B.Tech. Students of SHIATS, Allahabad	1.Ten 2. Ten 3.One Site 4. One Site	1.Determination of soil texture using sieve shaker and laser based particle size analyser 2. Determination of soil moisture retention characteristics 3.Guelph Permeameter Test 4.Infiltrometer Test

APPENDIX 68.4.5

LIST OF MASS AWARENESS ACTIVITIES ORGANISED DURING APRIL, 2014 – MARCH, 2015

Mass Awareness Activities at Headquaters, Regional Centres and CFMS:

The following activities have been taken under media programme by NIH, at the regional centres of NIH and its CFMS during 2014-15:

S.No.	Activities	Organised by & Date
1.	Hindi Sapthah	Sept.14, 2014, Belgaum
2.	Cleaniness Drive	Sept.25-30, 2014, Patna
3.	Vigilance Awareness Week	Oct.27-31, 2014, Roorkee
4.	Water Conservation for Teachers	Dec.6, 2014, Roorkee
5.	Ganga Cleaning and RejuvenationI (Abiral and Nirmal Dhara)	Dec. 16, 2014, Roorkee & Regional Centres

APPENDIX 68.5.1

MINUTES OF 41th MEETING OF THE WORKING GROUP OF NIH

MINUTES OF THE
41ST MEETING OF WORKING GROUP OF NIH
HELD AT NIH, ROORKEE, DURING NOVEMBER 26-27, 2014

The 41st meeting of the Working Group of NIH was held at NIH, Roorkee, during November 26-27, 2014 under the Chairmanship of Director, NIH. The list of the participants of the meeting is given in Annexure-I.

ITEM NO. 41.1: OPENING REMARKS BY THE CHAIRMAN

Dr Sharad K Jain, Director-in-charge, NIH & Chairman, WG welcomed the Working Group members and the Scientists of the Institute. After a round of introductions, the Chairman requested Dr V C Goyal, Member-Secretary, to take up the agenda of the meeting.

ITEM No. 41.2: CONFIRMATION OF THE MINUTES OF 40TH MEETING OF THE WORKING GROUP

The 40th meeting of the Working group was held during June 4-5, 2014. The minutes of the meeting were circulated to all the members and invitees vide letter No. RCMU/WG/NIH-10 dated July 7, 2014. Er. R.K. Khanna conveyed the following suggestions: (i) Training Course on EIA (ii) Taking up EIA studies by NIH and (iii) Certificate or PG Diploma Course on IWRM.

The members confirmed the Working Group minutes.

ITEM No. 41.3: ACTION TAKEN ON THE DECISIONS/RECOMMENDATIONS OF THE PREVIOUS WORKING GROUP MEETING

Dr V C Goyal gave a brief account of the actions taken on the recommendations/decisions of the 40th working group meeting.

ITEM No. 41.4: PRESENTATION AND DISCUSSION ON THE STATUS AND PROGRESS OF THE WORK PROGRAMME FOR THE YEAR 2014-15.

The Member-Secretary requested the respective Divisional Heads to present the progress of studies carried out during 2014-15. Accordingly, the progress of various studies and sponsored projects was presented by all Scientific Divisions on their turn during two day deliberations of the Working Group. The Division wise minutes of each study/project presented during the meeting are given below:

ENVIRONMENTAL HYDROLOGY DIVISION

S.No.	Project Study, Study Team, Date of Start and Completion	Recommendation/Suggestion
	Research Studies 2014-15	
1.	Water Quality Modelling using Soft Computing Techniques **Study Team:** Rama Mehta (PI), C. K. Jain and Anju Chowdhary **Duration**: 2 Years (06/14-03/16)	Results were appriciated by members. Dr. N.C. Ghosh suggested that the Water Quality Index should also be developed for other uses of water. Dr. V.K. Sharma, Director, GSI, Dehradun, suggested that sample locations presented in GIS map could be related with the soil and geology of that area.
2.	Himalayan River Water Quality Assessment in a Stretch from Gangotri to Haridwar. **Study group:** Rajesh Singh (PI) , C. K. Jain, M. K. Sharma, S. P. Rai , Renoj J. Thayyan, J. P. Patra **Duration:** 3 Years (07/14-06/17)	No comments.
	Consultancy Project 2014-15	
1.	Water Safety Impact Assessment through Sanitary Improvement of India Mark 2 Hand Pumps in Moradabad Division, Uttar Pradesh **Study team:** C. K. Jain (PI),Babita Sharma, Rakesh Goyal and Dayanand UNICEF Lucknow, Amount: Rs. 12 lacs **Duration:** 6 months (10/14-03/15)	No comments.
	Sponsored Projects 2014-15	
1.	Low Cost Technology for Purification of Arsenic and Microbes Contaminated Water using Nanotechnology **Study team:** Vijaya Aggarwala, IITR (PI) & Rama Mehta, NIH (Co-PI) **Duration**: 2 Years (04/14-03/16) DST Sponsored	No comments.
2.	Ionic Enrichment Dynamics of Glacial Sediment and Melt Water of Gangotri Glacier **Study Team:** M. K. Sharma (PI), C. K. Jain , Renoj Thayyan , Manohar Arora , Naresh Saini , Jatin Malhotra, Rakesh Goyal , Daya Nand **Duration:** 3 Years (04/14-03/17) DST Sponsored	Study was appreciated by member.

GROUND WATER HYDROLOGY DIVISION

Dr. Anupma Sharma, Scientist-D, presented an overview and progress of studies and activities carried out by the Division during the period June-November, 2014. She informed that out of 4 R&D studies approved for the year 2014-15, one is in-house study and 3 are sponsored continued studies of the year 2013-14. Out of the 3 sponsored studies, one study on ‘Saph Pani’ Project has been successfully completed, while 2 studies are being continued as in-house studies. The ‘Saph Pani’ Project was concluded in September, 2014 with organization of the International Conference at New Delhi.

The Division has proposed one training course to be organized in collaboration with DHI-India during 2014-15. As professional scientific activities, scientists of the Division have submitted/published a number of research papers in various journals/ conferences/ symposia, delivered lectures in various training courses and guided summer trainees during the period.

The study-wise progress reported and suggestions emerged are given below.

Project Ref. Code: NIH/GWD/NIH/13-14: **Estimation of specific yield and storage coefficient of aquifers**

Dr. Surjeet Singh (PI) presented the progress of the study and also demonstrated the software developed on the estimation of specific yield and storage coefficient. The work was appreciated by the Working Group Members as well as NIH Scientists. Dr. R.D. Deshpande suggested to include an option for the ranking of the suitable methods of specific yield estimation. Dr. S.N. Rai suggested preparing a professional paper for the scientific community on the developed software rather than preparing a study report. The professional paper can be in two parts (i) Part-1 should deal with unconfined aquifer, and (ii) Part-2 should deal with confined aquifer. Sh. S.K. Bhartya suggested to also explore suitable options of specific yield estimation for the hilly areas of Uttarakhand State. Dr. V.C. Goyal suggested to take 4-5 more months for value addition of this software.

An extension of four months was requested to make the software web-enabled which was approved by the WG Members.

Project Ref. Code: NIH/GWD/NIH/11-14: **Managed Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)**

Mr. Sumant Kumar (PI) presented the progress of the study. It was informed that, the study as per requirement of the ‘Saph Pani’ project has been completed and the report has been submitted to the Saph Pani consortium.

Because of contains in hydrogeological formations, the feasibility of MAR in Raipur area has been found limited, while the Raipur city area has about 85 surface water bodies, which with some scientific approaches can be used to meet city’s water supply. To work out a water management plan based on these water bodies, PI suggested continuing this study as an internal project till March, 2015. .

Project Ref. Code: Flow and Contaminant Transport Modeling of Riverbank Filtration.

Ms. Shashi Poonam Indwar, Scientist-B presented the progress made and work carried out in the study since April, 2014. She informed that model setup and its input data preparation using MODFLOW coupled with MT3D is in progress. It was also mentioned, because of her long leave, the completion of the study got delayed.

<u>Project Ref. Code:</u> <u>NIH/GWD/INT/14-17:</u> **Management of Water Resources for Quantity and Quality in Yamuna-Hindon Inter-basin**

Dr. Anupma Sharma (PI) presented the new study to be taken up for three years under collaboration with Dept. of Civil Engg., IIT Roorkee. Dr. N.C. Ghosh described the background of the study. The need for undertaking the comprehensive research study was also explained. Dr. S.N. Rai informed about related works carried out in different parts of the region by various other organizations which will be useful in the present study. Dr M.K. Sharma of NIH gave information about studies pertaining to water quality of River Hindon. PI informed that data from all such studies would be compiled for building up the historical database of the study area.

The work programme of the division for the year 2014-15 is given at annexure-I.

<u>Annexure-I</u>

WORK PROGRAMME OF THE GROUND WATER HYDROLOGY DIVISION FOR THE YEAR 2014-15

S. No.	Project	Project Team	Duration & Status	Funding Source
1. NIH/GWD/NIH/13-14	Estimation of specific yield and storage coefficient of aquifers	Surjeet Singh (PI) N.C. Ghosh (Co-PI) Sumant Kumar	1&1/2 year (04/13 – 10/14) Extension of 4 months up to March, 2015 was granted	NIH
Sponsored & HP-II Projects				
2. NIH/GWD/NIH/11-14	Management of Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)	Sumant Kumar (PI) Rajan Vatsa, N.C. Ghosh C.P. Kumar, Surjeet Singh, Sanjay Mittal	3 years (04/11 – 03/14) **Status:**. Etension up to March, 2015 was granted .	**NIH (**after September, 2014)
3.	Flow and Contaminant Transport Modeling of Riverbank Filtration	Shashi Poonam Indwar (PI), N.C. Ghosh Anupma Sharma, Rajan Vatsa	2 ½ years (04/12 – 09/14) **Status:** Extension up to September, 20/15 was granted	NIH (after September, 2014)
Proposed New Study				
4.	Ganges Aquifer management for Ecosystems services (GAMES)	Sharad Jain (PI), N.C. Ghosh, Sudhir Kumar, Sanjay Jain, M.K. Goel, Anupma Sharma, Surjeet Singh	1 year (01/06 – 31/05) **Status**: in progress.	IWMI, Hyderabad
5. NIH/GWD/INT/14-17	Management of Water Resources for Quantity and Quality in Yamuna-Hindon Inter-basin	Anupma Sharma (PI) N. C. Ghosh & other NIH study team member Collaborating Institute; IIT Roorkee, CED	3 years (December, 2014 –Nov., 2017) Status : New	Initially by NIH, later on by sponsoring agency.

HYDROLOGICAL INVESTIGATIONS DIVISION

INTERNAL STUDIES:

1. PROJECT REFERENCE CODE: NIH/HID/INT/2012-14/2:

Title of the Study: Water Quality, Hydrogeology and Isotopic Investigations in SW Punjab

Dr. M. Someshwar Rao, PI of the project brifly explained the objectives of the project and responsibilities of NIH and collaborative partner, Punjab University, Chandigarh in executing the project. He then explained the work components accomplished by NIH and the results obtained by samples analysis at NIH, Roorkee. He explained the results through spatial distribution maps on EC, nitrate, fluorides, sulphates and $\delta^{18}O$ in groundwater etc. Using correlation plot between water quality and stable isotopes he explained the groundwater contamination arising due to anthropogenic and geogenic sources. He told that due to non-receiving of funds at the collaborative organization (Punjab University), the component of work in relating hydrogeology with water quality could not be completed by Punjab University. However, as NIH component of the project is completed the report will be submitted with the accomplished results. Dr Rao concluded the presentation by highlighting measures that can be taken up to overcome the contamination problems in the Bhatinda district of Punjab and informed completion of the project.

2. PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/1

Title of the Study: **Water Availability Studies for Sukhna Lake, Chandigarh**

The study was presented by Dr. S. D. Khobragade, Sc-E and PI. He informed that the major objectives of the study are: (i) To study inflow regime of the lake, (ii) To study seepage losses from the lake, (iii) To analyze long term trends in rainfall and evaporation (iv) To study water availability in the lake.

Dr. Khobragae presented the analysis carried out so far and the results in details including the water balance of the years 2011-12, 2012-13. He discussed the relative significance of various factors in the water balance of the lake. He also presented the analysis of variation of the lake water levels to understand the possible impact of the check dams on inflow to the lake. Detailed analysis of the inflow and the runoff coefficients of the lake and their trend over the past 10 years was also presented. In the end Dr. Khobragade presented the results of the prediction of the water availability of the lake in the coming summer of 2015. He informed that as per the predictions, the lake shall be on the verge of drying on 1st July, 2015. Although, the lake shall have a significant water spread area, but the depth of the water shall be only about a feet. He further added that if the monsoon is significantly delayed, the lake may dry up during July 2015.

The working group noted progress of the study. No comments were received.

3. PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/2

Title of the Study: Isotope Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains

Dr. Sudhir Kumar (PI) presented the progress of the work done carried out since the last meeting. He informed that the analysis of the noble gases for 12 samples has been completed from IAEA Vienna. The results on noble gases indicate that there is a good correlation between the age of groundwater with built up of He in the groundwater. He further informed the working group that $^{3}He/^{4}He$ v/s Ne/He plot indicates that the source of helium in the groundwater is from continental crust.

Dr. Sudhir Kumar further informed that as the study is being funded by IAEA under the project "Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains", the sponsorer has requested that a deep borehole be drilled to verify the finding of the isotopic investigations. It is proposed to drill a deep well (upto 350 m) tapping all the three aquifer systems, and samples will be collected for isotopic analysis from each aquifer. He further informed that sampling work of deep groundwater shall start in the month of December 2014 and shall finish by February 2015. The samples shall be shipped to Netherland and Vienna for dating and noble gas analysis.

Dr. RD Deshpande suggested computing the noble gas temperature from the analysis of different noble gases.

Working group noted the progress of the work done under the study.

4. PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/4

Title of the Study: Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes

Sh. S. K. Verma, the principal investigator of the study, presented the study before the members of the WG meeting. He mentioned about the objectives of the study along with the location of study area, brief methodology, action plan, achievement so far received for the study etc. He also mentioned that there were no comments or suggestions raised during the last working group meeting i.e. 40th meeting of working group.

While discussing the progress of the study, he informed that 1st objective of the study has been partially achieved. The groundwater samples collected from intermediate/deep tube wells from 5 districts located in the study area have been analysed for radon concentration. The radon concentrations monitored in these districts were found within the maximum permissible limit for drinking water as per the guide lines of WHO. A small part of the study area is left to be investigated for radon measurement which will be taken up during the next field trip. Sh. Verma further informed that in order to meet 2nd objective of the study, the analysis of environmental tritium in 39 groundwater samples which were collected during the field trips is in progress to identify the location for carbon dating.

The working group noted the progress of the study.

SPONSORED PROJECTS:

5. PROJECT REFERENCE CODE: NIH/HID/MOES/2012-15

Title of the Study: **The Structure and Dynamics of Groundwater Systems in North-western India under Past, Present and Future Climates**

Based on results of stable and radio-isotope, Dr. S. P. Rai presented the progress study. The main highlights of the presentation were the identification of recharge source of the shallow and deeper groundwater aquifer. On a query from Dr. R. D. Deshpande, Dr. S. P. Rai informed about the variation of tritium values in shallow aquifer 1 TU to 7 TU and deeper aquifer <3 TU. Dr. S. K. Bartarya asked the source of groundwater level data and Dr. Rai replied that water level data have been collected from the CGWB and State Groundwater Department.

The working group noted the progress of the study.

6. PROJECT REFERENCE CODE: NIH/HID/IAEA-1/2012-15

Title of the Study: **The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India**

Dr M. S. Rao, P. I. of the project explained depletion in water resources in the study area using falling water level data of Dholwaha reservoir (along with rainfall data). Using environmental tritium activity data for shallow and deep groundwater he told that shallow groundwater is getting poorly recharged in area falling diagonally along SE-NW zone in the study region. Along this zone, groundwater in shallow aquifer is about 20 years old and in the remaining region it is relatively young (about 10 years old). In the north of this zone, groundwater age is low due to modern recharge occurring from reservoirs of Kandi region whereas, in the southern side of this zone, modern recharge is occurring due to over pumping induced recharge from surface water sources (canal & rainfall). The deeper aquifer water is twice the age of shallow groundwater. In the deeper aquifer, groundwater is old towards river side (southern end towards river Satluj and western end towards river Beas). Stable isotope results show that shallow aquifer groundwater is formed from rainfall recharge all throughout the region except at few locations where recharge from canal is also seen. Isotopic data shows groundwater in deeper aquifer, in area close to the river Satluj, as water of canal origin. Since this water is old, it indicates a few decade old canal irrigated return flow water. PI Informed that the sampling and analysis will be continued for the premonsoon of 2015.

7. PROJECT REFERENCE CODE: NIH/HID/IAEA-2/2012-15

Title of the Study: **Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques**

Dr. S. P. Rai presented the progress of the study. He informed that rainfall, river, canal and groundwater samples were to collect from the study area and stable isotopes (δD and δ^{18}O) radioactive isotope (^{3}H) were measured. The results of the isotopes were presented in detail along with details of hydrogeological conditions. Dr. Rai also presented findings of surface water groundwater interaction of the study area. Results of modelling approach to assess the base flow component were also discussed.

The working group noted the progress of the study and appreciated the progress of the study.

8. PROJECT REFERENCE CODE: NIH/HID/BGS/2013-14

Title of the Study: **Review of Groundwater Resources in the Indo-Gangetic Basin: A Case Study on Resilience of Groundwater in the Punjab to Withdrawal and Environmental Change**

Dr M. S. Rao, PI of the project informed that the BGS funded project has two components; (i) preparing a review report by collating data from the published reports and (ii) groundwater dating using CFC & noble gas technique in Bist Doab region. For the review report, (i) landuse/landcover data at 1:50,000 has been collected, (ii) 20 years district average pre-monsoon/post monsoon water level data of UP, Bihar, West Bengal and Assam has been collected and (iii) water quality data from CPCB has been collected. To accomplish the 2nd objective of the project, major ions analysis of groundwater of Bist Doab region was done NIH, Roorkee and heavy metals & trace metals were analyzed at BGS, UK. Groundwater samples were collected for CFC dating and these were analyzed at BGS, UK. The CFC dating results were also compared with the tritium dating results obtained in the IAEA-CRP project. The two results obtained by two different technique and conducted at two different laboratories grossly show agreement and internal consistency. Groundwater Age using CFC dating technique has provided mean age of shallow groundwater as 25 years (range: 15 – 48 years) and mean age of deep groundwater (> 100m depth) is 46 years (age range: 38-54 years). The results has shown that withdrawal of groundwater from deeper wells for irrigation and its subsequent transfer to shallow aquifer through irrigation return flow has resulted into mixing of shallow aquifer water by deeper aquifer water, thereby, isotopic and chemical mixing of the two waters in the shallow aquifer. Similar to environmental tritium results, the CFC dating has shown that deeper aquifers of the Bist Doab region are getting recharged mainly at Bhabhar region. The excessive groundwater withdrawal in the central Bist Doab region especially from deeper aquifers has induced enhanced flow of groundwater from recharge zones to the central Bist Doab region. The excessive withdrawal of groundwater from deeper aquifer has accelerated groundwater movement from shallow to deeper aquifer (recharge to deeper aquifer) at points wherever interaction between the two exists. The results of the report are presented in 4 publications (3 international conferences and 1 in international journal). Dr Rao informed successful completion of the project.

NEW STUDIES:

1. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/1

Title of the Study: **Interaction between groundwater and seawater along the north east coast of India**

Dr M. S. Rao as a PI of this new study informed that the study is taken up as a pilot project as per the suggestion of the Working Group. Dr Rao presented the objectives and methodology of the proposed new project and informed that this 2 years project (Jan 2015-Dec 2016) project will be executed through internal funds with budget of Rs. 5.0 lakhs. He informed that the interaction between groundwater and seawater in the parts of east coast will be examined through measurement of groundwater salinity (EC), stable isotope composition of groundwater and dissolved radon in groundwater. Dr Rao provided importance of the study and methodology to achieve the objectives of the study. Under the project, groundwater sampling will be conducted in pre & post monsoon periods and the collected data will be analyzed in NIH, Roorkee.

Approved Activity Schedule:

S. No.	**Activities**	**Quarters**							
		1	2	3	4	5	6	7	8
1.1	Review of literature	√	√	√					
1.2	Site selection & preparation of index	√	√						

	map of the study area								
1.3	Collection and compilation of data	√	√						
1.4	Field work, sample collection and analysis of water samples		√	√	√	√	√		
1.5	Data interpretation					√	√	√	
1.6	**Project report & publications**							√	√

Budget Details:

Sl. No.	**Budget Head**	**Amount (lakhs)**
1	Travel Expenditure (2-3 field work of aprox. 15 days each)	2.0 lakhs
2	Analytical charges, field & lab assistance	2.0 lakhs
3	Miscellaneous expenses	1.0 lakhs
	Total	5.0 lakhs

The project is envisaged to bring out map on submarine groundwater discharge/seawater intrusion for the study area and research publication based on the results. The Working Group approved the project programme and the budget.

Suggestion by Working Group members: Shri Niladri Naha informed that he may be contacted for data and in the field support for the above study.
Dr Rao noted the suggestion of Shri Naha.

2. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/2

Title of the Study: **Isotopic investigation of benchmark Himalayan glaciers**

Dr M. S. Rao, PI of the project informed that the proposed study was submitted in the 40th Working Group of NIH with the title “Monitoring Isotopes in Air Moisture in Parts of Himalaya (Himachal Pradesh & Uttarakhand) for investigating the Cloud Condensation”. However, the title is modified in light of the following reason:

Under National Action Plan on Climate Change (NAPCC), Government of India launched a National Mission for Sustaining the Himalayan Eco-system *(NMSHE)”*. Of various objectives of the mission -NMSHE, one objective is to address Himalayan Glaciers and the associated hydrological consequences. To address this issue, DST, GoI, has asked NIH to submit a proposal to address “impact of water, snow and ice on Himalayan ecosystem”.

Considering the above recent developments and to fulfill the objective of the mission, it was decided to take up a pilot project to evaluate the feasibility of isotopes techniques for investigation of Himalayan glaciers. Accordingly, the previously submitted title of the project was modified as “Isotopic investigation of benchmark Himalayan glaciers”. The modified title directly addresses the glacial systems using isotopes.

Dr M. S. Rao, informed that the project is taken up as a pilot study to examine the feasibility of isotopes to investigate Himalayan glaciers using isotope and chemical analysis of glacial components. Technical support for field work will be taken up from Prof. AL Ramanathan, JNU, New Delhi. Prof. Ramanathan has agreed to provide glacial melt, snow-melt and shallow glacial core samples for the study with no financial support from NIH, Roorkee. The project will be completed in 2 years (January 2015 to December 2016) with budget of Rs. 5.0 lakhs from NIH internal funds. Dr Rao informed that for the pilot study, shallow glacial cores, melt-water and surface snow will be collected from glaciers of Uttarakhand, Himachal Pradesh and Ladakh parts of Himalayas. The isotopic and chemical analysis will be done at NIH Roorkee. As per the availability of stations in the study area, meteorological data will be collected and as per availability of sites, air-moisture sampling units for isotopic analysis will be installed. Isotopic and chemical data will be suitably inter-compared to interpret glacial environment at this regions. The study is expected to (i) generate the isotope database on snow & glaciers in the Himalayan region at Uttarakhand, H.P. and Ladakh (ii) assess spatial variability in isotopic & chemical characteristic of glacial environment (iii) isotope based interpretation of accumulation and ablation process of these glaciers.

Approved Activity Schedule:

S. No.	Activities	Quarters							
		1	2	3	4	5	6	7	8
1.1	Review of literature	√	√	√	√				
1.2	Site selection & preparation of index map of the study area	√	√						
1.3	Collection and compilation of data	√	√						
1.4	Workshop & training programme	√				√			
1.5	Field work, sample collection and sample analysis		√	√	√	√	√		
1.6	Data interpretation					√	√	√	
1.7	**Project report & publications**							√	√

Budget Details:

Sl. No.	Budget Head	Amount (lakhs)
1	Travel Expenditure	2.0 lakhs
2	Analytical charges , field & lab assistance, minor instrument purchase	2.0 lakhs
3	Miscellaneous	1.0 lakhs
4	Total	5.0 lakhs

The working group approved the project and budget requirements without any specific recommendations or suggestions.

3. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/3

Title of the Study: Assessment of dissolved radon concentration for groundwater investigations in Haridwar

The study was presented by Sh. P. K. Garg, Scientist-B. He informed that temporal variation in dissolved radon concentration in groundwater may provide a new way to look into the aquifer system and recharge conditions. So the study has been undertaken with the objectives: (i) Mapping the spatial distribution and temporal fluctuation in radon levels in groundwater in Haridwar district, (ii) To investigate the effect seasonal groundwater levels fluctuations on fluctuation in radon levels. He told that the study will be conducted in the district Haridwar which is considered to be the major recharge zone spanned in the Bhabhar-Siwalik region and, the local recharge zones along the canal length and along the western bank of the river Solani. Discussing the methodology he informed that the groundwater samples from the study region will be analyzed for radon concentration during pre and post monsoon seasons to generate the background radon concentration in the shallow aquifer, to investigate the recharge induced variation in radon concentration and to decipher change in radon concentration along the confined aquifer due to variation in radioactivity in the aquifer matrix. Samples will also be collected and analyzed for stable isotope analyze to support and collaborate the results and the inferences of radon measurements.

Activity Schedule:

S. No.	Activities	Quarter			
		1	2	3	4
1.1	Review of literature	√	√		
1.2	Site selection	√			
1.3	Collection and compilation of data		√		
1.4	Field work, sample collection and analysis of water samples	√	√	√	
	Data interpretation		√	√	
1.5	**Project report & publications**			√	√

Budget Details:

Sl. No.	Budget Head	Amount (lakhs)
1	Travel Expenditure	0.40 lakhs
2	Analytical charges , field & lab assistance, minor instrument purchase	0.25 lakhs
3	Miscellaneous	0.15 lakhs
4	Report Printing	0.20 Lakh
	Total	1.00 lakhs

The working group approved the project and budget requirements without any specific recommendations or suggestions.

REVISED WORK PROGRAMME OF HYDROLOGICAL INVESTIGATIONS DIVISION FOR THE YEAR 2014-2015

S. No.	Study	Team	Duration/ Status
	INTERNAL STUDIES		
1.	Water Quality, Hydrogeology and Isotopic Investigations in SW Punjab	M. S. Rao (PI), C. P. Kumar Gopal Krishan	**3 years** (07/12-06/15) **Completed Study**

S. No.	Study	Team	Duration/ Status
2.	Water Availability Studies for Sukhna Lake, Chandigarh	S. D. Khobragade (PI) C. P. Kumar Sudhir Kumar A. R. Senthil Kumar P. K. Garg V. K. Agarwal	**2 years** (04/13-03/15) **Continuing Study**
3.	Isotopic Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains	Sudhir Kumar (PI) C. K. Jain S. P. Rai S. D. Khobragade P. K. Garg B. C. Joshi (CGWB, Lucknow) Tejdeep Singh (CGWB, Chandigarh)	**2 years** (07/13-06/15) **Continuing Study**
4.	Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes	S. K. Verma (PI) S. P. Rai (Co-PI) M. S. Rao C. P. Kumar Mohar Singh	**2 years** (10/13-09/15) **Continuing Study**
5	Sub-marine Groundwater Discharge and Sea-water Intrusion in Coastal Aquifers of East Coast, India	M. S. Rao (PI)	**2 years** (06/14-05/16) **Revised Study as given as S No. 7**
6.	Monitoring Isotopes in Air Moisture in Parts of Himalayas (Himachal Pradesh & Uttarakhand) for investigating the Cloud Condensation	M. S. Rao (PI) C. P. Kumar Gopal Krishan	**2 years** (06/14-05/16) **Revised Study as given as S No. 8**
7.	Interaction between groundwater and seawater along the northern part of east coast of India	M. S. Rao (PI), Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16) **New Study**
8.	Isotopic investigation of benchmark Himalayan glaciers.	M. S. Rao (PI), Sudhir Kumar	**2 years** (01/15 - 12/16) **New Study**
9.	Assessment of dissolved radon concentration for groundwater investigations in Haridwar district	Pankaj Garg (PI), Sudhir Kumar, M. Someshwar Rao	**1 year** (01/15 – 12/15) **New Study**
SPONSORED PROJECTS			

S. No.	Study	Team	Duration/ Status
10.	The Structure and Dynamics of Groundwater Systems in Northwestern India under Past, Present and Future Climates	S. P. Rai (PI) M. S. Rao Surjeet Singh S. K. Verma C. P. Kumar Sudhir Kumar V. K. Agarwal Rajeev Gupta S. L. Srivastava Vishal Gupta Mohar Singh	**3 years** (06/12-05/15) **Continuing Study**
11.	The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India	M. S. Rao (PI) C. P. Kumar S. P. Rai	**3 years** (09/12-08/15) **Continuing Study**
12.	Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques	S. P. Rai (PI) R. V. Kale M. S. Rao C. P. Kumar Sudhir Kumar V. K. Agarwal Vishal Gupta Mohar Singh	**3 years** (10/12-09/15) **Continuing Study**
13.	Review of Groundwater Resources in the Indo-Gangetic Basin: A Case Study on Resilience of Groundwater in the Punjab to Withdrawal and Environmental Change	M. S. Rao (PI) C. P. Kumar Gopal Krishan	**One year 8 months** (02/13-09/14) **Continuing Study**
14.	Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains	Sudhir Kumar (PI) S. P. Rai S. D. Khobragade C. K. Jain P. K. Garg	**2 years** (05/13-04/15) **Continuing Study**
CONSULTANCY PROJECTS			
15.	Integrated Hydrological Investigations of Sukhna Lake, Chandigarh for its Conservation and Management	Suhas Khobragade (PI)	**Initially 2 years** (7/11-12/13) **(extended upto 3/15)**
16.	Hydrogeological Study for Dewatering of Jhamarkotra Mines, Distt. Udaipur	Sudhir Kumar (PI)	**3 years** (05/13-04/16) **Continuing Study**
17.	Impact Assessment of Ash Pond on the Groundwater Quality in the Surrounding Villages of NTPC Simhdri through Stable Isotopic Studies	Sudhir Kumar (PI)	**1 year** (07/13-06/14) **Completed**
18.	Isotopic Characterization of Groundwater of District Raigarh, Chhattisgarh	S. P. Rai (PI)	**6 months** (04/14-09/14) **Extended till 3/15**

S. No.	Study	Team	Duration/ Status
19.	Hydrogeological Studies for Ash Pond of 2 X 525 MW Maithon Power Limited and an Abandoned Coal Mine, District Dhanbad, Jharkhand	Sudhir Kumar (PI)	**3 months** (06/14-8/14) **Extended till 12/14 Interim report sunbmitted**
20.	Possible impact of construction activities in Kansal area (Mohali, Punjab) on water flow to Sukhna lake in Chandigarh	Suhas Khobragade (PI)	**2 months** (9/14-11/14) **Draft Report Submitted.**

SURFACE WATER HYDROLOGY DIVISION

S.N.	Title of Project/Study, Study Team, Start/Completion Dates	Status and Recommendations/Suggestions
1.	Sedimentation Studies for Pong Reservoir, Himachal Pradesh **Team** A. R. Senthil kumar Manohar Arora Suhas D Khobragade Avinash Agarwal and Sanjay Jain DOS:April 2012 DOC: March 2015	Dr. A. R. Senthil Kumar, PI of the project, presented the objectives, methodology and progress of the study for the period from June 2014 to November 2014 and overall progress in brief. The PI presented the development of sediment yield model for pong dam using ANN and the simulation of sediment yield for future 25, 50, 75 and 100 years using the generated series of rainfall and flow volume. The PI presented the uncertainty analysis of the rainfall and flow volume of 10%, 50% and 90% dependable series for future 25, 50, 75 and 100 years. The PI presented the determination of average simulated sediment yield using the sets of weights of ANN model by boots trap method and the dependable series of rainfall and flow volume. The PI also presented results on the computation of unit weight of sediment and consolidated unit weight of sediment in the reservoir by different methods such as particle size distribution of suspended sediment concentration, porosity of the settled sediment and hydrographic survey.
2.	Study Of Hydro-Meteorological Droughts For Chitrakoot Bundelkhand Region In India R.P. Pandey DOS: April 2012 DOC: March 2015	The Head, Surface Water Hydrology Division reported the progress of studies in brief and invited Dr R.P. Pndey, PI of the project, to presented details of activities and work carried out in respect of ongoing study for the period after last working group meeting held in May 2014. Dr Pandey presented the analysis and results based on past records of long-term meteorological data. He informed that the study site had faces acute drinking water shortages from time to time during summer months and this problem was very severe during drought years in the recent past i.e.

		2004-2008. The major objective of the study is to quantify water scarcity during droughts and to identify possible options for augmenting water supply and minimizing crop loss due to droughts**.** The PI further reported that th**e** data processing & analysis and preparation of base maps, dryspell analysis and estimation of supplemental irrigation water requirement for dry-spell periods for kharif season, village-wise domestic drinking water demand assessment and water availability have been completed. It was informed that a new methodology has been devised and verifies for regular drought monitoring using rainfall data. The method has been compared with Standardized Precipitation Index (SPI) and Effective Drought Index (EDI). The method provides comparable assessment of onset of drought and its progression. Further, it was informed the villages have been grouped in to different clusters based on local topographic features, potential source of water supply, population, source-wise water availability, and magnitude of demand. It was reported that a comprehensive plan drinking water supply and supplemental irrigation water supply to kharif crop during dry spells has been and the same was presented for comments from the distinguished members of the Working Group. It was informed that the second Interim Report of this study has been submitted in June 2014. The final report is expected to be completed by the April 2014.
3.	Application of DSS (P) for Integrated Water Resources Development & Management **Team** A.K. Lohani, Surjeet Singh, Rahul Jaiswal, D K Sonkusale and Akilesh Verma DOS: April 2013 DOC: March 2015)	Dr. A K Lohani presented the background the DSS(P) activity completed under HP-II and objectives of the study. Dr Lohani mentioned that the DSS(P) software has been developed under HP-II and the same model is being applied in Arpa basin of Seonath river basin to demonstrate the capabilities of the DSS(P) model. Dr Lohani mentioned that the data has been collected from Chhattisgarh for the application of DSS(P) software. Dr Lohani asked that the names of Shri D.K. Sonkusale and Shri Akilesh Verma of Water Resources Department, Raipur may be included in the study group of this project. Members and the Chairman, of the working group have approved the inclusion of these officers in the study group. Dr Lohani further mentioned that the collected data has been computerized and a NAM rainfall-runoff model has been setup in Mike basin and Mike-11 RR. He further mentioned that as an academic exercise the NAM model results have been compared with the ANN model results. He informed that an interim report of this project on

		rainfall-runoff modelling using NAM model has been submitted. Members of the working group appreciated the work.
4.	Quantitative assessment of uncertainties in river discharge estimation **Team** Sanjay Kumar and Sharad Jain DOS: April 2013 DOC: March 2016	Dr. Sanjay Kumar presented the study on "Quantitative assessment of uncertainties in river discharge estimation". He explained the background and objectives of the study and mentioned that study is a part of the systemic review of uncertainty clause of the ISO 9123 document. He explained the methodology based on ISO documents GUM (Guide to the expression of uncertainty in measurement), HUG (Hydrometric uncertainty guidance) and presented the progress made in the study. He mentioned that the working draft of the ISO 9123 was circulated to SC1 member bodies for call of experts. Accordingly the experts were nominated to review the draft ISO 9123 documents. He informed that the review comments have been received from experts and currently being resolved. He also mentioned that the revised draft ISO document will be considered in the ISO meeting scheduled during May 2015 in Tokyo. There were no comments from WG members
5.	Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills **Team** Avinash Agarwal, Manohar Arora and R K Nema DOS: November 2013 DOC: October 2016	Dr. Agarwal presented the study entitled "Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills". Objective wise progress was presented. It was informed that rainfall-runoff-sediment model with using SWAT and CCH1D is in progress. Regarding rejuvenation of springs, it was concern of the house to use isotope techniques to exactly locate the points of recharge within the identified springshed. Working group accepted the study progress.
6.	Estimation of Water Balance for Integrated Water Resources Management in Yerrakalva Pilot Basin, A.P. **Team:** J.V.Tyagi and YRS Rao DOS: April 2014 DOC: March 2015	Dr. J.V. Tyagi presented the study and informed the house that NIH has taken up Pilot Basin Studies (PBS) for IWRM in Yerrakalva river basin in coastal Andhra Pradesh under 12th five-year plan program. The program involves detailed studies on various components of the hydrologic cycle including water balance study of the basin. The components of water balance of a basin are influenced by climate, the physical characteristics of the basin such as morphology, land use and soil. Therefore, understanding the relationship between these physical parameters and hydrological components are very essential for integrated

		water resources management and long term sustainability of water resources in the basin. Dr. Tyagi explained that the SWAT, one of the most recent models developed by the USDA, will be used to analyse and quantify the water balance of the Yerrakalva river basin. He informed that the observed data on rainfall, runoff has been collected and the base maps in GIS have been prepared. The progress of the study is as per the approved schedule. There were no comments on the study.
7.	Systematic treatment and analytical solutions for surges and bores in rectangular channels (research study) **Team:** S.K. Singh DOS: April 2014 DOC: March 2015	Dr. S. K. Singh presented the study highlighting the technical and innovative content of the study, which are the formulating nondimensional hydraulic force equation in a moving frame of reference for a systematic treatment of surges and bores in rectangular channels and, deriving its analytical solution. The positive surges and bores are characterized by increased depth of flow moving upstream or downstream and are formed due to sudden increase or decrease in discharge in the channel on account of sudden opening or closing of a gate, sudden tides, or sea wave of increased height. The derived analytical solutions help solve the concerning problems in a single step, avoiding the trial and error method currently being practised. The Chairman opined this type of basic research is also required and stressed that the application of the study is important and should be presented in the next meeting. Dr. Singh informed, few illustrative examples are complete and, distributed hard copy of it to the Chairman and the Members of the Working Group.
8.	Status Report on "Impact of Anthropogenic and Climate Change on Sediment Load of Rivers" **Team:** Archana Sarkar DOS: April 2014 DOC: March 2015	Mrs Archana Sarkar, PI of the study presented the background, objectives, methodology and expected deliverables of the new study. Mrs Sarkar informed that the sediment load of a river represents a key component of its hydrology, and in turn exerts an important influence on its aquatic ecology, its morphology and the exploitation of its water resources. She further informed the house that changes in the sediment loads of rivers can therefore have wide-ranging environmental and social and economic implications. She also informed about the growing evidence (reported by various authors for different rivers of the world) that the sediment loads of many rivers of the world, especially Asian rivers have changed significantly in recent years due to many reasons, including anthropogenic as well as climate change impact). Mrs Sarkar presented some of the findings of

		various research workers in the subject area. Dr Deshpande from PRL, Ahemdabad enquired about the double mass curve plots of sediment yield. Mrs Sarkar explained about the double mass curve plots. Mrs Sarkar further informed about the work plan for the next two quarters. Working group members noted the progress of the study and appreciated the work.
9.	Study of Rainfall Patterns and Comparison of Rainfall Data from different Sources for Uttarakhand State **Team:** Archana Sarkar, N.K. Bhatnagar, Vaibhav Garg and Rakesh Kumar DOS: April 2014 DOC: March 2016	Mrs Archana Sarkar, PI of the study presented the background, objectives, methodology and expected deliverables of the new study. Mrs Sarkar informed that the study area is the Uttarakhand State, often referred to as the "Land of the Gods" due to the many holy Hindu temples and pilgrimage centres found throughout the state which observed a massive flood disaster in June 2013. Mrs Sarkar informed the house that a good knowledge of local rainfall-regime is crucial for planning and management of domestic, urban as well as industrial water use, irrigation and crop practices besides forecasting and management of extreme events like floods and droughts. She further informed that in view of the recent flood disaster in the Uttarakhand state, it becomes all the more important to carry out a scientific analysis of the rainfall regime of the region. Mrs Sarkar also informed that a comparative accuracy assessment of various data sources of rainfall viz, Rain gauges, satellite sensors (TRMM), and high resolution gridded re-analysis rainfall (APHRODITE) is of prime importance as the rainfall data from these data sources are further provided to hydrological models to produce forecasts. Mrs Sarkar presented the progress of the study with preliminary results of trend analysis of historical rainfall data (annual and seasonal) by parametric and non-parametric methods for four rainfall stations two each in Kumoan and Garhwal regions. Dr Deshpande suggested to carry out the trend analysis for extreme events. Mrs Sarkar informed that the IMD guidelines would be followed to carry out the trend analysis work for extreme events. Working group members noted the progress of the study and appreciated the work.
10.	Monitoring and modelling of streamflow for the Gangotri Glacier **Team:**	Dr. Arora presented the progress of the study. He informed the house that the data collection for the ablation period of 2014 has been analyzed and the results were presented. He informed the house that the total volume of water from the glacier for the entire melt season was 853

	Manohar Arora and Rakesh Kumar DOS: May 2014 DOC: March 2017	MCM with the date of peak discharge on 15th July 2014. Dr R D Deshpande suggested some minor changes in the map of the study area. He was interested in knowing whether some noticeable changes have been observed in the discharge pattern. The PI replied that since it is a big glacier there is inter seasonal variability and no such noticeable changes have been observed. Dr N C Ghosh enquired about the trend line fitted in the graph of daily melt depth with daily mean temperature. The PI answered that the R^2 obtained for this was very poor therefore the mean monthly values of melt depth were plotted with the mean monthly temperature which resulted in significant improvement of R^2 values.
11.	Effect of climate change on evaporation at point scale **Team:** Digambar Singh, A. R. Senthil kumar and Manohar Arora DOS: June 2014 DOC: March 2017	Shri Digambar Singh, PI of the study, presented the objectives, methodology and progress of the study from June 2014 to Nov 2014. The PI, presented the computation of evaporation using the data of temperature, humidity and wind speed observed at the NIH observatory. The computed evaporation is computed with observed data of the pan evaporation and presented in graphical form. Dr. Anshuman asked the method of observation of evaporation data. The PI replied that the observation is made from the standard or class A pan (dia 1.22 m and depth 0.254 m, filled up to 0.180 m) evaporimeter installed at the observatory. Dr. N.C.Ghosh querried about the developer of empirical formula. The PI replied that it is taken from the text book “Engg. Hydrology” written by E.M.Wilson.
12.	Hydrological Modelling of Brahmani Baitarani River Basin using eWater Source Platform **Team:** J.P.Patra, Dr. Rakesh Kumar and Pankaj Mani DOS: April 2014 DOC: March 2017	Mr. Jagadish Prasad Patra, PI of the study presented the objectives, present state of art, brief description of study area and methodologies with progress made during last six months. There were no specific comments from the members.

WATER RESOURCES SYSTEM DIVISION

Dr. Sharad K Jain, Sc. G and Head (WRS Div.), presented an overview of the division – scientific strength, the ongoing studies, technical publications and training courses organized. Following are the comments received from working group on the presentations of the various studies.

PI: Dr. M. K. Goel, Scientist "F"
Study title: *NIH_Basin* – A WINDOWS based model for water resources assessment in a river basin (Ongoing)

Dr. M. K. Goel (MKG) presented the progress for the study. He informed that envisaged objectives of the study included modifications in the modeling methodology and development of WINDOWS interface (named as NIH_Basin – NIH_Basin-Simulation) of the model. Since the last working group meeting, a number of modifications have been made in the FORTRAN program of the model which include: a) incorporation of EAC tables for a reservoir (3 options), b) incorporation of rule-curve based operation analysis (for hydropower, irrigation, and domestic supply including environmental flows) for reservoir systems, c) incorporation of hydropower simulation analysis (with eight different options for supply of releases for various purposes through power plant), and d) simplification of groundwater representation in the model. MKG explained the two modes of model application: monthly and continuous simulation. For application of the model to larger basins, dimensions in the model for sub-basins, cities, hydraulic structures, rainfall stations, and river segments have been significantly increased. Various existing options in the model have been preserved and new modifications have been added as additional options.

In WINDOWS interface of the model, various data input forms have been developed in Visual BASIC environment. He presented some forms for the data entry. It was informed that forms will be finalized after completing model modifications as input requirements are getting revised with increased options.

Dr. R. D. Deshpande (RDD) suggested for the inclusion of industrial demands separately. MKG replied that at present the same is clubbed with the domestic demand but it is possible and preferable to give industrial demand a separate identity in the model. Further, RDD enquired about the model availability after its development. MKG informed that it is planned to put the model on NIH website for download and wider usage. Dr. S. C. R. Vishwakarma (SCRV) enquired whether the model is applicable in Himalayan basins? MKG informed that as yet, snow melt has not been included in the model and it can be used for the rainfall areas only. However, snowmelt can be calculated separately (through another model) and given as an input series for a specified downstream river segment. For this purpose, option is provided in the model to attach daily import/export time series with any river segment. In response to a query from Dr. S. K. Mittal (SKM), MKG confirmed that irrigated and rain-fed areas are treated separately in the model methodology.

PI: Dr. Sanjay K. Jain, Scientist "F"

Study title: Glacier change and glacier runoff variation in the upper Satluj river basin (Ongoing)

Dr. Sanjay K Jain presented the objectives of the study as well as the progress made so far. He informed that three sub basins of Upper Satluj basin have been taken for this study. Glacier change detection in all three sub basins has been carried out using temporal satellite data. The meteorological and discharge data have been collected. Dr. Jain presented the analysis of temperature and snow water equivalent data and explained correlation between these with glacier change. Dr. Ritesh Arya asked about the glacier change in different period of the study. Dr. Jain said that change is almost uniform but in recent years there is less change. He also said that the retreat is comparable with the other studies carried out in the region. Dr. Bartarya asked about the comparison of glacier retreat of western Himalayan and central Himalayan region. Dr. Jain said that as per the literature and a study carried out for Gangotri glacier the retreat in central Himalayan region is less and has reduced in recent years. Dr. S K Mittal asked about the software used and whether & RADARSAT data has been used in the study. Dr. Jain replied that ERDAS image processing software has been used and no RADARSAT data have been used. He said that the possibility of using RADARSAT will be explored.

PI: D. S. Rathore, Scientist "F"

Study titles:

1. **Decision Support System for Water Resources Planning in Upper Bhima basin, Maharashtra**
2. **Web GIS based snow cover information system for Indus basin (Ongoing)**

The progress of the study on DSS for water resources planning in Upper Bhima basin was presented by Mr D.S. Rathore. Study area was described and information on availability of the data was presented. Mula, Mutha and Ghod are main tributaries. Information on Taluka wise gross crop area and livestock population, district wise N and P- Fertilizer are available and these will be used for non-point pollution load estimation for watersheds. Daily discharge data, meteorological data and reservoir performance data are available and utilized for hydrological modelling in catchments. Water quality data were available at six sites on Mutha and Bhima rivers. Lumped conceptual model NAM in Mike Hydro was used for rainfall runoff simulation in 24 sub basins (14 head water and 10 intermediate). Models setup is in progress for simulating water allocation of Khadakwasla reservoir complex and Mutha RBC command, and for water quality simulation of Bhima basin. RDD asked regarding outcomes from the study that may be of interest to water resources manager and whether location of water purification facilities may be identified through study. Mr Rathore replied that among many uses, typically simulating water allocation in post monsoon period may be of interest to water managers. Further, through model locating suitable site for facilities may not be possible, but water quality in the river network may be simulated.

The progress of the study on Web GIS based snow cover information for Indus basin was presented by Mr D.S. Rathore. The objective of the study is to develop snow delineation methodology and to publish snow cover maps on web/ intranet using Web GIS software. During the period of review, MODIS Aqua data for 2010- 12 were downloaded. Snow mapping was done by using 8-day composite MODIS data using NDSI and NIR bands. Cloud scenes were identified by visually inspecting FCC using QGIS software. The information will be used to modify snow statistics at sub basin level. Statistics from cloud free preceding and/ or succeeding scene will be used for that of clouded scene. Snow cover statistics for years 2007-08 to 2011- 12, and median snow cover were presented for sub basins. Snow accumulation was visible in post monsoon period of September to December and its relation to snow availability in ablation period could be seen in temporal snow statistics. Mr Ritesh Arya stated that the graph indicates that this phenomenon is visible in Indus basin as well. Mr Rathore affirmed this and informed that though in all basin snow is accumulating in these months, but in general the phenomena is more pronounced in Satluj basin.

PI: D. Chalisgaonkar, Scientist "F"
Study title: Assessment of Water Footprint of the National Capital Territory (NCT) of India (Ongoing)

Mrs. Deepa informed that the objective of this study is to estimate the water footprints of NCT Delhi by quantifying green, blue and grey water footprints and the methodology used in this study is largely based on earlier studies supported by Water Footprint Network. She also informed that in the present study, the previous methodologies are integrated and upgraded where possible and the water footprint of NCT Delhi is being assessed for three major sectors i.e. domestic, agriculture and industrial. She informed that the assessment of the domestic water footprint has been done as a first step during 2013-14. It has been done by computing the environmental pressure exerted by the population of NCT Delhi in terms of the water it uses directly and indirectly. The assessment of agriculture water footprint has been taken up and industrial water footprint will be assessed in the next step. For the computation of crop water requirement, CROPWAT software is being used. It uses precipitation data, crop growth inputs, and soil data to calculate crop water requirements. After all yields and variables in the CROPWAT program are accounted for, the blue and green water footprints can be determined.
Dr Anshuman suggested including supply-chain perspective in the assessment. He also suggested to define the boundaries for the assessment and differentiate between water demand and use. Mrs Deepa replied that two levels of water consumption in supply chain are being considered and the boundaries of the study will be separately indicated. Working group noted the progress of the study.

PI: Dr. Renoj J Thayyen, Scientist "D"
Dr Renoj presented three studies.

1. Glaciological studies of Phuche Glacier, Ladakh Range (Ongoing- Sponsored)

Dr. N.C. Ghosh suggested that future research may look into the relationship between Positive Degree Days and energy balance of glacial systems in the cold-arid climate. RJT agreed to this point and mentioned that monitoring of soil heat flux is needed for such study and will be taken up during next phase of the project.

A member queried how the snowfall during May and June could retard the glacial melt as suggested in the study as it is widely seen that snowfall during May -June period generally lead to increased discharge in the stream. RJT explained that the May - June snowfall on glacier occur over the winter snow pack which further reduced the snow pack albedo leading to prolonged stay of snow over the glacier ice leading to retarded glacier melt. However, the snow falling in May-June over non-glacial lower reaches melts faster, resulting into higher discharge in the streams.

2. Cryospheric system studies and runoff modeling of Ganglass catchment, Leh, Ladakh Range (Ongoing)

No specific suggestions/ comments from any Working Group Members.

3. Runoff modeling of Shyok River, Karakorum Range (New)

Mr. Ritesh Arya said that the proposed bridge by Border Roads Organisation (BRO) is an important bridge for the supply to the forward post in a very difficult terrain. He appreciated the NIH effort to set up a discharge station in this area.

PI: Shri L N Thakural, Scientist "B"
Study Title: Trend and variability analysis of Rainfall and Temperature in Himalayan region (Ongoing)

The study was presented by Sh. L. N. Thakural. The objectives of the study are to create the database for Rainfall and Temperature variables for the Himalayan region and to carry out statistical analysis to detect trend and variability in these variables in the Himalayan region, India. The parametric (Linear regression) and non-parametric (Mann-Kendall and Sen's estimator of Slope) approaches are being used to determine the trends in the time series data of these meteorological variables. During the presentation, trend analysis of rainfall and temperature data for the Himalayan region was presented. RDD mentioned that this study for the Himalayan region will be useful. Moreover, he suggested that the rainfall intensity may also be considered and attempts be made to determine regional patterns. Dr. Naha and Dr. Vishvakarma offered to provide data on rainfall & temperature of some stations. The same will be collected by Mr Thakural and analyzed.

PI: Shri P. K. Mishra, Scientist "B"
Study title: Assessing Climate Change Impact across KBK (Kalahandi- Bolangir-Koraput) region of Odisha (Ongoing)

The status of the study was presented by Shri P.K. Mishra on behalf of his team. He informed about the progress made in the study since inception as well as during last six months (June'14-November '14). Shri Mishra presented the results for the 2nd objective of the study, i.e. to analyze the future climate in the region based on downscaled GCM data. He informed that future rainfall for the region has been generated based on downscaled HadCM3 A2 and HadCM3 B2 GCM data utilizing SDSM model. The study has been carried out using SDSM tool version 4.2.9.

RDD suggested to find the physiographic relationship for the trends observed for rainfall and temperature for the KBK region. Dr. Sharad K. Jain, Head, WRS Division also suggested to ponder on the trend findings and if possible, present findings. Mr. Mishra compiled the same and gave a brief presentation next day highlighting the possible impact of slopes and land cover. Another suggestion of RDD to find the relationship between the trend and atmospheric air temperature for the region will be explored based on data availability.

Shri Mishra ended the presentation informing the next course of actions analyzing downscaled GCM data for temperature using different models and running Soil and Water Assessment Tools (SWAT) for the Tel basin during the next six months.

PI: Shri M. K. Nema, Scientist "B"
Study titles:

1. **Variability of the Hydro-climatic variables in Punjab Plains of lower Satluj (Ongoing)**
2. **Hydrological Processes and Characterization of Lesser Himalayan Catchments**

For the ongoing study on variability of the hydro-climatic variables in Punjab plains of lower Satluj, no specific comments were made during the presentation. Dr. Renoj Thayyen suggested to examine the monsoonal cyclic effect on the trend of rainfall and temperature series.

While, presenting the proposed new study, Dr. NC Ghosh, suggested to modify the title of the study orienting towards its objectives. Accordingly, the new title of the study is proposed as "Hydrological Processes and Characterization in Lesser Himalayan Catchments". Dr. S.K. Bartarya (WIHG) suggested that while inter-comparing the various results from two different watersheds, the size and geologic condition of them should be proportionate. Dr. J.V. Tyagi suggested to take care of interception loss measurements in the proposed study.

PI: Shri P. K. Agarwal, Scientist "B"
Study title: Hydrologic Modelling of a part of Satluj Basin using SWAT Model (Ongoing)

The status and progress of the study was presented by Shri P.K. Agarwal, Scientist B. Shri Agarwal presented the DEM, drainage network, land use map prepared from landsat data, and soil map prepared for the study area. He informed that classification of the soil map as well as landuse map is in progress.
No specific comments were received on the study. However, Dr Anshuman, suggested ground truth verification of the data.

RESEARCH MANAGEMENT AND OUTREACH DIVISION (RMOD)

S.N.	Title of Project/Study, Study Team, Start/Completion Dates	Status and Recommendations/Suggestions
1.	Pilot Basin Studies (PBS) at six identified sites, jointly with the RCs and CFMSs (**Joint Study)** **NIH HQs:** V C Goyal (Leader), Omkar Singh, R V Kale **NIH RCs/CFMSs:** RC-Belgaum, RC-Jammu, RC-Kakinada, RC-Sagar, CFMS-Guwahati, CFMS-Patna DOS: Apr 2012; DOC: Mar 2015	No comments
2.	Water Conservation and Management in Ibrahimpur Masahi Village of Hardwar District (Uttarakhand) **Team:** Omkar Singh, V.C. Goyal and C.K. Jain, J.V. Tyagi and Sanjay K. Jain DOS: Apr 2013; DOC: March 2015	Er. Anshuman (TERI University) wanted to know about water conservation mesures being adopted in the study. The PI responded to his query. Dr. V.C. Goyal, Head, RMOD, also suplemented.
3.	Participatory development of structure for IWRM Framework in identified sub-basins under Pilot Basin Studies (PBS) program **(New Study)** **Team:** V C Goyal (PI), Omkar Singh and R V Kale DOS: July 2014 DOC: June 2015	No comments
4.	Customization of WEAP model for application in Ur river watershed in Tikamgarh district of Bundelkhand region. **(Under TIFAC Project)** **Team:** R V Kale (PI), T Thomas- RC Bhopal, Jyoti Patil, Rajesh Agarwal DOS: Apr 2014 DOC: Sep 2015	Er. Anshuman (TERI University) wanted to know about different scenarios considered for planning & decesion making in agriculture water management. The PI responded to his query. Er. Anshuman was keen in this study and offered PI to provide his relevant research pulications.

Dr. V C Goyal thanked the members for their valuable contributions during deliberations in the Working Group meeting.

The meeting ended with vote of thanks to the Chair.

ANNEXURE-I

List of Working Group Members attended the 41st WG meeting

1.	Er. R.D. Singh, Director, NIH	Chairman
2.	Dr. V K Sharma, Director, GSI, State Unit-Uttarakhand, Dehradun	Member
3.	Dr. S.K. Bartarya, WIHG, Dehradun	Member
4.	Dr. S.K. Mittal, Chief Scientist, CSIO, Chandigarh	Member
5.	Dr. S C R Vishvakarma, Sc.F, GBPIHED, Almora	Member
6.	Sh. Niladri Naha, State Water Invest. Dir., Kolkata	Member
7.	Dr. R D Deshpande, Sc.SF, PRL, Ahmedabad	Member
8.	Dr. S N Rai (Retd.) CSIR-NGRI, Hyderabad	Member
9.	Dr. Ritesh Arya, Panchkula, Haryana	Member
10.	Dr. Anshuman, TERI, New Delhi	Member
11.	Dr. S.K. Jain, Sc. G & Head WRS Division, NIH	Member
12.	Dr. N.C. Ghosh, Sc. G & Head GWH Division, NIH	Member
13.	Dr. Rakesh Kumar, Sc.G & Head SWH Division, NIH	Member
14.	Dr. Sudhir Kumar, Sc. G & Head HI Division, NIH	Member
15.	Dr. V C Goyal, Sc.F & Head, RMO Division, NIH	Member-Secretary

Scientists from National Institute of Hydrology, Roorkee

1. Dr. J.V. Tyagi, Sc.G
2. Dr. Sanjay Jain, Sc.F
3. Dr. Avinash Agarwal, Sc.F
4. Dr. M.K. Goel, Sc.F
5. Er. D. S. Rathore, Sc. F
6. Smt. D.Chalosgaonkar, Sc.F
7. Dr. A.K. Lohani, Sc.F
8. Dr. R.P. Pandey, Sc.F
9. Er. Omkar Singh, Sc.E
10. Dr. S.P. Rai, Sc.D
11. Dr.A R Senthil Kumar, Sc.D
12. Dr. Anupama Sharma, Sc.D
13. Dr. Sanjay Kumar, Sc.D
14. Dr. Surjeet Singh, Sc.D
15. Dr. R.D. Mehta, Sc.D
16. Sh. S.K. Verma, Sc.D
17. Dr. Renoj J. Thayyen, Sc.D
18. Dr. Archana Sarkar, Sc.C
19. Dr. Manohar Arora, Sc.C
20. Dr. M.K. Sharma, Sc.C
21. Sh. P.K. Garg, Sc.B
22. Sh.Rajan Vatsa, Sc.B
23. Sh. Digamber Singh, Sc.B
24. Dr. Ravindra Vitthal Kale, Sc.B
25. Sh. J.P. Patra, Sc.B
26. Sh. Sumant Kumar, Sc.B
27. Dr. Rajesh Singh, Sc.B
28. Sh. L.N. Thakural, Sc.B
29. Mrs. Shashi Poonam, Sc.B
30. Sh. P.K. Mishra, Sc.B
31. Sh. Manish Nema, Sc.B
32. Sh. Tanveer Ahmad, Sc.B
33. Sh. P.K. Agrawal, Sc.B

MINUTES OF 42nd MEETING OF THE WORKING GROUP OF NIH

MINUTES OF THE
42^{ND} MEETING OF WORKING GROUP OF NIH
HELD AT NIH, ROORKEE, DURING MARCH 19-20, 2015

The 42^{nd} meeting of the Working Group of NIH was held at NIH, Roorkee, during March 19-20, 2015 under the Chairmanship of Director, NIH. The list of the participants of the meeting is given in Annexure-I.

ITEM NO. 42.1: OPENING REMARKS BY THE CHAIRMAN

Er R D Singh, Director, NIH & Chairman, WG welcomed the Working Group members and the Scientists of the Institute. The Chairman mentioned that the Institute has received many additional responsibilities from the Ministry of WR, RD & GR, namely- development of a Ganga Knowledge Centre; two pilot sites for demonstration of the wastewater treatment systems, including phytoremediation technique; and pilot demonstration of natural treatment techniques, such as Bank Filtration, at selected sites in the country.

A Memorandum of Understanding (MoU) was signed between National Institute of Hydrology (NIH) and Centre for Water Resources Development and Management (CWRDM), Kozhikode. The ED, CWRDM and the Director, NIH exchanged the MoU document.

The Chairman then requested the Working Group members to give their general observations, suggestions and remarks on the scientific activities of the Institute. These are summarized below:

S N	Member	Suggestion(s)
1	Dr N B N Prasad	▪ Explore new, innovative ideas ▪ Provide list of publications in the working group meeting agenda document ▪ Mention name of funding agency and budget for sponsored projects
2	Dr R Rangarajan	▪ Intensity of rainfall should be considered for modelling
3	Dr (Mrs) Surinder Kaur	▪ Emphasize on water quality studies
4	Dr S C R VIshwakarma	▪ Revisit published work, and highlight public-utility work
5	Sri Kishore Kumar	▪ Provide meta-data on NIH’s website
6	Dr R D Deshpande	▪ EHD should explore plasma-based remediation techniques (contact Institute of Plasma Research, Ahmedabad) ▪ Use SAT along with MAR ▪ Improve presentations, focusing on results and time management ▪ Visibility of research results through publication of edited books, etc.

After taking the views of the members and their self-introduction, the Chairman asked the Member-Secretary to take up the agenda of the meeting.

ITEM No. 42.2: CONFIRMATION OF THE MINUTES OF 41st MEETING OF THE WORKING GROUP

The 41st meeting of the Working group was held during November 26-27, 2014. The minutes of the meeting were circulated to all the members and invitees vide letter No. RCMU/WG/NIH-10 dated December 10, 2014. No Comments were received. The members confirmed the Working Group minutes.

ITEM No. 42.3: ACTION TAKEN ON THE DECISIONS/RECOMMENDATIONS OF THE PREVIOUS WORKING GROUP MEETING

Dr V C Goyal gave a brief account of the actions taken on the recommendations/ decisions of the 41st working group meeting.

ITEM Nos. 42.4 & 42.5: PRESENTATION AND DISCUSSION ON THE STATUS AND PROGRESS OF THE WORK PROGRAMME FOR THE YEAR 2014-15 AND FINALIZATION OF THE WORK PROGRAMME FOR THE YEAR 2015-16.

The Member-Secretary requested the respective Divisional Heads to present the progress of studies carried out during 2014-15 and work programme for the year 2015-16. Accordingly, the progress of various studies and sponsored projects was presented by all Scientific Divisions on their turn during the two day deliberations of the Working Group. The Division wise minutes of each study/project presented during the meeting are given below:

ENVIRONMENTAL HYDROLOGY DIVISION

S.N.	**Title of the Project/Study, Study Group & Duration**	**Recommendation/Suggestion**
	Internal Studies	
1.	Water Quality Modeling using Soft Computing Techniques Study Group: Rama Mehta (PI), C. K. Jain, and Anju Chowdhary **Duration: 2 Year (05/14-03/16)**	Dr. N. B. N. Prasad (CWRDM) suggested that there must be some plasma based remediation. Dr. R.D. Deshpande suggested that the WQI should be done for heavy metals like Cadmium, Chromium, Zink etc. He also suggested that a software with all guidelines to calculate WQI like CCME guidelines must be developed by NIH itself.
2.	Himalayan River Water Quality Assessment in a Stretch from Gangotri to Haridwar Study Group: Rajesh Singh (PI), C. K. Jain, M. K. Sharma, S. P. Rai, Renoj J. Thayyan and J. P. Patra Duration: 3 Years (07/14-06/17)	Dr. S.K. Bartarya, WIHG, Dehradun suggested analysis of silica and plot Na+K conc. Vs Silica concentration for silicate weathering. Director, NIH suggested correlating the water quality parameters with flow.
	Sponsored Projects	
3.	Low Cost Technology for Purification of Arsenic and Microbes Contaminated Water using Nanotechnology Study Group: Vijaya Aggarwala, IITR (PI), Rama Mehta, NIH (Co-PI) **Duration: 2 Years (04/14-03/16)** Sponsored by DST, New Delhi	-
4.	Ionic Enrichment Dynamics of Glacial Sediment and Melt water of Gangotri Glacier Study Group: M.K. Sharma (PI), C. K. Jain, Renoj Thayyan, Manohar Arora, Naresh Kumar, Jatin Malhotra, Rakesh Goyal and Dayanand **Duration: 3 Years (04/14-03/17)** Sponsored by DST, New Delhi	-

ENVIRONMENTAL HYDROLOGY DIVISION
WORK PROGRAM FOR 2015-16

S.N.	Code	Study	Study Team	Duration
Internal Studies				
1.	EH/2015/TS-1	Water Quality Modelling using Soft Computing Techniques	Rama Mehta (PI) C. K. Jain	**2 Years (05/14-05/16)**
2.	EH/2015/TS-2	Himalayan River Water Quality Assessment in a Stretch from Gangotri to Hardwar	Rajesh Singh (PI) C. K. Jain M. K. Sharma S. P. Rai Renoj J. Thayyan J. P. Patra	**3 Years (07/14-06/17)**
Sponsored Projects				
1.	EH/2015/SR-1	Ionic Enrichment Dynamics of Glacial Sediment and Melt water of Gangotri Glacier **(DST)**	M. K. Sharma (PI) C. K. Jain Renoj Thayyan Manohar Arora Naresh Saini Jatin Malhotra Rakesh Goyal Karan Jamwal	**3 Years (04/14-03/17)**
2.	EH/2015/SR-2	Low Cost Technology for Purification of Arsenic and Microbes Contaminated Water using Nanotechnology **(DST)**	Vijaya Aggarwala, IITR (PI) Rama Mehta, NIH (Co-PI)	**2 Years (04/14-03/16)**

GROUND WATER HYDROLOGY DIVISION

Mr. C. P. Kumar, Scientist 'F' presented an overview and progress of studies and activities carried out by the division during the period December 2014 - March 2015. While presenting the technical activities carried out and progress made on different studies during last six months, he gave an account of scientific personnel available at the division and the sponsored projects being pursued by the Division. He informed that out of four R&D studies approved for the year 2014-15, one is in-house study and three are sponsored studies. The '*Saph Pani*' project was concluded in September, 2014 with organization of the International Conference at New Delhi. Two out of the three sponsored studies are being continued as in-house studies. Three new studies have been proposed for the year 2015-16.

The division has organized one training course on "*Groundwater Modeling using MODFLOW and MIKE SHE*" during 2-6 February, 2015 in collaboration with DHI-India. As professional scientific activities, scientists of the division have submitted/published a number of research papers in various journals/conferences and delivered lectures in various training courses during the period.

The study-wise progress reported and suggestions emerged are given below.

Project Ref. Code: NIH/GWD/NIH/11-15: **Managed Aquifer Recharge (MAR) and Aquifer Storage Recovery (ASR)**

Mr. Sumant Kumar (PI) presented the study and explained about the analytical modeling and analyses of various hydrological, meteorological, hydro-geological and water quality parameters. Dr. Prasad asked about the connectivity of lakes with groundwater and his question was well answered based on the analyzed data. PI informed that, the study was under the framework of Saph Pani project and based on the study 3 technical reports have been published, treating Raipur as one of the case study.

Project Ref. Code: EU-sponsored Project no. 282911: **Flow and Contaminant Transport Modeling of Riverbank Filtration.** - After October 2014 as internal study.

Ms. S.P. Indwar (PI) presented the study," Flow and Contaminant Transport Modeling of Riverbank Filtration", its objectives, statement of the problem; water quality analyses results.The Conceptualization of the flow model has been completed and Steady-state modelling of flow path for monsoon (23.08.12) and post-monsoon (11.10.12) is completed. PI was advised to carry out the further data analysis of water quality and to model the bank filtrate travel-time using MODPATH and composition of extracted water in each Infiltration wells through ZONEBUDZET tools of Visual MODFLOW.

Project Ref. Code: NIH/GWD/NIH/14-17: **Management of Water Resources for Quantity and Quality in Yamuna-Hindon Inter-basin**

Dr. Anupma Sharma (PI) presented the progress of the study initiated in Dec. 2014 in the Yamuna-Hindon Inter-basin. Declining groundwater levels and presence of harmful contaminants in some portions of the shallow groundwater system were shown as the major issues that need to be addressed in the study area. The project budget was also presented. Dr. Prasad opined that the study objectives were complex given the time frame of the study. PI informed that existing data from different studies pertaining to various portions of the region was being utilized in the project in addition to the laboratory experiments and planned field surveys in the region.

Project Ref. Code: NIH/GWD/NIH/15-18: **Development of Website and e-Portal on "Mitigation and Remedy of Arsenic Menace in India"**

Mr. C. P. Kumar informed that Inter-Ministerial Group (IMG) on "Arsenic Mitigation" constituted by the Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India has desired that National Institute of Hydrology (NIH), Roorkee should take lead role on R & Ds activities related to "Arsenic Mitigation" as per the areas suggested by the 'Core Committee' on "Mitigation & Remedy of Arsenic Menace in India". One of the recommendations by the 'Core Committee' is website and e-Portal development on Arsenic related matter for information dissemination as well as gathering responses and opinions. Mr. R. D. Singh, Chairman also informed about background for taking-up this task. Mr. Kumar further informed that NIC will be contacted to get the website/e-Portal designed by its empanelled vendors and also the domain name (gov.in) will be registered. Necessary hardware and software will be procured and the website is proposed to be hosted on a dedicated NIH server. However, Mr. Kishore Kumar suggested to consider hosting the website on NIC server in view of security concerns.

Project Ref. Code: NIH/GWD/NIH/15-16: **Diagnosis Survey and Selection of Suitable Sites for Development of Riverbank Filtration Demonstration Schemes in Different States**

Dr. Surjeet Singh (PI) made a presentation on river bank filtration study on diagnosis survey and selection of suitable sites. Dr. C. Rangarajan, NGRI inquired about the possibility of aquifer clogging which was well replied and Sh. R.D. Singh, Director, NIH inquired about the status of RBF project to be submitted to MoWR, RD & GR. No specific observations/comments were made.

Project Ref. Code: NIH/GWD/NIH/15-16: **Alternate Water Supply Management Strategies in Arsenic Affected/ Vulnerable Areas: Mapping of Arsenic Affected Zones/ Regions in Eastern U.P.**

Mr. Sumant Kumar (PI) presented the objectives, methodology and expected outputs of the proposed study. It was advised by Dr. Deshpande that objectives should be curtailed down and PI agreed upon that. PI informed that this study was undertaken in the light of the recommendations given by Inter-Ministerial Group (IMG) on "Arsenic Mitigation" constituted by Ministry of Water Resources, River development & Ganga Rejuvenation and Public Accounts Committee(PAC, eighth report, 16th Lok Sabha) on 'Water Pollution in India'. It was informed that the proposed study will be a step forward in understanding the root causes and magnitude of arsenic contamination in eastern U.P. and for attaining sustainable supply of arsenic safe groundwater to affected areas.

The work program of the division recommended for the year 2015-16 is given below.

GROUND WATER HYDROLOGY DIVISION
WORK PROGRAM FOR 2015-16

S. No.	Code	Study	Study Team	Duration & Status
1.	GWH/2015/TS-1	Flow and Contaminant Transport Modeling of Riverbank Filtration	Shashi P. Indwar (PI) N.C. Ghosh Anupma Sharma Rajan Vatsa	3 ½ years (04/12 – 09/15) Status: In progress
2.	GWH/2015/TS-2	Management of Water Resources for Quantity and Quality in Yamuna-Hindon Inter-basin	Anupma Sharma (PI) Deepak Kashyap, CED, IITR (Technical Advisor) N. C. Ghosh M K Sharma R.P. Singh Sumant Kumar Shashi P. Indwar	3 years (12/14 – 11/17) Status: In progress
3.	GWH/2015/TS-3	Development of Website and e-Portal on "*Mitigation and Remedy of Arsenic Menace in India*"	N. C. Ghosh (Coordinator) C. P. Kumar (PI) Anupma Sharma Shashi P. Indwar Sanjay Mittal	2.5 years (04/15 – 9/17) Status: New
4.	GWH/2015/TS-4	Diagnosis Survey and Selection of Suitable Sites for Development of Riverbank Filtration Demonstration Schemes in Different States	Surjeet Singh (PI) N.C. Ghosh C. P. Kumar Sumant Kumar Sanjay Mittal	1 year (04/15 – 3/16) Status: New
5.	GWH/2015/TS-5	Alternate Water Supply Management Strategies in Arsenic Affected/ Vulnerable Areas: Mapping of Arsenic Affected Zones/ Regions in Eastern U.P.	Sumant Kumar (PI) & Shashi P. Indwar (PI) N. C. Ghosh R. P. Singh Rajesh Singh S. L. Srivastava	1 year (04/15 – 3/16) Status: New

HYDROLOGICAL INVESTIGATIONS DIVISION

Dr. Sudhir Kumar, Scientist G and Head, presented an overview and progress of studies and activities carried out by the Hydrological Investigations Division during the year 2014-15. He informed that out of 8 internal R&D studies approved for the year 2014-15, 2 studies have been completed (out of which 1 study was completed till last working group meeting). Out of the 5 sponsored studies, one study on sponsored by BGS, UK has been successfully completed, while 4 studies are being continued. He further informed that the scientists of the division have also completed 5 consultancy projects, conducted 5 training programs / workshops and published more than 45 papers in Journals and conferences.

Dr. Sudhir Kumar informed that for the next year, i.e., 2015-16, 5 internal studies, 4 sponsored projects, and one consultancy project shall continue from the year 2014-15. Further, 2 new internal studies and 1 sponsored project has been proposed for the year 2015-16. Also, many consultancy projects have been submitted by the scientists of the division and expected to be started during 2015-16

The study-wise progress reported and suggestions emerged are given below.

INTERNAL STUDIES:

1. PROJECT REFERENCE CODE: NIH/HID/INT/2012-14/2

Title of the Study: Water Quality, Hydrogeology and Isotopic Investigations in SW Punjab

Head, HI Division informed that the study was being conducted in collaboration with Punjab University, Chandigarh. He told that due to some administrative problems Punjab University could not complete the component of work assigned to it. However, as NIH component of the project was completed in September 2014 and presented in the 41st working group meeting. The study has been completed and the report is being prepared.

2. PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/1

Title of the Study: **Water Availability Studies for Sukhna Lake, Chandigarh**

The study was presented by Dr. S. D. Khobragade, Sc-E and PI. He informed that the study has been completed. He told that the major objectives of the study were: (i) To study inflow regime of the lake, (ii) To study seepage losses from the lake, (iii) To analyze long term trends in rainfall and evaporation, and (iv) To study water availability in the lake. All the objectives have been achieved. However, he informed that the work related to trend analysis has been done based on trend line only and analysis based on statistical tests would be completed in next few days and would be included in the final report.

Dr. Khobragade presented the analysis carried out so far and the results in details including the water balance of different years including monsoon 2015. He discussed the relative significance of various factors in the water balance of the lake. He also presented the analysis of variation of the lake water levels and analysis of catchment requirement vis-a-vis cumulative number of check dams to demonstrate the possible impact of the check dams on inflow to the lake. He informed that since in the water balance approach seepage was determined indirectly, to confirm seepage losses from the lake a number of parameters such as piezometer water level variation, radon, stable isotopes, EC, pH and temperature were measured. He presented the results of these parameters to demonstrate seepage from the lake. However, he informed that long term data and further investigations are needed for detailed analysis of seepage. In the end Dr. Khobragade presented the various findings of the study.

The working group noted the progress of the study and appreciated the work done under the study. Dr. Deshpande suggested that the water balance results may be presented as normalised data. The study has been completed and report is being prepared

3. PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/2

Title of the Study: Isotope Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains

Dr. Sudhir Kumar (PI) informed that progress of the work done upto November, 2014 was presented in the last meeting wherein it was informed that analysis of the noble gases for 12 samples has been completed from IAEA Vienna and that the results indicated a good correlation between the age of groundwater with built up of He in the groundwater. He further informed that the next phase of sampling has been started only recently and is still under progress. The results of analysis of the collected samples of this phase are yet to be obtained. Working group noted the progress of the work done under the study. No comments were received.

4. PROJECT REFERENCE CODE: NIH/HID/INT/2013-15/4

Title of the Study: **Estimation of Radon Concentration in Water and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes**

Sh. S. K. Verma, Sc. D and P.I. of the study, presented the study before the members of the WG meeting. He mentioned about the objectives of the study along with the location of study area, brief methodology, action plan, achievement so far received for the study etc. He also mentioned that there were no comments or suggestions raised during the last working group meeting i.e. 41st meeting of working group held during Nov. 26-27, 2014.

While discussing the progress of the study, he informed that 1st objective of the study has been partially achieved. The groundwater samples collected from intermediate/deep tube wells from 5 districts located in the study area have been analyzed for radon concentration. The radon concentrations monitored in these districts were found well below the maximum permissible limit for drinking water as per the guide lines of WHO. A small part of the study area is left to be investigated for radon measurement which will be taken up during the next field trip. Sh. Verma further informed that in order to meet 2nd objective of the study, a total of 19 groundwater samples have been analyzed for environmental tritium in the laboratory and the analysis of environmental tritium in rest of the 20 groundwater samples is in progress to identify the location for carbon dating.
The working group noted the progress of the study. No comments were received.

5. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/1

Title of the Study: **Interaction between groundwater and seawater along the north east coast of India**

Dr M. S. Rao as a PI of the study informed that the study is a new study. The objectives and methodology of the project were presented in the last meeting. The study was supposed to start from 1st January, 2015 but due to technical reasons it shall now be started as a new study from 1st April, 2015. The working group noted the progress of the study. No comments were received.

6. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/2

Title of the Study: **Isotopic investigation of benchmark Himalayan glaciers**

Dr M. S. Rao, PI of the study, informed that the study was supposed to start from 1st January, 2015 but due to technical reasons it shall now be taken up as a new study from 1st April, 2015. The working group noted the progress of the study. No comments were received.

7. PROJECT REFERENCE CODE: NIH/HID/INT/2014-16/3

Title of the Study: Assessment of dissolved radon concentration for groundwater investigations in Haridwar

The study was presented by Sh. P. K. Garg, Scientist-B and PI. He informed that the objectives of the study are: (i) Mapping the spatial distribution and temporal fluctuation in radon levels in groundwater in Haridwar district, (ii) To investigate the effect seasonal groundwater levels fluctuations on fluctuation in radon levels. He told that the groundwater samples from the study region are being collected and analyzed for radon concentration during pre and post monsoon seasons to generate the background radon concentration in the shallow aquifer, to investigate the recharge induced variation in radon concentration and to decipher change in radon concentration along the confined aquifer due to variation in radioactivity in the aquifer matrix. He further informed that the samples are also being collected and analyzed for stable isotope analyze to support and collaborate the results and the inferences of radon measurements.

Discussing the progress of the study he informed that samples have been collected (shallow depth= <50 m) from six locations and radon analysis has been completed. Other parameters such has pH, EC, and temperature have also been measured. Results indicate that the values of radon concentration in shallow groundwater samples is within the permissible limits as prescribed by USEPA (1991).

<u>SPONSORED PROJECTS:</u>

8. PROJECT REFERENCE CODE: NIH/HID/BGS/2013-14

Title of the Study: **Review of Groundwater Resources in the Indo-Gangetic Basin: A Case Study on Resilience of Groundwater in the Punjab to Withdrawal and Environmental Change**

Dr M. S. Rao, PI of the project informed that the BGS funded project had two components; (i) preparing a review report by collating data from the published reports and (ii) groundwater dating using CFC & noble gas technique in Bist Doab region. The results of the report are presented in 4 publications (3 international conferences and 1 in international journal). Dr Rao informed successful completion of the project during September 2014.

9. PROJECT REFERENCE CODE: NIH/HID/MOES/2012-15

Title of the Study: **The Structure and Dynamics of Groundwater Systems in North-western India under Past, Present and Future Climates**

Based on results of stable and radio-isotope, Dr. S. P. Rai presented the progress study. The main highlights of the presentation were the identification of recharge source of the shallow and deeper groundwater aquifer. On a query from Dr. R. D. Deshpande, Dr. S. P. Rai informed about details of the study area and it fall with the north western India and further pointed out that GRACE satellite data has been used for same area. Dr. S. K. Bartarya asked about the source water of groundwater in study area and Dr. Rai replied that findings of the study indicate about the recharge from local precipitation and recharge through the canals.The working group noted the progress of the study and appreciated the progress of the study.

10. PROJECT REFERENCE CODE: NIH/HID/IAEA-1/2012-15

Title of the Study: The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India

Dr M. S. Rao, P. I. of the project presented the progress of project. Dr Rao presented the 'Local Meteoric Lines' analyzed and developed for sites at Mukerian, Dasuya, Bolath, Bhaddi, Ropar, Kapurthala, Dholwaha and Maily using isotopic data of rainfall data measurements made for 2 years period. The LMWL displayed an unusual high slope ~10 for precipitation data at Mukerian. At other sites, the slopes of LMWL were in the range 7.5 to 8.5. The intercept of LMWL at these sites ranged from +5 to +15. During the study, isotopic fluctuation of reservoir water at Dholwaha and Maily dams were also compared with Bhakra reservoir water (measured on Satluj river at site Ropar). The comparison made over 2 years indicated altitude effect (depleted isotopic composition of Bhakra water (□^{18}O = -10‰) compared to Dhowaha and Maily dam water (□^{18}O = -3‰) and impact of local effects (evaporation, local rainfall etc) in affecting the isotopic composition of the reservoir water. Being very large in size compared to Maily and Dholwaha dams, the isotopic composition of Bhakra reservoir water fluctuated over a narrow range (< 10%) compared to large fluctuation observed in isotopic values of – Dholbaha and Maily reservoir water (>□50%). The parameters- EC & □^{18}O of Bhakra water were found correlating positively indicating changes in □^{18}O value of Bhakra water as mainly due to evaporation effect. However, no specific relation was observed between EC and □^{18}O for Maily dam. In addition to isotopic investigations, groundwater level trend was also analyzed for over 20 sites for the period 1999 to 2009. The analysis indicated depleting groundwater conditions in more than 80% of the study region (the groundwater falling trend is not observed in the northern region and in area close to Ropar). The average groundwater fall rate in the region was ~1m/yr.

PI Informed that the sampling and analysis will be continued for the pre-monsoon and post-monsoon of 2015.

Dr R. D. Deshpande, member, Working Group suggested to re-confirm the isotopic slope of 10 for LMWL observed at Mukerian as the observed slope is un-usual and is not reported in the literature.

11. PROJECT REFERENCE CODE: NIH/HID/IAEA-2/2012-15

Title of the Study: **Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques**

Dr. S. P. Rai presented the progress of the study. He informed that rainfall, river, canal and groundwater samples were to collect from the study area and stable isotopes (δD and δ^{18}O) radioactive isotope (^{3}H) were measured. The results of the isotopes were presented in detail along with details of hydrogeological conditions. Dr. Rai also presented findings of surface water groundwater interaction and origin of groundwater of the study area. Results of modelling approach to assess the base flow component were also discussed. Dr. Rai also presented the chemical analysis of groundwater data and its interpretation for origin of groundwater. Dr. Rai showed that finding of chemistry also corroborated the isotope data. Dr. S. K. Bartarya suggested to analyse SiO_2 if possible, which can help to understand silicate weathering pattern. The working group noted the progress of the study and appreciated the progress of the study.

12. PROJECT REFERENCE CODE: NIH/HID/IAEA-3/2013-15

Title of the Study: Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains

Dr. Sudhir Kumar (PI) informed that after the progress which was reported in the last meeting, next phase of sampling has been started only recently and is still under progress. The results of analysis of the collected samples of this phase are yet to be obtained. Working group noted the progress of the work done under the study. No comments were received.

<u>NEW STUDIES:</u>

1. PROJECT REFERENCE CODE: NIH/HID/SPON/12-15

Title of the Study: Understanding of hydrological processes in Upper Ganga basin by using isotopic techniques

Dr. S. P. Rai, PI, informed that this study is being proposed under the NMSHE project which is under the process of finalization by the Institute as a sponsored project by DST. The study would be started once the project is approved. The objectives of the proosed study would be : (i) Isotopic characterization of precipitation and identification of sources of vapour, (ii) Runoff generation processes in headwater region of Ganga using isotope and modeling (iii) Spatial and temporal variation of snow and glacier melt in Ganga and its major tributaries. (iv) Contribution of transient groundwater and its role in sustainable flow of Ganga and (v) Groundwater dynamics in mountainous area including identification of recharge sources and zones of major springs

2. PROJECT REFERENCE CODE: NIH/HID/INT/2015-16/1

Title of the Project: Status Report on Rewalsar Lake, Himachal Pradesh

Dr. Khobragade, PI, presented the study. He informed that this is a new study which is being proposed by the division. The proposed objectives of the study are : (i) To determine the environmental status of the lake (ii) To identify major problems of the lake (iii) To identify major management issues of the lake (iv) To review current research status and research needs for lake and (v) To review the data availability scenario and identify data gaps vis-a-vis identified research needs. He informed that the Rewalsar lake is significant from religious, cultural and tourism purposes but water quality degradation has been reported for the lake and due to pollution more than 700 lake fish died during May 2014. So in the first phase a status report is being proposed and based on the recommendations of the status report, of the lake, a full ledged study would be proposed in the future. He informed that the proposed budget of the study is 3.27 lakhs. While discussing the methodology, he informed that the envisaged objectives will be achieved through collection, processing and analysis of the available data, review of literature, field survey, interaction with management authorities and local people and collection and laboratory analysis for water sample/sediment samples for water quality and isotopic characteristics. Informing about the outcome of the study he told that the output of the study would be in the form of a comprehensive report wherein all data, maps, information and analysis would be included. The report would also contain major identified problems of the lake, current research status of the lake, identified data gaps. Major management issues related to the lake would be discussed and possible approaches to deal with them would be suggested.

Working Group approved the proposed study. No specific comments were received.

3. PROJECT REFERENCE CODE: NIH/HID/INT/2015-18/1

Title of the Project: Lake-Groundwater Interaction Studies for Sukhna Lake, Chandigarh

The study was presented by Dr. S. D. Khobragade, Scientist E. He informed that Sukhna Lake in Chandigarh faces water scarcity problems especially during the deficit rainfall years. No studies on the interaction of the lake with surrounding groundwater have been reported for the lake so far except for the preliminary investigations carried out by NIH. Studies on water balance carried out by NIH indicated that seepage may be a significant factor determining the water availability in the lake. As such studies on seepage was one of the major observation of the water availability studies on the lake carried out by the Institute. Therefore, the present study has been proposed with the major objective of understanding the lake-ground water interaction regime of the lake and to determine seepage losses from the lake. While discussing the methodology he informed that it is proposed install few piezometers in the vicinity of the lake as adequate ground water data are presently not available for the lake. Dr. Sudhir Kumar, Scientist-G & Head, HI Division informed that efforts would be made to model the lake-ground water interaction. Dr. Khobragade informed that the proposed budget of the study is 59.59 lakhs.

Working Group approved the proposed study. However, Dr. Prasad suggested that the first objective may be modified and identification of zones of lake-water interaction may be removed from the objectives as it would not be possible to establish such zones.

HYDROLOGICAL INVESTIGATIONS DIVISION
WORK PROGRAM FOR 2015-2016

S. N.	Code	Study	Team	Duration/ Status
	Ongoing Internal Studies			
1.	HI/2015/TS-1	Isotopic Studies for the Identification of Different Aquifer Groups and their Dynamics in Upper Yamuna River Plains	Sudhir Kumar (PI) C. K. Jain S. P. Rai S. D. Khobragade P. K. Garg CGWB, Lucknow CGWB, Chandigarh	**2 years** (07/13-06/15)
2.	HI/2015/TS-2	Estimation of Radon Concentration in Waters and Identification of Paleo-groundwater in Part of Punjab Located in Satluj River Basin using Isotopes	S. K. Verma (PI) S. P. Rai (Co-PI) M. S. Rao C. P. Kumar Mohar Singh	**2 years** (10/13-09/15)
3.	HI/2015/TS-3	Interaction between groundwater and seawater along the northern part of east coast of India	M. S. Rao (PI), Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16)
4.	HI/2015/TS-4	Isotopic investigation of benchmark Himalayan glaciers.	M. S. Rao (PI) S.P. Rai, Sudhir Kumar Pankaj Garg	**2 years** (01/15 - 12/16)
5.	HI/2015/TS-5	Assessment of dissolved radon concentration for groundwater investigations in Haridwar district	Pankaj Garg (PI) Sudhir Kumar, M. Someshwar Rao	**1 year** (01/15 – 12/15)

S. N.	Code	Study	Team	Duration/ Status
	New Internal Studies			
6.	HI/2015/TS-6	Status Report on Rewalsar Lake, Himachal Pradesh	SD Khobragade (PI) Sudhir Kumar, C. K. Jain	**1 year** (04/15 – 03/16)
7.	HI/2015/TS-7	Lake-Groundwater Interaction Studies for Sukhna Lake, Chandigarh	SD Khobragade (PI) Sudhir Kumar, Senthil Kumar, Pankaj Garg	**3 year** (04/15 – 03/18)
	Sponsored Projects			
8.	HI/2015/SR-1	The Structure and Dynamics of Groundwater Systems in Northwestern India under Past, Present and Future Climates **(MoES)**	S. P. Rai (PI) M. S. Rao Surjeet Singh S. K. Verma C. P. Kumar Sudhir Kumar V. K. Agarwal Rajeev Gupta S. L. Srivastava Vishal Gupta Mohar Singh	**3 years** (06/12-03/16) **Continuing Study**
9.	HI/2015/SR-2	The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems in North Eastern Parts of Punjab, India **(IAEA)**	M. S. Rao (PI) C. P. Kumar S. P. Rai	**3 years** (09/12-08/15) **Continuing Study**
10.	HI/2015/SR-3	Assessment of Baseflow and its Impact on Water Quality in the Part of Satluj River in India using Environmental Isotopes and Age Dating Techniques **(IAEA)**	S. P. Rai (PI) R. V. Kale M. S. Rao C. P. Kumar Sudhir Kumar V. K. Agarwal Vishal Gupta Mohar Singh	**3 years** (10/12-09/15) **Continuing Study**
11.	HI/2015/SR-4	Integration of Isotope Hydrology in Aquifer Mapping Efforts in India: A Pilot Study of Upper Yamuna Plains **(IAEA)**	Sudhir Kumar (PI) S. P. Rai S. D. Khobragade C. K. Jain P. K. Garg	**2 years** (05/13-04/15) **Continuing Study**
12	HI/2015/SR-5	Understanding of hydrological processes in Upper Ganga basin by using isotopic techniques **(DST)**	Dr. S. P. Rai (PI) Dr. Sudhir Kumar Rajesh Singh S. D. Khobragade Dr. M. Arora Dr. R. J. Thayyen Sh. P. K. Garg	**5 years** **(4/15 – 3/20)** **New Study**

SURFACE WATER HYDROLOGY DIVISION

S.N.	Title of Project/Study, Study Team, Start/ Completion Dates	Status and Recommendations/ Suggestions
1.	Sedimentation Studies for Pong Reservoir, Himachal Pradesh **Team** A. R. Senthil kumar Manohar Arora Suhas D Khobragade Avinash Agarwal and Sanjay Jain DOS:April 2012 DOC: March 2015	Dr N B N Prasad suggested to derive the elevation-area-capacity table for every 5 and 10 years and observe any reduction in the rate of sedimentation in the reservoir after soil conservation practices in the catchment. Dr. R. D. Deshpande inquired about the contribution of sediment yield from small tributaries joining the reservoir, which was replied by the PI. The PI requested six months extension for the computation of elevation-area-capacity table for the consolidated sediment volume for each ensemble, which will present a range of elevation-area-capacity table. The Chairman granted the permission to compute the elevation-area-capacity tables and the present the whole result in the next working group meeting.
2.	Study of Hydro-Meteorological Droughts For Chitrakoot Bundelkhand Region In India **R.P. Pandey** DOS: April 2012 DOC: March 2015	The Working Group was informed about the details of Simple Drought Index (SDI), a new method, devised and validated for regular drought monitoring using monthly rainfall data. It was reported that a comprehensive plan for augmenting drinking water supply and supplemental irrigation water supply to kharif crop during dry spells has been prepared.
3.	Application of DSS (P) for Integrated Water Resources Development & Management **Team** A.K. Lohani, Surjeet Singh, Rahul Jaiswal; D K Sonkusale and Akilesh Verma DOS: April 2013 DOC: March 2015)	Dr Lohani mentioned that the DSS (P) software has been developed under HP-II and the same model is being applied in Arpa basin of Seonath river basin to demonstrate the capabilities of the DSS(P) model. Dr Lohani mentioned that the crop water requirement data is not yet provided by the Water Resources Department, Raipur and therefore about six month extension may be granted to complete the study. Members and the Chairman, of the working group have approved the six month extension.
4.	Quantitative assessment of uncertainties in river discharge estimation **Team** Sanjay Kumar and Sharad Jain DOS: April 2013 DOC: March 2016	Dr. Sanjay Kumar mentioned that review comments received from the nominated experts of member countries have been resolved and the draft was circulated to member bodies and national committees for further comments. Dr. Kumar informed that comments from member bodies/national committees are currently being resolved. The final draft would be placed in the ISO meeting scheduled during May 2015 in Tokyo. There were no comments from the WG members.
5.	Evaluation and modeling of hydrological support system	Dr. Agarwal informed that rainfall-runoff-sediment model with using SWAT and CCH1D is in progress. Working

	for watersheds of Garhwal, Uttarakhand hills **Team** Avinash Agarwal, Manohar Arora and R K Nema DOS: Nov 2013 DOC: Oct 2016	group accepted the study progress.
6.	Estimation of Water Balance for Integrated Water Resources Management in Yerrakalva Pilot Basin, A.P. **Team:** J.V.Tyagi and YRS Rao DOS: April 2014 DOC: March 2015	Dr. J.V. Tyagi informed that the required spatial database and attribute data tables for the model have been prepared and SWAT has been set up for the Yerrakalva basin. The model calibration is pending for want of the out flow data from the Yerrakalva reservoir. In view of this, Dr. Tyagi requested the Chairman to grant an extension of six months to complete the study. The Chairman approved the extension for the study up to up to 30th September, 2015.
7.	Systematic treatment and analytical solutions for surges and bores in rectangular channels (research study) **Team:** S.K. Singh DOS: April 2014 DOC: March 2015	Dr. S. K. Singh informed that the study is complete and the report will be submitted by this month.
8.	Status Report on "Impact of Anthropogenic and Climate Change on Sediment Load of Rivers" **Team:** Archana Sarkar DOS: April 2014 DOC: March 2015	Mrs Archana Sarkar presented some of the findings of various research workers in the subject area. Working group members noted the progress of the study and appreciated the work.
9.	Study of Rainfall Patterns and Comparison of Rainfall Data from different Sources for Uttarakhand State **Team:** Archana Sarkar, N.K. Bhatnagar, Vaibhav Garg and Rakesh Kumar DOS: April 2014 DOC: March 2016	Mrs Archana Sarkar presented the progress of the study with results of trend analysis of historical rainfall data (annual, seasonal and monthly) by parametric and non-parametric methods for four rainfall stations two each in Kumoan and Garhwal regions. Mrs Sarkar informed to include the data comparison work through hydrological modeling and requested for an extension of the study by another six months, i.e., a new time frame of April 2014 to Sept 2017. Working group members agreed for the extension.
10.	Monitoring and modelling of streamflow for the Gangotri Glacier **Team:** Manohar Arora and	The PI presented the future GCM scenarios of GFDL GCM. He validated the past data with observed data and explained the reason for over estimation. The future RCM output of REGCM4.3 model for the RCP8.5 scenarios

	Rakesh Kumar DOS: May 2014 DOC: March 2017	were presented for 100 years. Dr Arora explained that these output will be considered while assessing the future water availability. No specific questions were asked by the experts.
11.	Effect of climate change on evaporation at point scale Team: Digambar Singh, A. R. Senthil kumar and Manohar Arora DOS: June 2014 DOC: March 2017	The PI reported that there was a slight decrease in rainfall during the considered period of analysis. There was a mild variation in temperature and humidity. The PI informed the house that high variability was observed in evaporation in the month of January from the analysis of recorded data. Highest value of the evaporation was observed in the month of May.
		NEW STUDIES
12.	Study of regional drought characteristics and long term changes in supplemental irrigation water requirement in Seonath Basin in Chhattisgarh Dr. R.P. Pandey Dr. Rakesh Kumar DOS: April 2015 DOC: March 2017)	Dr R.P. Pandey presented a new study to be carried out in the Seonath basin in Chattisgarh state of India. The Director NIH and the Chairman Working Group suggested taking up a study in Bundelkhand region to study the possible impact of proposed Ken-Betwa interlinking project. He suggested to propose a project proposal on the above in the next working group meeting.
13.	Flood and Sediment studies in Himalayan basin using MIKE-11 Model Dr. A.K. Lohani DOS: April 2015 DOC: March 2018	Dr. A. K. Lohani mentioned that the flood study is required to be carried out in the Himalayan basins so as to simulate the impact of flooding due to cloud burst. Furthermore, the Himalayan rivers carry very sedimentation load and therefore, scientific study of river sedimentation is also required to be carry out.
14.	Snowmelt Runoff Modelling and Study of the Impact of Climate Change in Sharda River Basin Team: Dr Achana Sarkar Er. T. Thomas Dr. Vaibhav Garg DOS: April 2015 DOC: March 2018	Mrs. Archana Sarkar informed that the Institute has already carried out related studies for the Ganges basins mostly in the Garhwal Himalayas but the proposed study would be the first one for the Kumaon Himalayan River basin. Various scenarios of precipitation and temperature would be considered to study the impact of climate change on the hydrological regime of the study basin using GCM outputs.
15.	Generalization and parameter estimation of GEV distribution for flood analysis Dr. S. K. Singh	Dr. S. K. Singh presented the study highlighting the intended objectives of the study. The GEV distribution as is widely used has two different forms (Type 2 and Type 3) as used in flood frequency analysis. It is intended to possibly unify both type 2 and type 3 GEV distributions in a single GEV and suggest both a simple and optimization method for estimation of its parameters with illustration on

	DOS: April 2015 DOC: March 2016	measured/ published data. This was well received during the discussion and no suggestions were received from the members at this stage.
16.	Analytical Solution for meeting of two surges or bores Dr. S. K. Singh DOS: April 2015 DOC: March 2016	Dr. S. K. Singh presented the study highlighting the intended objectives of the study as developing analytical equations/solutions in case two surges or bores in rectangular channel intersection from opposite direction, avoiding the currently used iterative solution, with a systematic treatment of surges. An abrupt change in discharge or depth of flow causes a surge or bore in channels. This abrupt change may be due to a sudden opening or closure of gate, part-blockage of a channel due to landslide or tidal effect. This was well received with discussion and no suggestion from the members at this stage.

SURFACE WATER HYDROLOGY DIVISION
WORK PROGRAM FOR 2015-16

S.N.	Code	Study	Study Team	Duration
	Ongoing Internal Studies			
1.	SWH/2015/TS-1	Application of DSS (P) for Integrated Water Resources Development & Management	A.K. Lohani Surjeet Singh Rahul Jaiswal D K Sonkusale Akilesh Verma	2 years (April 2013 to Sept. 2015)
2.	SWH/2015/TS-2	Estimation of Water Balance for Integrated Water Resources Management in Yerrakalva Pilot Basin, A.P.	J.V.Tyagi YRS Rao,	1 year (April 2014 to Sept. 2015)
3.	SWH/2015/TS-3	Study of Rainfall Patterns and Comparison of Rainfall Data from different Sources for Uttarakhand State	Archana Sarkar Vaibhav Garg, IIRS Rakesh Kumar N.K. Bhatnagar	2 years (April 2014 to Sept. 2017)
4.	SWH/2015/TS-4	Quantitative assessment of uncertainties in river discharge estimation	Sanjay Kumar Sharad Jain	3 Years (April 2013 to March 2016)
5.	SWH/2015/TS-5	Evaluation and modeling of hydrological support system for watersheds of Garhwal, Uttarakhand hills.	Avinash Agarwal Manohar Arora RK Nema	3 Years (Nov 2013 to Oct 2016)
6.	SWH/2015/TS-6	Effect of climate change on evaporation at point scale	Digambar Singh A. R. Senthil kumar Manohar Arora	3years (June 2014 to March 2017)
7.	SWH/2015/TS-7	Hydrological modelling, water availability analysis	J.P.Patra Rakesh Kumar Pankaj Mani	3years (April 2014 to March 2017)
	Ongoing Sponsored Projects			
1.	SWH/2015/SR-1	Modeling of Gangotri Glacier melt runoff and simulation of stream flow variation under different climate scenarios	Manohar Arora Rakesh Kumar	3years (May 2014 to March 2017)
	New Internal Studies			
1.	SWH/2015/TS-8	Flood and Sediment studies in Himalayan basin using MIKE-11 Model	A.K. Lohani	3 years (April 2015 to March 2018)
2.	SWH/2015/TS-9	Snowmelt Runoff Modelling and Study of the Impact of Climate Change in Sharda River Basin	Archana Sarkar T. Thomas Vaibhav Garg	3 years (April 2015 to March 2018)
3.	SWH/2015/TS-10	Study on effect of climate change on sediment yield to Pong reservoir	A. R. Senthil Kumar J. V. Tyagi Avinash Agarwal Suhas Khobragade Manohar Arora	3 years (April 2015 to March 2018)
4.	SWH/2015/TS-11	Study of regional drought characteristics and long term changes in supplemental irrigation water requirement in Seonath Basin in Chhattisgarh	R.P. Pandey Rakesh Kumar	2 years (April 2015 to March 2017)

WATER RESOURCES SYSTEM DIVISION

Dr. Sharad K Jain, Sc. G and Head (WRS Div.), presented an overview of the division – scientific strength, the ongoing studies, sponsored & consultancy studies, technical publications and training courses organized. Following are the comments received from working group on the presentations of the various studies.

PI: Dr. M. K. Goel, Scientist "F"
Study title: *NIH_Basin* – A WINDOWS based model for water resources assessment in a river basin (Ongoing)
Dr. M. K. Goel (MKG) presented the progress of the study. He informed that envisaged objectives of the study included modifications in the modeling methodology and development of WINDOWS interface named as **NIH_Basin** (**NIH_ Basin Simulation**) of the model. MKG informed that, a number of modifications have been made in the model methodology and the source code for making it more practicable and realistic. Some of these include:

i) Number of land use classes has been increased from 6 to 51 for more detailed representation.
j) As suggested in last WG by Dr. Deshpande, option has been included to consider industrial demands separately and the same has been linked to city attributes.
k) Date of commissioning of hydraulic structures has been included and in the long-term simulation, their effects are considered only after their commissioning.
l) Variable GW development is now considered (it was constant initially).
m) Baseflow computation now depends on the actual GW storage in upstream basin above a gauging site.
n) Rather than considering constant human and cattle population, population growth is considered as per defined rate. For long-term simulation, revised population is estimated at the beginning of each year.
o) In the command area of hydraulic structures, which are commissioned in intermediate stages during simulation, option has been included for considering the revised cropping pattern while computing irrigation demands.

Since these modifications required changes in the input data, it was decided to first complete the model modifications and then develop the WINDOWS based forms for database preparation. The program development is nearing completion but interface development needs considerable time. MKG requested to increase the study period by 6 months which was agreed by the WG.

PI: Dr. Sanjay K. Jain (SJ), Scientist "F"

1. Glacier change and glacier runoff variation in the upper Satluj river basin (Ongoing)
Dr. Jain presented the objectives as well as the progress made so far. Three sub basins of Upper Satluj basin have been taken for this study. Dr. Jain presented the analysis of temperature and snow water equivalent data and explained correlation between these with glacier change. SJ informed that the data base preparation for snowmelt runoff modelling is under progress and presented the results of snow cover depletion. Dr. Deshpande asked whether snow and glacier mapping vis-à-vis aspect can be carried out. He also suggested that analysis related to trend in a time series may be carried out at different time step, say a decade instead of taking long-term linear trend. Dr. Bartarya informed that some of glacier studies in Baspa basin have been carried out which can also be reviewed. These suggestions were noted.

2. Modelling of Narmada Basin using GWAVA Model (Ongoing)

SJ presented the status as well as the progress. He informed that entire Narmada basin will be considered in the present study, however, initial calibration will be carried out up to Hoshangabad in which three important storage structures are Bargi, Barna and Tawa reservoirs. Dr. Jain also informed about different processes and components of GWAVA model. A training workshop on the GWAVA model was conducted by experts from Centre of Ecology and Hydrology (CEH), United Kingdom during 02-05 March, 2015. Dr. Jain also presented different thematic maps/ model inputs prepared so far. Dr. Sharad Jain suggested inclusion of Madhya Pradesh Council of Science and Technology in the study. Dr. Deshpande suggested inclusion of tectonic features (differential pathways) in the model. Dr. Jain replied that if such feature is available in the GWAVA model, the same will be tried.

PI: D. S. Rathore (DSR), Scientist "F"

3. Decision Support System for Water Resources Planning in Upper Bhima basin, Maharashtra (Ongoing)

The progress of the study was presented by DSR. For multi reservoir operation application, Khadakwasla reservoir complex was chosen. The complex has four reservoirs namely Khadakwasla, Temghar, Warasgaon and Panshet. Uptake of water for urban supply to Pune city and Mutha RBC is done from Khadakwasla reservoir. Hydro power generation is also done in Warasgaon and Pashet reservoirs. Simulations were done for FRL and 75% dependable reservoir water levels for varying demands. For 6% increased demands, reliability of supply reduced up to 86% and 73% for town and irrigation demands respectively. Probability of drought magnitude (SPI based) was estimated for monthly rainfall data. The probability varies from 40 to 70% for magnitude greater than one. Water quality model setup was elaborated. Availability of data for various pollutant sources, person-load were presented. Pollutant load temporal distribution was conceptualized as runoff based or uniform. Dr Deshpande inquired about differences in reliability of water supply to different users for a scenario. DSR informed that difference is due to different priority assigned to the users. Water allocation in any time step is based on priority. Water supply reliability will be higher for higher priority user. In this case, urban user is given first priority and irrigation user is assigned 2nd priority. Chairman pointed out that in reliability table, demand should also be written for clarity.

4. Web GIS based snow cover information system for Indus basin (Completed)

In the study, snow cover mapping for Indus basin was completed for year 2007 to 2012 using MODIS data. NDSI and NIR bands were used from 8-day composite MOD09A1. FCC were visually inspected to identify cloud cover and for scenes with significant cloud cover, snow area of cloud free preceding and/or succeeding dates were used in snow statistics. Snow cover raster maps were processed to obtain snow polygons. The polygons were used in Geoserver based web application. Sub basin wise yearly variation in snow cover area during 1st September to 31st August was studied. There was significant snowfall in eastern part of Indus basins during September- November in many years. Visualization in web browser for snow cover maps in different days was demonstrated. Mr Kishor Kumar inquired about extending the application to other basins. Further, since web pages are created dynamically, i.e. server data being accessed by the application on user request, the security audit of the application will be needed. The audit may be done by empanelled agencies. It was informed that for extending the application to other basin, snow maps need to be generated from MODIS data and published in Geoserver. Further, links in HTML application need to be updated. Application is currently deployed on intranet. Dr. Sanjay Jain informed that security audit will be initiated prior to deploying the application on web.

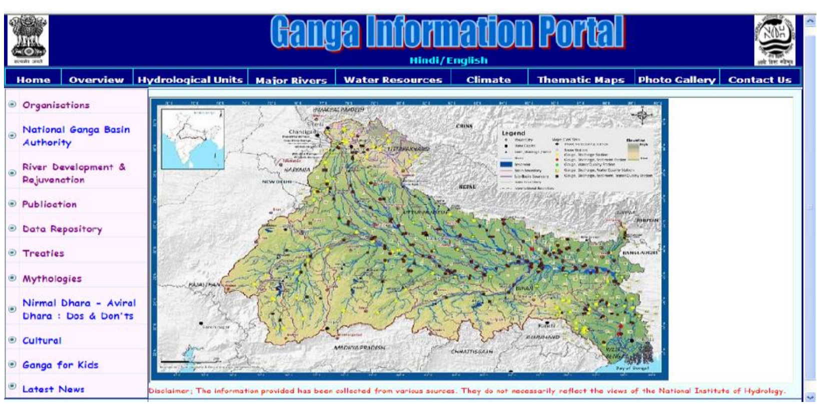
PI: Deepa Chalisgaonkar (DC), Scientist "F"

1. Assessment of Water Footprint of the National Capital Territory (NCT) of India (Completed)

DC informed that the objective of this study is to estimate the water footprints of NCT Delhi from both a supply and consumption perspective by quantifying green, blue and grey water footprints. Additionally, the aim is to understand how the water resources of NCT Delhi are being utilized for water consumption. The methodology used in this study is largely based on earlier studies supported by Water Footprint Network (www.waterfootprint.org) and the three components of water footprint have been computed for domestic, agriculture and industrial sector based on the data for the period 2006-2010 collected from various sources, published reports from various departments of government of NCT Delhi and from websites. The virtual water content related data is available at country level not at NCT Delhi level, so it is being used for NCT Delhi as well. Missing data has been assumed. As the computation of grey water footprint includes the amount of freshwater required for mixing pollutants and maintaining water quality according to agreed water quality standards, the water quality criterion of Central Pollution Control Board ('C' Class water) has been taken for the computation of dilution water requirement. For the computation of crop water requirement, CROPWAT software has been used and for the grey water component only the nitrogen fertilizer use has been incorporated. This means only the most critical pollutant with the greatest application rate is being considered. Virtual water import component has also being considered for the computation of agriculture water footprint as lot of agriculture related products are brought in Delhi for consumption. WG noted the progress of the study.

2. Development of Ganga Information Portal

DC presented the proposed new study on development of Ganga Information Portal, which is envisaged to provide a unique platform comprising multisource data and information on Ganga basin. The major objective is to develop a knowledge/ information e-portal with exhaustive information on Ganga basin. Govt. of India is keen to clean rivers of India, beginning with Ganga and restore 'Nirmal dhara' and 'Aviral dhara'. Recognizing the multi-sectoral, multi-dimensional and multi-stakeholder nature of information in the Ganga basin, the need is to develop a web-based platform where different types of data/ information (facts; publications; data; maps; photographs; etc.) related to Ganga basin is available at one place. 'Ganga Information Portal' (GIP) is a step in this direction. DC also presented the proposed framework of the portal.



PI: Dr. Renoj J Thayyen (RJT), Scientist "D"

1. Glaciological studies of Phuche Glacier, Ladakh Range (Ongoing- Sponsored)

Main objective of this project is to evaluate the winter and summer mass balance of the Phuche glacier. RJT informed that the Phuche glacier experienced negative mass balance during 2013-2014 mass balance year. Progress made on analysing the energy balance data to achieve the mass balance modelling was also presented. No specific suggestions were received.

2. Cryospheric system studies and runoff modeling of Ganglass catchment, Leh, Ladakh Range (Ongoing)

This project is aimed to evaluate the catchment scale hydrologic processes of the cold-arid regime. RJT informed about the establishment of a new discharge station at Gonpa near Leh to monitor round the clock discharge of the perennial stretch of the stream. Studies on permafrost thaw in the catchment continued during the reporting period. Electrical conductivity and discharge showed clear inverse relationship between the two during the peak discharge month of July and August which changed to in phase relationship in the month of September suggesting ground ice melt contribution. There were no specific suggestions/ comments from any member.

3. Runoff modeling of Shyok River, Karakorum Range (New)

This project is executed in coordination with border Roads Organisation (BRO) at km 150 of Durbuk—DBO axis. The project was initiated in January 2015. RJT informed that the Radar Water Level Recorder has been already installed to monitor the water level at km 150. It has been a challenging task to raise a cantilever structure with a 10m long arm. RJT informed that steps for procurement of AWS will be initiated soon. No specific suggestions were received for this project.

PI: Shri L N Thakural (LNT), Scientist "B"

1. Trend and variability analysis of Rainfall and Temperature in Himalayan region (Completed)

The objectives of the study were to create the database for rainfall and temperature variables for the Himalayan region and to carry out statistical analysis to detect trend and variability in these variables in the Himalayan region, India. The parametric (linear regression) and non-parametric (Mann-Kendall and Sen's estimator of Slope) approaches were applied to determine the trends in the time series data of these meteorological variables. The trend analysis on seasonal and annual scale carried out for the rainfall using APHRODITE data during the last quarter along with overall results for the entire Himalayan region were presented in the meeting. No specific suggestions were received for this project.

2. Study of Hydrological Changes in selected watersheds in view of Climate Change in India (New)

PI of the study (LNT) presented the background, objectives, methodology and the expected deliverables of the new studyand informed that this 3 years (2015 to 2018) project will be executed through internal funds. It was informed that probable climate change and its perilous impact on the hydrologic system poses a threat to global fresh water resources and aquatic ecosystems worldwide. These changes are not uniform and vary from place to place or region to region. Thus, the present study intend to assess the hydrological changes in watersheds located in different parts of India under changing environment for proper planning and management of water resources. It was also informed that four watersheds will be selected from four different climatic regions of India mainly depending upon the data availability, easy accessibility and having different usage classes (Land use/Land cover). It was decided that one watershed will be studied in association with CWRDM, Kerala, under the MOU signed between NIH and CWRDM.

PI: Shri P. K. Mishra (PKM), Scientist "B"
Study title: Assessing Climate Change Impact across KBK (Kalahandi-Bolangir-Koraput) region of Odisha (Ongoing)
PKM presented the progress made in the study since inception as well as during last six months (November '14-March '15). PKM presented the objective-wise progress made in the study. Shri Mishra presented the future rainfall and temperature downscaled from HadCM3 A2 and HadCM3 B2 GCM data utilizing SDSM model for the KBK region. The study has been carried out using SDSM tool version 4.2.9. Further, to assess the water availability and utilization, input data for two basins viz. Tel basin (sub-basin to Mahanadi basin) and Sarbari basin (sub-basin to Godavari basin) is under preparation to run Soil and Water Assessment Tool (SWAT) model. Mr. Mishra requested to extend the study by 12 months which was agreed by the WG.

PI: Shri M. K. Nema (MKN), Scientist "B"

1. Variability of the Hydro-climatic variables in Punjab Plains of lower Satluj (Ongoing)
The progress of the study was presented by MKN. During the presentation no specific comments were made by any member. However, Dr. Rangarajan Ramaswamy, Chief Scientist, NGRI suggested to modify the tabular representation of groundwater data. Suggestion shall be followed in the future presentations.

2. Hydrological Processes and Characterization of Lesser Himalayan Catchments
MKN presented the progress of the study, which is experimental in nature and requires setting up instruments in the proposed watersheds. Dr. Sharad K Jain, Sc 'G' & Head WRSD, suggested that the stream gauging structure be constructed before the monsoon so that the flow data of the monsoon season can be collected. Mr. Nema replied that initiatives have already been taken to implement the gauging structure before monsoon.

PI: Shri P. K. Agarwal, Scientist "B"
Study title: Hydrologic Modelling of a part of Satluj Basin using SWAT Model (Ongoing)
The progress of the study was presented by Shri Tanvear Ahmad, Scientist B & Co-PI. He informed that SRTM DEM has been downloaded and the study area and drainage network have been generated with the help of the same. Preparation of land use map & Soil map are nearing completion. Some meteorological data has been collected. Database preparation for running SWAT is under progress. No specific comments were received.

WATER RESOURCES SYSTEMS DIVISION
WORK PROGRAM FOR 2015-2016

SN	Code	Study	Study Team	Duration
	Ongoing Internal Studies			
1.	WRS/2015/TS-1	NIH_Basin – A WINDOWS based model for water resources assessment in a river basin	M. K. Goel Deepa Chalisgaonkar Sharad K. Jain Prabhash K. Mishra	3 Years (04/13-03/16)
2.	WRS/2015/TS-2	Assessing climate change impact across KBK region of Odisha	P. K. Mishra Sharad K. Jain Sanjay K. Jain	3 Years (04/13-03/16)
3.	WRS/2015/TS-3	Glacier change and glacier runoff variation in the upper Satluj river basin	Sanjay K. Jain Sharad K. Jain Renoj J. Thayyen	2.5 Years (10/13-03/16)
4.	WRS/2015/TS-4	Variability of the Hydro-climatic variables in Punjab Plains of Lower Satluj	M. K. Nema Sharad K. Jain	2 Years (11/13-10/15)
5.	WRS/2015/TS-5	Catchment scale evaluation of cold-arid cryospheric system Hydrology, Ganglass catchment, Ladakh	Renoj J. Thayyen S. P. Rai Sanjay K Jain Sudhir Kumar	3 years (04/14-03/17)
6.	WRS/2015/TS-6	Hydrologic Modelling of a part of Satluj Basin using SWAT Model	P. K. Agarwal Sharad K. Jain M. K. Goel Sanjay K. Jain M. K. Nema Tanvear Ahmed	2 -3/4 Years (06/14-3/17)
7.	WRS/2015/TS-7	Decision Support System for Water Resources Planning in Upper Bhima basin, Maharashtra	D. S. Rathore M. K. Goel, R.P. Pandey Sanjay Kumar Surjeet Singh	2 years (07/14-06/16)
8.	WRS/2015/TS-8	Modeling of Narmada basin by using the GWAVA model	Sanjay K. Jain Sharad K. Jain T. Thomas (RC-Bhopal) P. K. Mishra P. K. Agarwal M. K. Nema	2.25 years Dec. 2014 – Mar 2017
9.	WRS/2015/TS-9	Runoff modeling of Shyok River, Karakorum Range	Renoj J.Thayyen Sanjay K.Jain	3 years Dec-2014 to Nov-2017
10.	WRS/2015/TS-10	Hydrological process and characterization of Lesser Himalayan Catchments	M. K. Nema Sharad K. Jain Sanjay K. Jain Renoj J.Thayyen P. K. Mishra P. K. Agarwal	5 Years 12/14-12/19
	Ongoing Sponsored Studies			
1.	WRS/2015/SR-1	Glaciological studies of Phuche Glacier, Ladakh Range, India (DST)	Renoj J. Thayyen M K Goel S P Rai	5 Years 1/10-06/15

2.	WRS/2015/SR-2	Assessment of Environmental flow for Himalayan River (MOES)	Sharad K. Jain Pradeep Kumar P. K. Agarwal P. K. Mishra	1 Year 07/14-07/15
	New Internal Studies			
1.	WRS/2015/TS-11	Development of Ganga Information Portal	Deepa Chalisgaonkar Sharad K. Jain D. S. Rathore Sanjay K. Jain Sudhir Kumar P. K. Mishra P. K. Agarwal M. K. Nema Furquan Ullah	3 years (04/15-03/18)
2.	WRS/2015/TS-12	Study of Hydrological Changes in selected watersheds in view of Climate Change in India	L. N. Thakural D. S. Rathore Surjeet Singh Tanvear Ahmed Sanjay K. Jain Sharad K. Jain	3 years (04/15-03/18)

RESEARCH MANAGEMENT AND OUTREACH DIVISION (RMOD)

SN	Title of Project/Study, Study Team	Status and Recommendations/Suggestions
1.	Participatory development of structure for IWRM Framework in identified sub-basins under Pilot Basin Studies (PBS) program **Team:** V C Goyal (PI), Omkar Singh and R V Kale DOS: July 2014, DOC: June 2015	The study was presented by Dr. V.C. Goyal (PI). There were no any comments in this study.
2.	Customization of WEAP model for application in Ur river watershed in Tikamgarh district of Bundelkhand region. **(Under TIFAC Project)** **Team:** R V Kale (PI), T Thomas- RC Bhopal, Jyoti Patil, Rajesh Agarwal, DOS: Apr 2014, DOC: Sep 2015	The study was presented by Dr. R.V. Kale (PI). There is no any specific comment. However, Mrs. S. Kaur, IMD opinioned that it should have better option when application of WEAP model may have carried out initially for a gauged basin.
3.	Water conservation and management in Ibrahimpur Masahi village of Hardwar district (Uttarakhand) **Team:** Omkar Singh, V.C. Goyal, C.K. Jain, and Rajesh Singh DOS: Apr 2013, DOC: March 2015	The study was presented by Er. Omkar Singh (PI). The PI requested for one year extension to perform relevant tasks of this study and WG agreed. However, the Chairman suggested to utilize the boat facility for bathymetric survey of ponds in the villages. The PI noted the suggestions for compliance.
4.	WEAP Model set up for four sub-basins under Pilot Basin Studies (PBS) Programme, jointly with the RCs/CFMSs **NIH HQs:** V C Goyal (PBS Leader), Jyoti Patil and R V Kale **Co-investigators from NIH RCs/CFMSs:** Chandramohan T (RC-Belgaum), Y R S Rao (RC-Kakinada), T R Nayak (RC-Bhopal), B Chakravorty (CFMS-Patna) DOS: Apr 2015, DOC: Mar 2016 (**New study)**	The study was presented by Dr. Jyoti Patil. There is no any specific comment. However, the duration of this study may be increased from 1 year to 2 years.

RESEARCH MANAGEMENT AND OUTREACH DIVISION

WORK PROGRAM FOR 2015-2016

SN	Code	Title of Project/Study, Study Team	Duration
	Ongoing Internal Study		
1.	RMO/2015/TS-1	Participatory development of structure for IWRM Framework in identified sub-basins under Pilot Basin Studies (PBS) program **Team:** V C Goyal (PI), Omkar Singh and R V Kale	DOS: July 2014 DOC: June 2015
2.	RMO/2015/TS-2	Water Conservation and Management in Ibrahimpur Masahi Village of Hardwar District (Uttarakhand) **Team:** Omkar Singh, V.C. Goyal, C.K. Jain, and Rajesh Singh	DOS: Apr 2013 DOC: March 2016
	New Internal Study		
3.	RMO/2015/TS-3	WEAP Model set up for four sub-basins under Pilot Basin Studies (PBS) Programme, jointly with the RCs/CFMSs **NIH HQs:** V C Goyal (PBS Leader), Jyoti Patil and R V Kale **Co-investigators from NIH RCs/CFMSs:** Chandramohan T (RC-Belgaum), Y R S Rao (RC-Kakinada), T R Nayak (RC-Bhopal), B Chakravorty (CFMS-Patna)	DOS: Apr 2015 DOC: Mar 2017
	Sponsored Project		
1.	RMO/2015/SR-1	Customization of WEAP model for application in Ur river watershed in Tikamgarh district of Bundelkhand region. **(Under TIFAC Project)** **Team:** R V Kale (PI), T Thomas- RC Bhopal, Jyoti Patil, Rajesh Agarwal	DOS: Apr 2014 DOC: Sep 2015 (**Ongoing study)**

Proposed Technical Transfer & Outreach Activities during 2015-2016

S N	Code	Activity
1	RMO/2015/OR-1	Outreach activities (IITF-2015, IWW, other exhibitions)
2	RMO/2015/TW-1	5-day Workshop on “Citizen science in hydrology and water resources”
3	RMO/2015/TW-2	Orientation training of newly appointed scientists
4	RMO/2015/OR-2	Science-Policy interface, IPR issues, and technical meetings
5	RMO/2015/OR-3	Establishment of “Water Activity Centre”
6	RMO/2015/LCU	Operational expenses of LCU-Delhi

Dr. V C Goyal thanked the members for their valuable contributions during deliberations in the Working Group meeting.

The meeting ended with vote of thanks to the Chair.

ANNEXURE-I

List of Working Group Members who attended the 42nd WG meeting

1.	Er. R.D. Singh, Director, NIH	Chairman
2.	Dr. S.K. Bartarya, WIHG, Dehradun	Member
3.	Dr. (Mrs.) Surinder Kaur, DDGM(H), IMD, New Delhi	Member
4.	Dr. S C R Vishvakarma, Sc.F, GBPIHED, Almora	Member
5.	Dr. R D Deshpande, Sc.SF, PRL, Ahmedabad	Member
6.	Dr. R.Rangarajan, Sc.G, CSIR-NGRI, Hyderabad	Member
7.	Dr. N.B. Narasimha Prasad, Ex. Director, CWRDM. Kozhikode	Member
8.	Dr. Kishore Kumar, Sr. Tech. Director, NIC, New Delhi	Member
9.	Dr. S.K. Jain, Sc. G & Head WRS Division, NIH	Member
10.	Dr. Rakesh Kumar, Sc. G & Head SWH Division, NIH	Member
11.	Dr. Sudhir Kumar, Sc. G & Head HI Division, NIH	Member
12.	Dr. V C Goyal, Sc. F & Head, RMO Division, NIH	Member-Secretary

Scientists from National Institute of Hydrology, Roorkee

	EH Division		**SWH Division**
1	Dr. R.D. Mehta, Sc.D	18	Dr. J.V. Tyagi, Sc.G
2	Dr. M.K. Sharma, Sc.D	19	Dr. Avinash Agarwal, Sc.F
3	Dr. Rajesh Singh, Sc.B	20	Dr. S.K. Singh, Sc.F
	GWH Division	21	Dr. R.P. Pandey, Sc.F
4	Er. C.P. Kumar, Sc.F	22	Dr. A.K. Lohani, Sc.F
5	Dr. Anupama Sharma, Sc.D	23	Dr.A R Senthil Kumar, Sc.D
6	Dr. Surjeet Singh, Sc.D	24	Dr. Sanjay Kumar, Sc.D
7	Sh.Rajan Vatsa, Sc.B	25	Dr (Mrs) Archana Sarkar, Sc.D
8	Sh. Sumant Kumar, Sc.B	26	Dr. Manohar Arora, Sc.D
9	Mrs. Shashi Poonam, Sc.B	27	Sh. Digamber Singh, Sc.B
	HI Division	28	Sh. J.P. Patra, Sc.B
10	Dr.Suhas Khobragade, Sc.E		**WRS Division**
11	Dr. S.P. Rai, Sc.D	29	Smt. D.Chalosgaonkar, Sc.F
12	Dr. M.S. Rao, Sc.D	30	Dr. Sanjay Jain, Sc.F
13	Sh. S.K. Verma, Sc.D	31	Dr. M.K. Goel, Sc.F
14	Sh. P.K. Garg, Sc.B	32	Er. D. S. Rathore, Sc. F
	RMO Division	33	Dr. Renoj J. Thayyen, Sc.D
15	Er. Omkar Singh, Sc.E	34	Sh. L.N. Thakural, Sc.B
16	Dr. Ravindra Vitthal Kale, Sc.B	35	Sh. Manish Nema, Sc.B
17	Dr (Mrs) Jyoti P. Patil, Sc.B	36	Sh. P.K. Mishra, Sc.B
		37	Sh. Tanveer Ahmad, Sc.B
		38	Sh. P.K. Agrawal, Sc.B