Dr Manoj Kumar Jain

Department of Hydrology
Indian Institute of Technology Roorkee

Profession / Specialisation:	Watershed Management, Surface Water Hydrology Major
Job Title:	Professor & Head, Department of Hydrology

Professional and Educational Qualifications

PhD Hydraulics & Water Resources Engineering	Indian Institute of Technology, Roorkee	2002
M. Tech. (Soil and Water Engineering)	J.N.K.V.V. Jabalpur	1988

Research interests and expertise

Watershed Modelling & Management, Soil Erosion and Sediment Transport Modelling, Remote Sensing and GIS Applications in Hydrology and Watershed Management, Surface Water Hydrology, Spatial data Analysis using Image Processing and GIS, Long term Water Resources Management and Modelling, Drought Studies.

Summary of Professional Expertise

Dr Jain has more than 29 years of teaching/research experience in the field of Hydrology & Water Resources Engineering. He has supervised over 8 PhD and 48 MTech theses. He has extensive experience of leading and completing many research and consultancy projects both nationally and internationally. His teaching activities include Hydrologic Elements and Analysis; Planning and Management of Watersheds; Watershed Bahaviour and Conservation Practices; Forests and Agricultural Hydrology; Engineering Hydrology; Irrigation and Drainage Engineering; Experimental Hydrology. He has also developed the watershed hydrology laboratory.

He has published many papers in various national & international journals of repute, national and international conferences and published several technical reports.

Employment History

2018	-	Present	Professor & Head, Department of Hydrology, IIIT Roorkee
2012	-	2018	Associate Professor, Indian Institute of Technology Roorkee
2006	-	2012	Assistant Professor, Indian Institute of Technology Roorkee
2002	-	2006	Scientist E1, National Institute of Hydrology Roorkee
1996	-	2001	Scientist C, National Institute of Hydrology Roorkee
1990	-	1995	Scientist B, National Institute of Hydrology Roorkee

Work Experience

2018	-	Onwards	ET-NFP for WMO RTC Roorkee
2019	-	2022	PI, Real-Time Discharge Estimation using non-contact Hydrometric Measurements, Ministry of Earth Science, Govt. of India.
2018	-	2019	Co-PI, Technical Study (PMF, back water and other hydrological studies) on Polavaram Project, Department of Water Resources, Govt. of Odisha
2017	-	2020	PI, Lead Time Inflow Estimation for Reservoir Operation during Monsoon, Dam Rehabilitation and Improvement Project, CWC, Ministry of Jal Shakti, Govt. of India.
2016	-	2017	PI, Academic and Governance Planning for up-gradation of River Research Institute, West Bengal to Degree Awarding Institute, EdCIL India Limited, Sector 16A, Noida.
2013	-	2018	PI, Strengthening the S & T Infrastructure to meet Emerging Challenges in the field of Hydrology, Department of Science and Technology, Govt. of India.

2012	-	2016	Hydrological modeling using upscale physical (UP) model for river system of Andhra Pradesh and establishment of stage discharge relationship, AP State Disaster Mitigation Society, Govt. of Andhra Pradesh.
2012	-	20014	Co-PI, Planning for optimal development of ground water in coastal sand dune pockets of Orissa, Directorate of ground water survey & investigation, Bhubaneshwar, Orissa, PDS under World Bank Funded Project.
2011	-	2013	Co-PI, Study of Impact of River/Khad bed Mining on Water Resources (Water winning structures) & Evolution of policies & guidelines to prevent adverse impact, Himachal Pradesh Irrigation & Public Health Department, PDS under World Bank Funded Project.
2010	-	2011	Landuse Mapping for Lao PDR using Remote Sensing Satellite data, NLMA, Vientiane Capital City, Loa PDR.
2009	-	2012	PI, Integrated Hydrological Appraisal of Dabka-micro watershed: Surface runoff and spring flow modelling, Department of Science and Technology, Govt. of India.
2007	-	2012	Co-PI, Identification of vulnerable areas in Himalayan watersheds, INCOH, MoWR, Govt. of India.
2004	-	2008	PI, Integrated Hydrological study for Sustainable Development of two Hilly Watersheds in Tehri Garhwal, Department of Science and Technology, Govt. of India.

Training Experience

2019	Training programme on 'Water Resources Management', 2 programs of 3 week duration each for working engineers from different African countries, East & Southeast Africa Division, MEA, Govt. of India.
2019	Hydrologic and hydraulic methods of flood routing" training to Dam Rehabilitation & Improvement Project (India)
2019	River discharge estimation using non-contact hydrometric techniques" training sponsored by Ministry of Water Resources, RD&GR (India National Hydrology Project).
2019	Conventional and advanced hydrometric techniques for discharge estimation" training to Dam Rehabilitation & Improvement Project (India).
2018	State of the art hydrometric data acquisition and transmission networks" training sponsored by Ministry of Water Resources, RD&GR (India National Hydrology Project).
2017	Emerging hydrometric techniques for discharge estimation and rating curve development" training sponsored by Ministry of Human Resource Development (India).
2014	One-week training to field engineers and academicians on "Spatial Data Processing using ERDAS and ArcGIS", NLMA, Vientiane, Lao PDR.
2014	One-week training to field engineers and academicians on "Drought Vulnerability Analysis", NLMA, Vientiane, Lao PDR.

Memberships of committees, boards, etc.

2013 – Present	Editor, Hydrology Journal of IAH
2018 – Present	Member, Senate, IIT Roorkee
2010 – 2014	Member, Institute Academic Program Committee, IIT Roorkee
2019 – present	Member, Technical Advisory Committee, NIH Roorkee
2013 – 2017	Member, Editorial Board, J. Environmental Management, Springer, USA.
2006 – present	Reviewer for many International and National Journals.

Membership of Professional Societies:

2019-Present	Fellow, Institution of Engineers, India (IE)
2015-Present	Fellow, Indian Water Resources Society (IWRS)

1995 -Present	Life Member, Indian Association of Hydrologists (IAH)
2017-Present	Member, American Society of Agricultural and Biological Engineers (ASABE)
2005-Present	Member, International Association of Hydrological Sciences (IAHS)
2017-Present	Member, European Geophysical Union (EGU)

Academic Achievements:

❖ *Thesis Supervision*	Awarded	In progress	Details
Ph.D.	8	4	Annexure-I
M. Tech.	48	2	Annexure-II

❖ *Publications*	Published	Under review	Details
Research papers in referred journals	62	4	Annexure-III
Papers in conferences/symposia	45		Annexure-IV

❖ *Projects*	*Completed*	*In progress*	*Financial outlay (Rs.) Details*	
Sponsored Research Projects	6	3	429.82 lakh	Annexure-V
Consultancy Projects	13	3	286.50 lakh	Annexure-VI
Research/Design/Project Reports	37			Annexure-VII

❖ *Professional Activities*

- Editor, Hydrology Journal of IAH
- Member, Editorial Board, J. Environmental Management, Springer-Verleg, USA
- Reviewing manuscripts for
  - J. Hydrology, Elsevier; J. Hydrologic Engineering, ASCE
  - Water Resources Research, AGU; Science of Total Environment
  - Hydrology Research; Achieves of Agronomy
  - J. Environmental Management; Springer; Hydrological Sciences J.
  - Hydrological Processes; Water Resources Management, Springer

❖ *Honours/Awards:*

- Certificate of Honors, JNKVV, Jabalpur.
- University Gold Medal, JNKVV, Jabalpur
- Jindal Gold Medal, JNKVV, Jabalpur

❖ *Administrative Assignments:*

At NIH Roorkee
OC (Remote Sensing Lab., Soil Water Lab., Vehicle)
Chief Vigilance Officer (2003 – 2006)

At IIT Roorkee
Head of Department since February 2018
Prof. Incharge (Watershed Hydrology Lab., tour, placement, time table)
Chief Warden (Ganga Bhawan, Ravindra Bhawan) (2012-15)
Member IAPC
Editor, Hydrology Journal, IAH
Member, Senate IIT Roorkee

Annexure – I

Details of doctoral thesis supervised

Sl. No.	Title	Year awarded	Name of Scholar	Co-supervisor (if any)
1.	Formulation and Validation of Hybrid Conceptual Models for Runoff Generation	2018	Ajay Ahirwar	Dr. M. Perumal
2.	Objective Assessment of Indices and Vulnerability to Drought	2014	Vinit Jain	Dr. R.P. Pandey, NIH
3.	Prioritization of Maintenance Management Decisions for Urban Transport Network	2014	Yogesh U. Shah	Dr. S.S. Jain, Dept. of Civil Engg; Dr. Devesh Tiwari, CRRI, New Delhi
4.	Study on Influence of Variable Surface Runoff on Overland Flow	2013	Sunil Panduranga Maske	--
5.	Impact of climate and catchment dynamics on runoff generation	2012	Negash Wagesho Amencho	Dr. N.K. Goel, DoH
6.	Rainfall runoff sediment yield modeling of mountainous watersheds	2012	Soban Singh Rawat	Dr. S.K. Mishra, WRDM
7.	Distributed rainfall-runoff modeling with variable storage using GIS	2011	S. Sarvanan	Dr. Z. Ahmad, Dept. of Civil Engg.
8.	SCS-CN based Long term hydrologic simulation	2010	Dilip G. Durbude	Dr. S.K. Mishra, WRDM

Details of doctoral thesis in progress

Sl. No.	Title	Registration year	Name of Scholar	Co-supervisor
1.	Modelling of runoff and soil erosion under changing climate	2019	Mr. Subhankar Das	--
2.	Climate Change impacts on water resource through catchment Similarity and Hydrological modelling in ungauged basin of Himalayas	2018	Mr. Yogesh Joshi	Dr. A.K. Lohani, NIH
3.	Spatiotemporal Projections of Drought in 21st Century under Climate Change Scenario in India	2015	Mr. Vivek Gupta	--
4.	Hydrologic Regime Alterations and Climate Change Uncertainty on Environmental Flow	2014	Mr. Rahul Kumar Singh	--

Annexure – II

Details of master's thesis supervised

Sl. No.	Title	Year awarded	Name of Scholar	Co-supervisor (if any)
1.	Influence of Channel Bed Slope on Entropy Parameter used for Discharge Estimation	2019	Mr. Gurpinder Singh	Dr. Tommaso Moramarco, IRPI, CNR, Italy
2.	Flood Inundation Modeling & Mapping in a Reach of River Jamuna in Bangladesh	2019	Mr. Abdur Rakib	--
3.	Hydrological Modeling of Gilgel Abay River Basin, Ethiopia using SWAT	2019	Mr. Abraham Degu Belay	--
4.	Spatial and Temporal Assessment of Drought in the Krishna River Basin	2018	Ms. Gauranshi Raj Singh	--
5.	Modeling of Runoff and Sediment Outflow from a Basin Using HEC-HMS	2018	Mr. Shekhar Saini	--
6.	Study on the Influence of Bed Roughness on Entropy Parameter	2018	Md. Irfan Anwar	--
7.	Entropy Based Estimation of Discharge in Laboratory Flume	2017	Mr. Rishabh Singh Tomar	--
8.	Comparative Evaluation of HEC-HMS And SRM Model in Simulating Rainfall-Runoff Behavior of Budhigandaki Catchment	2017	Mr. Hari Bahadur Khatri	Dr. Sanjay Jain, NIH Roorkee
9.	Comparative Study on Permanent and Semi-Permanent Sprinkler Irrigation System Design for Onion Crop in the Hilly Lands of Nyagatare District, Rwanda	2017	Mr. Vital Munyandinda	--
10.	Modelling of a River System using Mike-11	2016	Ms. Sabah Parvaze	--
11.	Rainfall-Runoff modeling of a watershed using SWAT model	2016	Mr. Sanbor Kurbah	--
12.	Evaluating sampling strategies for rainfall simulation studies	2016	Mr. Pravesh Chandra	Dr. Sumit Sen
13.	Continuous Hydrological Modeling using HEC-HMS Conceptual Model	2015	Mr. Waikhom Rahul Singh	--
14.	Environmental Flow Assessment for Various Stretches in the Cauvery Basin	2015	Mr. Sumit Kumar Kawde	Dr. Dilip Durbude, NIH, Roorkee
15.	Hydrological Assessment of Burhnanpur with Special Reference to Kundi Bhandara	2015	Mr. Pardeep	Dr. Himanshu Joshi
16.	Estimation of Soil Erosion using Universal Soil Loss Equation (USLE) and GIS	2014	Mr. Daleep Kumar	--
17.	Hydrological Modelling of Vamsadhara River Basin, India using SWAT	2014	Mr. Survey Daman Sharma	--
18.	Long Term Hydrological Simulation using SCS-CN Method	2014	Mr. Samarjeet Debbarma	Dr. Dilip Durbude, NIH, Roorkee
19.	Experimental study of overland flow using advanced hydrologic system	2013	Mr. Shailendra Kumar Kumre	--

20.	Geohydrological and resistivity studies of a Limestone Mine in Coastal Saurastra	2013	Mr. Prashant Bhakar	Dr. D.C. Singhal; Dr. M. Israil
21.	Runoff and sediment modeling using SWAT in Gumera Catchment, Ethiopia	2013	Mr. Kaleab Habte Michael	--
22.	River Discharge Estimation using Entropy Principles	2013	Mr. Jitendra Kumar Vyas	Dr. M. Perumal
23.	Impacts of Riverbed Mining on Hydrological Regime of Swan River, Himachal Pradesh	2013	Ms. Nishi Rahangdale	Dr. H. Joshi, Dr. D.C. Singhal
24.	Stream flow modeling in the Nacunday river basin (Paraguay, South America) using SWAT model	2012	Ms. Sandra Mongelos	--
25.	Long term hydrological simulation using SCS-CN method	2012	Mr. Nilotpal Debbarma	--
26.	Hydrological Simulation in Dabka Watershed using SWAT model	2011	Ms. Akansha Kushwah	--
27.	Sediment Yield Estimation and Risk Mapping of Nutrient Emission in a Sub-tropical watershed	2011	Mr. Akhilesh Gupta	Dr. Himanshu Joshi
28.	Experimental Investigation of Overland Flow Simulation	2011	Mr. Ajinkya Kemble	Dr. M. Perumal
29.	Experimental investigations for rainfall runoff analysis.	2010	Mr. Ankit Chakravarty	--
30.	Initiation and characterisation of bed load motion	2010	Mr. Rajendra Prasad Gawari	--
31.	Hydrological simulation of Xedone basin using SWAT model	2009	Mr. Phetsamone Khanophet	Dr. Ranvir Singh, DOH, IIT Roorkee
32.	Hydrological appraisal under missing data conditions	2009	Mr. Diganta Sarmah	--
33.	Snowmelt runoff modeling in Chenab basin using remote sensing and GIS	2009	Mr. Harsh Jindal	Dr. Sanjay Jain, NIH Roorkee
34.	Evaluation of the conceptual basis of the Clark and Nash models	2009	Mr. Jainet PJ	Dr. M. Perumal, DOH IIT Roorkee
35.	Rainfall runoff modeling of a hilly catchment	2009	Mr. Prabhat K. Bhatt	--
36.	Soil erosion hazard modeling of Namgnen watershed, Lao PDR	2009	Mr. Kaona Boupha	--
37.	Hydrological studies for small watershed in India using ANSWERS model	2008	Ms. Deepti Joshi	--
38.	Multi objective hydrological modeling of watershed using SWAT-2005	2008	Mr. Vinit Kumar Jain	--
39.	Identification of critical erosion prone area for watershed prioritization using GIS and remote sensing	2008	Mr. Devjyoti Das	--
40.	Simulation of Flood Flows using GIS	2008	Ms. Sweta Gaur	--
41.	Surface hydrologic appraisal of a natural catchment	2008	Mr. Sunil Bagde	Dr. BS Mathur, DOH, IIT Roorkee.
42.	Hydrologic simulation of runoff using SWAT model	2007	Mr. Nikhil Kumar	Dr. SK Mishra, WRDM, IIT Roorkee.
43.	Estimation of Soil Erosion and Sediment Yield using GIS	2007	Mr. RB Shah	Dr. SK Mishra, WRDM, IIT Roorkee.

44.	Runoff Simulation using TOPMODEL.	2007	Mr. Gunjan Kumar	Dr. SK Mishra, WRDM, IIT Roorkee.
45.	Modelling of Spring flow using ANN	2006	Mr. Dharani Kumar Penki	Dr. VK Pandey, College of Agril. Engineering, IGAU, Raipur.
46.	Rainfall-runoff modeling using remote sensing and GIS	2005	Ms. Dwi Hari Shanti	Dr. SK Mishra, WRDM, IIT, Roorkee.
47.	Modelling catchment scale soil erosion patterns using remote sensing and GIS	2005	Mr. Deshmukh Sunil Balasaheb	Dr. VK Pandey, College of Agril. Engineering, IGAU, Raipur.
48.	Preliminary Investigations on Soil Moisture Retrieval through Microwave Remote Sensing.	2002	Mr. SS Haider	Dr. UC Kothyari and Dr. Manoj Arora, Dept. of Civil Engg, IIT Roorkee.

Annexure – III

DETAILS OF RESEARCH PUBLICATIONS IN JOURNALS:

1. Gupta, V., **Jain, M.K.**, Singh, P. and Singh, Vishal. *An Assessment of Global Satellite-based Precipitation Datasets in Capturing Precipitation Extremes: A Comparison with Observed Precipitation Dataset in India.* **International Journal of Climatology,** (https://doi.org/10.1002/joc.6419) 2019. (Q1).
2. Gupta, V., **Jain, M.K.** and Singh, V.P. *Multivariate Modeling for Projected Drought Frequency and Hazard over India.* **J. Hydrologic Engineering, ASCE, 25(4)**, 2020. (Q1).
3. Gupta, V., and **Jain, M.K.** *Impact of ENSO, Global Warming, and Land Surface Elevation on Extreme Precipitation in India.* **J. Hydrologic Engineering, ASCE, Vol.** 25, No. 1: 05019032), (https://doi.org/10.1061/(ASCE)HE.1943-5584.0001872), 2020. (Q1, SJR: --, IF: --).
4. Singh, G.R., **Jain, M.K.** and Gupta, V. *Assessment of Spatiotemporal Drought Hazard, Vulnerability and Risk in the Krishna River Basin, India.* **Natural Hazards,** Vol. 99, No. 2, pp. 611 – 635 (https://doi.org/10.1007/s11069-019-03762-6), 2019. (Q1).
5. Gupta, V., and **Jain, M.K.** *Investigation of Multi-model Spatiotemporal Mesoscale Drought Projections over India under Climate Change Scenario.* **J. Hydrology, Elsevier,** 567, 489-509, (https://doi.org/10.1016/j.jhydrol.2018.10.012), 2018. (Q1).
6. Khatri, H., **Jain, M.K.** and Jain, S.K. *Modelling of stream flow in snow dominated Budhigandaki catchment in Nepal.* **J. Earth System Sciences, Springer,** Vol. 127: 100, (https://doi.org/10.1007/s12040-018-1005-5), 2018. (Q2).
7. Ahirwar, A., **Jain, M.K.** and Perumal, M. *Performance of the Xinanjiang Model.* **Chapter 48, In: Hydrologic Modelling, by Vijay P. Singh (Ed.). Water Science Technology Library, Springer Singapore, Select proceedings of ICWEES-2016** ISBN 978-981-10-5800-4, Vol. 81, 2017. (downloads: 102)
8. Waikhom, R.S. and **Jain, M.K.** *Continuous Hydrological Modeling using Soil Moisture Accounting Algorithm in Vamsdhara River Basin, India.* **J. Water Resources and Hydraulic Engineering,** Vol. 4, Issue 4, pp. 398 – 408. (DOI: 10.5963/JWRHE0404011), 2015. (Citations: 10)
9. Singh, P.K., Mishra, S.K. Berndtson, R., **Jain, M.K.** and Pandey, R.P. *Development of a Modified SMA Based MSCS-CN Model for Runoff Estimation.* **Water Resources Management, EWRA,** Vol. 29, Issue 11, pp. 4111 – 4127. (DOI: 10.1007/s11269-015-1048-1), 2015. (Q1)
10. Jain, V.K., Pandey, R.P., **Jain, M.K.** and Byun, H.R. *Comparison of Drought Indices for Appraisal of Drought Characteristics in Ken River Basin.* **Weather and Climate Extremes, Elsevier,** Vol. 8, pp. 1 – 11. (DOI:10.1016/j.wace.2015.05.002), 2015. (Q1)
11. Jain, V.K., Pandey, R.P. and **Jain, M.K.** *Spatiotemporal Assessment of Vulnerability to Drought.* **Natural Hazards, Springer,** Vol. 76, pp. 443-469. (DOI:10.1007/s11069-014-1502-z), 2015. (Q1).
12. Jain, V.K., **Jain, M.K.,** and Pandey, R.P. *Effect of the Length of Streamflow Record on Truncation Level for Assessment of Streamflow Drought Characteristics.* **Hydrologic Engineering, ASCE,** Vol. 19, No. 7, pp. 1361-1373. (DOI:10.1061/(ASCE)HE.1943-5584.0000922), 2014. (Q1)

13. Singh, P.K., Mishra, S.K., and **Jain, M.K.** *A Review of Synthetic Unit Hydrograph: from the Empirical UH to the Advanced Geomorphological Methods.* **Hydrological Sciences Journal,** Vol. 59 No. 2, pp. 239-261. (DOI: 10.1080/02626667.2013.870664), 2014. (Q1)
14. Maske, S.P. and **Jain, M.K.** *Study on Effect of Surface Roughness on Overland Flow from Different Geometric Surfaces through Numerical Simulation.* **Hydrological Process,** Vol. 28, pp. 2595-2616. (DOI: 10.1002/hyp.9773), 2014. (Q1)
15. Mishra, S.K., Rawat, S.S., Pandey, R.P., Shiulee Chakraborty, **Jain, M.K.**, Chaube, U.C. *Relation Between Runoff Curve Number and PET.* **Hydrologic Engineering, ASCE,** Vol. 19, No. 2, pp. 355-365. (DOI:10.1061/(ASCE)HE.1943-5584.0000780), 2014. (Q1)
16. Chakravarti, A. and **Jain, M.K.** *Experimental Investigation and Modelling of Rainfall-Runoff Process.* **Indian J. of Science and Technology,** Vol. 7, No. 12, pp. 2096 – 2106, 2014. (Q3)
17. Mallappa, J.M., Sen, S. and **Jain, M.K.** *Trends in Precipitation and Temperature in Karnataka, India.* **Hydrology Journal (IAH),** Vol. 37, No. 1-4, pp. 61 – 71, 2014.
18. Kaleab, H.M.M and **Jain, M.K.** *Runoff and Sediment Modeling using SWAT in Gumera Catchment, Ethiopia.* **J. Open Journal of Modern Hydrology, Scientific Research,** Vol. 3: 196 – 205. (DOI: 10.4236/ojmh.2013.34024), 2013.
19. Kushwaha, A., and **Jain, M.K.** *Hydrological Simulation in a Forest Dominated Watershed in Himalayan Region using SWAT Model.* **J. Water Resources Management, Springer,** Vol. 27: 3005 – 3023. (DOI: 10.1007/s11269-013-0329-9), 2013. (Q1)
20. Wagesho, N., **Jain, M.K.** and Goel, N.K. *Effect of Climate Change on Runoff Generation: An Application to Rift Valley Lakes Basin of Ethiopia.* **J. Hydrologic Engineering, ASCE,** Vol. 18, No. 8, pp. 1048-1063. (DOI:10.1061/(ASCE)HE.1943-5584.0000647), 2013. (Q1)
21. Wagesho, N., Goel, N.K., and **Jain, M.K.** *Temporal and Spatial Variability of Annual and Seasonal Rainfall over Ethiopia.* **Hydrological Sciences J.,** Vol. 58, No. 2, pp. 1-20. (DOI:10.1080/02626667.2012.754543), 2013. (Q1)
22. Jain S.K., **Jain, M.K.**, and Jindal, H.K. *Snowmelt Runoff Modeling in Chenab Basin using Remote Sensing and GIS.* **Hydrology Journal (IAH),** Vol. 36, No. 1-4, pp. 55 – 71, 2013.
23. Meena, B.L., Agrawal, J.D. and **Jain, M.K.** *Reconstruction of missing rainfall data using artificial neural network.* **Indian J. Power and River Valley Development,** Vol. 63, No. 5&6, pp. 82-86, 2013.
24. Singh, P.K., Mishra, S.K. and **Jain, M.K.** *Suitability of Distribution Function Based Models for SUH Derivation.* **J. Indian Water Resources Society,** Vol. 33, No. 4, pp. 33-41, 2013.
25. Kemble, A.D., Perumal, M., and **Jain, M.K.** *Study of Overland Flow Phenomenon using Experimental and Modeling Approach.* **ISH Journal of Hydraulic Engineering, Taylor & Frances,** Vol. 18, No. 3, pp. 162-172. (DOI: 10.1080/09715010.2012.721182), 2012. (Q3)
26. Wagesho, N., Goel, N.K., and **Jain, M.K.** *Investigation of Non-Stationarity in Hydro-climatic Variables at Rift Valley Lakes Basin of Ethiopia.* **J. Hydrology, Elsevier,** Vol. 444-445, pp. 113-133. (DOI:10.1016/j.jhydrol.2012.04.011), 2012. (Q1).
27. **Jain, M.K.,** Durbude, D., and Mishra, S.K. *Improved CN based Long Term Hydrological Simulation Model.* **J. Hydrologic Engineering, ASCE,** Vol. 17, No. 11, pp. 1204 - 1220. (DOI:10.1061/(ASCE)HE.1943-5584.0000592), 2012. (Q1).

28. Singh, P.K., **Jain, M.K.** and Mishra, S.K. *Fitting a Simplified two-parameter Gamma Distribution Function for Synthetic Sediment Graph Derivation from Ungauged Catchments.* Arab **J. Geosciences, Springer**. (DOI: 10.1007/s12517-011-0473-6), 2011. (Q3).

29. Durbude, D., **Jain, M.K.** and Mishra, S.K. *Long term Hydrological Simulation using an SCS-CN based Advanced Soil Moisture Accounting Procedure.* **J. Hydrological Process,** Vol. 24, No. 4, pp. 561-579. (DOI: 10.1002/hyp.7789), 2011. (Q1).

30. **Jain, M.K.** *Recession of Discharge.* **In: Encyclopedia of Snow, Ice and Glaciers, Encyclopedia of Earth Science Series, by Singh, V.P; Singh, P and Haritashya, U.K. (Editors). Springer, Dordrecht, The Netherlands,** 922 – 924 ISBN: 978-90-481-1641-5, 2011.

31. **Jain, M.K.** and Das, D. *Estimation of Sediment Yield and Areas of Soil Erosion and Deposition for Watershed Prioritization using GIS and Remote Sensing.* **J. Water Resources Management, Springer,** Vol. 24: 2091 – 2112. (DOI: 10.1007/s11269-009-9540-0), 2010. (Q1).

32. **Jain, M.K.**, Mishra, S.K. and Shah, R.B. *Estimation of Sediment Yield and Areas Vulnerable to Soil Erosion and Deposition in a Himalayan Watershed using GIS.* **Current Science,** Vol. 98, No. 2, pp. 213 – 221, 2010. (Q2)

33. **Jain, M.K.**, Mishra, S.K. and Shah, R.B. *Identification of Sediment Source and Sink in a Himalayan Watershed using Remote Sensing and GIS.* **Land Degradation and Development,** Vol. 20: 623 – 639. (DOI: 10.1002/ldr.952), 2009. (Q1)

34. Singh, P.K., Mishra, S.K., **Jain, M.K.** and Bhunya, P.K. *A Review on Synthetic Unit Hydrograph Methods.* **Geophysical Research Abstracts,** Vol. 10, EGU2008-A-00000, 2008.

35. Mishra, S.K., **Jain, M.K.**, Suresh Babu, P., Venugopal, K. And Kaliappan, S. *Comparison of AMC-Dependent CN-conversion Formulae.* **J. Water Resources Management, Springer,** Vol. 22, pp. 1409-1420. (DOI: 10.1007/s11269-007-9233-5), 2008. (Q1).

36. Mishra, S.K., Pandey, R.P., **Jain, M.K.** and Singh, V.P. *A Rain Duration and Modified AMC-Dependent SCS-CN Procedure for Long Duration Rainfall-Runoff Events.* **J. Water Resources Management, Springer,** Vol. 22, pp. 861-876. (DOI: 10.1007/s11269-007-9196-6), 2008. (Q1).

37. Sahu, R.K., Mishra, S.K., Eldho, T.I, and **Jain, M.K.** *An Advanced Soil Moisture Accounting Procedure for SCS Curve Number Method.* **J. Hydrological Processes,** Vol. 21, No.21, pp. 2872-2881. (DOI: 10.1002/hyp.6503), 2007. (Q1).

38. Rai, R.K., **Jain, M.K.**, Mishra, S.K., Ojha, C.S.P. and Singh, V.P. *Another Look at Z-transform Technique for Deriving Unit Impulse Response Function.* **J. Water Resources Management, Springer**. Vol. 21, No. 11, pp. 1829-1848. (DOI: 10.1007/s11269-006-9132-1), 2007. (Q1).

39. Deshmukh, S.B., Pandey, V.K. and **Jain, M.K.** *Integration of GIS with MUSLE in Assessment of Sediment Yield.* **Indian J. Soil Conservation,** Vol. 35, No. 1, pp. 1-5, 2007.

40. Mishra, S.K., Sahu, R.K., Eldho, T.I, and **Jain, M.K.** *A Generalized Relation Between Initial Abstraction and Potential Maximum Retention in SCS-CN-Based Model.* **J. River Basin Management, IAHR,** Vol. 4, Issue 4, 2006. (Q3).

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46. **Jain, M.K.** and Singh, V.P. *DEM Based Modelling of Surface Runoff using Diffusion Wave Equation.* **J. Hydrology, Elsevier Science,** Vol. 302, No. 1-4, pp. 107-126, 2005. (Q1).

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Annexure – IV

Details of Research Publications Presented in Conferences:

1. Gupta, V., and **Jain, M.K.** *A multi-model ensemble based drought characterization over India for 21st century.* **International Conference on Sustainable Technologies for Intelligent Water Management. Springer, India**, 2018.
2. **Jain, M.K.** and Wagesho, N. *Assessment of Runoff generation at Rift Valley lake basin of Ethiopia for present and future climate scenario.* **International Watershed Modelling (SWAT) Conference, Jan 10-12**, **Chennai, India**, 2018.
3. Gupta, V., **Jain, M.K.** *Comparison of SPI and SPEI indices for drought characterization under climate change.* **2017 American Geophysical Union Fall Meeting, December 11-15, New Orleans, USA,** Paper No. H11I-1317; ID: 271633, New Orleans, USA, 2017
4. **Jain, M.K.** and Sabah, P. *Hydrodynamic Modelling of extreme flood events in Kashmir valley in India.* **2017 EGU General Assembly, April 23-28, Geophysical Research Abstracts, Vol. 19, EGU2017-12021-1, Vienna, Austria**, 2017
5. Gupta, V., **Jain, M.K**. *Spatiotemporal analysis of trends and periodicities of regional drought projections in India.* **2017 EGU General Assembly, April 23-28, Geophysical Research Abstracts, Vol. 19, EGU2017-15327-1, Vienna, Austria,** 2017
6. Gupta, V., **Jain, M.K.** *Analysis of Projected Precipitation Changes in 21st Century Over India using CMIP5 Data.* **Proceedings of International Conference on Hydraulics, Water Resources and Coastal Engineering (Hydro2016), CWPRS, Pune, India. Dec. 8 -10, pp. 554 – 561**, Pune, 2016**.**
7. **Jain, M.K.**, Jain, V.K. and Pandey, R.P. *Influence of Rainfall Data Length on Meteorological Drought Assessment.* **VIth Annual Conference of the International Society for Integrated Disaster Risk Management, Disaster Risk Reduction Challenges and Opportunities for Sustainable Growth, TIFAC IDRIM 2015,** 17-18, New Delhi, 2015
8. Pandey, R.P., Jain, V.K. and **Jain, M.K**. *A New Method for Integrated Assessment of Vulnerability to Drought using Multiple Factors.* **3rd India Water Week, Water Management for Sustainable Development, 13-17 January 2015,** New Delhi, 2015.
9. Pandey, R.P., Jain, V.K. and **Jain, M.K.** *A New Method for Integrated Assessment of Vulnerability to Drought using Multiple Factors.* **3rd India Water Week, Water Management for Sustainable Development, 13-17 January 2015, New Delhi, India,** 2015.
10. Shah, Y.U., Jain, S.S., Tiwari, D. and **Jain, M.K.** *Analysis of Flexible Pavement Serviceability Using ANN for Urban Roads.* **Proceedings of the 2013 Airfield and Highway Conference, ASCE, June 9-12, 2013,** pp. 478-489, Los Angeles, California, USA, 2013.
11. **Jain, M.K.,** Jain, V.K. and Pandey, R.P. *Impact of climate change on extreme drought events in Ken river basin, India.* **Paper No. 121340846, 2012 ASABE Annual International Meeting,** July 29 – August 01, Dallas, Texas, USA, 2012.
12. Mongelos, S. and **Jain, M.K.** *Stream flow modeling in the Nacunday River basin (Paraguay, South America) using SWAT model.* **2012 International SWAT Conference & Workshop, July, IIT Delhi,** New Delhi, India, 2012.
13. Gupta, A., Joshi, H. and **Jain, M.K.** *An investigation of soil moisture accounting in long term hydrological simulation models based on SCS-CN concept.* **GEOMETRIX-11,** 26-27 February, **IIT Bombay,** Mumbai, India, 2011.

14. Gosavi, V.E., **Jain, M.K.** and Srivastava, D.K. *Looking at NRCS-CN method for smooth variation of curve number and soil moisture accounting procedure for continuous hydrological simulation of ungauged catchments.* Proceeding of the **International Conference on "Sustainable Water Resources Management and Climate Change Adaptation (SWRMCCA),** NIT, Durgapur, February 17 - 19, Durgapur, West Bengal, India, 2011.

15. Singh, P.K., Mishra, S.K., Ojha, C.S.P., Gaur, M.L. and **Jain, M.K.** *A comparative Study of Probability Models for SUH Derivation from Un-gauged Catchments Using ILWIS GIS and SRTM Data.* Proceeding of the **International Conference on "Sustainable Water Resources Management and Climate Change Adaptation (SWRMCCA),** NIT, Durgapur, February 17 - 19, Durgapur, West Bengal, India, 2011.

16. Gupta, A., Joshi, H. and **Jain, M.K.** *Sediment Yield Estimation and Risk Mapping Of Nutrient Emission in a Subtropical Watershed.* **Geometrix'11, February 26-27, 2011, IIT Bombay,** Mumbai, 2011.

17. Singh, P.K., Mishra, S.K., **Jain, M.K.,** Rawat, S.S. *Usefulness of Geo-spatial Tools Coupled with Parametric Expressions of Density Functions for Flood Estimation from Un-gauged Catchments.* **Geomatics-2010: National Conference on Climate Change: Coastal Ecosystems with Special Session on Planetary Geomatics, Space Applications Centre, Ahmadabad, India,** February 04 - 06, Ahmadabad, 2010.

18. Durbude, D., **Jain, M.K.** and Mishra, S.K. *An investigation of soil moisture accounting in long term hydrological simulation models based on SCS-CN concept.* **FSES 2009, IIT Kharagpur, India,** 17th-19th Dec., Kharagpur, 2009.

19. **Jain, M.K.** and Das, D. *Identification of sediment source and sink areas for watershed prioritization using GIS and remote sensing.* **Paper No. 096112, 2009 ASABE Annual International Meeting,** 21st – 24th June, Reno, Nevada USA, 2009.

20. Sahu, R.K., Mishra, S.K., Eldho, T.I., and **Jain, M.K.** *Generalization of relationship between antecedent moisture and antecedent rainfall for SCS-CN based rainfall-runoff model.* **6th International R&D Conference by CBIP,** 13th-16th Feb., Lucknow, India, 2007.

21. Sarvanan, S, Ahmad, Z. and **Jain, M.K.** *Modelling of flood events using spatially distributed unit hydrograph.* **Proc. SPIE, Vol. 6411 – Agriculture and Hydrology Applications of Remote Sensing**, 641113 (Dec. 11, 2006), 10 p. doi:10.1117/12/706274, 2006.

22. Sahu, R.K., Mishra, S.K., Eldho, T.I., and **Jain, M.K.** *An empirical relation between antecedent moisture and antecedent rainfall for use in SCS-CN-based rainfall-runoff model.* **Proc., 15th Congress of Asia and Pacific Division of IAHR and International Symposium on "Maritime Hydraulics" held at IIT Madras, August 7-10,** Vol. I, pp. 521-526, Chennai, India, 2006.

23. Sahu, R.K., Mishra, S.K., Eldho, T.I., and **Jain, M.K.** *Evaluation of recent SCS-CN-based model incorporating hydrologically sound soil moisture accounting procedure.* **"An International Perspective on Environmental and Water Resources" organized by the Environmental and Water Resources Institute (EWRI) of ASCE and the Indian Institute of Technology (IIT) Kanpur, December 18-20,** New Delhi, India, 2006.

24. **Jain, M.K.**, Shanti, D.H. and Mishra, S.K. *Simulation of runoff hydrograph using time variable isochrone technique incorporating catchment storage.* **Proceedings International Conference, 'Recent Advances in Water Resources Development and Management (RAWRDM-05), Vol. I, Nov. 23-25, 2005, IIT, Roorkee**, pp 437-447, Roorkee, 2005.

25. Pandey, R.P., Rai, R.K., **Jain, M.K.**, Mishra, S.K. and Parida, B.P. *Stochastic modelling of hydrological drought.* **Proceedings International Conference, 'Recent Advances in Water**

Resources Development and Management (RAWRDM-05), Vol. I, Nov. 23-25, 2005, IIT, Roorkee, pp 322-335, Roorkee, 2005.

26. Sahu, R.K., Mishra, S.K., Eldho, T.I. and **Jain, M.K.** *A modification to the initial abstraction in the existing SCS-CN methodology incorporating storm duration and antecedent rainfall.* **Proceedings International Conference, 'Recent Advances in Water Resources Development and Management (RAWRDM-05), Vol. II, Nov. 23-25, 2005, IIT, Roorkee,** pp 697-704, Roorkee, 2005.

27. Sahu, R.K., Mishra, S.K., Eldho, T.I. and **Jain, M.K.** *A SCS-CN-Based Model Incorporating Direct Use of Antecedent Rainfall in Runoff Equation.* **Proceedings of the XXXI IAHR Congress on 'Water Engineering for the Future-Choices and Challenges' held at Convention and Exhibition Centre (COEX), 11-16 Sept.,** pp. 3727-3736, Seoul, South Korea, 2005.

28. Mishra, S.K., Pandey, R.P., **Jain, M.K.** and Singh, R. *Derivation of AMC and storm duration-dependent curve numbers from daily rainfall-runoff data.* **International Conference on Hydrological Perspectives for Sustainable Development (HYPESD-2005), Roorkee, Feb. 23-25, 2005, Allied Publishers Private Limited, New Delhi**. Vol-I, pp. 404-419, Roorkee 2005,.

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31. Pandey, R.P., Mishra, S.K., **Jain, M.K.**, Singh, R. and Ramasastri, K.S. *Assessment of low flow and stream flow drought severity in Ken basin.* **Proc. of the 11th National Symposium on Hydrology with focal theme on Water Quality, Nov. 22-23, Roorkee, Allied Publishers Pvt. Ltd., New Delhi,** pp. 59-69, Roorkee, 2004.

32. **Jain, M.K.**, Kothyari, U.C. and Ranga Raju, K.G. *Distributed Modelling of Storm Runoff and Sediment Yields using Remote Sensing and GIS*. **In: Singh, V.P. and Yadava, R.N. (eds.), Advances in Hydrology, Proceedings of the Int. Conf. on Water and Environment (WE-2003),** Dec. 15–18, pp. 303-312, Bhopal, India, 2003.

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35. Rai, R.K., **Jain, M.K.**, Rastogi, R.A., Shrivastava, S.K. and Choudhury, A. *Deriving instantaneous unit hydrograph of ARMA(2,2) process using Z-transform technique.* **In: Singh, V.P. and Yadava, R.N. (eds.), Watershed Hydrology, Proceedings of the Int. Conf. on Water and Environment (WE-2003),** Dec. 15–18, pp. 146-157, Bhopal, India, 2003.

36. **Jain, M.K.** and Singh, R.D. *Rainfall Runoff Modelling of Upper Narmada Basins using a Geomorphological Approach.* **In Analysis and Practice in Water Resources Engineering for Disaster Management, Proceedings of International Conference on Water Related Disasters**

(ICWRD-2002), Kolkata, Vol. 1, pp. 76-79, New Age International Publisher, New Delhi, Kolkata, 2002.

37. **Jain, M.K.** *Soil erosion modelling using satellite remote sensing and GIS.* **Proceedings, International Conference, ICIWRM-2000,** Dec. 19-21, New Delhi, 2000.

38. **Jain, M.K.** A *GIS based method for estimation of soil erosion and sediment yield.* **Proceedings, National Workshop on Hydrologic and Hydraulic Routing in Alluvial Rivers, Nov. 26-27, 1999, National Institute of Hydrology, Roorkee,** 1999.

39. **Jain, M.K.** *eomorphological and Landuse Planning for Danda watershed.* **Paper presented in National Symposium "Map India 99", New Delhi,** 1999.

40. Seth, S.M., Jain, S.K., and **Jain, M.K.** *Remote Sensing and GIS Application Studies at National Institute of Hydrology.* **Paper presented in National Symposium "Map India 99", New Delhi,** 1999**.**

41. **Jain, M.K.**, Jain, S.K. Soni B. and Seth S.M. *GIS application in watershed modelling - current status.* **Proceedings, International conference on watershed management and Conservation, CBIP, New Delhi,** Dec. 8-10, 1998.

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44. **Jain, M.K.**, Seth S.M. and Ahmad T. *Rainfall runoff modelling of Kolar basin using a distributed approach.* **Proceedings, International Symposium on Emerging trends in Hydrology, University of Roorkee, Sep. 25-27, 1997,** Vol. I, pp. 91-100, Roorkee, 1997.

45. **Jain, M.K.**, Mishra S.K. and Seth S.M. *Hysteresis criteria for the applicability of CPC and CPMC methods of flood routing.* **Proceedings, International conference on disaster and mitigation (INCODIM), Anna University, Madras, Jan. 19-22, 1996,** Vol. II, pp. B2-20 to B2-32, Chennai, 1996.

46. **Jain, M.K.** and Ramasastri, K.S. *Modelling of Flood Flows in a Mountainous Catchment in Western Ghats.* **Proceedings, International Symposium on Hydrology of Mountainous Areas,** May 28-30, Shimla, India, 1992.

Annexure – V

DETAILS OF SPONSORED RESEARCH PROJECTS:

Title	Sponsoring Agency	Amount (Rs. Lakh)	PI or Co-PI	Start date	End date	Co-PI if any
Real-time discharge estimation using non-contact hydrometric measurements	Ministry of Earth Science, New Delhi	88.04	PI	01/2019	12/2022	M.Perumal (co-PI); Sumit Sen (co-PI)
Lead time inflow estimation for reservoir operation during monsoon	DRIP, CWC, MoRW, RD&GR, New Delhi	97.00	PI	11/2017	10/2020	M Perumal (Co-PI); Sumit Sen (Co-PI)
Developing capabilities for hydrological studies	FIST Scheme, DST, New Delhi	94.00	PI	03/2012	12/2018	--
Integrated Hydrological Appraisal of Dabka-micro watershed: Surface runoff and spring flow modelling.	DST, New Delhi	11.36	PI	07/2009	8/2012	DC Singhal (Co-PI)
Identification of vulnerable areas in Himalayan watersheds	INCOH, MoWR, Govt. of India	21.55	Co-PI	01/2007	03/2012	SK Mishra (PI)
Integrated Hydrological study for Sustainable Development of two Hilly Watersheds in Tehri Garhwal (Phase – II)	DST, New Delhi	48.47	PI	2004	2008	--
Integrated Hydrological study for Sustainable Development of two Hilly Watersheds in Tehri Garhwal (Phase – I)	DST, New Delhi	36.90	Co-PI	1998	2003	VC Goel (PI); Sudhir Kumar (Co-PI)
Hydrological study of NTPC Kahalgaon Power Station Area	National Thermal Power Corporation Ltd., New Delhi	10.50	Co-PI	2000	2001	RD Singh (PI); SK Jain; AK Lohani; PK Mohapatra; CC Chatterjee
Developing Capabilities for Hydrological Modelling Using Geomorphologic Parameters	USAID	22.00	PI	1997	2000	Rakesh Kumar (Co-PI)

Annexure – VI

Details of Consultancy Projects:

Title	Sponsoring Agency	Amount (Rs. Lakh)	PI or Co-PI	Start date	End date	Co-PI if any
Hydrological Study of Proposed Pachnad Barrage Project	UP Irrigation Division, Itawa	40.00	PI	01/2020	08/2020	Z. Ahmad (Co-PI)
Technical Study (PMF, back water and other hydrological studies) on Polavaram case matter	Department of Water Resources, Govt. of Odisha	36.58	Co-PI	06/2018	03/2019	M.Perumal (PI); Sumit Sen (Co-PI)
Water Study and Calculation of per day Effluent Discharge from the plant at Baddi	Baddi Plant shared services leader, P&G, Baddi.	4.40	PI	05/2018	12/2018	Brijesh Yadav (co-PI)
Survey for Identifying Bore Well sites within the Premise of Koteshwar Pooling Station	Power Grid Corporation of India Ltd., New Tehri	3.15	PI	07/2018	12/2018	Brijesh Yadav (co-PI)
Academic and Governance Planning for up-gradation of River Research Institute, West Bengal to Degree Awarding Institute	EdCIL India Limited, Sector 16A, Noida.	3.73	PI	06/2016	05/2017	--
Hydrological modeling using upscale physical (UP) model for river system of Andhra Pradesh and establishment of stage discharge relationship.	AP State Disaster Mitigation Society, Govt. of Andhra Pradesh.	24.95	PI	06/2012	06/2016	M Perumal
Delineation of waterlogged and salt affected area in the coastal tract of Orissa	Directorate of ground water survey & investigation, Bhubaneshwar, Orissa	27.94	Co-PI	06/2012	05/2014	H Joshi (PI); DS Arya; DC Singhal
Planning for optimal development of ground water in coastal sand dune pockets of Orissa	Directorate of ground water survey & investigation, Bhubaneshwar, Orissa	24.13	Co-PI	06/2012	05/2014	H Joshi (PI); DS Arya; DC Singhal
Detailed hydrological study of Adityana limestone and marl mines of M/S Saurastra Cement Ltd.	Saurastra Cement Ltd., Ranavav, Gujarat.	12.64	PI	04/2012	12/2013	DC Singhal; M Israil
Study of Impact of River/Khad bed Mining on Water Resources (Water winning structures) & Evolution of policies & guidelines to prevent adverse impact	Himachal Pradesh Irrigation & Public Health Department	13.70	Co-PI	11/2011	11/2013	H Joshi (PI), DC Singhal

Landuse Mapping for Lao PDR using Remote Sensing Satellite data	NLMA, Vientiane Capital City, Loa PDR	34.58	PI	03/2010	06/2011	--
Study of Flood Plain Demarcation of the Selected site for setting up a 2X250 MW coal based thermal power plant of Himachal EMTA Power Ltd. at Raniganj, District – Burdwan, West Bengal.	Himachal EMTA Ltd., Kolkata	14.47	Co-PI	03/2010	01/2011	M Perumal (PI); H Joshi
Water Availability Study of River Damodar (West Bengal Stretch) at the intake point of the proposed 2X250 MW coal based thermal power plant of Himachal EMTA Power Ltd. at Raniganj, District – Burdwan, West Bengal.	Himachal EMTA LTD., Kolkata	7.44	Co-PI	01/2010	06/2010	H Joshi (PI); DK Shrivastava
Review of hydrological studies for Tehri dam project using inflow series from 1940 to 2006	THDC Ltd., Rishikesh	2.20	Co-PI	05/2009	06/2009	NK Goel (PI); DS Arya
Review of hydrological studies for Tehri project	THDC Ltd., Rishikesh	4.50	Co-PI	01/2008	06/2008	NK Goel (PI); BS Mathur; DS Arya
Review of hydrological aspects of Tato-II & Siyom hydro-electric projects	Reliance Energy Ltd., New Delhi	6.74	Co-PI	01/2008	10/2008	NK Goel (PI); DS Arya
River migration, design flood and scour depth studies in CAIRN BSPL pipeline project	L & T Ltd., New Delhi	25.00	Co-PI	02/2008	12/2008	NK Goel (PI); DS Arya

Annexure – VII

Review/Research/Design/Feasibility Reports Completed:

1. Jain, M.K. and Perumal, M. (2019). *Study on Probable Maximum Flood (PMF) for Polavaram Project*. **Final project report. Submitted to Dept. of Water Resources, Govt. of Odisha.**
2. Perumal, M and Jain, M.K. (2019). *Backwater Study in the Territory of Odisha due to upcoming Polavaram Project*. **Final project report. Submitted to Dept. of Water Resources, Govt. of Odisha.**
3. Jain, M.K. and Yadav, B.K. (2018). *Survey for Identifying Bore Well sites within the Premise of Koteshwar Pooling Station.* **Final project report. Submitted to Power Grid Corporation of India Ltd., New Tehri.**
4. Jain, M.K. (2017). *Academic and Governance Planning for upgradation of River Research Institute, West Bengal to degree awarding Institute*. **Final project report. Submitted to EdCIL India Limited, Sector 16A, Noida.**
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