

Curriculum Vitae

1. **Name:** **Rajendra Singh**
2. **Present Position:** Professor (HAG)
Agricultural & Food Engineering Department,
IIT Kharagpur
3. **Postal Address:** Agricultural & Food Engineering Department,
IIT Kharagpur,
Kharagpur 721302
4. **Email Address:** rsingh@agfe.iitkgp.ernet.in
5. **Personal Webpage:** <http://rsinghiitkgp.co.in>
6. **Date of Birth:** **8th August 1963**
7. **Educational Qualification:**

Degree (Year)	Institution	Major	Performance
Ph.D. (1993)	IIT Kharagpur	Irrigation System Management	Won ICAR Best PhD Award, 1994
M.Tech. (Jan 1987)	IIT Kharagpur	Soil & Water Conservation Engineering	9.76/10 CGPA
B.Sc. Ag. Engg. (1985)	University of Allahabad	Agricultural Engineering	1 st rank in the University Merit List

8. **Present Scale of Pay:** **INR 224100 (Pay Level: 15)**
9. **Experience:**

Academic Experience (IIT Kharagpur):

1. **Brahmaputra Chair Professor for Water Resources, IIT Kharagpur; Sep 2016 –Sep 2021.**
2. **Professor (HAG; Scale: INR 67000-79000), Agricultural and Food Engineering Department, IIT Kharagpur; Sep 2009 onward.**
3. **Professor (Scale: PB4; INR 37400 – 67000, AGP INR 10500), Agricultural and Food Engineering Department, IIT Kharagpur; Jun 2003 - Aug 2009.**
4. **Associate Professor, Agricultural and Food Engineering Department, IIT Kharagpur; May 1999 - Jun 2003.**

5. **Assistant Professor**, Agricultural and Food Engineering Department, IIT Kharagpur; **Jan 1994 - May 1999**.
6. **Lecturer**, Agricultural and Food Engineering Department, IIT Kharagpur; **May 1989 - Jan 1994**.
7. **Junior Scientist**, Agricultural and Food Engineering Department, IIT Kharagpur; **Mar 1987 - May 1989**.

Academic Experience (Outside IIT Kharagpur):

1. **Visiting Professor**, School of Engineering, Science & Primary Industries, Waikato Institute of Technology, Hamilton, **New Zealand**; One year (**Jan 2012 - Dec 2012**);
2. **Visiting Researcher**, School of Engineering, University of Guelph, **Canada**; Three months (**May 2008 – July 2008**).
3. **DAAD Visiting Professor**, Institute of Earth & Environmental Sciences, University of Potsdam, Potsdam, **Germany**; Three months (**May 2007 - July 2007**).
4. **Mathematical Modelling Expert**, State Water Resources Agency (SWaRA), U.P. Water Sector Restructuring Project, **Lucknow**; Two years (**Jan 2004 - Dec 2005**).
5. **Guest Researcher**, Institute of Hydrology & Meteorology, Technical University of Dresden, **Germany**; One month (**June 2003 – July 2003**).
6. **Guest Researcher**, Institute of Hydrology & Meteorology, Technical University of Dresden, **Germany**; Two months (**May 2002 – June 2002**).
7. **DAAD Visiting Researcher**, Institute of Hydrology & Meteorology, Technical University of Dresden, **Germany**; Three months (**May 2001 – July 2001**).
8. **Post-Doctoral Researcher**, Civil & Environmental Engineering Department, University of Connecticut, **USA**; One year (**May 1999 - May 2000**).
9. **BOYSCAST Fellow**, Danish Hydraulic Institute, **Denmark**; One year (**May 1995 - May 1996**).

Administrative Experience:

1. **Dean (Undergraduate Studies)**, Indian Institute of Technology Kharagpur; **August 16, 2013 onward**
2. **Member, Board of Governors**, Indian Institute of Technology Kharagpur; **Jan 2014 – Dec 2015**.
3. **Member, Finance Committee**, Indian Institute of Technology Kharagpur; **Jan 2014 – Dec 2015**.
4. **Head of Department**, Agricultural & Food Engineering Department, IIT Kharagpur; **Sep 2008 – Aug 2011**.
5. **NSS Coordinator**, IIT Kharagpur; **2006-2007**.
6. **Professor-in-Charge**, Central Time Table, IIT Kharagpur; **2003**.
7. **Member**, Rajbhasha Parishad Executive Council; **2009-2010**
8. **Rector's Nominee**, Technology Students' Gymkhana, IIT Kharagpur; **2001-2002**.

10. Number and Names of reputed Awards/Recognitions: 10

1. **Recognition Award**, 2013-14 (National Academy of Agric. Sciences (NAAS))

2. **Wintec Fellowship** 2012 (Waikato Institute of Technology, **New Zealand**)
3. **DAAD Visiting Professorship** 2007 (DAAD, **Germany**)
4. **DAAD Research Fellowship** 2001 (DAAD, **Germany**)
5. **Post-Doctoral Fellowship** 1999 (University of Connecticut, **USA**)
6. **AICTE Career Award for Young Teachers** 1998 (**AICTE**)
7. **Vasantrao Naik Memorial Gold Medal** 1996 (Dr. P.D. Agril. Uni., **Akola**)
8. **ICAR Young Scientist Award** 1995-96 (**ICAR**)
9. **BOYSCAST Fellowship** 1995 (**DST**, Government of India)
10. **Jawaharlal Nehru Award** for Best Postgraduate Research 1994 (**ICAR**)

11. **Number of Ph.D. Guided (Completed/In Progress): 17 (Completed) + 05 (in Progress)**
[\[Please refer Annexure I for details\]](#)

12. **Number of Publications (National /International): 110 (20 National/90 International)**
[\[Please refer Annexure II for details\]](#)

h-index (Google Scholar): 32

h-index (ISI web of science): 21

13. **Number of Book/Book Chapters/Monographs Published: 04**
[\[Please refer Annexure III for details\]](#)

14. **Number of Patents (Filed/Awarded): 05 (Software Copyright)**

Copyrights have been obtained for the following Software Packages under **Section 45 of the Copyright Act, 1957 (14 of 1987)**

Sl. No.	Name of the Software	Copyright Number
1.	Hydrology_Calculator	SW-858/2002
2	Soil Conservation Structure Designer (SCS_Designer)	SW-860/2002
3	Decision Support System for Reference Crop Evapotranspiration (DSS_ET)	SW-859/2002
4.	CanalMod – Hydraulic Simulation Model	SW-085/2006
5.	IRCIM – Integrated Reservoir Based Canal Irrigation Model	L-29594/2007

15. **Details of Courses Taught at IIT Kharagpur:**

Sl.	Subject	Number	L-T-P	Level
1.	Elements of Soil & Water Engineering	12305	3-0-3	UG
2.	Land & Water Resources Engineering	AG31003	3-1-0	UG
3.	Land & Water Resources Engineering Laboratory	AG39003	0-0-3	UG
4.	Operations Research	12406	3-1-0	UG
5.	Head Water Hydrology	AG60011	3-0-0	PG
6.	Head Water Hydrology Laboratory	AG69007	0-0-3	PG
7.	Surface Water Hydrology	AG60201	3-0-0	PG
8.	Hydrological Systems Laboratory	AG69037	0-0-3	PG
9.	Water Resources Systems Analysis	AG60042	3-1-0	PG
10.	Systems Approach in Agriculture	AG60064	3-1-0	PG

16. **Teaching Assignments in Foreign Universities:**

Sl.	University	Subject	Level
1.	University of Connecticut, USA; Civil & Environmental Engineering Department	Hydraulic Engineering	UG
2.	University of Potsdam, Germany; Institute of Earth & Environmental Sciences	Water Management	UG/PG
3.	Waikato Institute of Technology, New Zealand; School of Engineering, Science & Primary Industries	Hydrology & Erosion Management	UG

17. **Number of Projects (Completed/In Progress):**

- a. **Sponsored projects:**
- 06 (ongoing; Total Value: 9.43 Crore)**
- 27 (completed; Total Value: 36.98 Crore)**

- b. **Consultancy projects:** **01 (ongoing; Total Value: 3.05 Lakh)**
09 (completed; Total Value: 87.41 Lakh)
[Please refer Annexure IV for details]

18. **Research Contribution in the Relevant Area:**
[Please refer Annexure V for details]

19. **Membership in Societies:**

1. **Fellow**, National Academy of Agricultural Sciences, **FNAAS**
2. **Life Member**, Indian Society of Agricultural Engineers, **LISAE**
3. **Member**, Irrigation Management Network, **UK**
4. **Member**, Institution of Engineers, **India**

20. **Any other information:**

(a) **Member of Prestigious Committees/Leadership Positions held:**

1. Member, **National Institute of Hydrology Society**, Ministry of Jal Shakti (2020-continuing)
2. Member, **Research Advisory Committee**, Indian Institute of Water Management, Bhubaneswar (2019 – Continuing)
3. Member, **Joint Panel of ICAR & CWC** to deal with the problem relating to optimizing return from investment on irrigation (21/05/2013 – 2017)
4. Member, **Research Advisory Committee, Central Institute of Agricultural Engineering**, Bhopal (2015 – 2018)
5. Member, **Technical Advisory Committee, National Institute of Hydrology**, Roorkee (2010-13)
6. Member, **Research Advisory Committee, Directorate of Water Management**, Bhubaneswar (2009 – 2012)
7. Member, **Management Committee, Water Technology Centre for Eastern Region**, Bhubaneswar (Directorate of Water Management) (2009-2012)
8. Member, **Board of Studies, Department of Agricultural Engineering, North Eastern Regional Institute of Science & Technology**, Nirjuli (2011 – 2013)
9. **Mathematical Modelling Expert** position in the **World-Bank** funded “UP Water Sector Restructuring Project” (2004 - 2005)

(b) **Student and Extra-Curricular Activities:**

Student Activities at IIT Kharagpur

1. **Chairman**, Spring Fest; 2003, 2007
2. **Rector's Nominee**, Technology Students' Gymkhana, 2001-2002
3. **Member-Secretary**, Spring Fest Coordination Committee; 2006
4. **Member-Secretary**, Core-Committee for Modernization Plan of Technology Students' Gymkhana; 2006-07
5. **Election Officer**, Technology Students' Gymkhana Elections; 2003, 2006
6. **Advisor**, Tennis, Technology Students' Gymkhana; 2002, 2009, 2010

Extra-Curricular Activities

1. **Tennis Gold Medal**, Inter-IIT Staff Sports Meet 2011, 2016
2. **Tennis Silver Medal**, Inter-IIT Staff Sports Meet 2014, 2019
3. **Tennis Bronze Medal**, Inter-IIT Staff Sports Meet 2017
4. **Tennis Winners Medal**, Inter-District Tennis Tournament, Midnapore, 2011, 2015
5. **Tennis Winners Medal**, Inter-District Tennis Tournament, Bankura, 2015
6. **Tennis Runners Up Medal**, Inter-District Tennis Tournament, Kolkata, 2015
7. **Tennis Runners Up Medal**, Inter-District Tennis Tournament, Midnapore, 2013



Date: April 2022
Place: Kharagpur

(Rajendra Singh)
Professor, Agricultural & Food Engineering
Indian Institute of Technology Kharagpur

Details of PhD Guided

	Student's Name	Thesis Title	Year
1	Chandranath Chatterjee	Discharge Characteristics of Chimney Weir Under Free and Submerged Flow Conditions	1998
2	Atmaram Mishra	Development of An Integrated Opti-simulation Model for Major Irrigation Projects	2002
3	Niranjan Panigrahy	Hydrological Modelling of a Small Watershed	2003
4	M.B. Nagdeve	Hydrological Water Balance Modelling of a Treated Watershed	2004
5	Praveen Gupta	Distributed Hydrological Modelling of Command Area Using Remotely Sensed Data and GIS	2004
6	Adlul Islam	Development and Testing of a Hydraulic Simulation Model for Irrigation Canal Network	2004
7	Damodhara Mailapalli	Development and Testing of a Physically Based Model (ZIGASED) for Simulating Flow and Sediment Transport in Furrow Irrigation	2006
8	Aditi Bhadra	Development and Testing of an Integrated Reservoir Based Canal Command Model	2007
9	Arnab Bandyopadhyay	Temporal and Spatial Trends of Reference Evapotranspiration in Agro-ecological Regions of India	2008
10	Anish Bansal	Development of a Physically Based Distributed Hydrological Modeling System	2011
11	Dibyendu Samantray	Flood Risk Modelling using MIKE FLOOD and Remote Sensing Data for Optimal Rice Planning	2014
12	Neha Mittal	Assessment of Future Climate Change and Alteration of River	2014
13	Arun Kumar	Ensemble Modelling of Rainfall Runoff Transformation Process	2017
14	Pradnya Dhage	Assessing The Combined Impact of Climate and Land Use Changes on The Performance of Kangsabati Irrigation Project	2017
15	Manjushree Singh	Development of Integrated Water Resources Management Plan for a Basin using Water Evaluation and Planning (WEAP) Model	2018
16	Gajanan Ramteke	Assessing the Impacts of Conservation Measures on Watershed Hydrology using MIKE SHE	2019
17	Mohite Archana Ramchandra	Development of Flood Forecasting System for Mahanadi River Basin using A Coupled Rainfall-Runoff Hydrodynamic Model	2019

Details of Paper Published in Refereed Journals

1. Gaur S, Singh B, Bandyopadhyay A, Stisen S, **Singh R**. 202X. Spatial pattern-based performance evaluation and uncertainty analysis of a distributed hydrological model. *Hydrological Processes*, *In Press*.
2. Dubey M, Mishra A, **Singh R**. 2022. Identification of the most appropriate adaptation for rice and wheat in the face of climate change in eastern India. *Journal of Water and Climate Change*, 13 (2): 943–962.
3. Gaur S, Bandyopadhyay A, **Singh R**. 2021. Projecting land use growth and associated impacts on hydrological balance through scenario-based modelling in the Subarnarekha basin, India. *Hydrological Sciences Journal*, 1–14, <https://doi.org/10.1080/02626667.2021.1976408>
4. Gaur S, Bandyopadhyay A, **Singh R**. 2021. From changing environment to changing extremes: Exploring the future streamflow and associated uncertainties through integrated modelling system. *Water Resources Management*, 35(6), 1889-1911.
5. Dubey M, Mishra A, **Singh R**. 2021. Climate change impact analysis using bias-corrected multiple global climate models on rice and wheat yield. *Journal of Water and Climate Change*, 12(4), 1282-1296.
6. Nagdeve M, Paul PK, Zhang Y, **Singh R**. 2021. Continuous Contour Trench (CCT): Understandings of hydrological processes after standardisation of dimensions and development of a user-friendly software. *Soil and Tillage Research*, 205, 104792.
7. Paul PK, Zhang Y, Ma N, Mishra A, Panigrahy N, **Singh R**. 2021. Selecting hydrological models for developing countries: Perspective of global, continental, and country Scale models over catchment scale models. *Journal of Hydrology*, 126561.
8. Biswas A, Mailapalli DR, Raghuwanshi NS, **Singh R**. 2021. Water use efficiencies, productivities, and footprints of rice under a system of rice intensification practice. *ACS Agricultural Science & Technology*, 1 (3), 262-269.
9. Bhadoriya UPS, Mishra A, **Singh R**, Chatterjee C. 2020. Implications of climate change on water storage and filling time of a multipurpose reservoir in India. *Journal of Hydrology*, 590, 125542.
10. Bisht DS, Mohite AR, Jena PP, Khatun A, Chatterjee C, Raghuwanshi NS, **Singh R**, Sahoo B. 2020. Impact of climate change on streamflow regime of a large Indian river basin using a novel monthly hybrid bias correction technique and a conceptual modeling framework. *Journal of Hydrology*, 590, 1-21.
11. Ramteke G., **Singh R**, Chatterjee C. 2020. Assessing impacts of conservation measures on watershed hydrology using MIKE SHE model in the face of climate change. *Water Resources Management*, 34(13), 4233-4252.
12. Paul PK, Kumari B, Gaur S, Mishra A, Panigrahy N, **Singh R**, 2020. Application of a newly developed large-scale conceptual hydrological model in simulating streamflow for credibility testing in data scarce condition. *Natural Resource Modeling*, 33(4), e12283.
13. Gaur S, Bandyopadhyay A, **R Singh**. 2020. Modelling potential impact of climate change and uncertainty on streamflow projections: a case study. *Journal of Water and*

- Climate Change*, 12(2), 384-400.
14. Gaur S, Mittal A, Bandyopadhyay A, **Singh R**. 2020. Spatio-temporal analysis of land use and land cover change: a systematic model intercomparison driven by integrated modelling techniques. *International Journal of Remote Sensing*, 41(23), 9229-9255.
 15. Paul PK, Gaur S, Yadav B, Panigrahy N, Mishra A, **Singh R**. 2019. Diagnosing credibility of a large-scale conceptual hydrological model in simulating streamflow. *Journal of Hydrologic Engineering*, 24(4), 0401900
 16. Paul PK, Zhang Y, Mishra A, Panigrahy N, **Singh R**. 2019. Impact of spatial discretization on streamflow simulation: A comparison of grid and HRU based hydrologic models. *Water*, 11, 1-20.
 17. Adimala S., Raghuwanshi N.S., Mishra A., **Singh R**. 2019. Generalized wavelet neural networks for evapotranspiration modeling in India. *ISH Journal of Hydraulic Engineering*, 25(2): 119-131.
 18. Raghuwanshi NS, **Singh R**, Adimala S, Prasad A, Chamoli A. 2019. Hydrologic Calculator: An educational interface for hydrological processes analysis. *Agricultural Engineering International*, CIGR Journal, 21(1), 1-17.
 19. Paul PK, Kumari N, Panigrahi N, Mishra A, **Singh R**. 2018. Implementation of cell-to-cell routing scheme in a large scale conceptual hydrological model. *Environmental Modelling and Software*, 101: 23–33.
 20. Dhage PM, Raghuwanshi NS, **Singh R**. 2018. Development of finer resolution rainfall scenario for Kangsabati catchment and command. In: Singh, V., Yadav, S., Yadava, R. (eds) *Climate Change Impacts*. Water Science and Technology Library, 82. Springer, Singapore, 127-136.
 21. Srivastava A, Sahoo B, Raghuwanshi N.S., **R Singh**. 2017. Evaluation of variable-infiltration capacity model and MODIS-Terra satellite-derived grid-scale evapotranspiration estimates in a river basin with tropical monsoon-type climatology. *Journal of Irrigation & Drainage Engineering*, ASCE, 143(8)
 22. Chakraborty P, Das B.S., **Singh R**. 2017. An ensemble modeling approach for estimating diffusive tortuosity for saturated soils from porosity. *Soil Science*, 182(2): 45-51
 23. Dhage PM, Raghuwanshi NS, **Singh R**, Mishra, A. 2017. Development of daily temperature scenarios and their impact on paddy crop evapotranspiration in Kangsabati command area. *Theoretical and Applied Climatology*, 1–15.
 24. Mittal, N., Bhawe, A.G., Mishra, A., **Singh, R**. 2016. Impact of human intervention and climate change on natural flow regime. *Water Resources Management*, 30: 685-699.
 25. Dhage, P.M., Raghuwanshi, N.S., **Singh, R.**, Mishra, A. 2016. Development of daily temperature scenarios and their impact on paddy crop evapotranspiration in Kangsabati command area. *Theoretical and Applied Climatology*, DOI 10.1007/s00704-016-1743-8.
 26. Kumar, A., **Singh, R**, Jena, P.P., Chatterjee, C., Mishra, A. 2015. Identification of the best multi-model combination for simulating river discharge. *Journal of Hydrology*, 525: 313-325.
 27. Bhadra, A., Bandyopadhyay, A., **Singh, R.**, and Raghuwanshi, N.S. 2015. Development and application of a simulation model for reservoir management. *Lake and Reservoirs: Research and Management*, 20(3): 216-228.
 28. Kneis, D., Chatterjee, C., **Singh, R**. 2014. Evaluation of TRMM rainfall estimates over

- a large Indian river basin (Mahanadi). *Hydrology & Earth System Sciences Discussions*, 11(1): 1169-1201.
29. Samantray, D., Chatterjee, C., **Singh, R.**, Kumar, P., Panigrahy, S. 2014. Flood risk modeling for optimal rice planning for delta region of Mahanadi river basin in India. *Natural Hazards*, 76(1): 347-372
 30. Dhage, P.M., Bhadra, A., Raghuwanshi, N.S., **Singh, R.** 2014. Testing of catchment module of intergrated reservoir based canal irrigation model for Kangsabati irrigation project. *International Journal of Agriculture, Environment and Biotechnology*, 7(4): 859.
 31. Mittal, N., Mishra, A., **Singh, R.**, Kumar, P. 2014. Assessing future changes in seasonal climatic extremes in the Ganges river basin using an ensemble of regional climate models. *Climatic Change*, 173(2): 273-286.
 32. Nag, A., Adamala, S., Raghuwanshi, N.S., **Singh, R.**, Bandyopadhyay, A. 2014. Estimation and ranking of reference evapotranspiration for different spatial scales in India. *Journal of Indian Water Resources Society*, 34(3): 35-45.
 33. Mittal, N., Mishra, A., **Singh, R.** 2013. Combining climatological and participatory approaches for assessing changes in extreme climatic indices at regional scale. *Climatic Change*, 119: 603-615.
 34. Mailapalli, D.R., Raghuwanshi, N.S., **Singh, R.** 2013. Sediment transport model for a surface irrigation system. *Applied and Environmental Soil Science*, Article ID 957956, doi:10.1155/2013/957956.
 35. Mishra, A., **Singh, R.**, Raghuwanshi, N.S., Chatterjee, C., Froebrich, J. 2013. Spatial variability of climate change impacts on yield of rice and wheat in the Indian Ganga basin. *Science of the Total Environment*, 468–469: S132–S138.
 36. Bhadra, A., Bandyopadhyay, A., **Singh, R.** and Raghuwanshi, N.S. 2013. Development of a user friendly water balance model for paddy. *Paddy and Water Environment*, 11 (1-4): 331-341.
 37. Khalkho, D., Raghuwanshi, N.S., Khalkho, S., **Singh, R.** 2013. A computer model for designing of permanent gully control structures. *African Journal of Agricultural Research*, 29(8): 3860-3872.
 38. Patra, J.P., Mishra, A., **Singh, R.**, Raghuwanshi, N.S. 2012. Detecting rainfall trends in twentieth century (1871–2006) over Orissa State, India. *Climatic Change*, 111:801–817.
 39. Bandyopadhyay, A., Bhadra, A., Swarnakar, R.K., Raghuwanshi, N.S., **Singh, R.** 2012. Estimation of reference evapotranspiration using a user-friendly decision support system: DSS_ET. *Agricultural & Forest Meteorology*, 154: 19-29.
 40. Gupta, S., Kumar, M., Bandyopadhyay, A., Raghuwanshi, N.S. and **Singh, R.** 2011. Modelling of evapotranspiration using artificial neural networks. *Hydrology Journal*, 34 (1 & 2), 22-32.
 41. Kumar, M., Raghuwanshi, N.S. and **Singh, R.** 2010. Artificial neural networks

approach in evapotranspiration modeling: a review. *Irrigation Science*, 29(1): 11-25.

42. Sharma, B., Amarsinghe, U., Xueliang, C., Condappa, D., Shah, T., Mukherji, A, **Singh, R.**, Ambili, G. and Quereshi, A. 2010. The Indus and the Ganges: river basins under extreme pressure. *Water International, Taylor & Francis*, 35 (5): 493-521.
43. Bhadra, A., Bandyopadhyay, A., **Singh, R.**, Raghuwanshi, N.S. 2010. An alternative rotational delivery schedule for improved performance of reservoir based canal irrigation system. *Water Resources Management*: 24 (13), 3679-3700.
44. Bhadra, A., Bandyopadhyay, A., **Singh, R.**, Raghuwanshi, N.S. 2010. Development of a rainfall-runoff model: Comparison of two approaches with different data requirements. *Water Resources Management*, 24: 37-62.
45. Mailapalli, D.R., Wallender, W.W., Raghuwanshi, N. S., **Singh, R.** 2010. Closure to “A quick method for estimating furrow infiltration” by D.R. Mailapalli, W.W. Wallender, N.S. Raghuwanshi, R. Singh, *Journal of Irrigation & Drainage Engineering, ASCE*, 136(1): 75-76.
46. Mishra, A., **Singh, R.** and Singh, V.P. 2010. Evaluation of non-point source N and P loads in a small mixed land use land cover watershed. *Water Resource and Protection*, 2(4): 362-372.
47. Patro, S., Chatterjee, C., **Singh, R.** and Raghuwanshi, N.S. 2009. Hydrodynamic modelling of a large flood-prone river system in India with limited data. *Hydrological Processes*, **23 (19)**: 2774-2791.
48. Kumar, M., Raghuwanshi, N.S. and **Singh, R.** 2009. Development and application of GANN Model for evapotranspiration estimation. *Journal of Hydrologic Engineering, ASCE*, 14 (2): 131-140.
49. Mailapalli, D.R. Wallender, W.W., **Singh, R.** and Raghuwanshi, N.S. 2009. Application of a non-standard explicit integration to solve Green and Ampt infiltration equation. *Journal of Hydrologic Engineering, ASCE*, 14 (2): 203-206.
50. Mailapalli, D.R., Wallendar, W.W., Singh, R. and Raghuwanshi, N.S. 2009. Closure to “Application of a non-standard explicit integration to solve Green and Ampt infiltration equation. *Journal of Hydrologic Engineering, ASCE*, 14 (10): 1196-1196.
51. Bandyopadhyay, A., Bhadra, A., Raghuwanshi, N.S. and **Singh, R.** 2009. Temporal trends in estimates of reference evapotranspiration over India. *Journal of Hydrologic Engineering, ASCE*, 14 (5): 508-515.
52. Mailapalli, D.R., **Singh, R.**, Raghuwanshi, N.S. 2009. Physically based model for simulating flow in furrow irrigation: 1. Model development. *Journal of Irrigation & Drainage Engineering, ASCE*, 135(6): 739-746.
53. Mailapalli, D.R., Raghuwanshi, N.S., and **Singh, R.** 2009. Physically based model for simulating flow in furrow irrigation: 2. Model evaluation. *Journal of Irrigation & Drainage Engineering, ASCE*, 135(6): 747-754.
54. Bhadra, A., Bandyopadhyay, A., **Singh, R.** and Raghuwanshi, N.S. 2009. Integrated Reservoir-based Canal Irrigation Model (IRCIM) - I: Description. *Journal of Irrigation & Drainage Engineering, ASCE*, 135 (2): 149-157.
55. Bhadra, A., Bandyopadhyay, A., Raghuwanshi, N.S. and **Singh, R.** 2009. Integrated Reservoir-based Canal Irrigation Model (IRCIM) - II: Application. *Journal of*

56. Mailapalli, D.R., Raghuwanshi, N. S., **Singh, R.** 2009. Sediment transport in furrow irrigation. *Irrigation Science*, 27: 449-456.
57. Patro, S., Chatterjee, C., Mohanty, S. and **Singh, R.** 2009. Flow inundation modelling using MIKE FLOOD and remote sensing data. *Journal of the Indian Society of Remote Sensing*, 37: 107-118.
58. Bandyopadhyay, A., Raghuwanshi, N.S. and **Singh, R.** 2008. Estimation of monthly solar radiation from measured air temperature extremes. *Agricultural & Forest Meteorology*, 148 (11): 1707-1718.
59. Bhadra, A., Panigrahy, N., **Singh, R.**, Raghuwanshi, N.S., Mal, B.C. and Tripathi, M.P. 2008. Development of a geomorphological instantaneous unit hydrograph model for scantily gauged watersheds. *Environmental Modelling & Software*, 26: 1013-1025.
60. Gupta, P.K., **Singh, R.**, Raghuwanshi, N.S., Dutta, S. and Panigrahy, S. 2008. Effect of remotely sensed data on the performance of a distributed hydrological model: a case study. *Journal of Hydrologic Engineering, ASCE*, 13 (10): 939-947.
61. Bhadra, A., Bandyopadhyay, A., Raghuwanshi, N.S. and **Singh, R.** 2008. Development of a GIS-based runoff prediction model using SCS CN method and Muskingum routing technique. *Asian Journal of Geoinformatics*, 8 (4): 3-12.
62. Mailapalli, D.R. Wallender, W.W., Raghuwanshi, N.S. and **Singh, R.** 2008. Quick method for estimating furrow infiltration. *Journal of Irrigation & Drainage Engineering, ASCE*, 134 (6): 788-795.
63. Kumar, M., Bandyopadhyay, A., Raghuwanshi, N.S. and **Singh, R.** 2008. Comparative study of conventional and artificial neural network-based ETo estimation models. *Irrigation Science*, 26: 531-545.
64. Islam, A., Raghuwanshi, N.S. and **Singh, R.** 2008. Development and application of hydraulic simulation model for irrigation canal network. *Journal of Irrigation & Drainage Engineering, ASCE*, 134(1): 49-59.
65. Mailapalli, D.R., Raghuwanshi, N. S., **Singh, R.**, Schmitz, G.H., and Lennartz, F. 2008. Evaluation of Time Domain Reflectometry (TDR) for estimating furrow infiltration. *Irrigation Science*, 26: 161-168.
66. Mailapalli, D.R., Raghuwanshi, N. S., **Singh, R.**, Schmitz, G.H., and Lennartz, F. 2008. Spatial and temporal variation of Manning's roughness coefficient in furrow irrigation. *Journal of Irrigation & Drainage Engineering, ASCE*, 134 (2): 185-190.
67. Islam, A., Raghuwanshi, N.S. and **Singh, R.** 2008. Development and application of hydraulic simulation model for irrigation canal network. *Journal of Irrigation & Drainage Engineering, ASCE*, 134 (1): 49-59.
68. Rao, M.D., Raghuwanshi, N.S. and **Singh, R.** 2006. Development of a physically based 1-D infiltration model for irrigated soils. *Agricultural Water Management*, 85(1-2): 165-174.
69. Sahoo, B., Chatterjee, C., Raghuwanshi, N.S., **Singh, R.** and Kumar, R. 2006. Flood estimation by GIUH-based Clarke and NASH models. *Journal of Hydrologic Engineering, ASCE*, 11(6): 515-525.

70. Raghuwanshi, N.S., **Singh, R.** and Reddy, L.S. 2006. Runoff and sediment yield modelling using artificial neural networks: upper Siwane river, India. *Journal of Hydrologic Engineering, ASCE*, 11(1): 71-79.
71. Mishra, A., **Singh R.** and Raghuwanshi, N.S. 2005. Development and application of an integrated optimization-simulation model for major irrigation projects. *Journal of Irrigation & Drainage Engineering, ASCE*, 131(6): 504-513.
72. Islam, A., Raghuwanshi, N.S., **Singh, R.** and Sen, D.J. 2005. Comparison of gradually varied flow computation algorithms for open-channel network. *Journal of Irrigation & Drainage Engineering, ASCE*, 131(5): 457-465.
73. Wohling, Th., **Singh, R.** and Schmitz, G.H. 2004. Physically based modelling of interacting surface-subsurface flow during furrow irrigation advance. *Journal of Irrigation & Drainage Engineering, ASCE*, 130(5): 349-356.
74. Tripathi, M.P., Panda, R.K., Raghuwanshi, N.S. and **Singh, R.** 2004. Hydrological modelling of a small watershed using generated rainfall in the Soil and Water Assessment Tool model. *Hydrological Processes*, 18: 1811-1821.
75. Biju A. George, Raghuwanshi, N.S. and **Singh, R.** 2004. Development and testing of a GIS integrated irrigation scheduling model. *Agricultural Water Management*, 66(3): 221-237.
76. Lohani, A.K., **Singh, R.** and Srinivas, B. 2003. Optimisation of Clark's unit hydrograph using HEC-1 with support of GIS. *Journal of Institution of Engineers (India)*, 83: 252-258.
77. Mishra, A., **Singh R.** and Raghuwanshi, N.S. 2002. Alternative Delivery scheduling for improved canal system performance. *Journal of Irrigation & Drainage Engineering, ASCE*, 128(4): 244-248.
78. Kumar, M., Raghuwanshi, N.S., **Singh, R.**, Wallender, W.W. and Pruitt, W.O. 2002. Evapotranspiration modelling using artificial neural network. *Journal of Irrigation & Drainage Engineering, ASCE*, 128(4): 224-233.
79. Chatterjee, C., **Singh, R.** and Kar, S. K. 2002. Discharge characteristics of chimney weirs under free flow conditions. *Journal of Irrigation & Drainage Engineering, ASCE*, 128(3): 175-179.
80. Chatterjee, C., Jha, R., Lohani, A.K., Kumar, R and **Singh R.** 2002. Estimation of SCS curve numbers for a basin using rainfall runoff data. *ISH Journal of Hydraulic Engineering*, 8:40-39.
81. Kumar, P., Mishra, A., Raghuwanshi, N. S. and **Singh, R.** 2002. Application of unsteady flow hydraulic model to a large and complex irrigation system. *Agricultural Water Management*, 54: 49-66.
82. Kumar, M., Raghuwanshi, N.S., **Singh, R.**, Wallender, W.W. and Pruitt, W.O. 2002. Evapotranspiration modelling using artificial neural network. *Journal of Irrigation & Drainage Engineering, ASCE*, 128(4): 224-233.
83. Ali, S. and **Singh, R.** 2001. Regional runoff frequency curve for small watersheds in the Hirakud catchment of Eastern India. *Applied Engineering in Agriculture, ASAE*, 17(3): 285-292.

84. Mishra, A., Anand, A., **Singh R.** and Raghuwanshi, N.S. 2001. Hydraulic modelling of Kangsabati main canal for performance assessment. *Journal of Irrigation & Drainage Engineering, ASCE*, 127(1): 27-34.
85. Ali, S. and **Singh, R.** 2000. Morphological and hydrological investigation in Hirakud catchment for watershed management planning. *Journal of Soil and Water Conservation*, 28(2): 103-109.
86. Ali, S. and **Singh, R.** 2000. Stochastic model for estimating runoff in Hirakud catchment. *Journal of Soil and Water Conservation*, 28(4): 245-256..
87. **Singh, R.**, Refsgaard, J.C. and Yde, L. 1999. Application of irrigation optimization system (IOS) to a major irrigation project in India. *Irrigation & Drainage Systems*, 13(3): 229-248.
88. **Singh, R.**, Subramanian, K. and Refsgaard, J.C. 1999. Hydrological modelling of a small watershed using MIKE SHE for irrigation planning. *Agricultural Water Management*, 41: 149-166.
89. **Singh, R.**, Panigrahy, N. and Philip, G. 1999. Modified rainfall simulator infiltrometer for infiltration, runoff and erosion studies. *Agricultural Water Management*, 41: 167-175.
90. Singh, M.K., Panigrahy, N. and **Singh, R.** 1999. Development, calibration and validation of a geomorphological instantaneous unit hydrograph (GIUH) model for a small watershed. *Journal of Institution of Engineers (India)*, 80: 27-34.
91. Panigrahy, N. and **Singh, R.** 1999. Evaluation of an Existing raingauge network using kriging technique. *Journal of Institution of Engineers (India)*, 80: 46-51.
92. Chatterjee, C., **Singh, R.**, Kar, S. K., Panda, S.N. and Bohra, S.L. 1998. Flow characteristics of chimney weirs under submergence. *Journal of Irrigation & Drainage Engineering, ASCE*, 124(2): 96-101.
93. **Singh, R.**, Refsgaard, J.C., Yde, L., Jorgensen, G.H. and Thorsen, M. 1997. Hydraulic-hydrological simulations of canal-command for irrigation water management. *Irrigation & Drainage Systems*, 11: 185-213.
94. Chatterjee, C., **Singh, R.** and Satyanarayana, T. 1997. Discharge characteristics of chimney weir. *Journal of Institution of Engineers (India)*, 77: 190-194.
95. Mohanty, S. and **Singh, R.** 1996. Determination of soil hydrologic properties under simulated rainfall conditions. *Agricultural Water Management*, 29(3): 267-281.
96. Lohani, A.K. and **Singh, R.** 1996. Comparison of transformation techniques for frequency analysis of annual runoff. *Journal of Indian Water Resources Society*, 2(3): 5-10.
97. Nikam, H.V. and **Singh, R.** 1995. Development of regional curve for small watersheds in Upper Damodar Valley using non-parametric Fourier Series Method (FSM). *Journal of Applied Hydrology*, 8(1-4): 41-50.
98. Bundela, D. S., **Singh, R.** and Mishra, K. 1995. Sediment yield modelling for small watersheds in Barakar river valley. *Journal of Institution of Engineers (India)*, 76: 22-25.

99. **Singh, R.**, Manivannan, D. and Satyanarayana, T. 1994. Discharge coefficient of rectangular side weirs. *Journal of Irrigation & Drainage Engineering, ASCE*, 120 (4): 814-819.
100. **Singh, R.** and Satyanarayana, T. 1994. Automated field irrigation system using side weirs. *Journal of Irrigation & Drainage Engineering, ASCE*, 120(1): 48-59.
101. **Singh, R.**, Manivannan, D. and Satyanarayana, T. 1993. Discharge characteristics of rectangular side weirs. *Journal of Indian Water Resources Society*, 13 (1&2): 33-47.
102. Bhardwaj, A. and **Singh R.** 1993. Relationship between rain infiltration and ponded water infiltration. *Agricultural Engineering Journal*, 2 (1&2): 73-81.
103. Bhardwaj, A. and **Singh, R.** 1992. Development of a portable rainfall simulator for infiltration, runoff and erosion studies. *Agricultural Water Management*, 22 (3): 235-248.
104. **Singh, R.** and Nikam, H. V. 1992. Development of regional frequency curve using non-parametric Fourier series method. *Agricultural Engineering Journal*, 1 (2): 93-104.
105. **Singh, R.** and Satyanarayana, T. 1992. Flow behaviour of side weirs - A review. *Journal of Institution of Engineers (India)*, 73 (AG I): 37-43.
106. Agrawal, D. K., **Singh, R.** and Satyanarayana, T. 1990. Operation schedule of irrigation outlets in a rotational water distribution system. *Journal of Institution of Engineers (India)*, 71 (AGI): 34-36.
107. Wankhede, D. M., Satyanarayana, T. and **Singh, R.** 1990. Performance of V-shaped and trapezoidal broad crested weirs as critical flow measuring structures in field channels. *Indian Journal of Soil Conservation*, 18 (3):67-74.
108. Srivastava, S. K., Satyanarayana, T. and **Singh, R.** 1989. Testing of broad-crested trapezoidal weirs in earthen field channels. *Indian Journal of Power and River Valley Development*, 79-82.
109. **Singh, R.**, Misra, N. and Satyanarayana, T. 1987. Relationship between mean annual runoff and geomorphic characteristics of small watersheds. . *Indian Journal of Soil Conservation*, 31(2): 155-162.
110. **Singh, R.**, Misra, N. and Satyanarayana, T. 1987. Frequency analysis of annual runoff for small watersheds in upper Damodar valley. *Journal of Institution of Engineers (India)*, 68 (AGI): 14-17.

Details of Books/Book Chapters/Monographs Published

1. Das, D.M., **Singh, R.**, Kumar, A., Mailapalli, D.R., Mishra, A. and Chatterjee, C. 2016. A multi-model ensemble approach for stream flow simulation. In: Panigrahi, B. and Goyal, M.R. (Eds.), *Modelling Methods and Practices in Soil and Water Engineering*, CRC Press, Taylor & Francis, pp 72-100.
2. Bhadra, A., Raghuwanshi, N.S. and **Singh, R.** 2012. Generation of Monthly Irrigation Maps for India using Spatial Interpolation Techniques, In: Bjornlund, H., Brebbia, C.A., and Wheeler, S. (Eds.), *Sustainable Irrigation and Drainage IV: Management, Technologies and Policies*. WIT Press, Southampton, UK, pp 291-302.
3. Kumar, R. , **Singh, R.**, Raghuwanshi, N.S., Chatterjee, C. 2011. Flood Inundation Zoning for Different Return Periods. Technical Report. Ministry of Water Resources, New Delhi, 82 pp.
4. **Singh, R.** 1990. *Weirs and Flumes for Irrigation Water Measurement*. Quality Improvement Program, IIT Kharagpur Press, Kharagpur, 62 pp.

Details of Sponsored Research & Consultancy Projects

A. Ongoing Sponsored Research

1. Title: **Development and Evaluation of Real-Time River-Reservoir Water Quality Advisory System WAQAS-IMPRINT-2**
Sponsored by: Science and Engineering Research Board (SERB), DST, New Delhi
Duration: 2019-2023
Value: INR 52.47 lakh
Position: Principal Investigator
2. Title: **Securing Water for Agricultural and Food Sustainability: Developing Transdisciplinary Approach to Ground Water Management**
Sponsored by: Apex Committee of SPARC, MHRD, New Delhi
Duration: 2019-2022
Value: INR 58.51 lakh
Position: Co-Principal Investigator
3. Title: **Development of Digital Platform for Financial Inclusion and Rural Women Empowerment**
Sponsored by: Apex Committee of SPARC, MHRD, New Delhi
Duration: 2019-2022
Value: INR 45.90 lakh
Position: Co-Principal Investigator
4. Title: **Climate Change Impact and Adaptation Options for Sustaining Rice-Wheat Crop Production in India**
Sponsored by: DST, Government of India
Duration: 2017-2022
Value: INR 37.25 lakh
Position: Co-Principal Investigator
5. Title: **Impact of Climate Change on Flood Risk (IFR)**
Sponsored by: DST, Government of India
Duration: 2017-2022
Value: INR 58.51 lakh
Position: Co-Principal Investigator
6. Title: **Vulnerability and Risk Assessment due to Various Environmental Drivers in a Climate Change Scenario over Eastern India**

Sponsored by: **DST, Government of India**
Duration: **2017-2022**
Value: **INR 690.36 lakh**
Position: **Co-Principal Investigator**

B. Completed Sponsored Research

1. Title: **Development and Testing of a Large Scale Conceptual Hydrological Model**
Sponsored by: **National Institute of Hydrology, Government of India**
Duration: **2018-2022**
Value: **INR 55.55 lakh**
Position: **Principal Investigator**
2. Title: **Effect of Climate Change & Land Use/Land Cover Changes on Spatial and Temporal Water Availability in Subarnarekha Basin**
Sponsored by: **Ministry of Water Resources, Government of India**
Duration: **2018-2021**
Value: **INR 25.26 lakh**
Position: **Co-Principal Investigator**
3. Title: **Soil Matrix Temperature Gradient Influence on Migration of Plant Nutrients in Soil**
Sponsored by: **IIT Kharagpur, Kharagpur**
Duration: **2018-2021**
Value: **INR 25.00 lakh**
Position: **Co-Principal Investigator**
4. Title: **Sustainable Food Security Through Technological Interventions for Production, Processing and Logistics**
Sponsored by: **Ministry of HRD, Government of India**
Duration: **2014-2018**
Value: **INR 2600 lakh**
Position: **Co-Principal Investigator**
5. Title: **Measurement to Management (M2M): Improved Water Use Efficiency and Agricultural Productivity Through Experimental Sensor Network**
Sponsored by: **Information Technology Research Academy (ITRA), Ministry of Communications & Information Technology, Government of India**
Duration: **2013-2018**
Value: **INR 191.35 lakh**
Position: **Co-Principal Investigator**

6. Title: **Water & Nutrient Use Efficiency of Different Rice Management Techniques with The Use of On-Farm Reservoirs Facilities**
Sponsored by: **Ministry of HRD, Government of India**
Duration: **2014-2017**
Value: **INR 46.72 lakh**
Position: **Principal Investigator**
7. Title: **Integrated Pilot Project on Food Grain Production and Post-Harvest Processing and Storage at Farm Level (GPL)**
Sponsored by: **Ministry of HRD, Government of India**
Duration: **2014-2017**
Value: **INR 186.30 lakh**
Position: **Co-Principal Investigator**
8. Title: **Development of a Conceptual Water Balance Model for Various Ecosystems of India**
Sponsored by: **Space Applications Centre, Ahmedabad**
Duration: **2014-2017**
Value: **INR 20.30 lakh**
Position: **Principal Investigator**
9. Title: **Climate Change Adaptations to Improve Agricultural Production in Eastern India**
Sponsored by: **Ministry of HRD, Government of India**
Duration: **2014-2017**
Value: **INR 25.57 lakh**
Position: **Co-Principal Investigator**
10. Title: **Development of a Sensor Based Networking System for Improved Water Management for Irrigated Crops**
Sponsored by: **Ministry of HRD, Government of India**
Duration: **2014-2017**
Value: **INR 46.02 lakh**
Position: **Co-Principal Investigator**
11. Title: **Development of Optimal Crop Planning Model Based on Flood Risk**
Sponsored by: **Indian Council of Agricultural Research**
Duration: **2016-2017**
Value: **INR 34.92 lakh**
Position: **Co-Principal Investigator**
12. Title: **Optimum Water & Fertilizer-N Management Strategies for Rice**
Sponsored by: **Indian Council of Agricultural Research**
Duration: **2016-2017**

Value: **INR 18.53 lakh**
Position: **Co-Principal Investigator**

13. Title: **Ensemble Modeling of Rainfall-Runoff Transformation Process**

Sponsored by: **Ministry of Water Resources, Government of India**
Duration: **2012-2016**
Value: **INR 26.44 lakh**
Position: **Principal Investigator**

14. Title: **Development of GIS Based Decision Support System for Irrigation System Management**

Sponsored by: **Ministry of Water Resources, Government of India**
Duration: **2012-2016**
Value: **INR 42.48 lakh**
Position: **Co-Principal Investigator**

15. Title: **Flood Inundation Zoning for Different Return Periods in Mahanadi River Basin**

Sponsored by: **Ministry of Water Resources, Government of India**
Duration: **2011-2016**
Value: **INR 36 lakh**
Position: **Co-Principal Investigator**

16. Title: **Adaptation to Changing Water Resources Availability in Northern India with Himalayan Glacier Retreat and Changing Monsoon Pattern**

Sponsored by: **European Commission**
Duration: **2009-2012**
Value: **INR 155 lakh**
Position: **Co-Principal Investigator**

17. Title: **Impact Assessment of MGNREGA in One District of Madhya Pradesh (Mandla) and West Bengal (PaschimMedinipur)**

Sponsored by: **Ministry of Rural Development, Government of India**
Duration: **2011-2012**
Value: **INR 19.15 lakh**
Position: **Co-Principal Investigator**

18. Title: **Distributed Hydrological Modelling to Analyse Sediment and Nutrient Status of Brahmani-Baitarani Delta**

Sponsored by: **Space Applications Centre, Ahmedabad**
Duration: **2008-2010**
Value: **20.18 lakh**
Position: **Principal Investigator**

19. Title: **Flood Risk Modelling Using Satellite Remote Sensing Data for Optimal Crop Planning**
Sponsored by: **Indian Space Research Organisation, Bengaluru**
Duration: **2008-2011**
Value: **INR 10.78 lakh**
Position: **Co-Principal Investigator**
20. Title: **Hydrological Modelling of a Watershed to Evaluate Impacts of Watershed Structures on Surface Flow and Groundwater Recharge**
Sponsored by: **Department of Science & Technology, Government of India**
Duration: **2007-2010**
Value: **INR 19.3 lakh**
Position: **Principal Investigator**
21. Title: **Development and Application of a Decision Support System for Estimating Reference Crop Evapotranspiration under different Agro-Climatic Zones**
Sponsored by: **Indian Council of Agricultural Research**
Duration: **2003-2006**
Value: **INR 23 lakh**
Position: **Co-Principal Investigator**
22. Title: **Modelling Flow and Sediment Transport Phenomena for Improved Furrow Irrigation Management**
Sponsored by: **Volkswagen Research Foundation, Germany**
Duration: **2002-2005**
Value: **INR 35 lakh**
Position: **Principal Investigator**
23. Title: **Hydrological Water Balance Modelling of Agricultural Watershed**
Sponsored by: **DST-DAAD Project Based Personnel Exchange Programme**
Duration: **2002-2004**
Value: **INR 8 lakh**
Position: **Principal Investigator**
24. Title: **Integration of Remote Sensing Data with Distributed Hydrological Models to Analyse Cropping System Sustainability and Water Use Efficiency**
Sponsored by: **Space Applications Centre, Ahmedabad**
Duration: **1999-2002**
Value: **INR 12.3 lakh**
Position: **Principal Investigator**
25. Title: **Development and Application of a Management System for Optimal Control and Operation of Irrigation Projects**

Sponsored by: **Indian Council of Agricultural Research**
Duration: **1998-2001**
Value: **INR 9 lakh**
Position: **Principal Investigator**

26. Title: **Hydrologic and Geomorphic Studies of Watersheds using Uncertainty Analysis and Principle of Maximum Entropy**

Sponsored by: **Indian Council of Agricultural Research**
Duration: **1994-1998**
Value: **INR 6 lakh**
Position: **Principal Investigator**

27. Title: **Development of a Low-cost Portable Rainfall Simulator Infiltrometer**

Sponsored by: **Institute Scheme for Innovative Research & Development, I.I.T., Kharagpur**
Duration: **1994-1995**
Value: **INR 0.25 lakh**
Position: **Principal Investigator**

C. Ongoing Consultancy Projects

1. Title: **Testing of Nano Liquid Complex Fertilizers (N-K and P-K) for Cereals**

Client: **AARSHANANO Composite Technologies Pvt. Ltd., Andhra Pradesh**
Duration: **01-02-2022 to 31-08-2022**
Value: **INR 3.05 lakh**
Position: **Co-Principal Consultant**

D. Completed Consultancy Projects

1. Title: **Validation of Remote Sensing Technology Based Crop Yield Estimation**

Client: **Greenthink Ventures Private Limited, Kolkata**
Duration: **15-02-2021 to 30-09-2021**
Value: **INR 1.53 lakh**
Position: **Co-Principal Consultant**

2. Title: **Setting-up RiverWare Model for Operational Management and Climate Change Impact Assessment of Damodar River Basin Reservoirs**

Client: **The World Bank, New Delhi**
Duration: **16-02-2018 to 31-07-2018**
Value: **INR 5.46 lakh**
Position: **Co-Principal Consultant**

3. Title: **Testing and Evaluation of the Internet of Things (IOT) based prototype designed for water management in Alternate Wetting and Drying (AWD) rice**

Client: **The World Bank, New Delhi**
Duration: **14-02-2018 to 31-07-2018**
Value: **INR 9.13 lakh**
Position: **Principal Consultant**

4. Title: **Educational and Design Software (EDSP)**

Client: **Various Govt./Industrial/Private Organization**
Duration: **2002 – 2012**
Value: **INR 3.5 lakh**
Position: **Co-Principal Consultant**

5. Title: **Evaluation of Probable Maximum Flood for NagarjunSagar Dam**

Client: **Irrigation and CAD Department, Govt. of Andhra Pradesh**
Duration: **2009-2010**
Value: **INR 29.09 lakh**
Position: **Principal Consultant**

6. Title: **Intervention Analysis of the IGB Basin Focal Project**

Client: **International Water Management Institute, Sri Lanka**
Duration: **2008 – 2010**
Value: **INR 6.7 lakh**
Position: **Principal Consultant**

7. Title: **Training Course on Watershed Management and Restoration Measures**

Client: **Western Orissa Rural Livelihood Project, Government of Odisha**
Duration: **2008**
Value: **INR 8 lakh**
Position: **Principal Consultant**

8. Title: **Training Course on Canal Hydraulic Modelling**

Client: **State Water Resources Agency, Government of Uttar Pradesh**
Duration: **2007**
Value: **INR 12 lakh**
Position: **Principal Consultant**

9. Title: **Decision Support System for Irrigation Projects**

Client: **Tata Consultancy Services, Pune**
Duration: **2001 – 2002**
Value: **INR 12 lakh**
Position: **Principal Consultant**

Significant Research Contributions in the Area of Water Resources and River Basin Management

Several *Models, Concepts, and Processes* have been developed towards water resources management, in general, and river basin management, in particular, including the studies dealing with the impact of climate and anthropogenic changes on water resources. A few of the developed models have also been transferred to various users in the country.

A few of the notable contributions are mentioned below:

A. Model Development

- (a) A *Satellite Based Hydrological Model (SHM)* is presently being developed under PRACRITI II program of *Space Applications Centre, Ahmedabad* for studying the *water balance of Indian river basins* at 5 km X 5 km resolution. *IIT Kharagpur* is leading this multi-institutional project which also involves *IISc Bangalore, IIT Guwahati, NERIST Nirjuli and GBPHED Almora*. The first version of this conceptual model will be ready in August 2016. Subsequently it will be tested for various basins, and finally operationalized at SAC server. The long-term goal is to utilize the satellite derived datasets for real time applications.

NIH Roorkee which is coordinating the Hydrology Project has already contacted IIT Kharagpur to join the effort in developing a National Hydrology Model being planned under HP III.

- (b) An *Integrated Reservoir-based Canal Irrigation Model (IRCIM)* has been developed for efficient planning and operation of the large irrigation projects. IRCIM includes catchment hydrologic module, reservoir water balance module, command hydrologic module and a rotational canal irrigation management system for the quantification of supply and demand and equitable distribution of supply to meet the demand, if possible, or to minimize the gap between the supply and demand. A graphical user interface is developed for better interaction between the model and its user. Kangsabati Irrigation Project, West Bengal has been used as case study for applying the model and for demonstrating the improvements in the system performance in terms of adequacy, efficiency, equity, and dependability.

This model has been well-appreciated by the hydrological community worldwide, which is evident from 45 citations, as per Google Scholar, for the following papers:

Bhadra, A., Bandyopadhyay, A., Singh, R., Raghuwanshi, N.S. 2010. Development of a rainfall-runoff model: Comparison of two approaches with different data requirements. *Water Resources Management*, 24: 37-62.

Bhadra, A., Bandyopadhyay, A., **Singh, R.** and Raghuwanshi, N.S. 2009. Integrated Reservoir-based Canal Irrigation Model (IRCIM) - I: Description. *Journal of Irrigation & Drainage Engineering, ASCE*, 135 (2): 149-157.

Bhadra, A., Bandyopadhyay, A., Raghuwanshi, N.S. and **Singh, R.** 2009. Integrated Reservoir-based Canal Irrigation Model (IRCIM) - II: Application. *Journal of Irrigation & Drainage Engineering, ASCE*, 135 (2): 158-168.

- (c) A *hydraulic simulation model (CanalMod)* has been developed for improving the performance of the irrigation systems by studying the flow behavior in a large and complex canal network under a variety of design and management scenarios. The model is applicable for simulating flow in a series of linearly connected reaches, and branched as well as looped canal networks, and is capable of handling different hydraulic structures such as weirs, sluice gate, drops/falls, pipe outlet, and imposed discharge.

This model has been well-appreciated by the hydrological community worldwide, which is evident from 16 citations, as per Google Scholar, for the following paper:

Islam, A., Raghuwanshi, N.S. and **Singh, R.** 2008. Development and application of hydraulic simulation model for irrigation canal network. *Journal of Irrigation & Drainage Engineering, ASCE*, 134(1): 49-59.

- (d) An *integrated hydraulic-hydrological modelling approach*, combining the hydraulic simulation of the canal system and hydrologic simulation of the irrigated command, has been propagated for improved management of the river basin projects. In two separate studies, the integrated modelling approach has been applied to Mahanadi Reservoir Irrigation Project and Kangsabati Irrigation Project to demonstrate its advantages in better supply-demand management.

This modelling approach has been well-appreciated by the hydrological community worldwide, which is evident from 51 citations, as per Google Scholar, for the following papers:

Singh, R., Refsgaard, J.C., Yde, L., Jorgensen, G.H. and Thorsen, M. 1997. Hydraulic-hydrological simulations of canal-command for irrigation water management. *Irrigation & Drainage Systems*, 11: 185-213.

Singh, R., Refsgaard, J.C. and Yde, L. 1999. Application of irrigation optimization system (IOS) to a major irrigation project in India. *Irrigation & Drainage Systems*, 13(3): 229-248.

Mishra, A., **Singh R.** and Raghuwanshi, N.S. 2005. Development and application of an integrated optimization-simulation model for major irrigation projects. *Journal of Irrigation & Drainage Engineering, ASCE*, 131(6): 504-513

B. Climate Change Impact Assessment

- (a) The *climatological and societal perspectives* have been combined to assess the future climatic extremes over **Kangasabati river basin** using an ensemble of four high resolution (25 km) regional climate model (RCM) simulations from 1970 to 2050. The relevant extreme indices and their thresholds are defined in consultation with stakeholders and are then compared using RCM simulations. The analysis shows an intensification of majority of extremes as projected by future ensemble mean. The study suggests that there is a marked consistency in stakeholder observed changes in climate extremes and future predicted trends.

The study is further extended to evaluate the *hydrologic alteration caused by dam construction and climatic changes* in the river basin. To analyse the natural flow regime, 15 years of observed stream flow (1950–1965) prior to dam construction is used. Future flow regime is simulated by SWAT, and Indicators of Hydrological Alteration (IHA) program based on the Range of Variability Approach (RVA) is used to quantify the hydrological alterations of different flow characteristics. Results indicate that flow variability has been significantly reduced due to dam construction, and it has been found that in the Kangsabati river basin, influence of dam is greater than that of the climate change, thereby emphasizing the significance of direct human intervention.

The following papers, published from this research. have been cited 15 times:

Mittal, N., Bhawe, A.G., Mishra, A., **Singh, R.** 2016. Impact of human intervention and climate change on natural flow regime. *Water Resources Management*, 30: 685-699.

Mittal, N., Mishra, A., **Singh, R.** 2013. Combining climatological and participatory approaches for assessing changes in extreme climatic indices at regional scale. *Climatic Change*, 119: 603-615.

- (b) *Rainfall pattern* has been analysed over Odisha state during 1871 – 2006 using both parametric and non-parametric tests. The analysis revealed a long term insignificant decline trend of annual as well as monsoon rainfall, whereas increasing trend in post-monsoon season. Rainfall during winter and summer seasons showed an increasing trend. The change in the rainfall trend during monsoon months is of major concern for the rainfed agriculture, hydro-power generation and reservoir operation.

In yet another study, the quality of *satellite-based precipitation estimates* produced by the tropical rainfall measuring mission 5 (TRMM) from passive microwave and infrared recordings were analysed for the Lower Mahanadi River Basin. At sub-basin level (4000 to 16000 km²) the satellite-based areal precipitation estimates were found to be moderately correlated with the gage-based counterparts, and rainfall–runoff simulation experiments validated these findings.

The following papers, published from these studies have been well-accepted by the research community, as evident from 34 citations, as per Google Scholar:

Patra, J.P., Mishra, A., **Singh, R.**, Raghuwanshi, N.S. 2012. Detecting rainfall trends in twentieth century (1871–2006) over Orissa State, India. *Climatic Change*, 111:801–817.

Kneis, D., Chatterjee, C., **Singh, R.** 2014. Evaluation of TRMM rainfall estimates over a large Indian river basin (Mahanadi). *Hydrology & Earth System Sciences Discussions*, 11(1): 1169-1201.

C. Concept Development

- (a) The applicability of a comprehensive hydrological modelling system has been illustrated successfully for the management of water resources in a watershed. The physically based distributed modelling system, MIKE SHE, has been used to simulate the hydrological water balance of a small watershed with the objective of planning and analysing the irrigation water requirements of crops, and developing the irrigation plan.

This new concept is well-accepted by the hydrological community worldwide, which is evident from 69 citations, as per Google Scholar, for the following paper:

Singh, R., Subramanian, K. and Refsgaard, J.C. 1999. Hydrological modelling of a small watershed using MIKE SHE for irrigation planning *Agricultural Water Management*, 41: 149-166.

- (b) Artificial Neural Network (ANN) models have been developed to predict runoff and sediment yield, on a daily as well as a weekly basis from simple information on rainfall and temperature, for a small agricultural watershed. These models based on simple inputs were found to be useful for estimation of runoff and sediment yield, missing data, and testing the accuracy of other models.

This concept is well-accepted by the hydrological community worldwide, which is evident from 87 citations, as per Google Scholar, for the following paper:

Raghuwanshi, N.S., **Singh, R.** and Reddy, L.S. 2006. Runoff and sediment yield modelling using artificial neural networks: upper SiwaneRiver, India. *Journal of Hydrologic Engineering, ASCE*, 11(1): 71-79.

- (c) The artificial neural network (ANN) has also been used to model evapotranspiration, a basic hydrological abstraction that affects the water balance of a river basin. Several issues associated with the use of ANNs were examined, including different learning methods, number of processing elements in the hidden layer(s), and the number of hidden layers.

The best ANN architecture was selected on the basis of weighted standard error of estimate and minimal ANN architecture. Based on the results, it was concluded that the ANN can predict reference evapotranspiration better than the conventional methods.

This research has been highly acclaimed and the following paper has been cited 311 times, as per Google Scholar:

Kumar, M., Raghuwanshi, N.S., **Singh, R.**, Wallender, W.W. and Pruitt, W.O. 2002. Evapotranspiration modelling using artificial neural network. *Journal of Irrigation & Drainage Engineering, ASCE*, 128(4): 224-233.

- (d) In first of its kind study, MIKE 11 hydraulic model was applied to the 137 km long Right Bank Main Canal (RBMC) system of the Kangsabati irrigation project. The objective was to improve the operation and management of a large and complex canal network through performance assessment. The results suggested that the validated MIKE 11 model can be used as a tool for understanding the operational aspect that can help in enhancing the overall performance of large irrigation systems.

This new operational concept has been received well. This is evident from 30 citations, as per Google Scholar, for the following paper:

Mishra, A., Anand, A., **Singh R.** and Raghuwanshi, N.S. 2001. Hydraulic modelling of Kangsabati main canal for performance assessment. *Journal of Irrigation & Drainage Engineering, ASCE*, 127(1): 27-34.

D. Process Development

A process has been developed to carry out the **Intervention Analysis of the Indo-Gangetic Basin (IGB) Focal Project** to identify potential and productive interventions capable of improving the water productivity in the IGB in a sustainable manner. The work was done in collaboration with IWMI, Sri Lanka. Altogether 111 reports, 289 research papers and 9 PhD theses were used to develop 289 matrices that included key intervention categories such as resource conservation techniques (RCT), water and watershed management, farming system, multiple use water scheme (MUS), climate change and environmental flow, institutional interventions, and land use. Eight different crops were selected for preparing questionnaire considering the major cropping systems prevailing in the IGB. Questionnaires for different crops were prepared for intervention ranking and sent to 70 experts covering the whole IGB for their opinion. *Analytic Hierarchy Process (AHP)* was adopted to analyse the expert opinions collected through sample survey, and interventions were ranked for each crop. The highest

ranked interventions for each crop were identified. The process was adopted to recommend interventions for improving the water use efficiency in the basin.

This process has been adopted to recommend interventions which will help to improve sustainability of the resources, enhance agricultural productivity, and alleviate poverty, and published in the following research paper, cited by 31, as per Google Scholar:

Sharma, B, Amarsinghe, U., Xueliag, C., Condappa, D., Shah, T., Mukherji, A, **Singh, R.**, Ambili, G. and Quereshi, A. 2010. The Indus and the Ganges river basins under extreme pressure. *Water International, Taylor & Francis*, 35 (5): 493-521.

E. Software Development & Transfer

Copyrights have been obtained for the following Software Packages under **Section 45 of the Copyright Act, 1957 (14 of 1987)**

Sl. No.	Name of the Software	Copyright Number
1.	Hydrology_Calculator	SW-858/2002
2	Soil Conservation Structure Designer (SCS_Designer)	SW-860/2002
3	Decision Support System for Reference Crop Evapotranspiration (DSS_ET)	SW-859/2002
4.	CanalMod – Hydraulic Simulation Model	SW-085/2006
5.	IRCIM – Integrated Reservoir Based Canal Irrigation Model	L-29594/2007

The software packages; **Hydrology_Calculator** (a user-friendly software for hydrological analyses), **DSS_ET** (Decision Support System for Reference Crop Evapotranspiration), **SCS_Designer** (a user friendly software for designing soil conservation structures) and **GIUH_CAL** (a Geomorphology-based Rainfall-Runoff Model) are **commercially sold** for **INR 20000** per license for the first three software each, and **INR 30000** per license for the fourth software, through the Sponsored Research & Industrial Consultancy Centre of IIT Kharagpur.

The above mentioned four software products have been sold to several clients all over India at nominal prices through **“Education and Design Software Project (EDSP)”, Sponsored**

Research & Industrial Consultancy Centre of IIT Kharagpur, and are being used extensively as teaching, research and design tools. The clients include **8 ICAR Institutes, 13 State Agricultural Universities (SAUs), 2 Centrally Funded Institutes, 3 other Educational Institutes, 2 State Government Agencies and 1 International Consultancy Firm**. This shows the wide-spread adoption of these software products and their acceptance by clients/stakeholders. It also shows their commercial value.

The client list is as follows:

ICAR Institutes

1. Central Soil and Water Conservation Research and Training Institute, **Vasad**
2. ICAR Research Complex for Eastern Region, **Patna**
3. Central Research Institute for Dryland Agriculture, **Hyderabad**
4. Division of Agricultural Engineering, ICAR Research Complex, **Meghalaya**
5. Vivekananda ParvatiyaKrishiAnusandhanSansthan, **Almora**
6. Central Soil and Water Conservation Research and Training Institute Research Centre, **Ootacamund**
7. ICAR Research Complex for Goa, **Goa**
8. Central Institute of Agricultural Engineering, **Bhopal**

State Agricultural Universities

1. Indira Gandhi Agricultural University, **Raipur**
2. DrPanjabraoDeshmukhKrishiVidyapeeth, **Akola**
3. College of Agricultural Engineering & Technology, Dapoli, **Ratnagiri**
4. College of Agricultural Engineering, M.A.U., **Parbhani**
5. College of Agricultural Engineering, **Dharwad**
6. Department of Soil and Water Engineering, College of Technology & Engineering, **Udaipur**
7. Department of Soil and Water Engineering, College of Agricultural Engineering & Technology, **Junagadh**
8. Department of Soil and Water Engineering, College of Agricultural Engineering, JNKVV, **Jabalpur**
9. Centre for Watershed Management, Participatory Research and Rural Engineering, S. D. Agricultural University, **SardarKrushinagar**
10. Department of Soil & Water Conservation Engineering, Agricultural Engineering College and Research Institute, **Coimbatore**
11. University of Agricultural Sciences & Technology, **Jammu**
12. Baba Saheb Dr. BhimRaoAmbedkar College of Engineering & Technology, Etawah, **Uttar Pradesh**

13. Dr. A.S. College of Agricultural Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, **Maharashtra**

Centrally Funded Institutes

1. National Institute of Technology, **Kurukshetra**
2. North Eastern Regional Institute of Science & Technology, Nirjuli, **Arunachal Pradesh**

Other Educational Institutes

1. Water Resources Engineering & Management Institute, Maharaja Sayajirao University of Baroda, **Samiala**
2. Karunya Institute of Technology & Sciences, Karunya Nagar, **Coimbatore**
3. Department of Natural Resource Management, College of Forestry, **Sirsi**

State Government Agencies

1. State Water Resources Agency, UP Water Sector Restructuring Project, WALMI Bhawan, **Lucknow**
2. Office of the Conservator of Forests, **Kolkata**

Consultancy Firm

1. SMEC International Pvt. Ltd., **Lucknow**

In addition, **key international collaborations** have been established with renowned hydrologist from institutions like **Texas A & M University**, USA; **Danish Hydraulic Institute**, Denmark; **Dresden Technical University**, Germany; **Potsdam University**, Germany; and **Waikato Institute of Technology**, New Zealand.