Curriculum Vitae

Somnath Mondal

Graduate Research Assistant
Glenn Department of Civil Engineering
Clemson University, Clemson – 29631, SC
8649865168
smondal@g.clemson.edu

EDUCATION

Ph.D. Civil Engineering *(Research Focus: Complex Climate Extremes)* ***Clemson University (GPA 3.54/4.0)*** *(Fall 2018-Present)*

Masters of Engineering in Civil Engineering ***Indian Institute of Technology (IIT), Guwahati (GPA 9.4/10)*** *(Specialisation: Water Resources Engineering)(2014-2016)*

Bachelor of Engineering in Civil Engineering ***Jadavpur University, Kolkata, India (GPA 7.2/10)*** *(2010-2014)*

RESEARCH INTERESTS

- *Climate Extremes*
- *Complex Network Analysis in Climate*
- *Machine Learning*
- *Deep Learning*
- *Big Data Analytics for hydrometeorological analysis*
- *Bayesian Statistics*

RESEARCH EXPERIENCE

Graduate Student (August 2018 - Present)
Clemson University

Senior Research Fellow (March 2017 - August 2018)
Northeastern Space Applications Center, Dept. of Space, Govt. of India
Project name: Flood Level Early Warning System

Research Fellow (August 2016-March 2017)
Indian Institute of Technology, Guwahati

PUBLICATIONS

1. Mondal, S., K. Mishra, A., Leung, R. *et al.* **Global droughts connected by linkages between drought hubs.** ***Nature Communications*** **14, 144 (2023). https://doi.org/10.1038/s41467-022-35531-8**

2. Mondal, S., & Mishra, A. K. (2021). **Complex Networks Reveal Heatwave Patterns and Propagations Over the USA**. ***Geophysical Research Letters*****,** ***48*****(2),** **https://doi.org/10.1029/2020GL090411**

3. Mondal, S., Mishra, A. K., & Leung, L. R. (2020). **Spatiotemporal Characteristics and Propagation of Summer Extreme Precipitation Events Over United States: A Complex Network Analysis.** ***Geophysical Research Letters*****,** ***47*****(15),** **https://doi.org/10.1029/2020GL088185**

4. Konapala, G., Mondal, S. & Mishra, **A. Quantifying Spatial Drought Propagation Potential in North America Using Complex Network Theory. *Water Resources Research*, e2021WR030914 (2022). https://doi.org/10.1029/2021WR030914**

5. Mondal, S., Mishra A. K., (2022). "**Projected Structural Evolution of Global Drought Synchronization",** To be submitted to Nature Climate Change.

6. Mondal, S., Mishra A. K., (2022), "**Detection of Drought Spatial Propagation, Synchronized Communities and their Spatial Dynamics**", To be submitted to Water Resources Research.

7. Mondal, S., Mishra A. K., (2020). "**A networked view of Global Hydrological Cycle from a multi-plex Network perspective**". To be submitted to Water Resources Research.

CONFERENCES/Workshops/Seminars attended

1. *Mondal, S., Mishra, A. K; **"Complex Network Reveals Heatwave Pattern and Propagations over USA" ASCE-EWRI conference,** Atlanta, 2022

2. Mondal, S., Mishra, A. K. **"Spatiotemporal Characteristics and Propagation of Summer Extreme Precipitation Events over USA: A Complex Network Analysis." American Geophysical Union,** San Francisco, December 2020

AWARDS AND RECOGNITIONS

1. Our article "Global Droughts connected by linkages between drought hubs" got selected as editor's featured article in Nature Communications
2. Awarded NSF internship for three consecutive years (2020, 2021,2022)
3. Were in the top 1% in all entrances that I appeared
4. Graduated masters top of the class from Indian Institute of Technology, Guwahati (2016)
5. Obtained full marks in mathematics in matriculation and Intermediate education (2008-2010)

WORK EXPERIENCE

Junior Research Fellow (June 2017 – December 2018)
Flood Level Early Warning Systems' Division
Northeastern Space Applications Center,
Department of Space, Govt. of India
Shillong, Meghalaya, India

TEACHING EXPERIENCE

- **Graduate *Teaching* Assistant**
  (August 2018-Present)
  Clemson University
  CE 3420 – Applied Hydraulics and Hydrology (Fall 2018)
  CE 3430- Introduction to Fluid Mechanics lab (Spring 2019-Spring 2022)

SKILLS

Software: Python, Matlab, ArcGIS, QGIS, R Language, MS Office, NCL, CDO.

Linguistics: English, Bengali, Hindi, Punjabi, and German

Hydrological Modeling: Hec-HMS, SWAT, Hec-RAS, EPANET

OVERVIEW OF CONDUCTED RESEARCH

Clemson University

- **Complex Network Analysis of Climate Extremes**

Droughts

– Formulated the spatial synchronizability (or compounding) of drought events globally using undirected complex network analysis. The study revealed presence of a 'rich club phenomena' (affinity among drought hot spots) in multiple spatial scales in the occurrences of drought events. The derived information can be used to regionalize and quantify the likelihood of such spatially compounding droughts and, thus, possibly mitigate simultaneous breadbasket failures.

Co-Authors: **Dr. Ashok Mishra, Dr. Ruby Leung, Dr. Benjamin Cook, Published in Nature Communications (I.F. = 17.69)**

Extreme Precipitation

– Investigated the spatial topology of summer (June, July, August) extreme precipitation over USA using complex network analysis. In the aspect of USA, this study is first of its kind looking into the high-dimensional dynamical connectivity among extreme precipitation events. The study revealed important regions of divergence (source) and convergence (sink) of extreme precipitation and areas taking part in precipitation recycling. The derived connectivity information can be utilized in spatial forecasting and spatial parameterization of the global climate models.

Co-Authors: **Dr. Ashok Mishra, Dr. Ruby Leung**, **Published in GRL in 2020 (I.F. = 5.58)**

Heatwaves

– Quantified spatial synchronization and propagation characteristics of warm-period (March-September) heatwaves over USA using complex network analysis. In the aspect of heatwaves, this novel study revealed control of air mass transport on creating areas of *divergence (source)* and *convergence (sink)* as well as regions acting as a ***bottleneck***. The derived spatial propagation characteristics have been used to ***predict*** occurrences of heatwaves in a ***lead time of 2 days*** with an ***accuracy of 63%***.

Co-Author: **Dr. Ashok Mishra, Published in GRL in 2020 (I.F. = 5.58)**

– Contributed through providing atmospheric process based validation in the article titled "Quantifying Spatial Drought Propagation Potential in North America using Complex Network Theory". The study revealed, for the first time, source and sink areas of spatial droughts over different subregions in North America.

Co-Authors: **Dr. Goutam Konapala, Dr. Ashok Mishra, Published in Water Resources Research in 2022 (I.F. = 5.24)**

– Quantified Projected change in spatial connectivity of global drought events under different socio-economic pathways (SSP 245 & 585) using Evolving Complex Network Analysis. The study revealed an increased likelihood of multi-continental droughts engulfing a sizeable subtropical and midlatitude (i.e., Central and Eastern USA, Southern Europe) over the Northern Hemisphere.

Co-Author: **Dr. Ashok Mishra, to be submitted (tentative) to Nature Climate Change**

–Applied Complex network-based community analysis to understand and delineate independent subregions in the occurrence of global drought events. The study further used the concept of 'Kuramato Oscillators' to reveal how coupling force (dominant surface pressure anomaly) can lead to collective order (or spatial synchronization) in the spatial evolution of a drought event.

Co-author: **Dr. Ashok Mishra, to be submitted (tentative) to Water Resources Research**

Global Hydrological Cycle

–To get an 'integrated systems view' of the global hydrological cycle along with addressing the complexity of underlying processes at different spatial scales, we applied Multiplex Complex Network Approach to model the interconnectedness among different hydrologic fluxes. The derived information can be used in the spatial parameterization of hydrologic fluxes in the global climate models and to quantify the likelihood of compound hydrometeorological extremes.

Co-Author: **Dr. Ashok Mishra, to be submitted (tentative) to Water Resources Research**

Department of Space, Govt. of India

- **Semidistributed Flood Modelling**

  – Developed Hec-HMS based semi-distributed hydrological models for 60 different catchments in the northeastern states of India. Compared with gauge-based discharged values, the R^2 value for all models exceeds 0.62, with the highest value being 0.85.

- **Developing a machine learning based decision support system**

  – Developed an ensemble decision support system (for flood forecasting three days ahead) using machine learning algorithms (Support Vector Machines, Random Forest), catchment models, and meteorologic data obtained from Satellites (Cloud cover and Cloud top temperature). The decision support system displayed an accuracy of 84% in suitably classifying flood events in the lead time of 3 days. For the northeastern region of India, such a system is the first of its kind and highly crucial to mitigate recurring fatalities and other damages.

- **Developing Deep learning based Image Segmentation Model**

  –Contributed to developing a deep learning based image segmentation model to extract physical features such as roads, buildings, and canopies from drone-captured high-resolution images (combined with LIDAR data)

- **Deep Learning based precipitation forecasting at Cherrapunjee station (25°15' N, long. 91°44' E)**

  –Employed Recurrent Neural Network and LSTM-based model for temporal rainfall prediction at Cherrapunjee Station. The R^2 **value for daily rainfall was 0.81, whereas, for the weekly sum of rainfall, the** R^2 value went up to 0.93.

- **Automation of Integrated Flood modeling and forecasting System**
  – Automated the flood models and their output (as a decision along with a spatial map of inundation sent to the corresponding district authorities)
- **International Collaboration**
  - **We developed a**n integrated methodology based on Extreme Learning Machine (ELM) technique for developing functional relationships between mechanical factors and soil and fiber parameters.

    Co-Author: Dr. Ankit Garg (Shantou University, China), Published in Journal of Natural Fibers in 2018 (I.F. = 3.5)

Indian Institute of Technology, Guwahati

- Modeling and software development **(Matlab-based GUI)** for the Hillslope hydrology Project funded by the Indian Space Research Organisation
- Employed **Machine learning Algorithms (GPR, ELM, SVR)** to model suspended load and bed load in the Brahmaputra basin

Professional Memberships

- Student Member, American Society of Civil Engineers

REFERENCES

1. **Dr. Ashok Mishra, Professor, Glenn Department of Civil Engineering, Clemson University,** Clemson, SC
2. **Dr. Nigel Kaye**, **Professor, Glenn Department of Civil Engineering, Clemson University,** Clemson, SC
3. **Dr. Jennifer Ogle, Department chair, Professor, Glenn Department of Civil Engineering, Clemson University**, Clemson, SC
4. **P.L.N. Raju, Director, Scientist H, Department of Space, Govt. of India,** Shillong, Meghalaya, India