

Project Title: A data-model fusion approach for flood-inundation forecasting

Project Number IMURA1020

Monash Main Supervisor
(Name, Email Id, Phone) Prof. Jeffrey Walker; Email: jeff.walker@monash.edu *Full name, Email*

Monash Co-supervisor(s)
(Name, Email Id, Phone)

Monash Head of Dept/Centre (Name,Email) Prof. Jeffrey Walker; Email: jeff.walker@monash.edu; *Full name, email*

Monash Department: Civil Engineering

Monash ADGR
(Name,Email) Timothy Scott *Full name, email*

IITB Main Supervisor
(Name, Email Id, Phone) Prof. Basudev Biswal; basudev@iitb.ac.in *Full name, Email*

IITB Co-supervisor(s)
(Name, Email Id, Phone) *Full name, Email*

IITB Head of Dept
(Name, Email, Phone) Prof. Deepankar Choudhury; Email: eldho@civil.iitb.ac.in *Full name, email*

IITB Department: Civil Engineering

Research Clusters:

Research Themes:

Highlight which of the Academy's CLUSTERS this project will address? <i>(Please nominate JUST one. For more information, see www.iitbmonash.org)</i>		Highlight which of the Academy's Theme(s) this project will address? <i>(Feel free to nominate more than one. For more information, see www.iitbmonash.org)</i>	
1	Material Science/Engineering (including Nano, Metallurgy)	1	Artificial Intelligence and Advanced Computational Modelling
2	Energy, Green Chem, Chemistry, Catalysis, Reaction Eng	2	Circular Economy
3	Math, CFD, Modelling, Manufacturing	3	Clean Energy
4	CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control	4	Health Sciences
5	Earth Sciences and Civil Engineering (Geo, Water, Climate)	5	Smart Materials
6	Bio, Stem Cells, Bio Chem, Pharma, Food	6	Sustainable Societies
7	Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng	7	Infrastructure
8	HSS, Design, Management		

The research problem

Define the problem

Floods are among the worst natural disasters, occurring on an annual basis in many parts of the world. An effective flood-disaster management system primarily requires accurate forecasting of flood inundation. Although hydrological science now is equipped with modelling frameworks capable of reliably forecasting flood inundation, a key challenge in front of engineers is to obtain necessary data for a flood forecasting system. Traditional flood-inundation models that solve hydrodynamic equations are not suitable for large-scale applications due to high run-time and data scarcity. Therefore, many attempts have been made in the recent past to develop computationally efficient models that require reasonable amount of input data. These efforts include machine learning algorithm-based alternatives such as the manifold model and conceptual approaches such as the TVD model. New methods have been developed to obtain flood inundation maps, necessary for training models. Nevertheless, many parts of the world still lack an effective flood-warning system due to resource constraint. In this proposed study, we intend to develop a data-model fusion approach for forecasting flood inundation using only easily available satellite-based data and meteorological forecasts.

Project aims

Define the aims of the project

- To set up a state-of-the art flood inundation model for the Mahanadi River basin.
- To use easily available satellite-based data such as SAR and optical images to obtain historical flood inundation maps following state-of-the-art tools such as machine learning algorithms.
- To use historical rainfall data and inundation maps to train the inundation model.
- To make the model ready for the river basin using numerical weather forecasts.

How skills/experience of the IITB and the Monash supervisor(s) support the proposed project

Highlight the purpose of the collaboration and/or the complementary skills/experience that you bring to the project. Do you have any joint or independent publications in the area of the proposed project?

Both Prof. Jeffrey Walker and Prof. Basudev Biswal have worked on subject areas related to flood inundation in the past. While Prof. Walker's research focuses more on utilization of remote sensing data, Prof. Basudev Biswal has experience in developing hydrological models. The collaboration is thus expected to result in the development of a successful flood warning system for the two study basins.

What is expected of the student when at IITB and when at Monash?

Highlight how the project will gain from the students stay at IITB and at Monash

At IIT Bombay, the student will perform literature reviews, set up a flood inundation model, collect observed inundation data for the study basins, and process satellite images to obtain inundation maps. The student will then work towards developing a data-model fusion approach to improve the inundation model. At Monash university the student will spend the last one year to analyse the results, make further improvements of the model, and write research papers.

Expected outcomes

Highlight the expected outcomes of the project

A flood forecasting system for the Mahanadi River basin that can be operated in real time.

How will the project address the Goals of the above Themes?

Describe how the project will address the goals of one or more of the 6 Themes listed above.

The proposed research will address the concerns raised by the IITB-Monash academy (themes 1 and 6) by developing modelling tools that can help forecasting flood inundation in river basins lacking adequate data.

How well the IITB and the Monash supervisor(s) know each other

Provide details of previous collaborations (if any). For new collaborators, have you had a chance to meet each other in person or through VC or Skype?

Multiple emails have been exchanged to communicate the ideas and finalize the topic.

Potential RPCs from IITB and Monash

Provide names of the potential research progress committee members (RPCs) and describe why they are most suited for the proposed project

Prof. Bellie Sivakumar and Prof. Edoardo Daly.

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.

The proposed research project needs a highly motivated PhD student with strong aptitude and quantitative skills. The candidate must have experience in computer programming, and he/she should have a masters' degree in any subject area related to water resources engineering and remote sensing and geoinformatics.

Necessary Courses

Name three tentative courses relevant to the project that the student should complete during his/her coursework at IITB (the student will require to secure 8 point in these courses)

Hydrogeomorphology (CE658). Advanced hydrology (CE654). Mechanics of fluid flow (CE731).

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

Dr. Antara Dasgupta (University of Osnabrück, Germany), Dr. Christoph Rüdiger (Beurau of Meteorology, Australia), and Prof. Subimal Ghosh (IIT Bombay).

Select up to **(4)** keywords from the Academy's approved keyword list (**available at <http://www.iitbmonash.org/becoming-a-research-supervisor/>**) relating to this project to make it easier for the students to apply.

Modelling and simulation (37); Data Science, optimisation, algorithms (6); Water, climate change (Carbon Capture and Sequestration) (9); Maths (8).