

Project Title: **Regionalizing Sustainable Development Goals related to water, food, and energy**

Project Number **IMURA1011**

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IITB Department: Civil Engineering

Research Clusters:

Research Themes:

Highlight which of the Academy's CLUSTERS this project will address? (Please nominate JUST <u>one</u> . For more information, see www.iitbmonash.org)		Highlight which of the Academy's Theme(s) this project will address? (Feel free to nominate more than one. For more information, see www.iitbmonash.org)	
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

Water supply, food production and energy constitute multiple goals within the Sustainable Development Goals. These resources are also mutually connected, with the availability of one directly impacting that of another. Developing regional models to represent these interactions is crucial to understand how different policies may affect the availability of these resources. To date, numerous studies exist that provide modelling frameworks for the water-food-energy nexus. However, limited research highlights how the institutional and governance settings can be incorporated into these models, or how these models may be co-developed by considering the views of diverse stakeholders.

Sustainable management also requires to identify the upper limits of their exploitation from natural sources. While we are aware of the global limits to exploitation for many critical resources, their regional limits considering specific socio-economic and hydro-climatic settings still remains a largely unexplored avenue. Regionalizing the goals implies understanding the hydro-climatic and socio-economic setting of a region and identifying its limits to growth. Here too, the institutional and governance context is crucial to translate how available natural resources might be appropriated.

Through this project we aim to address these two issues by developing methodologies to regionalize sustainable development goals related to water, food, and energy for a typical large river basin in India. A systems model representing the complex nexus of water, food, and energy would then help to identify whether the region may be considered as sustainable or not. In the final stage of the project, likely future trajectories of the basin will be analysed considering probable changes in climate and socio-economic conditions.

Project aims

- 1. Develop methodologies to quantify regional Sustainable Development Goals related to water, food, and energy in a selected river basin of India by considering governance and institutional settings.*
- 2. Develop a detailed systems model to simulate the water-food-energy nexus in the basin considering hydro-climatic and socio-economic setting.*
- 3. Analyse the evolution of the nexus components under changing climatic and socio-economic conditions of the river basin.*
- 4. Suggest potential improvements in policies to facilitate attainment of regionalized Sustainable Development Goals both in the present day and in the future.*

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

At IITB, the student is expected to undergo training in quantitative aspects of the problem, including modelling of the water-food-energy nexus and quantifying probable climate change in a region. The student is expected to identify the study river basin, and relevant data sources. At Monash, the student will learn about the approaches to regionalize Sustainable Development Goals related to water, food, and energy. They will also learn about the methods to incorporate institutional and governance settings while quantifying regional goals.

Expected outcomes

- 1. Scientific advancement in our understanding of how governance and institutional settings affect regional sustainable development goals related to water, food, and energy.*
- 2. A comprehensive systems model to simulate the complex water-food-energy nexus of a large river basin of India.*
- 3. An understanding of potential impacts of climate and population changes on the level of achievement of development goals and policies to enable their attainment.*

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

Water, food, and energy availability affect the attainment of several Sustainable Development Goals. However, it is well known that these resources are inter-connected, often in complex ways. The institutional and governance settings of a region also affect the way in which these resources are connected and managed. This project is designed to provide generalized frameworks to quantify and model the nexus of these resources for a typical region in India. It should help in identifying how policies will affect the Sustainable Development Goals that are affected by the nexus.

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

From IITB

Prof. Janga Reddy M.: He is an expert in water resource management focusing on reservoir operations.

Prof. Arpita Mondal: She is an expert in climate change impact assessments.

From Monash University:

A/Prof. Annette Bos: She is an expert in water governance and stakeholder engagement

A/Prof. Briony Rogers: She is an expert in water governance and transition management.

Capabilities and Degrees Required

The student should have high level programming skills, be strong in numerical analysis, should be willing to learn advanced optimization algorithms, and latest modelling techniques for water-food-energy nexus. Strong communications skills, both oral and written are crucial to the project that would involve stakeholder interaction.

Necessary Courses

CE766: Watershed Management

CE764: Hydroinformatics

CE608: Eco-hydro-climatology

Potential Collaborators

IITB: Prof. Yogendra Shashtri.

Monash University: Dr Cameron Allen

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.

- 6. Data science, optimization and algorithms
- 9. Water, climate change
- 36. Humanities
- 37. Modelling and Simulation