

Project Title: Adaptive planning under deep uncertainty for large scale water infrastructure projects

Project Number IMURA1012

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IITB Department: Civil Engineering

Research Clusters:

Research Themes:

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

The research problem

Rising populations and a transition to more water intensive lifestyles combined with a changing climate pose a daunting management problem for limited water resources. Large scale water infrastructure projects aim to relieve water stress by reducing disparities in water availability in space and time. These projects require tremendous economic investments and can affect regional water availability for decades. Therefore, adequate planning and management of such megaprojects will require a careful balancing of the needs of multiple users while accounting for potentially unpredictable changes in future conditions. Their scale of operations that span several basins or political boundaries also entail complex governance and institutional settings. Scientific advancements to address these issues suggest that piecemeal solutions, either focusing on quantitative aspects of the problem or intuitional issues alone, are likely to lend myopic solutions. Implementing solutions generated from idealized assumptions or policies that fail to appreciate the complex tradeoffs and their evolution under deeply uncertain changes in the future, will be detrimental to project performance. Given the long life-time of these megaprojects, adaptive planning is crucial, but it is not clear how and when to update an operational strategy. This project aims to address these research gaps and bring together the quantitative and governance aspects of adaptive water resource management under deeply uncertain climates and socio-economic conditions.

Project aims

The following are the main aims of this project:

- 1. Develop a systematic approach to long-term planning of large scale water projects under deep uncertainty, by bringing together planners, decision analysts and subject experts to formulate effective strategies.*
- 2. Identify governance and institutional settings that facilitate formulating and solving adaptive approaches to decision making for large scale water infrastructure projects undergoing climatic and socio-economic changes.*
- 3. Develop a simulation-optimization framework using outputs from (1 & 2) above to identify the multi-sector tradeoffs across multiple basins, and their evolution through time, for a typical largescale water infrastructure project in India.*
- 4. Develop methodologies to identify trigger points that warrant updating project's operational management or infrastructure setting.*

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

IITB Supervisor: is an expert in quantitative analysis of the performance of large scale infrastructure projects in India considering climatic uncertainties.

Monash Supervisor: is an expert in long-term policy planning, governance and institutional issues in planning, and regionalization of sustainable development goals.

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

At IITB, the student is expected learn the underlying methodologies related to planning of water projects under a changing climate. They will take courses related to the project goals and formulate the research problem. At Monash, the student will undergo training to understand how institutional and governance settings affect adaptive planning under deep uncertainty in the water sector and how to interpret information from stakeholder interviews.

Expected outcomes

- 1. Scientific advancement of our understanding of the impact of climate change on performance of large scale water projects in India and more broadly*
- 2. Policy briefs for large scale water infrastructure planning for selected megaprojects across India*
- 3. Interactions with planning authorities and stakeholders to co-produce knowledge that is timely and relevant for long-term policy planning of water projects.*

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

The project is directly related to the theme of sustainable water resource management, which are also important for sustainable societies. Sustainable management of water requires social scientists and hydrologists to work together to identify the best way to formulate science problems relevant to ongoing water challenges and communicate research outputs to policy makers and public. The project leverages the complementary expertise in IITB and Monash to address this challenging problem.

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, rainfall-runoff modelling, and data mining techniques. Strong communications skills, both oral and written are crucial to the project that would involve stakeholder interaction.

Necessary Courses

CE766: Watershed Management

CE764: Hydroinformatics

CE658: Hydrogeomorphology

Potential Collaborators

IITB: Prof. Yogendra Shashtri, Prof. Janga Reddy M.

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