IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

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| **Project Title:** | **Extreme rainfall and the role of orography** | |
| **Project Number** | **IMURA0746** | |
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| **IITB Department**: | Civil Engineering | |

## Research Clusters:

**Highlight which of the Academy's CLUSTERS this project will address?**
*(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*

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|---|---|
| 1 | *Material Science/Engineering (including Nano, Metallurgy)* |
| 2 | *Energy, Green Chem, Chemistry, Catalysis, Reaction Eng* |
| 3 | *Math, CFD, Modelling, Manufacturing* |
| 4 | *CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control* |
| 5 | *Earth Sciences and Civil Engineering (Geo, Water, Climate)* |
| 6 | *Bio, Stem Cells, Bio Chem, Pharma, Food* |
| 7 | *Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng* |
| 8 | *HSS, Design, Management* |

## Research Themes:

**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*** | *Advanced computational engineering, simulation and manufacture* |
| 2 | *Infrastructure Engineering* |
| 3 | *Clean Energy* |
| 4 | *Water* |
| 5 | *Nanotechnology* |
| 6 | *Biotechnology and Stem Cell Research* |
| 7 | *Humanities and social sciences* |
| 8 | Design |

## The research problem

*Define the problem*

Under global climate change, extreme rainfall events are likely to become more intense and more frequent because of the greater moisture-holding capacity of a warmer atmosphere. Extreme rainfall events can cause pluvial flooding leading to loss of life and property. This is particularly important for mountainous regions that are marked by chances of flash flooding. It is known that orography can play an important role in modifying rainfall patterns in a region. For example, areas that received the highest amounts of rainfall in India, such as the upwind areas of Western Ghats and the North-Eastern Himalayas, are strategic and unique in terms of their orography.

Orography may also play a role in altering temporal and spatial patterns of extreme rainfall. Circulation and local topography may interact at multiple scales, causing significant changes in extreme rainfall. Such interactions may be further influenced by climate change. Therefore, for better preparedness against extreme rainfall and related disasters, particularly in mountainous regions, it is imperative to understand the association between orography and extreme rainfall, and how such associations may change under global warming.

This project proposes enhancement of such understanding using a suite of observations and regional climate model simulations. Case studies may be taken up pertaining to the North-Eastern region of India and the Snowy Mountains in Australia. A framework will be developed to characterize the structure of the association between orography and extreme rainfall based on analysis of observed data. Statistical analyses will be complemented by numerical simulations using the Weather Research and Forecast (WRF) regional climate model. Finally, the nature of association between orography and extreme rainfall will be investigated under warming environments and flash flood potential would be assessed.

## Project aims

*Define the aims of the project*

The aims of the project are as follows:

i) Characterizing topographically distinct extreme rainfall and changes therein
ii) Understanding multiscale interactions between orography and extreme rainfall
iii) Analysing interactions between orography and extreme rainfall in changing climate, and
iv) Assessing flash flood potential in relation to association between orography and extreme rainfall

## Expected outcomes

*Highlight the expected outcomes of the project*

The proposed study aims at investigating the complex links between orography and extreme rainfall and changes therein. The expected outcome is therefore an enhanced understanding of such links with focus on regions in India and Australia that are unique in terms of their topography. Such an understanding can eventually inform operational forecasts of extreme rainfall and associated flooding. The evaluation of flash flood potential would also aid in disaster risk management. Each of the four broad aims of the proposed research mentioned above are also likely to spawn new methodologies resulting in good quality journal publications.

## 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.*

Extreme rainfall can induce flooding that is all the more important in complex mountainous topography that are marked by occurrences of flash floods. Thus, the project suits the IITB-Monash Research Academy's **Water** theme, with a specific focus on **Flood management and risk analysis** sub-theme.

## 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 candidate should have an exceptional academic background and a strong interest in research. Candidates with BTech/MSc./MTech degrees related to the fields of Atmospheric Science, or Civil Engineering and/or Hydrology, or Environmental Science and/or Engineering, Earth Science, or Applied Mathematical/Physical Sciences are encouraged to apply. A background on hydrometeorological processes, computer programming and basic mathematics including probability and statistics is favourable. Any prior experience of using numerical models (esp. weather simulation or climate models) or processing and analysing hydroclimatic datasets will be considered as advantage.

## 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.*

Prof. Chandra Venkataraman, IDP in Climate Studies, IIT Bombay.
Prof. Subhankar Karmakar, CESE, IIT Bombay.
Prof. Michael Manton, Monash University.

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.

**Water, climate change (Carbon Capture and Sequestration)**
**Modelling and Simulation**
**Computational Fluid Dynamics and Mechanics**
**Computer Simulation**