IITB-Monash Research Academy

An Indian-Australian research partnership

Indian Institute of Technology Bombay | MONASH University

Project Title:	**Monitoring Snow Water Equivalent in the Indian Himalayas**	
Project Number	**IMURA0483**	
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IITB Department:	Centre of Studies in Resources Engineering	

Research Academy 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

The research problem

Define the problem

Snow is a vital resource of fresh-water in high-latitude regions and for many densely populated areas in mid and lower latitudes, coinciding with high altitudes. If the climate continues to warm, reduced snow/ice storage will affect freshwater inflows into the river systems, resulting in serious consequences for human health, regional food security and biodiversity. These will affect the environment as well as the occurrence of floods and droughts, irrigation for agriculture, civilian water supply, groundwater recharge and hydropower industries, as well as soil moisture for spring planting.

Snow parameters (snow water equivalent) data collections by conventional and ground-based methods are cumbersome, both in terms of cost effective considerations

and sporadic occurrences. Even when made available by manual recovery, snow data represent only point measurements which may or may not be representative of a large area or region. Due to the strong spatial and time dependent dynamics of the terrestrial snow parameters, frequent continual observations are necessary. Satellite remote sensing promises great potential in the study of dynamics of snowpack parameters (e.g. SWE) due to its repetitive monitoring capability and synoptic coverage. On an average, at any one time about 70% of the Earth's surface is covered by clouds, and as consequence, optical remote sensing techniques from the space fail. Microwave sensors are ideally suited for day/night monitoring because those are almost weather independent, and microwaves propagate through the atmosphere with little deteriorating effects due to clouds, storms, rain, fog, haze, and with a synoptic coverage.

Although passive microwave remote sensing offers operational SWE products at high temporal resolution, it remains highly difficult to obtain reliable information on the spatial variation of SWE over rugged mountainous terrains such as the Himalayas because of the satellite product's coarse resolution (25 km x 25 km).

The aforesaid limitations can be overcome by using Synthetic Aperture Radar (SAR) active microwave remote sensing systems. The spaceborne SAR provides a high spatial resolution (potentially in the order of 10's of meters), significant snow penetration and multi polarization capabilities, which can be utilized to study the snow parameters. The unique idea of this research is to develop a novel radar remote sensing methodology to monitor snowpack dynamics in Himalayan regions of specific relevance to Northern Indian livelihood. Particularly, the snow extent, snow density, snow depth, snow water equivalent will be investigated in quantitatively improved manners.

Project aims

Define the aims of the project

1. Development of scattering models for snow.
2. Development of new methodology for snow density and snow depth estimation based on SAR data
3. Spatio-temporal analysis of SWE products, in terms of snow melt/accumulation patterns.

Expected outcomes

Highlight the expected outcomes of the project

The key results expected from the project are high resolution maps of spatially detailed observations on the snow , density, depth and the snow water equivalent in the part of Himalayan region. It will be a proof of the potential and contribution of microwave remote sensing to monitor regional variations of terrestrial snow density, depth and SWE. This new information

will fill the gaps in dedicated snow observations in intense snow-covered area. The results will be also disseminated through peer-reviewed publications and Ph.D. theses.

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.

In the Himalayan regions, the total annual precipitation occurs prevalently as snowfall and melting snow represents a major source of fresh water. Therefore, monitoring of SWE is useful for water resource management, weather and climate modeling, hydropower industry, and flood forecasting.

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.

M.Tech. in Remote Sensing/ Geoinformatics with strong background in Physics/Mathematics
Preference will be given to candidate (s) having good programming skill.

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. Christoph Rüdiger, Civil Engineering, Monash (Clayton)

Please provide a few key words relating to this project to make it easier for the students to apply.

Remote Sensing, snow water equivalent (SWE), Himalayas, Microwave remote sensing, Snow cover