ICIMOD

TRAINING ON

Glacier mass balance modelling using R

14–22 December 2020 | Microsoft Teams

Limitations in cryosphere monitoring

Snow, glaciers, and permafrost are key components of catchment hydrology and the climate system in the Hindu Kush Himalayan (HKH) region. Meltwater from glaciers and snow are major water resources for drinking, hydropower generation, and irrigation. However, glacier melt and snowmelt are also a source of disasters such as floods and glacial lake outburst floods, and thawing permafrost can trigger avalanches and landslides. Hence, it is important to assess and monitor cryosphere change processes to reduce disaster risks and improve mitigation.

Understanding the process of cryosphere change requires monitoring and analysis of hydrological, meteorological, and glaciological data. Information on cryosphere changes is gathered using both field-based monitoring activities and satellite imagery, but the data from these sources are not sufficient to better understand the cryosphere change processes in the region. This is mainly because field-based observations are limited and lack spatial representativeness of the cryosphere change processes. Remote-sensing data, despite the higher spatial coverage, also have their own limitations. Clouds have been one of the biggest challenges with optical remote sensing. Although microwave remote sensing considers this issue, its spatial resolution is often low and may not be suitable for small-scale studies. Additionally, remote sensing does not provide information about the future.

Models to simulate cryospheric processes

To fill this gap, scientists and researchers use models to simulate cryospheric processes. Models can be empirical as well as physical, and the choice depends on the application and data availability. Models are used to reconstruct the past and to predict the future. Modelling sometimes requires software and high computational resources, which might be expensive. However, the use of open-source and free software is becoming popular, as they can solve simple to very complex problems. R is one such software package which is often the choice of researchers due to its interactive platform, large user community, and improved visualisation.

The R programming language is free to download and use. It is a well-developed, simple, flexible, and effective programming language that includes conditionals, loop, and user-defined functions. RStudio is a popular, user-friendly interface for R, where the user can simultaneously view graphs, data tables, R code, and output. R will be installed as the underlying engine that powers RStudio's computations.

The training

Glacio-hydrological analysis and glacier mass balance modelling in R is becoming widely used. ICIMOD, through its Cryosphere Initiative, has conducted two workshops on data analysis using R in the past. This training is being organized at the request of our partners. With each new training, we are expanding how we use R. This time, we will explore the potential of R software and packages to set up a distributed glacier surface mass balance model using the glacierSMBM package authored by Alexander R. Groos and Christoph Mayer. This training is aimed at those who have prior experience in using R, although participants familiar with Python, Matlab, or similar coding experience will also benefit.

ICIMOD promotes the use of open-source software, standardized methodology, reproducible research, and regional collaboration. The main objective of this training is to build the capacity of our partners in the eight HKH countries.

Objectives

- Theoretical understanding of different cryosphere components and related processes
- Understanding and analysing spatial data for setting up a glacier surface mass balance model using R
- Running the distributed glacier surface mass balance model in R to better understand glacier changes

Agenda overview

Day 1	Basics of R
Day 2	Data visualization in R
Day 3	Spatial data analysis using R
Day 4	Preparing input forcing for glacier surface mass balance model
Day 5	Running glacier surface mass balance model for clean type glacier using R
Days 6 and 7	Problem solving and individual counselling

Detailed agenda

All speakers/facilitators are from ICIMOD. All timings are in Nepal Standard Time (UTC+05:45).

DAY 1 – Monday, 14 December 2020

R CAN BE USED AS A CALCULATOR AND A STATISTICAL TOOL

Time	Activity	Speaker/facilitator
10:00–10:10	Participants sign into Microsoft Teams meeting	
10:10–10:20	Welcome address	**Eklabya Sharma**, Deputy Director General
10:20–10:30	Introduction to the Regional Programme on River Basins and Cryosphere	**Arun B Shrestha**, River Basins and Cryosphere
10:30–11:00	Introduction of facilitators and participants	**Chimi Seldon**, Knowledge Management and Communication
11:00–11:10	Tea break	
11:10–11:20	Course overview	**Amrit Thapa**, Geospatial Solutions
11:20–12:00	Glacier mass balance research at each partner organization (presentations, 8 min each)	All
12:00–14:00	Extended lunch break	
14:00–14:30	Basics of R: The R platform, variables, data types, and structure (lecture, demo, and hands-on exercise)	**Amrit Thapa**, Geospatial Solutions
14:30–15:00	ICIMOD's Regional Database System and cryosphere data (presentation)	**Kiran Shakya**, Geospatial Solutions
15:00–15:10	Tea break	
15:10–15:50	Importing CSV files, calculating basic statistics, looping in R (demo, hands-on exercise)	**Amrit Thapa**, Geospatial Solutions
15:50–16:00	Summary of the day, Q&A	All

DAY 2 – Tuesday, 15 December 2020

R CAN BE USED AS A VISUALIZATION TOOL

Time	Activity	Speaker/facilitator
10:00–10:30	Reflections from the previous day	All
10:30–11:00	Data visualization in R (demo and hands-on exercise)	**Abhijit Vaidya**, Water and Air
11:00–11:10	Tea break	
11:10–12:00	Data visualization in R using ggplot2 (lecture, demo, and hands-on exercise)	**Abhijit Vaidya**, Water and Air
12:00–14:00	Extended lunch break	
14:00–14:50	Basic spatial analysis in R (lecture, demo, hands-on exercise)	**Amrit Thapa**, Geospatial Solutions
14:50–15:00	Tea break	
15:00–15:50	Glacier dynamics in the HKH region (lecture)	**Jakob Friedrich Steiner**, Water and Air
15:50–16:00	Summary of the day, Q&A	All

DAY 3 – Wednesday, 16 December 2020

R CAN BE USED AS RS AND GIS SOFTWARE

Time	Activity	Speaker/facilitator
10:00–10:30	Reflections from the previous day	All
10:30–11:00	Downloading APHRODITE and ERA5 (Demo)	**Abhijit Vaidya**, Water and Air
11:00–11:10	Tea break	
11:10–12:10	Raster time series analysis in R (APHRODITE and ERA5) (demo, hands-on exercise)	**Amrit Thapa**, Geospatial Solutions
12:10–14:10	Extended break for lunch	
14:10–15:00	Remote sensing of snow and glacier (lecture)	**Sher Muhammad**, Geospatial Solutions
15:00–15:10	Tea break	
15:10–15:50	Glacier mass balance modelling (lecture)	**Miriam Jackson**, Cryosphere
15:50–16:00	Summary of the day, Q&A	All

DAY 4 – Thursday, 17 December 2020

R CAN BE USED AS A MODELLING TOOL

Time	Activity	Speaker/facilitator
10:00–10:30	Reflections from the previous day	All
10:30–11:00	Field-based glacier mass balance measurement (lecture)	**Anushilan Acharya**, Water and Air
11:00–11:10	Tea break	
11:10–11:30	Overview of glacierSMBM package (lecture)	**Amrit Thapa**, Geospatial Solutions
11:30–12:00	Input mask preparation (demo and hands-on exercise)	**Amrit Thapa**, Geospatial Solutions
12:00–14:00	Extended lunch break	
14:00–15:00	Input mask preparation (demo and hands-on exercise)	**Amrit Thapa**, Geospatial Solutions
15:00–15:10	Tea break	
15:10–15:50	Input forcing preparation using ERA5 land (demo and hands-on exercise)	**Abhijit Vaidya**, Water and Air
15:50–16:00	Summary of the day, Q&A	All

DAY 5 – Friday, 18 December 2020

R CAN BE USED FOR GLACIER MASS BALANCE MODELLING

Time	Activity	Speaker/facilitator
10:00–10:30	Reflections from the previous day	All
10:30–11:00	Snowfall estimation using glacierSMBM package (demo and hands-on exercise)	**Amrit Thapa**, Geospatial Solutions
11:00–11:10	Tea break	
11:10–11:35	Snowmelt estimation using glacierSMBM package (demo and hands-on exercise)	**Abhijit Vaidya**, Water and Air
11:35–12:00	Ice melt calculation (demo and hands-on exercise)	**Amrit Thapa**, Geospatial Solutions
12:00–14:00	Extended lunch break	
14:00–15:00	Glacier melt estimation using glacierSMBM package (demo and hands-on exercise)	**Abhijit Vaidya**, Water and Air
15:00–15:10	Tea break	
15:10–15:50	Glacier surface mass balance estimation using glacierSMBM package (demo and hands-on exercise)	**Amrit Thapa**, Geospatial Solutions
15:50–14:00	Summary of the day, Q&A	All

DAY 6 – Monday, 21 December 2020

PRACTICE DAY

Time	Activity	Speaker/facilitator
10:00–10:30	Reflections from the previous day	All
10:30–11:00	Discussion on limitations of glacierSMBM package in R	All
11:00–11:10	Tea break	
11:10–12:00	Spatial analysis (NDSI) (practice)	All
12:00–14:00	Extended lunch break	
14:00–15:00	Individual project	All
15:00–15:10	Tea break	
15:10–16:00	Individual project	All

DAY 7 – Tuesday, 22 December 2020

PRACTICE DAY

Time	Activity	Speaker/facilitator
10:00–10:30	Individual project	All
10:30–11:00	Individual project	All
11:00–11:10	Tea break	
11:10–12:00	Presentation on individual project	Interested participants
12:00–14:00	Extended lunch break	
14:00–14:50	Possible future collaboration (discussion)	All
14:50–15:00	Tea break	
15:00–15:30	HKH CryoHub (lecture and demonstration)	**Chimi Seldon**, Knowledge Management and Communication
15:30–16:00	Closing remarks	**Miriam Jackson**, Cryosphere

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International Centre for Integrated Mountain Development
T +977 1 5275222 | **E** info@icimod.org | **www.icimod.org**