

# Cryosphere Monitoring in the Hindu Kush Himalayan Region

The Hindu Kush Himalayan (HKH) region contains one of the greatest concentrations of glaciers outside the Polar Regions. Ongoing changes in glaciers and snowpack, changes in the frequency and magnitude of extreme weather events, and a shift in monsoon patterns will affect future water availability. Ten major Asian river basins, supplying water to a population of 1.3 billion people, originate in the mountains of the HKH. Improved knowledge and monitoring practices are crucial to understand the changes taking place in the cryosphere and to determine the impacts of climate change on the region's water supply.

Under ICIMOD's Cryosphere Initiative, the Cryosphere Monitoring Programme aims to increase knowledge and understanding of the HKH cryosphere by through studies

of glaciers, snow, and glacier hydrology. It also works to enhance the institutional capacity of partners in the HKH for sustainable cryosphere monitoring. The programme is carried out in collaboration with regional governments and university partners and is supported by the Government of Norway.

Key activities:

- Field-based snow and glacier monitoring
- Field-based hydro-meteorological observations, monitoring, and modelling
- Remote sensing-based observations and monitoring
- Regional Cryosphere Knowledge Hub
- Capacity building of regional partners

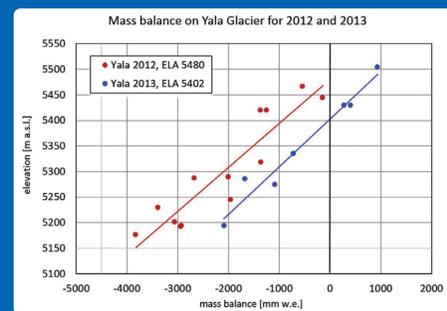


## Monitoring clean glaciers and snow

- Glacier mass balance monitoring
- Snow measurements
- Glacier terminus survey
- Glacier surface elevation profiles (dGPS)
- Geodetic glacier mass balance



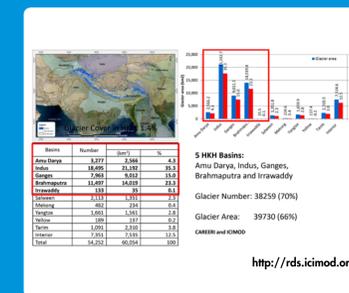
Downloading data from AWS, Rikha Samba Glacier, Nepal



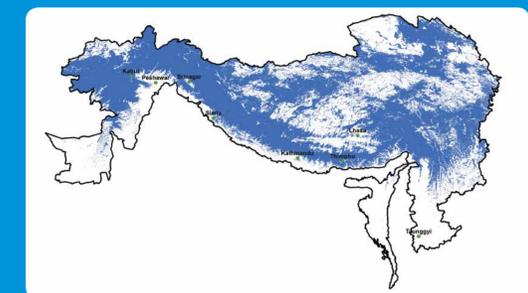
Source: Stumm, D; Joshi, SP (unpublished)

## Remote Sensing

- Mapping and monitoring of glaciers and glacial lakes using Landsat and other high resolution satellite images
- Monitoring snow cover using MODIS imagery
- Using unmanned aerial vehicles (UAV) and high resolution stereopair satellite images to monitor changes in glacier mass
- Conducting detailed investigations of glaciers in representative basins and sub-basins



The status of glaciers in the HKH region based on Landsat TM/ETM images



Snow distribution automatically mapped with MODIS

## Monitoring debris-covered glaciers

- Melt measurements (ablation stakes)
- Debris thickness
- Ground temperature measurements
- Ice cliff measurements
- Lake outlines
- Surface survey with unmanned aerial vehicle (UAV)



Bedrock, clean glacier, and debris-covered glacier



High-resolution monitoring of Himalayan glacier dynamics using unmanned aerial vehicles on the debris-covered Lirung Glacier

## Capacity Building

- Support for a two-year MSc programme in glaciology at Kathmandu University
- Scholarships for MSc and PhD students
- Short-term training courses and study tours
- Short-term personnel exchange and on-the-job training for professionals from the region



Use of steam drilling



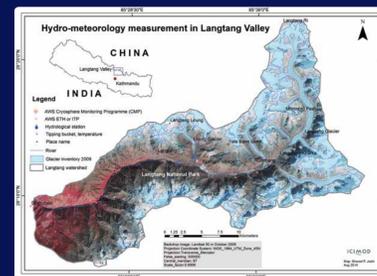
Mountaineering safety training

## Glacio-hydrological monitoring, modelling and water resources scenario analysis

- Measurements and maintenance of a network of automatic weather stations and hydrological stations
- Installation of short-term automatic weather stations on glaciers at 5,300 masl
- Data handling, analysis, storage, and sharing
- Discharge measurements and rating curve development
- Modelling the glacio-hydrological response of the upper Langtang catchment to climate



Discharge measurement at Langtang Khola



## Regional Cryosphere Knowledge Hub

- Hosting a web-based interactive portal for dissemination and visualization of cryosphere data
- Publishing a quarterly e-bulletin on cryosphere activities by ICIMOD and its partners in the HKH region
- Organizing conferences, seminars, and workshops
- Providing a platform for regional knowledge sharing events



www.icimod.org/cryosphere



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