Landslide analysis with radar data in the Indian Himalayas (SCA-Himalayas project)

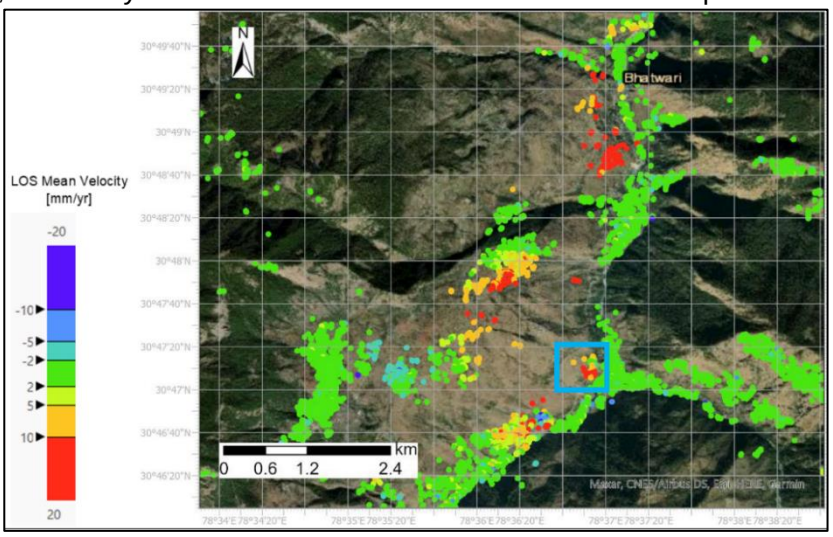
An SDC project addressing climate risks in the mountainous context

Communities in mountain regions depend on nature and its resources. At the same time they are highly exposed to the threats of natural disasters particularly landslides, floods, droughts, which increase with the effects of climate change. The SDC project Strengthening Climate Change Adaptation in the Himalayas (SCA-Himalayas) addresses these challenges by supporting the Indian Himalayan states through technical assistance by Swiss and national experts from universities, private sector and NGOs. The project interventions relate to the management of surface and springs water and management of Disaster Risks of **landslides, flash floods and glacial lake outburst floods.**

Bhagirathi Valley (Uttarakhand state) has over 0.6 mio residents and more than 6.0 million pilgrims and domestic tourists, since it is the source of the holy river Ganges. The 200 km long valley is characterized by a high geographic variability with altitudes ranging from 350 m to 5'000 m - and difficult access. Landslides are a major thereat for the people and infrastructure. Every year, particularly during monsoon season roads are closed, villages cut off and accidents occur due to landslides.

A study with digital technology of SAR data to assess landslides in Bhagirathi

To assess the landslide susceptibility SDC mandated the Swiss-based expert company Sarmap for a remote sensing study using Synthetic Aperture Radar data (SAR-data) from Satellite Sentinel-1, which are free and globally available. Through the method of Interferometry, SAR data from 2015 to 2020, taken in intervals of 12 days, was analyzed to measure surface deformations. With a precision of a few millimeters, the evolution of deformations, areas of (re-) activated landslides were mapped and correlation with external factors, such as the rainy season were identified. The results were presented as deformation-velocity maps (see Fig 1). This study of Bhagirathi valley shows that the lower part is generally stable. Most instable areas are in the middle upper part. For the highest areas the results were limited due to vegetation, snow and slope orientation.



Extract of a deformation-velocity map of Bhagirathi valley

Advantages, limitations and potential of the SAR data analysis

Traditionally, landslide assessments rely on ground-based surveys. In mountainous areas this refers to time intensive, arduous work, exposing field workers to risks, often resulting in a bias towards easily accessible areas. SAR-data offers an interesting digital approach to rapidly assess surface deformation over a large area. However, the study also indicated pockets with limited accuracy due to dense vegetation, steep slopes, hills oriented to the shadow of the satellite's radar signal and the maximum detectable deformation. Slow landslides can be easily detected while fast movements, such as debris-flow or rock falls cannot be analyzed. With the improvement of satellite data - a new generation of Sentinel-1 data and a new Indian Satellite, the SAR technique offer an interesting potential for a rapid, low-cost analysis of instable zones in order to avoid future disasters. The recent event in Joshimath in Uttarakhand /India, where a whole town is affected by land subsidence, is just one of many potential areas of application.

Follow up activities and conclusion
The SAR data analysis provided a useful overview of the landslides in the whole valley of Bhagirathi to identify critical instable areas where an in-depth analysis is required. In the frame of the SCA-Himalayas project the results were further processed for the elaboration of a landslide susceptibility and precipitation based forecast model, which shall finally feed into a landslide early warning system.

Web references
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Eveline Studer
Senior Regional Advisor on Disaster Risk Reduction (DRR) and Rapid Response (RR) in South Asia