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Identification of hidden ancient landslide hazards based on surface morphology enhancement and SBAS-InSAR methods

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Abstract

Remote sensing techniques are widely used for identification of ancient landslides and monitoring their activity. In the present study, we used the Hunza valley basin in Pakistan as the study area, and enhanced the DEM (Digital elevation model) based on RRIM (Red relief image map) to identify the ancient landslides; the SBAS-InSAR (Small baseline subset synthetic aperture radar) technique was also used to monitor the surface deformation rate in the study area from 2004 to 2022; and then the histograms of the radar line-of-sight deformation rate results were used to categorize the deformation rate results. In this research, a total of 157 ancient landslides with activity characteristics were identified. It is found that the RRIM method supplemented with InSAR technology can effectively monitor the ancient landslides and avoid the risk by monitoring the hidden ancient landslides in a long time series.

Data:

Tab.1 Remote sensing image data

Track Number (Ascending/Descending)	Satellite	Time (year, month, day)	Number of images	Polarization mode
27 (Ascending)	Sentinel	2017.02.05-2017.12.26	27	VV
27 (Ascending)	Sentinel	2018.01.07-2018.12.21	29	VV
27 (Ascending)	Sentinel	2019.01.02-2019.12.28	30	VV
27 (Ascending)	Sentinel	2020.01.09-2020.12.22	30	VV
27 (Ascending)	Sentinel	2021.01.03-2021.12.29	31	VV
27 (Ascending)	Sentinel	2022.01.10-2022.12.24	28	VV
456 (Ascending)	ENVISAT	2004.10.01-2009.05.08	27	VV
227 (Ascending)	ENVISAT	2004.11.24-2010.09.29	39	VV

Tab.2 DEM

Data	Source
12.5×12.5m DEM	https://search.asf.alaska.edu/

Data processing:

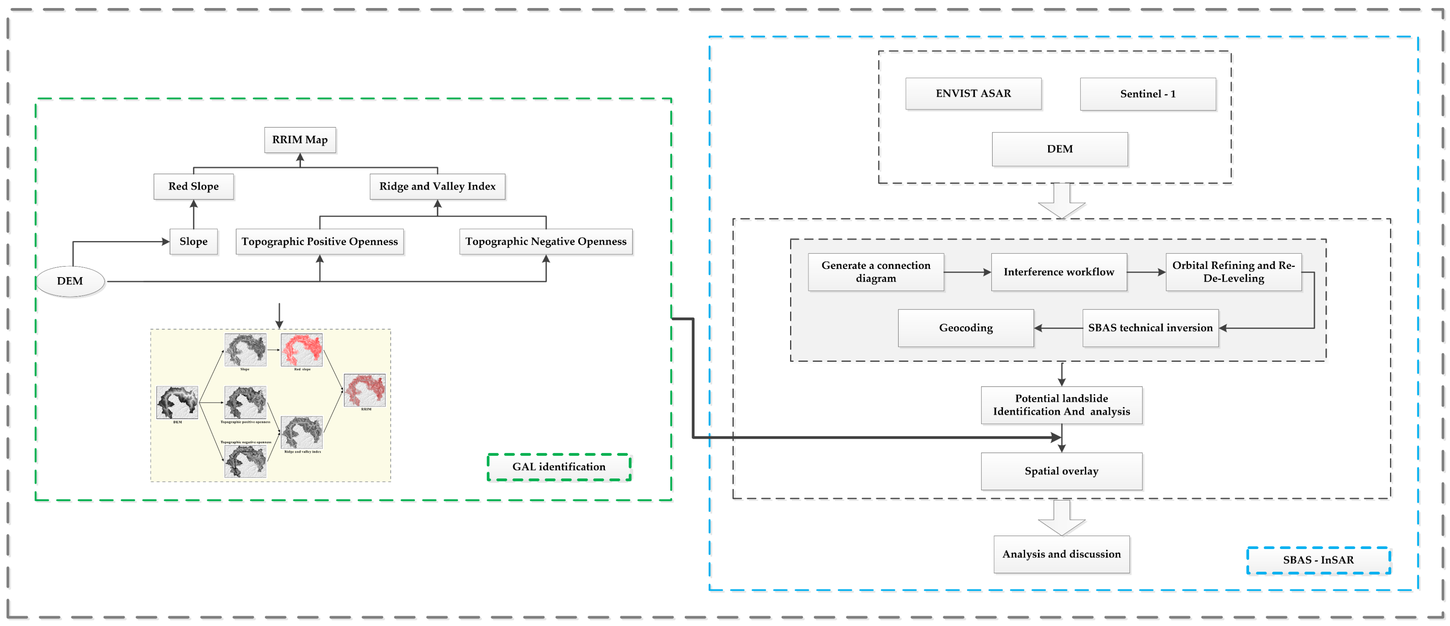

Fig.1 Flow chart

Objective:

- Production of RRIM map;
- Identify ancient landslides;
- 2004-2022 surface deformation rate monitoring;
- Monitor the location of ancient landslides with active features.

Methods:

- RRIM synthesis;
- SBAS-InSAR technology;
- Histogram statistics;
- Spatial overlay

Results:

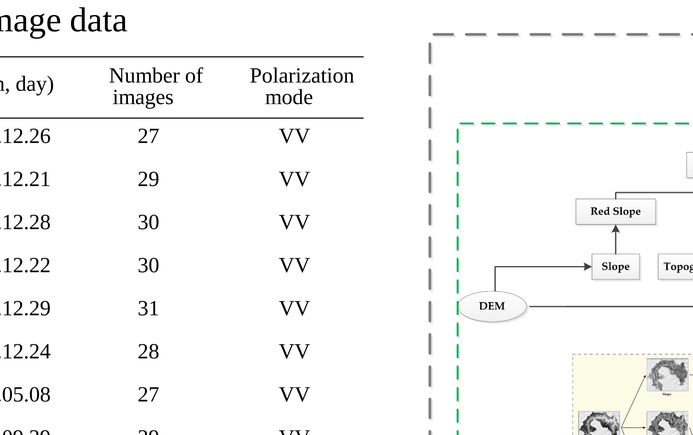

Fig.2 Time series deformation rate map of Hunza River Valley from 2017 to 2022 (LOS)

Fig.3 Histogram Statistics

Fig.4 Deformation rate grading chart

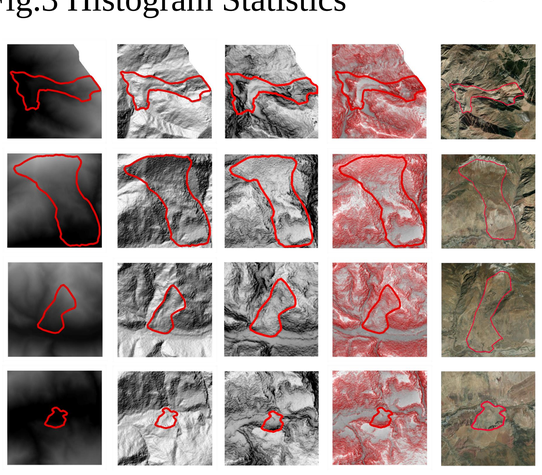

Fig.5 RRIM Synthesis Chart

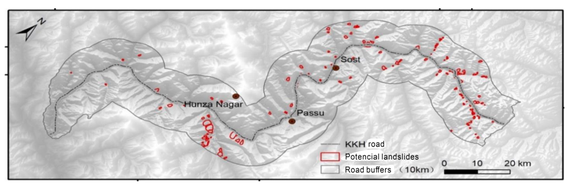

Fig.6 Potential landslides identified

Conclusions:

It was found that the RRIM method supplemented with InSAR technology can effectively monitor paleolandslides and avoid risks by long time series monitoring for hidden paleolandslide potential locations.

Major references:

[1] Berardino P, Fornaro G, Lanari R, et al. A New Algorithm for Surface Deformation Monitoring Based on Small Baseline Differential SAR Interferograms[J]. IEEE Transactions on Geoscience & Remote Sensing, 2002, 40(11): 2375-2383.
[2] Yokoyama, R.; Pike, R.J. Visualizing topography by openness: A new application of image processing to digital elevation models. Photogramm. Eng. Remote Sens. 2002, 68, 257–266.