Precursory and post-failure analysis of landslide deformation in Danba County, China using optical remote sensing and Multi-temporal InSAR (MTI) methods with corner reflectors

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On 17 June 2020, a large debris flow triggered by continuous heavy precipitation hit the Danba County in southwest China, blocked the river and a barrier lake was formed. Meanwhile, on the other side of the river, a large-scale landslide was triggered due to the reactivation of the ancient landslide body. Then an evacuation of more than 20000 people leaving their home town was urgently conducted.

This study exploits multi-sensor remote sensing techniques to assess landslide deformation, precursory deformation and post-failure motion of Danba landslide. We start with optical remote sensing images using the cross correlation method to investigate the overall information about this collapse, such as magnitude and moving direction of the sliding. Two high-resolution remote sensing optical images from Planet are processed right before and after the failure. Moreover, we apply the advanced Multi-temporal InSAR (MTI) techniques such as Persistent Scatterer Interferometry (PSI) and Small Baseline Subsets (SBAS) to analyze the precursors of the landslide over the long term. Based on the results of optical remote sensing, the descending Sentinel-1 data in 2014-2020 are extensively exploited with a better geometry of satellite observation. The long-term and transient of the deformation are analyzed against variations of precipitation, and then the related early warning systems are further explored.

The last stage of the work is the monitoring of current movements in the collapse region after the failure. It is explored by using multiple SAR datasets including C-band Sentinel-1 and X-band TerraSAR-X (TSX) high-resolution SAR images. With the help of the field works by our collaborators, stable artificial corner reflectors (CR) are deployed on selected sites to evaluate their performance in deriving landslide kinematics. Different from the traditional Triangle CR (TCR), the new design of dihedral CR (DCR) are introduced and exploited on the scene. The performance of this new design towards MTI processing and sub-pixel offset-tracking processing is examined and tested in this study. Results are presented and further discussed for a better assessment of Danba landslide.

The results of this paper can provide new strategies for developing an early warning system in this landslide using remote sensing technologies. Besides, the post-failure results are compared with the pre-event analysis, which could give an associated and comprehensive understanding of the whole landslide kinematics.