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Pre-, co- and post-failure analysis of the Aniangzhai landslide on 17 June 2020 with satellite remote sensing and corner reflector InSAR (CR-InSAR)

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A large, deep-seated ancient landslide body was partially reactivated close to the Aniangzhai village in the southwest of China on 17 June 2020. The catastrophic event occurred as a result of a complex cascading event, started by a debris flow triggered by the heavy rainfall in the summer. The debris flows, coming from the northern Meilonggou Gully, created a dammed lake just under the ancient landslide body and blocked the Xiaojinchuan river, leading to an increase in the water level. Thereafter, the overflow of the barrier dam, influenced by the discharge of the surplus water from the nearby hydropower station to reduce the flood pressure, undercut the toe of the landslide, resulting in partial reactivation of this ancient landslide body.

This paper provided a comprehensive analysis of the evolution of this hazard chain using both radar and optical remote sensing techniques.

Firstly, a horizontal displacement map is produced by cross-correlation technique using Planet data to retrieve co-failure motion. Results show that the horizontal displacement peaks at 14.7 m, and most of the large displacement, ranging from 12.5 m to 15.0 m, were found on the lower part of the slide compared to the middle and head parts in the large failure zone.

Next, pre-failure slope stability analysis is performed using a stack of Sentinel-1 SAR data from 2014 to 2020. InSAR time-series results show that the landslide has long been active before the failure. However, the rate of creep on this slow-moving landslide was not constant, rather it changed over time. The 3-year wet period that followed a relative drought year in 2016 resulted in a 14% higher average velocity in 2018-2020, in comparison to the rate observed for 2014-2017. An accelerated creep was observed on the head part of the failure body since spring 2020 before the large failure.

Finally, X-band TerrASAR-X data, C-band Sentinel-1 data, and newly designed artificial corner reflectors are used to investigate the post-failure deformation rate. Corner reflectors are helpful auxiliaries for SAR and InSAR target analysis since they are identified as stable objects during radar acquisitions, especially in vegetated or agricultural landscapes, where the widespread loss of coherence between consecutive image acquisitions could happen. We evaluated the performance

of newly designed miniature artificial cornel reflectors that are constructed for retrieving displacement signals from both ascending and descending TerraSAR-X satellites. The results indicate that the lower part of the ancient landslide body is still creeping. However, the average displacement rate of the active part has decreased since the catastrophic failure, although it is still higher than the rate recorded in the precursory analysis prior to the failure between 2014 and 2020. Given the lack of in-situ monitoring data at Aniangzhai and other large landslides in high mountain areas all over the world, the uses of high resolution remote sensing data offer a unique opportunity to assess the state of landslide activities and their relation with different triggering factors.