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Satellite observations reveal the activity cycle of a giant irrigation-triggered landslide in southern Peru

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Irrigation-triggered landslides have received much attention in recent years as they directly threaten the agricultural production and the lives of local communities. Although the triggering of such landslides has been well documented, their long-term post-triggering dynamics and complete activity history (important for landslide risk assessment) remain poorly understood. In this study, we focus on one of the largest irrigation-triggered landslides in Peru, i.e., the Punillo Sur landslide. Previous studies failed to observe and characterize the full cycle of landslide activity due to their inadequate monitoring capabilities, prompting us to combine satellite interferometric synthetic aperture radar (InSAR) and optical offset measurements to track its full 8.5-year kinematics from 2014 to 2023.

Our key findings include: (1) The landslide experienced three times of very large accelerations (i.e., three activity cycles) respectively in 2016, 2019 and 2022, with accumulated displacements of over 150 m; (2) These large accelerations, accompanied by headscarp retrogression, were all found to initiate from precursory/sudden movements of > 10 cm/yr (observed by InSAR) and were driven by long-term infiltration of irrigation water; (3) The southern portion of the landslide exhibited a greater magnitude of acceleration due to its thinner sliding layer that favors seepage-driven motion; (4) After the three large accelerations, the landslide invariably shifted to deceleration without catastrophic failures, which was found to be controlled by water evacuation and rate-strengthening friction.

These findings will serve as import materials for understanding the cycle of landslide activity and highlighting the prolonged effect of irrigation water on landslide dynamics. This will greatly increase our understanding of the long-term risk of irrigation-triggered landslides. Based on our findings, we also proposed critical disaster prevention/mitigation measures to support local communities in their disaster management efforts.