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Monitoring and prediction of InSAR-derived post-seismic hillslope deformation rates

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Strong earthquakes not only induce co-seismic mass wasting but also exacerbates the shear strength of hillslope materials and cause higher landslide susceptibility in the subsequent years following the earthquake. Previous studies have mainly investigated post-seismic landslide activity mainly by using landslide inventories. However, landslide inventories do not provide information on deformation given by ground shaking and limit our observations to only failed hillslopes. As a consequence, we lack comprehensive, quantitative analysis revealing how hillslopes behave in post- seismic periods. Satellite-based synthetic aperture radar interferometry (InSAR) could fill this gap and provide millimeter-scale measurements of ground surface displacements that can be used to monitor hillslope deformation.

InSAR also provides a rich dataset to put shed light on spatiotemporal patterns of hillslope deformation, which are influenced by a combination of static and dynamic environmental characteristics specific to any landscape of interest. However, these influences are yet to be explored and exploited to train data-driven models and make predictions on the deformation one may expect in space or time.

Here we use the Persistent Scatterer Interferometry technique to monitor pre- and post- seismic hillslope deformations for the area affected by the 2017 Mw 6.9 Nyingchi, China earthquake that occurred on the 2017 18th of November 2017 earthquake. We use Sentinel-1 satellite data acquired between 2016 and 2022 to examine post-seismic hillslope evolution. Using the same dataset, we also explore developing an interpretable multivariate model dedicated to InSAR-derived hillslope deformations

Our results show that the average post-seismic hillslope deformation level in the study area is still higher than its pre-seismic counterpart approximately four and a half years after the earthquake. As for the multivariate model dedicated to InSAR-derived deformation data, the results we obtain are promising for we suitably retrieved the signal of environmental predictors, from which we then estimated the mean line of sight velocities for a number of hillslopes affected by seismic shaking.