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InSAR application for the detection of precursors on the Achoma landslide, Peru

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In the last few decades, InSAR has been used to identify ground deformation related to slope instability and to retrieve time series of landslide displacements. In some cases, retrospective retrieval of time series revealed acceleration patterns precursory to failure. This suggests that, the higher temporal sampling of new generation satellites, may indeed offer the opportunity to detect motion precursory to failure with viable lead time.

However, the possibility to retrieve continuous time series over landslides is often impaired by factors such as unfavourable orientation or landcover and fast movements, which make phase unwrapping difficult if not, in certain cases, impossible.

One way to retrieve precursors of destabilisation for landslides that present characteristics unfavourable to unwrapping and to time series inversion is to analyse in detail changes in successive interferograms in the phase domain in combination with interferometric coherence.

We generated and analysed 102 Sentinel-1 interferograms, covering the period between April 2015 and February 2021, at high spatial resolution (8 and 2 looks in range and azimuth respectively) over the Achoma landslide in the Colca valley, Peru. This large, deep-seated landslide, covering an area of about 40 hectares, previously unidentified, failed on 18th June 2020, damming the Rio Colca and giving origin to a lake.

We developed a method to analyse the changes through time of the unwrapped phase difference between a stable point and points within the landslide. In combination with this, we investigated patterns of coherence loss both within the landslide and in the surrounding area.

We observed that, in the weeks prior to the landslide, there was an increase of the phase difference between a stable reference and points within the landslide, indicating an acceleration of the downslope displacements. In addition to that, seasonal coherence loss is seen both within the landslide and in the surrounding area, in correspondence with wet periods. However, we observed also significant, local coherence loss outlining the scarp and the southeastern flank of the landslide, intermittently in the years before failure, in periods in which coherence was overall higher. Moreover, we observe a sharp decrease in the ratio between the coherence within the landslide and in the surrounding area, roughly six months before the failure.

This type of approach is promising with respect to the extraction of relevant information from interferometric data when the generation of accurate and continuous time series of displacements is hindered by the nature of landcover or of the landslide studied, such in the case of the Achoma landslide. The combination of key, relevant parameters and their changes through time obtained with this methodology may prove necessary for the identification of precursors over a wider range of landslides than with time series generation alone.