EGU21-14447
https://doi.org/10.5194/egusphere-egu21-14447
EGU General Assembly 2021

A new methodology to detect changes in displacement rates of slow-moving landslides using InSAR time series

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Regional-scale landslide deformation can be measured using satellite-based synthetic aperture radar interferometry (InSAR). Our study focuses on the quantification of displacements of slow-moving landslides that impact a hydropower dam and reservoir in the tropical Ecuadorian Andes. We constructed ground surface deformation time series using data from the Copernicus Sentinel-1 A/B satellites between 2016 and 2020. We developed a new approach to automatically detect the onset of accelerations and/or decelerations within each active landslide. Our approach approximates the movement of a pixel as a piecewise linear function. Multiple linear segments are fitted to the cumulative deformation time series of each pixel. Each linear segment represents a constant movement. The point where one linear segment is connected to another linear segment represents the time when the pixel's rate of movement has changed from one value to another value and is referred to as a breakpoint. As such, the breakpoints represent moments of acceleration or deceleration. Three criteria are used to determine the number of breakpoints: the timing and uncertainty of the breakpoints, the confidence intervals of the fitted segments' slopes, and the Akaike Information Criterion (AIC). The suitable number of breakpoints for each pixel (i.e., the number of accelerations or decelerations) is determined by finding the largest number of breakpoints that complies with the three listed criteria. The application of this approach to landslides results in a wealth of information on the surface displacement of a slope and an objective way to identify changes in displacement rates. The displacement rates, their spatial variation, and the timing of acceleration and deceleration can further be used to study the physical behavior of a slow-moving slope or for (regional) hazard assessment linking the onset of change in displacement rate to causal and triggering factors.