EGU22-11186
https://doi.org/10.5194/egusphere-egu22-11186
EGU General Assembly 2022

Values and challenges of DInSAR derived velocity estimates for landslide hazard assessment and mapping

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Deep-seated slope instabilities pose a significant hazard to infrastructure and livelihoods in mountain regions all around the world. Increasingly accesible data from synthetic aperture radar (SAR) satellites, such as ESA' Copernicus Sentinel-1 mission, offer easier access to displacement data that can be used to detect, delineate, and monitor landslides in mountainous terrain. However, displacement measurements retrieved from differential interferometric processing (DInSAR) can be biased by the terrain geometry, which can lead to an underestimation of the true displacement. In addition, the quality of DInSAR results is highly susceptible to changes of surface geometry and moisture conditions, for example due to snow melt, hillslope erosion, or vegetation changes. Furthermore, the relative nature of DInSAR measurements can lead to underestimation of displacements due to phase aliasing. These factors may severely impact the accuracy of landslide velocities quantification. However, landslide velocities are often directly used in hazard assessment.

In Switzerland, mean and maximum landslide velocities are key factors used to assess the hazard intensity of unstable slopes, and thus to determine the slope hazard potential and consequently hazard zonation. The latter has direct implications for land use and land-use planning. In this study, we use two exemplary large deep-seated instabilities at Brienzauls (canton of Grisons) and Spitzer Stein (canton of Bern), both in Switzerland, to showcase the challenges of relying on DInSAR derived velocities for hazard mapping. We attempt to disentangle effects of terrain and orbit geometry on the measurable velocities from those caused by transient changes to surface geometry and conditions, and explore ways by which the value of DInSAR-derived displacement measurements can nevertheless be maximized for hazard zonation mapping.