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Integration of satellite SAR and optical acquisitions for the characterization of the Lake Sarez landslides in Tajikistan

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Around 1300 lakes make up Tajikistan, which is situated where the Euro-Asian and Indian tectonic plates intersect, and the majority of these were formed by rockfalls and collapsing moraine deposits. Moreover, the area is susceptible to powerful earthquakes due to its localisation. In 1911 a big earthquake in the area generated the Usoi dam, which consequently led to the creation of Lake Sarez, in the Easter side of the country. The region is dominated by high snow-covered mountains, and this complicated topography makes difficult to reach and work in it. So, due to this inaccessibility remote sensing plays an important role in risk assessment and monitoring of the region. The purpose of this work is to provide a detailed overview of ground deformation of the area of Lake Sarez using both the Interferometric Synthetic Aperture Radar (InSAR) technique and optical analysis, with a specific focus on both the right bank and left bank side landslides that affect and threaten the lake.

To study and analyse the two landslides, an integrated satellite analysis has been applied with the aim to collect as much information as possible about the slope instability phenomena of the area of interest. In particular, remote sensing practices such as InSAR using the Sentinel-1, processed through the SqueeSAR approach, and an optical image correlation using COSI-Corr technique applied to SPOT-6 and SPOT-7 acquisitions have been used. In this way, a synoptic and complete analysis of the ongoing displacements was retrieved, allowing to reconstruct the temporal evolution and to solve the spatial variability of the deformation affecting the Lake Sarez banks.

The InSAR data cover the period between 2016 and 2020, and the optical images have been chosen between 2015 and 2021. The two methods emphasize movement and displacement in both right-bank and left-bank landslide, and they concur on the definition of the broader kinematic picture of landslides that doesn't seem to have significant acceleration during the monitored period. The optical method shows the movement especially in the left-side bank landslide. In addition, since the volume of the right-bank landslide is still widely debated (estimated volume around $1.4 \cdot 10^9$ m^3 and area 5.34km^2), InSAR data have been also used to develop a model of the geometry and the depth of the sliding surface of a potential landslide that could occur and cause a huge wave that could top over the dam and create a destructive flood downstream. Data shows that most of the movement is located in the central part of the body.

The multi-perspective analysis performed has provided interesting results on the displacement and movement of the two landslides and it may represent a solid base and a starting point for modelling the mechanism of the landslides and also for the evaluation, reduction and mitigation of geohazard risks, especially in impervious areas.