Multi-temporal monitoring of slow-moving landslides in South Pindus mountain range, Greece

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Introduction

Mountain areas cover about 64% of the Greek territory. The area of interest is located at Central and Western Greece, where Pindus mountain chain or the ‘backbone’ of Greece’s mainland, lies. An existing well-establish ground truth dataset reveals the numerous landslides events that the area has experienced, due to its particular morphology, geological framework and predominant aquifer features. It is now attempted to enrich our awareness by monitoring slow moving landslides (according to velocity scale proposed by IGUS-WGL, 1995) exploiting the high temporal sampling rate of historical ERS-1/2 and ENVISAT SAR imagery. Average velocities rates and time-series displacements generated by Multi Temporal Interferometry (MTI) technique gave a thorough insight into landslide identification, new detections, activity and boundaries evaluation resulting to an updated landslide inventory for the studied area. Critical areas prone to slide are evaluated through susceptibility assessment and mapping taking into consideration the challenging environmental factors which dominate at the area of interest. Complementary to landslides monitoring, MTI technique reveals tectonic movements of active fault zones and structural deformations of dam infrastructures at the area of interest, findings that draw our attention.

Input data and methodology

- Pre-existing landslide field observations, generated by IGME - GRI (Greek Geological Survey)
- 23 ASAR ERS 1/2 descending mode
- 23 ASAR ENVISAT acquiring mode
- 5W STARS (Hooper et al., 2020)
- PSI challenging due to mountainous terrain and vegetated areas
- Thematic maps of conditioning factors controlling the occurrence of landslides

Results on landslides

- Mean temporal velocities (from the descending track 80 covering the periods 1994-2000 (up) and 2003-2010 (down))
- Confirmation of existing landslides
- New detections
- Image interpretation as a tool for updating landslide boundaries (Fig.1)
- Guidance PSI velocities

Landslide susceptibility statistical assessment

- Identification of the most probable initiation areas by attributing weight values based on landslide densities for each parameter class (Corominas et al., 2013)
- Success rate and prediction rate of the statistical model

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Complementary MTI results

- Trichonis Lake
- Subsidence detection along the entire processing time frame due to physical and anthropogenic processes at the Western shore
- ENVISAT results highlight profound subsidence at the South-Eastern side of the lake, measurements that can be linked with the tectonic structure of the Eastern shore of Trichonis Lake activated in 2007
- Ampholithia fault zone
- Opposite displacement rate signs for both ERS1/2 and ENVISAT intended in the detection of left lateral slide slip fault system of Ampholithia fault zones
- Settlements detection on Kremasta and Kastraki Achelous River earth dams

Conclusions and future work

- Confirmation of monitoring of slow-moving landslides
- Confirmation of past recorded landslides
- Detection of new landslides
- Updated landslide inventory
- Landslide susceptibility statistical assessment with greater weighted factors attributed to regional geological slope inclination, Western aspect, high-altitude and convex curvature
- Long-term subsidence detection -5-5mm/y at the Western shore of Trichonis Lake mainly due to water pumping
- Rapid subsidence: 1995 to between 2004 and 2008, at Trichonis Eastern shore attributed to 2007 earthquake swarms
- Detection of differential tectonic slow-moving deformation of Ampholithia fault zone
- Detection of settlements at crown and downstream face of the Kastraki earth dam
- Further field investigations will validate MTI results and they will reinforce the inventory with contemporary ground truth data
- Implementation of a physically based model at regional scale will permit the correlation of MTI results with a geotechnical slope stability safety factor approach
- At crucial landslide sites, site specific analysis will employ a sophisticated finite elements model to simulate slope stability linked with precipitation and dynamic loading

References