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

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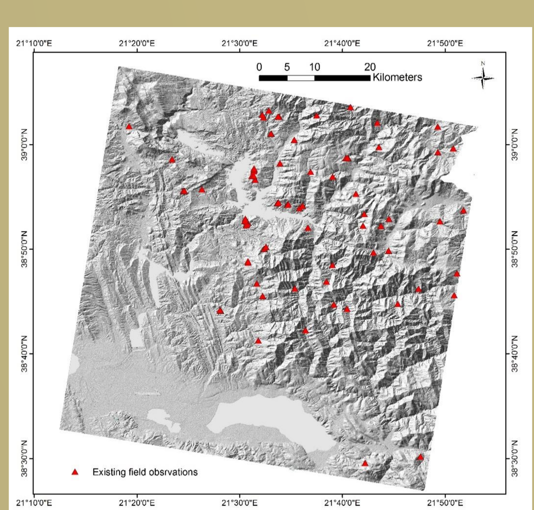
Introduction

Mountain areas cover about 64% of the Greek territory. The area of interest is located at Central and Western Greece, where Pindus mountain range, the 'backbone' of Greece's mainland, lies

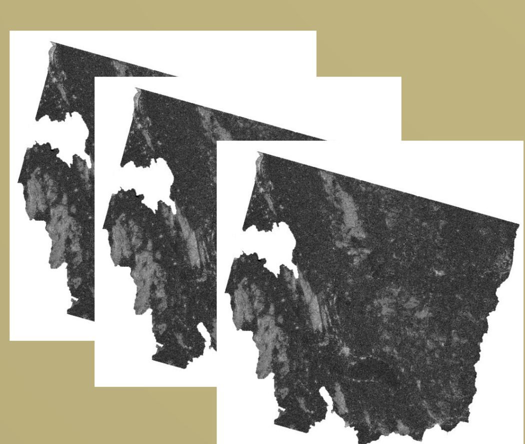
An existing well-establish ground truth dataset reveals the numerous landslides events that the area has experienced, due to its particular morphology, geological framework and predominant aquifer features. It is now attempted to enrich our awareness by monitoring slow moving landslides (according to 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

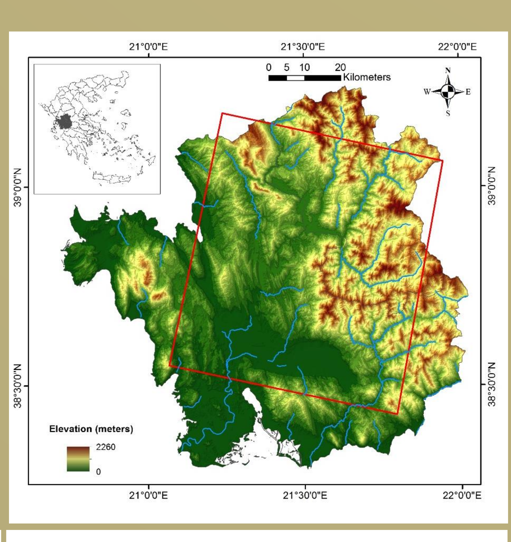
- ✓ Pre-existing landslide field observations, generated by IGME-GR (Greek Geological Survey)

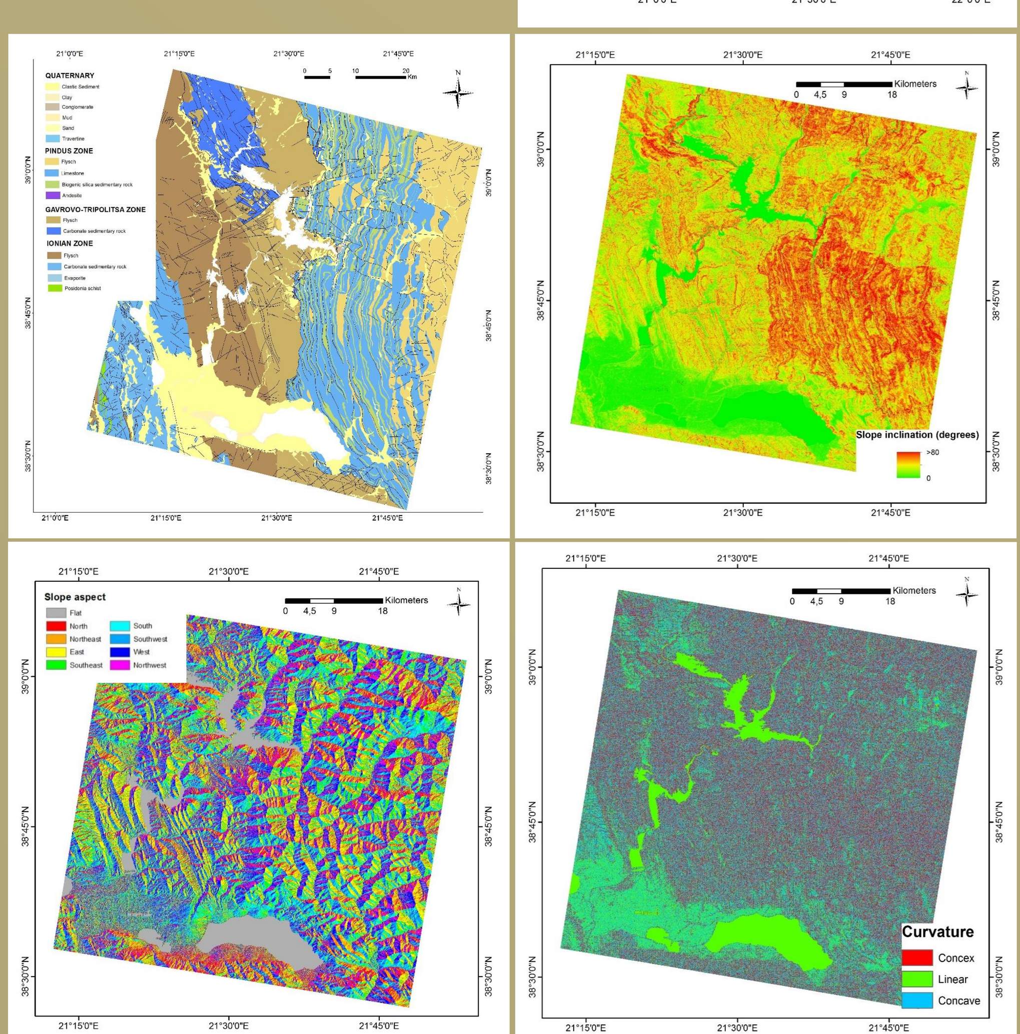


- ✓ 53 ASAR ERS 1/2 descending mode
- ✓ 23 ASAR ENVISAT descending mode
- ✓ S/W StaMPS (Hooper at al., JGR, 2007)
- ✓ PSI challenging due to mountainous terrain and vegetated areas

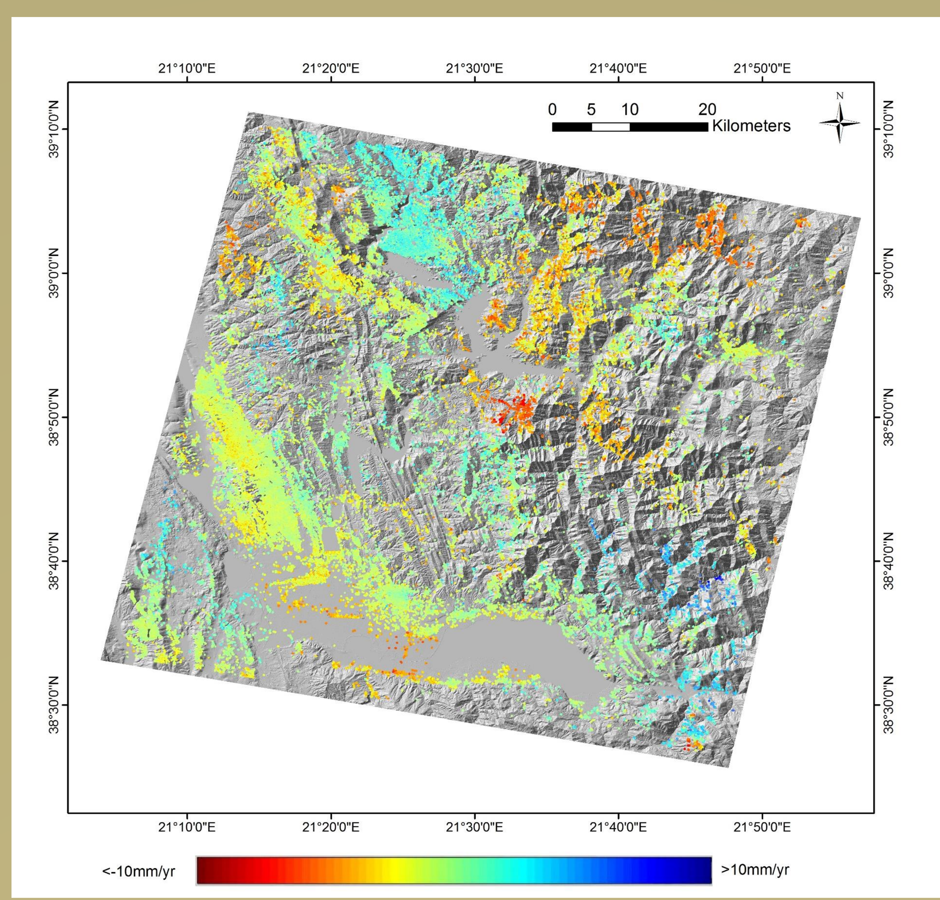


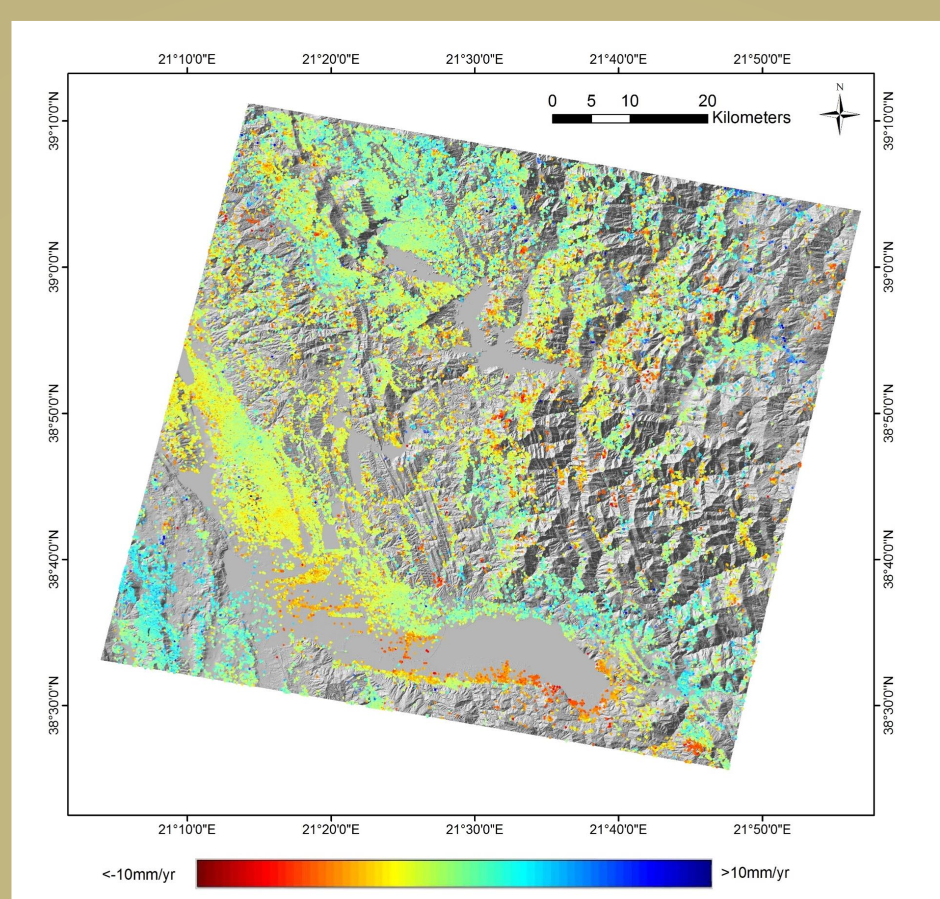
- ✓ Thematic maps of conditioning factors controlling the occurrence of landslides





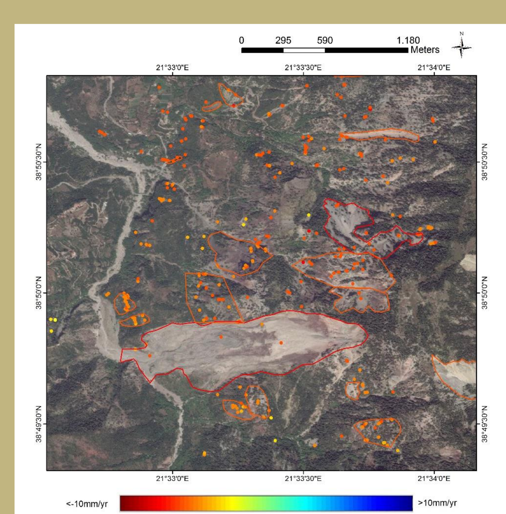
Results on landslides



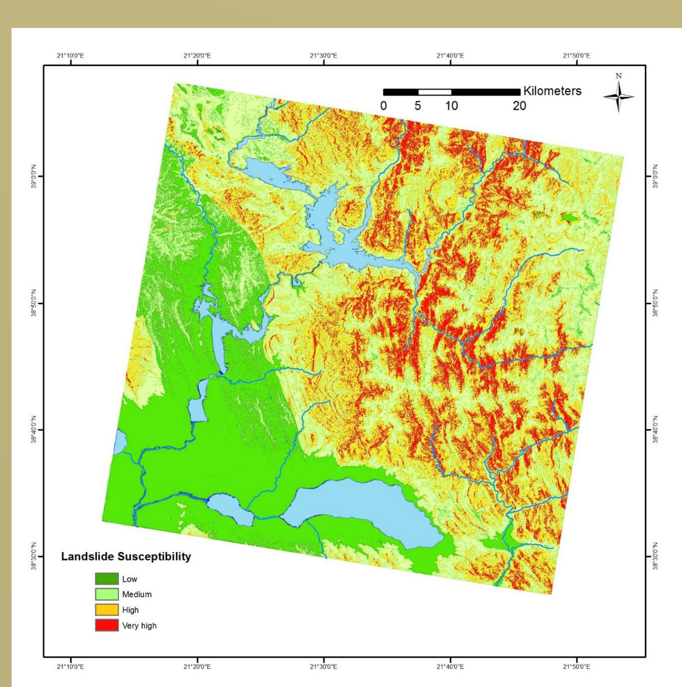


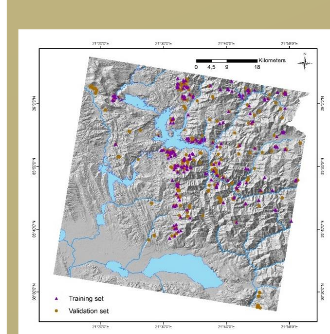
Mean temporal velocities from the descending track 50 covering the periods 1992-2000 (up) and 2003-2010 (down)

- ✓ Confirmation of existing landslides
- ✓ New detections
- ✓ Image interpretation as a tool for updating landslide boundaries using as a guidance PSI velocities

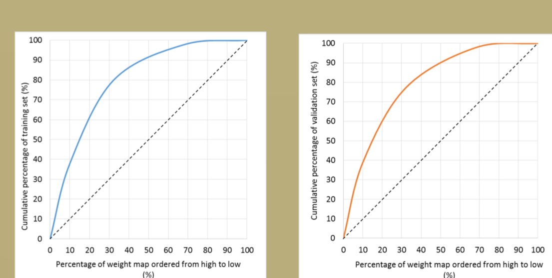


Landslide susceptibility statistical assessment





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

Acknowledgments

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http://www.beyond-eocenter.eu/
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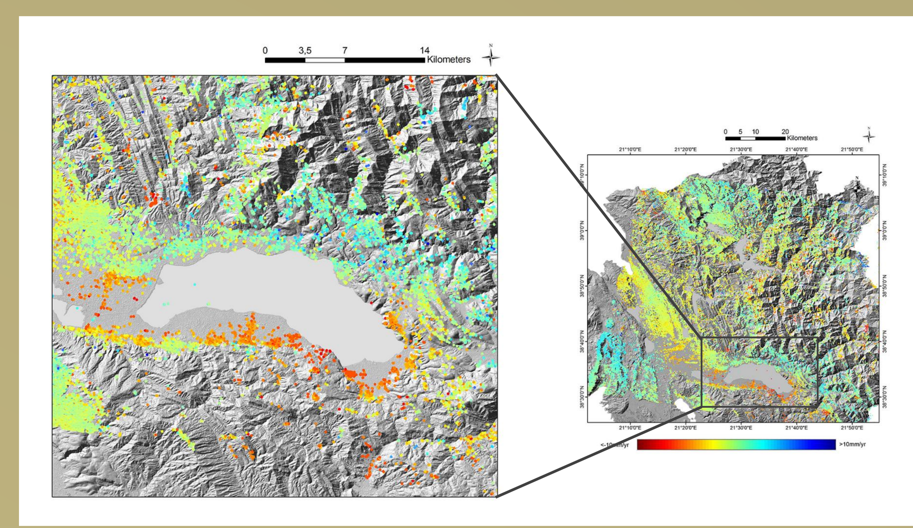
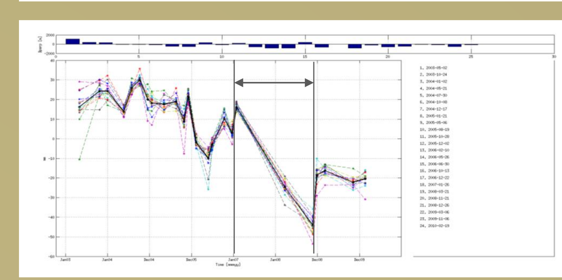
Complementary MTI results

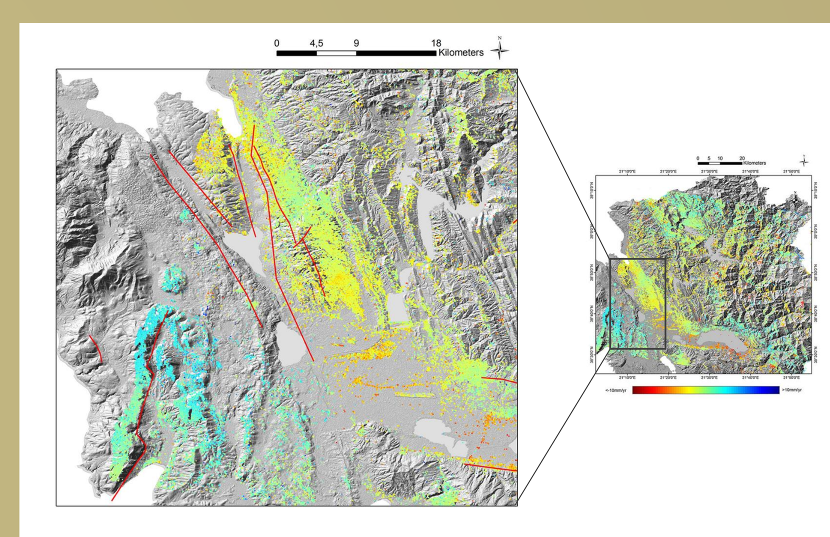
- **Trichonis Lake**





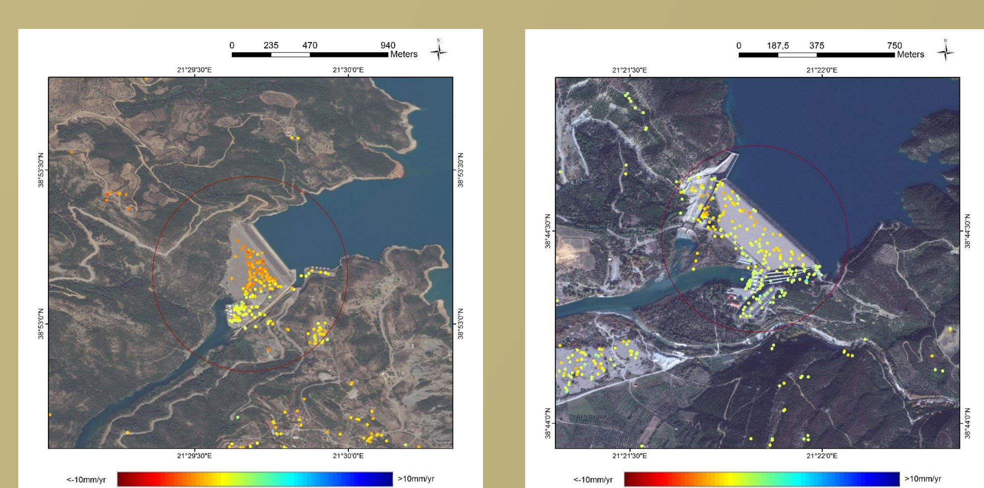
- ✓ Subsidence detection along the entire processing time frame due to physical and anthropogenic processes at the Western shore
- ✓ ENVISAT results highlight profound subsidence at the South-Eastern side of the lake, measurements that can be linked with the tectonic structure at the Eastern shore of Trichonis Lake activated in 2007

- **Amphilochia fault zone**



- ✓ Opposite displacement rate signs for both ERS1/2 and ENVISAT sets are attributed to the discontinuity of left lateral strike slip fault system of Amphilochia-Katouna

- **Settlements detection on Kremasta and Kastraki Achelous River Earth dams**



Conclusions and future work

- ✓ Continuous monitoring of slow moving landslides
- ✓ Confirmation of past recorded landslides
- ✓ Detection of new landslides
- ✓ Updated landslide inventory
- ✓ Landslide susceptibility statistical assessment with greater weighed factors attributed to regional geology, slope inclination, Western aspect, high altitudes and convex curvature
- ✓ Long-term subsidence detection -5.5mm/yr at the Western shore of Trichonis Lake mainly due to water pumping
- ✓ Rapid subsidence, 3cm in between 2007-2008, at Trichonis Eastern shore attributed to 2007 earthquake swarm
- ✓ Detection of differential tectonic slow-moving deformation at Amphilochia fault zone
- ✓ Detection of settlements at crown and downstream face of Kremasta and Kastraki earth dams
- ✓ 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 factor of safety approach
- ✓ At crucial landslide spots, site specific analysis will employ a sophisticated finite elements model to simulate slope stability linked with precipitation and dynamic loading

References

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