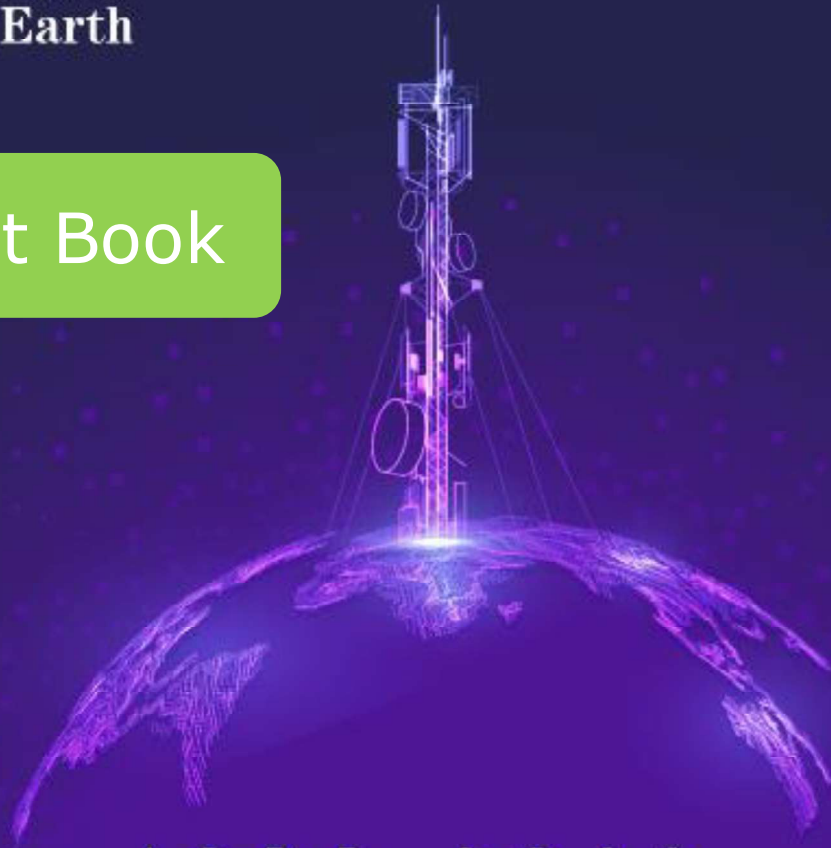




Abstract Book



I S D E 2 0 2 3

13th International Symposium
on Digital Earth

11-14 JULY 2023
ATHENS GREECE
Harokopio University



European Ground Motion Service for built heritage: a case study from Cyprus

Agapiou A¹, Lysandrou V¹, Kyriakidis P¹, Hadjipetrou S¹, Kyriakides N¹, Votsis R¹

¹Cyprus University Of Technology, Limassol, Cyprus

The recently launched European Ground Motion Service (EGMS) [1] provides consistent and reliable information about ground motion, with millimetre accuracy over large areas. It is based on the multi-temporal interferometric analysis of the European Copernicus Sentinel-1 radar sensors and its products are calibrated with a dense European Global Navigation Satellite System (GNSS) network.

EGMS could be of great importance in monitoring cultural heritage sites as an early warning system for local and national authorities responsible for heritage management and protection. Moreover, EGMS data are particularly useful for less accessible areas, which are more difficult to monitor with other means.

This study investigates the EGMS ground motion data over Paphos district in western Cyprus. Paphos district covers almost 1,400 square kilometres that constitutes the 15.1% of the total area of the island. This area is home of 147 ancient monuments and archaeological sites protected by the Antiquities law of the Republic of Cyprus. Few of them are also inscribed in the UNESCO World Heritage List, such as Paphos site, including the Ancient Nea Paphos and the Tombs of the Kings [2-4].

Average ground movement values for Paphos district were downloaded as ortho-product from the EGMS and were further processed into the ArcGIS-Pro environment. The ortho-product is provided as two separate data layers containing vertical (Up) and east-west (East) displacements. The east-west displacement values range between +21.3 to -39.9 mm and the vertical ones range between +11.8 to -21.0 mm.

In addition, time-series of vertical and east-west displacement values at each pixel are also available every 6 days (satellites' revisit frequency) from 2016 onwards. This information can be useful for the identification of trends and patterns in a spatio-temporal context. Site-specific statistical analysis could also include the computation of correlation lengths, crossings, and the magnitude of change between consecutive times focusing on key time periods (e.g., close to identified earthquake events).

Further statistical analysis was carried out, by creating different buffer zones around the monuments. An average displacement of -7.146 mm/year east-west and -1.375 mm/year vertical was estimated. In addition, specific archaeological sites within the Paphos district, have been further studied using EGMS data, to estimate annual ground motion displacements. For example, time series interferometric results for the 'Tombs of the Kings' necropolis, indicate a mean velocity of -1.20 mm/year.

In addition, numerical models of selected monuments using finite element modeling will be constructed to simulate the damage potential on the monuments from these vertical and horizontal displacements. The recorded displacements at the locations of the selected monuments will be applied at the supports of the numerical model to compute the resulting stresses on the monuments walls accounting thus for soil structure interaction and mapping damage patterns on the monument. This will provide information on the damage inflicted on the monument by ground movement and differentiate it from damage on the monument from previous seismic events.

This study is part of the multidisciplinary ENGINEER project, which brings together geoinformatics and structural engineering intended for ancient monuments and sites.

References

- [1] European Ground Motion (EGM), <https://land.copernicus.eu/pan-european/european-ground-motion-service> (29/01/2023)
- [2] Agapiou A., Lysandrou V., Themistocleous K., Hadjimitsis D.G., 2016, Risk assessment of Cultural Heritage Sites Clusters Using Satellite Imagery and GIS: the case study of Paphos District, Cyprus, "Applications of Geoinformatics for the Prevention and Mitigation of Natural Hazards", *Natural Hazards*, 83(1), 5-20, DOI:10.1007/s11069-016-2211-6
- [3] Agapiou A., Lysandrou V., Alexakis D. D., Themistocleous K., Cuca B., Sarris A., Argyrou N., Hadjimitsis D. G, 2015, Cultural heritage management and monitoring using remote sensing data and GIS: the case study of Paphos area, Cyprus, *CEUS Computers Environment and Urban Systems*, 54, 230-239, <http://dx.doi.org/10.1016/j.compenvurbsys.2015.09.003>
- [4] Kyriakides N., Lysandrou V., Agapiou A., Illampas R. and Charalambous E. 2017 Correlating damage condition with historical seismic activity in underground sepulchral monuments of Cyprus, *Journal of Archaeological Science: Reports* 14: 734-741. DOI:<https://doi.org/10.1016/j.jasrep.2016.07.007>

Acknowledgments: This project has received funding from the European Union's Horizon Europe Framework Programme (HORIZON-WIDERA-2021-ACCESS-03, Twinning Call) under the grant agreement No 101079377 and the UKRI under project number 10050486. Disclaimer: Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union or the UKRI. Neither the European Union nor the UKRI can be held responsible for them.