Contribution ID: **170** Type: **Talk**

Integrated Analysis Approach for Territorial Data at the Einstein Telescope Site in Sardinia (Italy)

The Sardinian site, identified for the underground Einstein Telescope (ET) gravitational wave observatory, features a complex morphology with distinctive geological characteristics typical of stable crystalline basements. The area is also marked by deeply incised valleys, underscoring the need for a detailed and comprehensive understanding of the territory to support site assessment and risk mitigation planning. These characteristics not only enhance the suitability of the site for an underground installation but also introduce challenges to investigate its geological structure at depth to better manage the interactions between the surface processes and subsurface structures.

To address these challenges, a detailed three-dimensional terrain model is being developed, which is integrated with a robust geological interpretation of morphological lineaments and a surface deformation analysis derived from satellite radar interferometry (InSAR). By combining high-resolution Digital Terrain Models, updated surveys, Synthetic Aperture Radar (SAR) imagery, and extensive geological information, we have established a comprehensive cartographic and territorial database within the ETIC project framework. This integrated dataset forms the foundation for evaluating territorial risks and supports the extraction of morphometric maps that identify tectonic structures, landslide-prone slopes and hydrographic networks, ultimately analysing the distribution of meteo-climatic parameters and improving the assessment of real hazard conditions in comparison with historical data.

This dataset, integrated in the 3G4ET Geographic Information Systems (GIS) web-based platform, can be implemented with alternative Building Information Modelling (BIM) of the underground facilities and advanced geological modelling, representing a valuable tool for investigating different geolocation scenario and an essential input for seismic noise analysis. The platform is designed to be continuously refined and enriched with site-specific imagery and data emerging from ongoing studies and future survey campaigns, ensuring that the model remains adaptive and up to date.

This comprehensive approach, which merges multidisciplinary data sources and advanced modelling techniques, lays a robust foundation for assessing both the feasibility and the risks associated with the Einstein Telescope underground site in Sardinia. Furthermore, it offers a scalable framework for territorial risk analysis that can be replicated in similar geotechnical and infrastructural projects, promising significant impact on future developments in the field.

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Session Classification: Parallel sessions

Track Classification: Site Preparation & Characterization (SPB): SPB/SCB