MULTISTAGE EVOLUTION OF COASTAL SLOPES AS A PROXY FOR THE CLIMATIC INFLUENCE ON LANDSLIDES

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Purpose: Landslide processes are strongly influenced by climatic factors at different temporal and spatial scales. Although climatic and associated hydrogeological factors are unequivocally some of the most important drivers of mass movements, mechanisms by which climate changes affect landslides are far from being well-framed. This study focuses on landslides affecting coastal areas, since they are expected to record the most effective influence of sea-level oscillations due to climatic changes. Starting from the literature case-study of the Vasto landslide (Central Italy), on which sea-level rise effects were outlined, this research focuses on the similar case-study of Petacciato landslide, a huge roto-translational earth slide that involves a coastal sector over 2000 m along the coast. The landslide significantly damaged infrastructures as road, railway and buldings. To weigh the contributions of different predisposing and preparatory climate-dependent factors on the landslide evolution, a multi-modeling approach is here introduced, integrating engineering geology and morpho-evolutionary approaches.

Methods: The landslide geological and geomorphological setting was derived by the interpretation of field surveys, borehole stratigraphies and geospatial analyses carried out in GIS environment. Once the engineering-geological model was refined, a new approach based on a cascade of stress-strain and Landscape Evolution Modeling (LEM) will be implemented to better frame the landscape carving effects under a changing base level. Such a model provides the slope geometries representing the main stages of a morpho-evolutionary sequence, transferrable into stress-strain numerical models. The modeling approach is based on a sequential coupling of LEM and of Finite Element Methods (FEM) and/or Finite Difference Methods (FDM), which can differ one from each other in terms of spatial and temporal resolution.

Results: Some of the recognized landforms show spatial continuity across the area. Specifically, a detailed analysis made it possible to identify three orders of landslide terraces, progressively less preserved moving toward the shoreline. Field surveys and remote morphometric analyses have highlighted the presence of back-tilted strata, counter-slopes and pond zones able to geomorphologically constrain the terraced surfaces. In addition, a continuous scarp-shaped surface has been recognized at the base of the lowest order of terraces. The results of the multi-temporal analysis support the constraining of different kinds of landforms related to the landslide process and spatially distributed along all the slope. In particular, it has been observed that the drainage network has been entrenching as a response to the emplacement of the landslide mass. Combination of the reconstructed models, with the support of documentary sources from historical landslide reactivation, allowed to better frame the most active sector of the landslide mass, in the perspective of back-analyzing the current state of the landslide.

Conclusions: Results of the ongoing LEM analyses will be used as morphological constraints for a FEM/FDM modeling. This study aims at experiencing the analytical solutions to consider climate forcings in modeling landscape evolution of slopes, as well as their stress-strains conditions, to weight the role of preparatory climate factors on slope instabilities, discussing the possible role of landslides as “proxies” for climate changes at local and regional scales.