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The Vasto Landslide (Adriatic coast, central Italy): geomorphological constraints and numerical modelling to reconstruct the evolution of a large instability affecting a coastal slope

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The Vasto town (Abruzzi, central Italy) raises 143 m a.s.l., on the top of an uplifted Quaternary regressive sequence. The coastal slope is affected by large slope instability (Vasto Landslide) with evidence of present activity, as suggested by several geomorphic features. Well documented historical disruptive events affected the town and the coastal slope in 1816, 1942 and 1956, with deformation locally reaching the near offshore. Field morpho-stratigraphic evidences suggest that sea cliff retreat must have removed considerable volumes of rock before the first activation of the large slope instability. Thus, a morpho-evolutive model of the Vasto Landslide is proposed here, which takes into account the present landforms, the field geological evidences as well as borehole stratigraphy and the combined effect of Quaternary uplift and eustatic oscillations on the coastal slope, since the area started emerging (early Middle Pleistocene) and up to present. Some significant steps were identified, given the tectono-eustatic constraints, and slope stability was analysed with the method of slices (Fellenius) for the different steps. The analysis confirms the kinematic consistency of the first activation of two major roto-translational surfaces in the Middle Pleistocene, after considerable sea cliff retreat. Finite difference stress–strain numerical modelling (FDM) of the Vasto Landslide was then performed in order to output: 1) the landslide mechanism; 2) the style of activity of the landslide; 3) the cumulative deformations occurred during the morpho-evolutive steps. The numerical modelling was calibrated by considering the present landforms as well as the effects recorded during the historical events. The results obtained here confirm that the Vasto Lanslide was first activated in the Middle Pleistocene ($\sim$200 ka B.P.), as a consequence of wave cut erosion and progressive emersion of the coastal slope. Moreover, the landslide evolved as a retrogressive, single-styled landslide, divided in two major blocks. In this frame, the historical events are interpreted as local re-activations, due to meteo-climatic agents, of the ancient rupture surfaces affecting the entire slope.