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Investigating land subsidence of transitional environments

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Lagoons and deltas are characterized by the presence of transitional environments, such as low-lying plains or islands, salt marshes, and tidal flats with fundamental value in terms of biodiversity, recreational activities, and protection of inland territories from storms. The fate of these morphological landforms is severely threatened by the ongoing rise of the mean sea level (SLR) and land subsidence (LS). The loss of elevation relative to mean sea level, i.e. SLR plus LS, must be counterbalanced by accretion of inorganic sediments and biodegradation of organic matter. A large contribution to LS of transitional landforms is due to auto-compaction of the Holocene sediments. In fact, the large porosity and compressibility of these recent deposits, especially when the organic fraction is high, are responsible for a significant thickness reduction because of consolidation when new deposition occurs on the surface. SAR interferometry on deep-founded and surface radar scatterers, ground-based monitoring equipment (deep levelling benchmarks, SET, accretion traps), and a novel in-situ loading test have been used in the Venice Lagoon to distinguish between deep and shallow LS contributions, i.e. LS occurring below and above the Pleistocene / Holocene bound. After a review of the available dataset, the present contribution describes the modelling activities that are ongoing to understand the collected measurements. In particular, an advance coupled mixed finite-element poromechanical model is used to reproduce the loading test carried out on the Lazzaretto Nuovo marshland on summer 2019. With the aim of reliably characterize the geomechanical properties of the Holocene sediments of the tidal-marsh, a number of plastic tanks were filled with seawater, reaching a cumulative load of 40 kN applied on a 2.5´1.8 m^2 surface. Specific instrumentations were deployed before positioning the tanks to measure soil vertical displacement and pore overpressure at various depths below the load and distances from the load center. The numerical model uses linear piecewise polynomials and the lowest order Raviart–Thomas mixed space to represent the three-dimensional porous medium motion and the groundwater flow rate, respectively. The model is applied to the various loading and unloading phases that superpose to the tidal fluctuation of the lagoon level recorded over the 4-day test duration. The geomechanical properties thus derived constitute a significant advancement to understand the LS drivers in transitional environments and predict their resilience to SLR.

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