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Poro-mechanical modelling of in-situ loading experiments on Venice Lagoon marshes

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Tidal marshes are coastal landforms daily flooded by sea water. Their fate is strongly conditioned by the future relative sea level rise, intrinsically linked to climate change. The significant ecological and socioeconomic value of these ecosystems is a compelling reason to improve our understanding of marsh platform dynamics relative to the mean sea level. Among various factors influencing the elevation of these depositional landforms, sedimentation and compaction of the marsh body itself play a major role. In particular, it has been observed that marsh soils undergo large autocompaction due to high porosity and compressibility. Hence, characterization of marsh geomechanical properties is of paramount importance to develop reliable long-term predictions. With the aim of characterizing the geomechanical features of tidal marshes in the Venice Lagoon (Italy), a campaign of in-situ loading experiments has been recently carried out. In each experiment, eight 500-l tanks were cyclically filled and emptied with lagoon water, applying loads of various duration and entities on marsh platform. A monitoring system, based on pressure and displacement transducers, tracks the marsh response to the applied loads. This work describes the modeling activities developed to interpret these measurements from the in-situ experiments. The simulations have been carried out using a 3D poro-mechanical model solving Biot's equations by a mixed finite-element formulation. A power law is used to describe the soil compressibility vs effective stress relationship, and main parameters are initially defined based on oedometric tests carried out on a few samples cored from the marshes. Mechanical hysteresis is also accounted for. The model calibration allows to satisfactory match the available pressure and deformations records. In particular, the numerical simulation accurately accounts for the behavior of (vertically) heterogenous marsh deposits as revealed by core interpretation. Based on these promising results, we are looking towards using the calibrated constitutive relationships in long-term biomorpho-geomechanical analyses, to forecast the fate of the marshes in the Lagoon of Venice.