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# Integration of geodetic observations and geological models for investigating the permanent component of land subsidence in the Po Delta (northern Italy)

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Defining land subsidence causes is not an easy task, because ground lowering is a complex phenomenon due to the contribution of different physical processes related to natural contest and to anthropic actions. Indeed, such processes, which are characterized by a specific origin and may act in different spatial and temporal intervals, can overlap giving rise to a single surface land deformation, observable through conventional and innovative monitoring techniques (i.e. high-precision levelling, InSAR and GNSS). Of course, discriminating the individual causes is fundamental for reducing environmental and social harms, especially in deltas and coastal areas, where land sinking, coupled with climatic effects, can induce massive flooding. The present work concerns an application of a multi-component and multi-source approach, recently proposed by some of the authors for studying land subsidence in deltas. Such a methodology is aimed at understanding the processes causing both periodic and permanent components of the vertical land movement and at retrieving more accurate subsidence rates. It consists of three steps, respectively involving: a component recognition phase, based on statistical and spectral analyses of geodetic time series; a source (or physical process) selection phase, based on the comparison with data of different nature; a source validation step, where the selected sources are validated through physically-based models. The proposed procedure has been applied to the permanent component of subsidence in the Po Delta (northern Italy), an area historically affected by land subsidence and influenced by climatic changes, where continuous GNSS data and differential InSAR-derived time series were simultaneously acquired from 2012 to 2017. In particular, the exponential relation found between the mean SAR-derived LOS velocity and the thickness of the Late Holocene prograding deposits, pointed out the key role of the sedimentary compaction process with respect to the spatial distribution of the subsidence rates and confirmed the importance, already highlighted by other authors, of the consolidation of the shallower strata. In order to validate the consolidation process and to quantify also the deeper contributions of tectonics- and isostasy-depending mechanisms, 2D geological models have been constructed along two west-east sections across the central part of the Delta. Finally, the computed subsidence

rates have been compared with the geodetic velocities estimated in Taglio di Po and Porto Tolle villages (Rovigo, northern Italy), clarifying the contribution of each geological mechanism to the observed delta subsidence.

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