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Is anthropogenic land-subsidence a possible driver of riverine flood-risk dynamics? A casa study in Ravenna, Italy.

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Can man-induced or man-accelerated land-subsidence modify significantly riverine flood-hazard in flood-prone areas? We address this question by investigating the possible changes in flood hazard over one of the most prominent cases of anthropogenic land-subsidence in Italy, a 77-km^2 area around the city of Ravenna. The subsidence rate in the area, naturally in the order of a few mm/year, increased dramatically after World War II as a consequence of groundwater pumping and natural gas extraction, exceeding 110 mm/year and resulting in cumulative drops larger than 1.5 m in roughly 100 years. The Montone-Ronco and Fiumi Uniti rivers flow in the southern portion of the study area, which is protected from frequent flooding by levees. We simulated the inundation events associated with different potential levee-breaching configurations by using a fully two-dimensional hydrodynamic model constructed on the basis of four different floodplain geometries: the current topography and a reconstruction of ground elevations before anthropogenic land-subsidence, both neglecting man-made infrastructures, and the current and historical topographies completed with a representation of road and railway embankments and main land-reclamation channels. Our results show that flood-hazard changes due to anthropogenic land-subsidence are limited (e.g. significant changes in simulated values of water depth, h, velocity, v, and intensity, i=h·v, are detected in roughly 1%, 2% and 8% of the flood-prone area, in this order) and overwhelmingly lower than those determined by the construction of road and railway embankments or artificial channel networks (20%, 14% and 48% of the flood-prone area, respectively).