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Past and current flood risk: human and landscape interactions in the anthropogenic floodplain of Polesine (Italy)

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A complex relationship exists between major rivers and adjacent lowlands. While proximity to rivers assures easy access to a wealth of resources (e.g. water, food, transport route), it also increases the risk of flooding. In the last centuries, urbanization, intense agriculture, and industrialization have led to significant changes in both rivers and lowlands. The construction of levees, the narrowing of river cross-sections and the increased surface runoff have exacerbated flood risk in these landscapes. Here we ask how (and how much) anthropogenic changes in lowland landscapes can affect flood risk.

The Polesine Region, which is a 1,800 km^2 nearly plane, low-lying and flood-prone area in the Po River valley (North Italy), is an example of a highly transformed alluvial plain and it is one of the major coastal flood-prone region in Europe. This region was completely flooded in 1951, when about 8 billion m^3 of water outflowed through three adjacent failures occurred in the right embankment of the Po River (known as the "Occhiobello breaches"). An area of about 1,000 km^2 was flooded with water depths up to 5-6 meters, and remained inundated for several months. In the Polesine Region, the expected frequency of major flooding events is still far from being negligible. Importantly, with respect to 1951, the landscape underwent three major anthropogenic changes: i) the destruction of the 6-meters-high levees of the Polesella navigable channel, one of the most effective transverse barrier for water flowing toward the sea, ii) the hightening of many levees and embankments, and iii) significant land subsidence, mostly due to the extraction of water and methane from the subsoil for hydrocarbons exploitation in the mid 1950s. In line to this background, historical outflow data have been used to simulate the flooding of the Polesine Region considering two different scenarios, referring respectively to 1951 and 2011. The comparison of flood dynamics revealed significant differences in terms of flooded areas (minor in 2011 due to the removal of the Polesella levees), maximum water depths (far greater in 2011 due to land subsidence and higher levees), and time to flood arrival (due to different flow paths). Based on the simulated scenarios, analysis of people and assets exposure, as they varied from 1951 to 2011, revealed the existence of non-trivial feedbacks in the complex relationship between floods, landscape, and population. Coastal lowlands are fragile and complex systems in which climatic and socio-economic factors interplay with each other in dynamic ways, and should be an upfront priority in the political and environmental agenda of governments and risk planners.