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Influence of vegetation and flood regimes on deltaic floodplain deposition

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In microtidal environments, sedimentation occurring during high freshwater discharges is essential to prevent floodplains from drowning with rising sea levels. Vegetation has long been considered as one of the main drivers of overbank deposition because it reduces flow velocity on the floodplains (trapping effect). However, it has recently been shown that dense vegetation patterns can behave as a barrier for sediments and water fluxes (buffering effect), thus reducing the mass of sediments flowing from the river to the floodplains and increasing the seaward export of sediments through the channel. The buffering effect has been shown to prevail over the trapping effect only in the Wax Lake Delta and only for a few specific hydrographs. Therefore, there is a need to systematically investigate the impact of floodplain vegetation on sediment trapping and buffering. To this purpose, we conduct numerical simulations with the Deltf3D model to analyze sediment deposition over floodplains for several different rivers and floodplains geometries, vegetation characteristics, and flood conditions (i.e., peak magnitude, duration, and hydrograph skewness). The model domain consists of a simplified riverine environment, constituted of a rectilinear channel surrounded by rectangular floodplains. Our results indicate that besides the trapping and buffering effects, there is a third important effect, which we name piling-up effect, consisting of a general increase of water level along the river for higher vegetation densities and heights. This increase favors higher fluxes of water and sediments from the river into the floodplains. We identify the parameter space for which trapping and piling-up effects are larger (or smaller) than the buffering effect, thus leading to more (or less) deposition in the vegetated case than in the unvegetated one. We also identify the vegetation characteristics that maximize floodplain deposition given the river and floodplain geometries. This information can be used for targeted floodplain restoration strategies.