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The effect of mud and vegetation on shaping infilling estuaries in laboratory scale experiments

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Stratigraphic records show that many Holocene estuaries were infilled and closed off from the sea, but how is unclear. Yet, understanding how to build and raise land to keep up with future sealevel rise is urgently needed. Current understanding of estuaries and analogies with rivers suggest that mud and vegetation play a key role in this process by elevating bars and confining flow. We aim to unravel how these local processes affected the filling up of entire systems, and what the resulting stratigraphy becomes. We used a 20 m long by 3 m wide tilting flume (the www.uu.nl/Metronome) to simulate complete tidal systems developing from an initial long rectangular basin with barrier islands. Tidal flow was driven by periodical tilting of the flume, which favoured ample sediment transport in both the flood and ebb direction. Tilting was chosen such that sediment was net imported (flood asymmetry), which is in contrast to former exporting systems simulated in the Metronome. We ran three experiments, one with only sand, a second with sand and mud, and a third with sand, mud and vegetation. Mud was simulated as crushed walnut shell, which was added to the river discharge and at the tidal inlet. Sprouts of three species with different colonising strategies simulated natural vegetation. Mud in the infilling estuaries with perpetual channel-shoal migration was deposited on top of bars and in abandoned channels, reduced overall dynamics due to its cohesivity, and its preservation potential increased in the landward direction. Vegetation effectively trapped most fluvial mud, resulting in considerable topographic variation on the fluvial delta, and strongly reduced bar mobility. Peat layers formed in the stratigraphic record by vegetation burial. The large-scale effect of mud and vegetation is lower dynamics, especially in the upstream part of the estuary, and faster local accumulation, effectively narrowing the estuary.