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Morphodynamics of Estuarine Channel Networks

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The effects of tides on the morphodynamics of estuarine channel networks is still poorly understood. Whereas bifurcations in rivers are often morphologically unstable where one branch would be abandoned occurring avulsion. In more tide-dominated systems, these seem to be more stable in which the two branches of bifurcation keep open. The main aim of this study was to understand the effects of tides on the morphological evolution of an idealized estuarine channel network. It consisted of an upstream river that bifurcates into two downstream channels that are connected to the sea. By analyzing the results obtained with a 2DH Delft3D model, we first identified the tidal propagation and sediment transport patterns in the system and subsequently examined the morphological development of the tidally-influenced junction. We analyzed four different scenarios. First, the branches of the junction were set up to be different in depth. Second, the branches of the junction were set to be different in length. In both scenarios, the tide at the mouth of both branches was equal. The effect of the tide on the stability of the junction was examined by varying the tidal amplitude. Third, the configuration of both branches was set to be equal but the branches were forced with different tidal amplitude at the mouth. Fourth, a different tidal phase at the seaward of the branches is combined with the similar configuration of the branches. For the first and second scenario, the unequal geometry causes differences in tidal deformation along the channel, so the transport capacity in the branches becomes more unequal. As a result, the tides enhanced the morphological evolution that would occur in the absence of tides. For the third and fourth scenario, the different tidal forcing induces the tidal propagation from one branch to another. This propagation causes the erosion at the junction that maintain the two branches to keep open. These results indicate that equal tidal forcing enhances the morphological instability that would occur in a river-only situation while the different tidal forcing can cause the junction to be more stable.