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Modelling Morphological Evolution of Deltaic Lobes in the Yellow River Mouth

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In history, channel avulsion occurred frequently in the Yellow River Delta featuring by the combination of large-scale north-south shifts and small-scale evolution of “wandering-merging-meandering-diverting” patterns. However, these evolution processes are lack of quantitative investigations due to the complex interactions between riverine and tidal flows, and between sediment-laden flow and river bed as well. Since public observations are scarce, we numerically study this problem focusing on the controlling factors for reproducing the “wandering-merging-meandering” evolution patterns and the characteristics of relative morphological equilibrium under constant discharge and sediment conditions. Using a 2-D depth-averaged fully coupled morphological model, numerical experiments are carried out for a schematic Yellow River Delta. The results show that random disturbance on initial topography is the key factor to initiate wandering patterns. Moreover, the development of river patterns and the associated morphological time scales are strongly related to initial bed slopes and upstream discharge and sediment conditions. Generally, a small bed slope and a low discharge favor the formation of wandering patterns in the early stage, while a large bed slope and a high discharge may accelerate the merging and routing processes. In the case of upstream clear flow, channel formation is dominated by erosion processes. Yet with increasing sediment, it results from the combination of levee lip sedimentation and channel erosion. In addition, the flow routing may be facilitated by enhanced tidal ranges whereas decelerated when subaqueous sedimentation extends to the sea. Regarding the equilibrium state, the morphological time scales are 4~8 years in most cases and the width-depth ratio increases longitudinally following a power-law function.