Quantifying the impacts of human interventions on the tide-river dynamics in river deltas

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Understanding the alterations in spatial-temporal tide-river dynamics caused by natural and anthropogenic changes is essential for water resources managements in river deltas, as they directly impact the estuarine morphology, sediment transport, salinity intrusion and navigation conditions etc. In this study, we propose a data-driven model to quantify the impact of river discharge on tide-river dynamics, using water level time series data collected through long-term observations along the estuary with substantial variations in river discharge. The proposed model has a physically-based structure representing the tide-river interaction, and can be used to predict tide-river dynamics using river discharge as the sole predictor. The model was used to reconstruct the tide-river dynamics that would have occurred in absence of large-scale human interventions. Subsequently, the model was applied to the Yangtze River estuary for examining the influence of the world's largest dam, the Three Gorges Dam (TGD), on the spatial-temporal tide-river dynamics in terms of subtidal (residual water levels) and tidal properties (amplitudes and phases for different tidal constituents) along the estuary. The satisfactory correspondence of the model outputs with measurements during the pre-TGD period at six gauging stations along the Yangtze River estuary suggest that the proposed model can serve as a powerful instrument to quantify the impacts of human interventions on tide-river dynamics. The proposed approach is very efficient and can be applied to other river deltas showing considerable impacts of human interventions on tide-river dynamics.