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Sediment routing though the apex of a mega-delta under future anthropogenic impacts and climate change

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Deltas are home to 4.5% of the global population and support a range of ecosystem services that are vital to lives and livelihoods. As low-lying regions, deltas are also amongst the most vulnerable areas to the threat climate change and relative sea-level rise, which are being exacerbated by ongoing local resource exploitation. Anthropogenic activities such as riverine sand mining, construction of flood embankments, deforestation and changes of land use and hydropower dams are disrupting the natural evolution of deltaic systems, with many of the world's large deltas now being sediment starved. This is important because changes of the sediment flux into large deltas can have implications for the evolution of the morphology of delta bifurcations and their function at routing water and sediment seaward. This can amplify flood hazard and risk for riparian communities and intensify processes such as bank erosion, presenting hazards to human lives and exacerbating land loss. The present study focuses on the Chaktomuk junction at the apex of the Mekong delta, connecting the Mekong with the Tonle Sap Lake and the downstream delta. The junction is important as it provides the connection between the Mekong and the largest freshwater lake in Southeast Asia and because of the proximity of the junction to the rapidly expanding urban centre of Phnom Penh. We present a combined 2D hydrodynamic and sediment transport model for the Chaktomuk junction, constructed and based on high-resolution bathymetric data obtained with multibeam echosounders. A series of established sediment transport equations are adopted and tested through a sensitivity analysis to identify the most appropriate sediment transport solver for the model, which is then validated against field observations. The model was forced with a series of scenario combinations including changes of water and sediment flux and rates of sand mining. Simulation runs are presented that project the future evolution of the apex of the Mekong delta, including changes in bifurcation morphology, water and sediment routing seaward through delta distributary channels and changes in water and sediment exchanges between the Mekong and the Tonle Sap. The implications of these future trajectories will be discussed in terms of the sustainability of the delta to future change.