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Robust multi-scale strategies for increasing the resilience of the Mekong Delta

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Rising sea levels, accelerated land subsidence, and changes in water and sediment supply from upstream basins put the major livelihoods and agriculture in global river deltas at risk. Identifying effective and robust strategies to make deltas more resilient will require to systematically address uncertainty while consider the coupling between global, basin and delta scale processes.

Here, we demonstrate a bottom-up exploratory approach to forecast land loss in the Mekong Delta by 2100 and to identify most effective management levers to fight that land loss through management on different scales. To our knowledge, this is the first time that such a robust approach is applied to study coupled delta and basin systems, thus considering the full range of drivers behind land loss and delta degradation.

For this analysis, we couple a network-scale river sediment model and a conceptual model of delta morpho-dynamics. Our land loss estimates cover a large range (20 – 90 %), driven mostly by uncertainty about accelerated subsidence from groundwater pumping. However, sediment supply from the basin plays an important role to maintain delta land, especially for low and moderate scenarios of accelerated subsidence. However, sediment supply from the basin is a function of counteracting and uncertain processes. Population growth and agriculture expansion are expected to increase erosion and sediment yield from the basin, but most of this increased sediment load will be trapped in existing and planned hydropower dams, ultimately reducing sediment delivery to the delta as a function of dam siting and design.

Using more than 2 million Monte Carlo runs of a river sediment model, we find that placement of hydropower dams is the dominant control on sediment supply, far outweighing increases in sediment yield due to land conversion or reduced sediment trapping in dams because of better sediment management. Thus, the future of the Mekong delta will be determined by renewable energy policies in the basin that strategically avoid excessive sediment trapping in dams as well as by effective water management in the delta.

Our results demonstrate (1) the need for connecting delta and basin scales for managing river deltas world-wide, (2) the contribution of basin-scale sediment management to maximize the resilience of delta land, and (3) the crucial control that dams and reservoirs exert on sediment continuity between rivers and deltas.