

## The Morphological Evolution and Sustainability of Deltas in the 21st Century

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Compared to terrestrial systems, there have been relatively few studies that focus on the successful simulation of long-term emergent phenomena in coastal catchments, especially in the specific context of deltas. To address this gap, this research aims to enhance our understanding of how emergent processes influence the multidecadal evolution of deltaic environments, and how they may lead to the crossing of critical morphodynamic thresholds under increasing conditions of climatic stress. Utilising the cellular automata model CAESAR-Lisflood, we develop a methodology to explore the nature of multidecadal morphological change in delta systems (with a specific focus on the Mahanadi delta in India) under a range of climatic and environmental change scenarios. These scenarios are designed in such a way so as to encapsulate stressors that are common to a broad range of deltaic environments; including sediment starvation, accelerated subsidence, eustatic sea-level rise, and increased exposure to meteorological extremes. We then seek to identify important connections between the emergent morphological system and ecosystem services that influence the habitability of the delta, such as water quality, nutrient distribution and habitat cover. The model therefore provides a platform to investigate the viability of potential engineering strategies that could enhance the habitability of a given location, with a particular focus on re-naturalising the channel network.