A conceptual systems model of an Anthropogenic delta

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Body of Extended Abstract: Deltas have long supported urbanisation, trade, and agriculture due to their ecological productivity and strategic location at the interface between land and water. However, the increase in human development has significantly altered deltas worldwide, undermining their resilience against climate impacts such as sea level rise and degrading the ecological richness on which local communities depend. Nature-based Solutions (NbS) are increasingly promoted as sustainable and integrative strategies, offering a means to balance climate adaptation with societal development and maintenance of biosphere integrity. However, realizing their potential remains elusive, largely because the systemic effects of NbS – outcomes spanning the social, economic, and ecological domains - are poorly understood and are rarely assessed together. In response, this paper adopts a systems approach and uses ecosystem services as the central lens to explore how the dynamics of complex deltaic systems shape the varying effects of NbS interventions. We present an aggregated causal loop diagram (CLD) of a generic Anthropogenic delta, designed to explore the system feedback associated with different NbS for climate change adaptation in deltas. We also apply the CLD to the Ebro Delta in Spain, to illustrate how this delta responds to diverse NbS interventions. Accordingly, the CLD serves two main functions: 1) it builds a system understanding of the delta in the Anthropocene, emphasizing the inseparable but primarily unsustainable link between intensive human development and deltaic ecosystems in the context of climate change, and 2) offers an explorative means to understand how NbS interventions affect this system as a whole. This modelling effort is intended as a first step in the development of a quantitative System Dynamics model of an Anthropogenic delta.

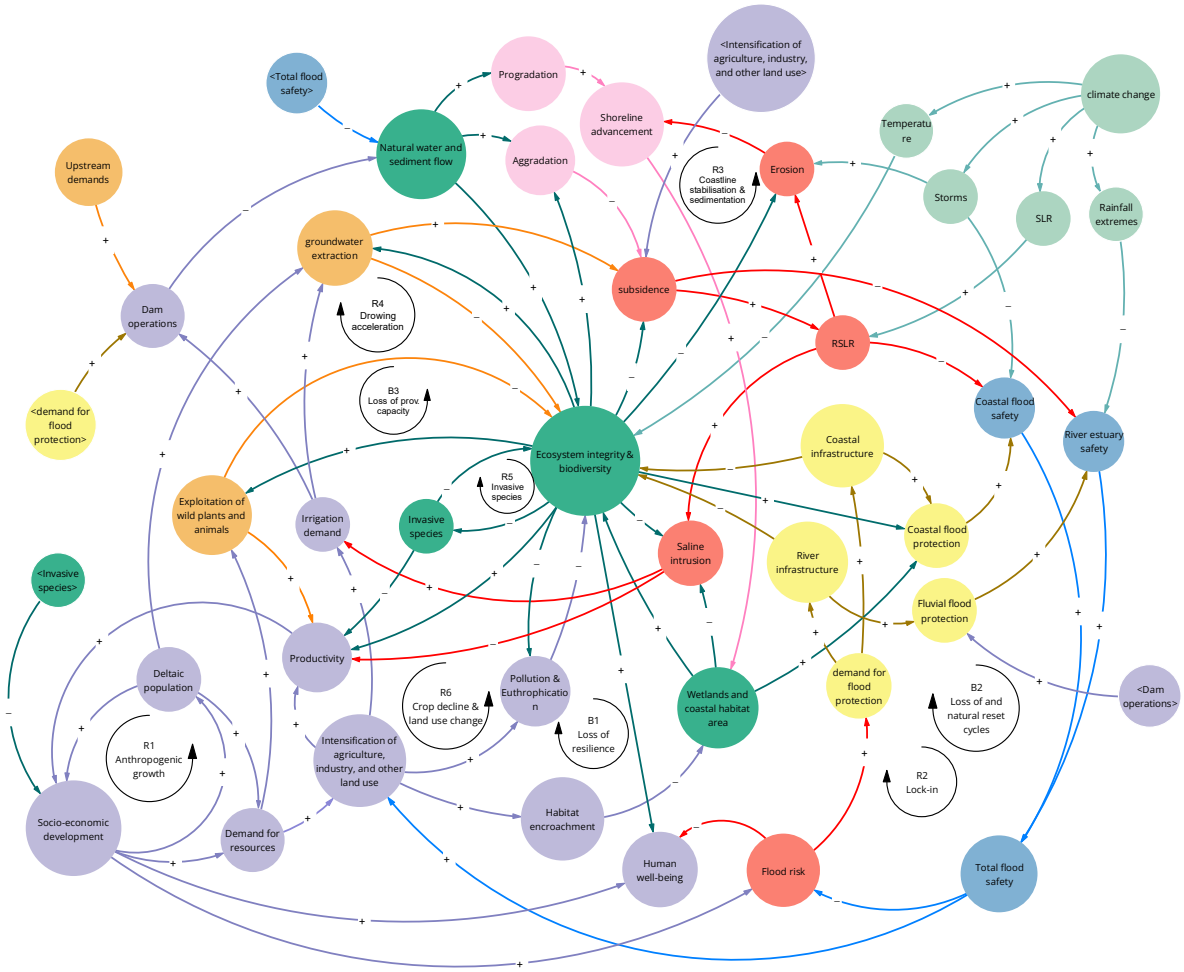

Figure 3.5: Causal Loop Diagram of deltaic social-ecological systems.

Legend: Colours represent the subsystems: ***Hydro-morphological pressures***, ***Human activity & socio-economic benefits***, ***Coastal & fluvial flood protection***, ***Coastal & river estuary safety***, ***Ecosystems & biodiversity***, ***Provisioning ES***, ***Regulating ES***, and ***Climate change***. ***Cultural ES*** are too interwoven with the system to be represented in the CLD without overcomplication. Many of the ***Regulating ES*** are represented within causal relations that originate from 'Ecosystem integrity & biodiversity' (e.g. the arrow from 'Wetlands and coastal habitat area' to 'Saline intrusion').

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