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TITLE: Approaches to defining deltaic sustainability in the 21st century

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ABSTRACT:

Deltas are among the most productive and economically important of global ecosystems but unfortunately they are also among the most threatened by human activities. Here we discuss deltas and human impact, several approaches to defining deltaic sustainability and present a ranking of sustainability. Delta sustainability must be considered within the context of global biophysical and socioeconomic constraints that include thermodynamic limitations, scale and embeddedness, and constraints at the level of the biosphere/geosphere. The development, functioning, and sustainability of deltas are the result of external and internal inputs of energy and materials, such as sediments and nutrients, that include delta lobe development, channel switching, crevasse formation, river floods, storms and associated waves and storm surges, and tides and other ocean currents. Modern deltas developed over the past several thousand years with relatively stable global mean sea level, predictable material inputs from drainage basins and the sea, and as extremely open systems. Human activity has changed these conditions to make deltas less sustainable, in that they are unable to persist through time structurally or functionally. Deltaic sustainability can be considered from geomorphic, ecological, and economic perspectives, with functional processes at these three levels being highly interactive. Changes in this functioning can lead to either enhanced or diminished sustainability, but most changes have been detrimental. There is a growing understanding that the trajectories of global environmental change and cost of energy will make achieving delta sustainability more challenging and limit options for management. Several delta types are identified in terms of sustainability including those in arid regions, those with high and low energy-intensive management systems, deltas below sea level, tropical deltas, and Arctic deltas. Representative deltas are ranked on a sustainability range. Success in sustainable delta management will depend on utilizing natural delta functioning and an ecological engineering approach.

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