



## **Delta pathways into the future: locked in or living deltas?**

Maria J. Santos (1) and Stefan C. Dekker (2)

(1) University of Zurich, Geography, Zurich, Switzerland (maria.j.santos@geo.uzh.ch), (2) Copernicus Institute of Sustainable Development, Utrecht University, Utrecht, The Netherlands, (3) Open University, Heerlen, The Netherlands

Delta systems are growingly at risk from ongoing global changes, sediment dynamics, and face many pressures from both upstream land use change and downstream sea level rise. Historically, deltas have been key locations for human occupation, and currently hold over 340 million inhabitants globally. Deltas provide water and food for their high populations, who in turn modify delta systems through (i) land use changes to crop and urbanized areas, (ii) land reclamation, channeling, water use and diversion resulting in larger subsidence and lower sedimentation rates, and (iii) added organic inputs and pollution.

This continuing pressure and risks have lead deltas to become locked-in, lost delta resilience to global change, and thereby their ability to provide ecosystem services. However, it is possible that deltas worldwide may have followed different pathways, with hard and soft locked in states, and that turning points can be found. To assess whether global deltas have followed similar pathways, we used historical HYDE data to (i) reconstruct the development of population and land use in 48 major deltas over the last 310 years, (ii) determine whether deltas are in locked in pathways, and (iii) if so, assess if we can predict current conditions given the time since locked in. We find that on average, deltas have 10 times higher population densities than the global average. Nonetheless, the average population growth rate of deltas was similar to the global average. Contrarily, cropland showed a global slow-down both globally and in the deltas over the last 50 years. Average rate of cropland development in deltas has not changed over the last 150 years, suggesting saturation; however, we observe higher rates of cropland development in deltas in the southern hemisphere. Irrigation increased almost 2 to 10x faster in deltas than global average, especially in the northern hemisphere. When correlating population with both cropland and irrigation, we find that at 1000 inhabitants/km<sup>2</sup> there is a switch in crop expansion, again suggesting that the delta has reached its maximum capacity for crop land; we found no similar effect for irrigated land. This suggests that these deltas (Sebou, Nile, Pearl and Han) might be in a locked in state. Historical land use change information highlights that deltas are old landscapes, and for some deltas the options for change are now limited due to locked-in, as large areas are human influenced. Further work is necessary to understand whether these trends can be reversed.