Deltas and Climate Change
Abstract

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The Intergovernmental Panel on Climate Change (IPCC) ranks heavily populated coastal deltas among the world's most vulnerable natural systems to the effects of climate change. The IPCC refers to large (>10^4 km^2) coastal deltas as "megadeltas", which they also classify as "hotspots of societal vulnerability". Even in the absence of a changing climate, most megadeltas are deteriorating as a result of human activities that have affected their natural flood pulses and sedimentary processes. Climate change has the potential to amplify the decline of deltaic systems through several mechanisms, but the most important drivers are sea level rise, increased storm intensity, and changes in rainfall and runoff to the coast. The formation and maintenance of deltas is inextricably linked with changes in sea level. All modern deltas of the world appear to be less than 10,000 years old and most began to form between 8500 and 6500 years before present, when sea level rise since the last glacial maximum (about 18,000 years ago) had decelerated to a pace that allowed deltas to accrete vertically and prograde seaward. Deltas are sensitive to any process that alters the balance between marine processes and the rate of sediment deposition. As long as the rate of sediment supply exceeds the rate of removal by marine forces and subsidence, a delta will tend to build seaward.

Several hundred million people currently live in deltaic plains and the development of cities, industry, ports, and agriculture in megadeltas has been accompanied by forced drainage of wetlands and the construction of flood control works that isolate deltaic environments from their sediment source. The drainage of organic soils and groundwater withdrawals to support human settlements have caused land surface subsidence in many deltas including the Chao Phraya in Thailand, the Ganges-Brahmaputra in Bangladesh, and the Changjiang (Yangtze) in China. Hydrologic modification has altered the seasonal flow of fresh water and sediment to many deltas -- such as the Mississippi in North America, the Indus in Pakistan, and the Nile in Egypt -- thereby creating sediment deficits that contribute to subsidence and erosion of the delta front.

Climate change will amplify the potential for erosion and submergence of deltaic systems, particularly those that are already stressed by human development. Sea level rise is projected to accelerate during the coming decades, thereby inundating low-lying coastal systems that are not experiencing sufficient tectonic uplift or sediment accretion that would allow them to keep pace with the rising sea. Tropical cyclones are projected to increase in intensity, creating higher wave energy and storm surge that contribute to erosion and land loss in coastal deltas. Due to changes in precipitation and temperature, runoff is projected to decrease in many land areas of the Northern Hemisphere. A decline of runoff to the coast has serious implications for sediment starved deltas and the populations that inhabit them. Recognition of the high vulnerability of deltas has led to several national and international efforts aimed at providing information that will help deltaic populations anticipate and adapt to climate change.