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Delta



Photograph on the largest group of lights in the northeastern United States. New York City and Newark, NJ, lie at the center of a string of city lights stretching roughly 300 kilometers (200 miles) from Philadelphia to Hartford. Image by NASA, January, 2017.

Antonia Sebastian

Delta (noun) /'deltə/¹

- the fourth letter of the Greek alphabet
 - a change in a figure or amount
 - an area of low, flat land, sometimes shaped approximately like a triangle, where a river divides into several smaller rivers before flowing into the sea.
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Coastal landscapes are naturally resilient, expanding and shrinking dynamically in response to sea level rise and fall. Within this context, modern river deltas began forming during a time of relatively stable sea levels in the late Holocene era approximately 7,000 years ago, making them relatively 'new' compared to other geologic formations. Deltas form where rivers enter the sea. They are built up as sediment-laden waters leave the river mouth and enter the sea depositing sediment in their wake. Over time, the slope of the river decreases and water levels in the river gradually increase relative to their surroundings until the river reaches a tipping point at which the river suddenly overflows its banks and charts a new shorter and steeper course towards the sea – a process known as avulsion. As rivers avulse, they leave behind well-sorted and fine-grained sediments, creating flat, fertile land on which human civilizations have thrived for thousands of years.

Over centuries, societies have learned to harness the power of the delta and to take advantage of its natural resources. As a result, deltas became global 'economic hotspots' driven by a wealth of timber, fisheries, and agricultural resources. Over time, deltas also developed into critical ports of entry because of their strategic connection to the hinterland via the river. Today, deltas are some of the most densely populated places in the world. They cover less than 1% of the world's landmass, yet they contain about 4% of the world's population – nearly half a billion people. Dams and channelization, built to control how and where water is distributed through the delta have enabled societies to thrive and exploit the resources of the deltas. Yet, river flow, sediment discharge, waves, and tides are all important controls on delta evolution, and are crucial to the delicate balance between the human uses and the natural function of the delta. As humans harden delta landscapes through urbanization and industrialization, the delta becomes less resilient to environmental change and increasingly fragile. Land subsidence, saltwater intrusion, and erosion have led to dramatic losses in coastal marshes and wetlands which protect and trap coastal sediments and provide critical ecosystem services.

Climate change presents an existential threat to the symbiotic relationship between natural delta evolution and communities that depend on the delta. Extreme precipitation and storm surge, as well as high river flows, can lead to biblical flood events with devastating social, economic, and environmental impacts. Sea level rise and more frequent and higher magnitude coastal and river floods further exacerbate these impacts. In turn, the delta evolves in response to these changing weather and climate patterns. The dynamic nature of the delta and the confluence of multiple hazards makes protection of delta settlements especially challenging and has led to the construction of massive structural engineering projects aimed at channeling rivers away from communities and blocking storm surge at the coast. Unfortunately, when humans continue to try and exert their control over these naturally dynamic landscapes, their efforts often hasten the delta's demise. As a result, short-term solutions aimed at combating flooding can lead to detrimental outcomes with long-term consequences, locking societies into a negative feedback loop in a fight against nature and time.

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