Connectivity in river deltas: Channel-wetland exchange, process couplings, and implications for water, sediment, and nutrient transport

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River deltas are highly dynamic landscapes composed of networks of channels and wetlands and subject to natural forcings such as waves, tides, and wind, and to multiple natural and anthropogenic stressors. Deltas are thus vulnerable to changes in sea level, subsidence, and extreme events such as storms, all of which pose significant risks to the large populations living in coastal areas. The delivery of water, sediment, and nutrients is fundamental to land growth and for maintaining a healthy and diverse ecosystem. Such delivery highly depends on the physical and process couplings in the delta system. Yet, portions of the delta (channels, wetlands, shoreline) are usually studied in isolation and process couplings are not quantified.
We present a framework for studying connectivity in river deltas based on field observations collected on Wax Lake Delta in Louisiana (USA) and numerical modeling. We show that wetlands are an important part of the delta hydrological network as up to 50% of the channel discharge is transferred from the channels to the wetlands. This value varies depending on the relative roughness of wetlands and channels, the discharge magnitude, and the tidal cycle, which we quantify by applying a numerical model under a range of conditions. Couplings among water depths, tides, wind, and discharge at different locations of the delta are quantified with an information theory approach, specifically by computing mutual information and transfer entropy from time series data. These metrics quantify the degree of information shared and transferred among variables and thus detect synchronization and forcing dominated couplings in the delta and associated scales.
The implications of connectivity on delta functioning are discussed in terms of land growth, potential for nutrient removal, and travel times through the system as a function of network structure.

Keywords: deltas, networks, connectivity

