Unintended consequences of modifying coastal river systems

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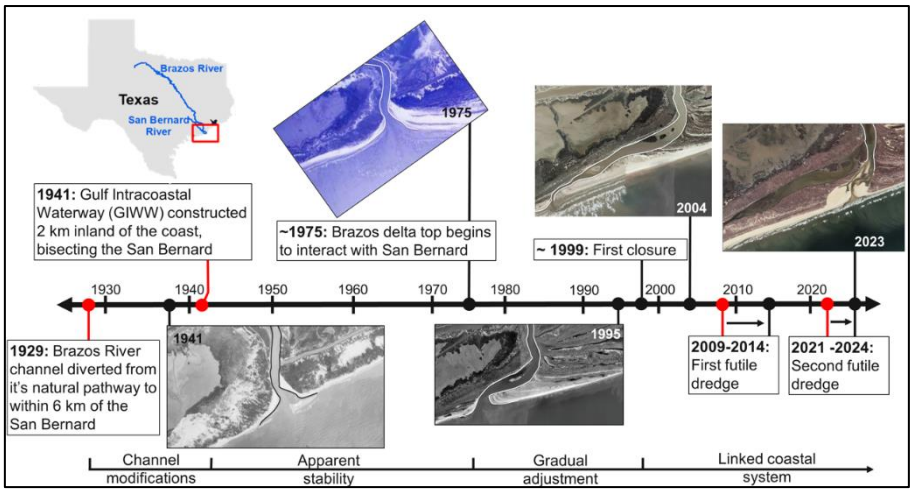

Study Summary

Coastal infrastructure projects, particularly those related to coastal river channels, are significant to economies worldwide. The importance of these projects is increasing in response to climate-driven changes and urban development. The benefits of channel modification projects can be realized quickly, but changes to the movement of sediments (sand and mud) in river channels can lead to unintended changes to the landscape decades later.

An example of this is the closure of the San Bernard River mouth, located on the central coast of Texas, which was clogged with sediments in the 1990s as a result of two major projects in the area: the diversion of the Brazos River channel (1929) and the construction of a barge canal, the Gulf Intracoastal Waterway (GIWW; 1940s). Because this river is no longer connected to the sea, a number of unintended problems developed over the next several decades, including enhanced flooding during major storm events such as Hurricane Harvey in 2017, hazardous currents and sediment pileups in the barge canal, and an influx of freshwater into the nearby estuary which can degrade coastal wetlands. Two corrective dredging projects have been attempted in recent years and both have failed, with costs surpassing $12 million to date.

The goal of this study was to a) document the delayed geomorphic response to the projects by analyzing historical maps and aerial imagery, and b) provide a snapshot of altered flow pathways in the area using field measurements. Results showed that flow from the San Bernard River travels along the GIWW at their intersection 2 km inland of the river mouth, reducing discharge at the river mouth. Due to this reduced flow, the river mouth became clogged with wave-transported sediment supplied in abundance by the Brazos River delta which had been diverted closer to the San Bernard River in 1929. With abundant sediments from the Brazos being transported into the river mouth and minimal flow from the San Bernard down its main channel, the mouth remains closed to this day despite (expensive) dredging efforts.

Coastal engineering is often focused on short-term benefits and rigidity (i.e., keeping coastal landforms in place) which can lead to costly consequences in a naturally dynamic environment. Optimizing the cost-effectiveness of channel modification projects requires considering their long-term impact on sediment transport in addition to the desired changes to flow in the system. One of the key challenges faced by coastal decision-makers is ensuring stability of built-structures in a coastal landscape that is dynamic, but slow-moving. At the San Bernard River mouth, this problem has yet to be solved.

Why is this research important and why do the results matter?

- Delayed responses to channel modifications on the coast can lead to costly hazards decades later.
- The example of the San Bernard River on the coast of Texas shows us that engineering projects, designed to change flow pathways for immediate economic benefit, also change the way sediments are transported throughout coastal river systems. The difference in timescale between the hydrodynamic change and the resultant sediment transport response is considerable and can lead to unforeseen and problematic coastal change.
- Understanding the interplay between coastal hydrodynamics, sediment transport, and human infrastructure can help guide future efforts to create sustainable coastal systems.

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