INFLUENCE OF SALINITY WEDGE ON FLOW AND SEDIMENT DIVERSION THROUGH A COMPLEX DELTAIC SYSTEM

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The Bird's Foot Delta (BFD) is located at the confluence of the Mississippi River and the Gulf of Mexico in southeast Louisiana, USA. It is a 521,000-acre delta located around the three main distributaries (Southwest Pass, South Pass, and Pass-a-Loutre) off the terminal end (Head of Passes) of the Mississippi River. Here, the delta is a highly productive ecosystem that serves as a refuge for migratory birds, harbors fisheries, and acts as defense mechanism against storm surge for the city of New Orleans. Over the past several decades, the wetlands of the eastern BFD have experienced severe degradation. The primary cause of wetland loss in this area is the combination of relative sea level rise (RSLR) and decreased hydrologic connection to the Mississippi River, which results in insufficient sediment deposition and increased salinity. The BFD restoration project proposes to restore the hydrology and improve the freshwater and sediment delivery to the Eastern Bird's Foot Delta through dredging some combination of the three largest distributaries south of Head of Passes (HOP). To inform restoration efforts, Mott MacDonald (MM) performed extensive modeling efforts to evaluate the influence of salt wedge on hydraulic and morphological patterns across the BFD.

A 2-D and 3-D hydrodynamic and morphological model was developed for a section of the Lower Mississippi River (LMR) using the MIKE21 Flexible Mesh (FM) and MIKE3 FM model (developed by Danish Hydraulic Institute), respectively. The analysis was performed on both 2-D and 3-D models to determine the relative influence of the vertical variability of salinity (salt wedge) on flow, sediment transport, and sedimentation patterns across the BFD. Various river flow scenarios (ranging from low to high flowrates), and their associated suspended sands and fine sediments, were implemented along the upstream boundary of the modeling domain to capture the variability of the salt wedge effects on the system.

Our 3-D modeling efforts showed the salt wedge was significantly present in Southwest Pass, and to a lesser extent in South Pass and Pass-a-Loutre given their shallow depths and significantly alters the flow distribution in the BFD system. During low river flows, we see approximately 30% reduction of flow, in Southwest Pass when salinity is included in the model (Figure 1). This flow, and sediment, is redistributed to both South Pass and Pass-a-Loutre. Further, it was observed that the salinity has 3-D variability and forms a stratified, wedge shape that propagates through Southwest Pass and upstream of HOP during lower flows which can affect sedimentation patterns (Figure 2). Ultimately, this could have implications on navigability planning in Southwest Pass (the primary shipping route to the Port of New Orleans) which would otherwise be overlooked in 2-D modeling.

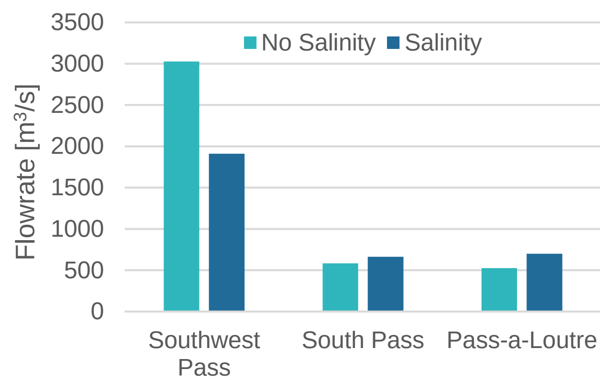

Figure 1 – The influence of salinity on flow distribution across the three main distributaries in the Bird's Foot Delta

Figure 2 – Influences of the salinity wedge on sedimentation patterns resolved in 3-D (red) vs. 2-D (blue)

Understanding the dynamics of the salt wedge, and its effects on flow and sediment distribution across the delta is paramount for the future of the BFD delta management efforts. Here, we found density-driven saltwater intrusion is an important physical process to resolve when modeling the BFD complex since it contributes to the flow redistribution across the three main distributaries and alters sedimentation patterns during low-flow periods (which occur 30% of the time).