Geomorphological modeling of tidal inlets for sustainable deltaic lagoon management: A case study in the Po River Delta, Italy

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Abstract

River deltas and enclosed lagoons represent a zone where fluvial and littoral processes interacts through a redistribution, erosion, and deposition of sediment, with a huge impact on coastal management and engineering. The focus of the study is to understand the correct balance between strategies to maintain the navigational efficiency of tidal inlets and the respect of the ecological and economical function in coastal lagoons. We applied an integrated modeling system which will link multiple hydrodynamic and morphodynamic models to understand how coastal processes and the associated sediment transport can influence the functioning of the southern inlet of the Barbamarco lagoon in the Po River Delta, Italy. Furthermore, our study provides engineering solutions aimed at the inlet functioning efficiency with a proposal for the monitoring plan. Our results highlight the importance of the seasonal effects of wave climate on the littoral sediment transport. Model outcomes show that the dredging volume is approximately 15,000 cubic meter/year for the southern inlet that might vary with wave climate. However, shaping a wider tidal channel seaward will reduce the dredging activities with a longer interval than the actual sediment removal. A design of a deeper and wider channel will deflect the along shore current seaward with a sediment bypass of the inlet. Therefore, the sediment will reach the erosional side of the inlet enhancing the redistribution of the sediment which might reduce the over-wash during storms and high-water levels. Our results display the ephemeral equilibrium of tidal inlets and coastal lagoons in deltaic systems impacted by large riverine sediment delivery. Shore management scenario and decision relies on hydro-morphodyanmic numerical model to predict the best practice for coastal sustainability.

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Abstract Text:

River deltas and enclosed lagoons represent a zone where fluvial and littoral processes interacts through a redistribution, erosion, and deposition of sediment, with a huge impact on coastal management and engineering. The focus of the study is to understand the correct balance between strategies to maintain the navigational efficiency of tidal inlets and the respect of the ecological and economical function in coastal lagoons. We applied an integrated modeling system which will link multiple hydrodynamic and morphodynamic models to understand how coastal processes and the associated sediment transport can influence the functioning of the southern inlet of the Barbamarco lagoon in the Po River Delta, Italy. Furthermore, our study provides engineering solutions aimed at the inlet functioning efficiency with a proposal for the monitoring plan. Our results highlight the importance of the seasonal effects of wave climate on the littoral sediment transport. Model outcomes show that the dredging volume is approximately 15,000 cubic meter/year for the southern inlet that might vary with wave climate. However, shaping a wider tidal channel seaward will reduce the dredging activities with a longer interval than the actual sediment removal. A design of a deeper and wider channel will deflect the along shore current seaward with a sediment bypass of the inlet. Therefore, the sediment will reach the erosional side of the inlet enhancing the redistribution of the sediment which might reduce the over-wash during storms and high-water levels. Our results display the ephemeral equilibrium of tidal inlets and coastal lagoons in deltaic systems impacted by large riverine sediment delivery. Shore management scenario and decision relies on hydro-morphodyanmic numerical model to predict the best practice for coastal sustainability.

Plain-Language Summary:
River deltas and enclosed lagoons represent a zone where fluvial and littoral processes interacts through a redistribution, erosion, and deposition of sediment, with a huge impact on coastal management and engineering. The focus of the study is to understand the correct balance between strategies to maintain the navigational efficiency of tidal inlets and the respect of the ecological and economical function in coastal lagoons. We applied an integrated modeling system which will link multiple hydrodynamic and morphodynamic models to understand how coastal processes and the associated sediment transport can influence the functioning of the southern inlet of the Barbamarco lagoon in the Po River Delta, Italy. Model outcomes show that the dredging volume is approximately 15,000 cubic meter/year for the southern inlet that might

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