NUMERICAL MODELING OF BAR-BUILT ESTUARIES AND IMPLICATIONS FOR THE MANAGEMENT OF INTERMITTENT INLETS

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INTRODUCTION

Bar-built estuaries are common in tropical and temperate regions, accounting for nearly 3% of the estuaries throughout the world (McSweeney et al. 2017). Bar-built estuaries tend to have intermittent inlets that can open from the estuary side outward in regions with seasonal changes in river discharge (Kraus et al., 2008; Orescanin and Scooler 2018). It is well known that intermittent inlet dynamics primarily depend on the interplay between wave energy and inlet discharge driven by lagoon water levels (Rich and Keller, 2013). Forcing processes are generally understood, however, less is known about their interaction or thresholds, which is ultimately what drives the closure of intermittent inlets.

The aim of this study is to explore numerical modeling techniques and parameters to simulate the hydrodynamics and closure of intermittent inlets in bar-built estuaries. Increasing the understanding of the conditions that lead to closing of intermittent inlets would allow for improved flood, sediment, and water quality management in the communities surrounding bar-built estuaries.

The region of interest is the Carmel River State Beach in CA, USA (Figure 1). This bar-built estuary has a river with discharges varying between 0 to 450 m^3/s, an average lagoon width of 60 m, and a barrier beach with an average width of 100 m and 5.5 m (NAVD88) elevation. The beach has a 10% slope and depths reach 30 m within 300 m of the shoreline. An intermittent inlet with depths up to 6 m and widths up to 20 m tends to open during high rainfall events in the river basin. The beach height is managed to allow for breaching to occur and prevent upstream flooding and improve water quality in the lagoon.

METHODS

To simulate the hydrodynamics and morphology of bar-built estuaries similar to the Carmel River, two numerical model domains were developed using Delft3D. The first domain includes the main features of the Carmel River State Beach system (Figure 1a). The second domain has an idealized set up with generic geometry that reflects the main features of the real estuary (Figure 1b). To explore inlet closure mechanisms, both models have been used to complete a sensitivity analysis to calibration parameters, wave conditions, and river discharge.

RESULTS AND DISCUSSION

Simulations from the idealized and realistic numerical models indicate that when the inlet is already open, waves have a larger impact on water levels in the lagoon than river discharge. Increase in either river discharge or wave height increases the overall max ebb discharge through the inlet. Initial morphological tests indicate that median sediment sizes (D_{50}) of up to 1000 μm most closely reflect observational changes in morphology. Increased MorFac values lowered the accreted bar profile on the beach and increased sedimentation in the inlet.

Ongoing research is focusing on hydrodynamic and morphologic response of the system to different inlet geometries, Results from this work will inform management practices for bar-built estuaries with intermittent inlets by using the two modeling approaches.
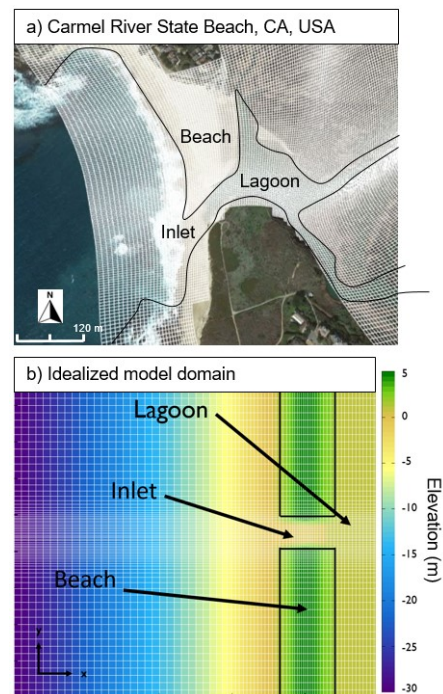

Figure 1 – Computational domains to represent a bar-built estuary in the California coast (a)Realistic and (b) idealized.

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