STORM MORPHODYNAMICS AND DECADAL EVOLUTION OF BEACHES IN MODIFIED ESTUARIES AND BAYS

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BEACHES IN ESTUARIES AND BAYS (BEBs)

Estuaries and bays have a long history as important locations for humanity, where societies and civilizations have thrived. The many sandy beaches within estuaries and bays (BEBs), often in urban environments, provide critical habitats and shoreline protection, as well as being important for recreation, often in urban environments.

BEB MORPHODYNAMICS

As BEBs are located in the semi-enclosed environments of estuaries, bays, and lagoons, they are characterized by diverse energy sources including locally generated wind waves, ocean gravity waves propagating into the estuary or bay, boat wakes, infragravity waves and currents driven by tides and river inflows (Vila-Concejo et al. 2020). Because wave energy is commonly low, BEBs can be narrow and low lying (Jackson et al. 2002) resulting in high vulnerability to climate change effects such as sea-level rise and changes in the direction and intensity of storms (Nordstrom and Jackson 2012, Gallop et al. 2020).

BEBs are particularly sensitive to changes in wave direction that allow ocean storm waves to propagate into estuaries and bays (Gallop et al. 2020). The decadal evolution of BEBs is controlled by storm-wave return time-scales and beach location relative to sediment sources/sinks such as flood-tide deltas and /tidal channels (Fellowes et al. 2021). Spectral analysis of local wave measurements at 4 BEBs inside a semi-enclosed bay in SE Australia showed that wave signatures were dominated by swell waves (>51%), followed by locally generated wind waves at 3 out of 4 BEBs (<43%), then infragravity waves (<35%) (Rahbani et al. 2022).

MODIFIED ESTUARIES

Due to their historic importance, many estuaries are subject to anthropogenic modification including: (1) dredging; (2) construction of ports and other infrastructure leading to “hard shorelines”; (3) urban sprawl causing encroachment of natural shorelines including BEBs, and wetlands such as mangroves or saltmarshes; (4) contamination and overfishing, leading for example to the ecosystem collapse of oyster reefs and loss of their shoreline protection, although there are efforts internationally at restoration to improve water quality and shoreline protection.

Here we present selected examples of BEBs located in modified estuaries and bays, highlighting their morphological diversity (Figure 1). We investigate their storm morphodynamics and decadal evolution and consider their response to anthropogenic modifications of the estuary. We also consider present efforts of oyster restoration and how they can affect BEB shoreline protection.

Figure 1 – BEBs in (A) Kamay/Botany Bay, Australia and (B) Sydney Harbour.

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