An investigation into the physical processes controlling the dynamics of the Jed/Buxton lagoon

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# ABSTRACT

Estuaries are complex systems. Intermittently Open/Closed Estuaries (IOCE) are particularly dynamic, experiencing periodic closure from wave dominance. The Jed/Buxton Lagoon (JBL), an IOCE in Gore Bay, New Zealand, has experienced substantial outlet migration over the last 40 years. This caused two rivers to flow into a single lagoon and discharge at a common mouth through a gravel barrier. Erosion has resulted along the lagoon banks, impacting critical infrastructure and farmland. This study analyses the drivers of this migration over decadal and event-based (i.e., storm) timescales. As IOCE on coarse-grained coasts are understudied compared to their sandy coast counterparts, this study contributes new information on how these systems respond to physical processes over these timescales. This is crucial for appropriate management, predicting future change, and mitigating erosion at JBL.  
  
Decadal scale dynamics were analysed using shoreline mapping (spanning 1955 - 2022), wave hindcast data to identify storms, and rainfall data. During 1985-1988, high storm frequency with south-east waves combined with low rainfall. This coincided with a period of shoreline erosion. This aligns with aerial imagery showing the beginning of the mouth migration, due to a potential increase in barrier height. Following 1988, mouth migration slowly continued under stable conditions, before the former conditions resumed between 2010 – 2019 causing more erosion and exacerbating lagoon formation. Pre/post storm dynamics during 2023 were analysed using geomorphic change detection from structure from motion, lagoon water level data, beach profiles, river flow data, wave data and time-lapse imagery. Pre-winter, the lagoon was stable/accretionary. A low energy storm in June 2023 resulted in mouth breaching as did two high energy events in July 2023 occurring within ~2 weeks. Data enabled the creation of a conceptual model depicting the JBL’s dynamics during events of varying intensity.

This study demonstrates how the JBL’s dynamics currently operate within the context of longer-term movement. This will benefit Hurunui District Council’s current investigation into management strategies to mitigate erosion and inundation caused by this mouth migration. It also provides vital information to bridge the knowledge gap that exists regarding high resolution analysis across long-term and short-term timescales for IOCE on coarse-sediment coasts.