SHORELINE RESPONSES TO 100 YEARS OF COASTAL INTERVENTIONS: CASE STUDY OF LETITIA SPIT – NSW, AUSTRALIA

Ana Paula da Silva, Griffith Centre for Coastal Management, ana.dasilva@griffithuni.edu.au
Lorena Woortmann, Griffith Centre for Coastal Management, lorena.garciawoortmann@griffithuni.edu.au
Guilherme Vieira da Silva, Griffith Centre for Coastal Management, g.vieiradasilva@griffith.edu.au
Tom Murray, Griffith Centre for Coastal Management, t.murray@griffith.edu.au
Darrell Strauss, Griffith Centre for Coastal Management, d.strauss@griffith.edu.au
Rodger Tomlinson, Griffith Centre for Coastal Management, r.tomlinson@griffith.edu.au

INTRODUCTION

Coastal interventions are used to modify the equilibrium state of coastal processes in order to address coastal community's needs. In several cases, the issues caused by the introduction of one structure are solved by other engineering solutions, but also creates new side effects. Letitia Spit (Tweed Heads, NSW) is a typical example of long-term coastal management actions that led to new shoreline equilibrium. Training walls built to stabilize the Tweed River Entrance in the late 1800's and their extension in the 1960's obstructed the natural longshore sand transport (LST). To regulate the sediment budget between the Letitia Spit and the downdrift Gold Coast beaches, the Tweed River Sand Bypassing System (TSB) was established in 2001. This paper aims to outline the shoreline response of Letitia Spit to these interventions and identify the extent of the updrift impact as well their influence on the regional stability.

METHODS

A dataset of 350 aerial and satellite images from Google Earth, Nearmap® and Queensland Government archives were analysed. It included: 115 individual days for the northern region of Letitia Spit (1930 to 2017); 61 days for central Letitia and Fingal Beach (1930 to 2018) and 53 for Dreamtime Beach (2003 to 2018). Images were rectified in a GIS environment with an average maximum root mean-square error of ± 2 m and a maximum of 9 m (at 95% confidence interval) for the 1930 image. Errors of this magnitude are considered negligible for the analysis here. Finally, wet-dry shoreline and dune vegetation base shoreline indicators (Boak and Turner, 2005) were mapped and analysed using the Digital Shoreline Analysis System (DSAS) version 4.3 (Himmelstoss, 2009). The changes were computed for 95 profiles, spaced at 50 m from north Letitia Spit to north Dreamtime Beach.

RESULTS AND DISCUSSION

The first training works on the Tweed River Entrance resulted in the fixation of Letitia Spit and its shoreline progradation. Between the 1930's and 1960's, the shoreline was around 150 m landward of its current position on north Letitia Spit, with the difference decreasing towards Fingal Beach. During this period, a large dune occupied the northern end of Letitia Spit covering an area of over 350,000 m^2 and indicating a stable condition of the spit. The extension of the training walls in 1962 caused obstruction of LST leading to 277 m of shoreline progradation by 1993-95. The shoreline of central Letitia Spit migrated 170 m seaward by the mid-1990s. Dunes followed the trend and accreted around 290 m between 1962 and 1990's in the northern region. This represents three times the dune accretion of the updrift Fingal Beach for the same period. In March 2001, the artificial bypassing system was initiated and after the first 8 months of operation, around 90 m of shoreline recession was observed at northern Letitia. Central Letitia Spit presented similar erosion trends (-70 m) towards the mid to late 2000's, whilst northern Letitia retreated by 150 m. During the 2000's, the shoreline indicators were in a dynamic equilibrium, varying ± 20-40 m for the wet-dry line and ±10 m for the dune from the average position. These oscillations are most likely the product of cross-shore sandbar transport, and longshore sand dispersion due to headland bypassing pulses around Fingal Head. This process appears to respond to wave direction and sediment availability at Dreamtime Beach (Silva et al., 2019). Between 2010 and 2018, three long-term cycles of shoreline changes were detected at Dreamtime Beach, with a lag of around 1-2 years later at Fingal Beach. The crest or trough of the sand pulse tends to migrate northward along Letitia Spit. The understanding of this process is fundamental to managing the TSB rates and to maintain the new equilibrium state of Letitia Spit.

CONCLUSION

Letitia Spit's formation and stabilisation is a result of coastal interventions that allowed sand deposition and fixation. Between 1962 and 2000, Letitia Spit presented an anomalous accretion due to LST obstruction by the extension of the Tweed River training walls. The introduction of the TSB regulated the sediment budget, causing at first an erosive state at Letitia Spit. Since 2010, however, shoreline position has assumed a new equilibrium state with natural oscillations. The current shoreline is located 150 m seaward of the pre-training wall position. The impacts caused by the coastal structures at the Tweed River did not appear to have significant impact on Fingal Beach, which is primarily controlled by the natural sand bypassing around Fingal Head.

REFERENCES

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