MODELLING SHORELINE EVOLUTION AT COLLAROY-NARRABEEN, DUE TO COMBINED CROSS-SHORE AND LONGSHORE SEDIMENT TRANSPORT PROCESSES

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INTRODUCTION

Changing wave climates and sea levels are leading to enhanced pressures on coastal communities and infrastructure. Coastal managers require better predictive tools in order to predict current and future coastal evolution and mitigate the potential impacts of coastal erosion and flooding. This contribution utilises a longshore extension and simplification of the Forecasting Coastal Evolution (ForCE; Davidson, 2021) profile model to examine the shoreline evolution of the Collaroy-Narrabeen embayment. The resulting one-line model combines cross-shore and longshore sediment transport processes, and unlike previous one-line models of this kind, both (longshore/cross-shore) terms are derived from the same theoretical arguments. Both model components are founded on equilibrium principles, whereby sediment transport is directly related to the disequilibrium in longshore and cross-shore components of wave energy dissipation.

Harley et al., (2011) conducted an EOF analysis of 30 years of shoreline evolution data spanning the Collaroy-Narrabeen embayment and demonstrated that both longshore and cross-shore sediment transport processes were significant in dictating the shoreline evolution, with cross-shore transport processes increasing towards the more energetic northern end of the embayment and representing the dominant mode of shoreline oscillation (60% of total variance). The new model lends itself to this application due to consideration of both longshore and cross-shore processes, as well as being based upon equilibrium concepts, which have proven successful at modelling this site in previous studies (e.g. Davidson et al., 2017). The model also allows for variable sediment exchanges between the neighbouring embayments at Turimetta and Fisherman's beach.

METHODOLOGY

In this contribution, the new one-line model is calibrated and validated using the 40+ year dataset of shoreline evolution at the Collaroy-Narrabeen embayment (Turner et al., 2016). An EOF analysis of the model output is conducted and compared to the prior complimentary analysis of field data (Harley et al., 2011) to examine whether the model can correctly emulate the observed spatial and temporal changes.

RESULTS & CONCLUDING REMARKS

Figure 1 represents a provisional, pre-calibrated example of the modelled temporal evolution of the shoreline within the Collaroy-Narrabeen embayment over a 30-year time-period with daily predictions of the shoreline location

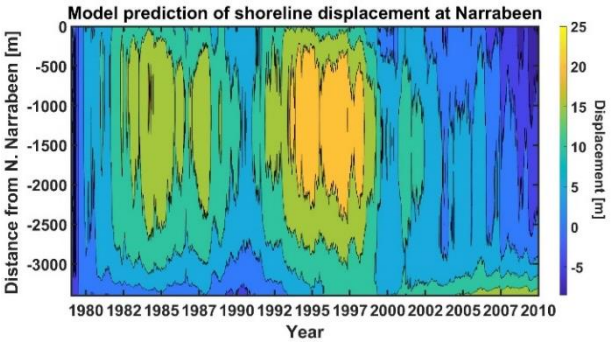

Figure 1 - Modelled shoreline displacement within the Collaroy-Narrabeen embayment between 1979-2010, whereby blue and yellow represent erosion and accretion, respectively

across the embayment. Temporal variability demonstrated both rotation and 'breathing' responses of the shoreline in response to longshore and cross-shore transport processes. Prior to the year 2000, the general qualitative trend demonstrates accretion towards the north of the embayment, with shoreline displacement of up to 25m, while the southern end erodes. Post-2000 this pattern reverses, demonstrating embayment rotation and emulating observed shoreline response. The favorable comparison with field observations, model simplicity, stability and computational efficiency combined with the ability to accommodate natural and anthropogenic complexities, suggests long-term (decadal) large scale (regional) application of the model is a feasible proposition.

REFERENCES

Davidson, Turner, Splinter, Harley (2017): Annual prediction of shoreline erosion and subsequent recovery, COASTAL ENGINEERING, vol. 130, pp.14-25.

Davidson (2021): Forecasting coastal evolution on time-scales of days to decades, COASTAL ENGINEERING, vol. 168, 103928

Harley, Turner, Short, Ranasinghe (2011): A reevaluation of coastal embayment rotation: The dominance of cross-shore versus alongshore sediment transport processes, Collaroy-Narrabeen Beach, southeast Australia. JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 116, F04033

Turner, Harley, Short, Simmons, Bracs, Phillips, Splinter (2016): A multi-decade dataset of monthly beach profile surveys and inshore wave forcing at Narrabeen, Australia. SCIENTIFIC DATA