# Investigating the past and future efficacy of sand recycling in Adelaide, South Australia using the one-line model ‘ShorelineS’

Ben Perry, Flinders University & Hatch, ben.perry@flinders.edu.au
Bas Huisman, Deltares, Bas.Huisman@deltares.nl
Dano Roelvink, IHE Delft & Deltares, d.roelvink@un-ihe.org
Patrick Hesp, Flinders University, patrick.hesp@flinders.edu.au
Graziela Miot da Silva, Flinders University, graziela.miotdasilva@flinders.edu.au

## INTRODUCTION

The past efficacy and future viability of sand recycling is evaluated for Adelaide’s beaches in South-Australia, making use of the one-line numerical model, ‘ShorelineS’. A wide variety of measures were introduced here in the last decades, such as (offshore) breakwaters, groynes, revetments and sand nourishments including regular sand recycling using both a pipeline and regular sand carting. Satellite derived shoreline change rates are used to verify modelled rates deduced from the one-line model wherein management and coastal structures were incorporated. The management is then removed from the model simulation to determine the underlying shoreline change rates. The results of these simulation scenarios provide insight into the system and historic performance of management practice. In addition, an investigation into the future viability of sand recycling as a primary management strategy is investigated using a dynamic nourishment application tool.

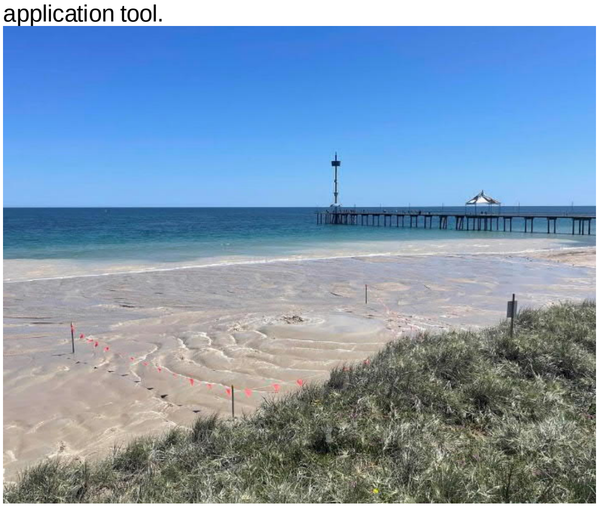

Figure 1 - Sand recycling outlet at Brighton Beach in Adelaide, South Australia

## SITE SETTING

Adelaide’s managed beaches have been defined as the 28 km stretch of beach between Kingston Park and Outer Harbour (Department of Environment and Water, 2021) (Figure 2). A dominant south-westerly wave direction causes sand to move in a net northerly direction (Harvey & Caton, 2012). The supply of sediment to Adelaide’s beaches, originating from sand dunes and beaches to the south, has been starved in the last decades since the urban development of the coastline and the construction of numerous coastal structures. These structures interrupted the natural littoral drift of sand around the LeFevre Peninsula to the north (Harvey, 2006). This has resulted in the deployment of the current beach nourishment regime that moves sand trapped by structures in areas of accretion to areas of erosion (Department of Environment and Water, 2021).

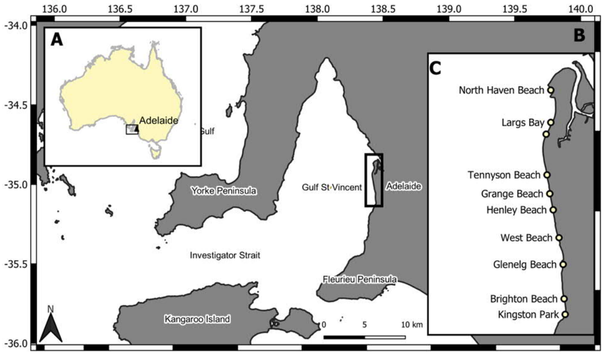


Figure 2 - Study location (A) Location within Australia, (B) Location with the Gulf St Vincent - South Australia, (C) Adelaide’s managed beaches

## METHODS

ShorelineS is utilised in this study with details of the model available in (Roelvink et al., 2020). The model uses a series of free form vectors to determine shoreline position forced by waves.

The effectiveness of the sand recycling and other coastal management schemes on the stability of the Adelaide beach is assessed from the comparison of the modelled shoreline change to observations across timescales of months to years. Surveyed shoreline trends are used to verify the satellite derived observations at the transects, which in-turn are used to verify the modelled shoreline change rates. Difference plots are used to assess the potential impact of a change in management, which is achieved by subtracting the unmanaged scenario rate of change at each transect from the managed rate of change at the same location.

The rate of change of the coastline is computed from the observed shoreline position changes along a cross shore transect through time. Using linear regression, an annual rate of change statistic is generated at each transect based on the (modelled and measured) shoreline positions. The gradient of the linear line of best fit to the shoreline positions then represents the shoreline change rate, which is then available for the in-situ profile-surveys, satellite-derived and modelled coastlines.

In order to assess the future viability of sand recycling, a dynamic nourishment application tool was built into the model to automatically model eroded beaches. This tool works by the user inputting a trigger line, when the shoreline erodes behind this trigger line, sand is transported (recycled) between user specified locations. Future recycling volume requirements are assessed by modelling a typical year of wave conditions under a variety of sea level rise conditions.

## RESULTS & DISCUSSION

Shoreline change at four locations have been presented in Figure 3 to highlight some varying impacts of shoreline management.

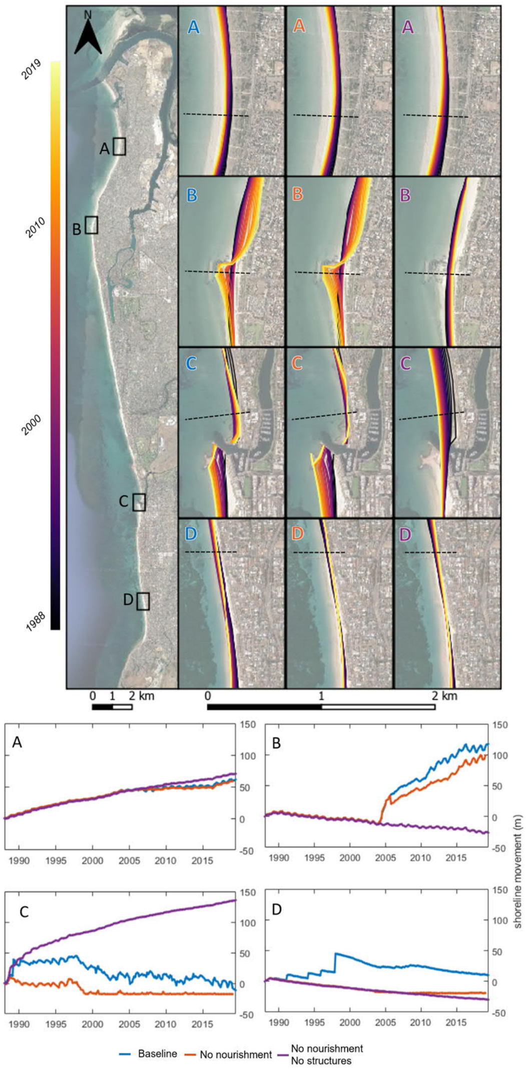


Figure 3 - ShorelineS modelled shoreline change at locations (A - Largs Beach, B - Semaphore breakwater, C - Glenelg North, D - Brighton Beach) between 1988 and 2019. Blue indicates baseline, orange indicates no nourishment and purple indicates no nourishment or structures

Location A highlights the net northerly migration of sand in this system with a steady increase in beach width over the simulation period regardless of whether sand recycling has been performed. Location B draws focus to the impact of building an offshore breakwater structure with significant accretion updrift of the structure and erosion just North on the downdrift side. The downdrift erosion is slightly overestimated in the model, nevertheless, the increased erosion in the no-nourishment case suggests that using sand for recycling from behind the breakwater decreases the erosion to the north of the structure. Location C shows the impact of the Glenelg marina with significant accretion on the southern side of the marina and erosion on the northern side. At this location it is clear that without beach nourishment the beach width quickly erodes, however, with no structures blocking the northern flow of sediment, nourishment would likely not be required. Location D highlights a typical section of coast in the south of the system where there is an erosional trend, regardless of structures. Similarly to location C, without beach nourishment, the beach widths in this section of coastline would erode and not recover.

Analysis of future nourishment requirements is currently underway with assessments of future sand recycling volumes for 2050 and 2100 to be performed. These assessments will allow coastal managers to understand the future viability of sand recycling in Adelaide.

This study found that beach nourishment is required on Adelaide's managed beaches to maintain beach widths and sand recycling has been a successful nourishment mechanism. In some locations beach nourishment is required due to the natural longshore movement of sand; however, other locations require beach nourishment due to the presence of hard structures which restrict longshore transport. The dynamic nourishment application tool has been developed and future sand recycling requirements for 2050 and 2100 are currently under assessment. The methods adopted for Adelaide can also be applied to other coastlines with managed beaches with complex structures and nourishment regimes.

## REFERENCES


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