Shoreline Response to the Southern Annular Mode at WEC site: Satellite Analysis

James Thompson1, Nick Cartwright1, Amir Etemad-Shahidi1, Guilherme Vieira da Silva1, Julian O’Grady2

1 Coastal and Marine Research Centre, Griffith University, Gold Coast, AUSTRALIA.

email: james.thompson3@griffithuni.edu.au

2 CSIRO, Melbourne, AUSTRALIA.

Keywords: shoreline change, beach morphology, beach rotation, wave energy converter, satellite-derived shorelines.

Understanding shoreline dynamics is a key step towards the successful management of coastal environments. This study investigates natural shoreline variability at Grassy Beach with a particular focus on the relationship between the local wave climate and the Southern Annular Mode (SAM). The present analysis is part of a larger study into the influence of a nearshore wave energy converter (WEC) on the shoreline dynamics. Grassy is a sandy embayment on King Island in Bass Strait, Australia, with a wave climate dominated by southwesterly Southern Ocean swells. Shoreline position pre-WEC deployment from 1987 to 2021 was determined from Sentinel and Landsat satellite imagery (n = 420 images) using the CoastSat Python toolkit. Empirical orthogonal function (EOF) analysis found seasonal beach rotation to be a dominant mode of variability (20% of total variability), with opposing shoreline movement at either end of the embayed beach and a pivot point near the middle. The corresponding temporal EOF alternated in sign between winter and summer. These results show shoreline retreat (erosion) happening in winter at the exposed eastern end and during summer at the western end. The Bass Strait wave climate is influenced by SAM, with more powerful waves likely in Austral autumn and winter when the SAM index is positive. A positive phase of SAM during winter was found to increase shoreline retreat at the eastern end and leads to a stronger beach rotation signal describing 24% of the total variability. These results provide new insights into the influence of SAM on shoreline dynamics and highlight the importance of considering relevant climate drivers in coastal assessments. For nearshore structures such as WECs, it is critical to first assess the natural variability of the site and relevant driving factors through multi-decade spatio-temporal analysis before analysing the coastal impact of such structures.

Abstract requirements:

* Abstract must be 250-300 words and should clearly state aim of paper, paper contents and main conclusions
* No references or reference list, no diagrams or tables
* Title max 12 words
* Max 5 keywords
* Presenting author underlined
* Abbreviations used must be listed in full at first use

From Gui:

The main point that needs about the logic behind mentioning the WEC (you can add the date of the installation). You talk about it at the start and I was expecting to read how it relates to your analysis toward the end.

Perhaps some words around how important it is to understand the natural variability of the site and the driving forces before you analyse the impacts of such structures. Another important point is to highlight that the dataset you are presenting is only for pre-deployment of the structure.

Other possible text / old text…

This study also highlights the importance of multi-decade spatio-temporal analysis of beach morphology for coastal management decision-making, with significant alongshore variability in shoreline movement identified here as a consideration for nearshore WEC site selection and other coastal projects at Grassy.

The Bass Strait wave climate is influenced by SAM, with more powerful waves in Austral autumn and winter months when the SAM index is positive. This study found that SAM-positive winters lead to increased shoreline retreat at the exposed eastern end of the beach and a stronger seasonal beach rotation response (x %?). Therefore, SAM plays a significant role in modulating shoreline dynamics at Grassy Beach. SAM is on a positive trend due to anthropogenic climate change and this could lead to gradual, small shifts in the morphology of Grassy Beach and similar southern beaches. This research highlights the importance of considering relevant climate drivers in coastal assessments as well as demonstrating the utility of satellite imagery and EOF analysis for medium- to long-term coastal monitoring studies.

SWAN modelling will be used to further investigate this response to the summer and winter wave conditions.

The aim of this study was to investigate the natural coastal change for future studies to analyse the impact of the WEC on these processes.

The area of shoreline stability found through EOF analysis compared to the highly variable shoreline position at the ends is two different (environments/problems/scenarios…) for coastal development. These results highlight the need for a comprehensive spatial and temporal analysis of shoreline movement as part of the site selection process for nearshore structures.

The study of shoreline dynamics has become increasingly important with the rapidly changing climate and increased coastal infrastructure.

ChatGPT attempt at opening statement…

The Southern Annular Mode (SAM) plays a significant role in coastal dynamics and shoreline evolution. This study investigates the shoreline response to the SAM at a wave energy converter (WEC) site using satellite analysis. The results of this research provide new insights into the influence of the SAM on shoreline dynamics and the potential for coastal vulnerability assessments to inform protection measures for nearshore structures. The findings of this study have important implications for coastal management and planning efforts globally.

Shoreline dynamics play a crucial role in coastal vulnerability assessments and the design and management of coastal infrastructure, making it an important field of research. This study investigates the shoreline response to the Southern Annular Mode (SAM) at a wave energy converter (WEC) site using satellite analysis, contributing to our understanding of the impact of climate drivers on shoreline dynamics and informing coastal management decisions.

The study of shoreline dynamics has gained significant attention in recent years due to the impacts of climate change on coastal environments.

The study of shoreline dynamics has become increasingly important in light of rapidly changing climate conditions and growing human pressures on coastal environments.