ASSESSING THE BENEFITS OF BEACHES IN FLOOD RISK REDUCTION

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INTRODUCTION

Beaches and other ecosystems such as dune systems, wetlands, mangroves, and coral reefs provide protection services against flooding that can be as valuable as hard engineered structures.

Over the last decade, significant efforts have been made to assess the services provided by mangroves and coral reefs in economic terms (Beck et al., 2019; Reguero et al., 2021). As for beaches, however, most studies to date have been limited to analysing physical evidence of their effectiveness as natural flood defences.

Beaches have the particularity of being more dynamic than coral reefs and mangroves as they adapt quickly to changes in coastal dynamics. Therefore, the protection benefits they provide are strongly linked to this dynamism and their changing shape at different scales. This brings additional complexity to coastal flood modelling as it can be shaped by shoreline changes that are often neglected (Toimil et al., 2023a).

OBJECTIVES

In this work, we present a new approach to quantify the benefits of beaches in flood risk reduction considering the dynamic interaction of storm and sea-level rise erosion, with and coastal flooding (Toimil et al., 2023b). We apply the proposed approach in Narrabeen-Collaroy (Australia) considering uncertainty in the climate part of the shared socioeconomic pathways, sea-level rise projections, and initial beach conditions (uneroded and eroded due to a previous back-to-back storm without time to recover).

The approach is a further step towards a more realistic valuation of beaches. It can provide evidence of the often-unknown value of beaches and contribute to improving their current and future management. This valuation can also support coastal planning and help to better allocate adaptation funds.

METHODOLOGY

We propose a dynamic approach based on the avoided damage cost method that relies on the assumption that flood protection depends on the evolution of the shoreline to climate forcing conditions. The dynamic nature of the approach is such that considers the complex interplays between coastal flooding and erosion at short- and long-term time scales.

The approach involves the use of process-based models to downscale offshore waves, compute storm hydro- and morphodynamics and model flood propagation overland. We account for shoreline changes in the flood modelling by updating the current topo-bathymetry to incorporate SLR-driven erosion and storm erosion.

We consider scenarios of coastal flooding with erosion driven by both SLR and storms, and without erosion. In either case, we quantify flood damage by combining flood maps, the value of buildings and vulnerability functions. We compute the flood protection value of the beach in terms of avoided flood damage by subtracting the flood damage of the scenarios without erosion from the flood damage of the scenarios with erosion.

Additionally, we compute the recreational value of the beach and calculate a proxy benefit-cost ratio assuming that the mean shoreline can be maintained through beach nourishment for different scenarios.

CONCLUSIONS

We found that, in Narrabeen-Collaroy, failing to consider erosion as flood enhancer can greatly underestimate flood damage. We also demonstrate its flood protection value can be of great importance. Our results give insight on the benefits of beaches for adaptation.

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