APPLICATION OF EQUILIBRIUM-BASED SHORELINE EVOLUTION MODELING TO DIVERSE COASTAL ENVIRONMENTS

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INTRODUCTION

Coastal zones are highly complex and dynamic environments shaped by diverse forcing agents such as waves, nearshore currents, sea levels, storm surges, winds, human interventions, and other oceanographic and sediment supply factors that occur on different spatio-temporal scales. Hence, coastal managers and stakeholders need simplified and practical models in order to estimate future beach morphodynamic changes to face decision-making.

The shoreline hindcast under the influence of changing marine conditions has been mostly considered by means of existing robust shoreline evolution models, such as one-line shoreline models, multi-line shoreline models, combined models, and 3D models. All of them require long data series, many calibration parameters and are computationally intensive.

This study presents the potential performance of some newly equilibrium-based shoreline evolution models used for daily to multiannual shoreline prediction, in diverse coastal environments (e.g. Jaramillo et al. 2020, 2021a, 2021b).

EQUILIBRIUM-BASED SHORELINE EVOLUTION MODELS (EBSEM)

Conceptually, EBSEMs are established on the balance between destructive and constructive forces that act upon a beach. In general terms, they are defined on a governing differential equation $dX'(t)/dt=K'\cdot\Delta X'$, where the beach parameter X' varies over time, $dX'(t)/dt$, depending on the product between a rapidly varying forcing, K', and the evolving disequilibrium through time, $\Delta X'$. This disequilibrium is the difference between the current conditions and a theoretical equilibrium (i.e., $\Delta X'=X'-X'_{eq}$). The determination of such an equilibrium condition is a cornerstone of all models based on those differential equations. The equilibrium condition is usually defined as a function of the shoreline position or through a weighted average of the antecedent conditions.

The rate parameter, K', is a function of both the prevailing wave conditions (e.g., the wave energy, or wave power) and the beach morphological characteristics, such as the mean grain size, beach length, closure depth, among others.

Briefly, these simplified models require few calibration parameters, some beach morphological characteristics, a time series of shorelines that are the reference basis, and hindcast and forecast prediction record of waves and sea levels that are the model's drivers.

APPLICATIONS

The use of EBSEM has increased in recent years, thanks to their ease, reduced complexity, and effective application. Based on the orthogonality hypothesis of the processes that take place on beaches, they can be separated according to the direction of sediment transport, cross-shore or longshore, responding only to beach profile movements or beach planform variability. They can also be combined in a simplified way to undertake both cross-shore and longshore processes.

This study presents the potential of EBSEMs in the shoreline variability simulation considering different coastal environments, as well as their potential to reconstruct the beach profile from the cross-shore model approach, or the intertidal bathymetry from the combination of cross-shore and longshore processes. Figure 1 shows the sites that have been evaluated with EBSEMs in this study, considering micro-, meso- or macrotidal environments, with coarse or fine sands and shoreline data obtained from various sources such as video-camera, orthophotos, satellite, or field surveys.

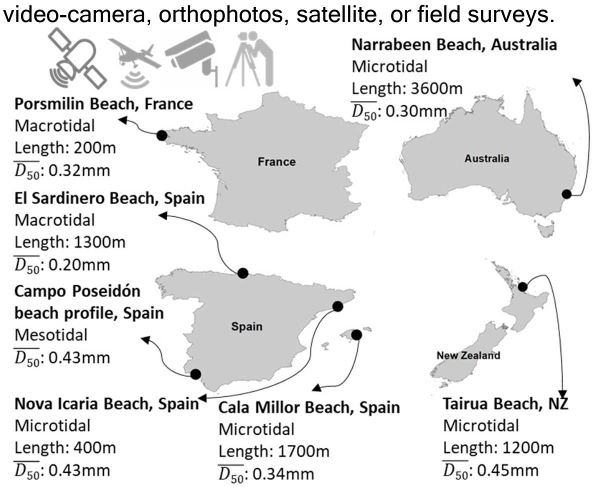

Figure 1 - Study sites

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