Evaluating future beach reduction in a changing climate: Methodologies and uncertainties.

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In recent years there have been endless coastal actions that have substantially modified the equilibrium conditions of much of the coastline. This fact, along with an unprecedented coastal population growth and the projected sea level rise, make beaches a particularly vulnerable region to climate change impacts. In particular, there is a clear need to quantify the reduction of the beach area due to the combination effects of the sea level rise and changes in the waves in the swash zone, under different future climate scenarios.

In this work different methodologies are developed to estimate the retreat of the coastline and to quantify the associated uncertainties. The methodologies have been applied to three beaches of the Balearic Islands, which have been continuously monitored during the last decade. The different methodologies imply the use of models to propagate the waves from deep waters to shallow depths and to compute wave runup. The results are compared to simpler approaches based on empirical formulations that provide a cost-effective solution to cover large domains. All the different approaches are validated with coastal wave recorders (AWACs) and data from cameras from which wave runup is estimated. Furthermore, a sensitivity analysis has been performed to assess the impact of uncertainties in the beach bathymetry.

The first results show that under the RCP8.5 scenario, the expected coastline retreat under mean conditions would be of \(\sim 22 \pm 5\) meters at mid-century. Considering extreme waves conditions, the retreat would reach \(\sim 40 \pm 5\) meters.

It is worth mentioning that the three studied beaches have a very different exposure, granulometry and maritime climate, and in spite of that, the estimated uncertainty level is relatively low (\(\sim 10\%-25\%)\) in all of them. Therefore, the proposed methodologies along with their uncertainty analysis, might be extrapolated to any sandy beach with a reasonable high degree of accuracy.