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Using global sensitivity analysis to evaluate the uncertainties of future shoreline changes under the Bruun rule assumption

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Future sandy shoreline changes are often assed by summing the contributions of longshore and cross-shore effects. In such approaches, a contribution of sea-level rise can be incorporated by adding a supplementary term based on the Bruun rule. Here, our objective is to identify where and when the use of the Bruun rule can be (in)validated, in the case of wave-exposed beaches with gentle slopes. We first provide shoreline change scenarios that account for all uncertain hydrosedimentary processes affecting the idealized low- and high-energy coasts described by Stive (2004)[Stive, M. J. F. 2004, How important is global warming for coastal erosion? an editorial comment, Climatic Change, vol. 64, n 12, doi:10.1023/B:CLIM.0000024785.91858. ISSN 0165-0009]. Then, we generate shoreline change scenarios based on probabilistic sea-level rise projections based on IPCC. For scenario RCP 6.0 and 8.5 and in the absence of coastal defenses, the model predicts an observable shift toward generalized beach erosion by the middle of the 21st century. On the contrary, the model predictions are unlikely to differ from the current situation in case of scenario RCP 2.6. To get insight into the relative importance of each source of uncertainties, we quantify each contributions to the variance of the model outcome using a global sensitivity analysis. This analysis shows that by the end of the 21st century, a large part of shoreline change uncertainties are due to the climate change scenario if all anthropogenic greenhousegas emission scenarios are considered equiprobable. To conclude, the analysis shows that under the assumptions above, (in)validating the Bruun rule should be straightforward during the second half of the 21st century and for the RCP 8.5 scenario. Conversely, for RCP 2.6, the noise in shoreline change evolution should continue dominating the signal due to the Bruun effect. This last conclusion can be interpreted as an important potential benefit of climate change mitigation.