ASSESSING A COST-EFFICIENT METHODOLOGY FOR LONG TERM WAVE COMPUTATION

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We compare two approaches for the computation of return period wave in shallow waters:

1. Perform Extreme Value Analysis (EVA) on offshore wave data and propagate design waves toward the coast (approach referred to as DW-EVM; see Figure 1).
2. Propagate the whole time-series to the coast first, then compute EVA on the downscaled data (referred to as SW-EVM).

Either one of these approaches is to be referred to in case that no extended time-series of wave data are available at the coast. Given that this is often the case (for example, hindcast dataset are often defined in deep waters, see e.g., Mentaschi et al., 2015), this work is deemed relevant for coastal engineering application.

To quantify the uncertainty stemming from the downscaling approach, the two methods are comparatively applied at the Son Bou Beach in Menorca (Balearic Island, West Mediterranean Basin). The work-flow of the research is shown in Figure 1. We take advantage of offshore hindcast data defined over the 1958-2016 period. The EVA's workflow for the two approaches is kept the same, so that differences in the resulting design waves are to be related only to the downscaling approach (that is, propagating waves prior of after the EVA).

To reduce the computational related of approach 2, we apply a hybrid method based on the work of Camus et al., (2011), which implies to normalize the wave data over a common space and to group them in a number of clusters through a clustering algorithm. Each cluster is represented by a centroid which is next back-normalized in the variables space and downscaled to the shallow waters. Finally, the whole time series of wave parameters at the coast is inferred through a radial basis function applied to the dynamically downscaled centroids. The method is validated against the records of an Acoustic Waves and Currents (AWAC) sensor, providing 6 years of data (2011-2016). Such time frame is not suited to perform sound EVA, though it is a reliable benchmark against which validating the numerical model used to propagate waves onshore (see Figure 2).

Results of the comparison are reported in Table 1, and show that, depending on the considered fetch, the 100 years wave height (H_s) can differ of as much as ≈1 m, a difference that would dramatically affect maritime projects that are closely tied to H_s, e.g., floating breakwaters or the rock armor mass computation for rubble mound breakwaters.

This research sheds light on an aspect that is often overlooked and opens the door to further research aimed to assessing possible implications for the design of coastal structures at different sites.

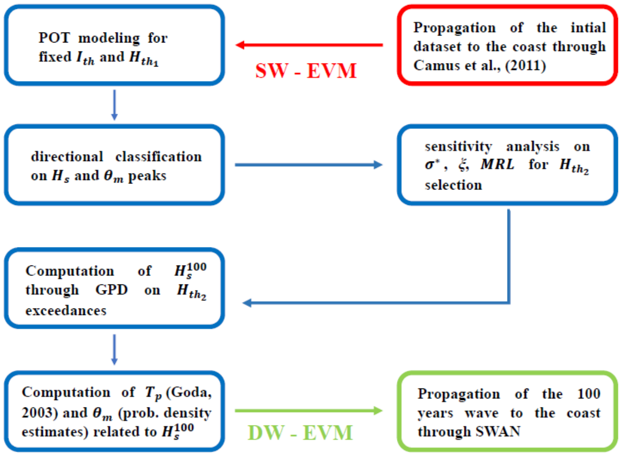

Figure 1 - Flow chart of the research. Steps related to EVA, which are common to SW-EVM and DW-EVM, are highlighted with blue boxes. The red box on top of the EVA refers to the SW-EVM approach, while the green box at the bottom refers to DW-EVM approach.

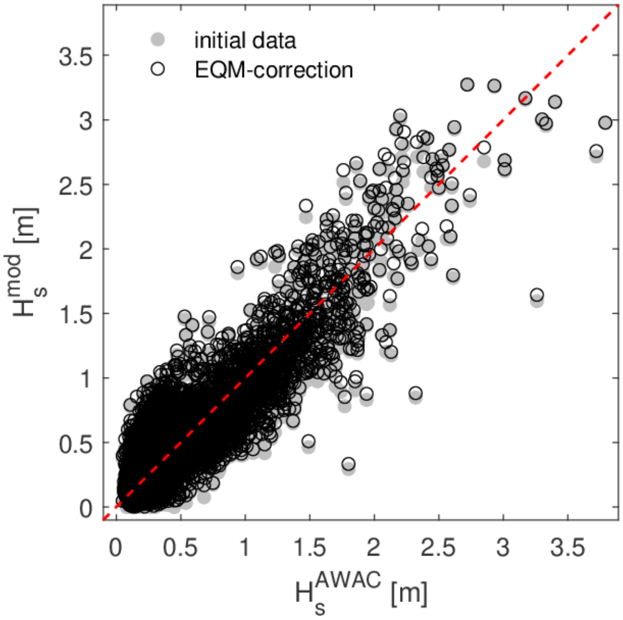

Figure 2 - Comparison of modeled and observed wave data at the AWAC sensor site.

Approach	Directional sector	100 years H_s
DW-EVM	S-SE	2.42
	S-SW	3.54
SW-EVM	S-SE	3.48
	S-SW	3.66

Table 1 – Parameters of the 100 years wave computed according to approaches 1 and 2.

REFERENCES

Camus, Mendez, & Medina (2011): A hybrid efficient method to downscale wave climate to coastal areas. *Coastal Engineering*, vol. 58, pp. 851-862.

De Leo, F., Enríquez, A. R., Orfila, A., & Besio, G. (2022). Uncertainty assessment of significant wave height return levels downscaling for coastal application. *Applied Ocean Research*, 127, 103303.

Mentaschi, Besio, Cassola, & Mazzino (2013): Developing and validating a forecast/hindcast system for the Mediterranean Sea. *Journal of Coastal Research*, vol. 65, pp. 1551-1556.