AN OVERVIEW OF THE WAVE ENERGY RESOURCES ALONG THE EUROPEAN COASTS

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Wave energy is abundant and has a higher density and predictability than wind and solar. Due to the global atmospheric circulation patterns the western coasts of the continents have higher wave energy. This resource is usually quantified in terms of wave energy flux (or wave power) expressed in watts per meter of crest length. The European coasts at the Atlantic Ocean are very resourceful from the point of the wave energy with average wave powers in general greater than 30W/m along the entire west European nearshore. The wave energy peak is close to the coast of Ireland with almost 80W/m as average wave power value in the nearshore (reaching even almost 100W/m in the offshore). A way to compare the resources from one time period to another, or between various geographical spaces, is to assess the normalised wave power. This is defined as the ratio between the average wave power corresponding to a certain place, or to a certain time interval, and the maximum value of the average wave power corresponding to all sites analysed, or alternatively to all time interval. This approach is particularly useful when comparing the wave power resources in different coastal areas.

However, there is variability in time of the wave power, with significantly higher values in the winter, variability that can be extended also from one year to another. That is why only a historical value of the average wave power is usually not enough, and in order to have an accurate picture of the wave conditions in a certain coastal environment, further and detailed evaluations of the wave conditions have to be performed. Besides, in situ measurements that indicate with precision the wave characteristics recorded in one point, nowadays satellite data provide relatively accurate and with an increasing resolution various parameters related to waves, especially the significant wave height, but although covering much larger areas/ However, they are still limited both in space and time. From this perspective, the best approach to assess the wave conditions in a certain region or coastal area is represented by the wave models. Such wave models based on the spectrum concept become in the last decades very effective tools in wave predictions. They integrate the action balance equation in five dimensions, time, geographical space (defined by latitude and longitude) and spectral space (defined by wave frequency and direction). The left side of this equation is the kinematic part, while the right side gives the sources terms (as wind input) and dissipations considered (as whitecapping, wave breaking or bottom friction). The process of energy transfer between the frequency bins due to nonlinear interactions is modelled in deep water through the quadruplet wave-wave interaction source term while in shallow water through triads for each being defined different source terms in the model. Although diffraction in water waves is a phase depended process and the spectral models are phase averaging, a parametrization for diffraction has been also implemented. The spectral wave models are generally classified in models focused on wave generation (as WAM or WW3) and models for wave transformation (as for example SWAN and STWAVE). Probably the most effective model can be considered at this moment SWAN (acronym from Simulating WAves Nearshore). Thus, although initially this model was designed especially for the costal environment, further on SWAN was extended to cover almost the full scale of the wave modelling process, from ocean basins to high resolution coastal areas.

In this context, advanced modelling techniques are considered by the research team of the DREAM project to assess the wave power at regional scales and identify the most significant hot spots. These are based on the SWAN model, which was implemented at the entire scale of the Atlantic Ocean, but also in the Mediterranean and Black Seas. Furthermore, the modelling system has been focused, considering various computational levels with increasing resolution, towards some coastal environments considered more significant, as for example the west Iberian nearshore. At the same time, considering various climate scenarios this modelling system will be used for evaluations of the expected dynamics of the wave power in the most relevant coastal environments.

Keywords: wave power, extreme events, hot spots, climate change, spectral wave models, SWAN

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