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Editorial

Numerical Assessments of Tidal Stream and Wave Energy in Coastal Shelf Seas

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Tidal stream and wave energy resources may have the potential to complement the exploitation of wind power currently promoted, in industrial countries, as one of the alternatives to fossil fuel energies. However, despite a wide range of energy converters tested and deployed in real sea conditions, the exploitation of tidal and wave resources still shows high economic uncertainties associated with the reduced lifespan and performance of devices. This has led to the failure of a series of innovative projects and reduced subsidies and investments. Thus, prior to the deployment of energy converters, refined numerical assessments are required to optimize the design and locations of devices while improving the economic reliability of projects. This Special Issue (SI) aims to promote original research papers and reviews dealing with numerical assessments of tidal stream and wave energy in coastal shelf seas.

Regarding the manuscripts published in this SI, particular interest has been given to the exploitation of wave energy, with only one investigation—conducted by Mackie et al. [1]—dealing with electricity generation from tidal resources. Complementing numerical assessments of the kinetic energy of tidal currents (see [2–4] for reviews of studies conducted in north-western Europe), tidal range energy is analysed in relation to the potential of three prospective power plants disseminated along the coast of Wales (UK). Particular interest is dedicated to the application of tidal range energy for continuous electricity generation. Beyond the approach of tidal dynamics, this investigation offers the contribution of a hydrodynamic model to explore different operational optimisation cases and assess project economic feasibility.

Specific research investigations were also conducted on wave energy converters (WECs), focusing on device performance in line with computational fluid dynamics approaches [5,6]. Thus, Neuvéglise et al. [5] investigated the behaviour of a floater oscillating in a heave motion in front of a dike with an analytical model assessed against numerical simulations with ANSYS Fluent software and experimental tests. In addition to using a physical approach to evaluate model performance, this study showcases the flexibility of numerical assessments for conducting a parametric analysis of floater dynamics, with respect to design and environmental conditions. Complementing this investigation, Medina Rodriguez et al. [6] studied the effects of front wall thickness and bottom profile on the performance of an oscillating water column (OWC) device. This investigation relied on a boundary element method (BEM) employing quadratic elements. In addition to numerous approximations associated with linear wave theory, this study exhibited, similarly to the previous study, the contributions of numerical assessments to provide further insights into OWC performances with respect to the thickness of the front barrier and the chamber length–water depth ratio.

These two evaluations were consistent with the review conducted by Sergent et al. [7] considering numerical assessments of onshore wave energy. Thus, interest is growing around near-shore and quayside systems used to convert wave energy into electricity.

These systems can be used to reduce maintenance and construction costs, and benefit from potential reflection effects liable to improve the amount of exploitable power. This review considered four families of onshore WECs including (i) over-topping systems, (ii) OWCs, (iii) oscillating flaps, and (iv) oscillating floats, focusing on available resources, device performance, and economic feasibility. Beyond theoretical considerations, an emphasis was placed on a wide range of potential locations along the coast of France, including an in-depth analysis of harbours in western Brittany and in the southern part of the Bay of Biscay. Complementing this evaluation of onshore technologies, Guillou et al. [8] proposed a review of the different methods for characterizing and technically exploiting the available wave energy resources in coastal shelf seas. Particular emphasis was placed on the exploitation of advanced numerical simulations at high spatial resolution liable to include the effects of tidal currents on waves, thus complementing resource evaluations based on in situ or remote-sensing observations, or large-scale hindcast databases. This review synthesized a series of pre- and post-production metrics to assess (i) resource temporal variability at annual and seasonal scales, (ii) WEC performances, and (iii) the economic reliability of a wave energy project.

Further investigations are naturally required to refine the evaluation of tide and wave energy resources in coastal shelf seas, including shallow water environments where hydrodynamics may be sensitive to environmental conditions (e.g., bathymetry, bottom friction, wave–current interactions, etc.) and may in turn impact the resources and performances of energy converters. The contributions of this SI will provide further insights regarding these different aspects, while promoting new investigations targeting the secure exploitation of renewable energies associated with tides and waves.

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