Editorial
Modelling of Harbour and Coastal Structures

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The world’s coasts are being continuously reshaped by the interplay between natural- and human-induced pressures. Projected climate change-driven variations in mean sea level, wave conditions and storm surges will add to the existing pressures, as already manifested by the effects of the presently observed climate variability on the frequency and intensity of extremes.

Being the most heavily populated areas in the world, coastal zones host the majority and some of the most important human settlements, infrastructure and economic activities. Harbour and coastal structures are essential to the above, facilitating the transport of people and goods through ports, and protecting low lying areas against flooding and erosion. While based on relatively rigid concepts about service life in the past, nowadays, the design of these structures—or the upgrading of existing structures—should effectively proof them against future pressures, enhancing their resilience and long-term sustainability (i.e., their compliance to performance and operability criteria).

In the above context, the scope of this Special Issue has been to investigate various aspects and methodological approaches on the modelling of harbour and coastal structures. The collection of articles published in the Special Issue is deemed to successfully serve this scope, as the body of work presented in the following covers a wide array of topics on the design of such structures through the study of their interactions with waves and coastal morphology, as well as on their role in coastal protection and harbour design.

Starting with studies that combine traditional and modern approaches for the evaluation of breakwater stability, ref. [1] presents two novel data-driven models based on the Extreme Machine Learning algorithm for the stability assessment of rubble-mound breakwaters, and compare their results to a well-established formula and two formulae derived from machine learning and genetic programming methods. On the same topic, ref. [2] investigates the conventional deterministic approach for the design of composite caisson breakwaters using reliability approaches (combining reliability methods and Monte Carlo simulations), and compares results for the evaluation of the three most significant failure modes of nine breakwaters in Korea. Shifting the focus to the use of advanced numerical models, ref. [3] presents a model based on the modified two-dimensional Navier–Stokes equations for two-phase flows in porous media and uses it to study the effect of various design parameters on the hydrodynamics and flow behavior in the vicinity of rubble-mound, permeable, zero-freeboard breakwaters. On the same topic, ref. [4] combines hydrodynamics and morphodynamics modelling in order to study the scour depth and patterns in front of vertical-wall breakwaters, presenting a coupled model that consists of a hydrodynamic model based on the Reynolds-Averaged Navier–Stokes equations (developed on the OpenFOAM toolbox) and a morphodynamics model based on a new formulation for the estimation of bed and suspended sediment load. On the general topic of damage evaluation in rubble-mound breakwaters, discussion, analysis and useful insights can be found in the companion review papers of [5,6], which cover aspects from the historical review of damage models to damage identification and assessment.

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Moving to topics related to harbour structures and harbour layout design, ref. [7] investigates the siltation problems in the harbour basin and approach channel of the Nowshahr Port in the Caspian Sea through the evaluation of field measurements and numerical modelling, using for the latter the wave, hydrodynamics and morphodynamics models of the DHI MIKE software package in coupled runs. Incorporating an aspect most interesting for natural hazard mitigation to the same general topic, ref. [8] studies the impact of tsunamis on wave agitation and related damages in harbours through a combination of numerical modelling (DHI MIKE software package) and damage mechanisms/threshold analysis; the event studied is the 2003 Boumerdès Earthquake and the analysis regards three ports in the Western Mediterranean.

Regarding approaches related to the design of protection and adaptation measures for coastal areas, ref. [9] presents a methodology for the design of coastal protection projects combining morphological modelling using an in-house model and a new nourishment performance index, the authors’ case study being a project (groin field + beach nourishment) in Abu Dhabi, UAE. Shifting the focus to improving the operational usefulness of coastal evolution models, ref. [10] present a wave input-reduction method based on the Shields criterion of incipient motion, applying the wave, hydrodynamics and morphodynamics models of the DHI MIKE software package in coupled runs, along with an in-house model, to a case study in Crete, Greece. Incorporating the impact of climate change on the same general topic, ref. [11] presents a set of interoperable in-house models (i.e., a large-scale wave propagation model, a storm-induced circulation model and an advanced nearshore wave propagation model based on the higher order Boussinesq-type equations) and applies them for projected scenarios of climate change-induced wave and storm surge events, simulating coastal flooding over the low-lying areas of a semi-enclosed bay and testing the effects of different structures on a typical sandy beach (both in northern Greece).

Concluding with studies that incorporate structural and geotechnical analysis aspects to the studied topics, ref. [12] investigates the hydrodynamic coefficients of column-stabilized structures in the coastal environment through combined physical and numerical modelling, the latter using the finite element software ANSYS. Following a combined physical and numerical modelling approach as well, ref. [13] investigates the interaction between wave loading and structural response for mortar-grouted riprap revetments, adopting the Plate on an Elastic Foundation model for the in-house algorithm developed for their numerical analyses. Focusing on an issue relevant to the stability of most structures built in the marine environment, ref. [14] investigates the uncertainty in settlement prediction of pile foundations, studying the performance of an embankment built by hydraulic filling with the use of an analytical model fitted to pile load test outputs, and afterwards tested by a probabilistic approach.

All in all, readers of this Special Issue will find in it a versatile collection of articles on the modelling of harbour and coastal structures, covering a variety of aspects, viewpoints and methodological approaches on the studied topics. The Editors hope that this Special Issue will contribute to research efforts in the field, as well as to the general discussion towards effectively designed coastal protection and adaptation measures in present and future climates.

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**References**

1. Wei, X.; Liu, H.; She, X.; Lu, Y.; Liu, X.; Mo, S. Stability Assessment of Rubble Mound Breakwaters Using Extreme Learning Machine Models. *J. Mar. Sci. Eng.* 2019, 7, 312. [CrossRef]
2. Doan, N.S.; Huh, J.; Mac, V.H.; Kim, D.; Kwak, K. Probabilistic Risk Evaluation for Overall Stability of Composite Caisson Breakwaters in Korea. *J. Mar. Sci. Eng.* 2020, 8, 148. [CrossRef]
3. Koutrouveli, T.I.; Dimas, A.A. Wave and Hydrodynamic Processes in the Vicinity of a Rubble-Mound, Permeable, Zero-Freeboard Breakwater. *J. Mar. Sci. Eng.* 2020, 8, 206. [CrossRef]
4. Karagiannis, N.; Karambas, T.; Koutitas, C. Numerical Simulation of Scour Depth and Scour Patterns in Front of Vertical-Wall Breakwaters Using OpenFOAM. *J. Mar. Sci. Eng.* 2020, 8, 836. [CrossRef]
5. Campos, Á.; Castillo, C.; Molina-Sanchez, R. Damage in Rubble Mound Breakwaters. Part I: Historical Review of Damage Models. *J. Mar. Sci. Eng.* 2020, 8, 317. [CrossRef]
6. Campos, Á.; Molina-Sanchez, R.; Castillo, C. Damage in Rubble Mound Breakwaters. Part II: Review of the Definition, Parameterization, and Measurement of Damage. *J. Mar. Sci. Eng.* 2020, 8, 306. [CrossRef]
7. Mahmoodi, A.; Lashteh Neshaei, M.A.; Mansouri, A.; Shafai Bejestan, M. Study of Current- and Wave-Induced Sediment Transport in the Nowshahr Port Entrance Channel by Using Numerical Modeling and Field Measurements. *J. Mar. Sci. Eng.* 2020, 8, 284. [CrossRef]
8. Masina, M.; Archetti, R.; Lamberti, A. 21 May 2003 Boumerdès Earthquake: Numerical Investigations of the Rupture Mechanism Effects on the Induced Tsunami and Its Impact in Harbors. *J. Mar. Sci. Eng.* 2020, 8, 933. [CrossRef]
9. Hamza, W.; Tomasicchio, G.R.; Ligorio, F.; Lusito, L.; Francone, A. A Nourishment Performance Index for Beach Erosion/Accretion at Saadiyat Island in Abu Dhabi. *J. Mar. Sci. Eng.* 2019, 7, 173. [CrossRef]
10. Papadimitriou, A.; Panagopoulos, L.; Chondros, M.; Tsoukala, V. A Wave Input-Reduction Method Incorporating Initiation of Sediment Motion. *J. Mar. Sci. Eng.* 2020, 8, 997. [CrossRef]
11. Samaras, A.G.; Karambas, T.V. Modelling the Impact of Climate Change on Coastal Flooding: Implications for Coastal Structures Design. *J. Mar. Sci. Eng.* 2021, 9, 1088. [CrossRef]
12. Zhao, Y.-P.; Chen, Q.-P.; Bi, C.-W.; Cui, Y. Experimental Investigation on Hydrodynamic Coefficients of a Column-Stabilized Fish Cage in Waves. *J. Mar. Sci. Eng.* 2019, 7, 418. [CrossRef]
13. Kreyenschulte, M.; Schüttrumpf, H. Tensile Bending Stresses in Mortar-Grouted Riprap Revetments Due to Wave Loading. *J. Mar. Sci. Eng.* 2020, 8, 913. [CrossRef]
14. Bueno Aguado, M.; Escolano Sánchez, F.; Sanz Pérez, E. Model Uncertainty for Settlement Prediction on Axially Loaded Piles in Hydraulic Fill Built in Marine Environment. *J. Mar. Sci. Eng.* 2021, 9, 63. [CrossRef]