Mathematics and the Ocean

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Tsunami hazard in the context of sustainable development

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The effects of tsunamis continue to be underappreciated or neglected in risk management of about the 60% of the world's coastal cities in tsunami-prone regions. Numerical approaches are potential tools to characterize the physics involved during a tsunami and tsunami-structure interactions. A numerical scheme composed of 1) an Eulerian system of Shallow-Water equations solved by Finite Volume method to reproduce the tsunami propagation and 2) a Lagrangian scheme of Navier-Stokes equations solved by Smoothed Particle Hydrodynamics method to reproduce the forces exerted against the structure was coupled by Dirichlet boundary conditions naturally inherent to each of the methods to investigate the tsunami actions. The numerical solutions of tsunami-like waves propagation and interaction with an elevated structure were correlated with physical data acquired during an experimental campaign [1]. After the experimental calibration and validation of the method, it was adopted to infer the effects of a severe tsunami scenario [2] on the strategic Sines port, which is currently in expansion to increase its international competitiveness. Supposing tsunami-engineering considerations keep being neglected by technicians, stakeholders and policy-makers, such an event can potentially constrain ecological, social and economic aspects of sustainable development, leading to short- and long-term impacts that will be difficult to revert.

References

[1] Claudia, Reis, et al. , *Experimentally validated numerical models to assess tsunami hydrodynamic force on an elevated structure.*, Engineering Structures 249, 113280 (2021).

[2] Claudia, Reis, et al. , *Cascade earthquake and tsunami hazard assessment: A deterministic perspective for engineering purposes.*, International Journal of Disaster Risk Reduction 75, 102952 (2022).