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Numerical Investigation of Tsunami Flow Characteristics and Energy Reduction through Flexible Vegetation

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Abstract : The investigation of tsunami flow characteristics and the quantification of tsunami energy reduction through the coastal vegetation is important to understand the protective benefits of nature-based mitigation parks. In the present study, a three-dimensional non-hydrostatic incompressible Computational Fluid Dynamics model with a two-way coupling enabled fluid-structure interaction approach (FSI) is used. After validating the numerical model against experimental data, tsunami flow characteristics have been investigated by varying vegetation density, modulus of elasticity, the gap between stems, and arrangement or distribution of vegetation patches. Streamwise depth average velocity profiles, turbulent kinetic energy, energy flux reflection, and dissipation extracted by the numerical study will be presented in this study. These diagnostics are essential to assess the importance of different parameters to design the proper coastal defense systems. When a tsunami wave reaches the shore, it transforms into undular bores, which induce scour around offshore structures and sediment transport. The bed shear stress, instantaneous turbulent kinetic energy, and the vorticity near-bed will be presented to estimate the importance of vegetation to prevent tsunami-induced scour and sediment transport.

Keywords : coastal defense, energy flux, fluid-structure interaction, natural hazards, sediment transport, tsunami mitigation
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