World Academy of Science, Engineering and Technology
International Journal of Marine and Environmental Sciences
Vol:14, No:09, 2020

Quantifying Wave Attenuation over an Eroding Marsh through Numerical Modeling

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Abstract : Although wetlands have been proposed as a green alternative to manage coastal flood hazards because of their capacity to adapt to sea level rise and provision of multiple ecological and social co-benefits, they are often overlooked due to challenges in quantifying the uncertainty and naturally, variability of these systems. This objective of this study was to quantify wave attenuation provided by a natural marsh surrounding a large oil refinery along the US Gulf Coast that has experienced steady erosion along the shoreward edge. The vegetation module of the SWAN was activated and coupled with a hydrodynamic model (DELFT3D) to capture two-way interactions between the changing water level and wavefield over the course of a storm event. Since the marsh response to relative sea level rise is difficult to predict, a range of future marsh morphologies is explored. Numerical results were examined to determine the amount of wave attenuation as a function of marsh extent and the relative contributions from white-capping, depth-limited wave breaking, bottom friction, and flexing of vegetation. In addition to the coupled DELFT3D-SWAN modeling of a storm event, an uncoupled SWAN-VEG model was applied to a simplified bathymetry to explore a larger experimental design space. The wave modeling revealed that the rate of wave attenuation reduces for higher surge but was still significant over a wide range of water levels and outboard wave heights. The results also provide insights to the minimum marsh extent required to fully realize the potential wave attenuation so the changing coastal hazards can be managed.

Keywords : green infrastructure, wave attenuation, wave modeling, wetland
Conference Title : ICCOE 2020 : International Conference on Coastal and Ocean Engineering
Conference Location : San Francisco, United States
Conference Dates : September 24-25, 2020

Open Science Index, Marine and Environmental Sciences Vol:14, No:09, 2020 publications.waset.org/abstracts/126418.pdf