Stem breakage of salt marsh vegetation under wave forcing: A field and model study

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Abstract

One of the services provided by coastal ecosystems is wave attenuation by vegetation, and subsequent reduction of wave loads on flood defense structures. Therefore, stability of vegetation under wave forcing is an important factor to consider. This paper presents a model which determines the wave load that plant stems can withstand before they break or fold. This occurs when wave-induced bending stresses exceed the flexural strength of stems. Flexural strength was determined by means of three-pointbending tests, which were carried out for two common salt marsh species: Spartina anglica (common cord-grass) and Scirpus maritimus (sea club-rush), at different stages in the seasonal cycle. Plant stability is expressed in terms of a critical orbital velocity, which combines factors that contribute to stability: high flexural strength, large stem diameter, low vegetation height, high flexibility and a low drag coefficient. In order to include stem breakage in the computation of wave attenuation by vegetation, the stem breakage model was implemented in a wave energy balance. A model parameter was calibrated so that the predicted stem breakage corresponded with the wave-induced loss of biomass that occurred in the field. The stability of Spartina is significantly higher than that of Scirpus, because of its higher strength, shorter stems, and greater flexibility. The model is validated by applying wave flume tests of Elymus athericus (sea couch), which produced reasonable results with regards to the threshold of folding and overall stem breakage percentage, despite the high flexibility of this species. Application of the stem breakage model will lead to a more realistic assessment of the role of vegetation for coastal protection

Keywords:

Salt marsh, Vegetation, Wave attenuation, Stem breakage model, Three-point-bending test, Coastal protection