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WAVE INDUCED EROSION IN ARTIFICIAL VEGETATED BEDS

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Vegetation has long been considered a component of any coastal resiliency plan. However, the magnitude of its importance has not been directly measured. Vegetation has been shown to both reduce the erosion due to waves and increase the residence time of sediment, which may lead to land building. This study aims at quantifying these beneficial properties for *Spartina alterniflora* commonly known as smooth cordgrass. To simulate *S. alterniflora* in the laboratory, polyolefin tubing cut to 41.5 cm are mounted in a staggered array of three varying densities of 100, 200 and 400 stems per square meter. Polyolefin tubing was chosen as the artificial vegetation since it has a comparable Young's modulus to *S. alterniflora* (Feagin et al., 2011).

The study is conducted in a 63m by 3m wave flume to measure the change in orbital velocities and turbulence of waves propagating through a 9.8 meter long emergent and submerged artificial vegetated bed. The wave flume was divided with a wall to provide simultaneous measurement of the control and vegetated side. The propagating waves are measured with 18 wave gauges, 6 acoustic Doppler velocimeters (ADV), and one high resolution acoustic Doppler current profiler. The ADVs were place at 0.95, 4.09, and 9.29 meters in both the control and vegetated sides. The waves are generated using a TMA spectrum with four peak wave periods, T, of 1.5, 1.75, 2.0 and 2.25 seconds and three water depths, h, of 30.48, 45.72 and 53.34 cm. These water depths correspond to vegetation submergence ratios, l_s/h, of 1.36 (emergent), 0.90, and 0.78.

The three ADV pairs revealed trends also seen in the wave gauge measurements whereby the velocity in the vegetation, u_v, is normalized by the velocity in the control, u_c. Figure 1 shows three subplots that reveal the dependence of the wave dissipation on wave period, wave height, and water depth for the lowest stem density. Subplot (a) shows higher dissipation correlated to longer wave periods. For a peak wave period of 2.0 s, subplot (b) shows the dissipation is greater for an increased wave height. Subplot (c) demonstrates the dependence of wave dissipation on submergence, where dissipation decreases with increased submergence.

The artificial vegetation leads to an increase in the turbulent energy present at higher wavenumbers, as seen in subplot (d). This spectrum includes both the wave and turbulent components with the mean removed. A closer inspection shows the spectral energy associated with the waves is smaller in the vegetation compared to the control as a result of wave attenuation at the paired location. Turbulence generation (k >1m) in the vegetation is higher, leading to greater dissipation.

In summary, preliminary results illustrate that a wave spectrum with a longer peak period will dissipate at a higher rate. Also, increasing the l_s/h ratio leads to greater dissipation. Longer-

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period waves have a greater wavelength, bottom excursion amplitude, and a more developed boundary layer, leading to greater potential for sediment erosion. The vegetation decreases wave velocities, thus, reducing the bottom shear stress and limiting sediment erosion. However, the increase in turbulence in the water column may decrease the rate of deposition by limiting flocculation of fine sediment.

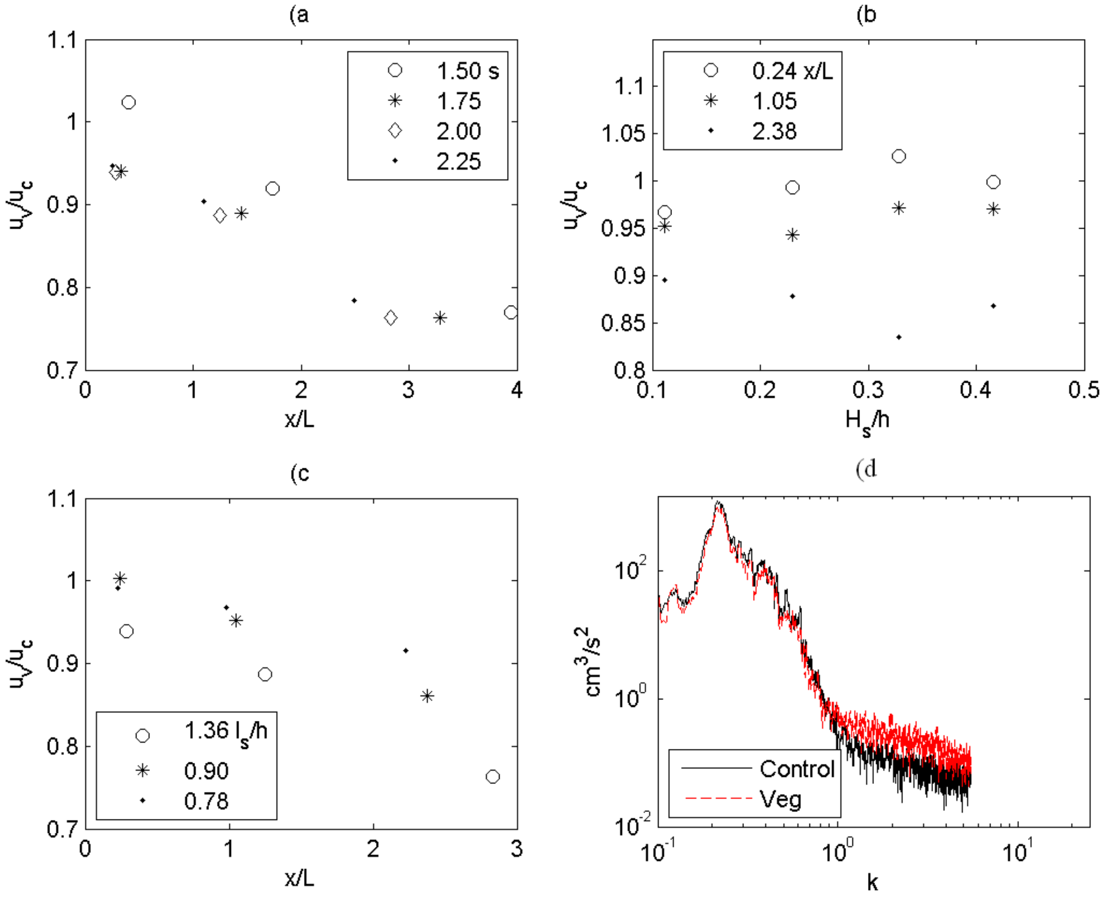

Figure 1 Wave velocity dissipation for varying peak periods (a), incident significant wave heights (b), and submergence (c). Subplot (d) is a spectral comparison between the paired ADVs at 4.09m.

REFERENCES

Feagin, R. A., Irish, J. L., Möller, I., Williams, A.M., Colon-Rivera, R. J., and Mousavi, M. E. (2011) "Short Communication: Engineering Properties of Wetland Plants with Application to Wave Attenuation", Coastal Engineer, Vol. 58, pp. 251-255.