Vegetation Farms as a Solution to Coastal Erosion for Saco Bay

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Introduction

Camp Ellis is under increasing environmental and economic threat from coastal erosion, losing up to 60 cm of beach per year. Previous attempts to mitigate erosion, including rock jetties along Saco River, exacerbated the problem by impeding natural sand restoration. The establishment of vegetative farms along the coastal zone, such as kelp or seagrass, is under consideration to attenuate incoming water waves through complex physical processes, such as

- Momentum transfer from waves to vegetation
- Vegetation skin friction
- Drag forces on current flow

Air Photo of Camp Ellis[1]

Methodology

Oceanographic data for Saco Bay was obtained from USACE[1], and geometric properties of sugar kelp (*S. latissima*) and seagrass (*Z. marina*) were obtained from Luhar, *et al*[2,3]. This data was used to develop an analytical model which calculates wave height and current attenuation as they propagate over a vegetation farm.

$$\frac{H}{H_0} = \frac{1}{1 + K_D H_0 x}$$

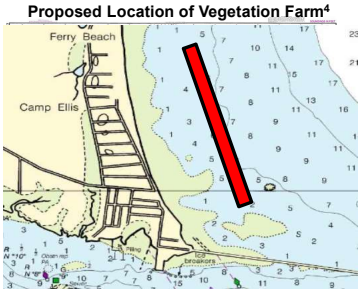
where $\frac{H}{H_0}$ is the ratio of final wave height to original wave height, and x is the position along the farm. K_D is the decay rate, defined as

$$K_D = \frac{2ka_v}{9\pi} C_D \left[\frac{9\sinh kl_e + \sinh 3kl_e}{\sinh kh\,(\sinh 2kh + 2kh)} \right]$$

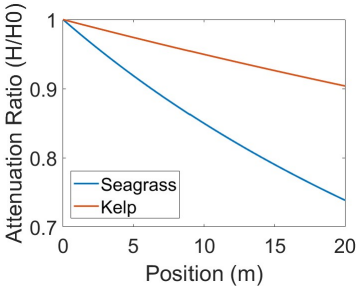
where a_v is the vegetation frontal area per unit volume, C_D is the drag coefficient, $k = 2\pi/\lambda$ is the wave number, λ is the wavelength, l_e is the effective blade length, and h is the stillwater depth.

Results

Proposed Location of Vegetation Farm[4]



Wave Attenuation Rates At Depth 5m



For a hypothetical farm of size 1370 m x 20 m, wave attenuation rates are upwards of 10% for kelp and 27% for seagrass. Although kelp is longer and wider than seagrass, seagrass is more densely planted, which our analytical model indicates is the primary determinant in wave attenuation. Estimated material costs are approximately $232,000 and $6,989,000 for a kelp and seagrass farm of this size. In comparison, a proposed perpendicular spur off of the rock jetty is estimated to cost $27 million[5]. Seagrass farming is an emergent industry in Maine, and local marketing trends indicate that industrial scale farming will be viable in the near future.

Conclusions

Vegetation farms and a beach nourishment program have the potential to reverse the effects of erosion, and they are relatively inexpensive to develop. However, they would require an infrastructure investment and consistent maintenance. Future studies should utilize numerical models to extensively examine environmental and economic impacts, in order to improve understanding of establishing vegetation farms along coastal zones.

Bibliography

1. USACE (2013), “Saco River and Camp Ellis Beach Saco, Maine”, Section 111 Shore Damage Mitigation Project Final Draft Decision Document and Environmental Assessment
2. Luhar, M., & Nepf, H. M. (2011). Flow-induced reconfiguration of buoyant and flexible aquatic vegetation. *Limnology and Oceanography*, *56*(6), 2003-2017.
3. Luhar, M., Infantes, E., & Nepf, H. (2017). Seagrass blade motion under waves and its impact on wave decay. *Journal of Geophysical Research:Oceans*.
4. “Saco Bay Nautical Chart.” Office of Coast Survey. NOAA, http://www.charts.noaa.gov/OnLineViewer/13287.shtml
5. Gotthelf, Liz. "Price tag for erosion mitigation project increases." Journal Tribune [Biddeford] June 17, 2017

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