Adaptation to a Changing Climate in the Coastal Zone – A Case Study of Prime Hook National Wildlife Refuge

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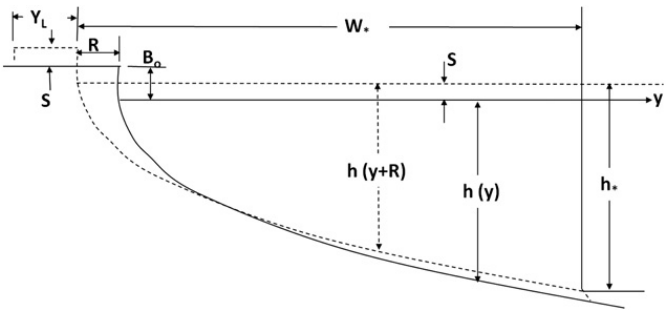
Prime Hook National Wildlife Refuge and its adjacent water bodies are important natural features along western Delaware Bay, USA. Historically salt and brackish marsh habitats, portions of the Refuge were diked and managed as freshwater impoundments starting in the early 1980s. Over the past decade, some of these impoundments have reverted to saline conditions, largely due to several storm events (including Hurricane Sandy in 2012) that have caused flooding, erosion, and opened several breaches between the Refuge and Delaware Bay. Because of these significant morphologic changes, the United States Fish and Wildlife Service (USFWS) completed a series of surveys and coastal engineering analysis to aid in developing restoration alternatives for managing the Refuge. As part of this effort, seasonal shoreline surveys were conducted in the fall of 2011 through the spring of 2017 to provide a temporal span of data for evaluating the rapid retreat.

The analysis followed the program developed by the U.S. Geological Survey (Thieler, et al., 2009) and the guidance of the shoreline analysis protocol produced for the National Park Service (Psuty, et al., 2010). This information coupled with historic survey positions demonstrated an acceleration in shoreline retreat of approximately 1.3 m/year to 3.1 m/year.

Herein will present findings from an analysis that evaluated the relationship between sea level rise and shoreline retreat using the Bruun Rule (Bruun, 1954, 1962). Scientists and engineers have widely used theBruun Rule to examine the relationship between sea level rise and shoreline retreat for over 50 years. The Bruun Rule calculates the amount of shoreline retreat as a function of sea level change based on the closed sediment balance between the beach/nearshore and offshore bottom profile. Moreover, this work will compare results between the Bruun Rule and Modified Bruun Rule Eq.(1) and Figure 1 that includes the landward transport of sediment due to overwashing, aeolian transport, etc. (Rosati, J.D., 2013).



The findings will demonstrate the difference between the two methods and correlate the results to sea level rise observations (Delaware Geologic Survey, 2016) to shoreline retreat. Also, this work will review the results of the strategic planning used in conjunction with the analysis to recommend a preferred alternative for managing the Refuge under the new environmental regime aimed at resiliency. A variety of marsh and beach configurations were developed and tested for their effects on water levels and salinity within the Refuge. The preferred design included dredging of 50 kilometers of conveyance channels and “thin layer” disposal of 460,000 cubic meters of sediment within the marsh and placement of 1.3 million cubic meters of sand along the shoreline to reconstruct the dune/beach and back-barrier system.

$$R \cong S \frac{W_* + V_D/S}{h_* + B_o} \quad (1)$$