EVALUATING THE CAPACITY OF NATURAL AND NATURE-BASED FEATURES TO REDUCE COASTAL STORM HAZARDS

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PURPOSE & MOTIVATION

This presentation and paper describes the capacity of natural and nature-based features (NNBF) to reduce coastal storm hazards. Through a synthesis of existing literature and studies, as well as meta-analysis and traditional data analysis where possible, the salient characteristics and capabilities of NNBF at reducing storm surge, wave action, and erosion are characterized. The research specifically focuses on the capacity of aquatic vegetation, oyster and coral reefs, beaches, dunes, maritime forests, and barrier islands to reduce and/or mitigate these coastal hazards.

NATURAL & NATURE-BASED FEATURES

The use of NNBF has long been an environmentally preferred strategy for habitat and ecosystem restoration. Such features are frequently being considered as a means of reducing the risk of coastal hazards. However, in recent years the focus on NNBF has shifted somewhat towards the concept of using them for reducing the risk of coastal storm hazards under current and future climates. Recent examples are Hurricane Katrina in the Gulf of Mexico in 2005 and Superstorm Sandy in the Northeastern US in 2012, where NNBF are being used to restore damaged coastlines. To some degree, though, the focus on NNBF for storm damage reduction may date back to the restoration of the historic marsh footprint of the Mississippi River Delta, based on evidence that marshes, as well as other natural components of coastal ecosystems such as seagrass beds and biogenic reefs, can buffer wave energy and reduce storm damage under varying storm intensities and sea levels. Despite increasing calls for NNBF, the degree to which NNBF truly lessen the risk of coastal storm hazards is not well known.

With approximately 14% of the U.S. shoreline now armored (Gittman et al., 2015), and much larger proportions of armoring along urban estuary shorelines, the need for adopting NNBF in environmental management and regulation policies is growing more important. Armored shorelines, such as bulkheads and walls, may have a series of deleterious impacts on the environment such as enhancing erosion on the adjacent bottom through reflection of waves and wakes, and leaching of contaminants as the armored structure ages. In addition, the construction of armored shorelines may degrade or require the removal of fringing marshes along the coastline, which are important nursery habitat for many commercially important fish species as well as filters of land-derived runoff pollution. Therefore, the replacement of armored shorelines with NNBF and/or adoption of NNBF in policies of storm hazard management and risk reduction could be highly beneficial for both coastal human and ecological communities since, along with providing effective protection against storms it would also enhance the health and productivity of coastal ecosystems (see Figure 1).

Figure 1 – This project in Pensacola, FL uses NNBF (oyster reefs offshore and fringing wetlands) for habitat enhancement and also protects a coastal roadway.

The best available science describing the physical performance and resilience of NNBF will be presented, including quantitative information where available. Significant knowledge gaps and implementation challenges will also be highlighted. Preliminary results indicate that there are some existing methods for quantifying the effects of NNBF on storm surge, waves, and erosion. For example, the published literature contains references to the wave tolerance and attenuating capabilities of aquatic vegetation, maritime forests, and reef systems. However, with few exceptions these capabilities have not been described in an engineering or risk-based context. A notable exception is our understanding of the protection that a coastal dune provides against coastal storm surge (and waves). Our community of professionals—in academia and practice—should look for opportunities to expand similar risk-based formulations to other common NNBF for the purpose of engineering design.

REFERENCES

Gittman, Fodrie, Popowich, Keller, Bruno, Currin, Peterson, Piehler (2015): Engineering away our natural defenses: an analysis of shoreline hardening in the US. Front. Ecol. Environ., vol. 13, no. 6, pp. 301-307.