

Design and Management of Natural and Nature Based Features Case Studies in Southwest Florida, USA

Mohamed A. Dabees
Humiston & Moore Engineers, 5679 Strand Ct., Naples, FL, 34110
md@humistonandmoore.com

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Abstract:

Natural disasters and coastal storms present an increasing threat for public safety and property damage in coastal communities. Climate and weather-related natural disasters have been on the rise in intensities and frequency over the past decades. The geography and exposure of the State of Florida to coastal storms necessitates development of coastal resiliency plans to manage and reduce the risk of flooding and damage due to coastal storms. Southwest Florida in particular, experienced increased frequency and intensity of tropical storms with multiple major hurricanes impacting the region over the past few decades. Recently, Hurricane Ian caused major catastrophic damages to the region in 2022 and Hurricane Idalia impacted the coastal areas with storm surge and waves as it passed through the Gulf of Mexico in 2023.

Natural and Nature Based Features (NNBF) are among recent concepts to utilize natural landscape features instead of hard structures to reduce risk of damage caused by coastal storms. NNBF concepts include maintaining natural morphological features as sustainable coastal protection measures for both environmental habitat and upland development. Examples of NNBF include beaches, dunes, wetlands, reefs and barrier islands that can dissipate storm energy and reduce the risk of damage to upland areas. Unlike hard structures NNBF can evolve with changing hydrodynamics allowing adaptability to future conditions and potential sea level change. The challenges for such features include spatial coverage availability, sustainability and feasibility to construct and maintain such features. New natural based barrier systems can be very challenging to implement in open coast conditions where development and coastal encroachment limit spatial availability between open coast and developed areas. However, enhancement of existing natural system in natural preserve areas adjacent to developed communities presents opportunities to preserve and enhance existing natural system to function as nature based coastal resiliency features.

Integrating the objectives of the environmental preservation of natural resources and upland development coastal management objectives is another challenge. Coastal management in the US in general and Florida in particular is regulated primarily for environmental protection ahead of other issues. The technical approach and management efforts discussed in this paper demonstrate balancing engineering design objectives with existing environmental regulations mandated by state and federal agencies in the United States. Among the challenges to this approach is to develop a plan that satisfies environmental protection objectives and those with upland development for coastal and flood risk reduction. Often the objectives of upland development and protected preserve areas are not coordinated, and as a result are managed independent of each other. Coastal flooding resiliency efforts typically focus on reducing risks for flooding of infrastructure and protecting habitable structures under future SLR scenarios and increased intensity of storms. On the other hand, environmental protection and preservation of ecosystems can be focused on protecting existing natural settings (natural preserves). Some aspects of that preservation are managed by designation of undeveloped ecosystems as natural preserves. When not maintained, in many instances, erosion of natural features progress until hard shore protection may be necessary.

Among the advantages of NNBF is adaptability to long term climate and morphologic changes. An incremental nature-based approach can start with preserving morphologic features that existed and functioned at time scales of years to decades. This approach would also allow for an adaptive management that is able to adjust in response to barrier island dynamics,

influences and climate change and would be more sustainable than conventional methods of typical flood wall, barriers and hardened shorelines.

This paper will discuss two examples of NNB in Southwest Florida, their responses to tropical storms and the management efforts to maintain those features. Examples include Clam Bay Natural Resources Protection Area (NRPA) in Naples and The Tigertail Lagoon/ Sand Dollar Island Ecosystem in Marco Island (Dabees et al 2022). Among the important aspects of the design development of such NNBs is the intersection between evolving coastal systems bordered by heavily developed coastal areas. For such quasi-natural systems to exist, management and maintenance are necessary to restore and support the vitality of such systems otherwise the erosion and retreat of such natural features may continue until it reaches the upland development. In many instances upland developments do not qualify for hard shore protection or structural solutions unless meeting eligibility and vulnerability requirements. As such, areas that are subject to chronic erosion without active beach management efforts would eventually qualify for conventional shore protection measures in the future via various types of shorelines hardening or coastal structures.

The Clam Bay NRPA represent the coastal front of Pelican Bay development in Naples and include 570 acres of nature preserve including 420 acres of mangroves, multiple tidal bays connected to the Gulf of Mexico through the small tidal inlet of Clam Pass. The Tigertail Lagoon/Sand Dollar Island Ecosystem in Marco Island consists of a 2-mile long sandspit backed by large tidal lagoon/ wetlands and mangrove shorelines on the northwest part of Marco Island. The Tigertail Lagoon/Sand Dollar Island Ecosystem habitats cover over 200 acres of wildlife habitat encompassing over 100 acres of tidal lagoon, wetland and mudflats with over 12 acres of seagrass beds, 48 acres of coastal vegetation, and over 40 acres of sandy habitat areas while acting as the coastal front of the northern part of Marco Island. The initial restoration project was constructed in 2023 followed by a comprehensive monitoring and maintenance program. **Figure 1** shows the collapse of the sand spit and tidal lagoon system due to natural evolution and hurricane Ian impacts in 2022 and the restoration project completed in 2023.



Figure 1. NNB example of Tigertail Lagoon/ Sand Dollar Island Restoration

The paper will discuss the distinct natural features of each system, the hydrodynamic and morphological design aspects and resiliency to tropical storms. The presentation will also discuss operational maintenance and adaptive management efforts.

References:

Dabees MA, Fleming M and Damon M (2022) Natural and nature-based features for environmental enhancement and coastal storm risk management: a case study on Marco Island, Florida, United States. *Front. Built Environ.* 8:884692. doi: 10.3389/fbuil.2022.884692