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Factors Influencing the Performance of Several Beach Nourishment Projects: Pinellas County, Florida, USA

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Beach nourishment has become a common method for erosion mitigation, especially in the United States. Many factors can influence the physical performance of beach nourishment projects, including both natural and anthropogenic. Natural forces that affect the performance of fill, includes variations in littoral drift induced by seasonal changes of the predominant direction of waves and currents, seasonal response to storms, wave refraction due to bathymetry variations, and post-nourishment profile and planform equilibration. Anthropogenic factors include not only the initial design of the fill including geometry and sediment compatibility, but also shoreline and morphology modifications due to the presence of or proximity to structures. This study examines factors influencing the temporal and spatial performance of several beach nourishment projects constructed in 2006 along three barrier islands in west-central Florida, USA. Morphologic characteristics of this microtidal low-wave energy coast include a shoreline orientation change of 65º from northwest to southwest; a slightly deeper inner continental shelf in the northern portion of the study area; and a regional southward longshore sediment transport interrupted by two tidal inlets. Waves in the study area are typically sea-type generated by local winds with an average significant wave height of less than 0.4 m. Higher waves are associated with the passages of cold fronts roughly every couple of weeks in the winter and occasional tropical storms in the summer.

The performance of the nourishment projects is evaluated based on monthly surveys of 145 beach-profiles spaced less than 300 m, extending to roughly the short-term closure depth. Erosion or deposition on the dry beach, above MSL, above spring low tide, and across the entire profile are calculated as the volume changes above +1 m, 0 m, -1 m NAVD88, and the depth of closure (DOC), respectively. The influence of the project length, width, and orientation, characteristics of the profiles (i.e. barred or non-barred), background transport gradients, grain size, regional bathymetry, and proximity to tidal inlets and structural barriers on nourishment performance are analyzed using surveyed beach profiles and wave modeling.

Spatial and temporal variations occurred at individual profiles as well as regionally. Generally, beach profiles can be classified as barred and non-barred (or winter and summer-profile, respectively). For the barred beaches, offshore bar migration and intertidal erosion occurred directly after a proximal high-energy event, such as a strong winter or nearby tropical storm. Subsequent to storms, gradual onshore bar migration with accretion in the vicinity of the shoreline occurred. Distal passages of strong tropical storms and the associated long-period swells tend to induce onshore bar migration. Profile change along barred beaches was dominated by the above cross-shore sediment transport patterns, and resulted in little volume change above DOC. Non-barred beach profiles, occurring in areas with interruption of the littoral drift (either by inlets or groins) or in areas of other hydrodynamic anomalies, (i.e. wave energy focusing due to a relic dredge pit). In contrast, profile change dominated by longshore sediment transport gradients occurred near inlets and stretches of smaller project length, and resulted in persistent cumulative volume loss at the four select contour levels.

Larger volume loss was measured at shorter projects with a persistent longshore transport gradient near inlets. Often, these areas are characterized by non-barred beaches. Barred beaches typically occur within the laterally longer projects or at some distance from the influence of inlets or ebb-tidal deltas, and have less overall volume loss. Other factors influencing nourishment performance include wave energy focusing at a headland and shoreward of a nearshore dredge pit, local longshore transport reversals, and interruptions to the littoral drift by shore perpendicular structures such as jetties, groins, and piers.