Morphological Adjustment of Dredged Sediments Placed in the Nearshore, St. Johns County, Florida

Jase D. Ousley[1], Jason A. Engle[2], Coraggio K. Maglio[1], Katherine E. Brutsché[1], Brian C. McFall[1], and Jesse McNinch[3]

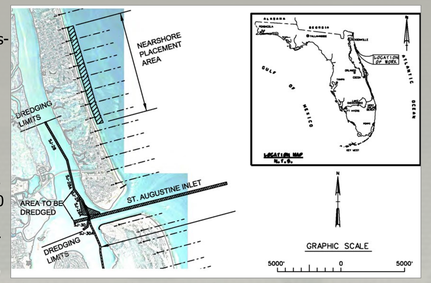
1: U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory,
3909 Halls Ferry Road, Vicksburg MS 39180

2: U.S. Army Corps of Engineers, Regional Sediment Management Center of Expertise, Jacksonville District, Jacksonville FL

3: U.S. Army Engineer Research and Development Center, Field Research Facility, Duck NC

Project Background

Maximizing the retention of dredged sediments in the coastal littoral system is vitally important to minimize the negative impacts of repeated dredging of inlets for navigation purposes and to enhance the overall resilience of the coastal inlet/beach systems. The Engineer Research and Development Center (ERDC) and the Regional Sediment Management Center of Expertise collaborated on an effort to construct and monitor an innovative nearshore placement project in Northeastern Florida. In the state of Florida, dredged sediments are often beneficially placed in the nearshore in water depths ranging from -3 to -45 feet (ft). The desired outcome is for added sediments to have a beneficial effect on the littoral system. Many shallow draft/small inlets in Florida are dredged using the US Army Corps of Engineers (USACE) split-hull hoppers *Murden* and *Currituck*. These vessels dredge up to 500 and 300 cubic yards (CY) per load respectively, and can place sediments as shallow as 5-feet of water. Stakeholders commonly question if positive effects on the littoral system from nearshore placement can be documented. Questions remain about morphological change following nearshore placements at small inlets on the east coast of Florida where strong littoral currents persist.



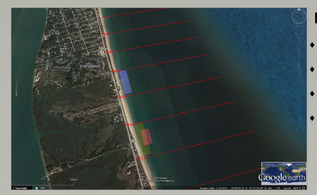
USACE Wilmington District's dredge *Murden* placed approximately 150,000 CY of sediment removed from St. Augustine Inlet and the Intracoastal Waterway navigational channels into the nearshore area along the St. Johns County Shore Protection Project, Florida over a period of 45 days in the summer of 2015. USACE personnel and local stakeholders created a placement plan that concentrated sediment in two 1,000-ft. berms with different placement designs adjacent to highly eroded sections of shoreline. Multi-beam surveys and cross-shore beach profiles of the placement area were collected prior to construction.

USACE Wilmington District split hull hopper dredge *Murden* placing sediment in the nearshore, St. Johns County, FL

Construction of two nearshore berms was completed during routine Operation and Maintenance (O&M) dredging, St. Augustine Inlet ebb delta, flood delta and part of the Intracoastal Waterway, St. Johns County, Florida.

Placement Plan

- Concentrate sediment into two separate berms between T–114 and R-115 and R-116 and R-117
- Focused in front of two vulnerable property clusters
- Worked with USACE Jacksonville District, the local homeowners and the USACE Wilmington District for design and constructability
- Sediment was placed between –5 to –12 feet, 300 to 500 feet offshore



Placement specifications:

- North to south
- 3 loads placed per line
- Blue, white, blue, white
- Red, green, orange, pink

Pre-Construction Instrument Deployment

- To visualize shoreline change, set up two camera arrays, T-114 and R-117
- 180˚view of the coastline
- Cross-shore topographic survey and multi-beam bathymetry
- Collected cross-shore profile sediment samples

Morgan & Eklund, Inc. survey the nearshore for St. Johns County prior to nearshore placement.

Radar Inlet Operating System (RIOS)
POC: Dr. Jesse McNinch, Jesse.McNinch@usace.army.mil

RIOS: Developed by Drs. Jesse McNinch and Katherine Brodie and other staff at ERDC CHL's Field Research Facility, RIOS utilizes X-band radar to measure wave conditions—breaking, speed, period and angle—from which depths on shoals and channels are determined. Wave speed dissipation, obtained from time series of radar spikes generated by the roughened surface waves, are used to calculate water depths. Wave orbital velocities (radial components) are also explicitly measured and used to determine wave height and surface currents. RIOS calculates water depth based on the linear wave dispersion relationship.

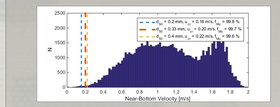
Sediment Mobility Tool

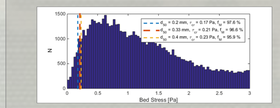
- Estimates the frequency of sediment mobility in the nearshore
- On/Offshore sediment migration direction
- Dominant axis of wave dominated sediment transport
- Effect of waves and sediment on beach profile, Dean Number: $D \equiv H_O / \omega T$, where H_O is the offshore deep water wave height, ω is the sediment fall velocity, and T is the wave period.
  - D >7.2, Offshore Migration
  - D <7.2, Onshore Migration *(Larson & Kraus, 1992)*

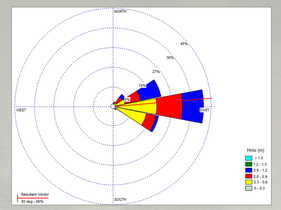
For St. Augustine O&M, nearshore placement area:

- d_{50} = 0.33 mm
- h = 3 m
- WIS Station 63416
- Wave data from 1990-2000
- Wave Direction, 85˚

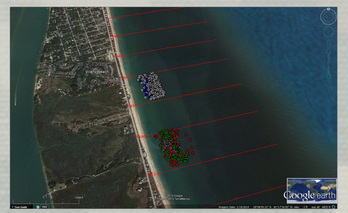
Grain size d (mm)	Predicted Sediment Migration
0.1	88% Offshore
0.2	93% Onshore
0.3	100% Onshore
0.33	100% Onshore
0.4	100% Onshore







Post Construction Observations



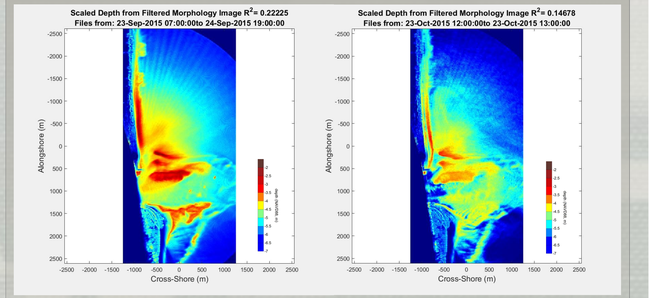
The USACE hopper dredge placing sediment in the nearshore.

Breaking waves are observed over the placed nearshore berm at T-114.

- Observe waves breaking over the nearshore berms
- Perturbations to the shoreline adjacent the berm

Conclusions

- The nearshore Sediment Mobility Tool predicted onshore migration for >95% of waves
- Camera arrays and photogrammetry observed wave breaking over the placed berms
- The RIOS observed movement of the berm
- The berms placed in –5 to –12 feet of water migrated onshore
- Dredged sediments that fall within the acceptable range for nearshore placement can be beneficially used following the best practices of Regional Sediment Management (RSM) and Engineering with Nature (EWN)



Images Courtesy of the ERDC Field Research Facility, RIOS: Radar Inlet Observing System

Future Research

- Two post-construction topo-bathymetric surveys are scheduled
- The Coastal Modelling System (CMS) will be run to investigate /validate sediment transport observations in St. Johns County
- Run Bi-modal sediment distributions in a nearshore berm physical model at the ERDC Coastal and Hydraulics Laboratory, Vicksburg MS

Nearshore berm physical model in the Large-scale Sediment Transport Facility (LSTF), Coastal and Hydraulics Laboratory, Vicksburg MS

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