

BALD HEAD ISLAND/CAPE FEAR RIVER ENTRANCE DELFT 3D MODEL ANALYSIS

Introduction

A Delft3D modeling study is proposed to evaluate historical, existing, and expected or predicted future inlet and shoreline sediment budget conditions in the vicinity of the Cape Fear River Entrance, North Carolina. Specific attention will be paid to the effects of the Cape Fear River Entrance Federal Navigation Channel and associated sediment management practices of the USACE-Wilmington District upon the inlet ebb shoal and the Bald Head Island and Oak Island shorelines sediment budgets. Maintenance dredging destabilization of South Beach at Bald Head Island and potential structural measures will be investigated.

Background

Delft3D is a world leading 2D/3D modeling system used principally to investigate riverine, tidal, wind, and wave-driven hydrodynamics, sediment transport and morphological change in the estuarine and coastal environments. Delft3D is modular software package that computes hydrodynamics and morphological change through two principle modeling applications. The FLOW module is the heart of Delft3D and is a multi-dimensional hydrodynamic and transport simulation program which calculates non-steady flow and transport phenomena resulting from riverine, tidal and meteorological (i.e., atmospheric, winds, and waves) forcing. Delft3D-WAVE module is used to simulate the propagation, transformation, breaking, and associated hydrodynamic forcing of random, short-crested, wind generated waves in coastal waters which may extend to estuaries, tidal inlets, barrier islands with tidal flats, channels etc. The Delft3D-WAVE module is fully-coupled with the Delft3D-FLOW model for the automatic transfer of relevant data back and forth to simulate short- and long-term time-dependent changes to hydrodynamics, sediment transport, and seabed morphology.

Project Goals

Existing Conditions

- Simulate present day Cape Fear River Entrance hydrodynamic regimen. Assess water flow impingement effects on West Beach.
- Simulate average annual sediment transport conditions (i.e., sediment budget) for the Cape Fear River Entrance ebb shoal and adjacent shorelines (i.e., Oak Island and Bald Head Island). Compare results to COE pre-deepening estimates used as basis of sand distribution associated with the Wilmington Harbor Sand Management Plan (WHSMP).

- Evaluate effect of 2000 channel reorientation and deepening upon inlet hydrodynamics, waves, sediment transport, and morphology conditions.
- Evaluate effect of biennial dredging of Point (removal of toe of island) and South Beach. Simulate recovery of toe and effects on Bald Head Island shorefront.
- Compare best available wave hindcast dataset (see “Data Requirements” below) to available wind and wave records as well as historical hindcast dataset available from and used previously by the USACE – known to be defective.

Historic Conditions

- Evaluate 1972 channel conditions – compare to existing (use best available data). Compare hydrodynamics, wave energy, etc.
- Evaluate littoral transport rates (Oak Island and Bald Head Island) pre-2000 Harbor deepening project – compare to today. Compare to COE estimates utilized by WHSMP.
- Attempt to estimate hydrodynamic sediment transport regimen of historical, pre-navigation project (1800’s) ebb tidal shoal and adjacent island shoreline configuration.
- Attempt to estimate historical, pre-navigation project (1800’s) inlet sediment budget.

Future Conditions

- Evaluate anticipated long-term deflation of Bald Head Island shoal due to biennial maintenance dredging and new channel alignment.
- Evaluate potential effects of future channel expansion upon tidal hydrodynamics and inlet sediment transport due to the construction and associated channel improvements for a new Port facility conceptually proposed at Southport.
- Evaluate potential effects to hydrodynamic, wave, and sediment transport conditions for the westward relocation of the Federal navigation channel as recommended by the Village of Bald Head Island.
- Evaluate effects of terminal structure alternative(s) for the Village of Bald Head Island southern shoreline. The evaluation shall consider the potential impacts, benefits, shoreline reconfiguration at the Point, effects on West Beach, and updrift stabilization effects at South Beach.

- Seek structure(s) alternative that is expected/predicted to have no significant adverse effect upon the inlet shoal system and Oak Island.

Data Requirements

- All available digital data (tide, current, wind, waves, bathymetric, etc.) from USACE related to the Cape Fear River Entrance, associated dredging projects and on-going physical monitoring program. Of particular interest are tide, current, wind, and wave data collected over the last 7 to 8 years. If necessary, utilize FOIA, through the Village of Bald Head Island legal counsel.
- Site-specific wave hindcast using third party commercial vendor, Oceanweather, Inc. Compare this hindcast dataset to hindcast data available from the USACE as well as actual wave conditions measured by the USACE since 2000.
- Plan sketches, drawings, etc. for conceptually proposed new Port facility and associated channel improvements at Southport.