Coastal Inlets Research Program

Waves at Navigation Structures

Description

This work unit develops, validates, and implements advanced numerical wave modeling technology which provides the USACE with more reliable and accurate estimates of waves and wave processes in navigation projects, coastal inlets, channels, ports and harbors, and coastal beaches. It conducts basic research on the coupling of wave and flow models to calculate waves and currents for engineering studies of channels, jetties, and morphology change. The work unit develops calculation capabilities for short- and long-term simulations of coastal inlet hydrodynamics and navigation
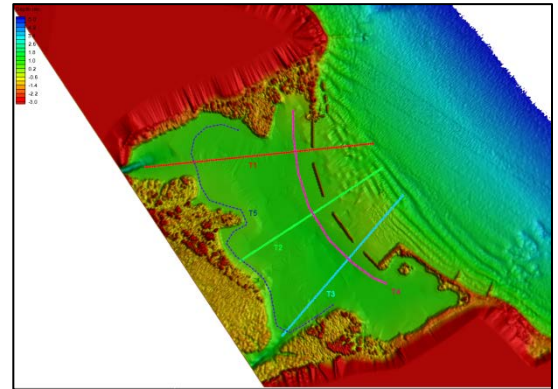

Figure 1. Wetland wave transformation study at Braddock Bay, NY

processes, and implements these technologies for practical applications. It continually upgrades the Coastal Modeling System (CMS) wave models CMS-Wave, a phase-averaged spectral wave model, and BOUSS-2D, a Boussinesq type nonlinear wave model. These models are required for shallow reefs, porous structures, variable structure roughness, infra-gravity waves, runup/overtopping, and for evaluating wave asymmetry. Using these models in-tandem, functional performance of navigation projects can be evaluated in calculations of flow and sediment transport in USACE projects (Figure 1). The work unit uses laboratory and field measurements to validate the models. It is also developing WaveNet and TideNet, two Web-based tool systems for wind and wave data access and processing, which provide critical data for USACE project applications and validation of numerical models (Figure 2).

Issue Addressed

This work unit provides technology and data, and develops guidance used by the USACE to maintain navigation and port infrastructures in support of federal navigation nationwide. These capabilities are used to improve prediction of waves at inlets, channels, ports/harbors and for jetties and breakwaters in the vicinity of coastal and estuarine navigation projects. Wave interaction with inlet jetties and breakwaters require calculation of wave reflection, diffraction, transmission, and runup/overtopping for an accurate estimation of navigation safety, and potential breaching or flanking. Infra-gravity waves that create seiching and wave asymmetry causing sediment transport in inlets and ports.
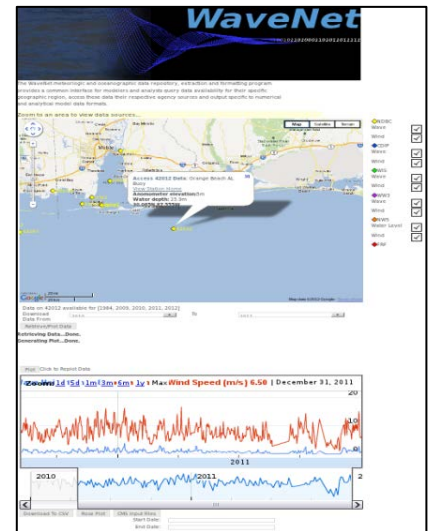

Figure 2. WaveNet application in Gulf of Mexico

Products	BOUSS-2D and CMS-Wave are two numerical wave models, and WaveNet and TideNet are two Web-based metocean database access, process, and analysis tools.

Figure 3. Coastal erosion study at Pillar Point Harbor, CA

Application of Products

Ambrose Entrance Channel, NY; Braddock Bay, NY; Tangier Island, VA; Norfolk, VA; Popular Island, MD; Cleveland Harbor, OH; Duluth Harbor, MN; Sand Island, WI; St. Augustine Inlet, FL; Cape Canaveral Harbor, FL; Mississippi Sound, MS; Terrebonne Bay, LA; Galveston Bay, TX; Matagorda Bay, TX; Hilo Harbor, HI; Kikiaola Harbor, HI; Dana Point Harbor, CA; Pillar Point Harbor, CA (Figure 3); Ocean Beach, CA; Noyo Harbor, CA; Port Orford, OR; Tillamook Bay, OR; Mouth of Columbia River, OR/WA; and Grays Harbor, WA, amongst others.
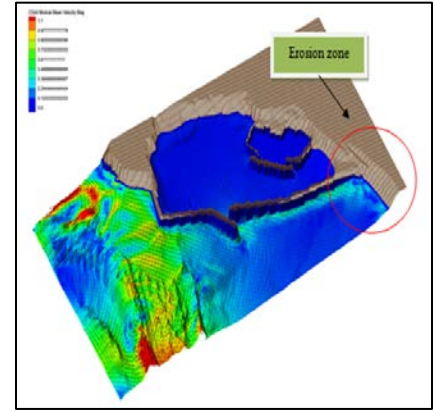
Projected Benefits

This work unit's activities have yielded guidance, desk-top models, and web-based database tools for Districts to evaluate the interaction of vessels with waves, currents, and sediment transport at inlets, channels, and near coastal structures. Products improve wave modeling capabilities for estuaries and bays to promote navigation reliability and sustain the estuarine and coastal environments. Improved wave modeling helps the USACE to reduce operation and maintenance (O&M) costs, and develop more accurate and cost-effective engineering solutions. Integrated technology is used for coupling of winds, waves, currents and water levels, which then calculates wave transformation in the vicinity of channels, ports, jetties, levees, and the resulting morphology change. Modeling capabilities have been applied for short- and long-term simulations of coastal inlet hydrodynamics and navigation-related processes in practical applications, resulting in optimization of navigation system to improve safety, reliability and operations with innovative infrastructures. These improved capabilities help the USACE evaluate design, performance, and realignment of channels to improve navigation by advanced dredging or modifications of ports, harbors and marinas infrastructure. Advanced models provide accurate probabilistic engineering design estimates for rehabilitation of jetties, breakwaters; facilitate evaluation of engineering activities affecting safety of coastal navigation (e.g., channel deepening, and jetty modifications) on port access and utilization; and quantify ship transit effects on coastal shoreline and river banks erosion.

Documentation

Model documentations include technical reports and a series of technical notes describing the theory, numerics, verification and validation, and step-by-step user's guide on use of the interface and application of models. More than a dozen journal and conference papers provide additional information about capabilities.

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CIRP Website

- Please see the CIRP website to download documentation: http://www.erdc.usace.army.mil/Missions/WaterResources/CIRP/Publications.aspx
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