Numerical Modeling of Coastal Inlets

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Coos Bay Inlet, OR
**Overview**

**Objective:** Support USACE coastal inlet projects involving navigation, structures, ports, harbors, marinas, adjacent beaches, reefs, and wetlands.

**Approaches:** Numerical models, physical models, field measurements.

**Needs:** Estimates of winds, waves, currents, water levels, sediment transport, morphology changes, and evaluation of impacts of infrastructure modifications.
Recent Studies (2012-2017)

- Coos Bay, OR
- Tillamook Inlet, OR
- Grays Harbor, WA
- Half Moon Bay, CA
- Hilo Harbor, HI
- Kikiaola Harbor, HI
- Tinian Harbor, CNMI
- Rota Harbor, CNMI
- Faleasao Harbor, Samoa
- Duluth Harbor, MN
- Waukegan Harbor, IL
- Algoma & Two Rivers Harbors, WI
- Buffalo Harbor, NY
- Braddock Bay, NY
- Ambrose Channel, NY
- Merrimack Inlet, MA
- Pt Judith Harbor, RI
- Rhodes Point, MD
- Tangier Island, VA
- Lynnhaven Inlet, VA
- Matagorda Ship Channel, TX
- Houston Ship Channel, TX
- Corpus Christi Ship Channel, TX

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B2D & CMS Models

BOUSS-2D (B2D)

- Phase-resolving wave model based on Boussinesq-type equations
- Time-domain, regular waves & irregular and random seas
- Linear and nonlinear wave processes (e.g., shoaling, refraction, diffraction, reflection, breaking, friction, dissipation, runup/overtopping, wave-wave interaction, IG/solitary/tsunami waves, vessel-generated waves)
- Open coast, reefs, coastal inlets, ports/harbors, structures, bays, overland flooding.
- Interface: SMS, Tecplot and Matlab

Coastal Modeling System (CMS)

- Integrated wave-flow-sedtrans modeling system
- CMS-Wave: phase-averaged; based on wave-action balance equation; steady-state, frequency-domain, wind-wave generation/growth and spectral energy transformation
- CMS-Flow: explicit & implicit models with sedtrans & morphodynamics; telescoping grids; regional & local scale desktop apps; computationally efficient
- Interface: Surface-water Modeling System (SMS)
Example 1: Buffalo Harbor Project

Regional CMS grid domain: 17 km x 12 km
Harbor B2D grid domain: 7 km x 4 km
CDF4 B2D grid domain: 1.6 km x 2.1 km

Lake Erie
Example 1 (Cont.)

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Example 1 (Cont.)

- Wave Overtopping Rate (m²/sec)
- Total Overtopping Rate (1,000 m²)
- Seabed Elevation (m)
- Overtopping Rate (m)

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Example 1 (Cont.)
Example 2: Coos Bay Inlet, OR

Regional CMS grid domain: 
32 km x 32 km

B2D grid domain: 
9 km x 10 km

Damaged North Jetty head
Example 2 (Cont.)

CMS results for Rank #1 4Jan2008 Storm (11 m, 18 sec, WSW)
Example 2 (Cont.)

**Interactive Dual-Modeling Approach**

**Physical Model**
- Construct 1:55 scale physical model
- Conduct jetty stability tests for design waves and water levels using a directional spectral wave generator
- Reproduce 20 sec, 28 ft waves and other severe forcing conditions
- Provide jetty stability test results for validation of Life-Cycle Modeling System

**Optimization of Structure Design Using Life-Cycle Modeling System**
- Gather site-specific data
- Perform regional wave modeling
- Perform wave and water level statistical modeling
- Perform structure design and life-cycle modeling using physical model results for validation
- Optimize structure design using Life-Cycle Modeling

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**Diagram Components:**
- North Jetty
- South Jetty
- Rollo Jetty Platform
- Navigation Channel
- Coxa Bay DEM with 5x Vertical exaggeration

**Graph:**
- Station 1
- Station 2
- 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200
- Station 1, Station 2, Station 3
- Linear Fit, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200
- Linear Fit, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200
- Jetty Recession and Channel Deepening
Example 2 (Cont.)

Coos Bay Inlet Physical Model (Scale 1:55)
Physical Model Wave Gauge Locations
Example 2 (Cont.)

Comparison of Rank 1 Storm Wave Heights, Time T6, Physical Model & CMS Numerical Model

Wave Height, m

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Physical Model Gauge Number

- R1T6r1_physical model
- T6-CMS, numerical model
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Thank you!

Questions?

Coos Bay Inlet

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