Coastal Structure Asset Management R&D

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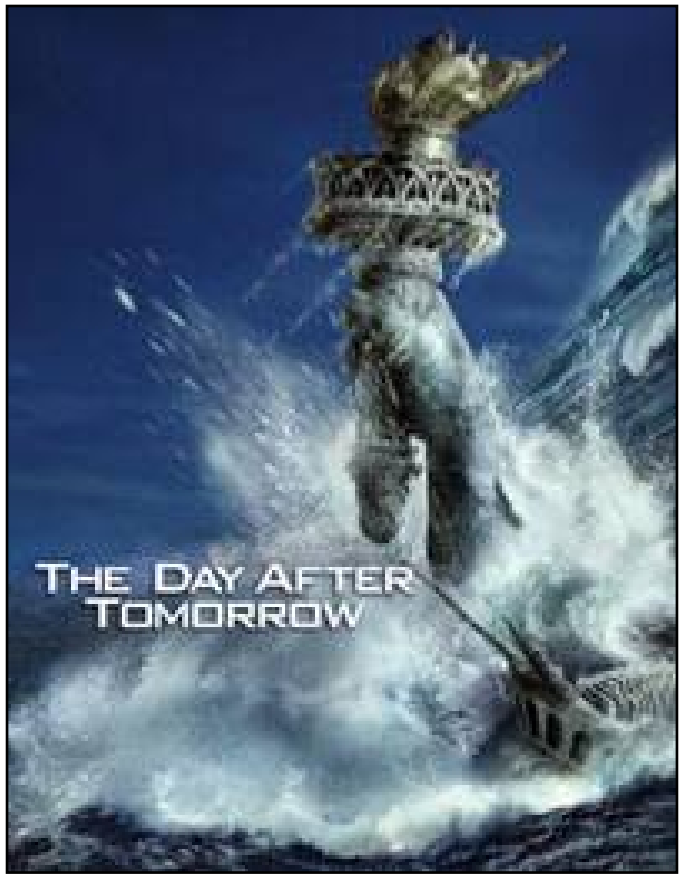


USACE Asset Management Program

Manager: Jose Sanchez

"Short list"
43,000 Structures
285000 Tracts of land
12000 Buildings

Includes:
1000 Coastal Structures
600 Dams
2500 Recreational Areas
250 Locks
75 Hydropower
10000 miles of levees

VALUE: $200 BILLION+

Summary of Corps Coastal Structures

Structure Type	Number
Breakwater	362
Jetty	272
Pier	97
Revetment	60
Groin	42
Dike	40
Bulkhead	10
Seawall	4
Wave Absorber	4
Revetted Mole	4
Wall	6
Other	28

What is Asset Management?

Asset Management is knowing what assets you own, the condition, and the expected future performance, and ranking these assets for maintenance

COMPONENTS

- Standards and criteria
- National inventory
- Condition and functional assessment
- Inspection and monitoring
- Engineering and risk analysis
- Asset ranking for maintenance

Coastal structure engineering is unique!

Lajes, Azores Breakwater

Fix as fails may be a viable maintenance strategy – but is not an asset management strategy

Coastal Structure
Asset Management R&D

Challenge:

- **Coastal structure maintenance backlog**
- **Need to prioritize maintenance requirements**
- **Antique infrastructure - precedes technology**
- **Varying strategies between Districts**
- **No national standards for AM**
- **No coordinated development of coastal structure asset management methods and tools**

What is Corps doing?

Asset Management Workshops

Districts are active

- **Inspection, condition assessment, risk evaluation, outreach**
- **Primarily NWP, Great Lakes**

Scattered R&D

Coastal/Navigation Management Advisory Board

- **Method for ranking repair needs including risk**
- **Guide for inventory system**
- **Oversee condition and function assessment system development**
- **Adapt Portfolio Risk Assessment Methods**
- **Design documents**

Coastal Structure Asset Management R&D

Major Rehab, Planning Studies, Feasibility

Life Cycle Analysis
Major Rehab Toolkit

Risk or Life Cycle Analysis

Consequence Analysis

Reliability Analysis

Structural and Functional Engineering Analysis

Engineering Models
Functional Performance
Limit States and Hazard Functions

Asset Decisions

District Efforts
AM Advisory Board
CSMART
Asset Management Workshops

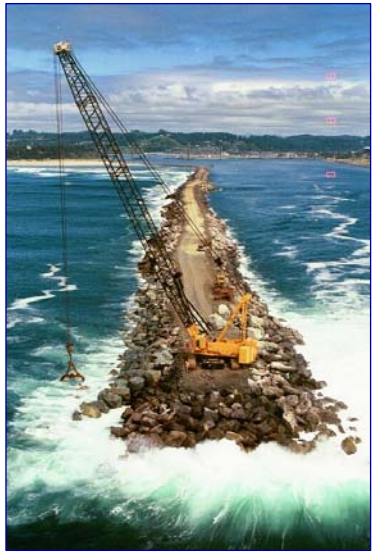
Condition Index
Survey Technology
COSCA

ECID - Enterprise Coastal Inventory Database

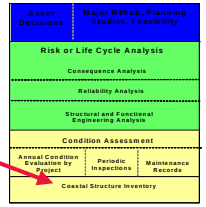
Condition Assessment

Annual Condition Evaluation by Project	Periodic Inspections	Maintenance Records

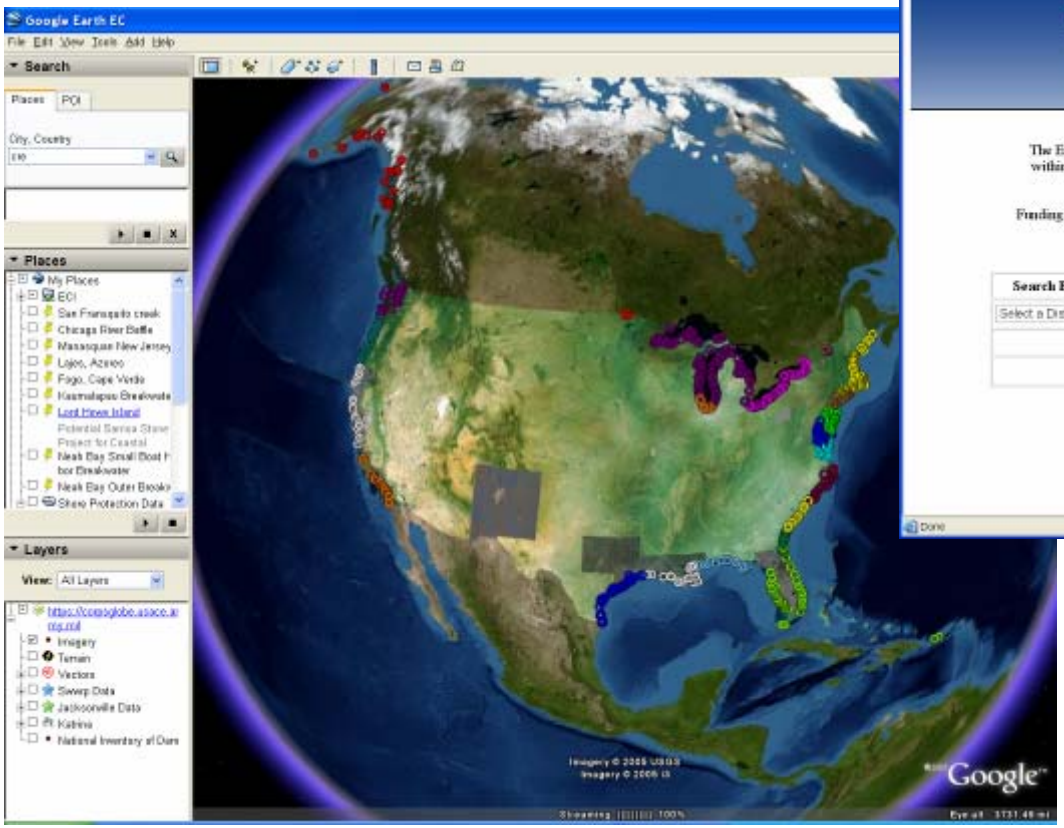
Coastal Structure Inventory

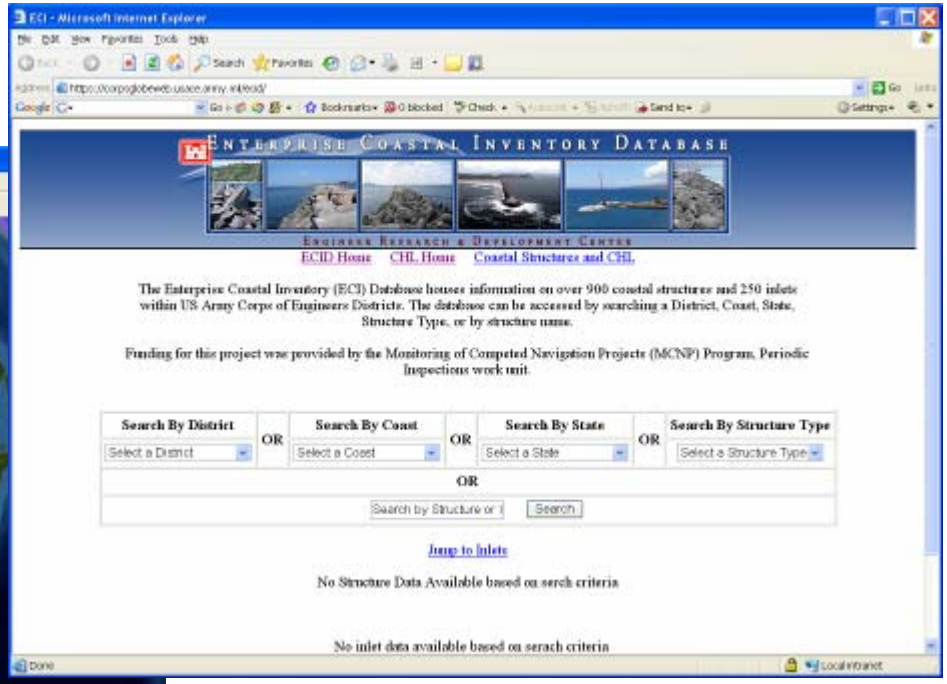


Enterprise Coastal Inventory



Google Earth Map Interface



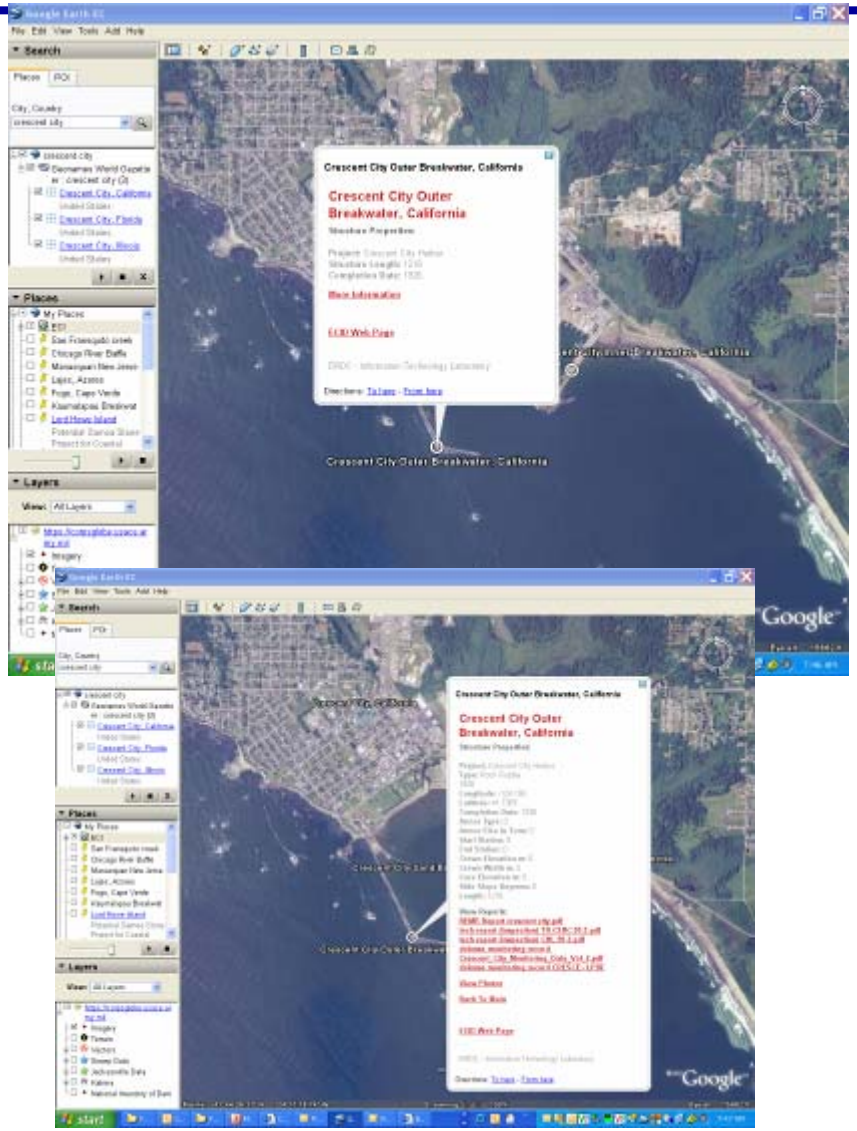


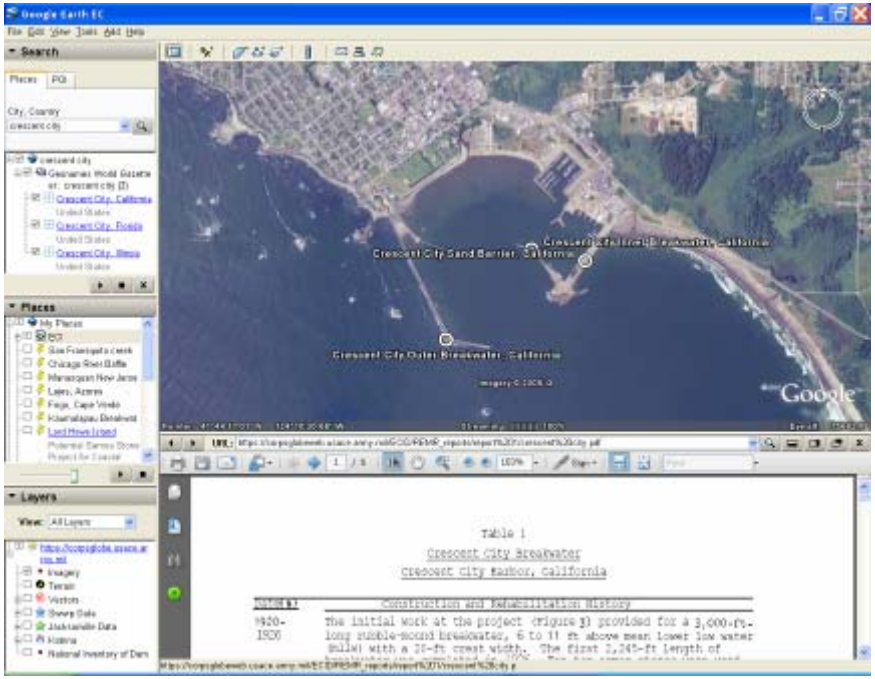
https://corpsglobeweb.usace.army.mil/ECID/

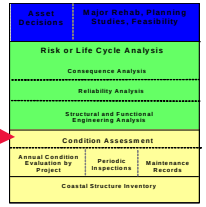
HTML Query Engine

https://corpsglobeweb.usace.army.mil/ECID/ECID.kml

Enterprise Coastal Inventory



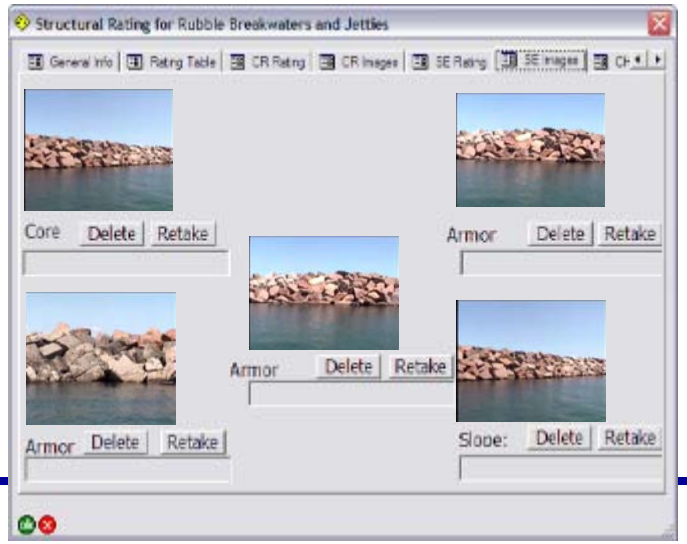


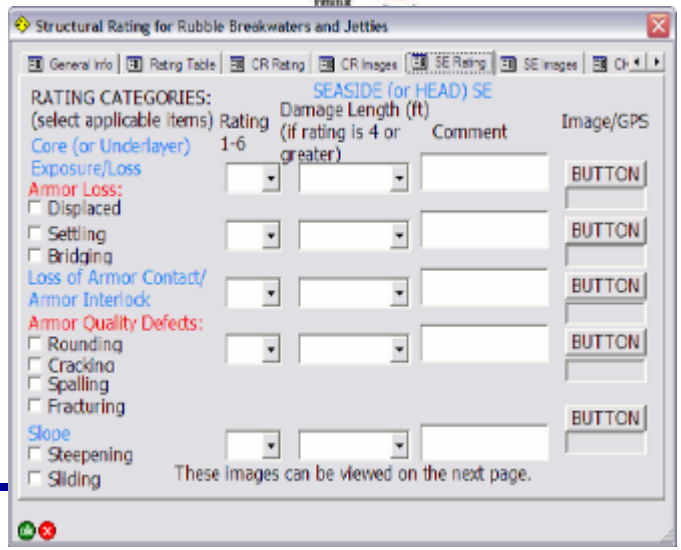


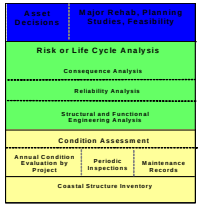
New Technologies

- Inspection methods and tools
  - Hammer with forms, camera, laser
  - Terrestrial Lidar and Geo-Swath multi-beam sonar
- National Coastal Mapping Program
- Condition index forms
- GIS and COSCA software

HAMMER

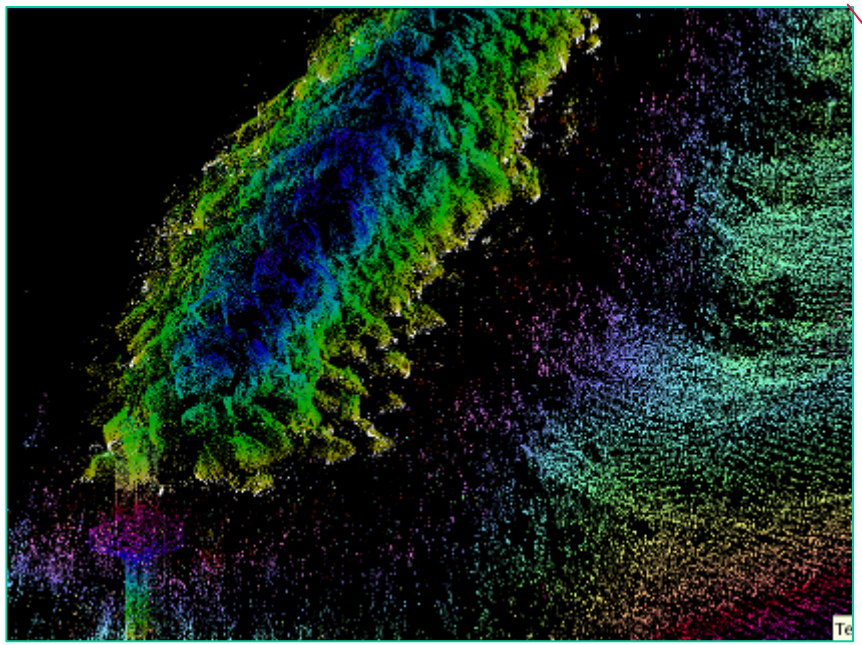


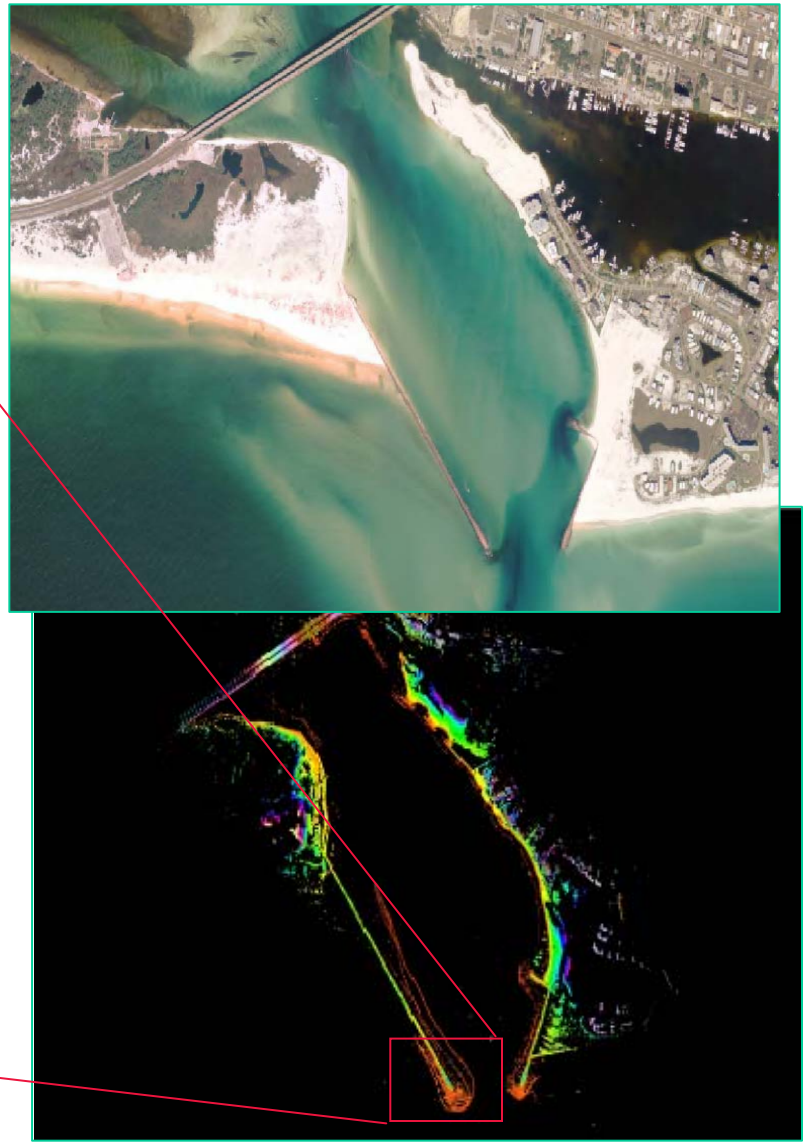




Remote Surveys

Terrestrial Lidar and Geo-Swath multi-beam sonar

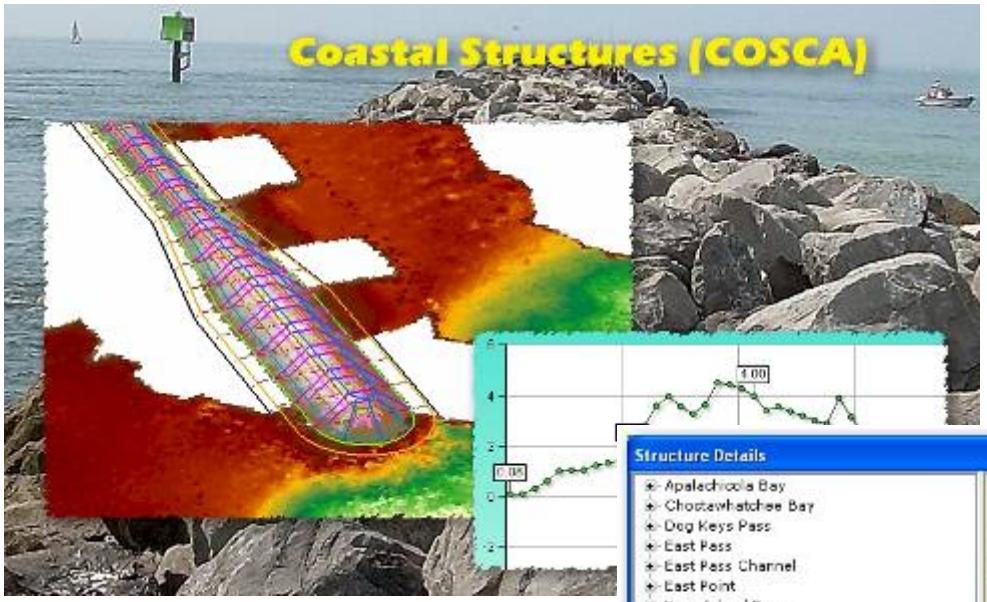




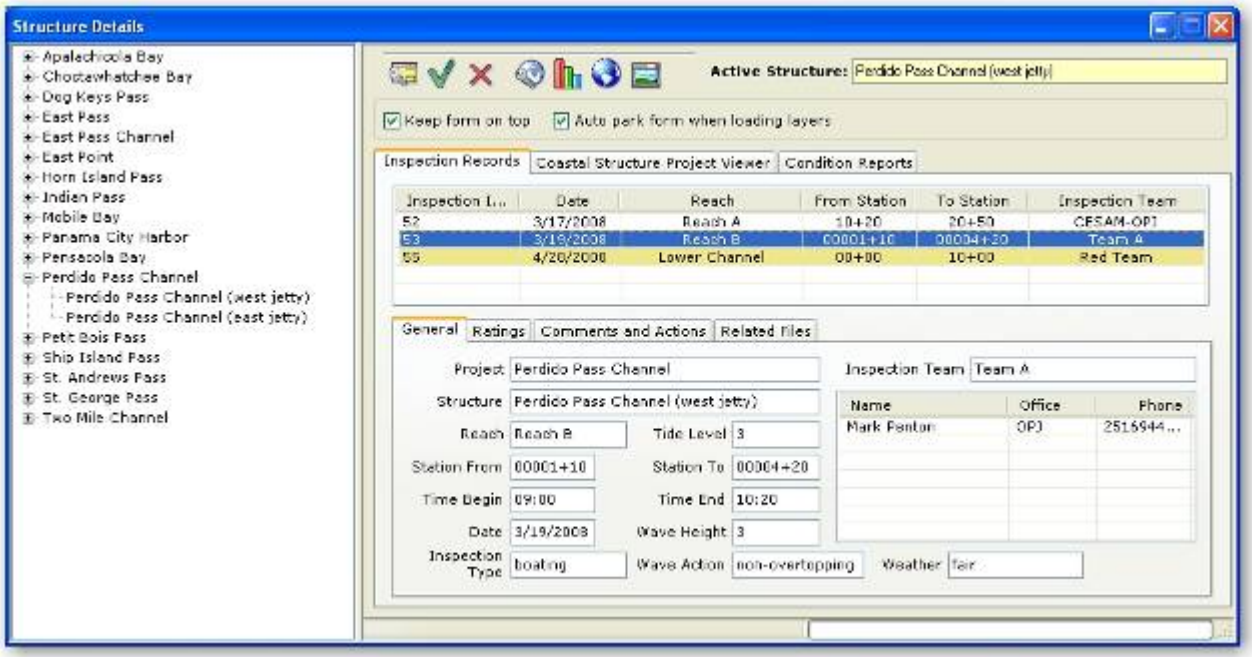
Fort Walton/Destin, FL

Color registered elevation point cloud

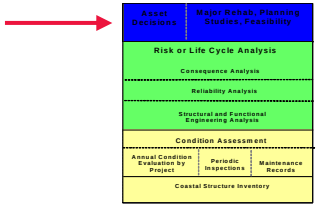
Condition Assessment



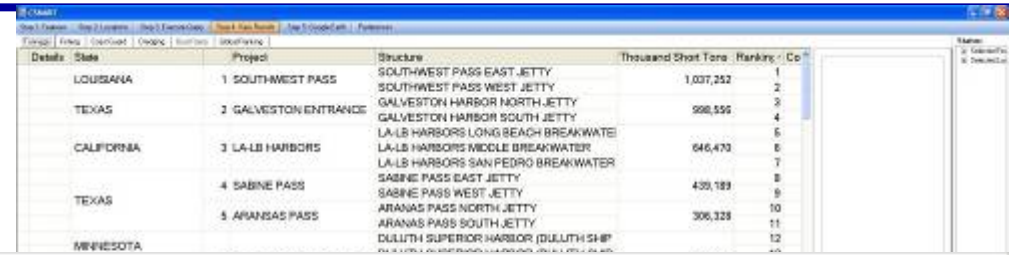
Coastal Structure Condition Assessment System COSCA

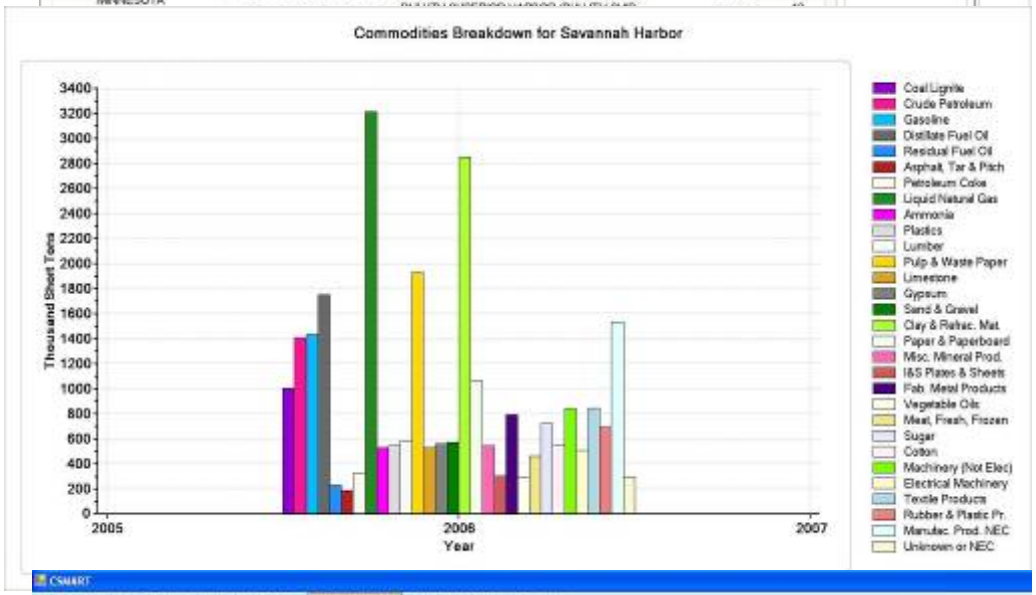


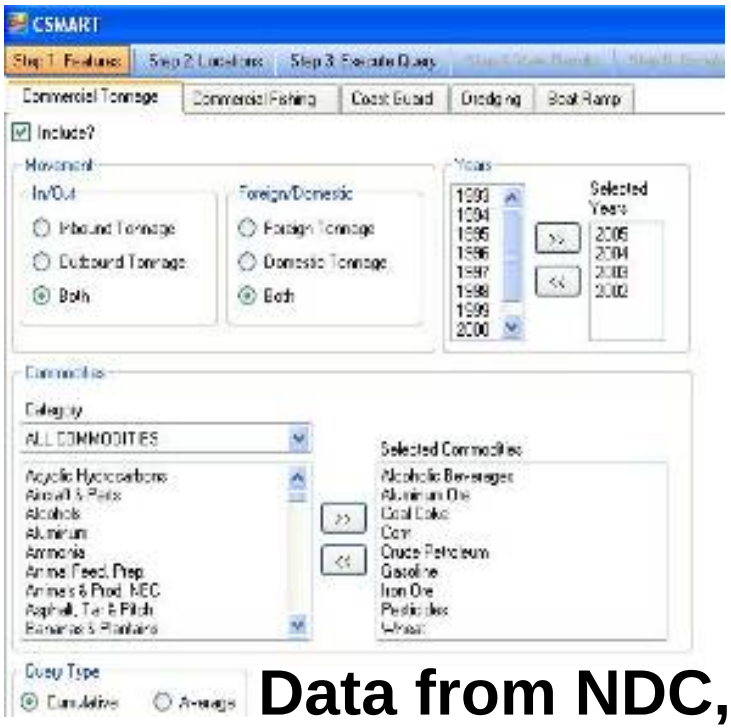
Asset Ranking

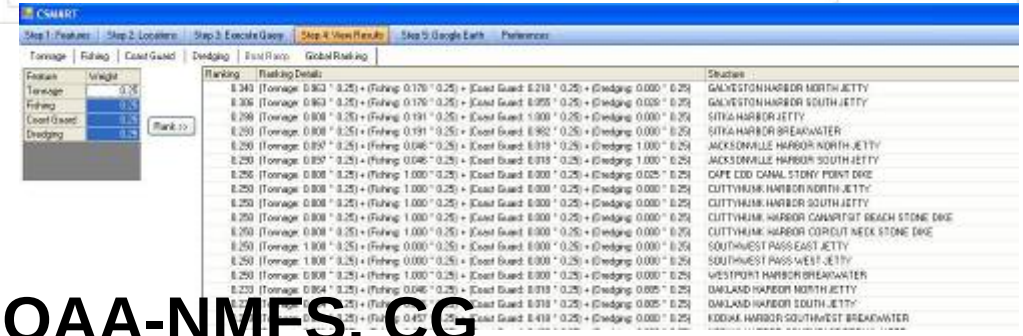


Coastal Structures Management, Analysis, and Ranking Tool CSMART





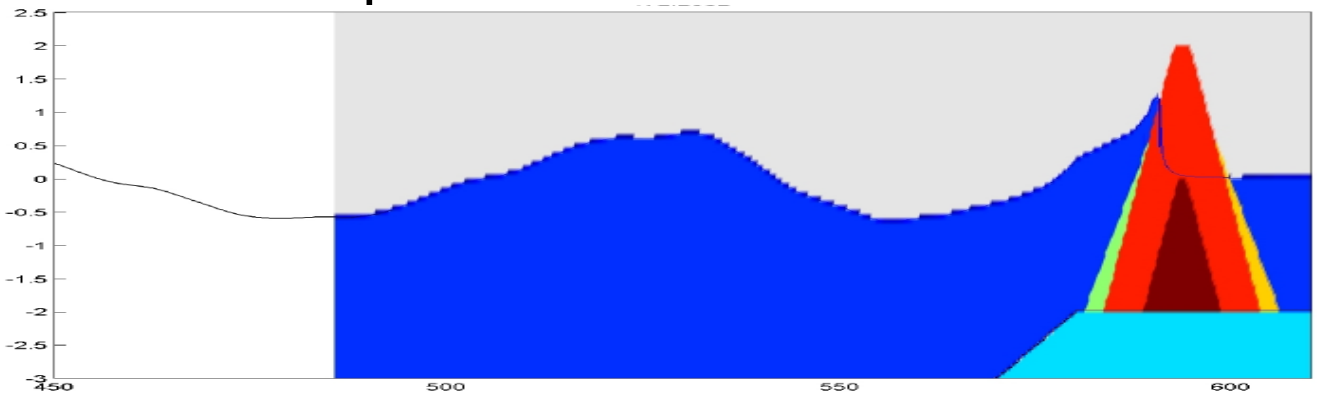




Data from NDC, NOAA-NMFS, CG

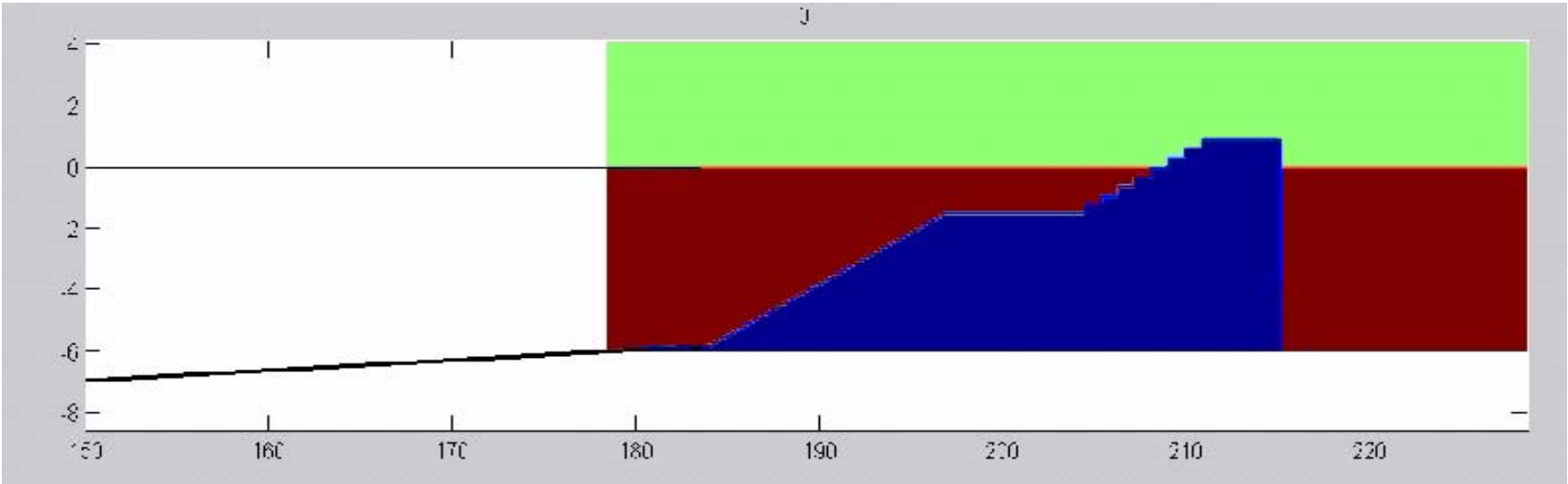
COBRAS (Cornell Breaking Wave And Structure)

- Solves RANS (Reynolds-Averaged Navier-Stokes) equations, single-phase
- Hybrid model - coupled with Boussinesq model
- Two-dimensional in vertical plane
- Includes k-ε turbulence closure
- Tracks free surface using volume-of-fluid method
- Includes porous flow model



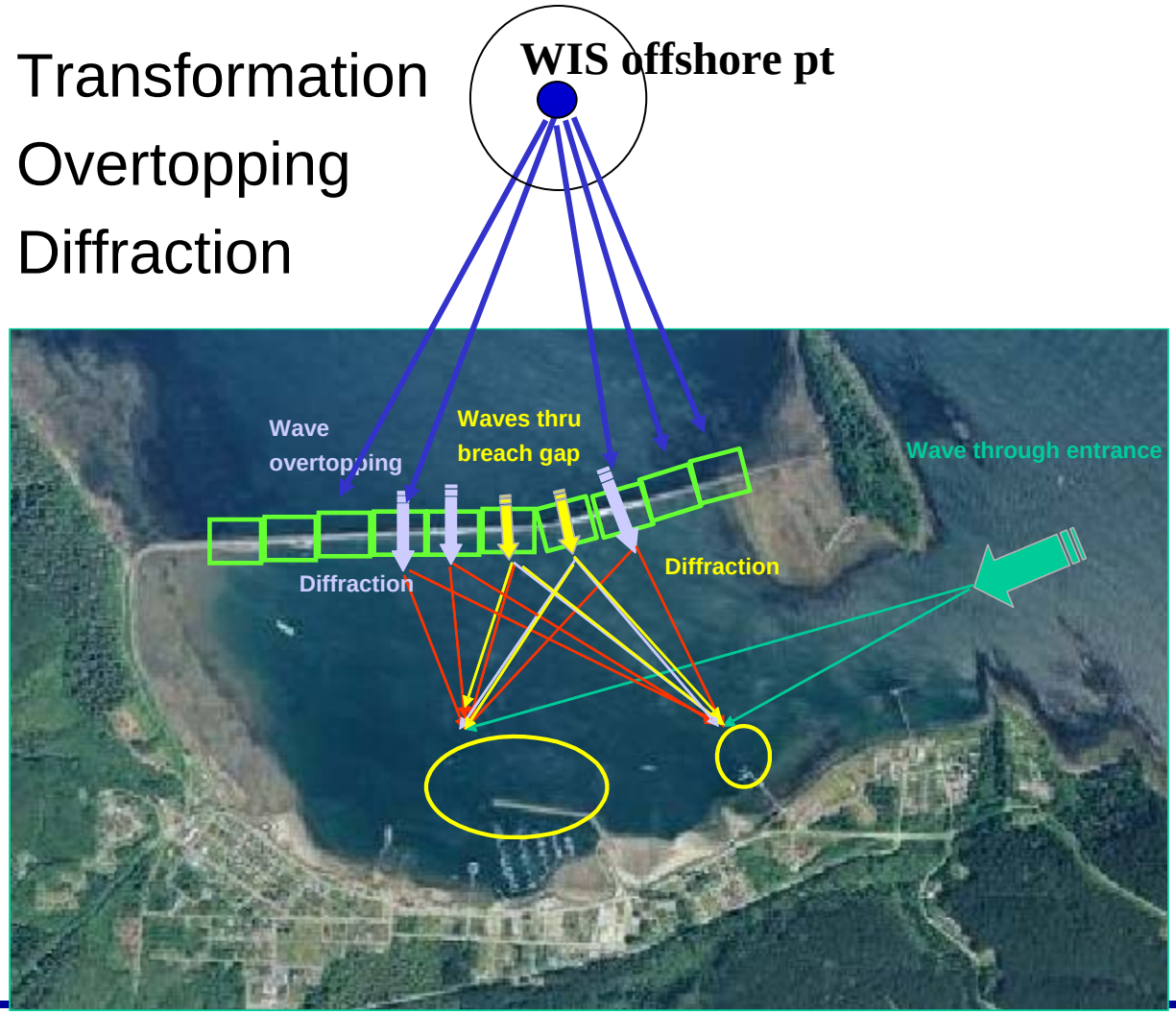
SAJ Reservoir Concrete Embankment Example

- Roller-compacted concrete
- Optimize cross-section by adjusting geometry to meet overtopping criterion
- Measure pressures on face to determine if slab thickness can be decreased by half



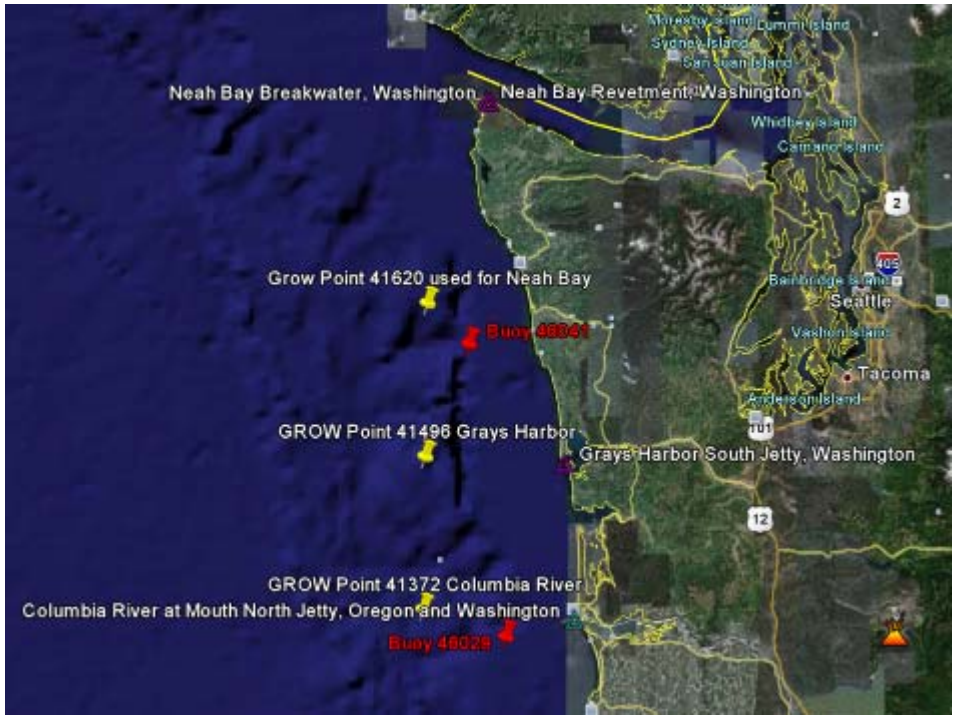
Generalized lookup tables and lookup tools

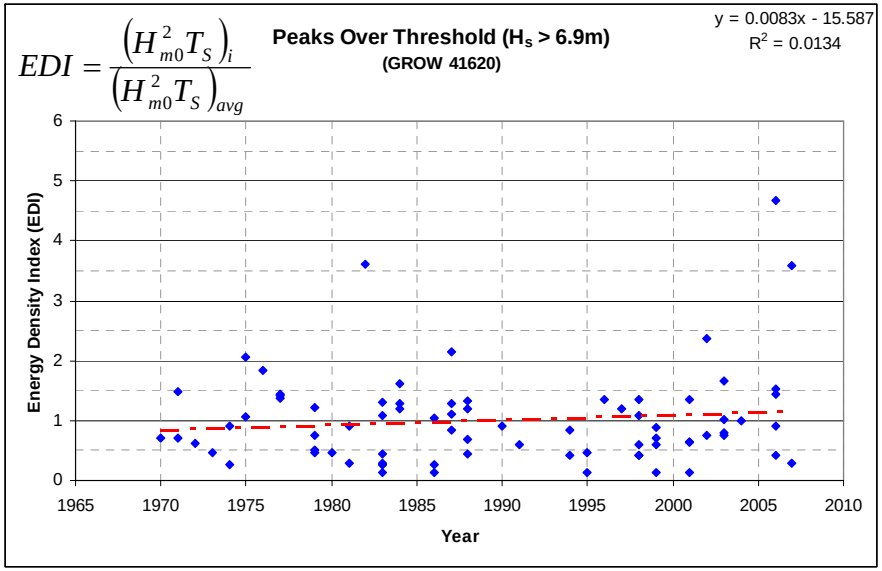
- Wave Transformation
- Wave Overtopping
- Wave Diffraction

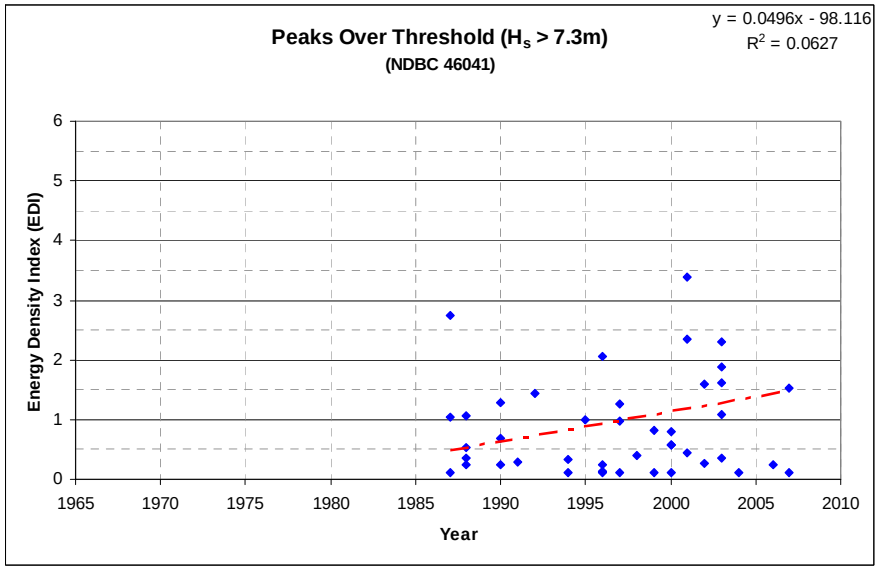


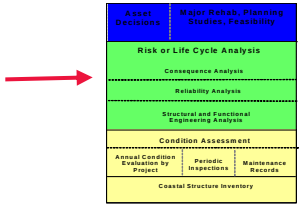
Risk Analysis

- Regional standards for wave and water level simulation
- Joint probability of waves and water levels

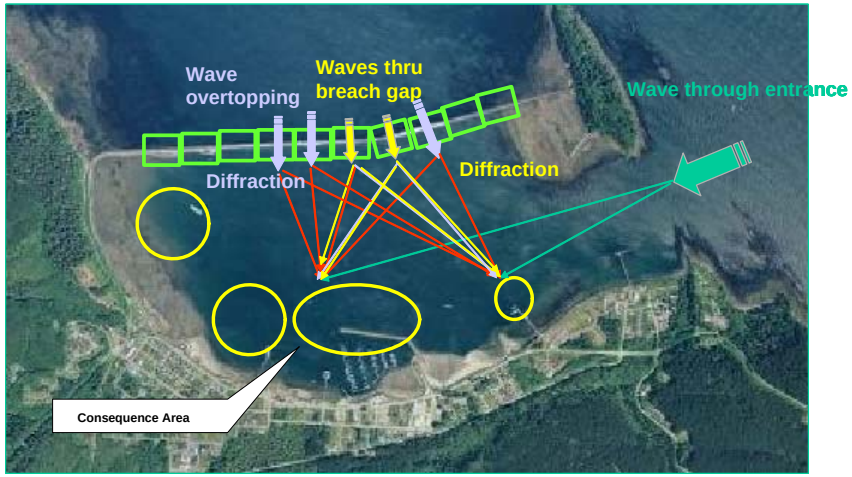




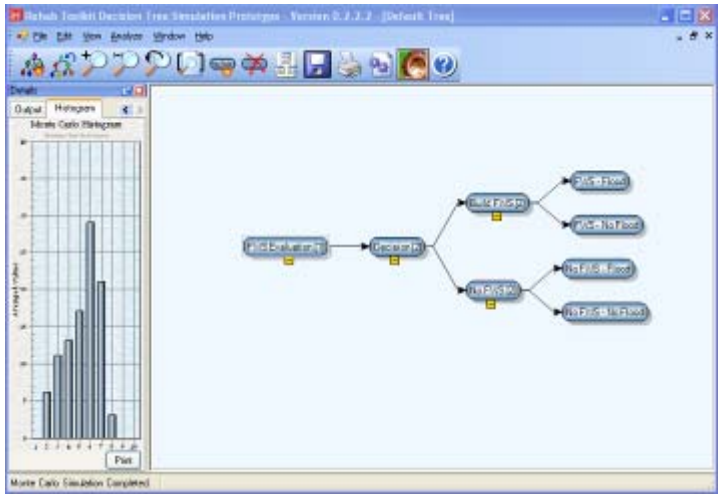




Major Rehab Toolkit



- Relational Database
  - Historical wave and water level time history at structure
- Event Tree Tool
- Storm Analysis Tool
  - Compute extremal distributions
- Structure Design Tool
  - Design structure cross-sections for select return periods
  - Crest height, slopes, armor stone, toe stone, toe berm, compound slope, low crest…
- Life-Cycle Simulation Tool
  - Simulate likely future wave and water level time histories
  - For each return period cross-section, compute life-cycle damage, repair costs and consequence costs
- User input: Repair rules, fixed costs, material costs
- Compute total present worth and annualized costs
- Compute annual exceedance probability of damage
- Pick least cost alternative given damage criterion

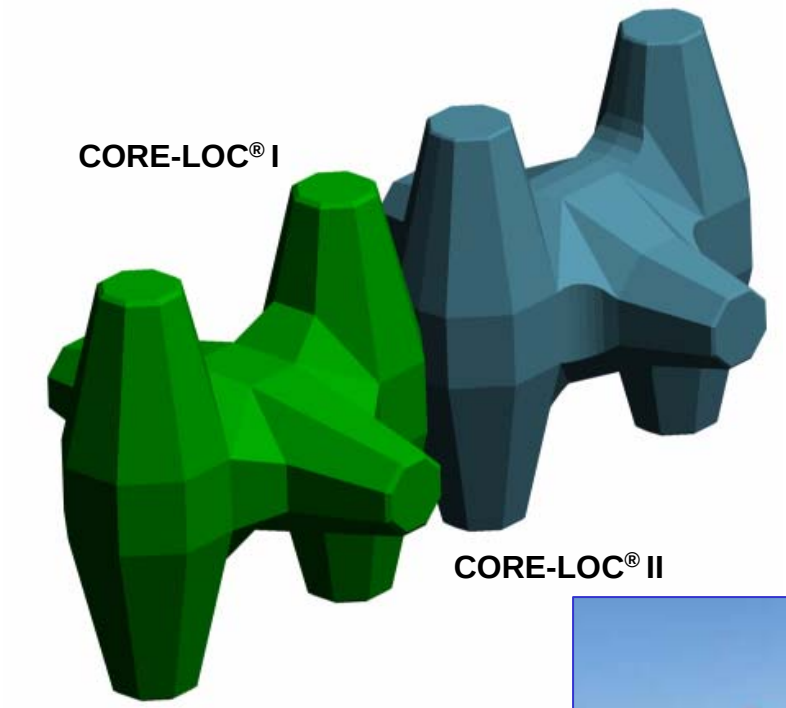


Conclusions

- Asset management is critical part of mission
- Coastal infrastructure is extensive and aging
- Need national standards and methods
  - Coastal Management Advisory Board
  - Great Lakes and Portland Districts
- New AM tools
  - CSID, CSMART, COSCA
  - Efficient engineering tools: RANS, functional lookup tables
  - Risk analysis tools

The End

CORE-LOC® Concrete Armor Units



35-ton CORE-LOC® I at Lajes, Azores

- 57 projects built, 30 projects designed & expected for construction
- Used in 25 countries

35-ton CORE-LOC® II at Kaumalapau, Hawaii