

Cascade

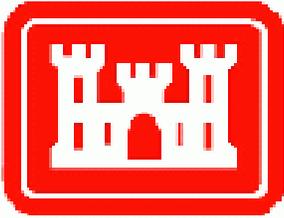
**An Integrated Coastal Regional Model for
Decision Support and Engineering Design**



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ERDC,
Coastal & Hydraulics Lab





Cascade



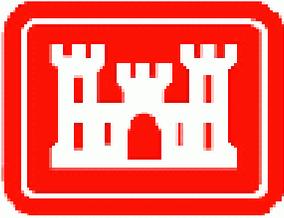
Motivation

- Need for predicting response of multiple-system, evolving coastal regions with interacting projects & coastal processes
- Oceanic and watershed scales involved: sea-level rise, storms, river sediment yields, sediment supply
- Coastal projects influence coast for centuries & on regional scale
- These process scales have not been studied! → Big benefit!

Objective

Develop a new class of model, called “Cascade,” for calculating

- Longshore sediment transport
- Inlet channel infilling, inlet morphology change, and bypassing
- Multiple projects, regional time and space scales
- Changes barrier islands, inlets, jetties, rivers, washover, wind-blown sand, and processes where data are not readily available

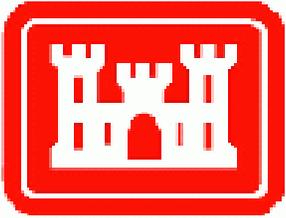


Cascade Overview



Simulate longshore and cross-shore sediment transport and long-term coastal evolution with respect to:

- **Complex regional trends**
- **Multiple, interacting projects with cumulative impacts**
- **Inlet sediment storage and transfer**
- **Breaching, washover (storms)**
- **Sources & sinks (beach nourishment, wind-blown sand, rivers)**
- **Jetty construction (impoundment, bypassing)**
- **Navigation channel maintenance**
- **Large-scale gradients in forcing**



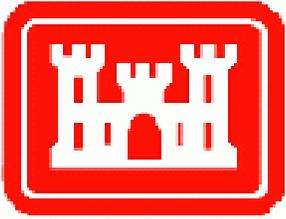
Cascade Model Details



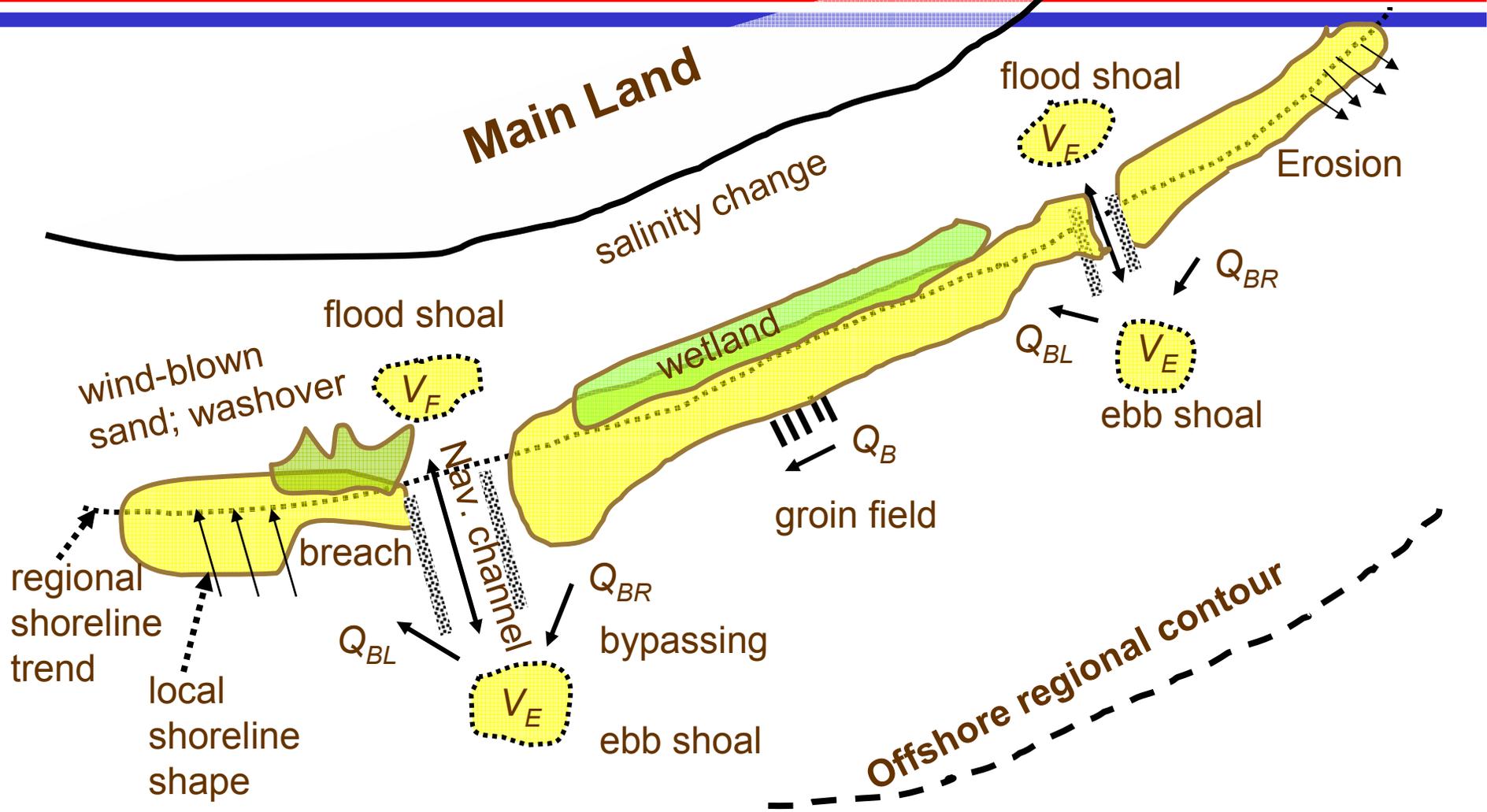
1. **Process identification**
2. **Equation selection**
3. **Numerical technique selection**

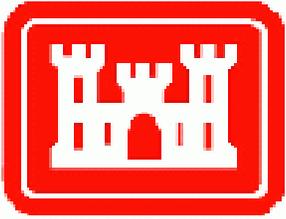
1. **Baseline conditions**
2. **Calibration**
3. **Validation**
4. **Sensitivity analysis**
5. **Uncertainty estimate**

1. **Analysis**
2. **Prediction**
3. **Design**
4. **O&M**
5. **"What if?"**



Cascade: Schematic of Coverage





Longshore Sediment Transport Rate

New, General Meso-scale Theory



$$Q = \frac{\varepsilon}{(\rho_s - \rho)(1 - a)gw} FV$$

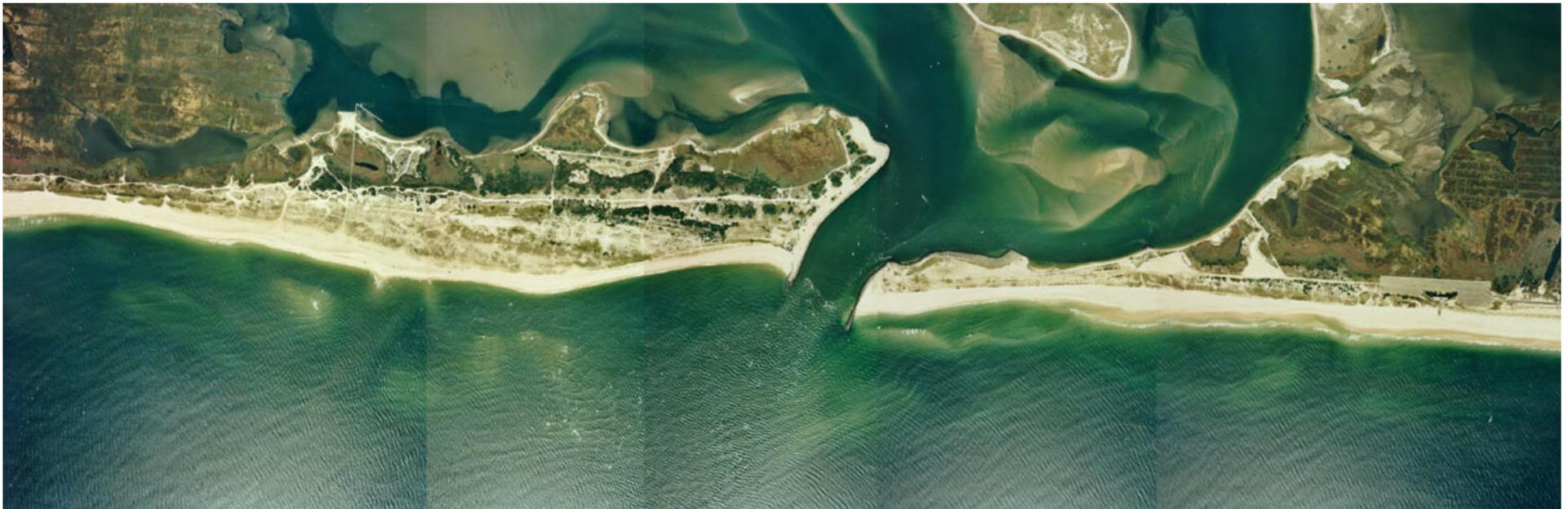
Q = longshore sed. transport rate

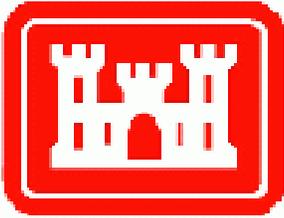
ε = efficiency factor $\varepsilon = 0.77c_f K$

F = wave energy flux towards shore

V = mean longshore current

w = sediment fall speed

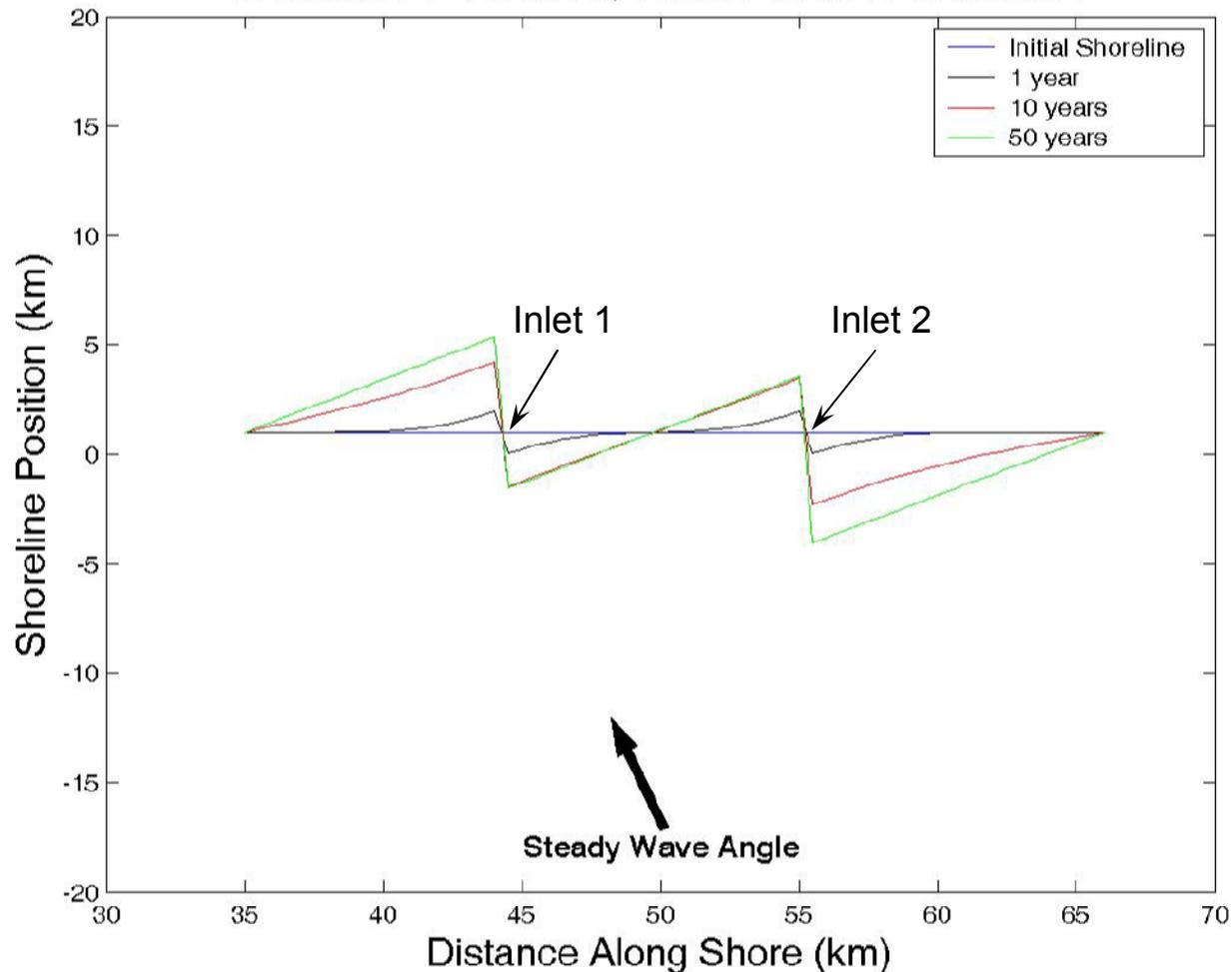




Cascade Sensitivity Analysis



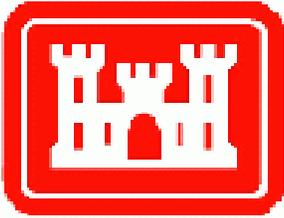
Shoreline Evolution, Ideal Parallel Shoreline



Idealized case:

- Three barrier islands
- Two inlets
- Constant wave height and angle
- Straight regional shoreline trend

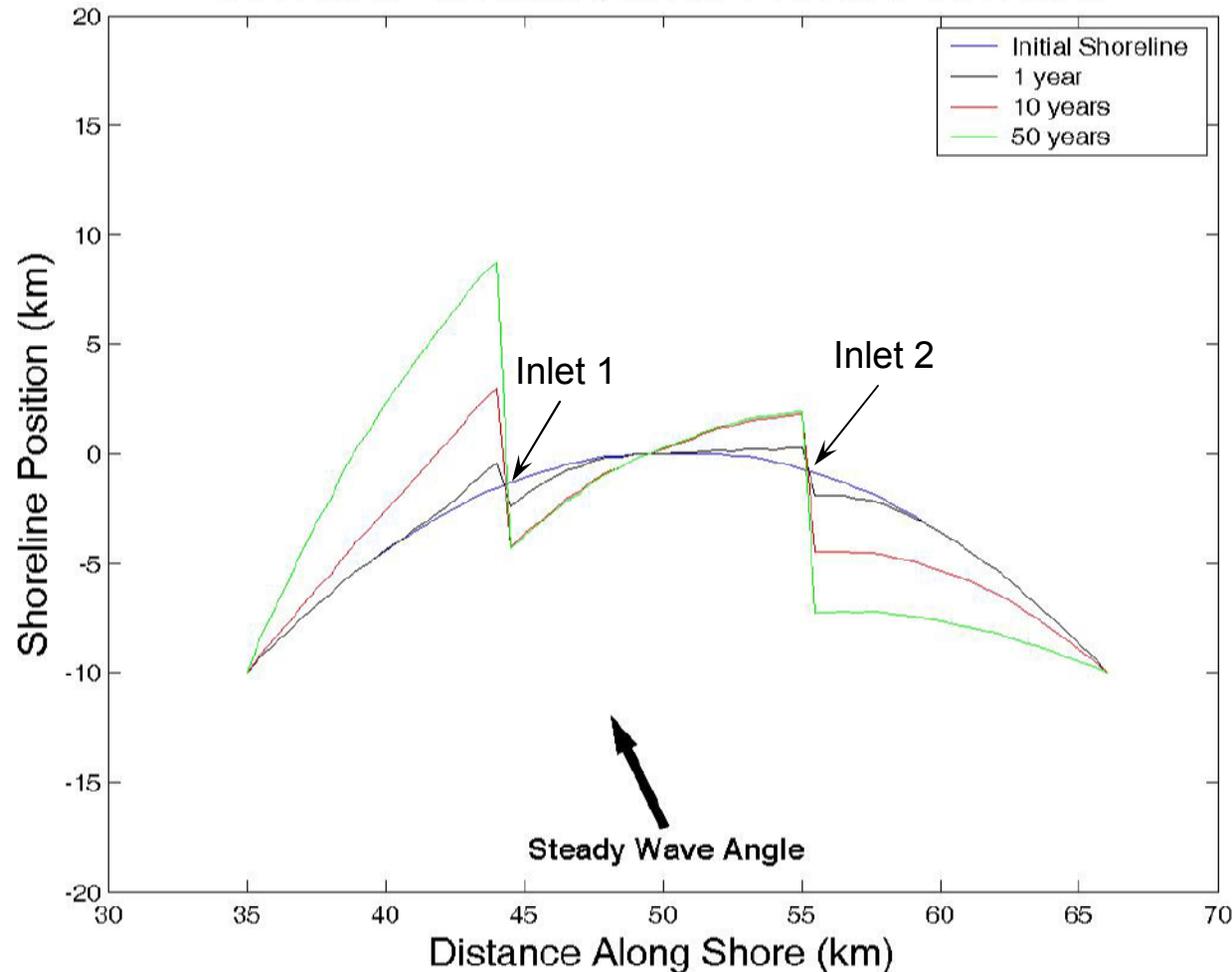
Test to examine wave & shoreline angle with evolving shoreline



Cascade Sensitivity Analysis



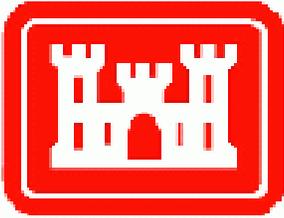
Shoreline Evolution, Ideal Concave Shoreline



Idealized case:

- Three barrier islands
- Two inlets
- Constant wave height and angle
- Curved regional shoreline trend

Test to examine wave & shoreline angle with evolving shoreline



Test Sites

Cascade Development and Validation

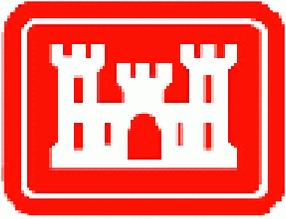


Present applications

- **South Shore of Long Island (Montauk Point to Fire Island Inlet), NY (~ 80 miles)**
- **Ocean City Inlet with Fenwick and Assateague Island (Cape Henlopen to Chincoteague), Delmarva Peninsula (~ 75 miles)**

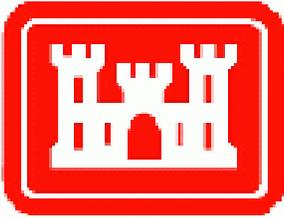
Future applications

Searching for leveraging partners

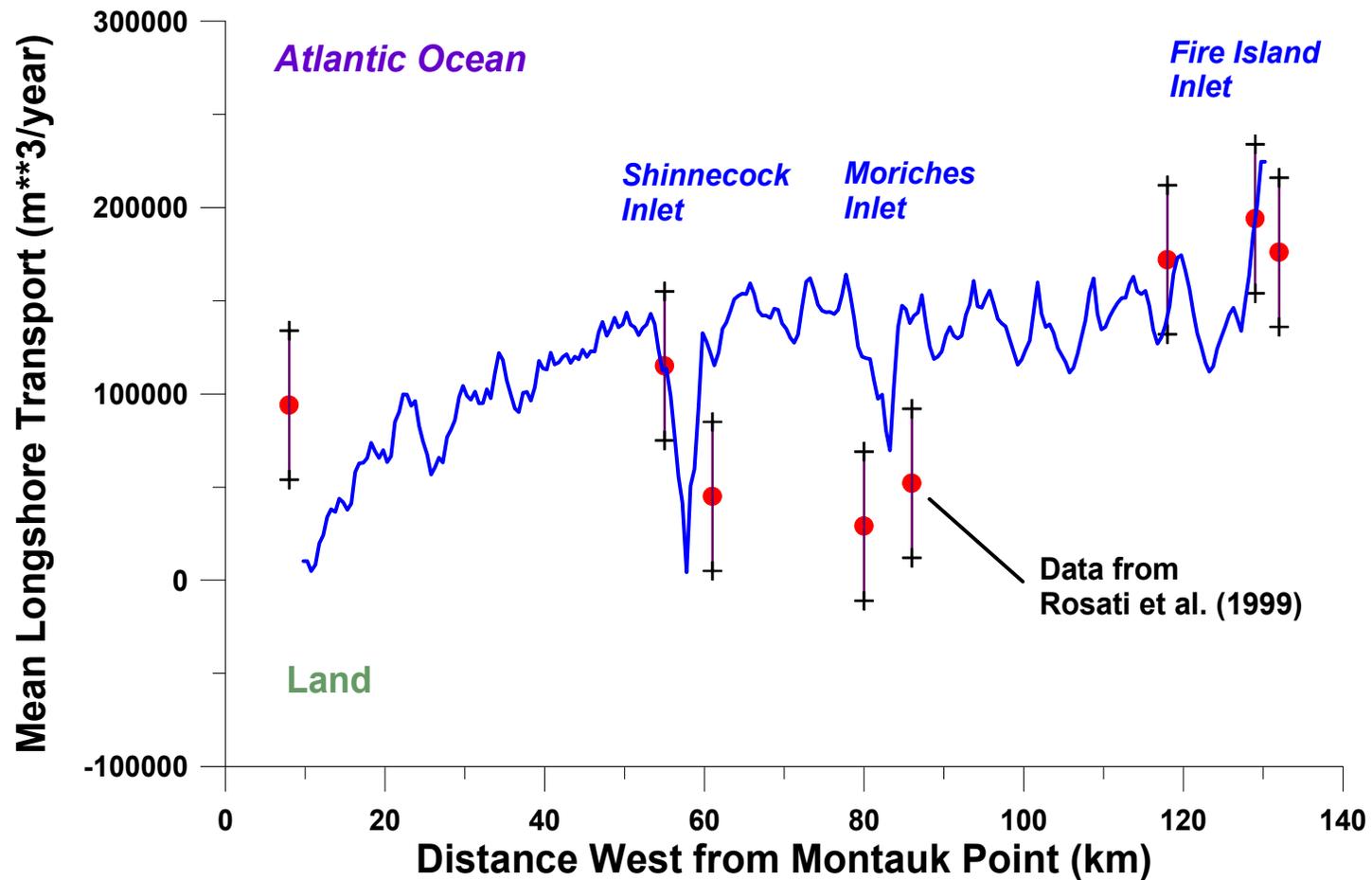


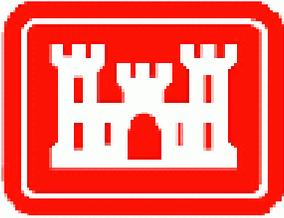
Long Island, NY



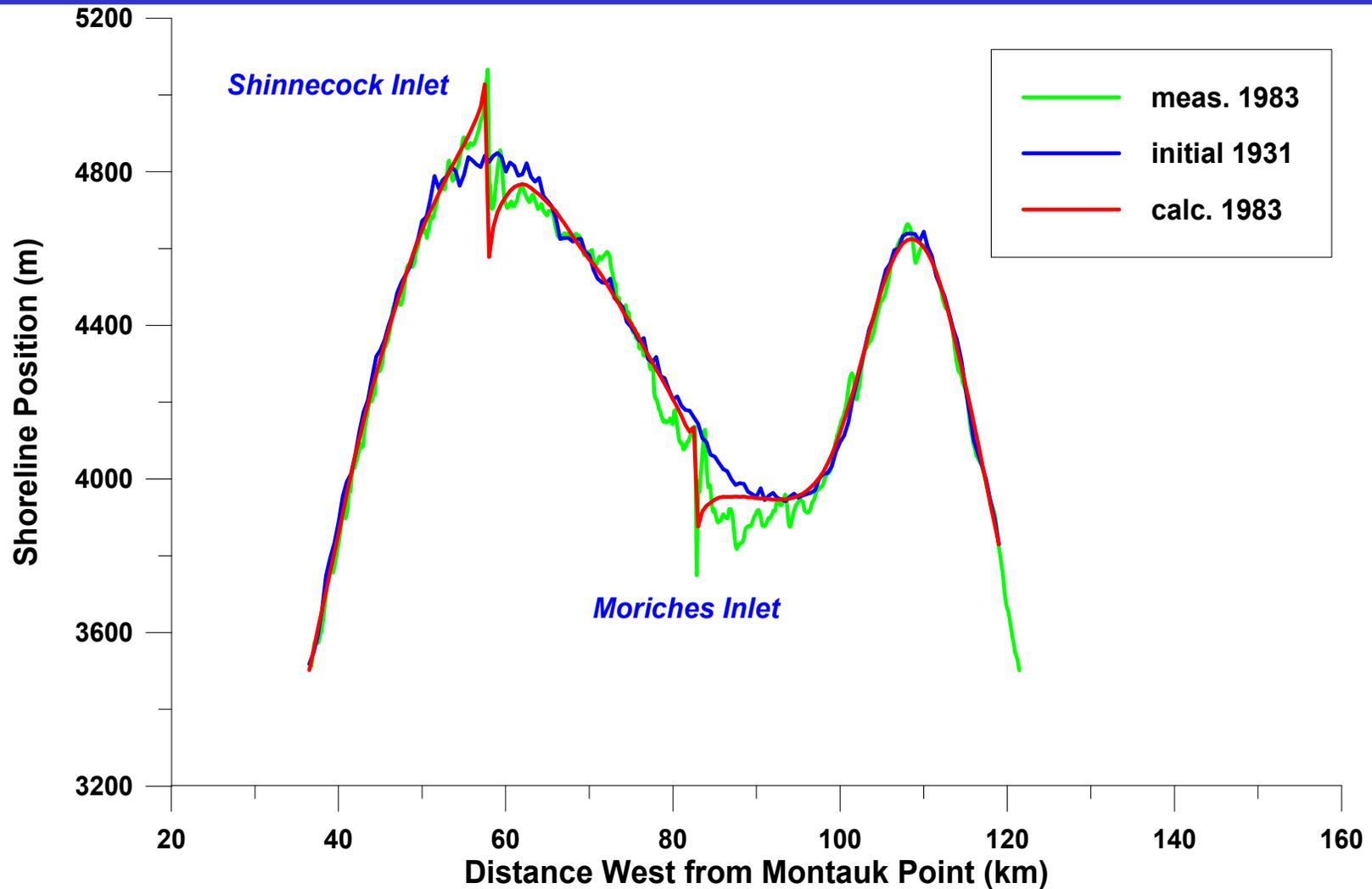


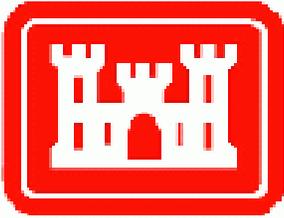
Cascade-Calculated Regional Net Longshore Sediment Transport Along South Shore of LI



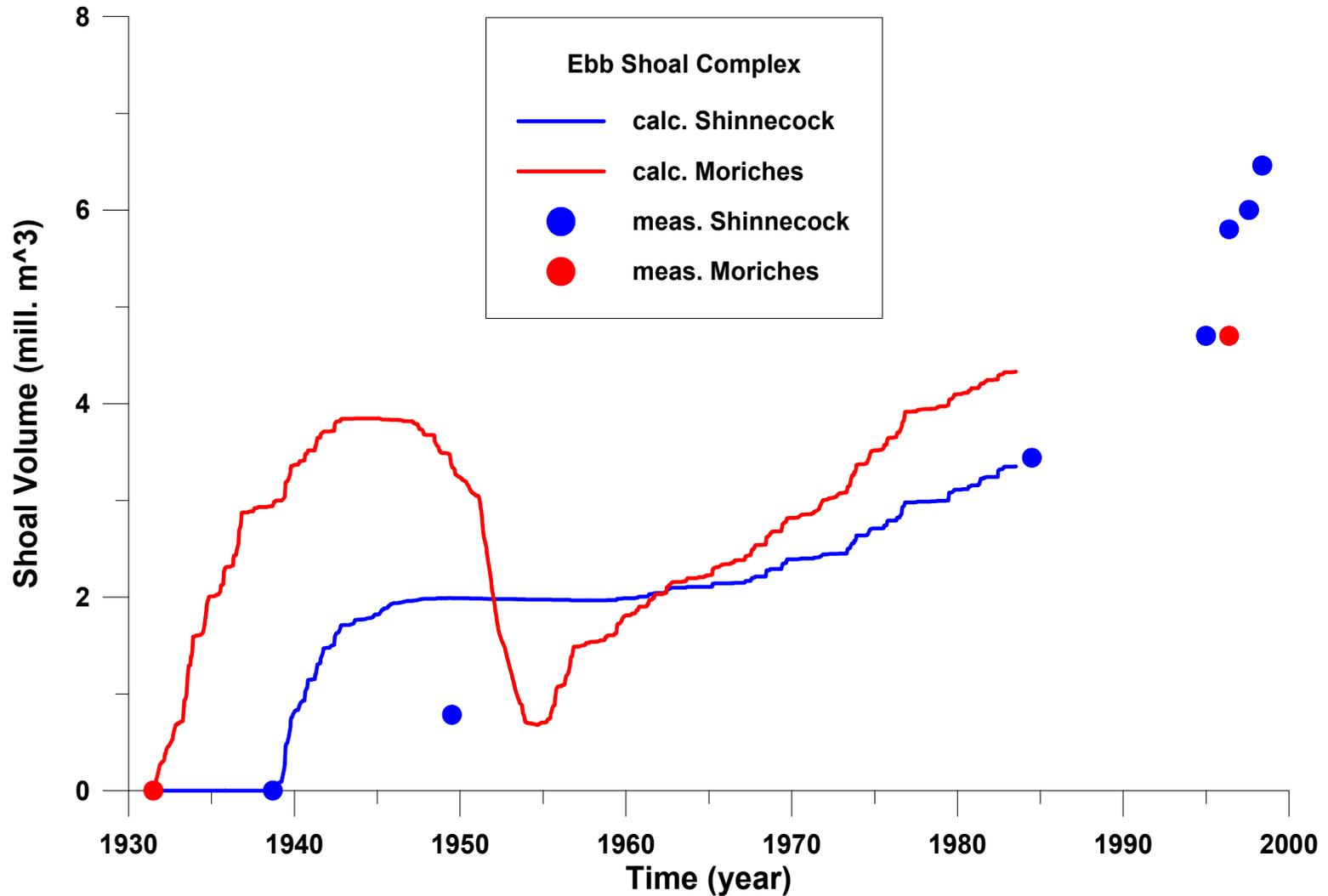


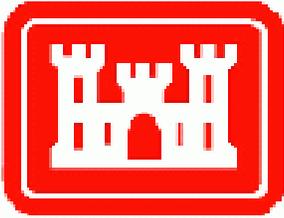
Simulation of Shoreline Evolution at Long Island, 1931-1983 (detail)



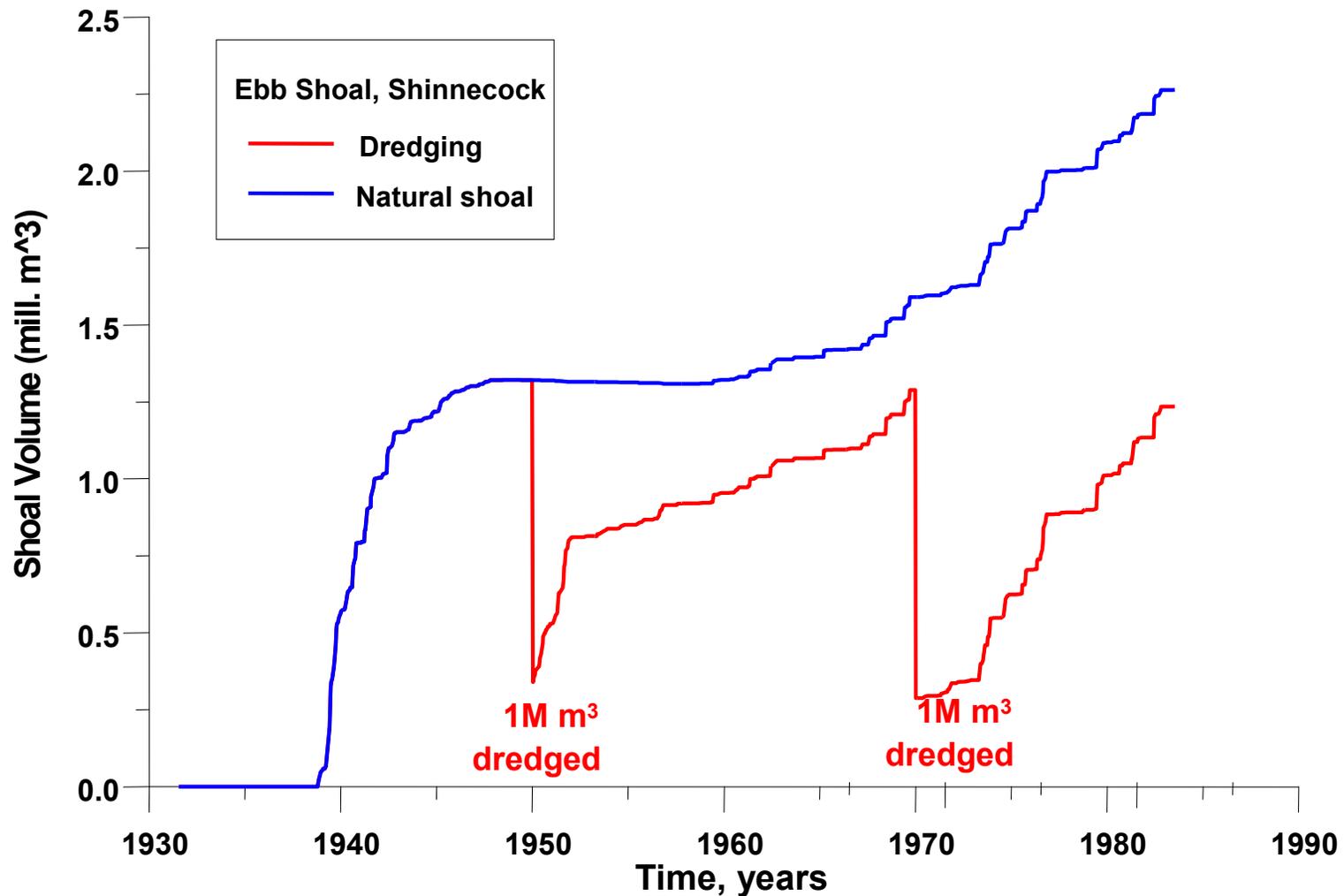


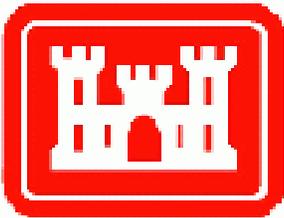
Time Evolution of the Ebb Shoal Complex at Shinnecock and Moriches Inlets





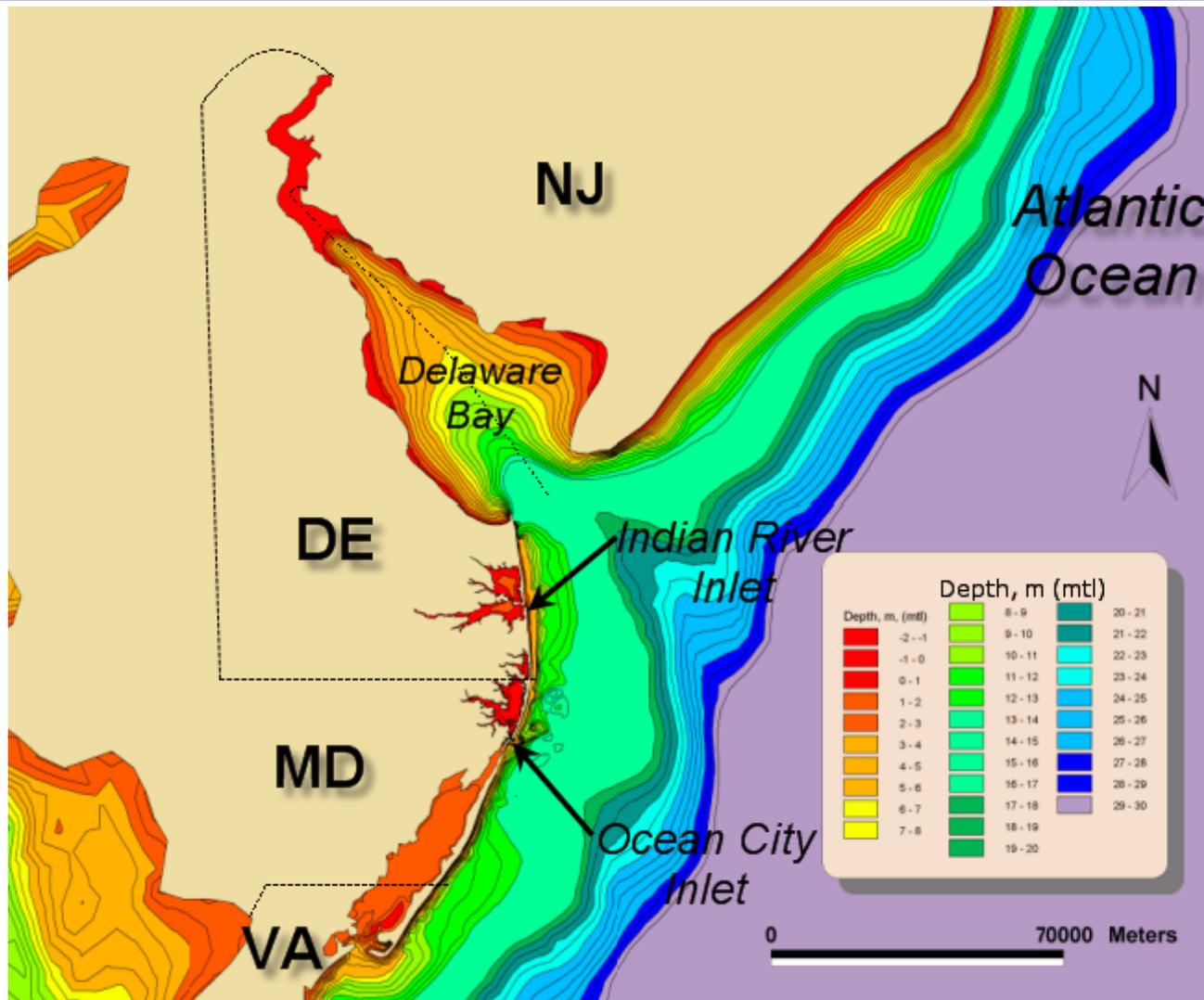
Simulation of Ebb Shoal Dredging, Shinnecock Inlet-Recovery of Shoal

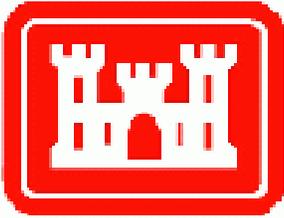




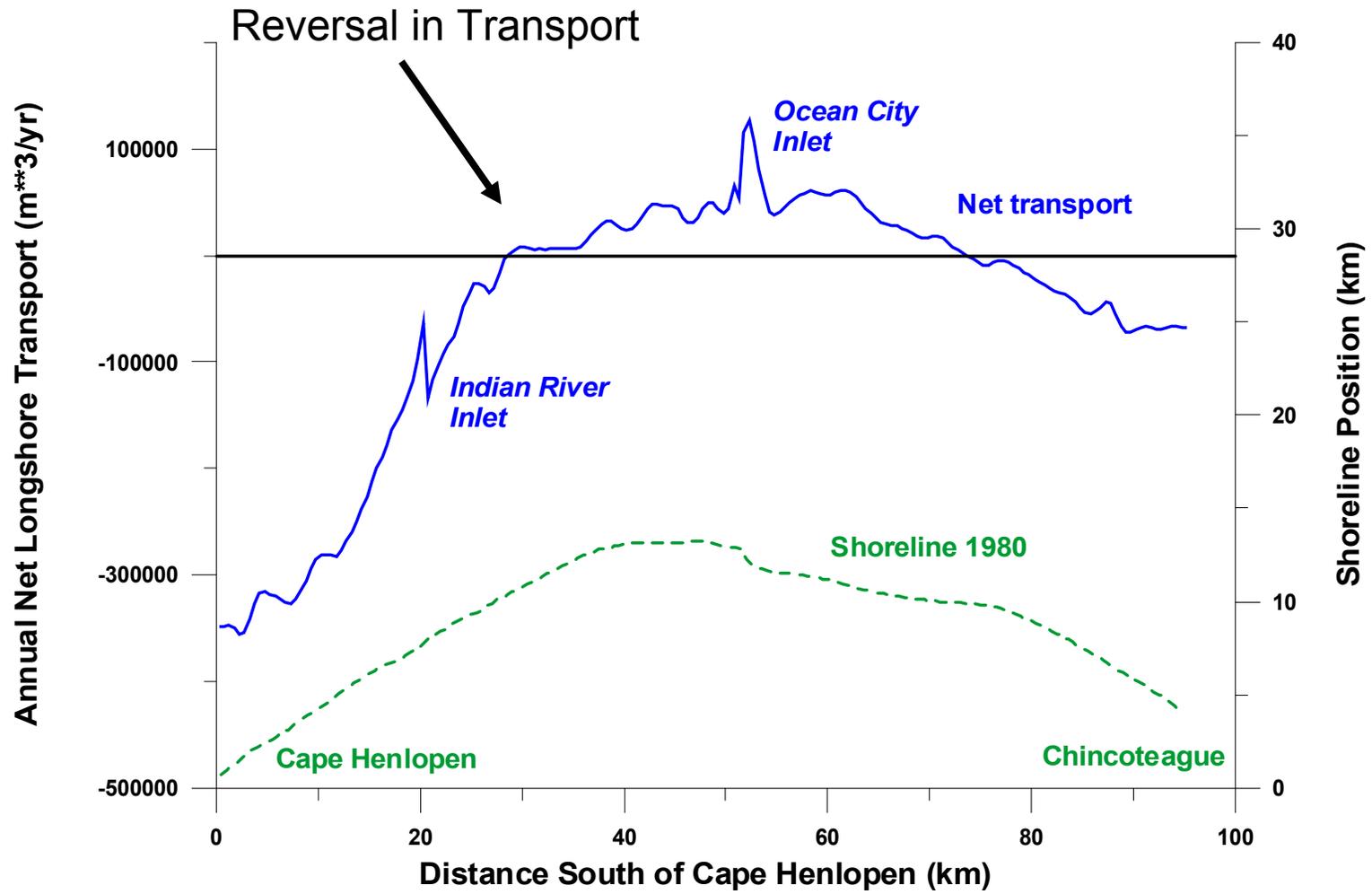
Delmarva Case Study

Large-Scale Topography of the Study Area



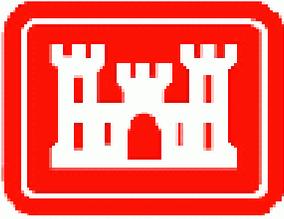


Calculated Net Annual Longshore Sediment Transport Along Delmarva Peninsula









Cascade SMS Interface as Technology-Transfer Delivery Mechanism



The screenshot displays the Cascade 1.0 software interface. The main window shows a map of the Delmarva Peninsula with a grid overlay. An arrow points to the peninsula with the label "Delmarva Peninsula".

An "About Cascade" dialog box is open, displaying the SMS logo and the following text:
Cascade 1.0 Beta
Build Date: Jul 11 2005
Cascade
Beach Morphology Model

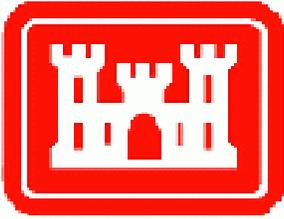
A "Model Control" dialog box is also open, showing various parameters for the model. The parameters are as follows:

Parameter	Value	Unit
Depth of Closure	6.0	m
Median Grain Size	0.2	mm
Bottom friction coeff	0.01	
CERC transport formula coeff	0.35	
Num inlet cells to add/remove sediment	1	
Calibration coefficient for bypassing	0.75	
Power in nonlinear reservoir model:		
During accumulation	1.0	
During depletion	1.0	

The "Boundary Conditions" section shows:
Starting Grid Boundary Type: Pinned Beach
Ending Grid Boundary Type: Pinned Beach

The "Time Controls" section shows:
Number of timesteps: 17155
Timestep size (hrs): 24.0
Shoal volume output interval: 10.0 num timesteps

An "Output Times" dialog box is also open, showing a list of output times: 3650, 7300, 10950, 14600, and 17155.



Cascade SMS Interface



The screenshot displays the Cascade 1.0 software interface. The main window shows a map of the Delmarva Peninsula, with a purple line representing a jetty or barrier. An arrow points to this line with the label "Delmarva Peninsula".

Two dialog boxes are open:

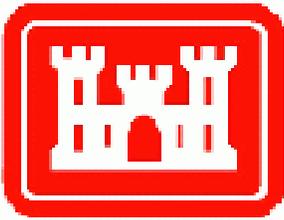
- Point Source/Sink Attributes**: A table with columns for Type, Time, and Vol Removed.
- Jetty Attributes**: A configuration window for a specific jetty, including options for Source/Sink Modeling and various volume parameters.

The Point Source/Sink Attributes dialog box contains the following data:

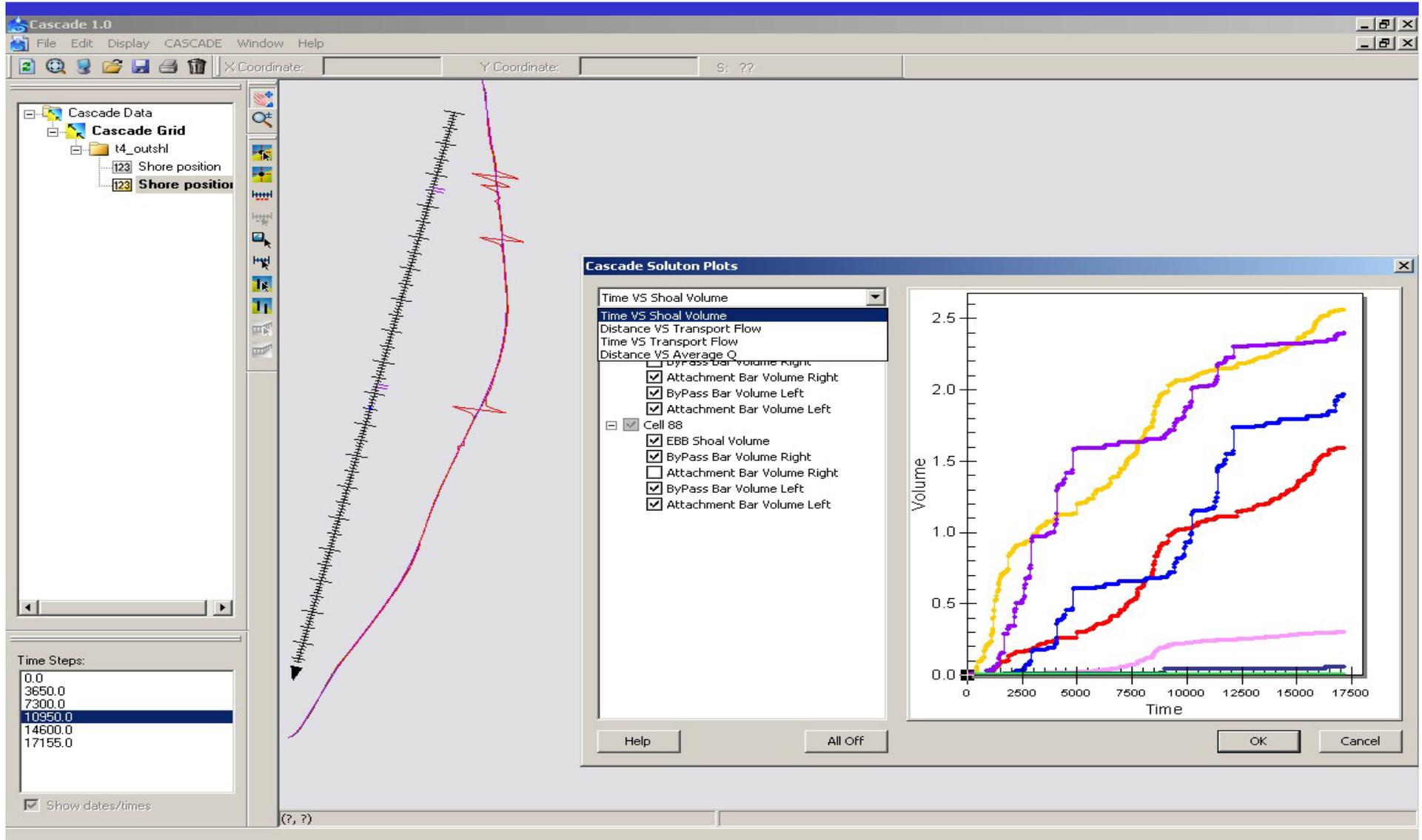
Type	Time	Vol Removed
Bypassing Ba...	10950	20000.0
Ebb Shoal	10950	1000000.0
Bypassing Ba...	10950	10000.0
Attachment B...	10950	-100000.0

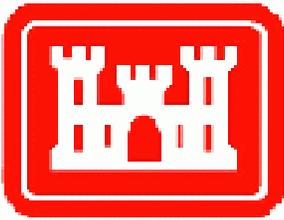
The Jetty Attributes dialog box shows the following settings:

- Jetty Index: 25
- Source/Sink Options:
 - Source/Sink Modeling
 - Initial Ebb Shoal Volume: 0.0
 - Initial Bypassing Bar Volume: 0.0 (Left), 0.0 (Right)
 - Initial Attachment Bar Volume: 0.0 (Left), 0.0 (Right)
 - Fixed Equilibrium Shoal Volume
 - Ebb Shoal Equilibrium Volume (VSEQ): 3000000.0
 - Bypassing Bar Equilibrium Volume (VSQB): 2000000.0
 - Attachment Bar Equilibrium Volume (VSAQ): 300000.0
 - Time Varying Equilibrium Shoal Volume
 - Relative Ratio between VSQB and VSEQ: 1.0
 - Relative Ratio between VSAQ and VSEQ: 1.0
 - Point Source/Sink

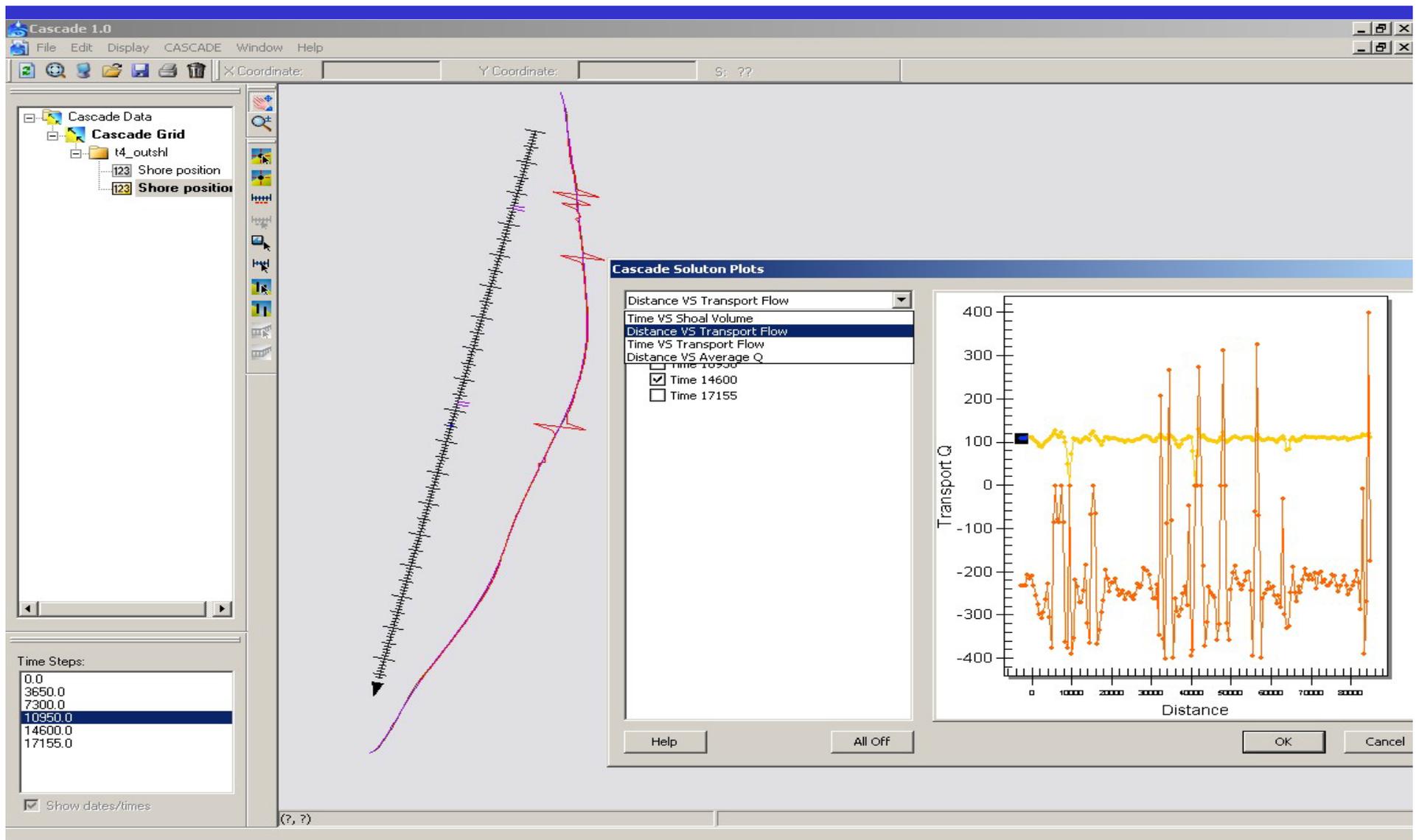


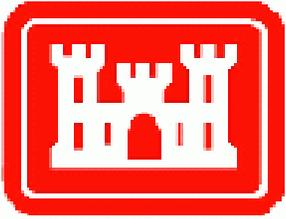
Cascade SMS Interface



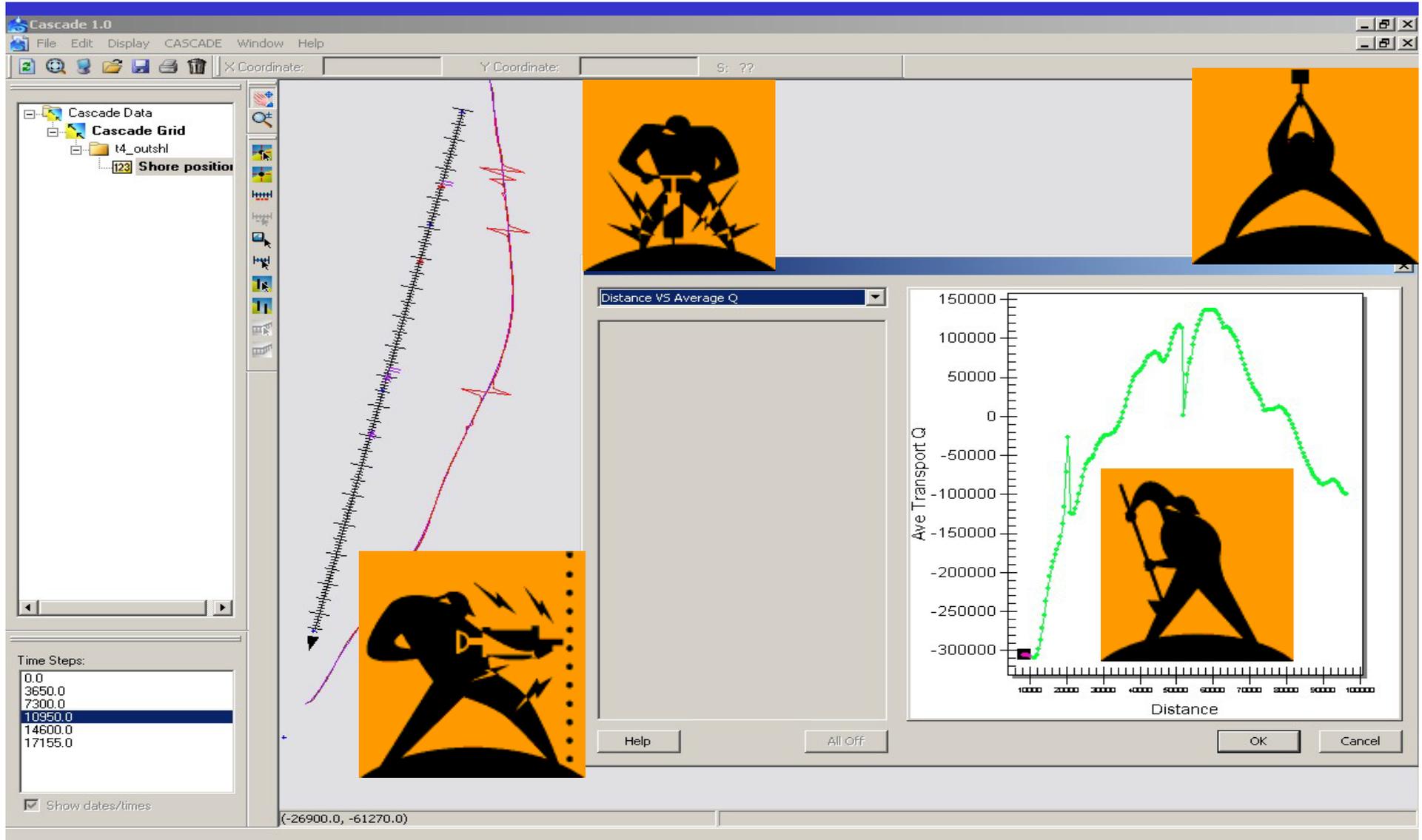


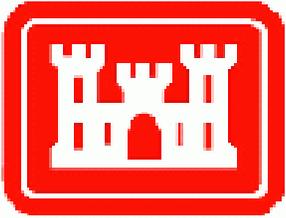
Cascade SMS Interface





Cascade SMS Interface



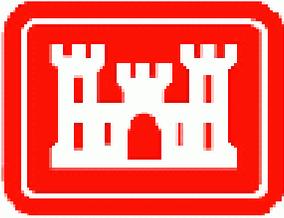


Cascade Applicability



- Coastal inlet maintenance
- Channel management
- Inlet and structure bypassing plans
- Fate of beach fill
- Beach fill project planning
- Storm erosion hazard management
- Overwash & breach susceptibility
- Unifying technology for multiple projects (RSM)

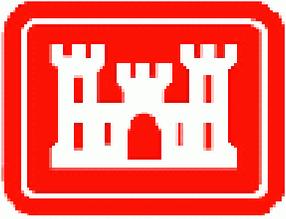




Cascade: Conclusions



- 1. Sediment transport & coastal evolution occur at many different scales with implications for modeling**
- 2. Engineering projects require considerations at regional scale, → dictating need for modeling processes & controls at this scale**
- 3. Cascade can simulate coastal evolution within complex regional trends, including inlet sediment storage & transfer, engineering activities, & structures**
- 4. Cascade SMS interface provides turn-key system to support practicing engineers & scientists in efficiently solving coastal watershed problems**



Cascade: Current & Future Developments



- Improved ebb & flood shoal bypassing
 - Integrated reservoir model (Kraus 2000)
- Spit evolution
- Automated breach opening & closure
- Improved dune & cliff dynamics based on driving forces

- Further applied testing
 - Partnerships welcome!

