Modeling Sediment Transport Along the Upper Texas Coast

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Sabine Pass to San Luis Pass
Shoreline Erosion Feasibility Study
ERDC’s Role in the Feasibility Study

- WIS wave hindcast
- ADCIRC water level and currents
- Sediment Budget
- SBEACH storm-induced beach changes
- STWAVE / GENESIS longterm shoreline change modeling
Status

Current

• Develop numerical modeling tools to predict shoreline change
• Use these tools to evaluate design alternatives for erosion control, storm damage reduction, and environmental restoration

Near Future

• Final design refinement and optimization
SBEACH
(Storm-induced BEAch CHange)

- Numerical Model for simulating cross-shore beach change
- Intended use is to predict short-term beach profile response to storms
Hurricane Claudette landfall
central Texas coast
July 15, 2003

SBEACH Calibration
Hurricane Claudette Beach Erosion

JUL 16 2003
Data Inputs

Pre- and Post-Storm Profiles

Waves and Water Levels
Example Result

Bolivar Peninsula Recession at 2.5 meters

Predicted Recession (m)

Measured Recession (m)

No Tube  Geo Tube
GENESIS
(GENERalized model for SIMulating Shoreline change)

- Numerical Model for simulating along-shore beach change
- Intended use is to predict long-term shoreline evolution
GENESIS Calibration

**Tools**
- STWAVE - transforms offshore waves to near-breaking depths
- GENESIS - predicts longshore transport rates and long term beach evolution

**Data**
- WIS hindcast waves
- WIS windfields
- NOS Bathymetry
- Texas BEG shorelines and change rates
Shoreline Change Rates - Galveston Island

South Jetty

Galveston Seawall

Pirates Beach

Jamaica Beach

San Luis Pass

East Beach

Galveston Entrance Channel

Shoreline Change Rate ft/yr

S&S 1882-1963
M 1882-1974
P&M 1974-1982
M 1974-1996
G 1974-2000

North
Shoreline Change Rates – High Island

- West Jetty
- Sabine Pass
- Texas Point
- Sea Rim State Park
- High Island
- Rollover Pass
- Gilchrist
- Caplen
- Crystal Beach
- North Jetty
- Galveston Entrance Channel
- Galveston Bay

Graph showing shoreline change rates from 1882 to 2000, with data for different time periods indicated.
Differences in Change Rates

- Differences in shoreline definitions
- Errors in the data and the analysis procedure
- Natural variations in the shoreline change rate at different times
Published Transport Rates

- Published reports indicate net transport is to the southwest along all or almost all of the study area.

- Net rates are generally within the 30,000 – 150,000 m³/yr range to the southwest.


Hall, G. L. (1975). Sediment transport processes in the nearshore waters adjacent to Galveston Island and Bolivar Peninsula, Ph. D. diss., Texas A&M.


West End of Galveston Seawall

February 2003
Angle and Sign Convention

- Wave angle convention
- Longshore transport sign convention
- Shore Normal
- Azimuth Angle
- N

Directions:
- Ocean to Shoreline: negative
- Shoreline to Land: positive
- Land to Ocean: negative
- Land to Shoreline: positive

Accretion: +
Erosion: -
Preliminary Transport Calculations

- Use offshore WIS wave data – 10 years of hourly data
- Remove offshore traveling waves
- Simple Snell’s Law transformation to breaking depth
- Transport rate from “CERC” formula

Net longshore sediment transport rate results:
- High Island – 75,000 m³/yr to southwest
- Galveston Island – 135,000 m³/yr to northeast
High Energy Wave Angles

Percent Occurrence

Wave Direction (deg)

All Galveston Waves

Most Energetic 20%

Coastal and Hydraulics Laboratory
Engineer Research & Development Center
Solution Attempts

- Earlier WIS hindcast 1976-1995
- NOAA Buoy 42035 data (off Galveston)
- Different definitions of wave angle and period
- Influence of coastal currents

Nothing shifted the direction of net transport on Galveston Island to the southwest . . .

until we investigated the influence of local winds.
Local Wind Effects

- Affects wave transformations (STWAVE).
- Modifies surfzone currents (GENESIS).

Including both requires modifications to both STWAVE and GENESIS standard procedures.
Net and Gross Transport Rates
Galveston Island

Galveston Seawall
San Luis Pass

Galveston Entrance Channel

Thousands of cubic meters per year

Net
Gross
Shoreline Change Rate
Galveston Island
Calibration Results

- Local winds are important in transport rate calculations
- 600-700 K gross and 0-40 K m³/yr net transport to southwest along West Galveston Island
- 500 K gross and 50-100 K m³/yr net transport to southwest along central portion of High Island
- Net transport reversals to the northeast at East Beach on Galveston Island and near Sea Rim State Park in Jefferson County
Current Activities

- Using SBEACH to look at the effects of storms on a suite of beachfill alternatives
- These data are being used by economic and environmental modelers to narrow the range of optimal alternatives