GENESIS/T

Formulation of Upgrades

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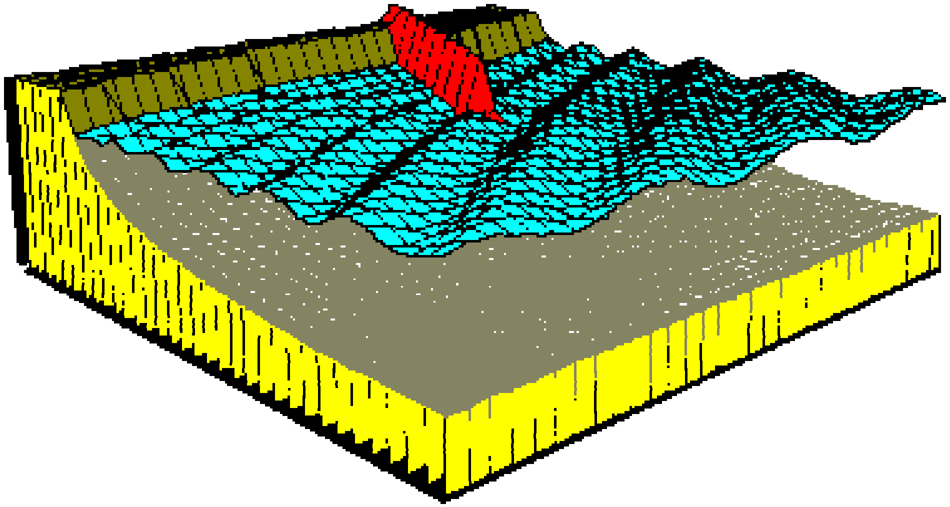
4th Annual CIRP Technology-Transfer Workshop

GENESIS model

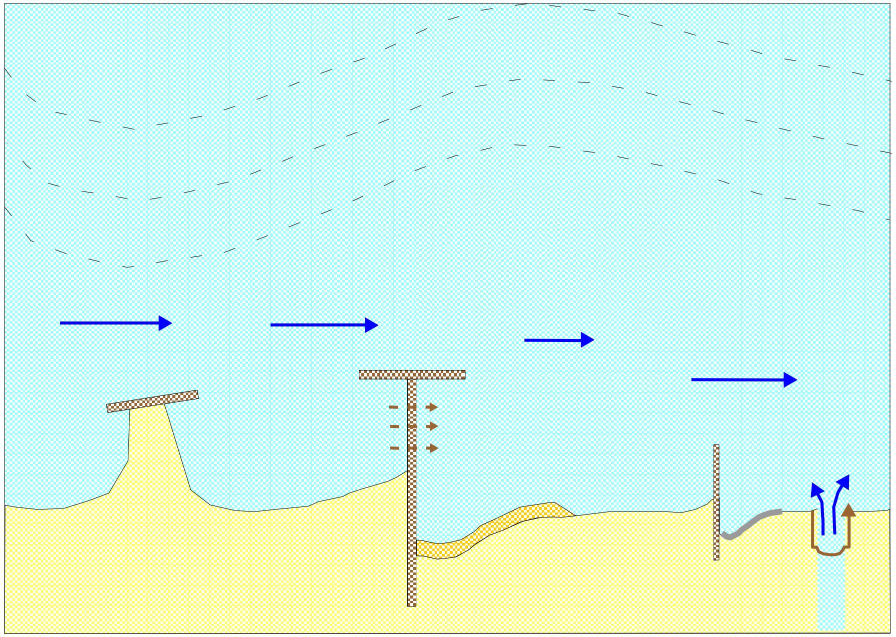


Shoreline change caused by longshore gradients in longshore sediment transport rate $Q(H_b, \alpha)$.

Spatial scale: ~ 1 – 100 km
Temporal scale: ~ 1 – 100 years

GENESIS CAPABILITIES

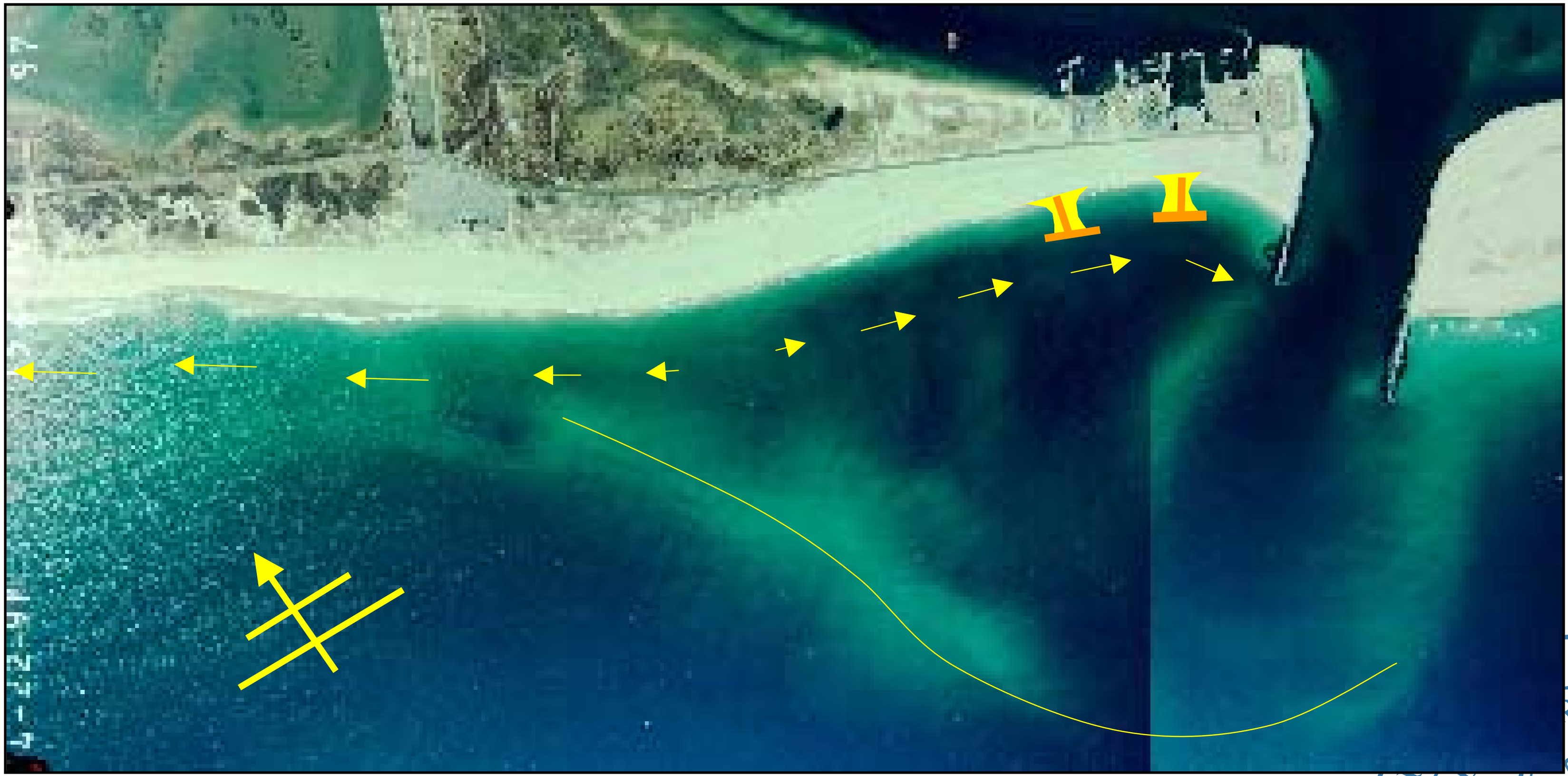
* Groins/Jetties (I, L, T)
* Detached Breakwaters
* Seawalls
* Beach Fills
* Bypassing Operations
* Sources & Sinks
* Transmission
* Multiple Diffraction
* Input Waves of Arbitrary H, T, α
* Multiple Wave Trains



Almost Arbitrary
* Numbers
* Placement
* Combinations

Not Previously Represented
* Cross-shore transport
* Tombolos
* Transport f(currents)
* Stable Regional Features
* Changing Tide Level
* Wave Reflection

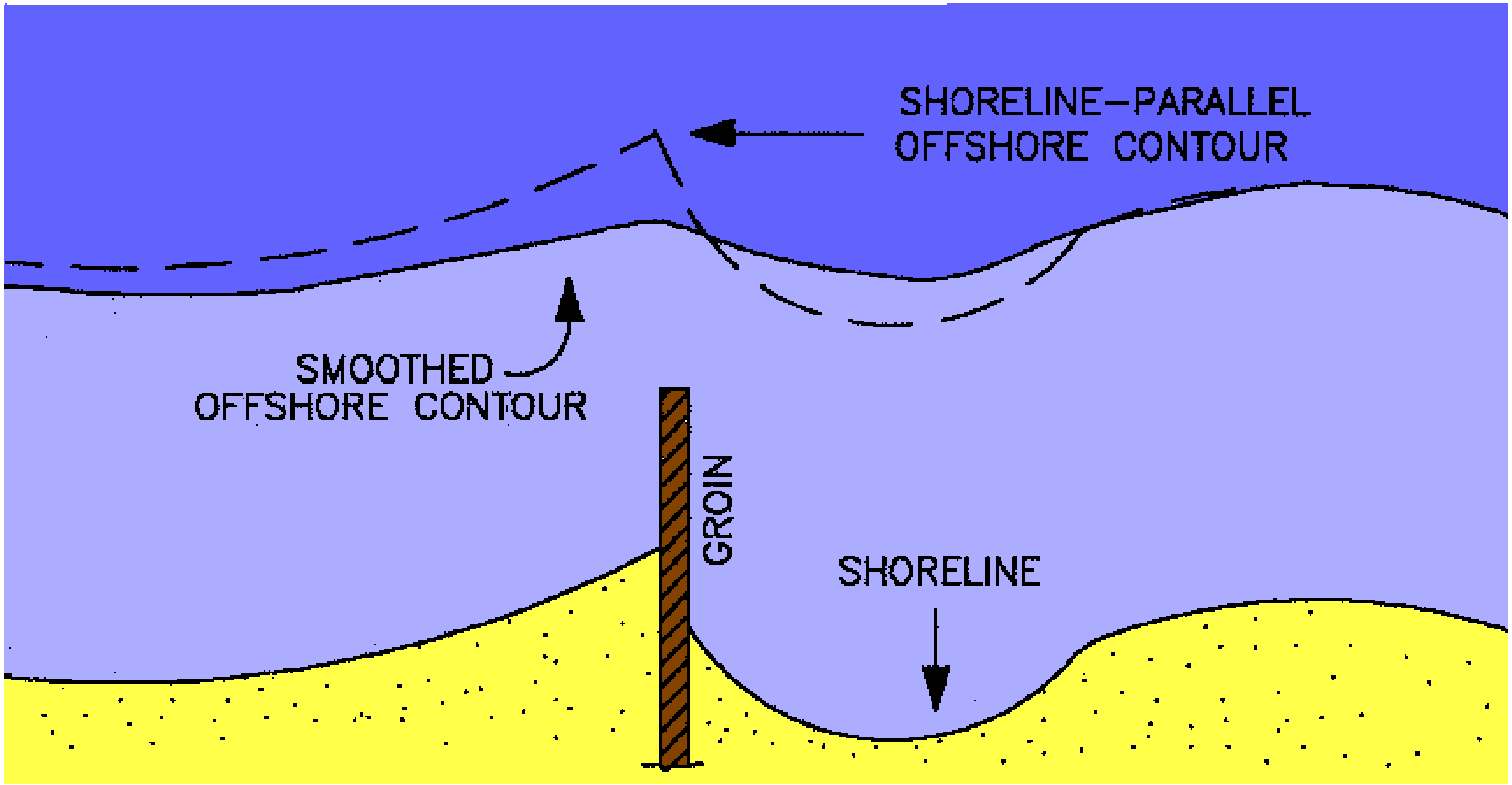
New Model Features & Capabilities

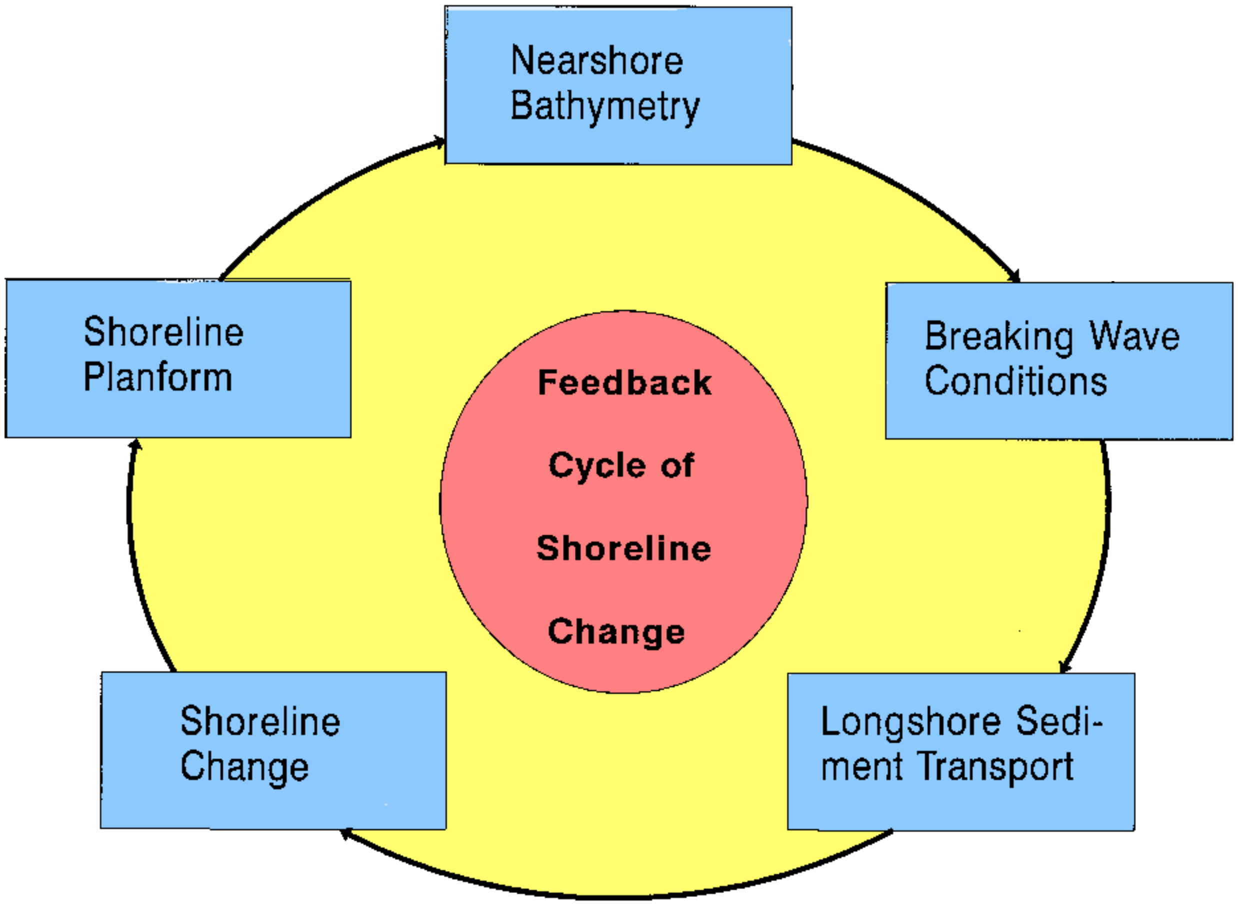


Outline

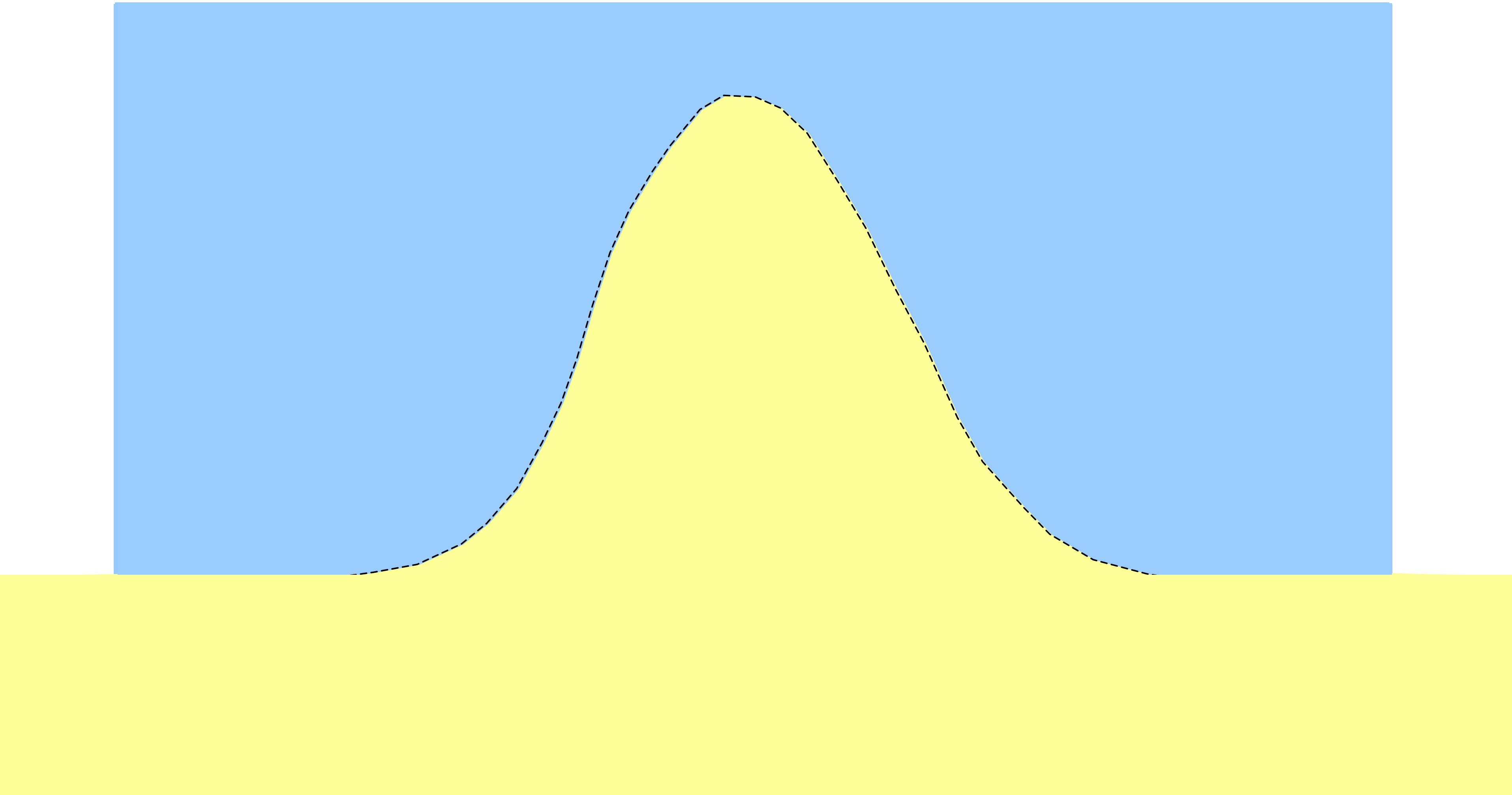
- Pre-Specified Offshore Contours
- Sediment Transport by Tidal Currents
- Sample Application: Shinnecock Inlet
- Tombolo

Introducing Pre-Specified Offshore Contours

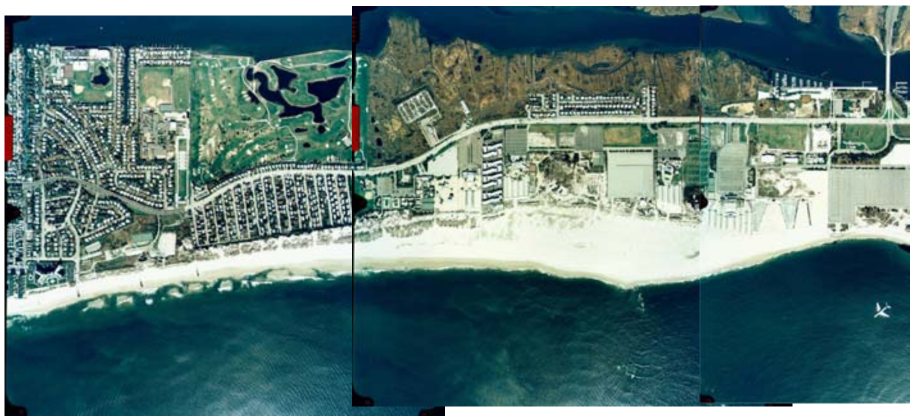



Nearshore Bathymetry
Breaking Wave Conditions
Longshore Sediment Transport
Shoreline Change
Shoreline Planform
Feedback
Cycle of
Shoreline
Change

Time Evolution of Curved Feature

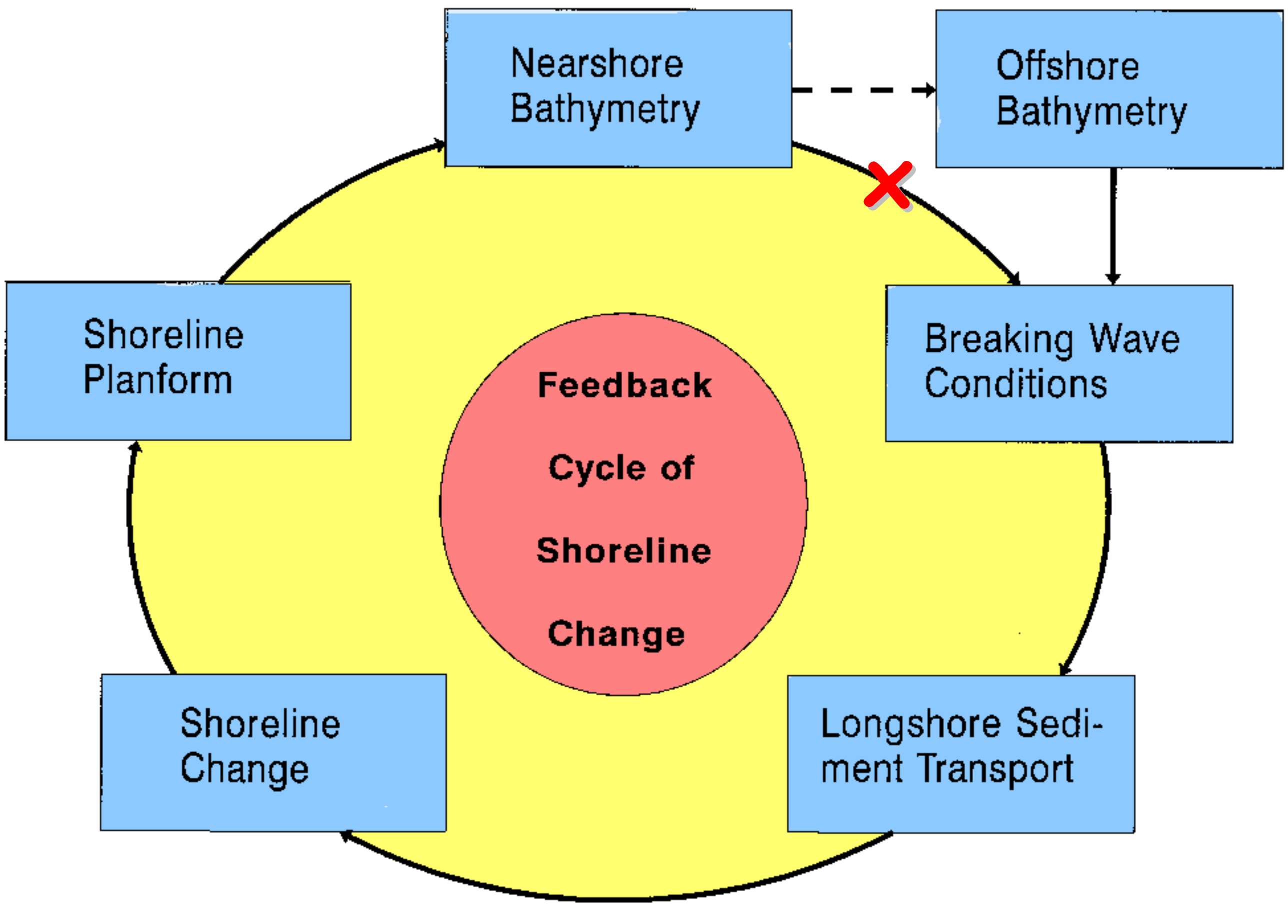


Long Beach, LI



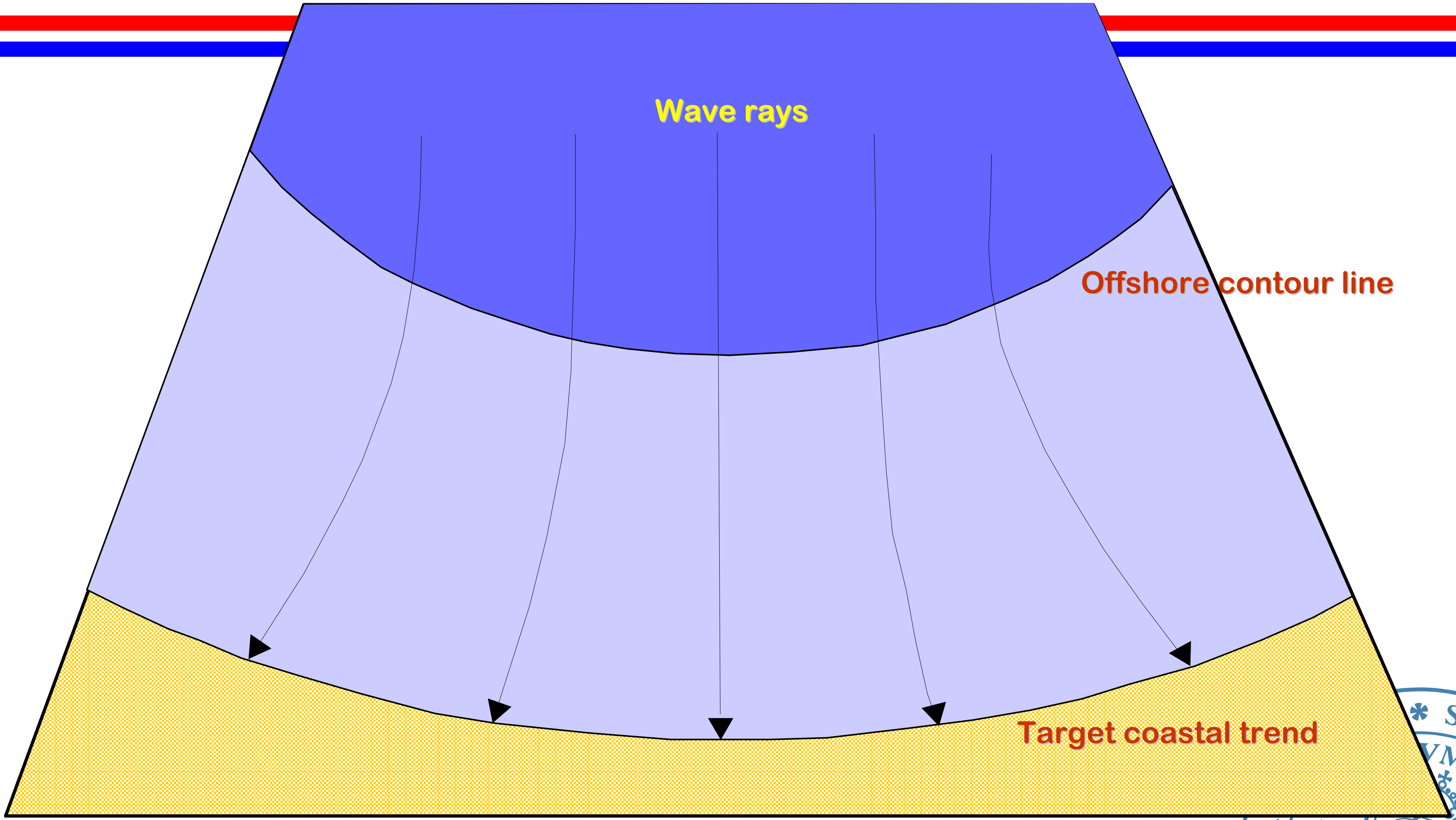
1995

1998

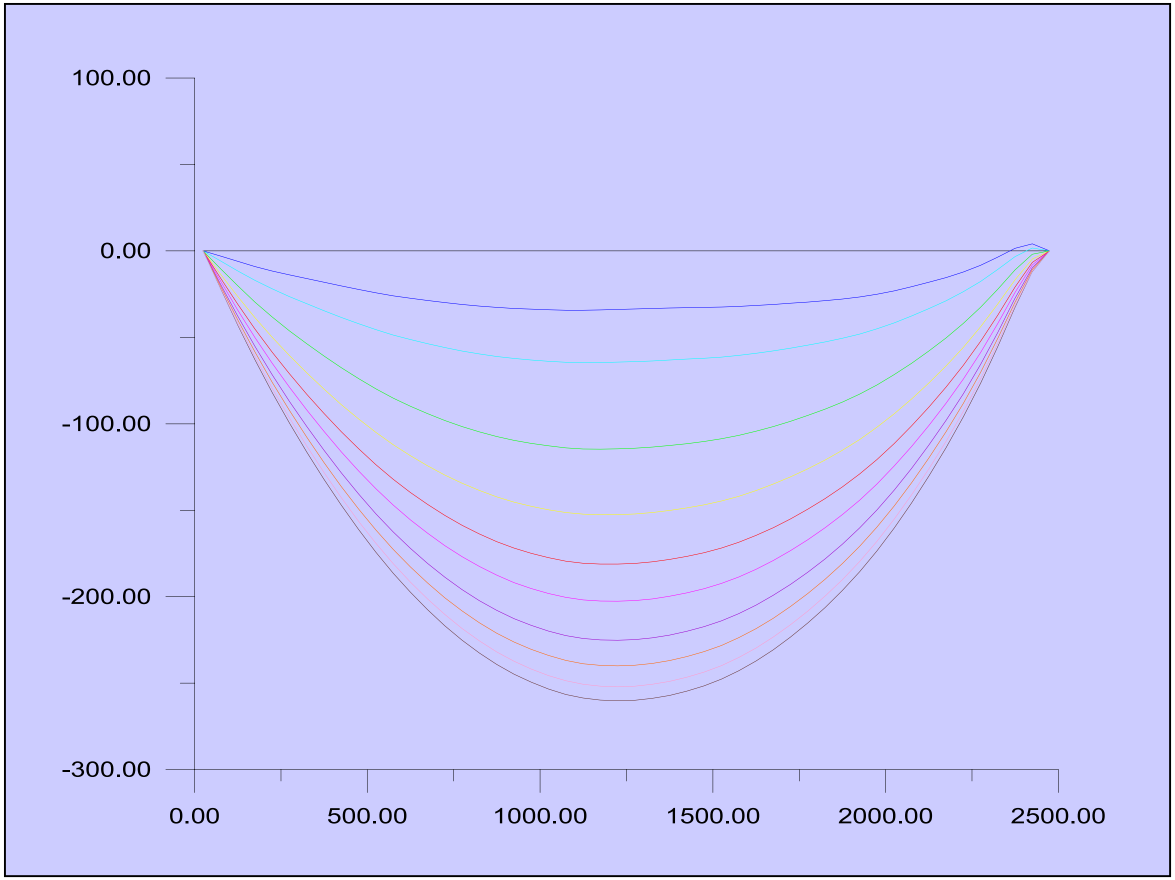


Nearshore Bathymetry
Offshore Bathymetry
Breaking Wave Conditions
Longshore Sediment Transport
Shoreline Change
Shoreline Planform
Feedback Cycle of Shoreline Change

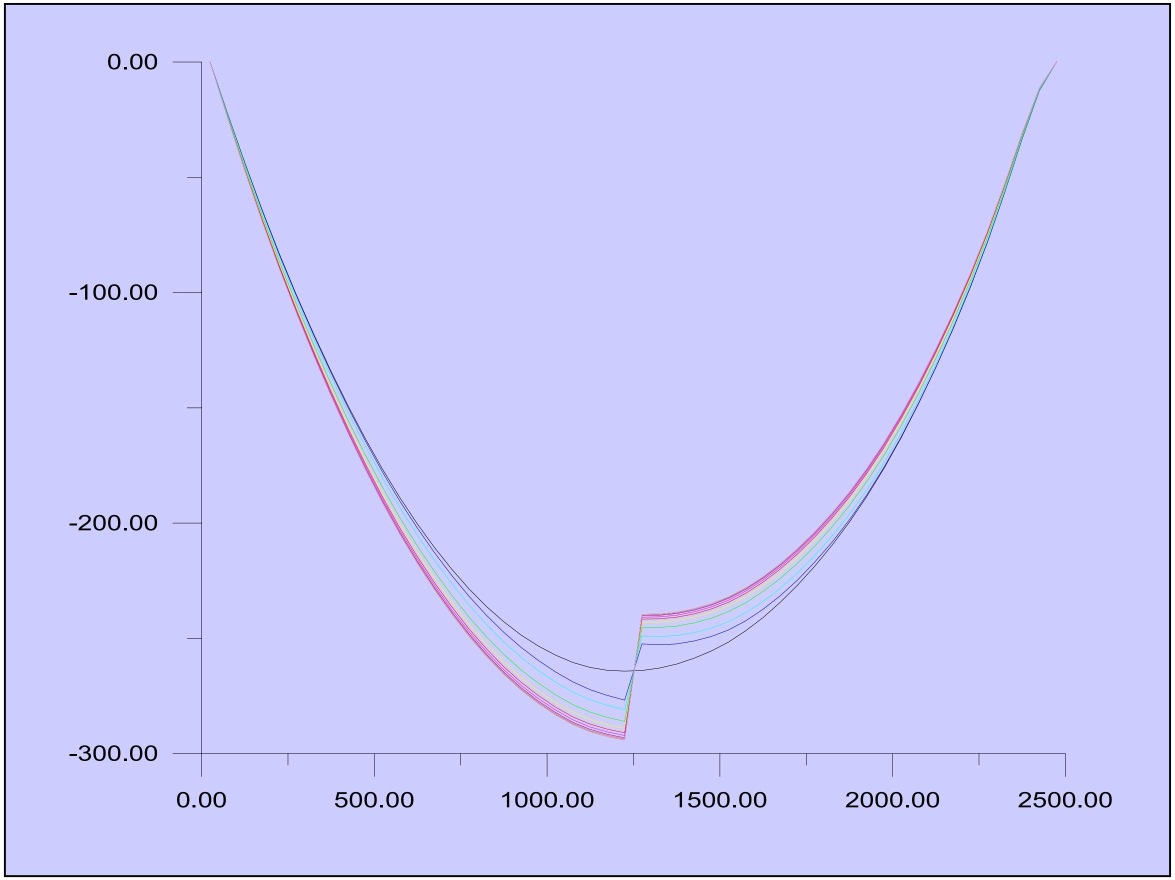
Pre-Specified Contour Line



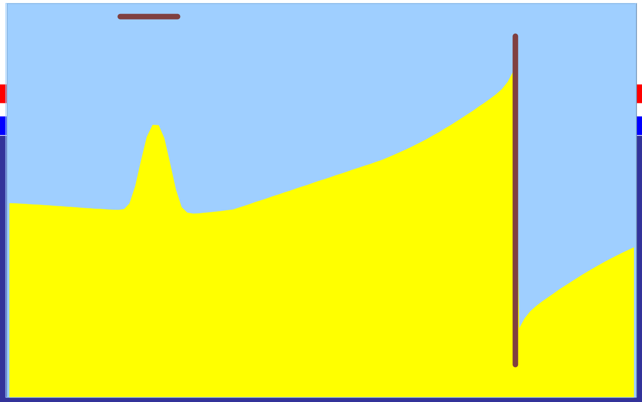
Development of Bay from Initially Straight Beach

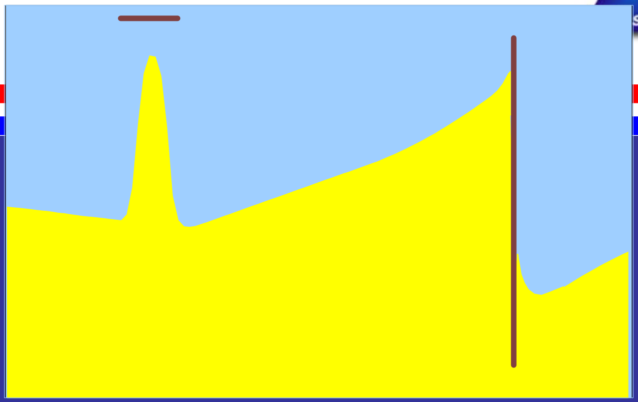


Further Impact of Center Groin



GENESIS
Sediment Transport from Waves & Tidal Current





CERC:

$$Q = \left(H^2 C_g\right)_b a_1 \sin 2\alpha_b$$

$$I_l = K_1 (ECn)_b \sin\alpha_b \cos\alpha_b$$

GENESIS:

$$Q = \left(H^2 C_g\right)_b \left(a_1 \sin 2\alpha_b - a_2 \cos\alpha_b \frac{\partial H}{\partial x}\right)_b$$

Inclusion of currents (Inman-Bagnold 1963):

$$I_l = K_3 (ECn)_b \cos\alpha_b \frac{\overline{v}_l}{u_m}$$

$$v_l = v_b + v_t + v_w$$

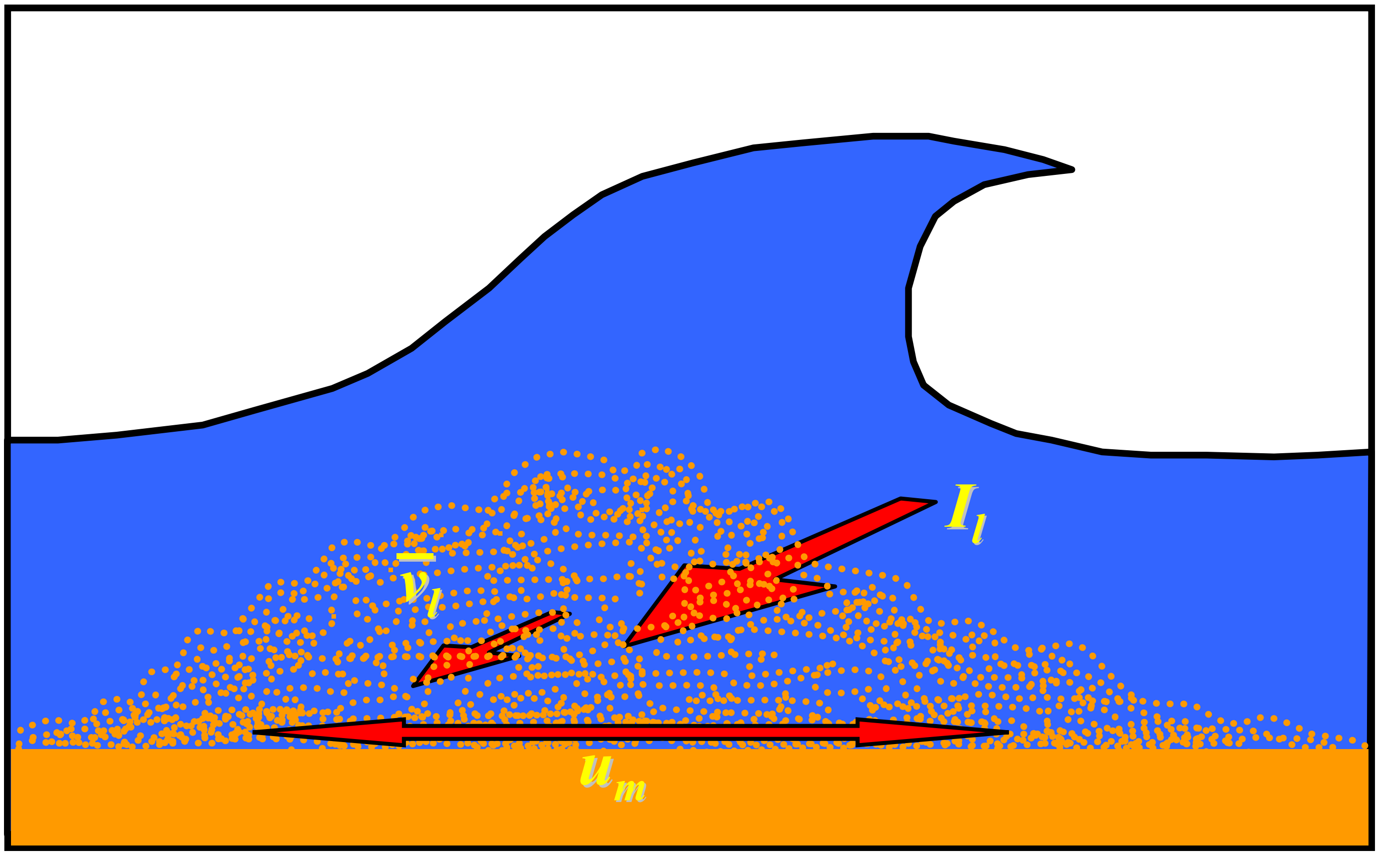
Bagnold (1963):

$$v_b = K_4 u_m \sin\alpha_b$$

Generalized here:

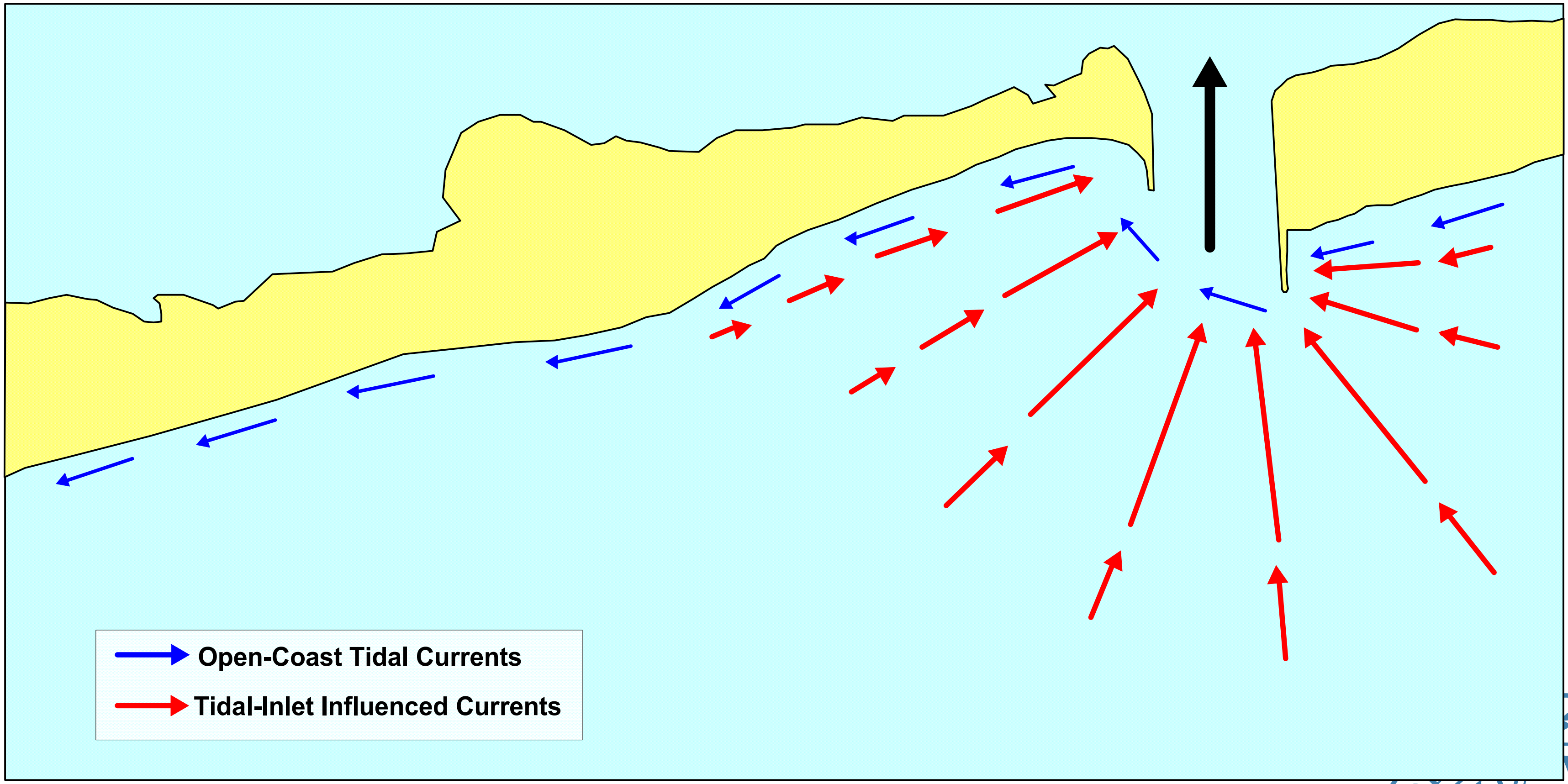
$$\overline{v}_b = K_5 u_m \sin\alpha_b - K_6 \frac{4}{\gamma g} u_m \frac{\partial (u_m^2)}{\partial x} \frac{1}{\tan\beta}$$

$$I_l = K_3 (ECn)_b \cos\alpha_b \frac{\bar{v}_l}{u_m} = \frac{K_3}{4}\frac{\rho g}{\gamma} H_b^2 \, \bar{v}_l \cos\alpha_b$$

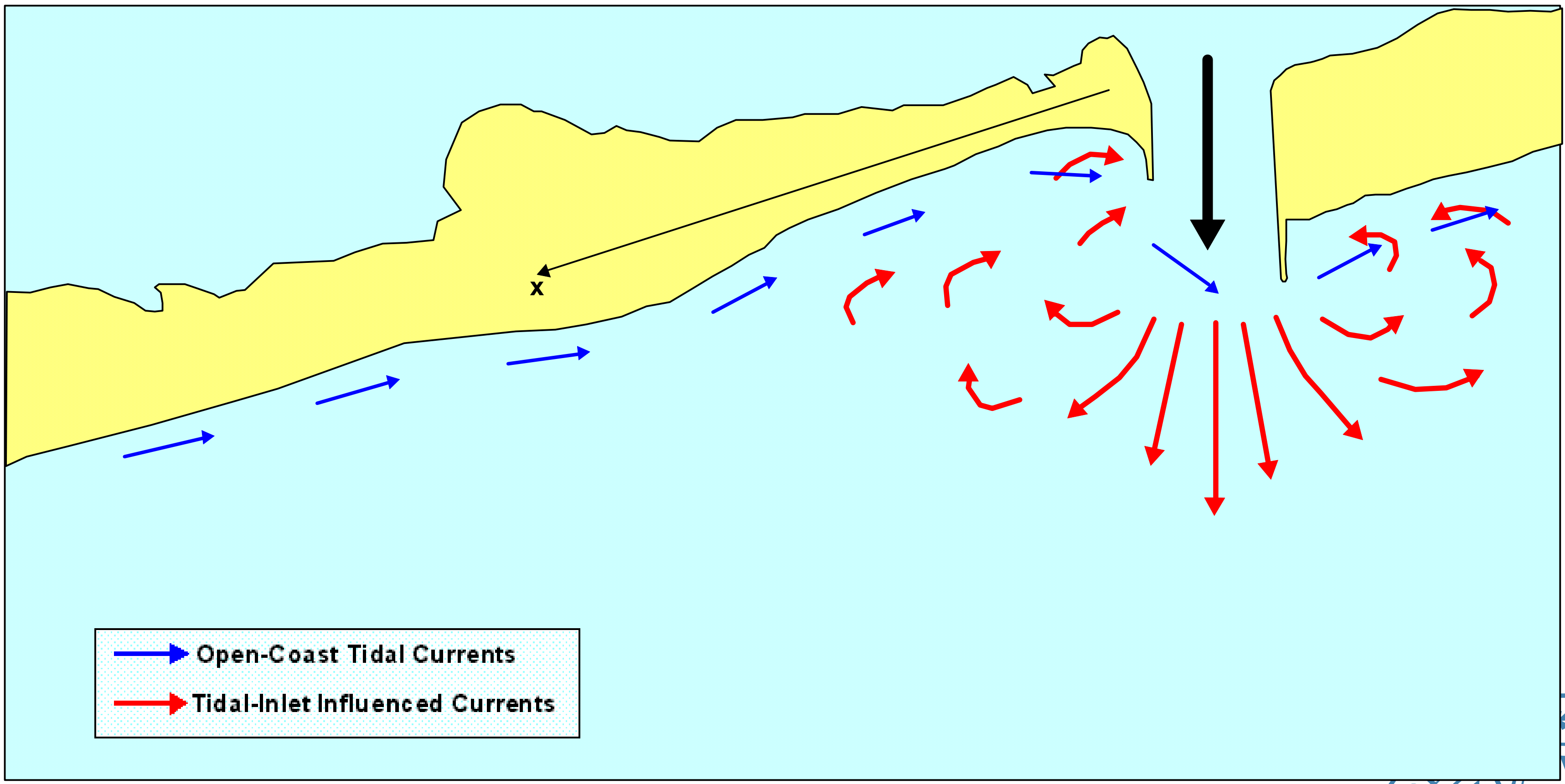


Shinnecock Inlet, Long Island, NY

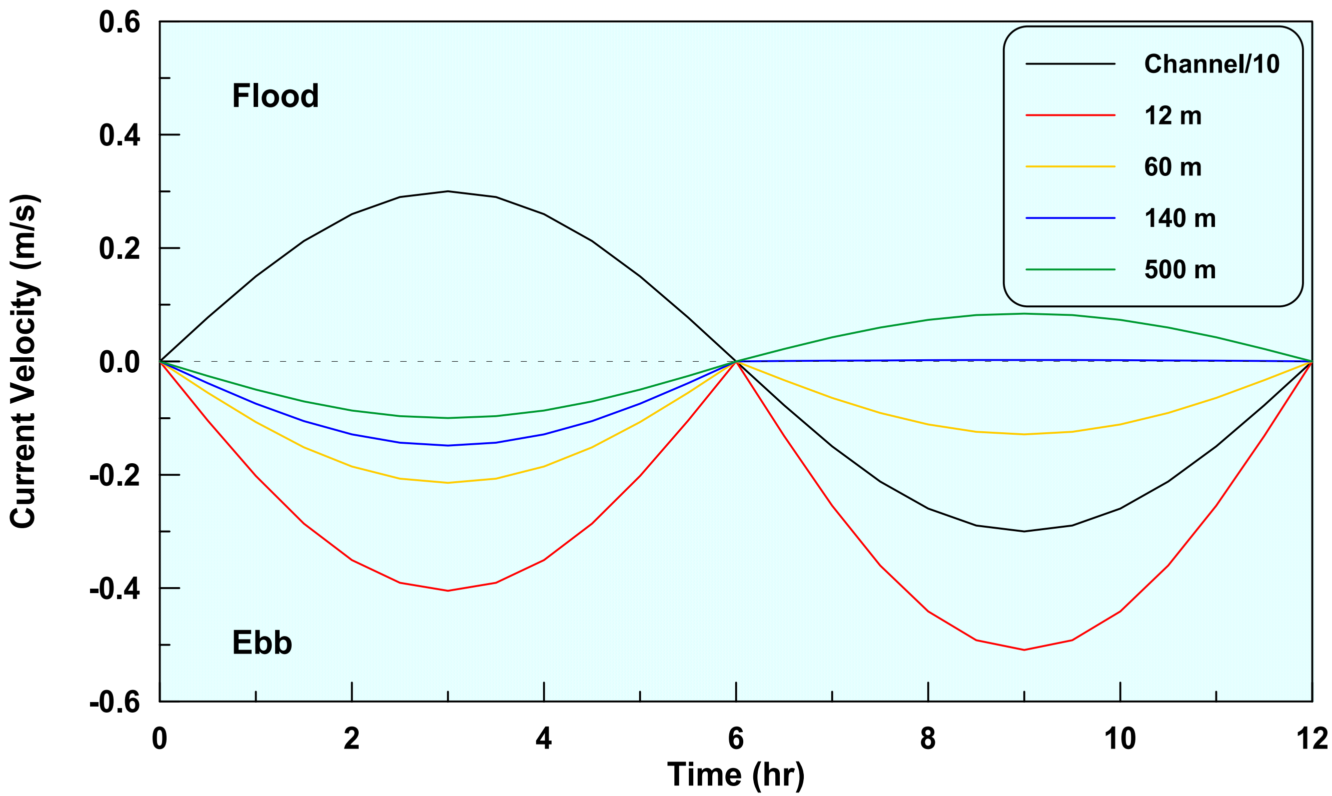
Flood-tidal Current



Ebb-tidal Current

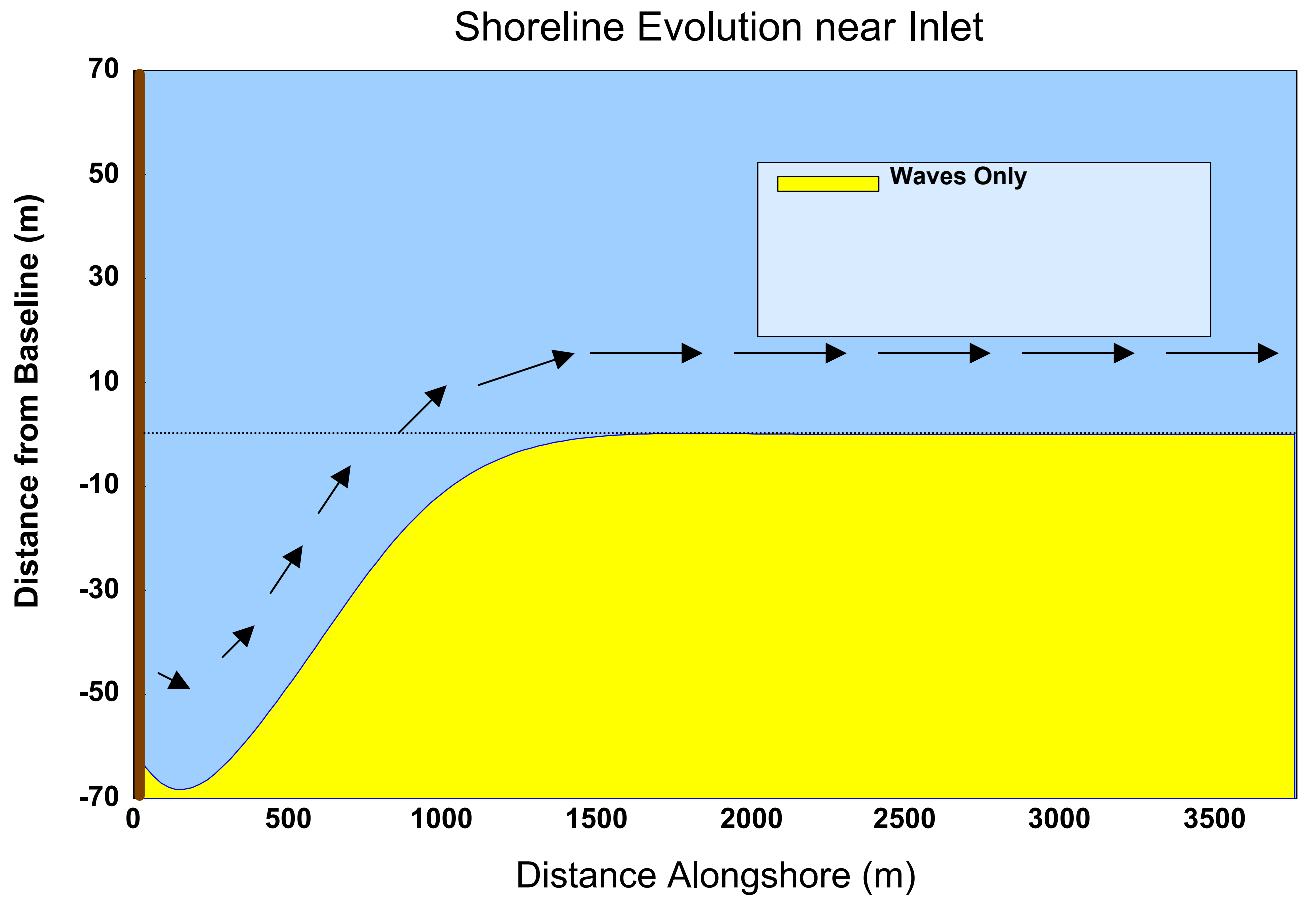


Longshore Component of Tidal Current (x)



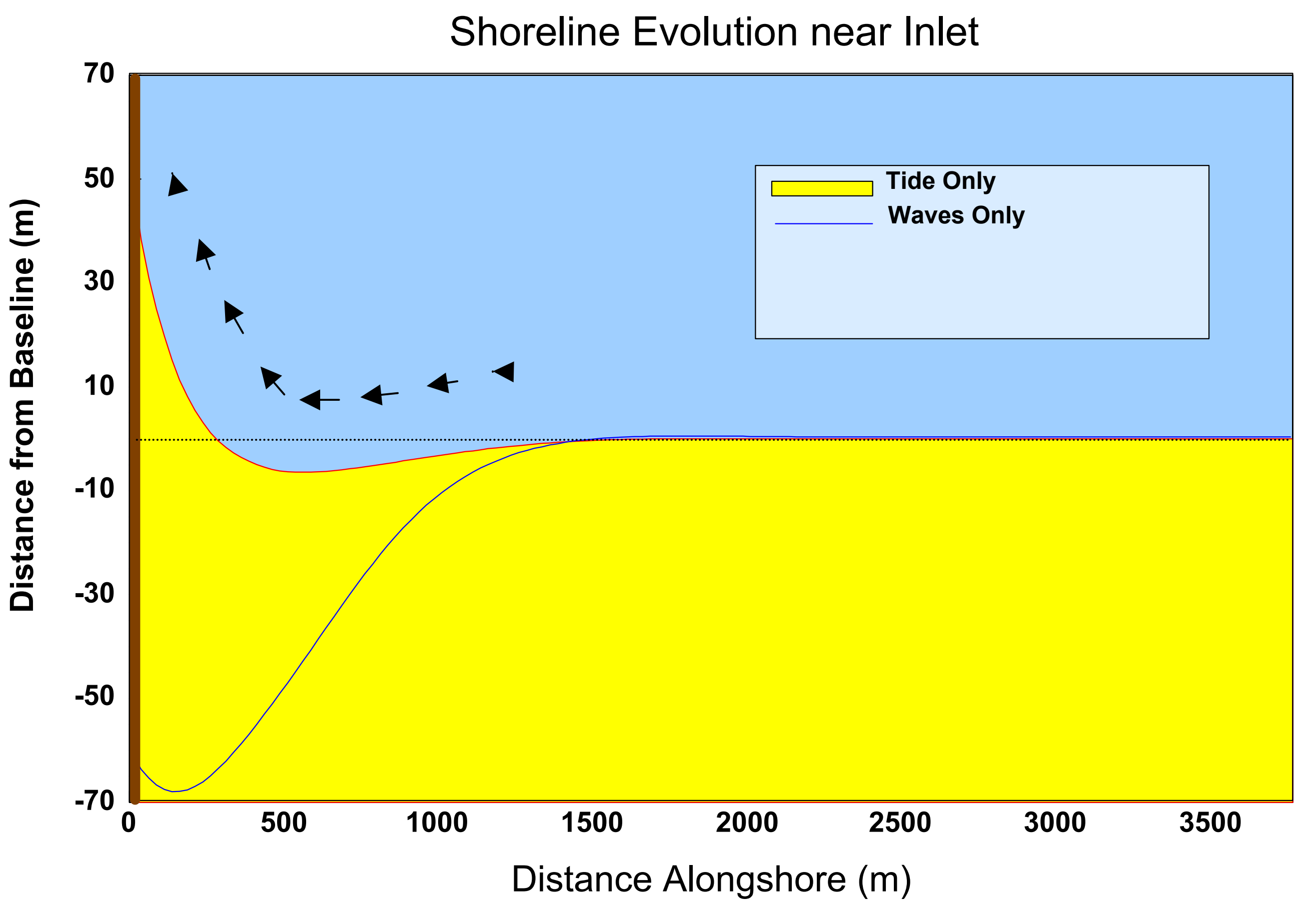
Schematic Illustration: Settings

Tidal Inlet: Waves Only

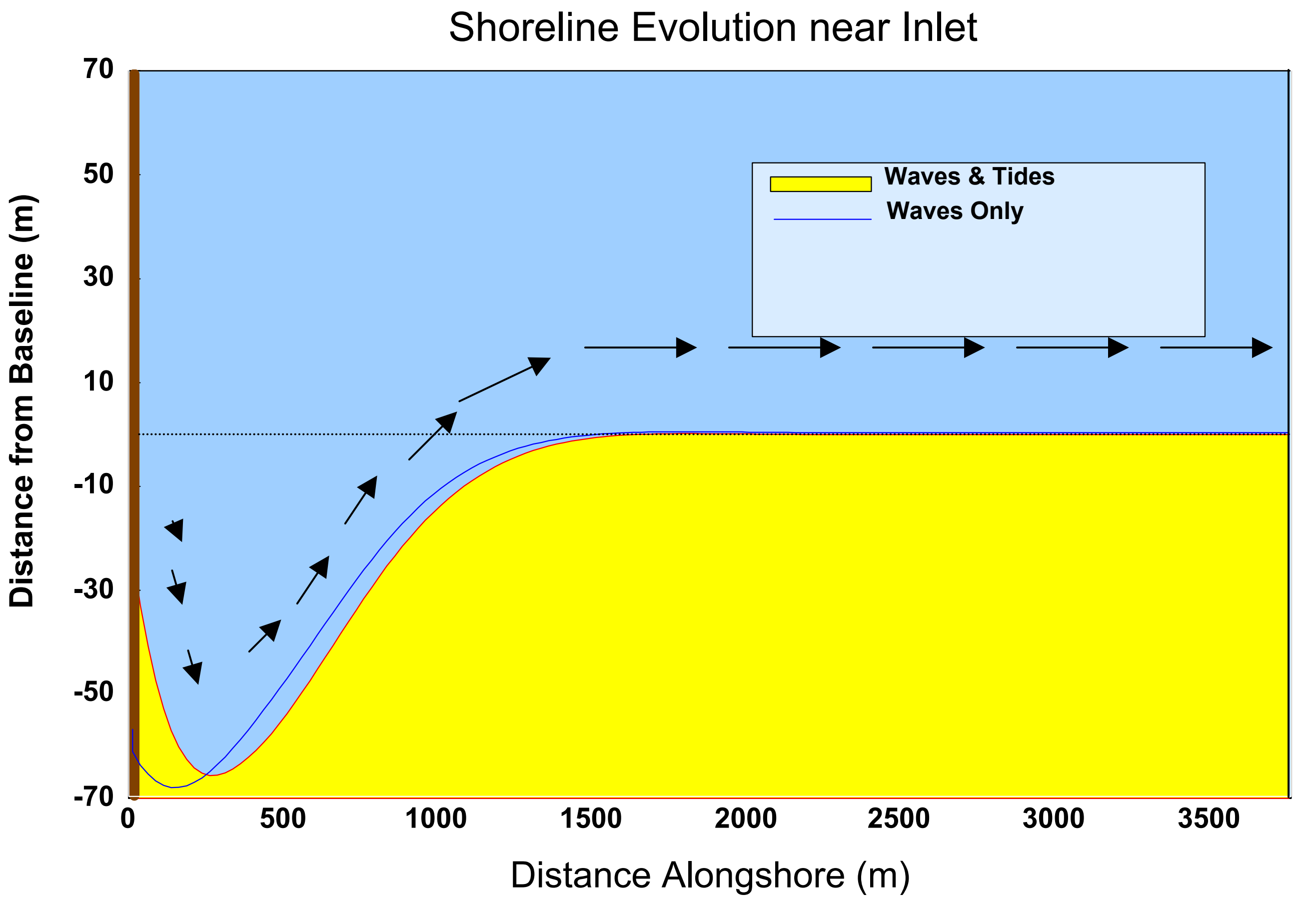


Waves: WIS 1956

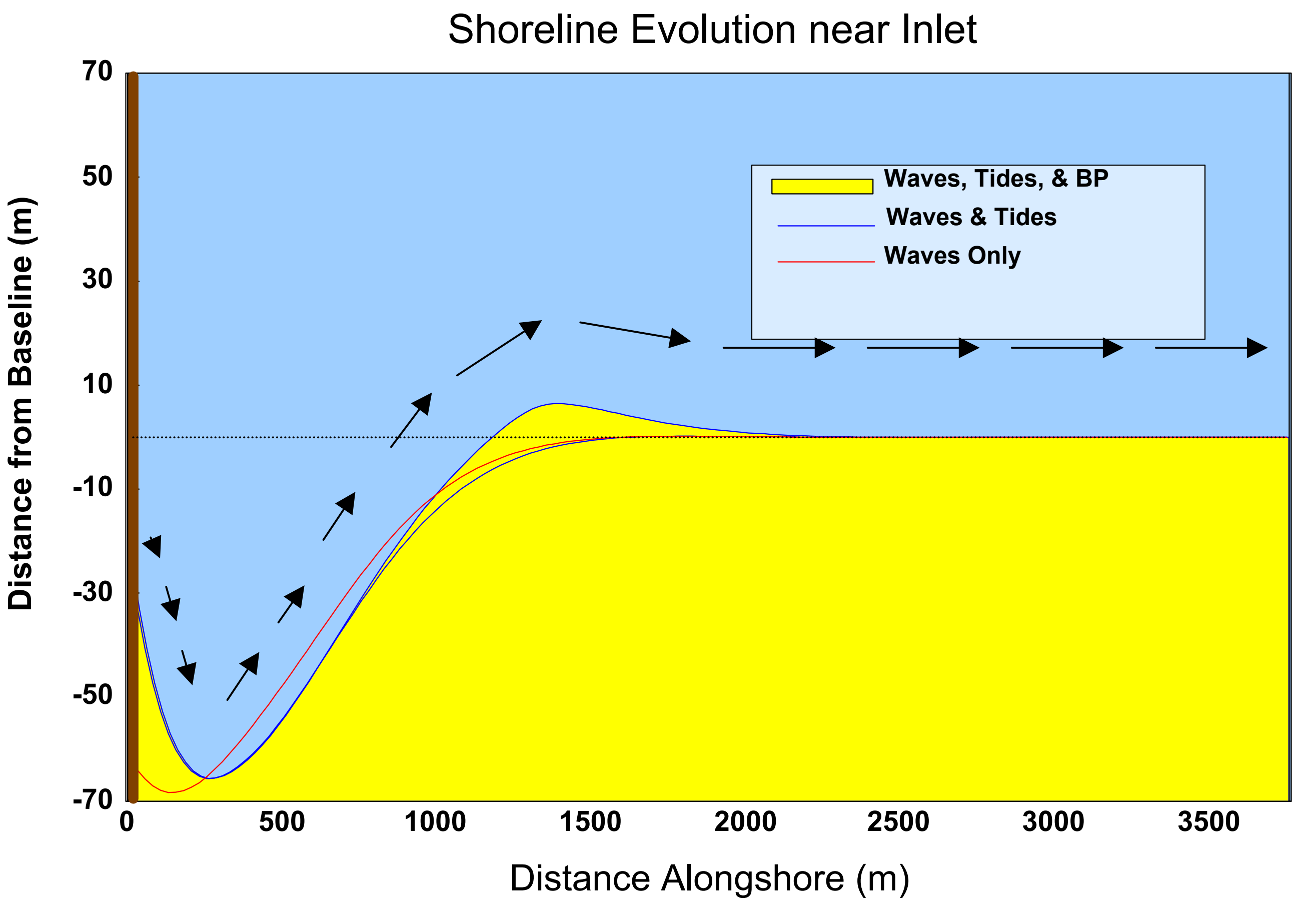
Tidal Inlet: Tidal Net Effect



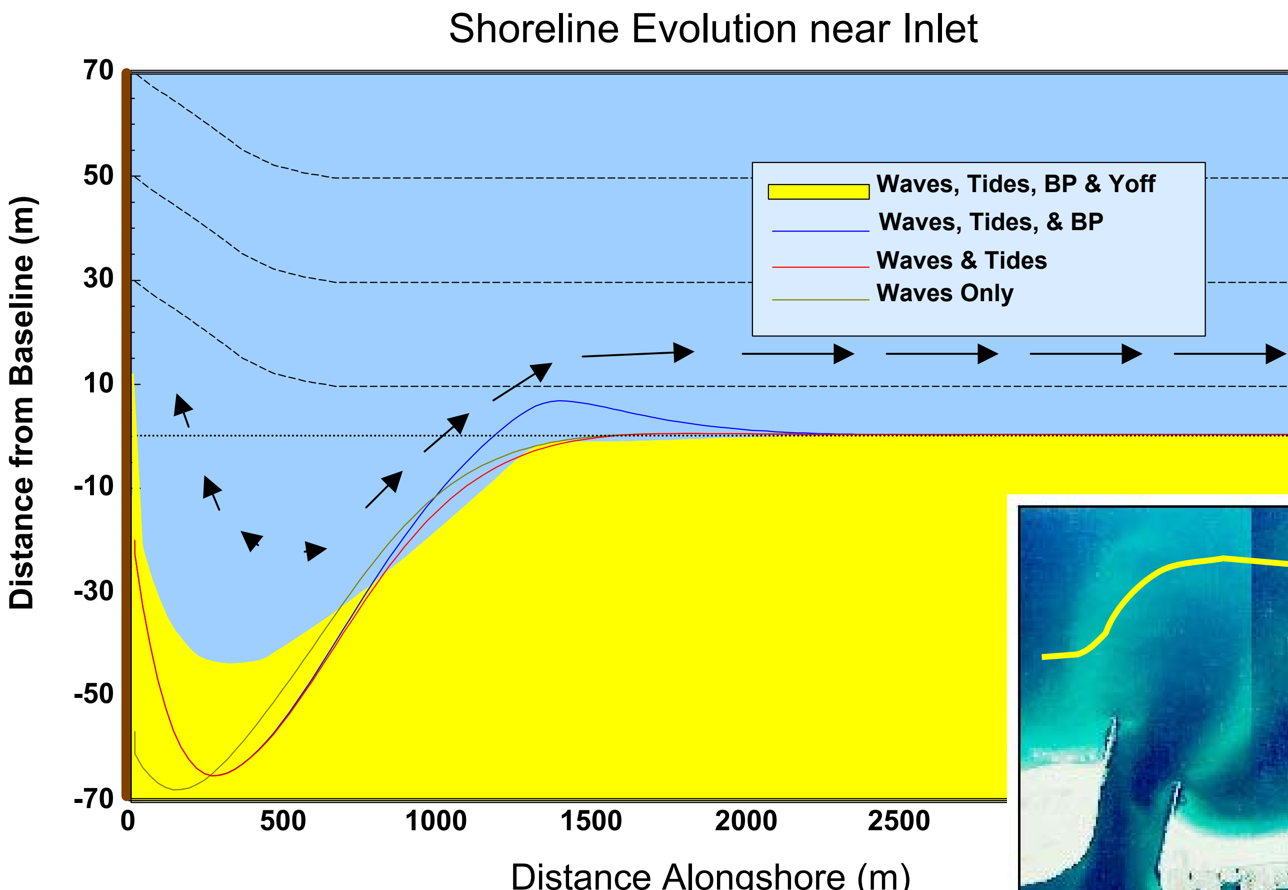
Tidal Inlet: Waves & Tide



Tidal Inlet: Waves, Tide, & Bypassing

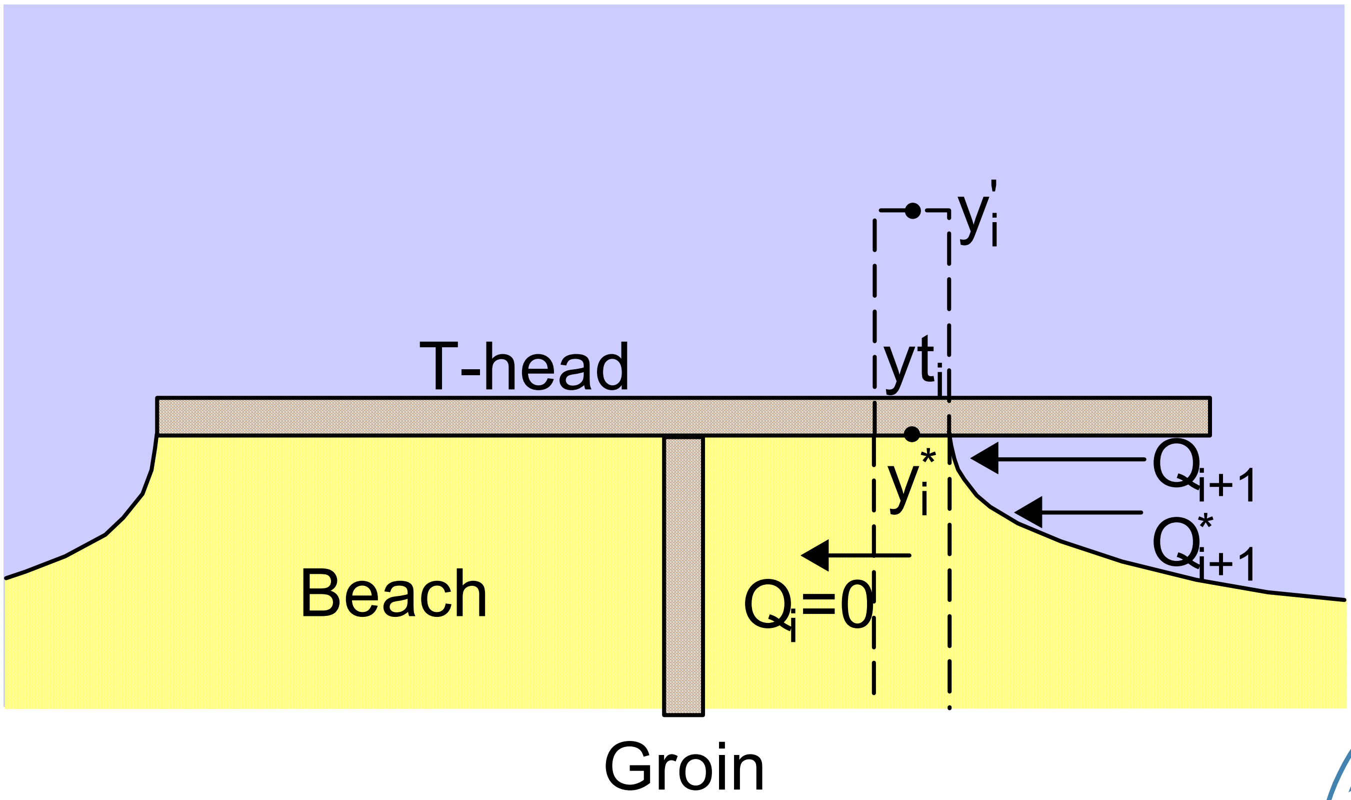


Tidal Inlet: Waves, Tide, Bypassing, and Specification of Offshore Contour for the Ebb Shoal

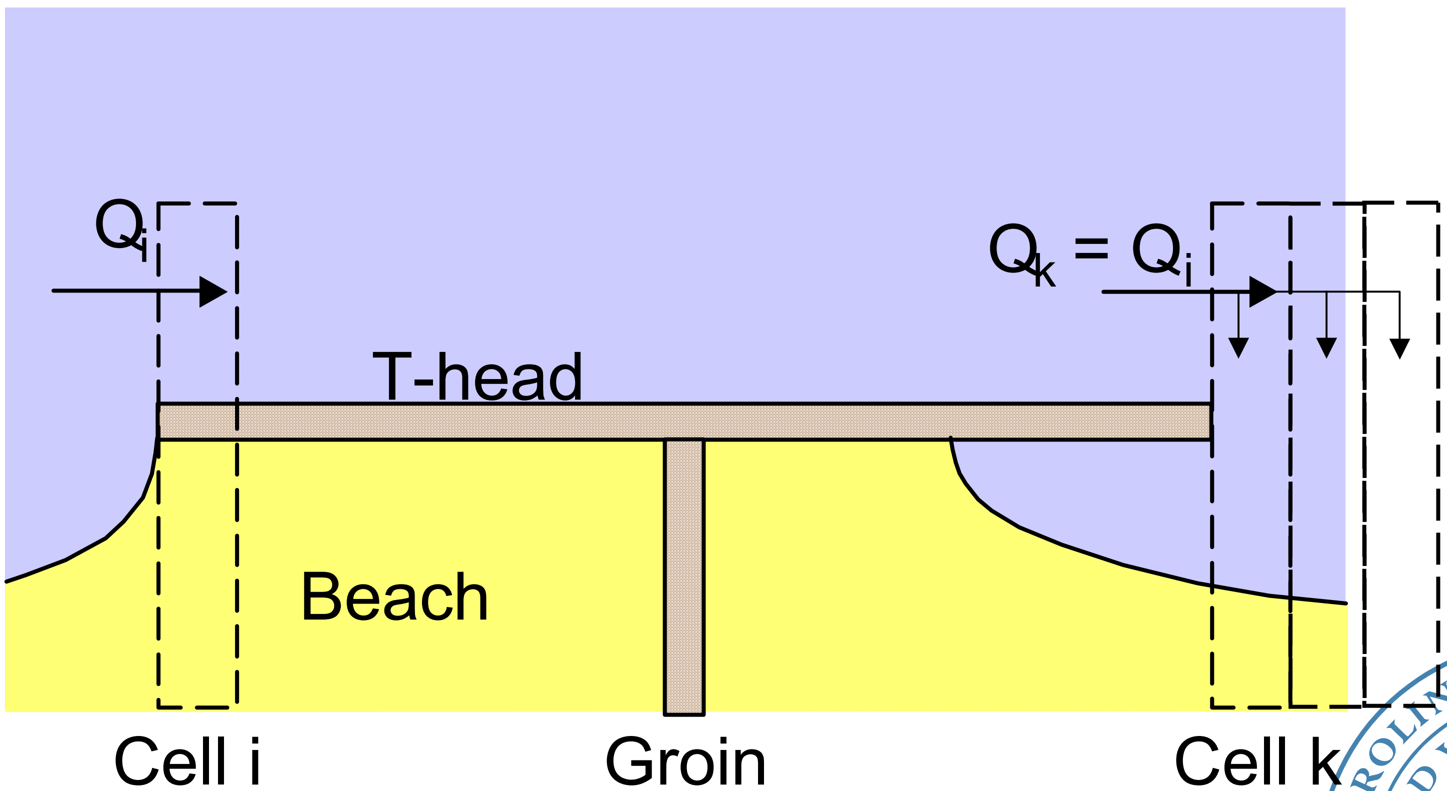


No rip!

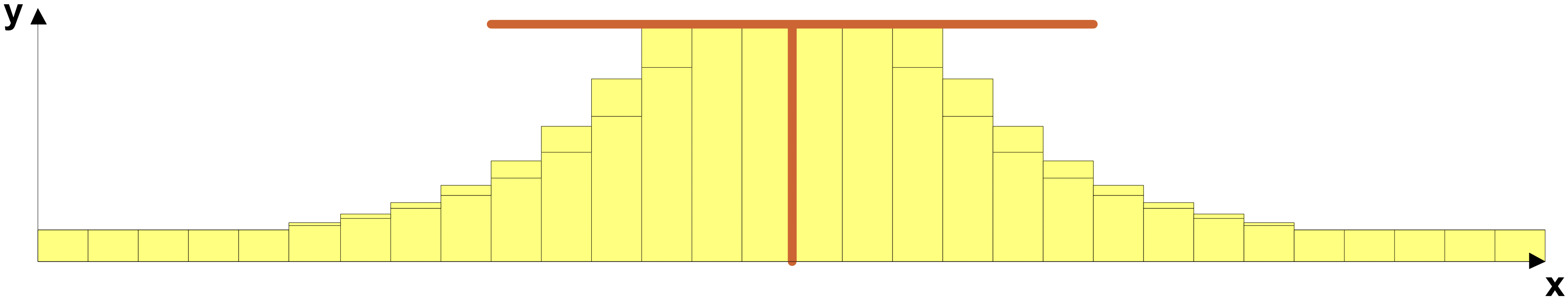
Tombolo Impact on y and Q-rates



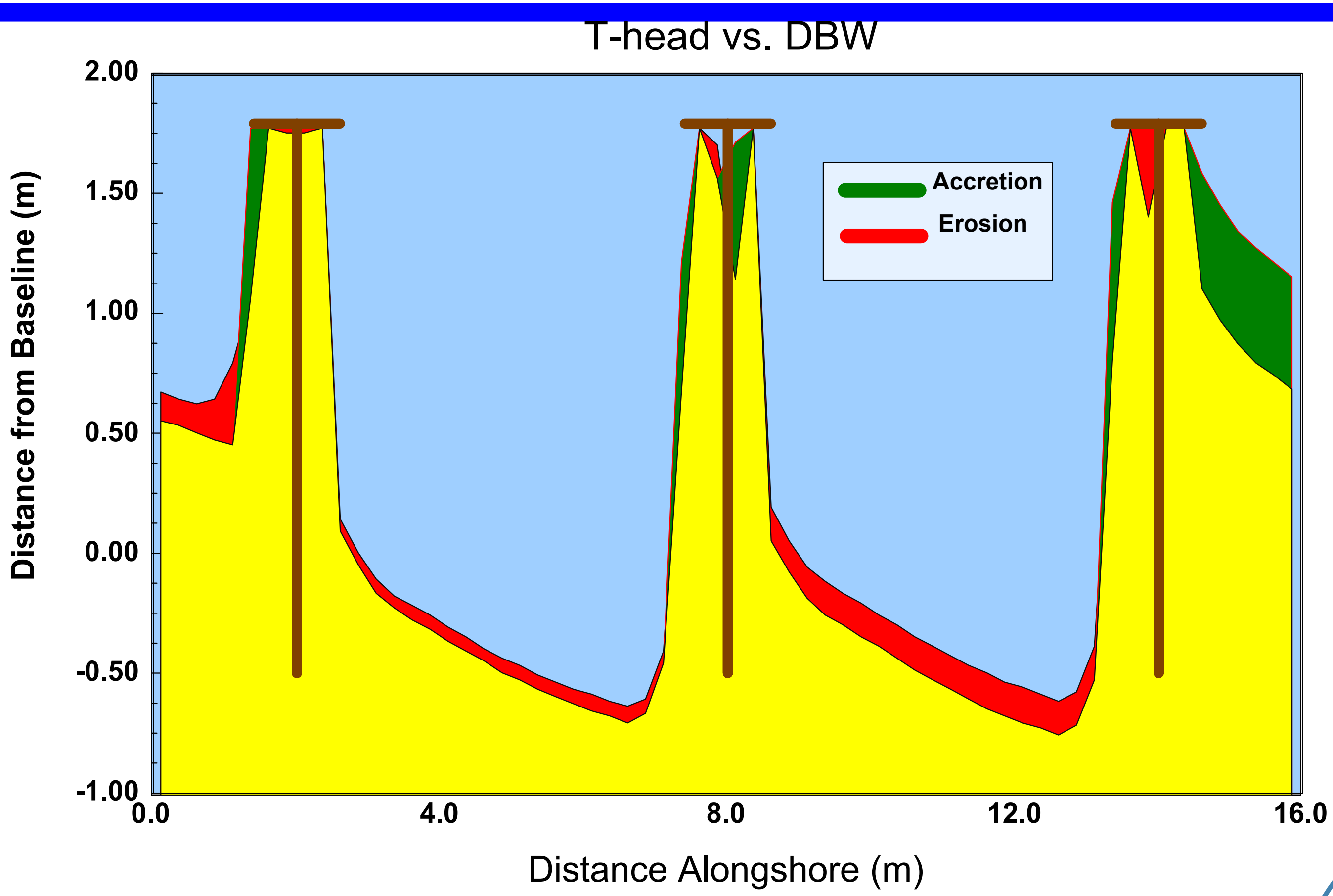
Tombolo Impact on Bypassing



Tombolo Development

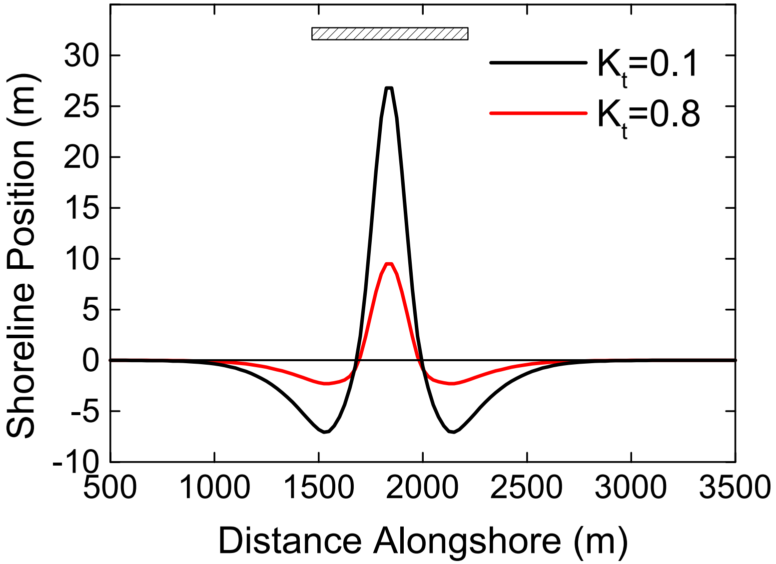


Comparison T-head vs. DBW Response



Time-Dependent K_t at Detached Breakwaters

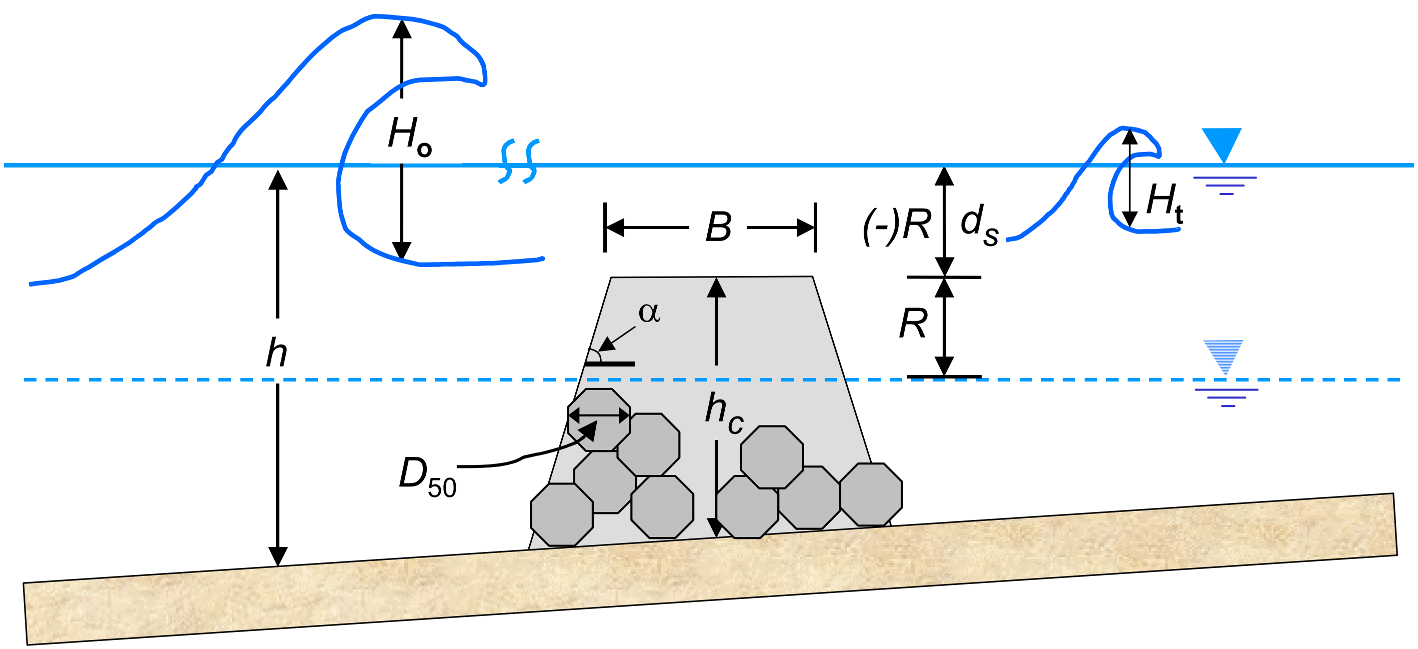
- The wave transmission coefficient, K_t, is a leading parameter in determining the shoreline response to structures as demonstrated by Hanson and Kraus (1990).



Hanson, H. and Kraus N.C. (1990). “Shoreline response to a single transmissive detached breakwater,” *Proc. of 22nd Coast. Eng. Conf.*, ASCE, 2034-2046.

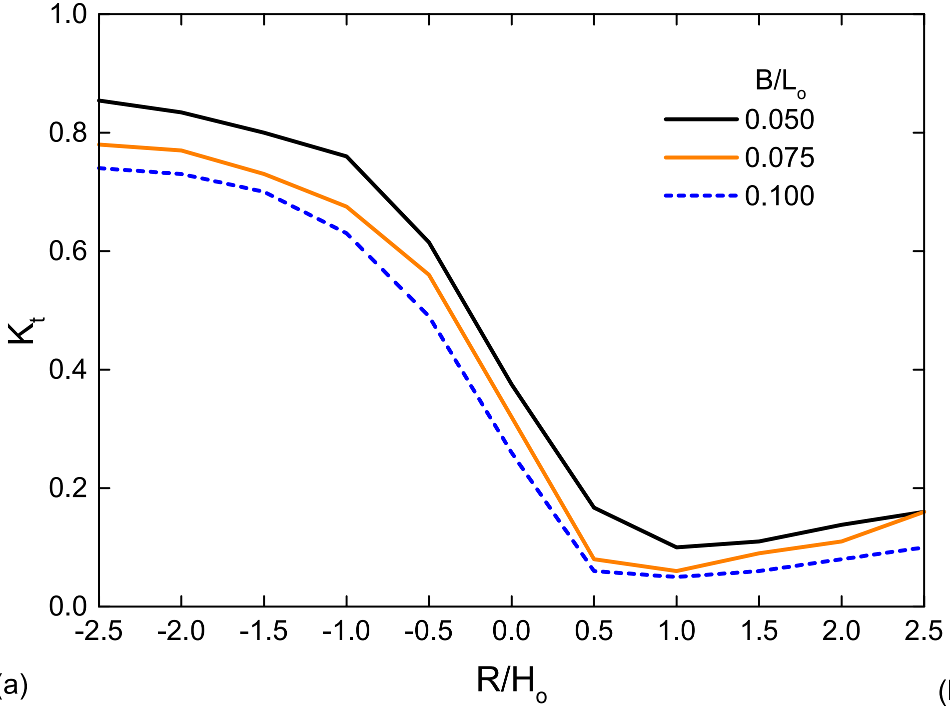
Time-Dependent K_t at Detached Breakwaters

- Wave transmission properties vary depending on structure configuration and composition and vary over different time scales as controlled by tidal variations and incident wave conditions.

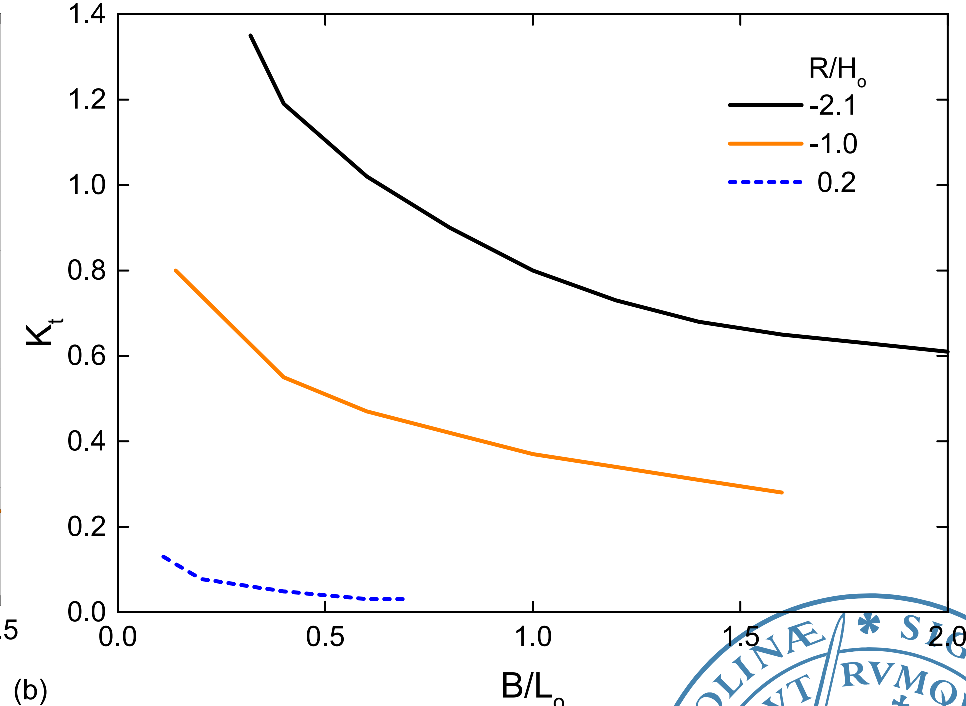


Tanaka (1976) Curves

K_t vs. Relative Submergence



(a)



(b)

K_t vs. Relative Crest Width

D'Angremond et al. (1996)

$$K_t = -0.4\frac{R}{H_s} + \left(\frac{B}{H_s}\right)^{-0.31}\left(1 - e^{-0.5\xi}\right)0.64$$ for permeable structures

$$K_t = -0.4\frac{R}{H_s} + \left(\frac{B}{H_s}\right)^{-0.31}\left(1 - e^{-0.5\xi}\right)0.80$$ for impermeable structures

where $\xi = \tan\alpha / \sqrt{H_s / L_0}$

These equations have limits of $0.075 < K_t < 0.8$

Seabrook and Hall (1998)

$$K_t = 1 - \left\{ e^{-0.65\left(\frac{d_s}{H_s}\right) - 1.09\left(\frac{H_s}{B}\right)} + 0.047\left(\frac{Bd_s}{LD_{50}}\right) - 0.067\left(\frac{d_s H_s}{BD_{50}}\right) \right\}$$

d_s is a positive value that corresponds to negative freeboard (-*R*)

The equation should be applied within the variable ranges:

$$0 \le \frac{Bd_s}{LD_{50}} \le 7.08 \qquad 0 \le \frac{d_s H_s}{BD_{50}} \le 2.14$$

Ahrens Dominant Mode Approach

- The total transmission coefficient is defined as:

$$K_t = \sqrt{\left(K_t\right)_{\text{over}}^2 + \left(K_t\right)_{\text{thru}}^2}$$

where

$$\left(K_t\right)_{\text{thru}} = 1.0 / \left(1.0 + f_{\text{thru}}\right)$$

$$\left(K_t\right)_{\text{over}} = 1.0 / \left(1.0 + f_{\text{over}}\right)$$

- f_{thru} and f_{over} differ depending on the dominant mode of wave transmission

Ahrens Dominant Mode Approach

- Transmission through the structure is included in the total transmission for all three fundamental modes. If the dominant mode is through the structure (R/H>2), then $K_t = (K_t)_{thru}$

$$f_{\text{thru}} = \left(\frac{H_s}{D_{50}}\right)^{0.982} \exp\left[0.433 + 2.35\left(\frac{A_t}{L_o h_c}\right)\right]$$

Ahrens Dominant Mode Approach

- If 0<=R/H<=2, the dominant mode is transmission by wave run up and overtopping.

$$f_{\text{over}} = \exp\left[0.465 + 12.7\frac{R}{\sqrt{(H_s L_o)}} - \frac{17.4}{\left(\frac{A_t}{h_c D_{50}}\right)} + \frac{0.00118}{\left(\frac{H_s}{L_o}\right)}\right]$$

Ahrens Dominant Mode Approach

- If R/H<0 (a submerged structure), the dominant mode is transmission over the crest of the structure.

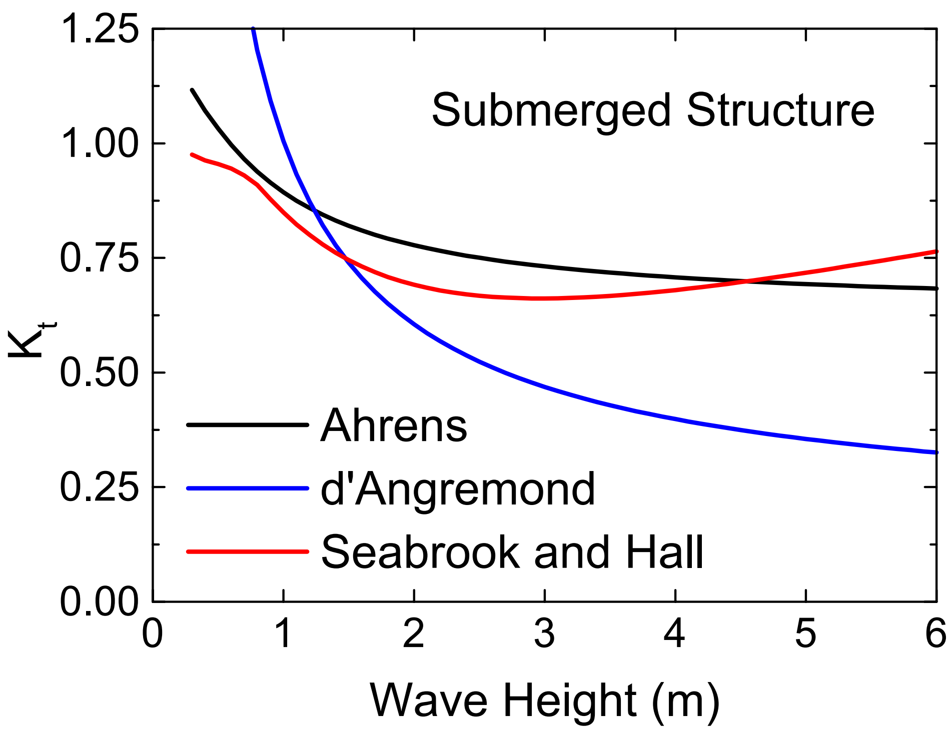
$$f_{\text{over}} = \exp\left[-0.646 + 0.631\frac{R}{H_s} + 0.00137\frac{A_t}{D_{50}{}^2}\right]$$

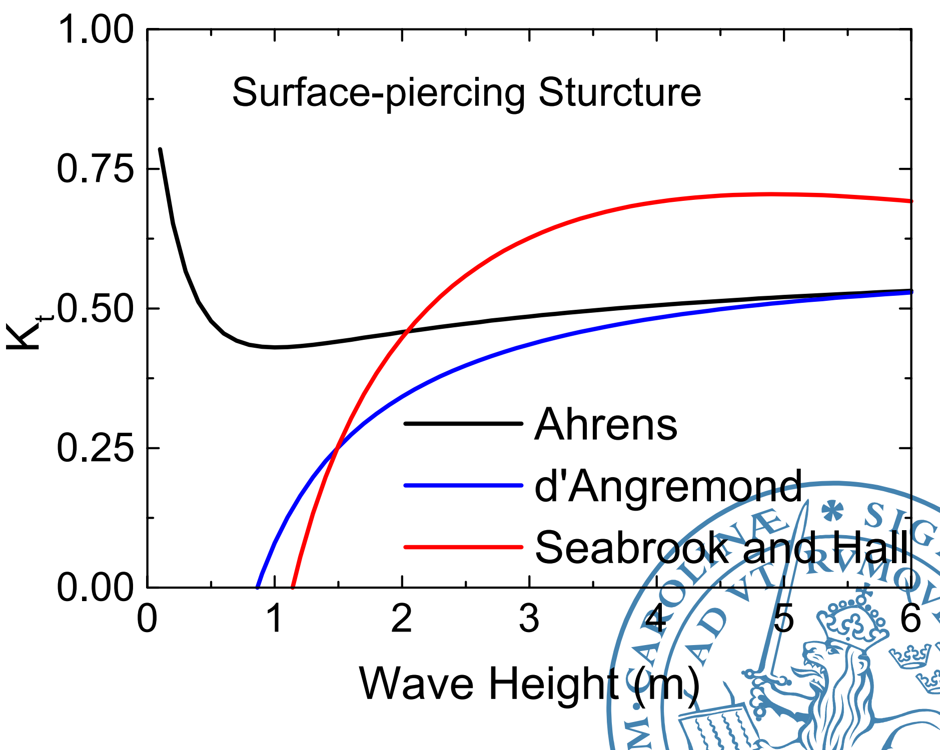
Comparison of Predictive Equations

- The Ahrens dominant mode approach is applicable over a wide range of environmental conditions and is generally the most appropriate method for shoreline response modeling.
- The Seabrook and Hall method can be applied to structures that are always submerged.
- d'Angremond is applicable to structures with a relative submergence that only varies between –0.75 and 0.5.

Comparison of Predictive Equations

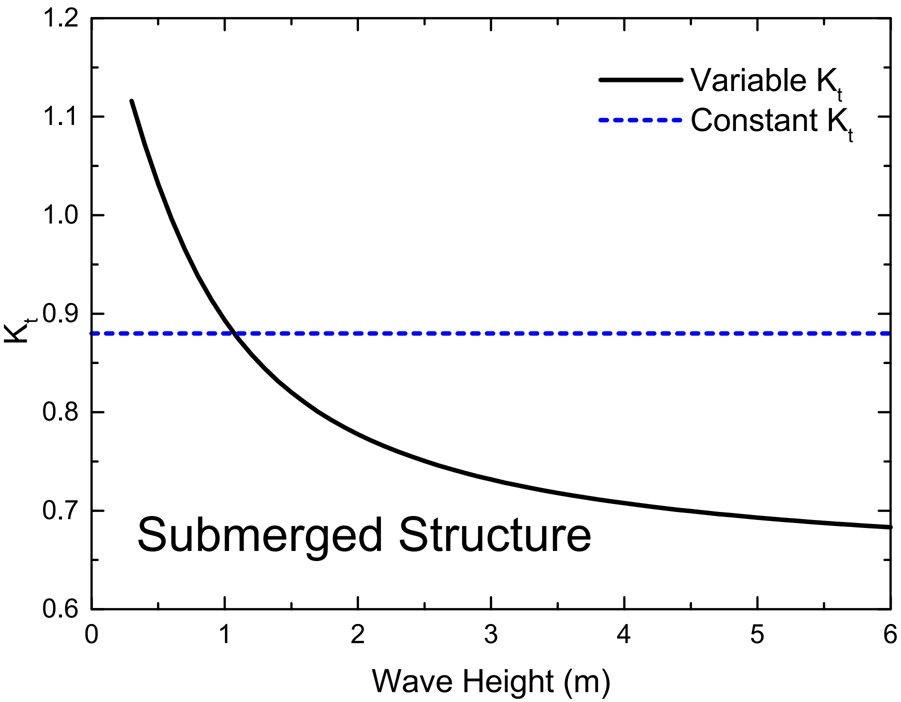
- The utility of the dominant mode approach is demonstrated by plotting the wave transmission coefficient versus wave height.

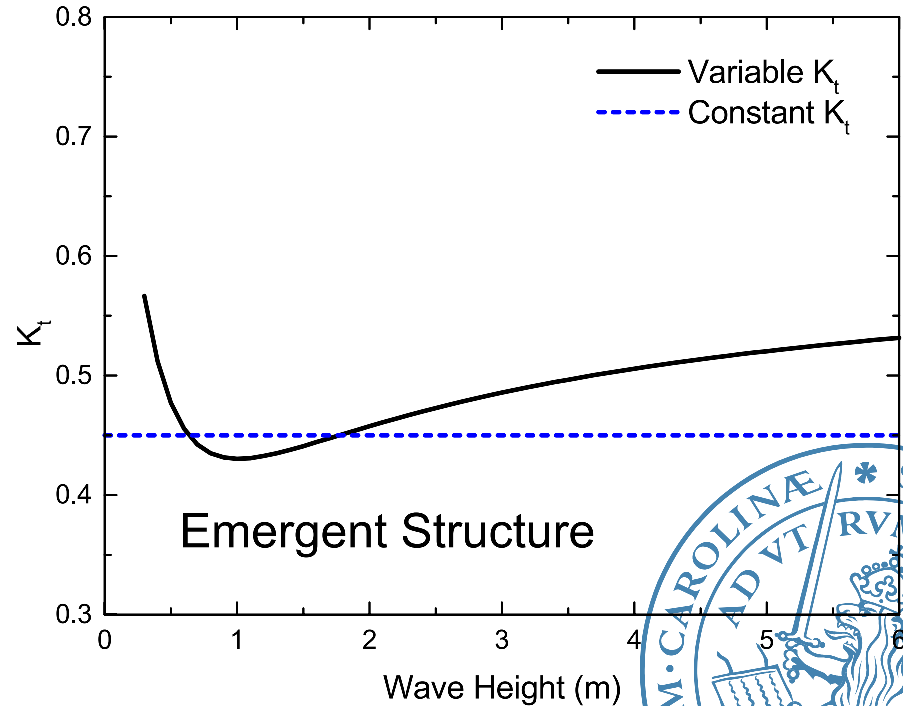




Functioning of Variable K_t

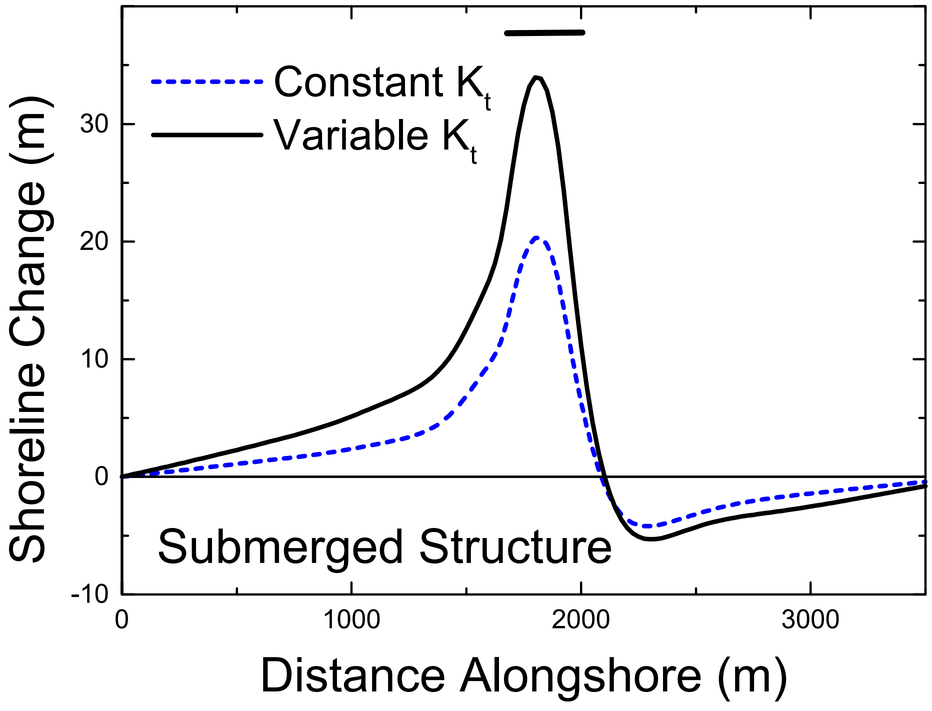
- The functioning of the variable K_t is demonstrated by comparing the shoreline response predictions of simulations based upon time-dependent and constant values of K_t.

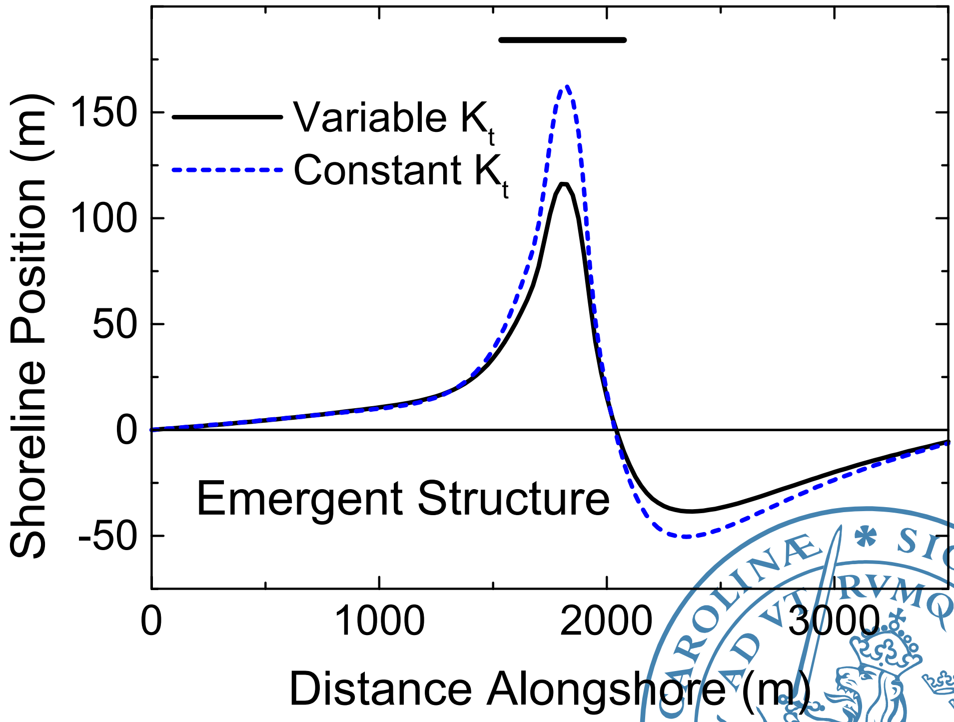




Functioning of Variable K_t

- Comparison of shoreline change behind a breakwater.





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