Beach-inlet Interaction and Regional Sediment Management at Pristine And Developed Barrier Islands

Research Laboratory

Coastal

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Outline

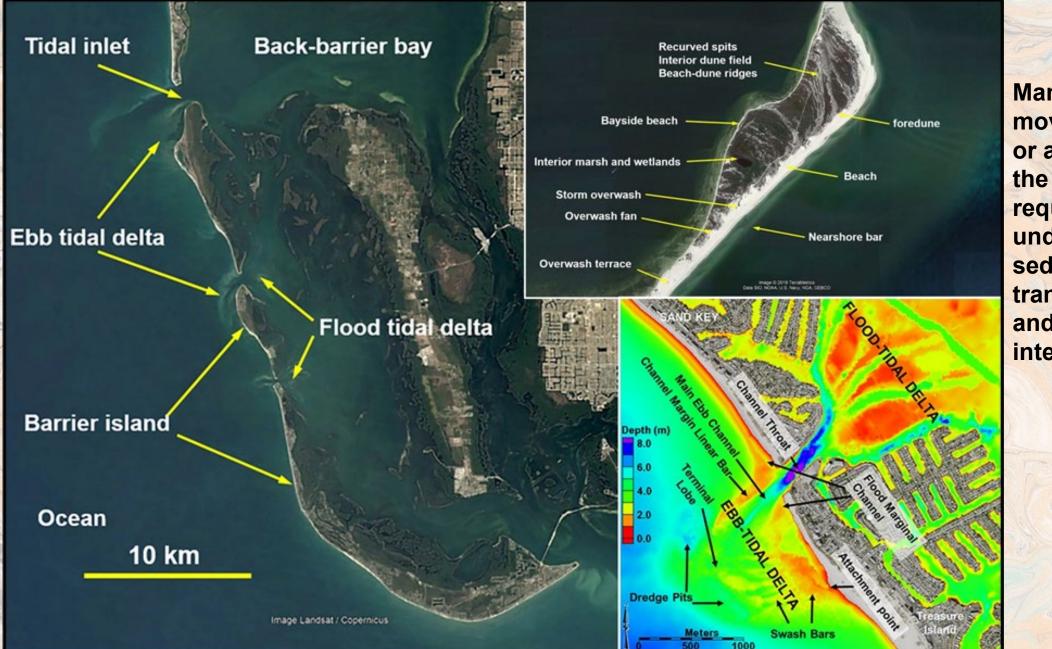
Introduction

Beach-inlet Interaction and Sediment Transport Pathways Sediment transport pathways and dominant processes Conceptual models on beach-inlet interaction (FitzGerald et al., 2000) Numerical modeling of beach-inlet interaction

Regional Sediment Management (RSM) at Beach-inlet System Establishing and balancing sediment budget at beach-inlet systems A Regional Sediment Management Framework

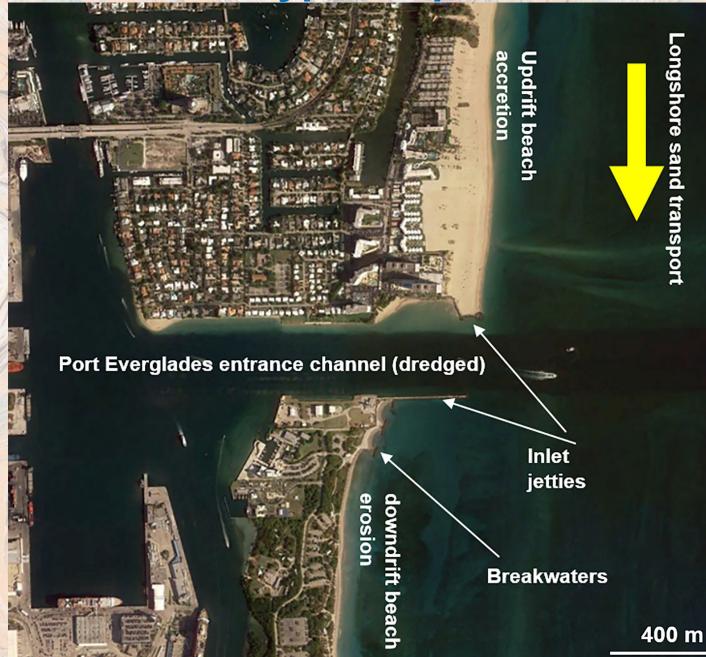
Summary

Introduction: morphological features in a beach-inlet system



Managing sand movement, naturally or artificially, among the different features requires in-depth understanding of sediment transport/deposition and beach-inlet interaction

Introduction: a typical "problem" at a beach-inlet system



Balancing a relatively stable-wide beach and stable-navigable inlet is a complicated task, requiring collaboration among various entities.

Introduction: managing sediment at a regional scale

4. TAKE ACTION

-Construct, monitor & adaptively manage -Capture benefits & lessons learned -Incorporate into standard practice

3. REGIONAL RSM STRATEGY

 Integrate projects into Regional Strategy
 ID authorities, funding, permit requirements, leveraging opportunities
 Prioritize: need, benefits, timelines

1. UNDERSTAND REGION

-Sediment sources, project needs, processes, gaps, engineering actions, ecological considerations -Resources, challenges & requirements



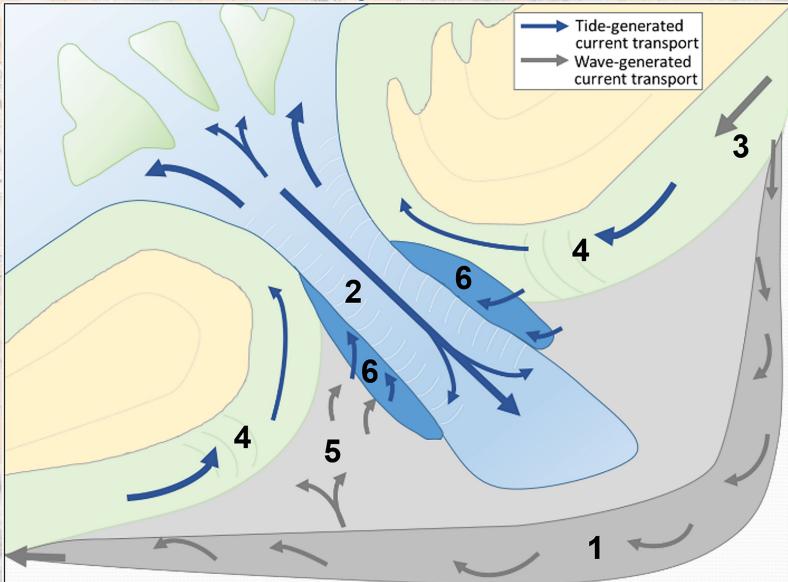
2. EVALUATE RSM STRATEGIES (PROJECT SCALE)

-Efficient & effective use of sediments -Project-level analysis

(tools, models, technologies) -RSM pilot projects

Communication, Collaboration, Innovation, Decision Making Interagency, Stakeholders, Partners, Resource Agencies The USACE regional sediment management process (<u>https://rsm.usace.army.mil/</u>: RSM Book: Tools and Technologies).

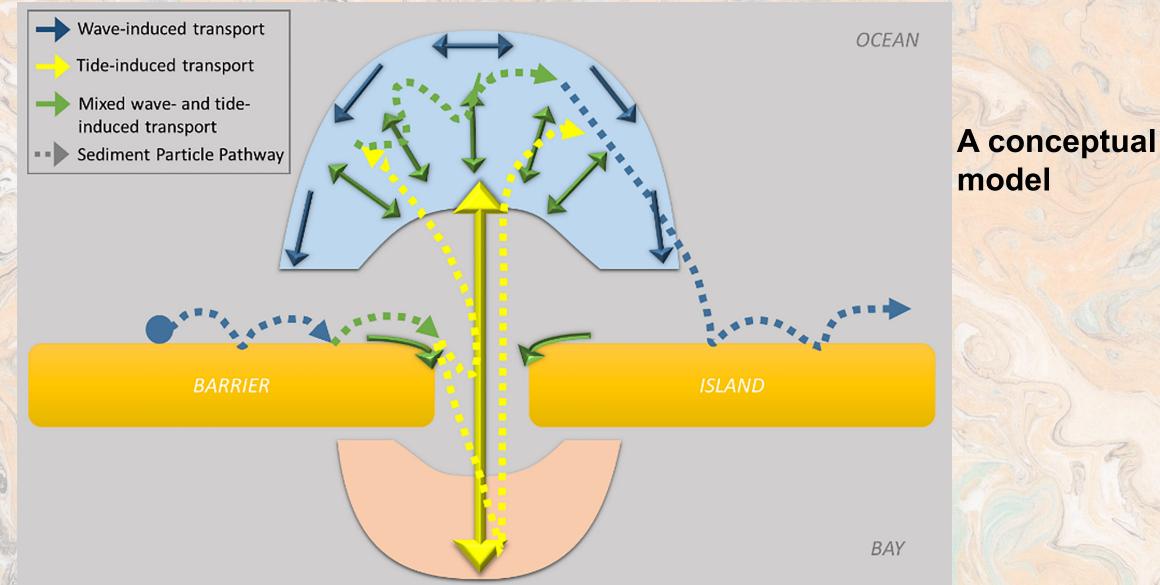
Beach-inlet Interaction and Sediment Transport Pathways How do sediments (sand) move from one side of the inlet to the other side? What are the dominant processes?



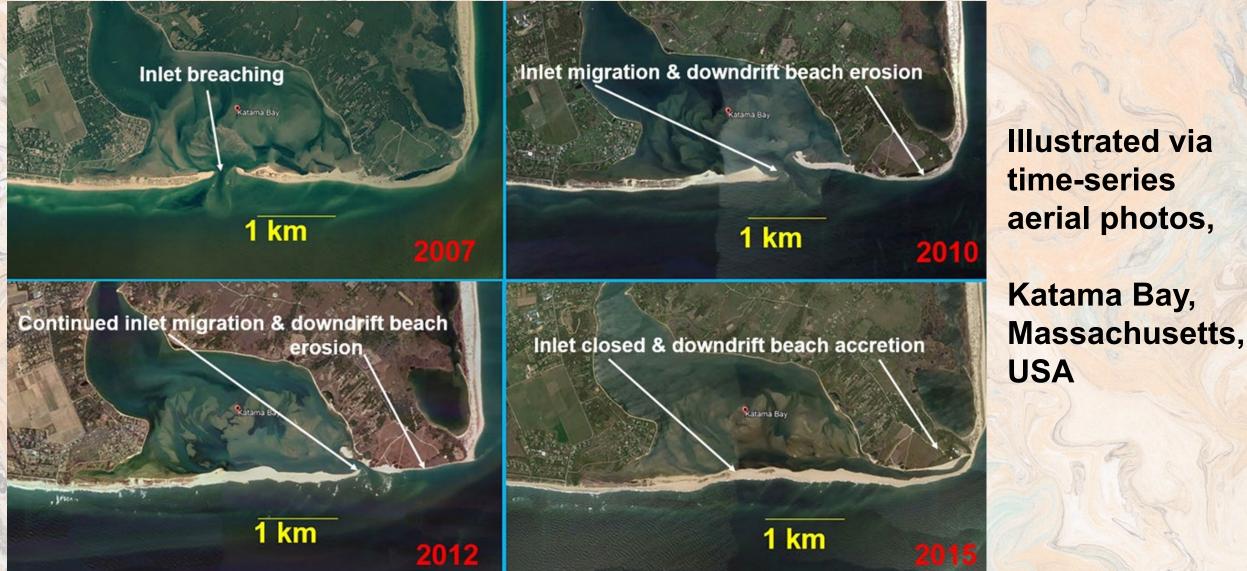
A conceptual model

terminal lobe or bypassing bar
 main inlet channel
 barrier island beach
 barrier island beach
 barrier island beach
 ebb shoal platform
 channel margin linear bar

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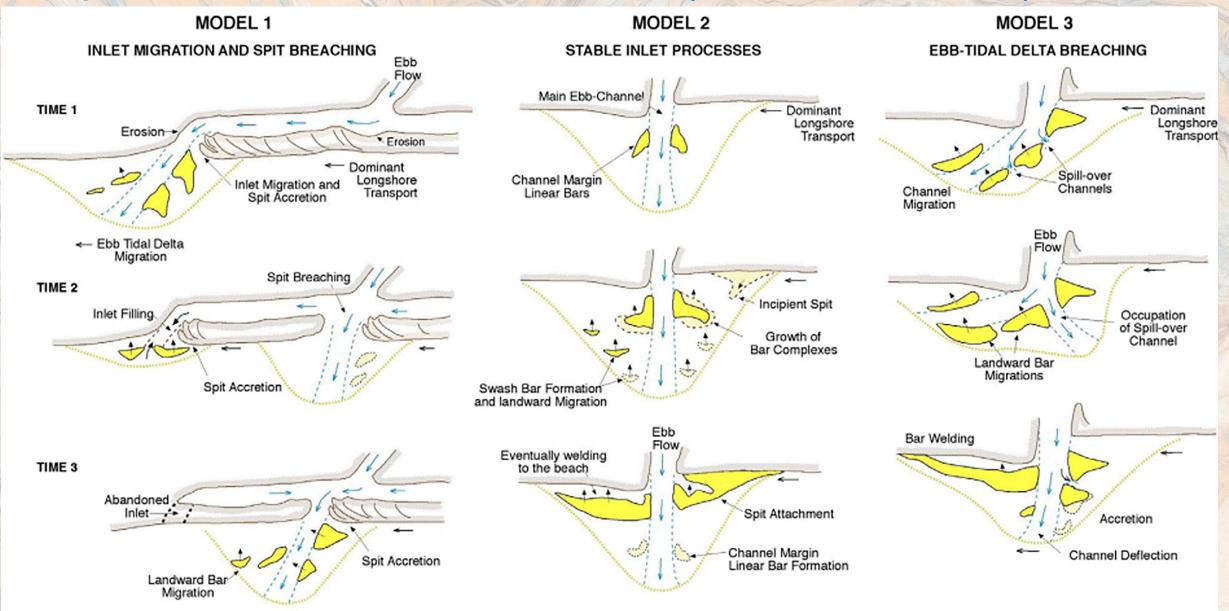
Illustrated via time-series aerial photos, Stump Pass, FL

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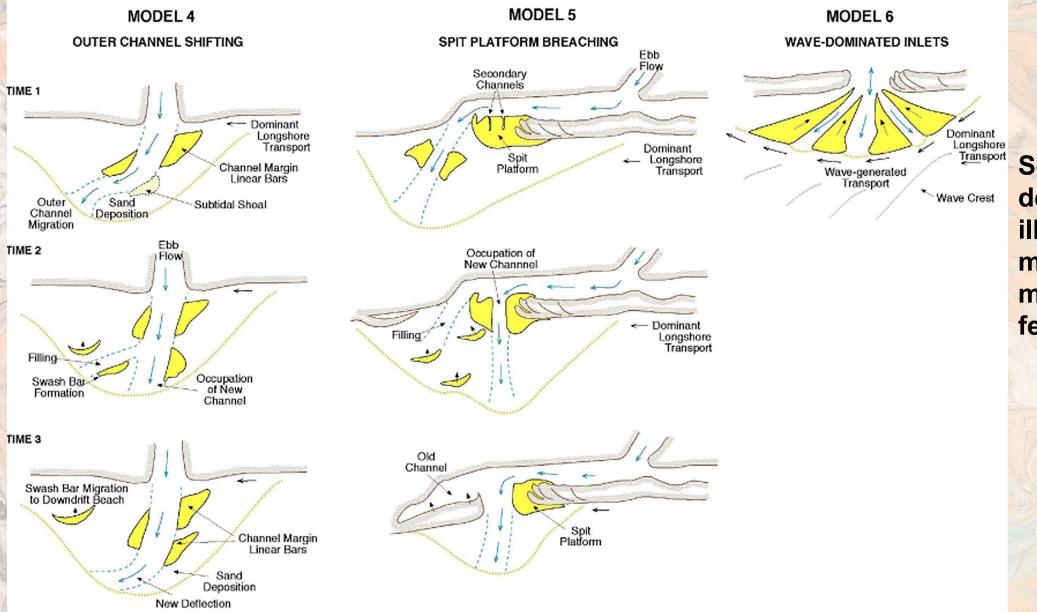


Illustrated via time-series aerial photos, Big Sarasota Pass, FL

Conceptual models on beach-inlet interaction (FitzGerald et al., 2000)



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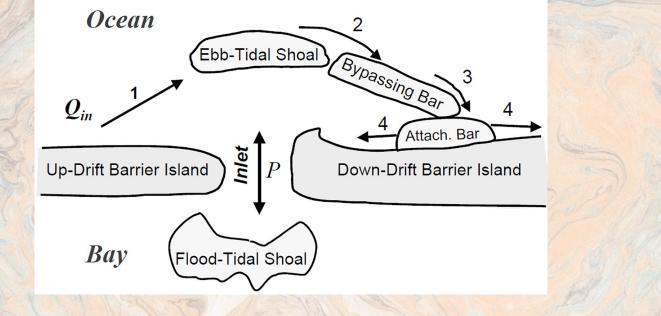
Sediment bypass is described and illustrated via movements of morphologic features

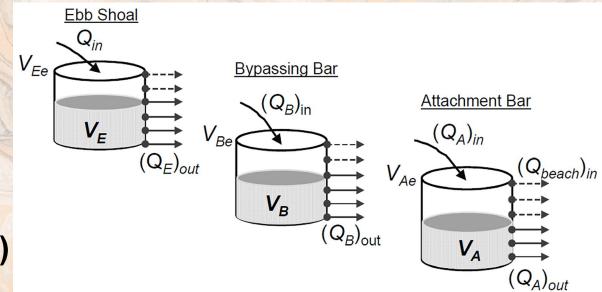
Numerical modeling of beach-inlet interaction: inlet reservoir model (IRM)



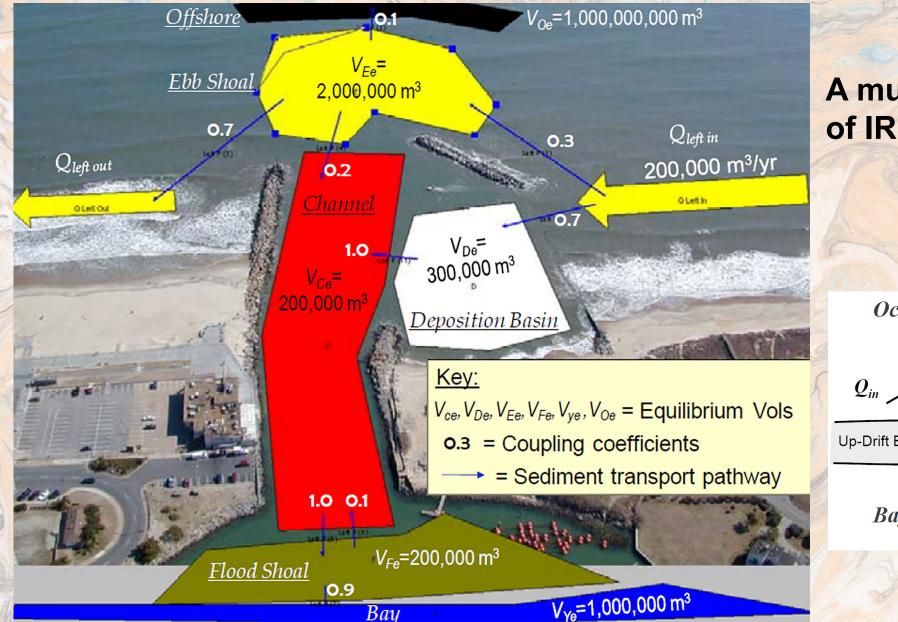
Key morphologic features are viewed as connected sand reservoirs, each has "an equilibrium volume".

(Kraus, 2000)

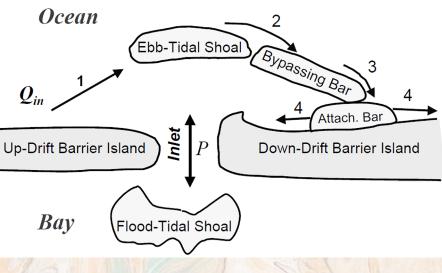




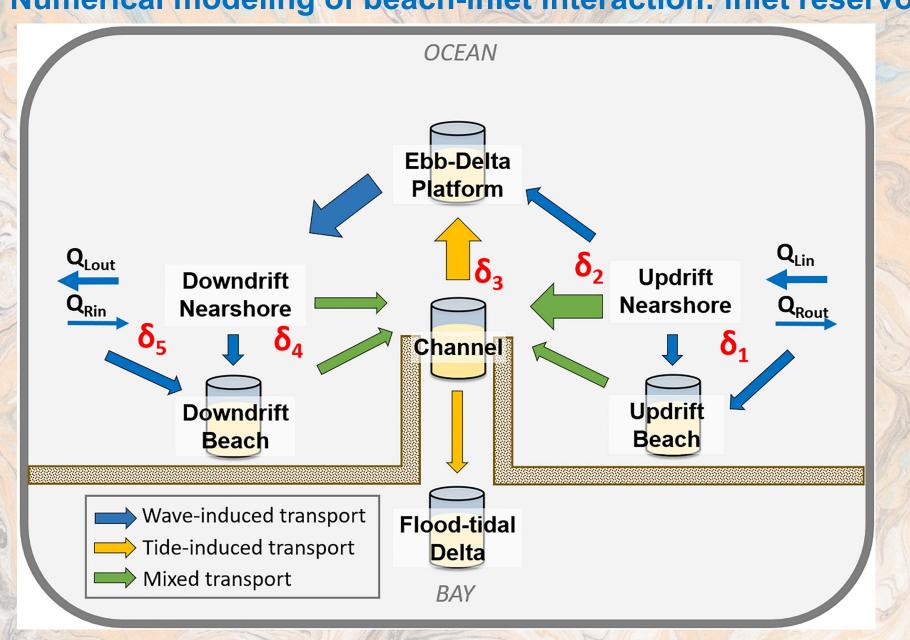
Numerical modeling of beach-inlet interaction: inlet reservoir model (IRM)



A multiple-pathway version of IRM (Rosati et al., 2011)



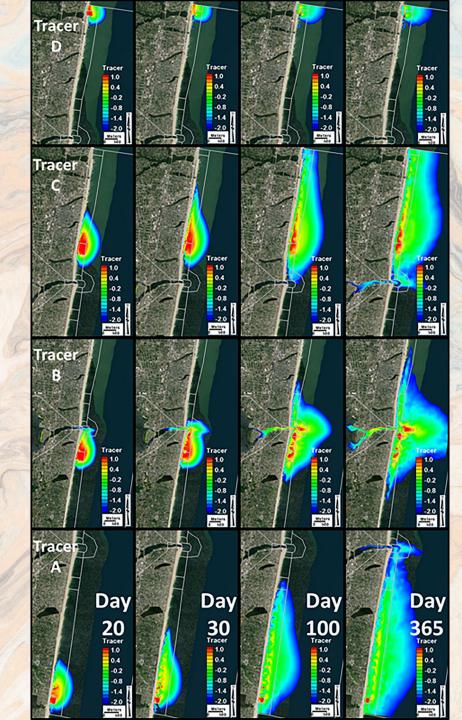
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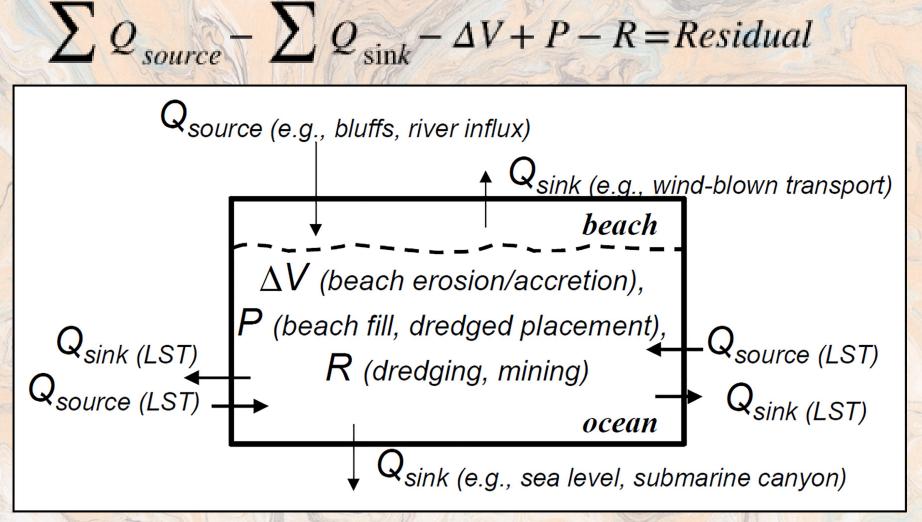
A multiple-pathway version of IRM

Process-based numerical modeling of beach-inlet interaction (CMS in this case)

> **Traced sediment** deployed at two nearshore locations each updrift (Tracer A and B) and downdrift (Tracer C and D) of Shark River Inlet illustrated as total tracer concentration (kg/m², log scale) throughout the bed layers at Days 20, 30, 100, and 365 (from Beck et al., 2020).



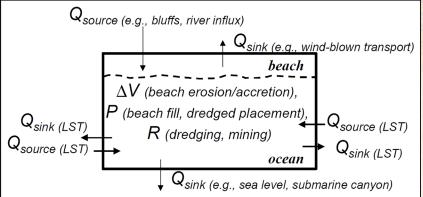
Beach-inlet Interaction and Sediment Transport Pathways Formulating and Balancing a Sediment Budget



Sediment budget parameters entering and leaving a budget area. LST denotes longshore sediment transport (from Rosati, 2005).

- Beach-inlet Interaction and Sediment Transport Pathways Formulating and Balancing a Sediment Budget: key considerations
- 1) Formulating and quantifying a sediment budget are often quite complicated, requiring practically everything we know about the system.
- 2) Determining the appropriate and efficient temporal and spatial scales.
- 3) Theoretically, long budget period (years to decades) is desirable. In reality, temporal scales are controlled by the availability of accurate data, and its applicability in representing future trends.
- 4) Spatially, it is desirable to have a sediment-budget area be defined by closed boundaries, e.g.,
 - a) landward boundary: without significant riverine sediment input, in the back-barrier bay;
 - b) seaward boundary: depth of closure;
 - c) lateral boundaries:
 - i) for rock coast: headlands;
 - ii) section of beach where longshore transport rate is known;
 - iii) tidal inlets with minimal or known sand bypassing rate





A Regional Sediment Management Framework

Develop Management Plan & Iteratively

Advance

Design long-term (e.g. 50-100 year) resource management plan
Implement and reevaluate

resource plan

Apply Engineering Tools Supporting RSM

Sediment dynamics in numerical models (1D, 2D, 3D)
Sediment budget analysis
Operational optimization

Define & Prioritize Objectives

Conserve resources
Minimize risks (e.g. inlet collapse or breaching)
Maximize inlet stability
Optimize navigability
Optimize social, economical or ecological benefits

Define Scope & Constraints

- Project spatio-temporal scope
- •Policy constraints and political boundaries
- Financial constraints
- Regulatory constraints

Gather Scientific Background Information

- •Regional geology and sediment supply
- •Inlet hydrodynamics and morphodynamics
- •Beach morphodynamics
- Environment and
- ecomorphodynamics
- •Long-term impact factors (SLR)

Quantify Risks & Knowledge Gaps

- •Ecological, economic, & societal value
- Information gaps
- •Risk event intensity/frequency of occurrence
- •Morphodynamic critical thresholds

Summary:

A systems approach incorporating adequate temporal-spatial scales is essential for modern beach protection & restoration.

Understanding & quantifying sediment bypassing, associated pathways, and the temporal scales of their morphodynamics are key to the RMS of tidal inlets and adjacent beaches.

Many tools, conceptual and numerical modeling, have been developed.

Managing sediment resources at a regional scale through a balanced sediment budget constitute a major component in coastal resilience building.