RESILIENCE AND REGIONAL SEDIMENT MANAGEMENT

Katherine Touzinsky
Research Physical Scientist
USACE-ERDC-CHL

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OUTLINE

• What is resilience?
• What are some best practices for resilience?
• How is resilience measured?
• R&D Update: Coastal Resilience Metrics & Applications
  • Project I: Southeastern Seaboard Ports and Hurricane Matthew
  • Project II: Dune and Beach Resilience Parameters
  • Project III: Pilot Coastal Resilience Index
RESILIENCE FOR COASTAL SYSTEMS

Definition of Resilience: the capacity to

• **Anticipate and plan** for disruptions,
• **Resist loss** in operations and/or **absorb the impact** of disturbances or stressors,
• **Rapidly recover** afterwards, and
• **Adapt** to short- and long-term stressors, changing conditions and constraints.
RESILIENCE FOR COASTLINES – EXAMPLE BAY COMMUNITY

• **Prepare** - Anticipate weak links, be ready to recover, build partnerships.
• **Resist** - Provide diverse and redundant protection.
• **Recover** - Ensure availability of alternate networks, prepare independent and complimentary components

• **Adapt** – foster natural and human actions to facilitate adaptation
NATURE OF THE BEAST – STRESSORS AND DISTURBANCES

Potential loss in relative functionality over time (e.g., no maintenance, greater demand, or increasing environmental forcing)

1. Disturbances - short-term recovery
2. Stressors - Slow motion disasters
RESILIENCE TIMELINE

Functionality

Time

Prepare; Anticipate

Resist; Withstand

Recover; Bounce Back

Adapt; Evolve

Rebuilding, new projects, community awareness, etc.

Disturbance

Disturbance

Resilience increased:
- Less loss in functionality
- Faster recovery time
QUANTIFYING RESILIENCE
Knowledge and Frameworks to Assess Resilience

Parameters of Resilience Assessments:
- **Critical Function** – component function essential to system performance
- **Threshold** – level of acceptable performance
- **Time** – stages of event cycle, including impact, recovery, and adaptation
- **Memory** – understanding past performance and progressive change in the system

Assessment Methods:
- **Scorecard Index**
- **Matrix**
- **Input-Output Network**

Increasing system customization, assess performance over time
Decreasing data needs, assess general system performance
PROJECT I: IMPACTS OF HURRICANE MATTHEW ON THE SOUTHEASTERN SEABOARD

Katherine Touzinsky, Brandon Scully, Marin Kress, Ned Mitchell, ERDC-CHL

RSM and Resilience: Define resilience metrics for navigation mission; proxy indicators for port function and performance of navigation channel. How can RSM actions improve preparations and recovery for coastal storms?
TANKER AND CARGO VESSEL HEAT MAPS
NAVIAGTION RESILIENCE METRIC – NET VESSEL COUNT

PREPARE RESIST RECOVER

Captain of the Port declares ZULU on 10/06 at 1800

POS reopens to vessel traffic on 10/12 at 0700

Hurricane Matthew declared a tropical storm 9/28

Bayesian network change point analysis - Return to “normal” 10/18

Net vessel count
Net vessel daily average

Port of Savannah – Cargo and Tanker Net Vessel Counts
POS dwell time greatly increased because channel was unavailable until 10/12 – 6 days after closure
PROJECT II: DUNE AND BEACH RESILIENCE METRICS

Marty Durkin, SAJ

RSM & Resilience - Suggest resilience metrics for dune and beach Coastal Storm Risk Management (CSRM) and RSM projects using Beach-fx output data
DUNE & BEACH RESILIENCE METRIC

• Buffer width (BW) – a measurement similar to the USGS Beach Closure. The combined horizontal distance of the dune width, seaward dune slope, and berm width.
• Based on the simplified representative profiles used in the Beach-fx
BUFFER WIDTH OVER 50 YEARS FROM BEACH-FX CALCULATIONS

Time (days from start of simulation, 2015)

Buffer Width (feet)

- Red: +00’dune +60’berm
- Blue: +10’dune +40’berm
- Green: +20’dune +20’berm
- Black: FWOP
BUFFER WIDTH OVER TIME

![Graph illustrating buffer width over time with phases labeled as "Disturbance", "Anticipate", "Resist", "Adapt", "Recover", and "Bounce Back".]

- **100% Functionality**
  - Initial Construction
  - Periodic Nourishment
  - Adapt; Evolve
  - Disturbance
  - Periodic Nourishment
  - Wear

- **Legend**:
  - Red: +00'dune_+60'berm
  - Blue: +10'dune_+40'berm
  - Green: +20'dune_+20'berm

(Additional details and explanations may be provided based on the diagram's context.)
PROJECT III: PILOT COASTAL RESILIENCE INDEX
Nicole Elko, ASBPA, Quin Robertson and Zhifei Dong, CB&I

RSM and Resilience: Create the groundwork for a national coastal resilience tool to help understand how RSM and CSDR actions change local and regional resilience
METHOD – BEACH PARAMETERS

• Pilot CRI considers five beach parameters: Protective Width (PW), Protective Elevation (PE), Volume Density (VD), Wave Runup (WR), Crest Freeboard (CF)
• Developed scripts to process LIDAR data or beach surveys to extract parameters and create profile plots:
COASTAL RESILIENCE INDEX (CRI) MODEL

Five non-dimensional factors based on beach, storm and wave parameters:

\[
\begin{align*}
  a &= \frac{PE}{PE_0} \\
  b &= \frac{PE \cdot PW \cdot (1 - s)}{PE_0 \cdot PW_0} \\
  c &= \frac{PW - MR}{PW_0} \\
  d &= \frac{DE - (MS + MHW)}{CF_0} \\
  e &= \frac{WR_0}{WR}
\end{align*}
\]

\[CRI = a + b + c + d + e\]

\[\begin{align*}
  a &= \text{PE (Protective Elevation) factor} \\
  b &= \text{VD (Volume Density) factor} \\
  c &= \text{PW (Protective Width) factor} \\
  d &= \text{CF (Crest Freeboard) factor} \\
  e &= \text{WR (Wave Runup) factor}
\end{align*}\]
CALCULATING CRI FOR DELRAY BEACH, FL

32 survey datasets between 1975 and 2016
6 periodic beach (re)nourishment projects and 2 storm repair projects
Storm and wave parameters set as constant during calculation
CRI<1.5, Low resilience; 1.5<CRI<2.0, Medium resilience; CRI>2.0, High resilience
DELRAY BEACH APPLICATION

May 1973 before the first project  
August 2016
Regional Sediment Management Process

UNDERSTAND REGION
- Identify sediment sources, needs, processes; engineering actions & ecological considerations
- Identify resources, challenges, & stakeholder requirements

ID/EVALUATE RSM STRATEGIES (PROJECT LEVEL)
- Identify efficient/effective use of sediments
- Includes project level analysis utilizing tools, models, technologies
- RSM pilot projects

TAKE ACTION - CONSTRUCT
- Construct, monitor, & adaptively manage a project
- Capture value, benefits, lessons learned
- Incorporate into standard practice

DEVELOP RSM STRATEGIES & OPTIMIZATION (REGIONAL)
- Identify how to coordinate & construct projects; define success criteria
- Includes authorities, funding, permits, timelines, & stakeholders/partnerships

COMMUNICATION, COLLABORATION, COORDINATION
- Interagency, stakeholders, partners, resource agencies

PREPARE
- Understand Region
- Understand Project – level functions
- ID resources, challenges, requirements
- Understand how to coordinate and construct projects; include authorities, funding, permits, partnerships, etc.
- Plan for rapid recovery

RESIST

RECOVER

ADAPT
- Pre-define success criteria
- Monitor and adaptively manage
- Capture value, benefits, and lessons learned
THANK YOU

Katherine.F.Touzinsky@usace.army.mil