

# North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk

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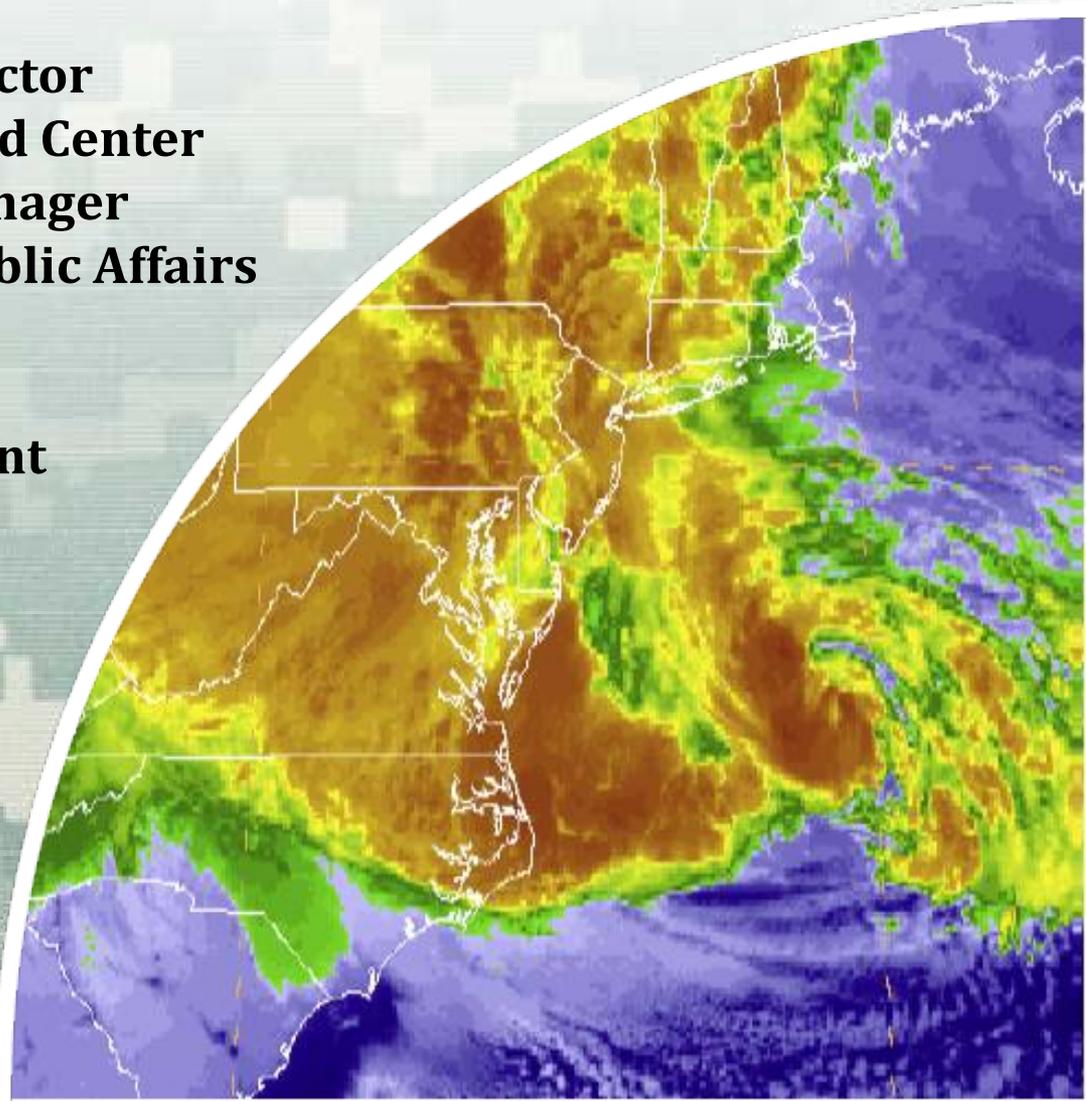
**Mr. Justin Ward, Chief, NAD Public Affairs**

**National Planning Center for  
Coastal Storm Risk Management  
U.S. Army Corps of Engineers**

**28 January 2015**



**US Army Corps of Engineers  
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# Outline

- Background
- Interagency Collaboration
- Findings, Outcomes, and Opportunities
- Coastal Storm Risk Management Framework
  - Trends
  - Flood Exposure and Risk Assessment
  - Risk Management Measures
- Technical Products Supporting the Framework
- Systems Approach and Resilience
- Institutional and Other Barriers
- Areas Warranting Additional Analysis
- Final Report
- Summary



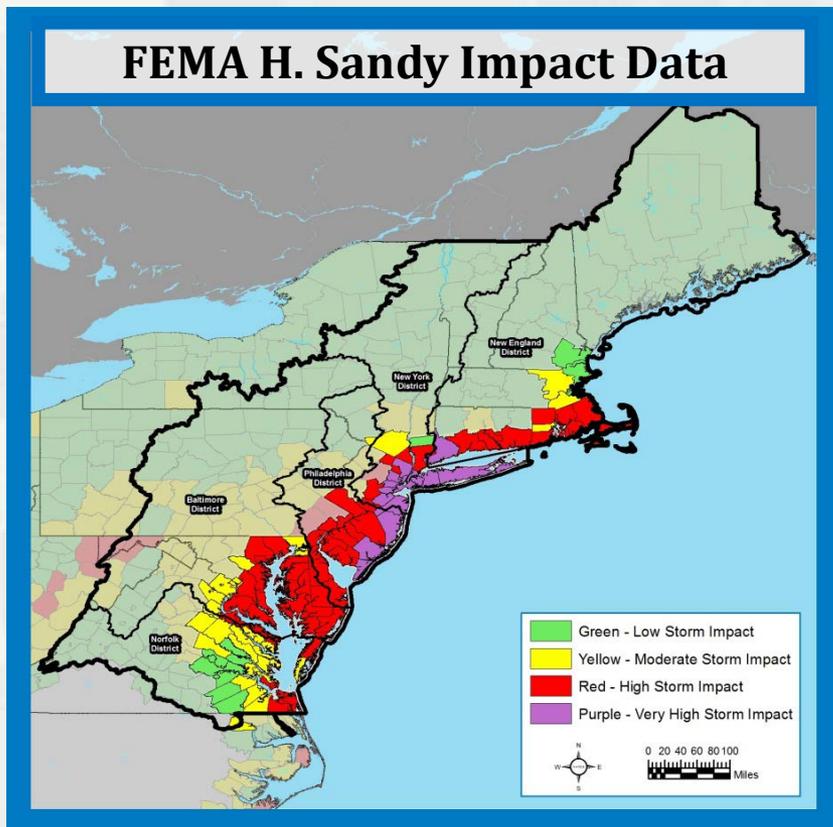
# Background

“That using up to \$20,000,000\* of the funds provided herein, the Secretary shall conduct a **comprehensive study** to address the flood risks of **vulnerable coastal populations** in areas that were affected by Hurricane Sandy within the boundaries of the North Atlantic Division of the Corps...” (\*\$19M after sequestration)

➤ Complete by Jan 2015

## Goals

- Provide a **Risk Management Framework**, consistent with USACE-NOAA Rebuilding Principles
- Support **Resilient Coastal Communities** and robust, sustainable coastal landscape systems, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable population, property, ecosystems, and infrastructure



# Background

## ➤ End State

- Address the legislative direction for a **comprehensive plan** to address vulnerable coastal communities
- Formalized and **consistent approach/framework** for more detailed, site specific coastal evaluations
- **Integration** of state-of-the-science techniques and collaboration
- Equip and link a broad audience and all levels of government with data, tools, and other stakeholders to make **INFORMED coastal risk management decisions**

[www.nad.usace.army.mil/CompStudy](http://www.nad.usace.army.mil/CompStudy)

## ➤ NACCS is *not*:

- A decision document authorizing design and construction
- A NEPA document evaluating impacts of any specific solution
- A USACE-only application



# Interagency Collaboration

## ➤ **Interagency and Tribal Input**

- Formal and informal letters and email
- Technical working meetings
- Tribal webinars and meeting participation
- Panel discussions and meetings upon request
- Subject Matter Experts embedded in team and via outreach
- Federal Register notices
- Public website with subscriber list and opportunity for input on resilience
- OMB Legislative Review Memorandum with Federal Agencies

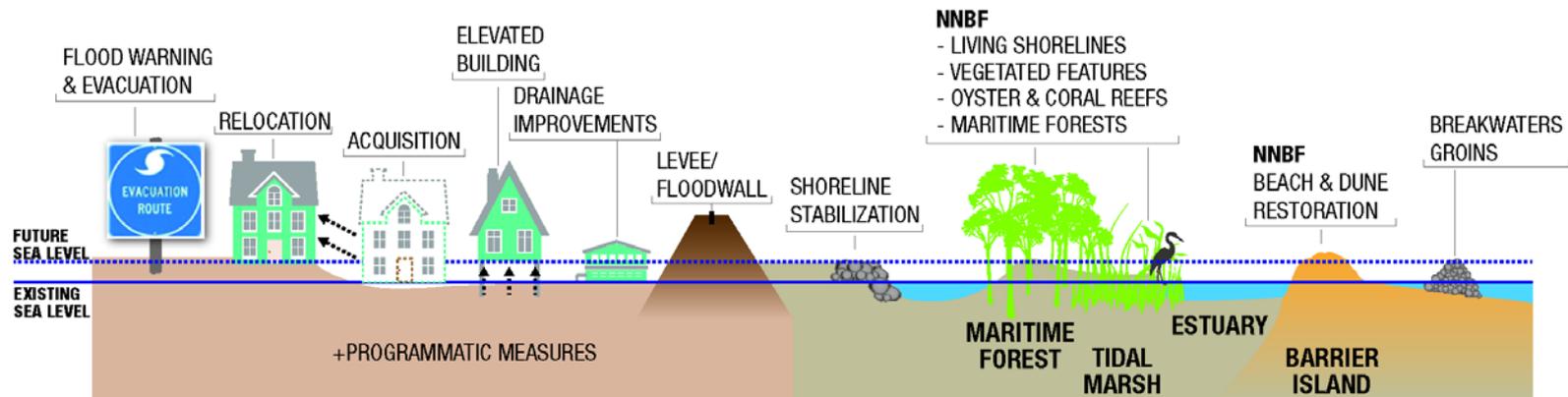
## ➤ **Interagency Webinar Collaboration Series**

- Webinar 1 (30 July 2013) Green/Nature Based Infrastructure
- Webinar 2 (29 August 2013) Ecosystem Goods and Services
- Webinar 3 (12 September 2013) Numerical Modeling and Sea Level Rise
- Webinar 4 (25 September 2013) Vulnerability Assessments
- Webinar 5 (19 December 2013) Policy Challenges and Other Barriers
- Webinar 6 (24 June 2014) Regional Sediment Management and Systems Approach



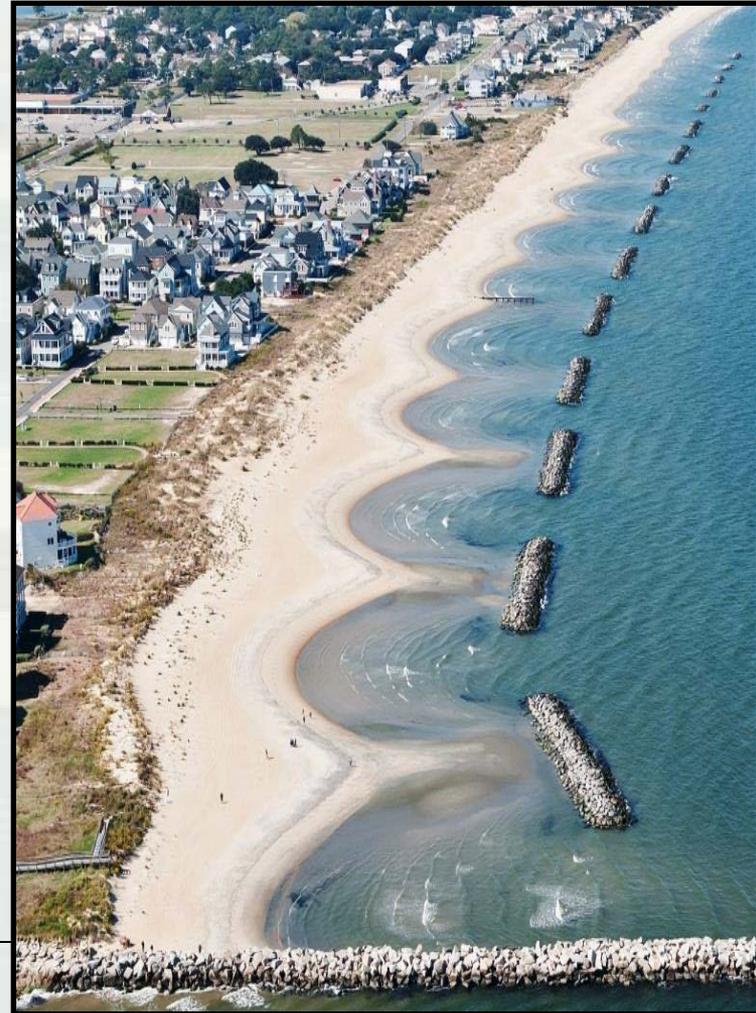
# Findings

- **Shared** responsibility of all levels of Government and partnerships
- Rethink approaches to **adapting to risk**
- Resilience and sustainability must consider a **combination and blend** of measures



# Outcomes

- **State-by-State Risk Management Frameworks informing, strengthening and catalyzing the focus on regional resilience, redundancy and robustness in coastal planning and implementation**
- **System-wide framework of solutions and best practices**
- **Interagency and Regional alignment with others**
- **Advanced the Science and closed data gaps**



# Opportunities

- Mitigate future risk with **improved pre-storm planning**
- Identify acceptable **flood risk at a community** and state scale
- **Prioritize** critical infrastructure
- **Rebuild with redundancy**
- Develop **creative incentives** to promote use of resilience measures
- Utilize a **collaborative regional governance structure**
- Develop **Public-Private Partnerships** for coastal risk management
- Integrate **nature-based features** in coastal risk management systems
- Encourage design **flexibility and adaptive management**
- Advance efforts in the 9 focus areas:

1) Rhode Island Coastline

2) Connecticut Coastline

3) Nassau County Back Bays, NY

4) New York Bay –New Jersey

Harbor and Tributaries

5) New Jersey Back Bays

6) Delaware Back Bays

7) City of Baltimore, MD

8) Washington, D.C.

9) City of Norfolk, VA



# Coastal Storm Risk Management Framework

- Who and what is exposed to flood risk?
- Where is the flood risk?
- What are the appropriate strategies and measures to reduce flood risk?
- What is the relative cost of a particular strategy compared to the anticipated risk reduction?
- What data are available to make RISK INFORMED decisions?
- How can the science be advanced/data gaps closed through the NACCS?



# Coastal Storm Risk Management Framework

➤ Managing coastal storm risk is a shared responsibility and requires:

- Shared tools
- Common methodology that all parties can follow together to assess risk and identify solutions

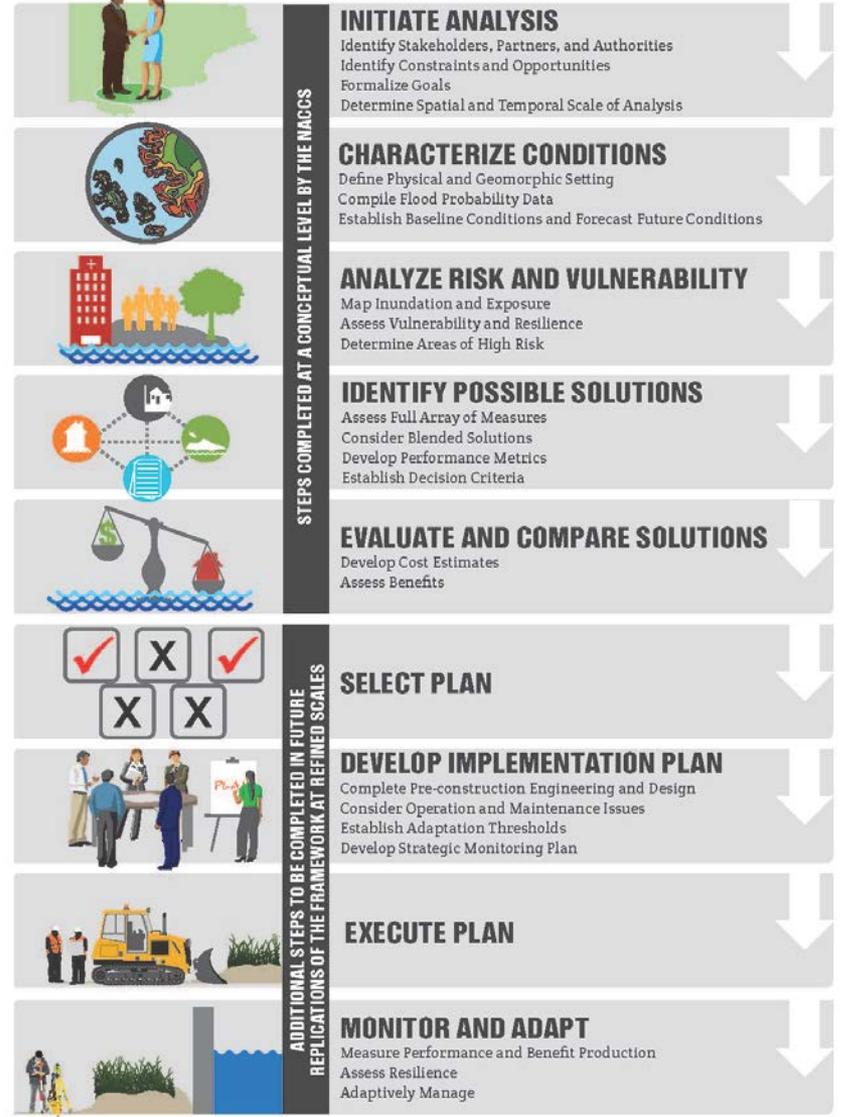
➤ The framework is:

- A 9-step process
- Customizable for any coastal area or watershed
- Repeatable at state and local scales
- Transferable to other areas of the country



## NACCS Coastal Storm Risk Management Framework

(Repeat initial five steps for each Tier 1, 2, and 3 Evaluations)



# Coastal Storm Risk Management Framework

## Trends

### ➤ **Climate and Sea Level Change**

- Sea level is increasing throughout the study area
- Shorelines are changing in response to sea level change
- Historic erosion patterns will continue and accelerate

### ➤ **Socioeconomic Trends**

- Population is aging (i.e. more difficult to evacuate/relocate during flooding)
- Population is increasing in coastal zone (more people exposed to flooding)
- Importance of operating channels and ports will become more critical to regional and national economy

### ➤ **Environmental Trends**

- Habitats subject to more stress with population increase, climate change, and other effects

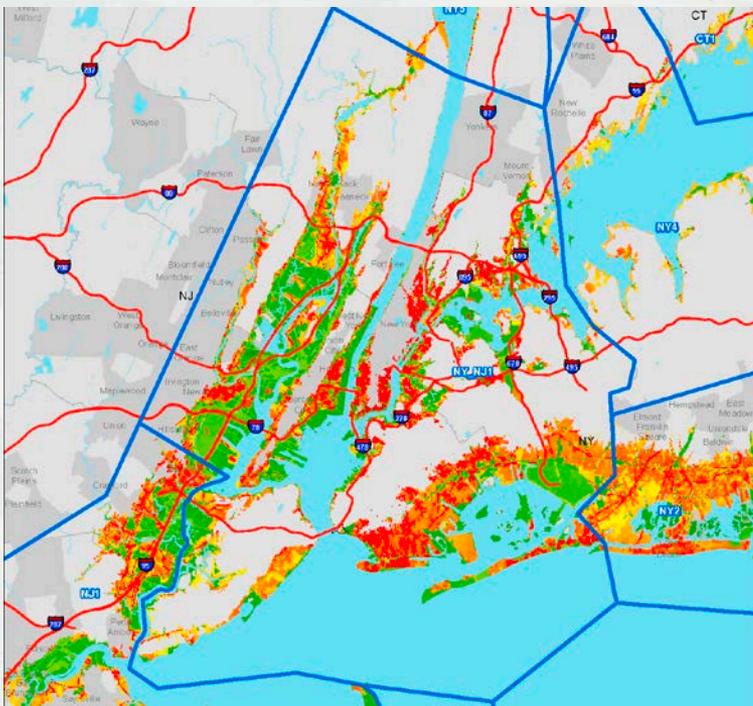


# Coastal Storm Risk Management Framework

## Flood Exposure & Risk Assessment

### ➤ Coastal Flood

- SLOSH CAT1-4 Maximum of Maximum
- FEMA DFIRM
- 10-percent-annual chance
- SLR Inundation (USACE high)



### ➤ Exposure Indices

- **Population density and infrastructure** (number of people and infrastructure in communities subject to flooding)
- **Socioeconomic groups** (populations that may have more difficulty preparing and responding to flooding)
- **Environmental & Cultural** (critical habitat, wetlands and other areas that maintain resiliency during flooding; key cultural resources subject to flooding)
- **Composite**

### ➤ Mapping

- Flood Hazard
- Relative Exposure
- Relative Risk



# Coastal Storm Risk Management Framework

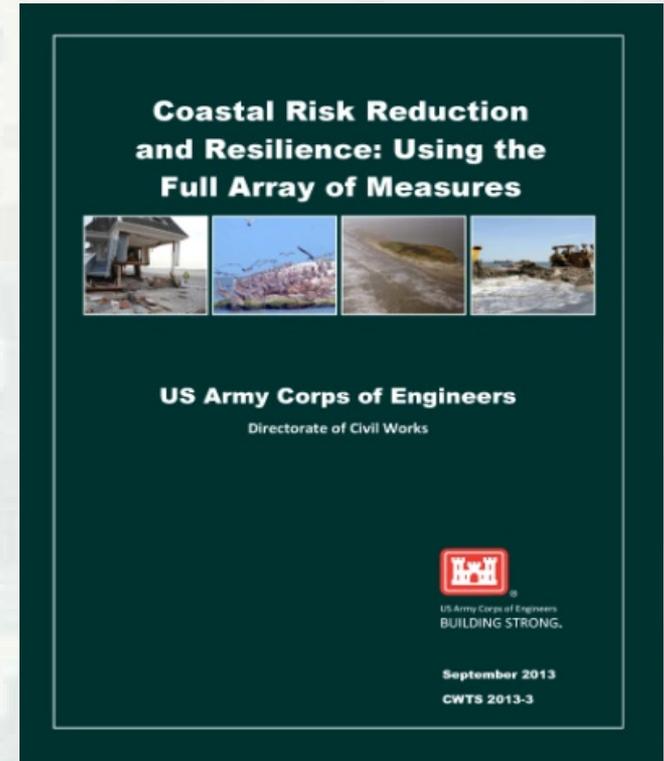
## Risk Management Measures

### ➤ **Structural**

- Storm surge barriers
- Levees, breakwaters, shoreline stabilization
- Natural and Nature-Based Features (e.g., beaches and dunes, living shorelines, wetlands, oyster reefs, SAV restoration)

### ➤ **Non-Structural** (e.g., floodproofing, acquisition and relocation, flood warning, etc.)

### ➤ **Programmatic** (e.g., floodplain management, land use planning, State/municipal policy, natural resources, surface water management, education, flood insurance programs, etc.)



# Coastal Storm Risk Management Framework

## Risk Management Measures

### Tier 1 Analysis

- Initial Screening
- Aggregated Measures
- Evaluated Applicability of Measures given Shoreline Type
- Next Step: Tier 2 and Tier 3 Analyses at smaller (more localized) scales

Table VIII-2. Structural and NNBF Measure Applicability by NOAA-ESI Shoreline Type

Measures	Rocky shores (Exposed)	Rocky shores (Sheltered)	Beaches (Exposed)	Manmade structures (Exposed)	Manmade structures (Sheltered)	Scarps (Exposed)	Scarps (Sheltered)	Vegetated low banks (Sheltered)	Vegetated low banks (Sheltered)	Wetlands/Marshes/ Swamps (Sheltered)
<b>Structural</b>										
Storm Surge Barrier <sup>1</sup>										
Beach Restoration <sup>2</sup>			x							
Breakwaters and Beach Restoration <sup>2</sup>			x							
Groins and Beach Restoration			x							
Shoreline Stabilization						x	x	x		
Deployable Floodwall					x					
Floodwall/Levee		x			x			x		
Drainage Improvements	x	x	x	x	x	x	x	x	X	x
<b>Natural and Nature-Based Features</b>										
Living Shoreline						X	x	x		X
Wetlands							x			X
Reefs	x	x				X				X
Submerged Aquatic Vegetation (SAV) Restoration <sup>3</sup>										X
Overwash Fan <sup>4</sup>										
Drainage Improvements	x	x	x	x	x	x	x	x	X	X

<sup>1</sup>The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.

<sup>2</sup>Beaches and dunes are also considered Natural and Nature-Based Features.

<sup>3</sup>SAV restoration is not associated with any particular shoreline type. It is initially assumed to apply to wetland shorelines.

<sup>4</sup>Overwash fans may apply to the back side of barrier islands, which are not explicitly identified in the NOAA Environmental Sensitivity Index Shoreline Classification dataset.



# Coastal Storm Risk Management Framework:

## Risk Management Measures

### Natural and Nature-Based Infrastructure at a Glance

#### GENERAL COASTAL RISK REDUCTION PERFORMANCE FACTORS:

STORM INTENSITY, TRACK, AND FORWARD SPEED, AND SURROUNDING LOCAL BATHYMETRY AND TOPOGRAPHY



#### Dunes and Beaches

##### Benefits/Processes

- Break offshore waves
- Attenuate wave energy
- Slow inland water transfer

##### Performance Factors

- Berm height and width
- Beach Slope
- Sediment grain size and supply
- Dune height, crest, width
- Presence of vegetation

#### Vegetated Features:

#### Salt Marshes, Wetlands, Submerged Aquatic Vegetation (SAV)

##### Benefits/Processes

- Break offshore waves
- Attenuate wave energy
- Slow inland water transfer
- Increase infiltration

##### Performance Factors

- Marsh, wetland, or SAV elevation and continuity
- Vegetation type and density

#### Oyster and Coral Reefs

##### Benefits/Processes

- Break offshore waves
- Attenuate wave energy
- Slow inland water transfer

##### Performance Factors

- Reef width, elevation and roughness

#### Barrier Islands

##### Benefits/Processes

- Wave attenuation and/or dissipation
- Sediment stabilization

##### Performance Factors

- Island elevation, length, and width
- Land cover
- Breach susceptibility
- Proximity to mainland shore

#### Maritime Forests/Shrub Communities

##### Benefits/Processes

- Wave attenuation and/or dissipation
- Shoreline erosion stabilization
- Soil retention

##### Performance Factors

- Vegetation height and density
- Forest dimension
- Sediment composition
- Platform elevation

Natural and Nature-Based Features



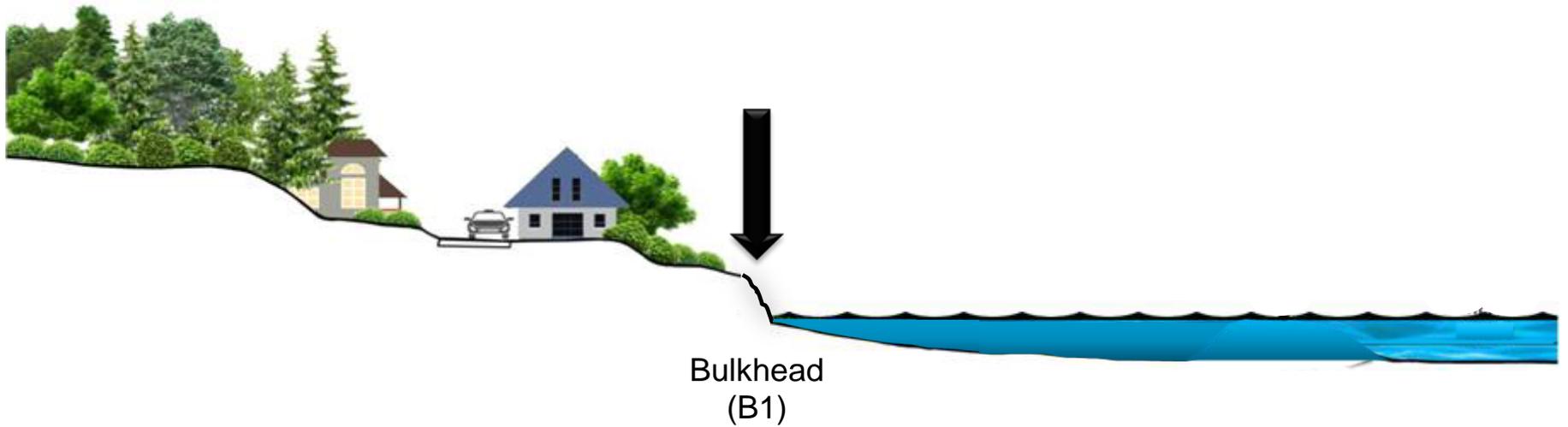
# Coastal Storm Risk Management

## Framework:

### Risk Management Measures

## Integration of Measures

	SB1	NBI 1	NBI 2	NBI 3	ALL
S1	✓				
S2	✓				
S3					
S4					
S5					
S6					



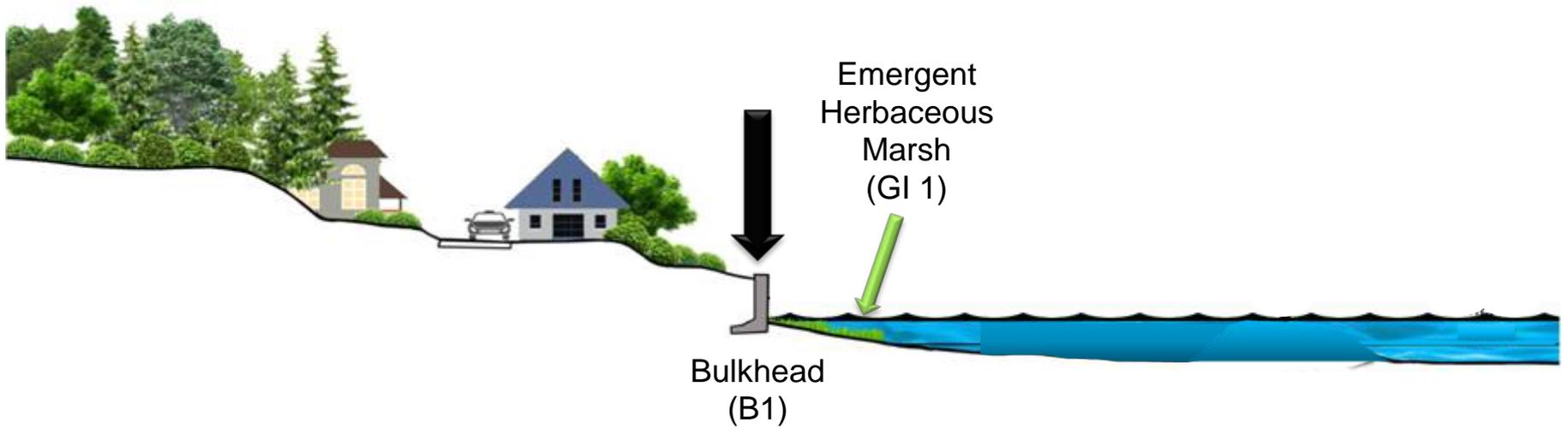
# Coastal Storm Risk Management

## Framework:

### Risk Management Measures

## Integration of Measures

	SB1	NBI 1	NBI 2	NBI 3	ALL
S1	✓				
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S3					
S4					
S5		✓			
S6		✓			



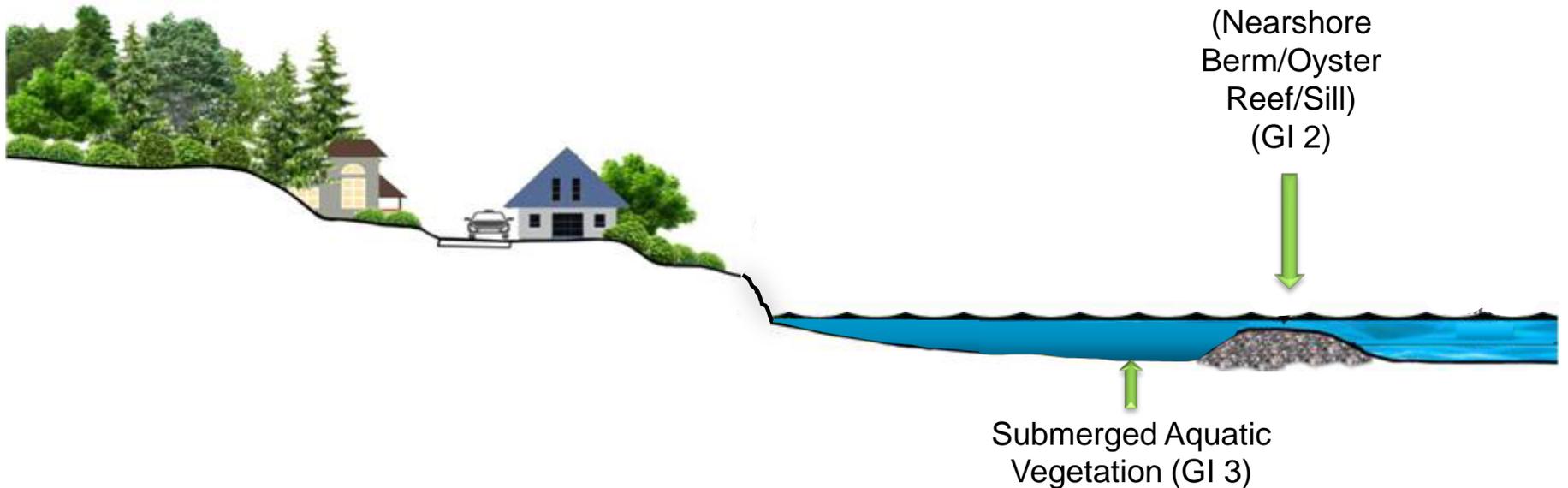
# Coastal Storm Risk Management

## Framework:

### Risk Management Measures

## Integration of Measures

	SB1	NBI 1	NBI 2	NBI 3	ALL
S1	✓		✓		
S2	✓		✓	✓	
S3			✓		
S4				✓	
S5		✓	✓		
S6		✓		✓	



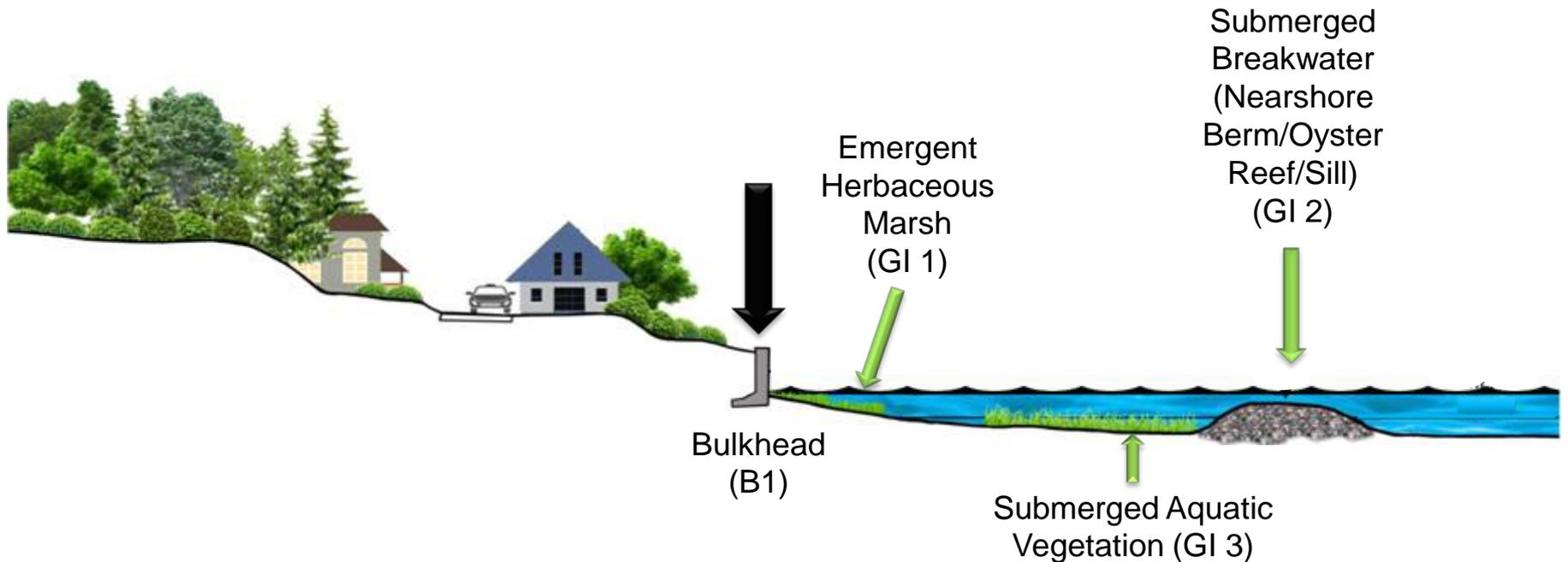
# Coastal Storm Risk Management

## Framework:

### Risk Management Measures

## Integration of Measures

	SB1	NBI 1	NBI 2	NBI 3	ALL
S1	✓		✓		✓
S2	✓		✓	✓	✓
S3			✓		✓
S4				✓	✓
S5		✓	✓		✓
S6		✓		✓	✓



# Technical Products Supporting the Framework

## NACCS Coastal Storm Risk Management Framework



### INITIATE ANALYSIS

Identify Stakeholders, Partners, and Authorities  
Identify Constraints and Opportunities  
Formalize Goals



### CHARACTERIZE EXISTING CONDITIONS

Define Physical and Geomorphic Setting  
Compile Flood Probability Data  
Establish Baseline Conditions



### ANALYZE VULNERABILITY AND RISK

Map Inundation and Exposure  
Assess Vulnerability and Resilience  
Determine Areas of High Risk



### IDENTIFY POSSIBLE SOLUTIONS

Assess Full Array of Measures  
Consider Blended Solutions  
Develop Performance Metrics  
Establish Decision Criteria



### EVALUATE AND COMPARE SOLUTIONS

Develop Cost Estimates  
Assess Benefits

STEPS COMPLETED AT A CONCEPTUAL LEVEL BY THE NACCS

### Technical Products Advanced by NACCS to Close Identified Data Gaps

- Visioning Sessions Report & Focus Area Analyses
- Institutional & Other Barriers Report

- NACCS GIS Geodatabase
- Environmental & Cultural Resources Conditions Report

- Storm Suite Modeling
- NACCS GIS Geodatabase
- NACCS Barrier Island Sea Level Rise Inundation Assessment Report

- Natural & Nature-Based Features Report
- Conceptual Regional Sediment Budget
- State Appendix
- Vulnerability Decision Tree

- Enhanced Depth-Damage Functions for Coastal Storms

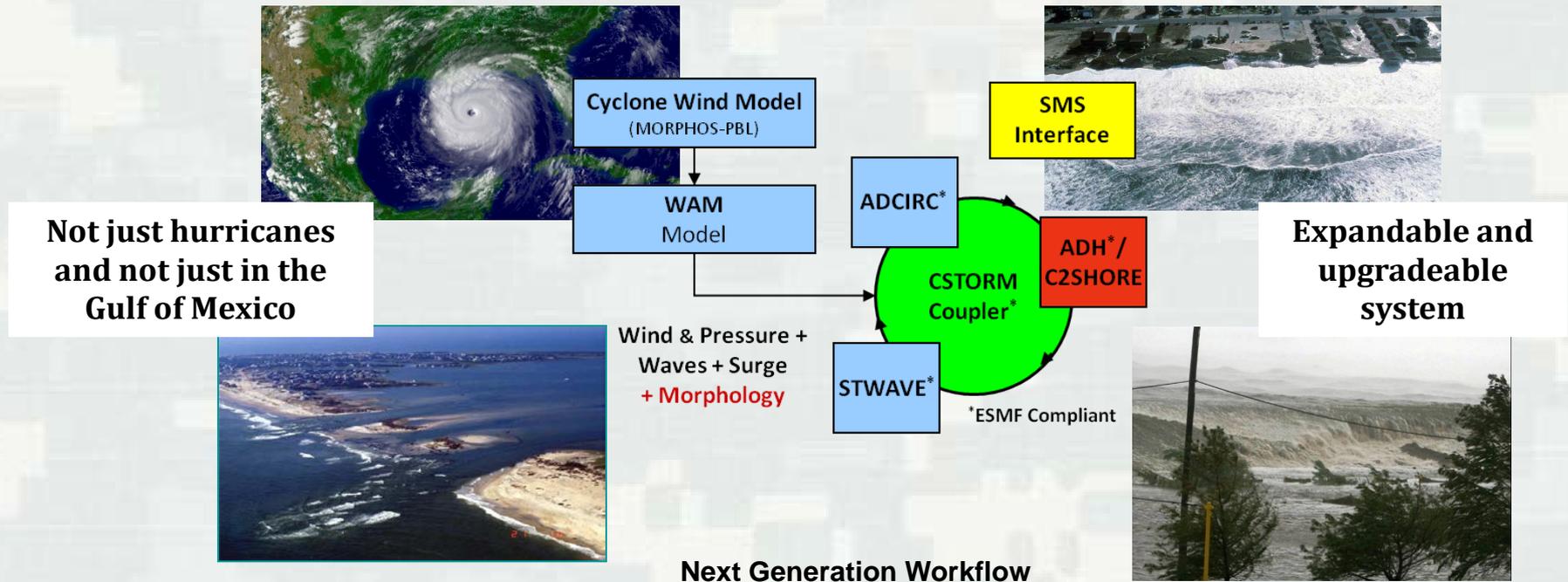
Several products, planning tools, and models were developed to assist decision makers in navigating the Coastal Storm Risk Management Framework



# Technical Products Supporting the Framework

## *Coastal Storm-Modeling System (ERDC CSTORM-MS)*

**Provides for a robust, standardized approach to establishing the risk of coastal communities to future occurrences of storm events.**



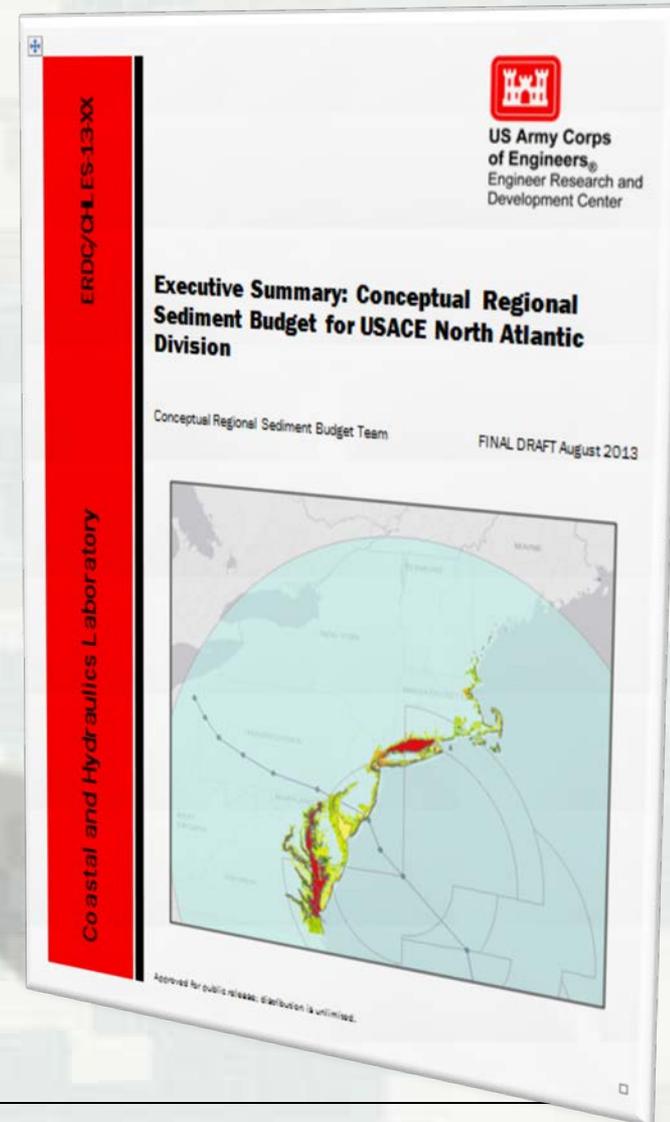
➤ Application of high-resolution, highly skilled numerical models in a tightly integrated modeling system with user friendly interfaces



# Technical Products Supporting the Framework

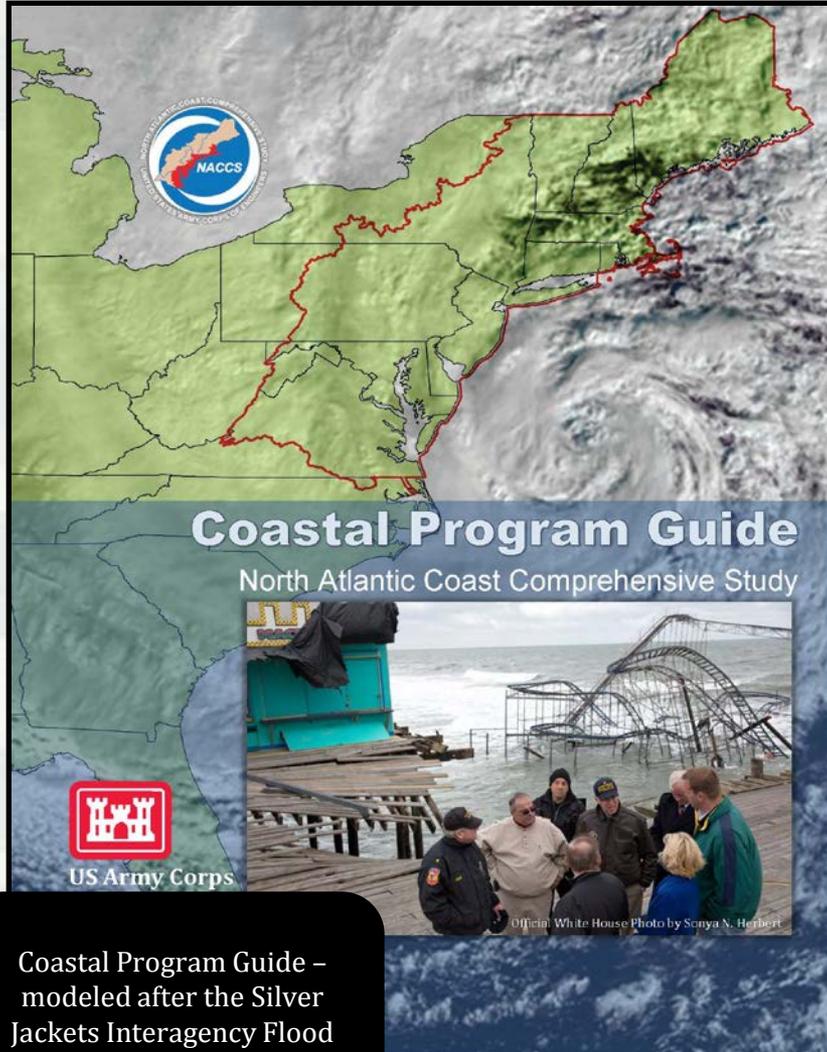
## Conceptual Regional Sediment Budget

- Enables and promotes a systems approach
- Visualizes magnitude and direction of sediment transport
- Includes dredging data from Dredging Information System and placement site (if available)
- Based on existing knowledge or morphology



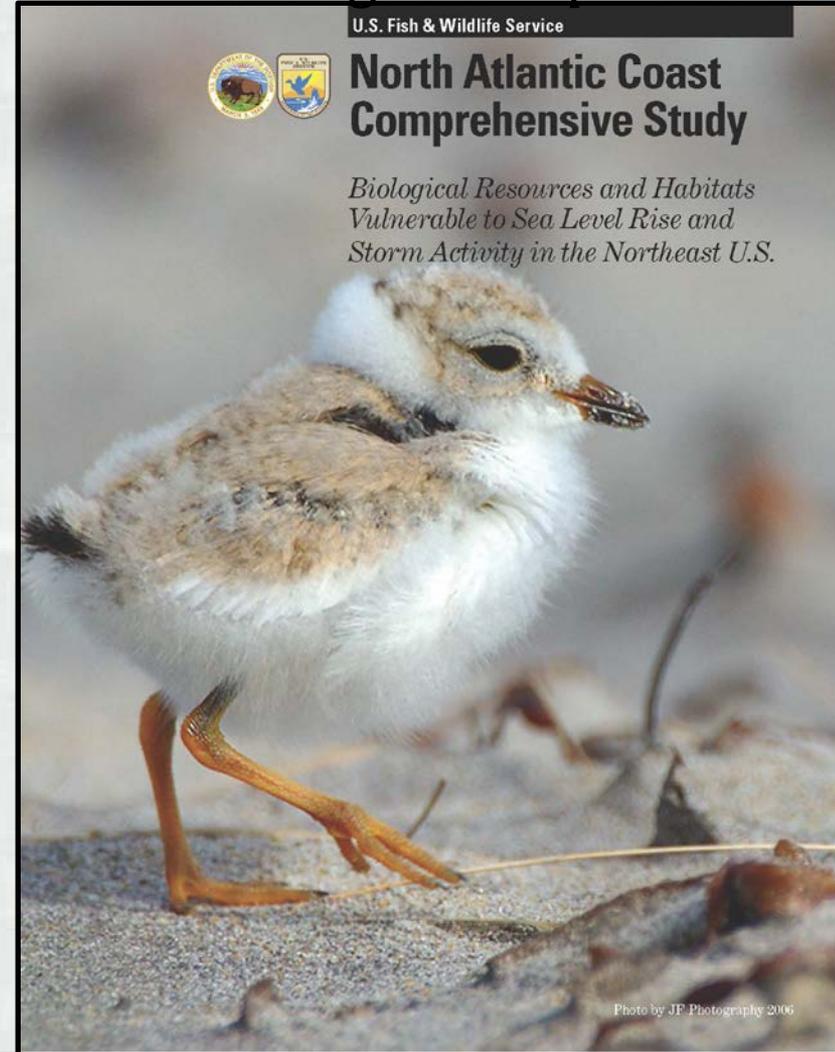
# Technical Products Supporting the Framework

## *Coastal Program Guide*



Coastal Program Guide – modeled after the Silver Jackets Interagency Flood Mitigation Program Guide

## *U.S. Fish and Wildlife Planning Aid Report*

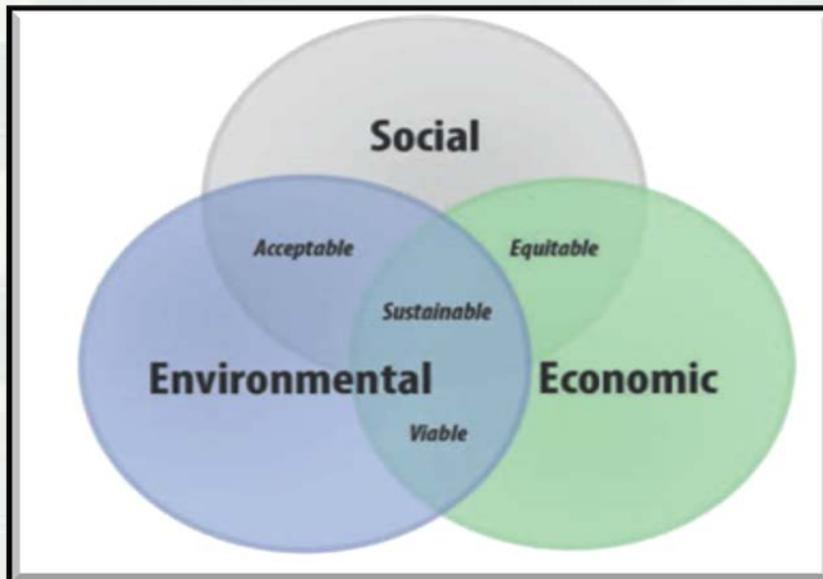


# Systems Approach and Resilience

## Why a Systems Approach?

- Coastal change occurs over large temporal and spatial scales
- Complex social, economic, and environmental interactions
- Multiple/possibly competing stakeholder objectives

- Systems Approach:
  - *Broad view of interactions & objectives to develop potential solution sets*
  - *Intentionally aligns engineering and natural systems*



*Restoration of Deer Island, MS  
Barrier Island and Marsh*



# Systems Approach and Resilience

## ➤ Quantify the resilience

- Natural & Nature-Based Features
- Engineering Projects
- Community Values
- And more...

## ➤ What are the best practices for assessing, operating and maintaining a resilient and integrated coastal system?

**Quantifying Resilience in Integrated Coastal Systems**

Julie Rosati, Martin Schultz, Ernie Smith  
U.S. Army Engineer Research & Development Center  
Coastal & Hydraulics Laboratory

**Resilience** The ability of a system to retain, recover, and adapt to achieve functional performance under the stress of disturbances.

**Assessing Resilience** Analyzing information to make decisions regarding the planning, design, construction, and management of integrated coastal systems so that the performance goals and objectives of that system can be achieved most cost-effectively.

**Managing Resilience** Influencing system response by planning and preparing for adverse events, implementing maintenance and recovery plans, and adapting new functions specifically conditioned on the disturbance.

A **Resilience network** illustrates how the resilience of a system can be calculated based on the probability of a hazard, the physical response of the system, integrated system response as it influences the functional performance, and the natural/anthropogenic capacity of the system to recover to meet the functional objective within the required time period.

- Measure coastal storms.
- Physical response of the system: total water level, waves, currents, and wind.
- Functional performance: reduction in channel depth through shoaling; water level as it affects bridge clearance, wharf access, etc.
- Reference objective: required functionality of the coastal system.
- Rapidly objective: time period allowed for recovery of the coastal system.

The figure shows a conceptual example of a barrier island system that incorporates engineering projects, environmental restoration, and community involvement.

**Operating and Maintaining this Integrated Coastal System** such that it would increase in resiliency would include:

- Anticipating the "weak links" in the system and developing strategies to rapidly address them.
- Providing diverse and redundant protection such that the functioning of the system does not depend on any single component.
- Ensuring that the system includes modular networks such that if one portion of the system fails, the functional performance can still be maintained.
- Providing readily available information for decision-making at local, regional, and national levels such that the community adequately understands their risks and can engage to increase their resiliency.

**BUILDING STRONG.**



# Institutional and Other Barriers

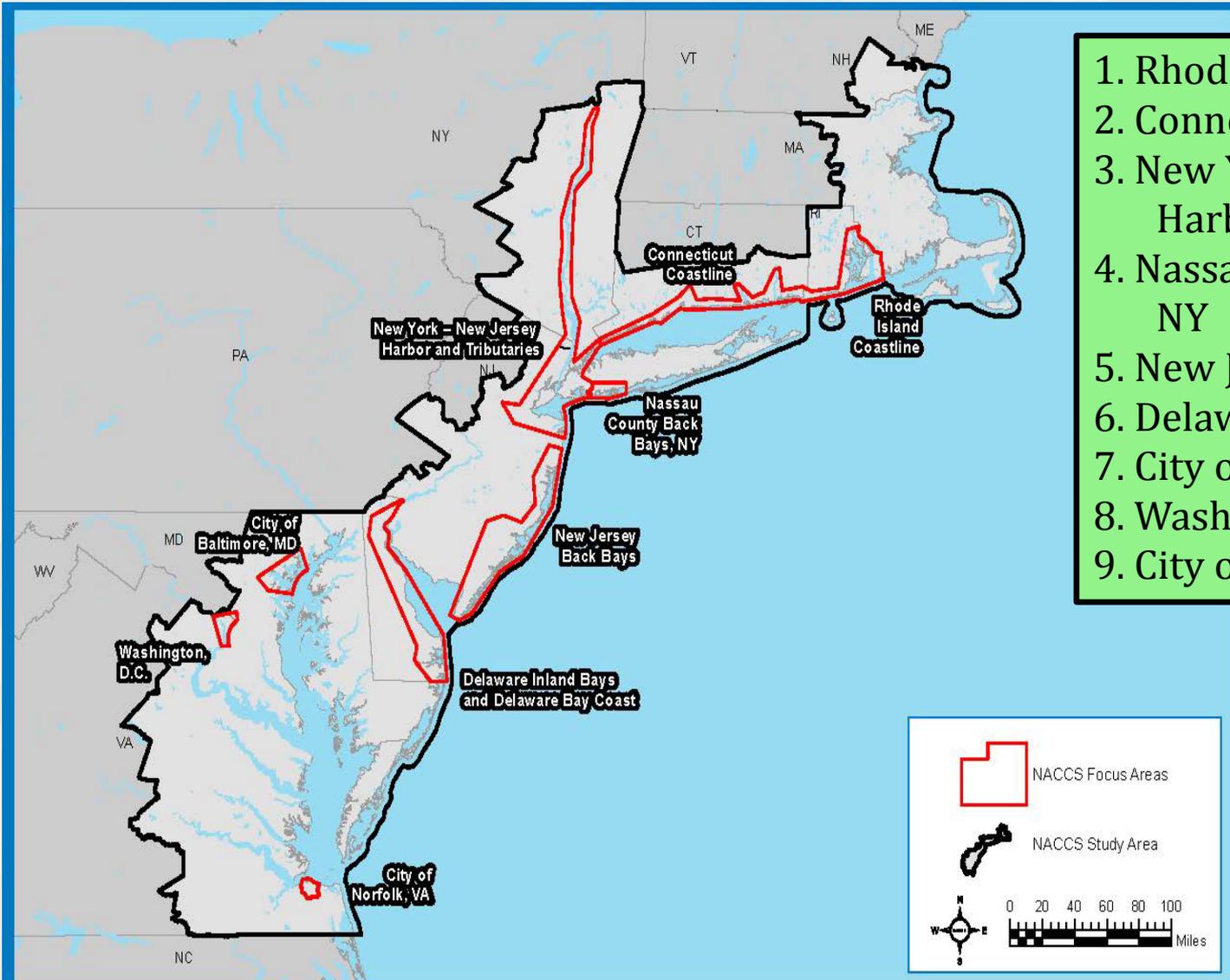
## ➤ Six themes

- Theme 1: Risk/Resilience Standards
- Theme 2: Communication and Outreach
- Theme 3: Risk Management
- Theme 4: Science, Engineering and Technology
- Theme 5: Leadership and Institutional Coordination
- Theme 6: Local Planning and Financing

## ➤ Aligned with Project Performance Evaluation Report and Hurricane Sandy Rebuilding Strategy



# Areas Warranting Additional Analysis



1. Rhode Island Coastline
2. Connecticut Coastline
3. New York - New Jersey Harbor and Tributaries
4. Nassau County Back Bays, NY
5. New Jersey Back Bays
6. Delaware Back Bays
7. City of Baltimore, MD
8. Washington, D.C.
9. City of Norfolk, VA

# Final Report

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VI. Institutional and Other Barriers to Achieving NACCS Goals and Opportunities for Action

VII. Activities Warranting Additional Analysis

VIII. Definitions and Acronyms

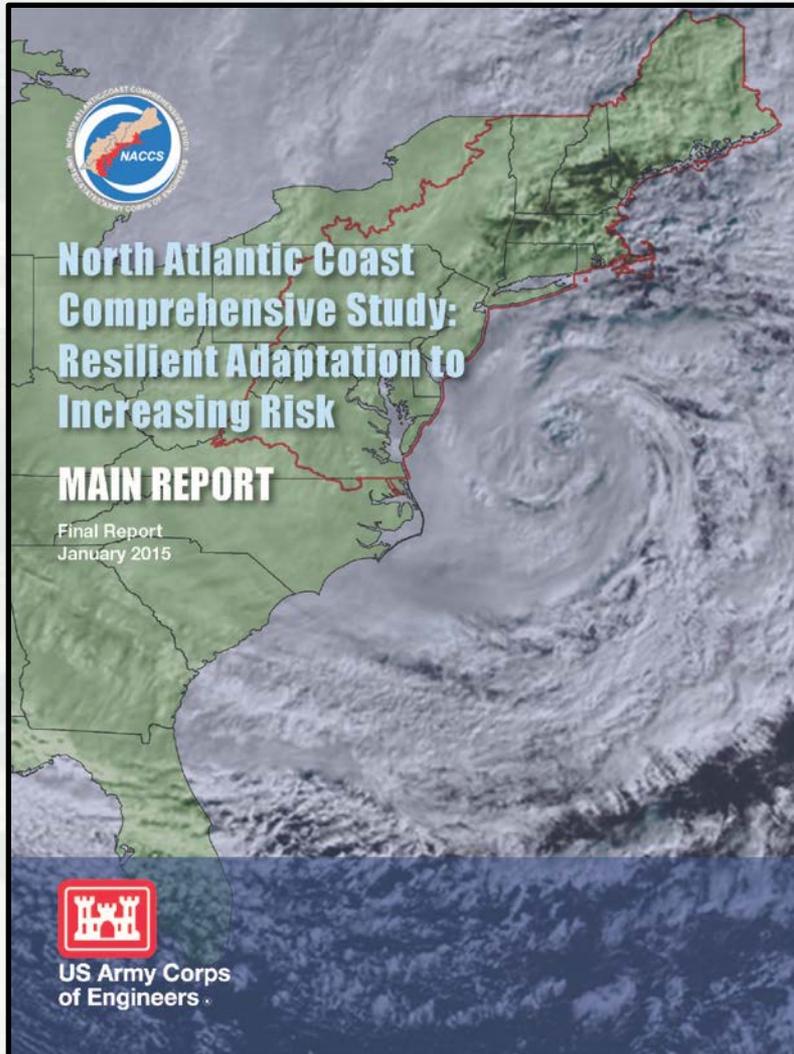
## Appendices

•Engineering

•Economics and Social Analyses

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•State and District of Columbia Analyses



# Summary

"The North Atlantic Coast Comprehensive Study is an unprecedented effort by the U.S. Army Corps of Engineers in collaboration with our partners to develop a coastal plan that considers future sea levels and climate change. The report provides a framework for communities that will arm them for the reality of future extreme weather."

Jo-Ellen Darcy  
Assistant Secretary of the Army  
for Civil Works

"Hurricane Sandy brought to light the reality that coastal storms are intensifying and that sea-level rise and climate change will only heighten the vulnerability of coastal communities. Coastal storm risk management is a shared responsibility, and we believe there should be shared tools used by all decision makers to assess risk and identify solutions. This report provides those tools."

Brig. Gen. Kent D. Savre  
Commanding General  
U.S. Army Corps of Engineers  
North Atlantic Division

