

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

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Regional Technical Specialist

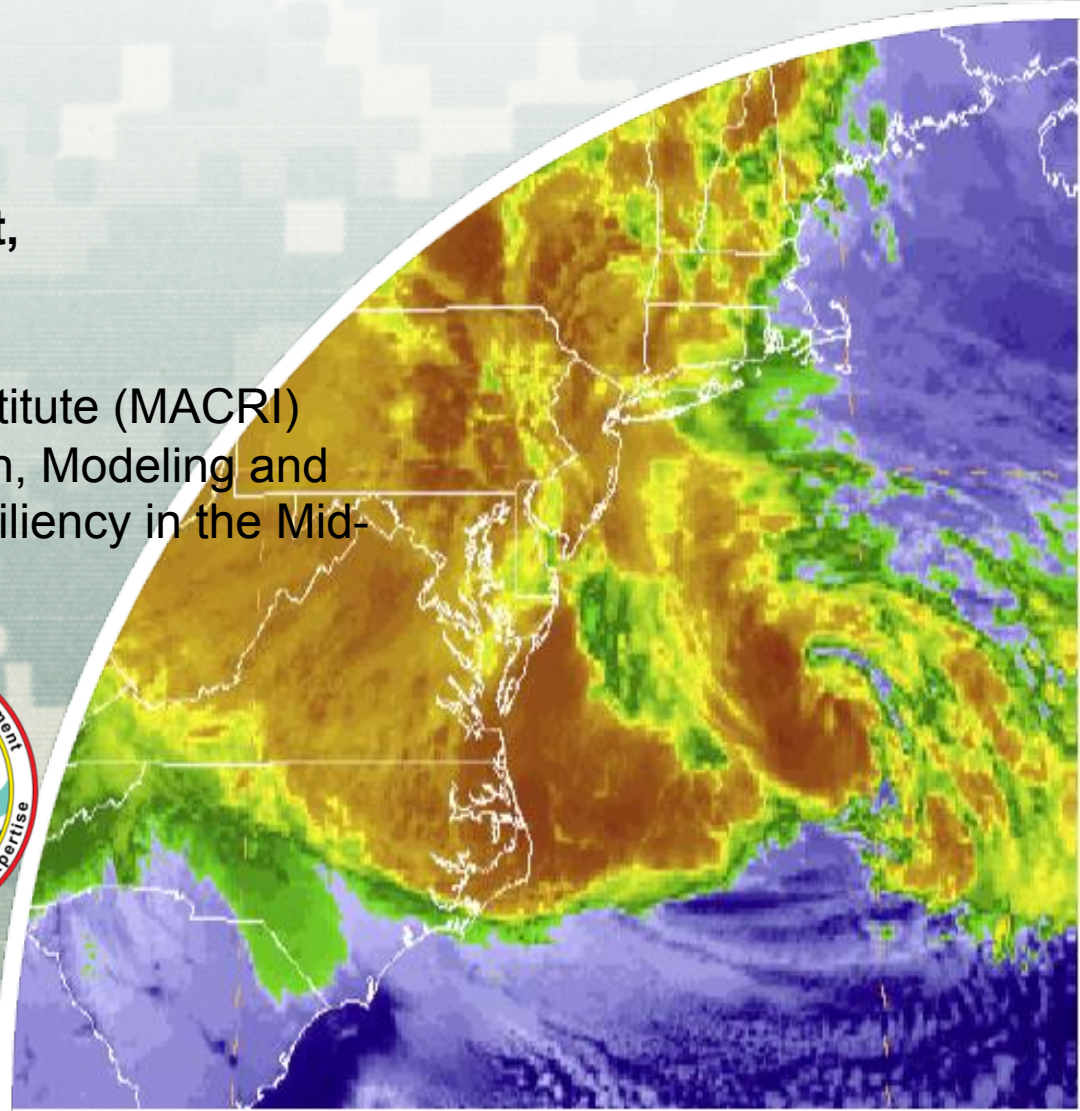
National Planning Center for
Coastal Storm Risk Management,
U.S. Army Corps of Engineers

Mid-Atlantic Coastal Resiliency Institute (MACRI)
Integrating Coastal Flood Research, Modeling and
Monitoring to Improve Coastal Resiliency in the Mid-
Atlantic Technical Workshop

16 September 2015



US Army Corps of Engineers
BUILDING STRONG

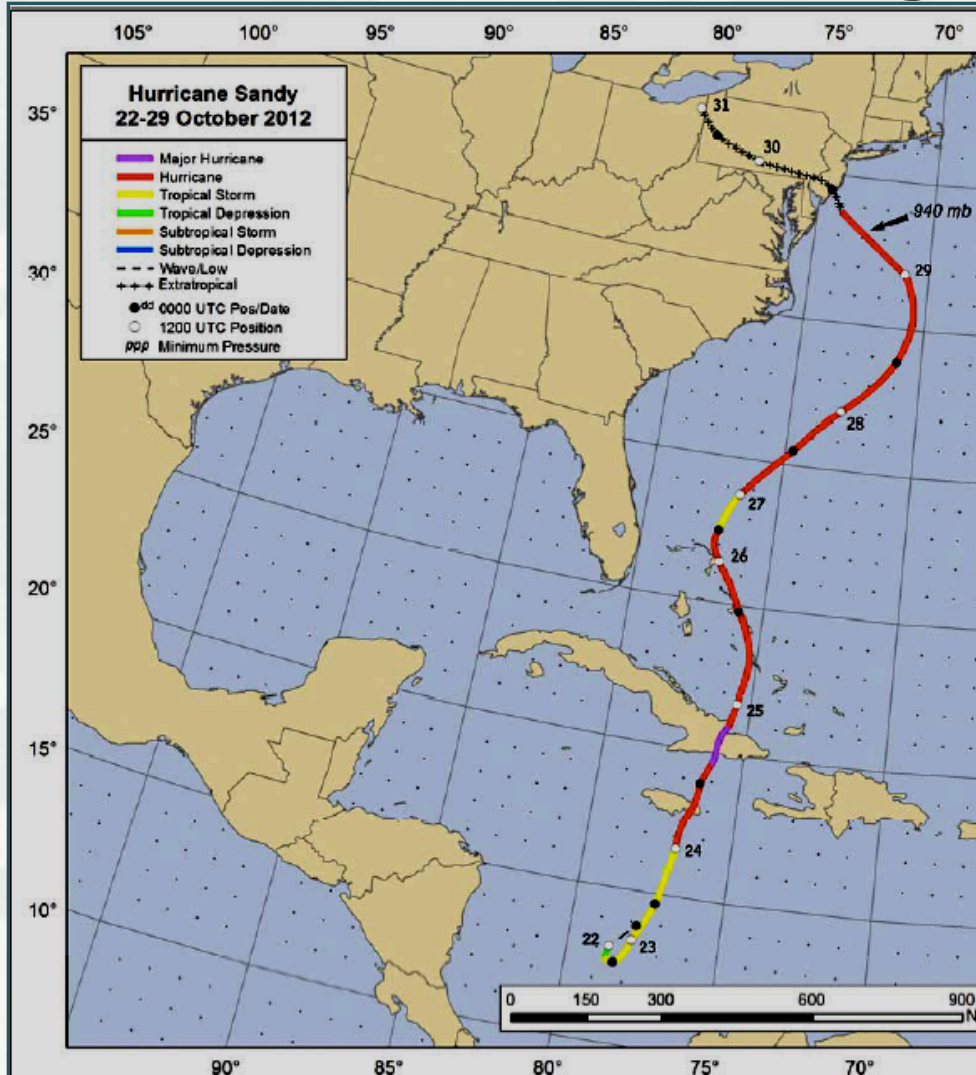


Outline

- NACCS Overview
 - Background
 - Collaboration and Alignment
 - Findings, Outcomes, and Opportunities
 - Coastal Storm Risk Management Framework
 - Coastal Risk Reduction and Resilience: Using the Full Array of Measures
- NACCS Technical Products
- Resilience Definition
- Focus Areas
- Summary



Background



- Sandy originated in the Caribbean on 22 October 2012
- Severely impacted Jamaica, Cuba, Haiti, Dominican Republic, and Cuba, reaching the USA Atlantic coastline 29 October
- In the USA, effects extended from Florida to Maine, and west to Great Lakes
- States of New Jersey, New York, and Connecticut greatly impacted; NY-NJ Harbor devastated by catastrophic surge



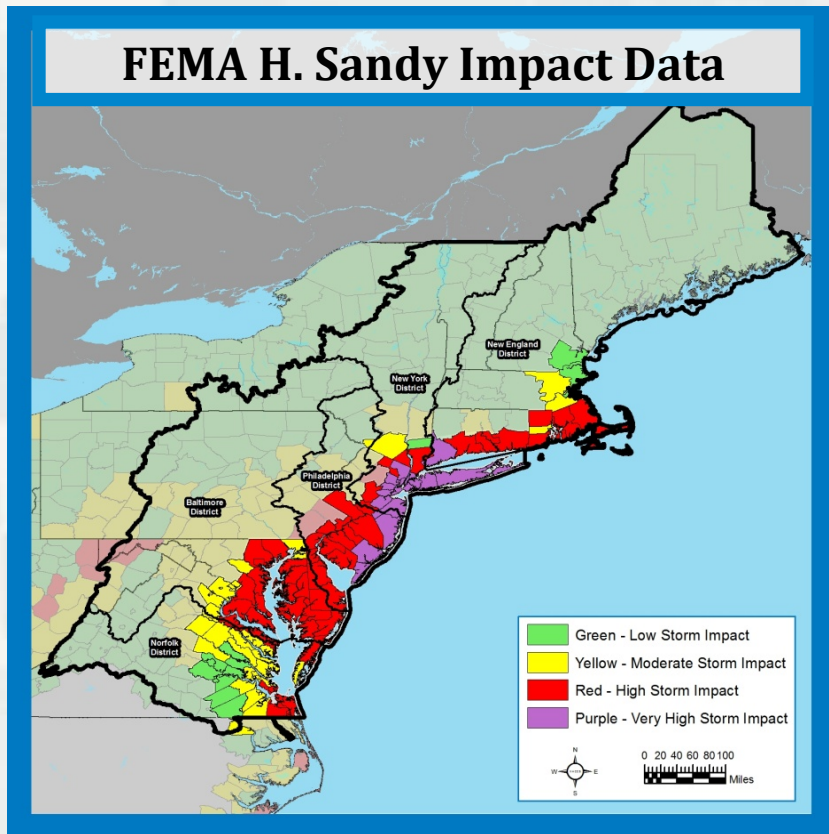
National Hurricane Center 12 Feb 2013



NACCS 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)

➤ Released to public 28 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

- Developed a **comprehensive plan** to address vulnerable coastal communities and applied it at the study area scale (Tier 1)
- Formalized and **consistent approach/framework** for more detailed, site specific coastal evaluations
- **Integration** of state-of-the-science techniques and collaboration
- Interagency collaboration
 - Interagency stakeholder validation and input
 - Interagency Collaboration Webinar Series
 - Stakeholder review and validation
- 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

➤ NACCS is *not*:

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



Collaboration and Alignment

➤ Agency, Interagency, and Tribal Collaboration

- USACE High Level Senior Governance Team/Enterprise Project Delivery Team/Strong Project Management
- Interagency correspondence/ technical working meetings/panel discussions
- Subject Matter Experts embedded in team
- Federal Register notices and public website
- Interagency Webinar Collaboration Series (2013-2014)
- Roll Out Webinars for Regional Partners (2 & 9 Feb 2015)

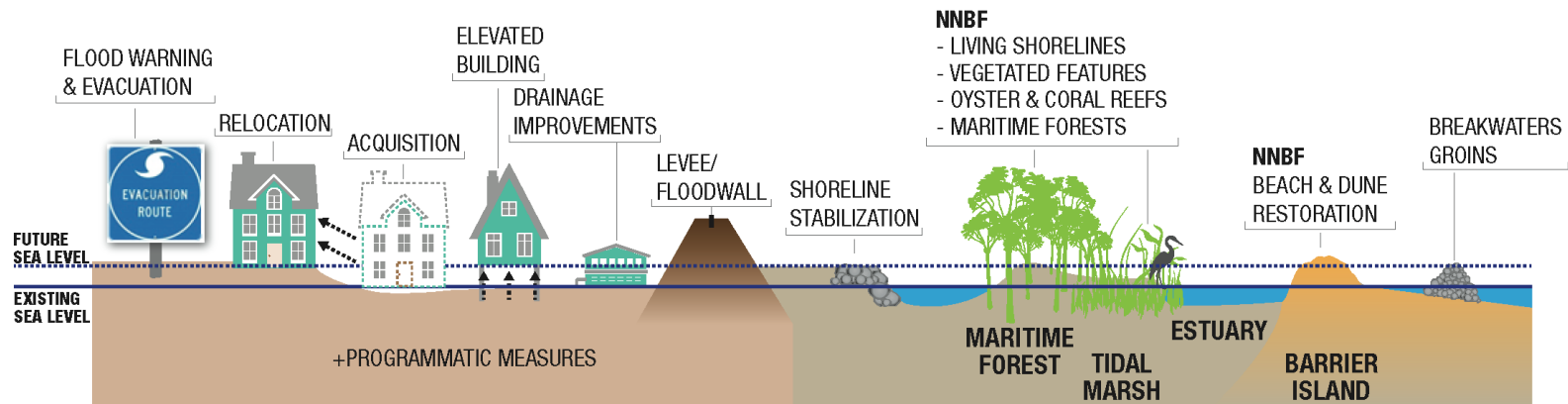
➤ Alignment

- President's Climate Action Plan
- Sandy Task Force "Hurricane Sandy Rebuilding Strategy"
- OMB Legislative Review Memorandum with Federal Agencies
- Sandy Regional Infrastructure Resilience Coordination



Findings

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



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 **natural-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 -New Jersey

Harbor and Tributaries

5) New Jersey Back Bays

6) Delaware Inland Bays

and Delaware Bay Coast

7) City of Baltimore, MD

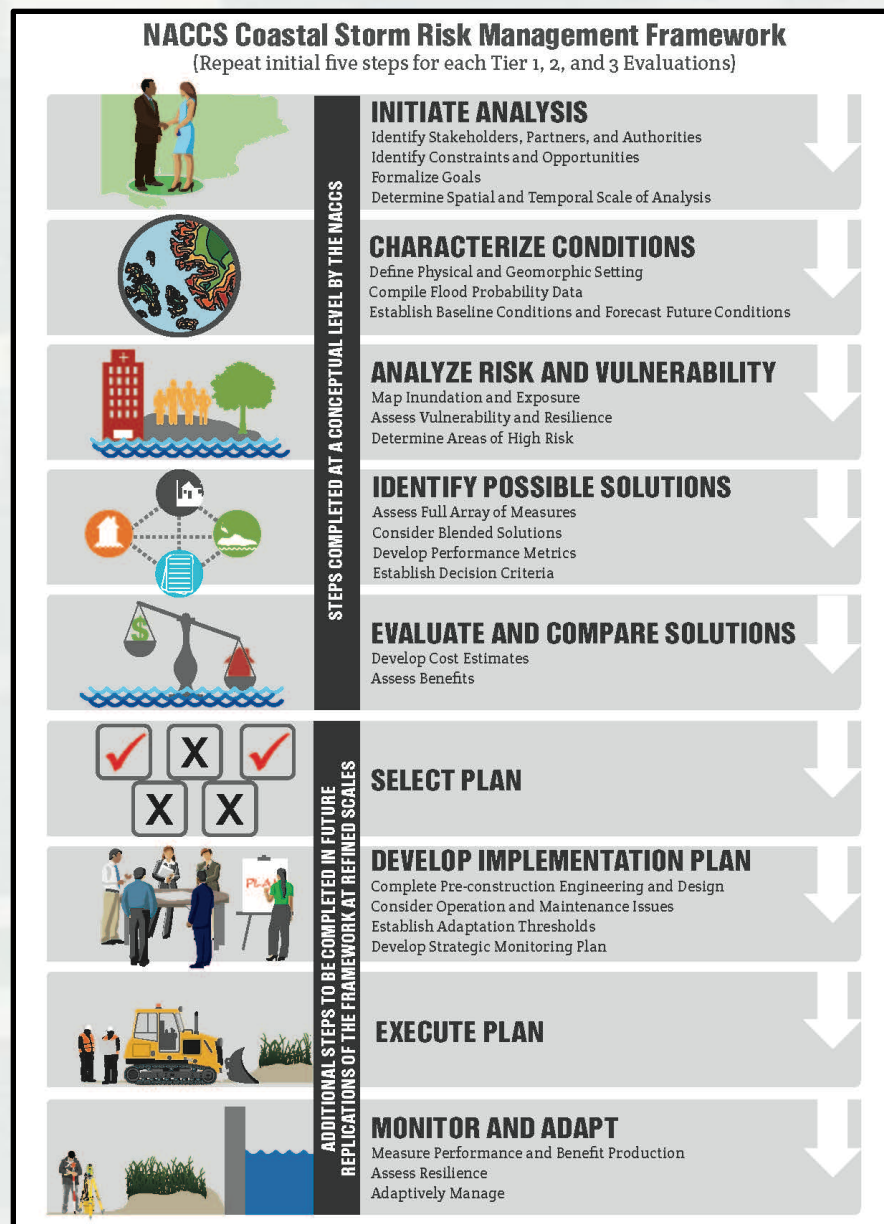
8) Washington, D.C.

9) City of Norfolk, VA



Outcomes: Coastal Storm Risk Management Framework

- Managing coastal storm risk is a shared responsibility
- The Framework is:
 - A 9-step process
 - Customizable for any coastal area or watershed and other regions
 - Repeatable at state and local scales
- Who/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?
- What is the residual risk?

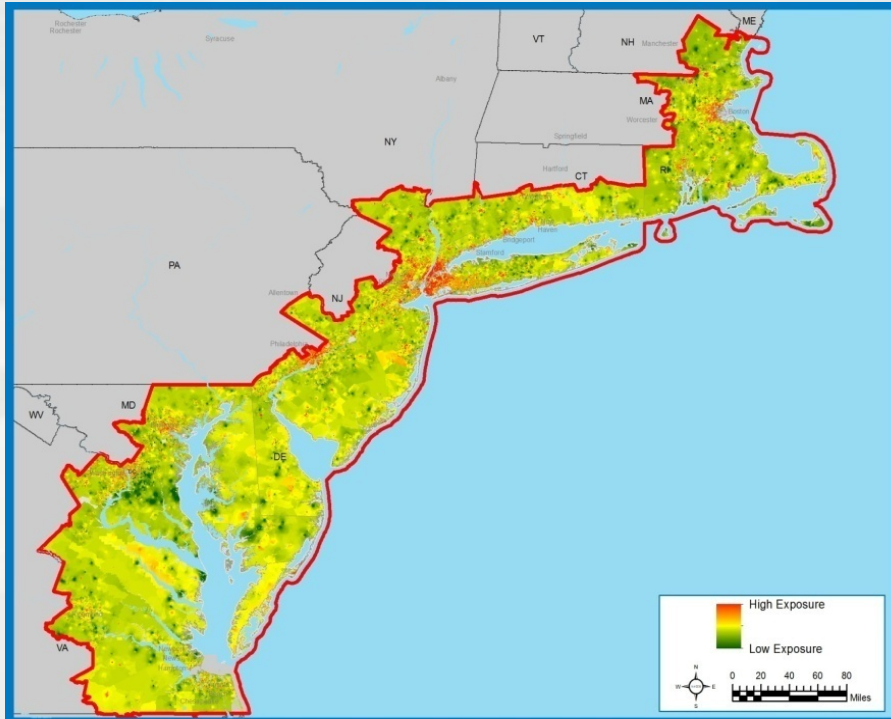


Coastal Storm Risk Management Framework

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

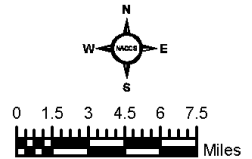
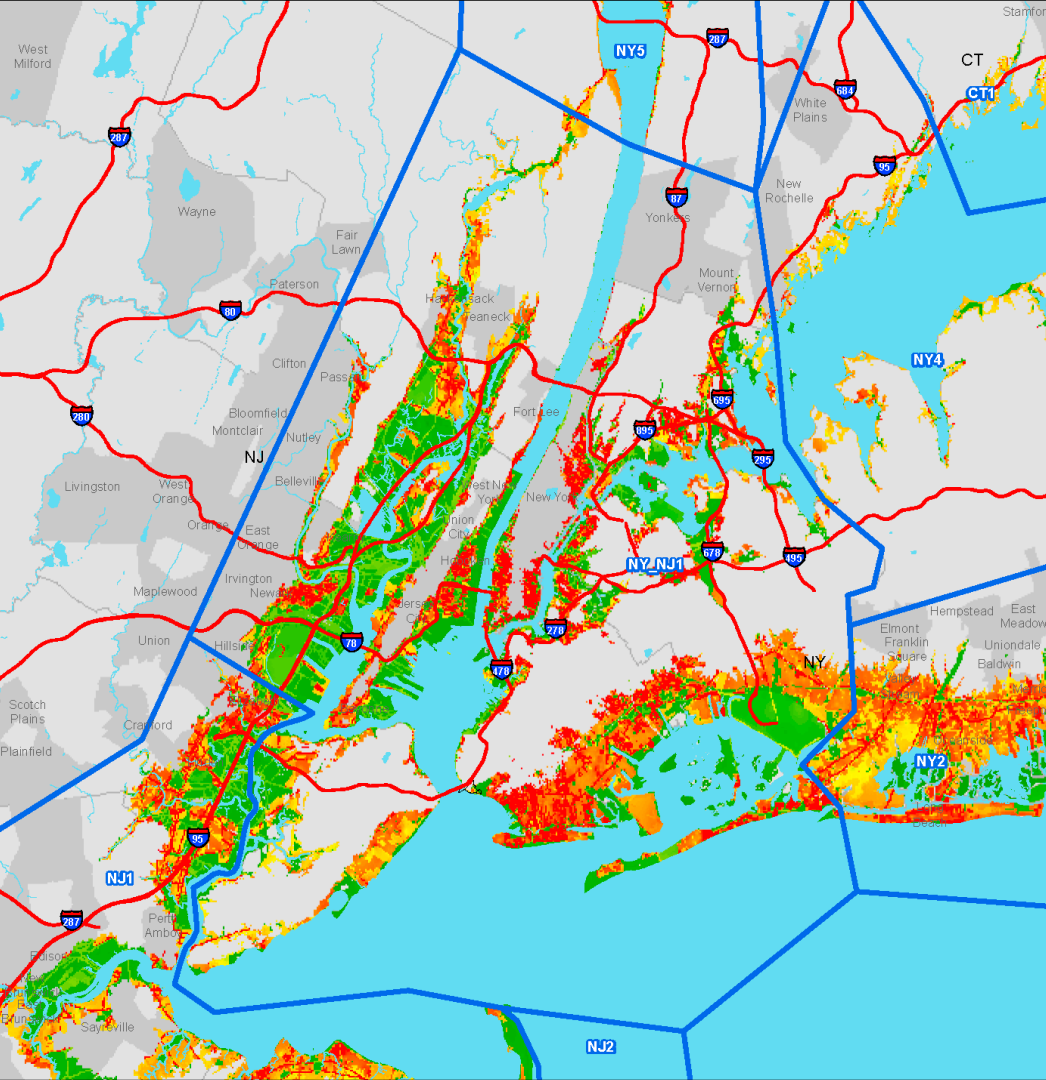
- Flood Hazard
- Relative Exposure
- Relative Risk



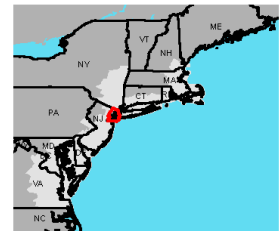
Coastal Storm Risk Management Framework

Flood Exposure & Risk Assessment

Composite Exposure



- High Exposure
- Low Exposure
- NACCS Planning Reaches
- Interstate Highways
- Military Installation
- Cities

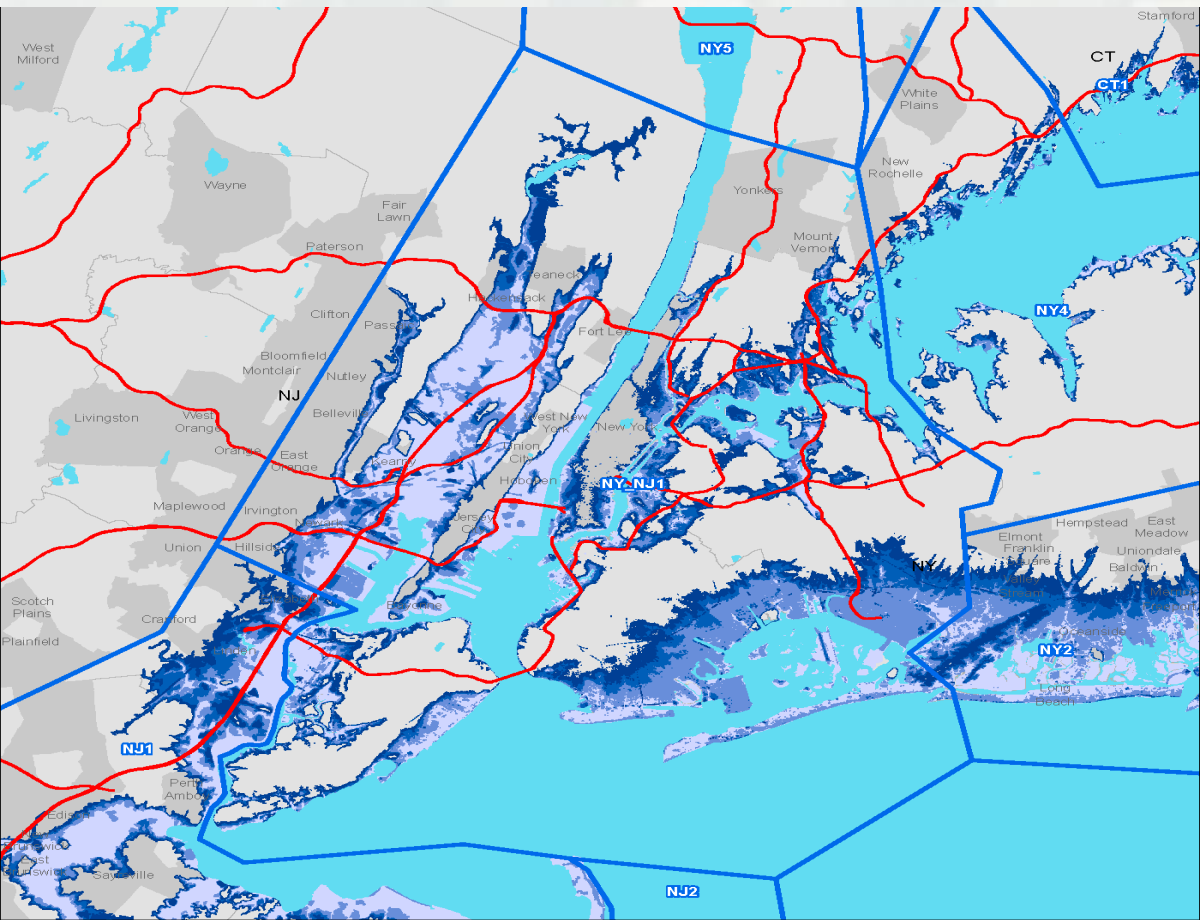


This figure presents the results of the NACCS exposure analysis completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.



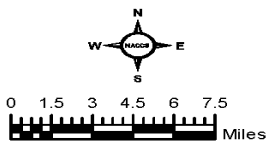
Coastal Storm Risk Management Framework

Existing/Future Conditions: Probability of Flooding

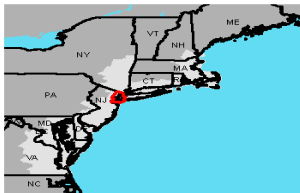


Widest
Extent of
Inundation

Hurricane Events
Category 1-4

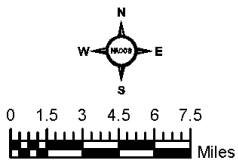
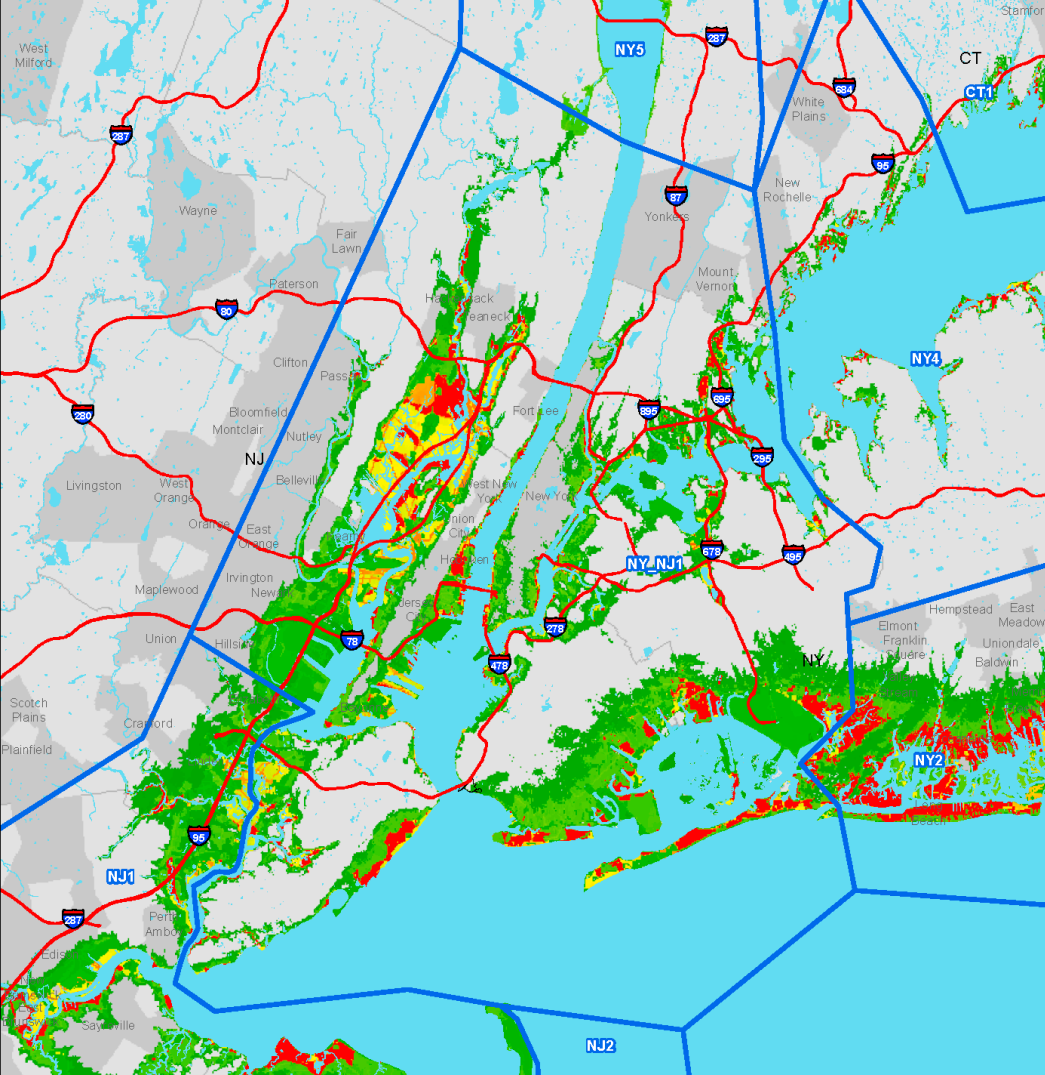


- Category 1 Maximum Water Level
- Category 2 Maximum Water Level
- Category 3 Maximum Water Level
- Category 4 Maximum Water Level
- Cities
- Interstate Highways
- NACCS Planning Reaches

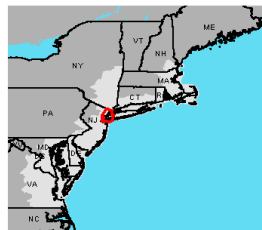


Coastal Risk Management Framework

Flood Exposure and Risk Assessment



- High Risk
- Low Risk
- Interstate Highway
- NACCs Planning Reach
- Military Installation
- Cities



This figure presents the results of the NACCs risk assessment completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.



Coastal Storm Risk Management Framework Future Sea Level Rise Scenarios

Sea level rise* evaluated for the years 2018, 2068, 2100** and 2118

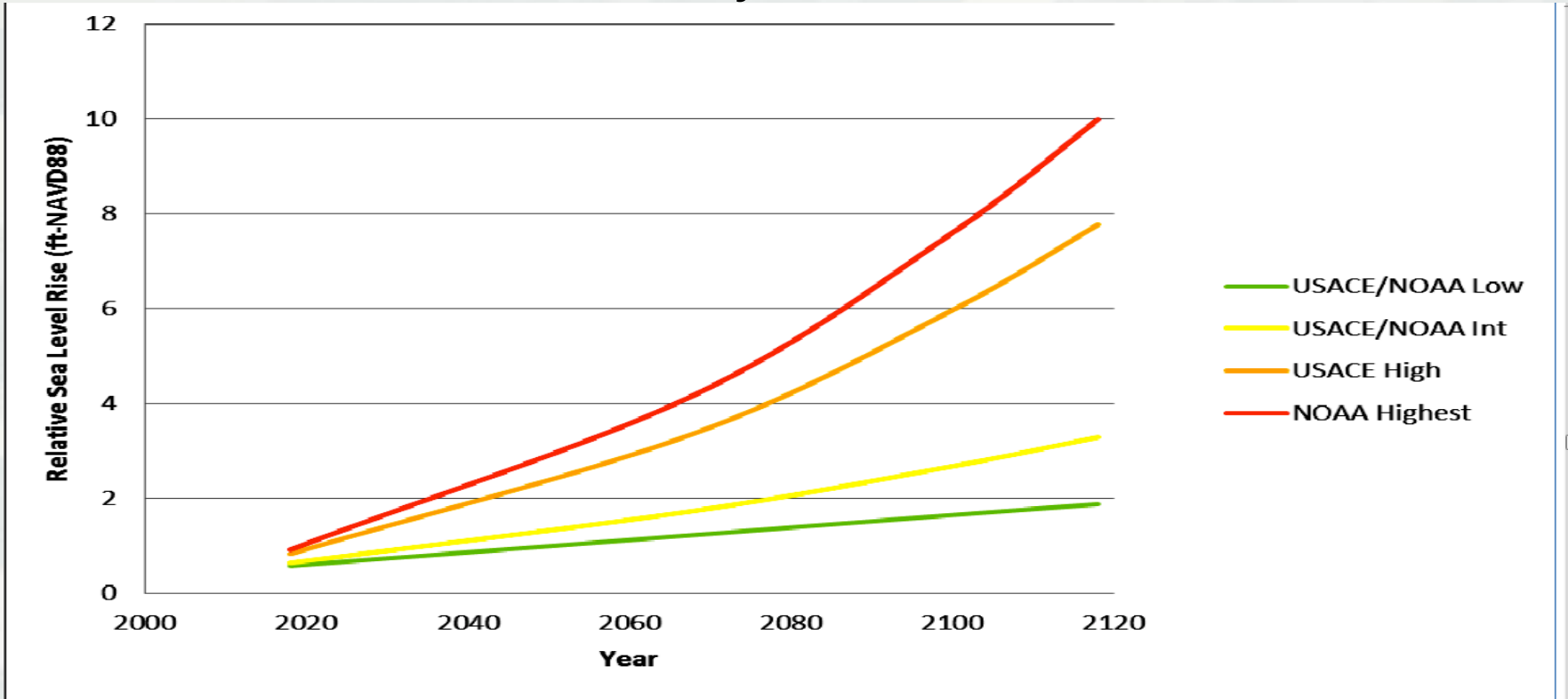


Figure V-1. Relative sea level rise for Sandy Hook, NJ for USACE and NOAA sea level change

* SLR evaluated using both USACE's Engineer Regulation (ER) 1100-2-8162 (low, intermediate high) and NOAA's highest SLR scenarios

** Intergovernmental Panel on Climate Change scenario



Coastal Storm Risk Management Framework:

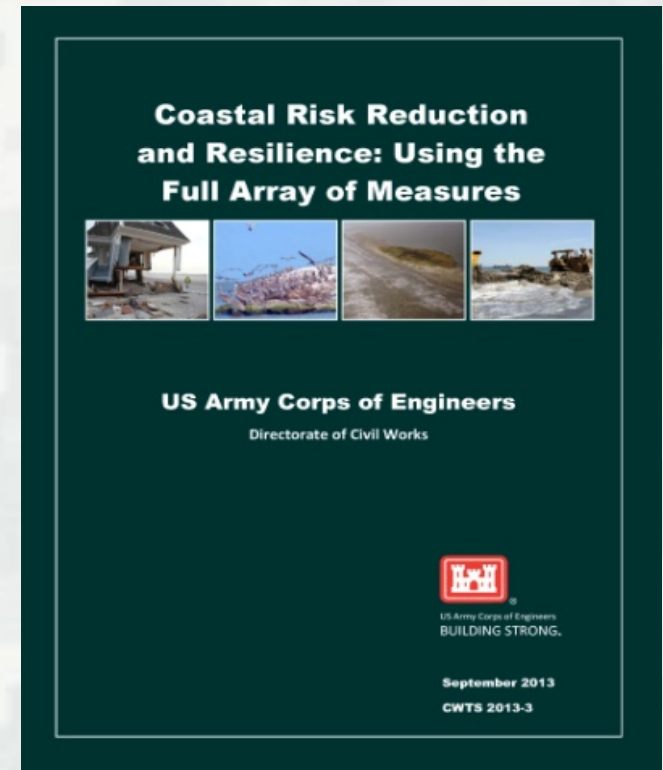
Risk Management Measures

➤ 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.)

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



Risk Reduction Nature-Based Solution Sets



Dunes and Beaches

Vegetated Features

Oyster and Coral Reefs

Barrier Islands

Maritime Forests/Shrub Communities

Benefits/Processes

- Breaking of offshore waves
- Attenuation of wave energy
- Slow inland water transfer

Benefits/Processes

- Breaking of offshore waves
- Attenuation of wave energy
- Slow inland water transfer
- Increased infiltration

Benefits/Processes

- Breaking of offshore waves
- Attenuation of wave energy
- Slow inland water transfer

Benefits/Processes

- Wave attenuation and/or dissipation
- Sediment stabilization

Benefits/Processes

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

Performance Factors

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

Performance Factors

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

Performance Factors

- Reef width, elevation, and roughness

Performance Factors

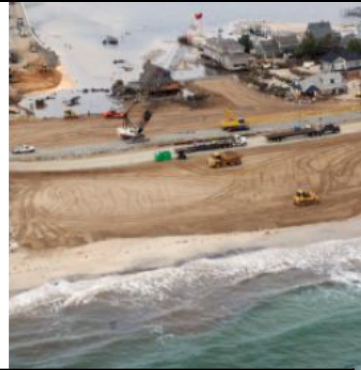
- Island elevation, length, and width
- Land cover
- Breach susceptibility
- Proximity to mainland shore

Performance Factors

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



Risk Reduction Structural Solution Sets



Levees

Storm Surge Barriers

Seawalls and Revetments

Groins

Detached Breakwaters

Benefits/Processes

- Surge and wave attenuation and/or dissipation
- Reduced flooding
- Reduced risk for vulnerable areas

Benefits/Processes

- Surge and wave attenuation
- Reduced salinity intrusion

Benefits/Processes

- Reduced flooding
- Reduced wave overtopping
- Shoreline stabilization behind structure

Benefits/Processes

- Shoreline stabilization

Benefits/Processes

- Shoreline stabilization behind structure
- Wave attenuation

Performance Factors

- Levee height, crest width, and slope
- Wave height and period
- Water level

Performance Factors

- Barrier height
- Wave height
- Wave period
- Water level

Performance Factors

- Wave height
- Wave period
- Water level
- Scour protection

Performance Factors

- Groin length, height, orientation, permeability, and spacing
- Depth at seaward end
- Wave height
- Water level
- Longshore transportation rates and distribution

Performance Factors

- Breakwater height and width
- Breakwater permeability, proximity to shoreline, orientation, and spacing



Risk Reduction Non-Structural Solution Sets



Floodplain Policy and Management

Benefits/Processes

- Improved and controlled floodplain development
- Reduced opportunity for damages
- Improved natural coast environment

Performance Factors

- Wave height
- Water level
- Storm duration
- Agency collaboration

Floodproofing and Impact Reduction

Benefits/Processes

- Reduced opportunity for damages
- Increased community resiliency
- No increase in flood potential elsewhere

Performance Factors

- Wave height
- Water level
- Storm duration

Flood Warning and Preparedness

Benefits/Processes

- Reduced opportunity for damages
- Increased community resiliency
- Improved public awareness and responsibility

Performance Factors

- Wave height
- Water level
- Storm duration

Relocation

Benefits/Processes

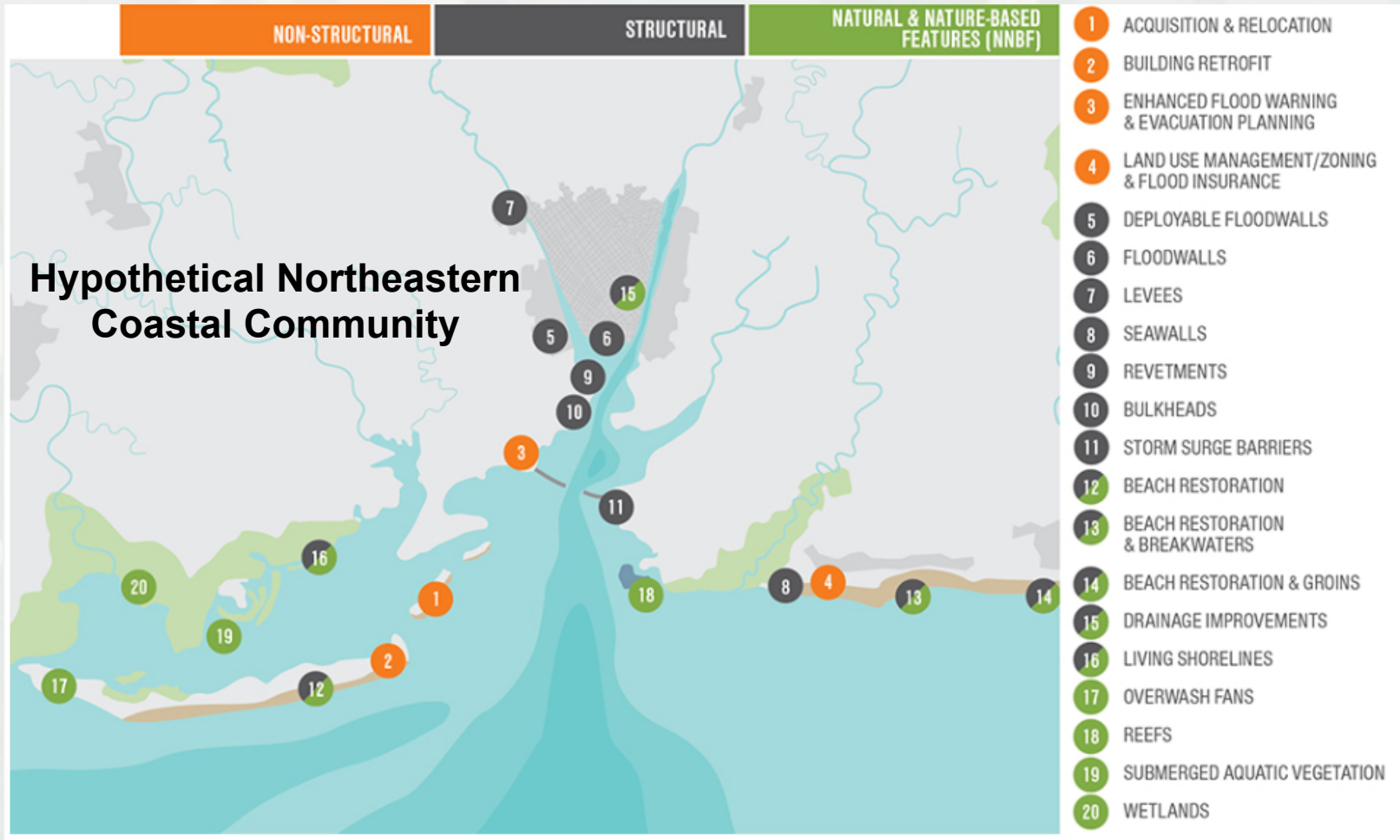
- Reduced opportunity for damages
- No increase in flood potential elsewhere
- Improved natural coast environment

Performance Factors

- Wave height
- Water level
- Storm duration



Full Portfolio of Measures



- Quantification of performance of natural and nature-based coastal storm risk management measures is a critical knowledge gap



Coastal Storm Risk Management Framework: Adaptation Planning Categories

➤ Preserve

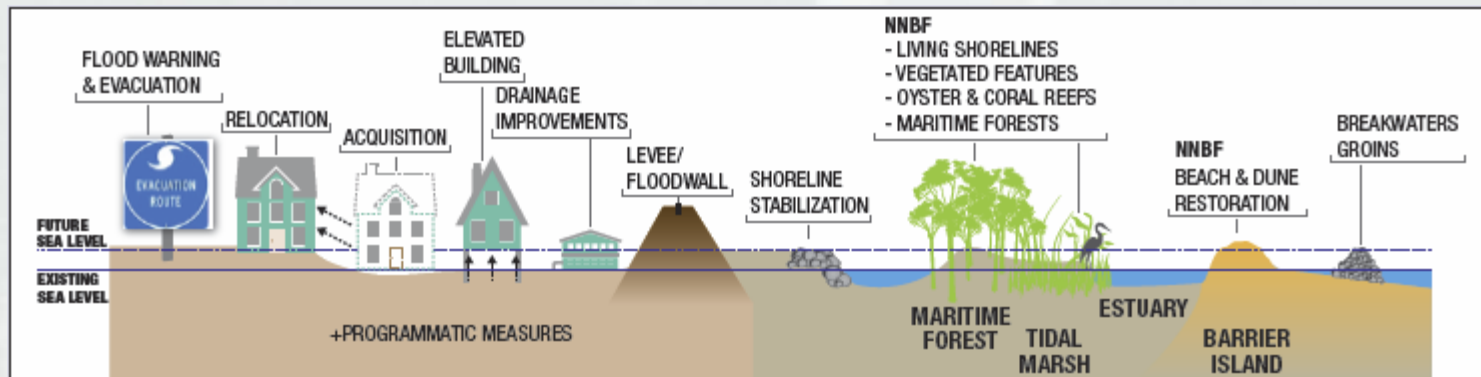
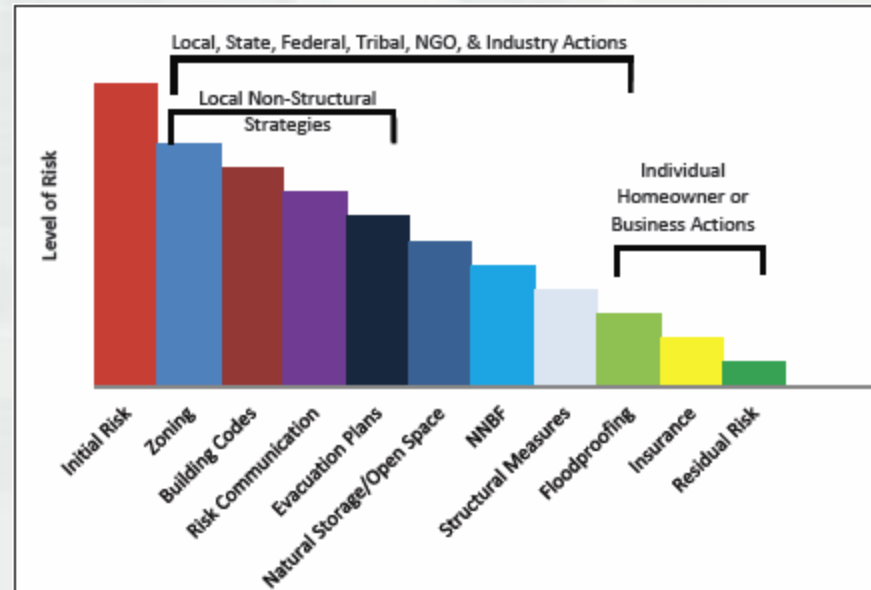
- Includes low regret measures to address current and future vulnerability

➤ Accommodate

- Adaptive capacity of the system

➤ Avoid

- Strategic retreat



NACCS Technical Products

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

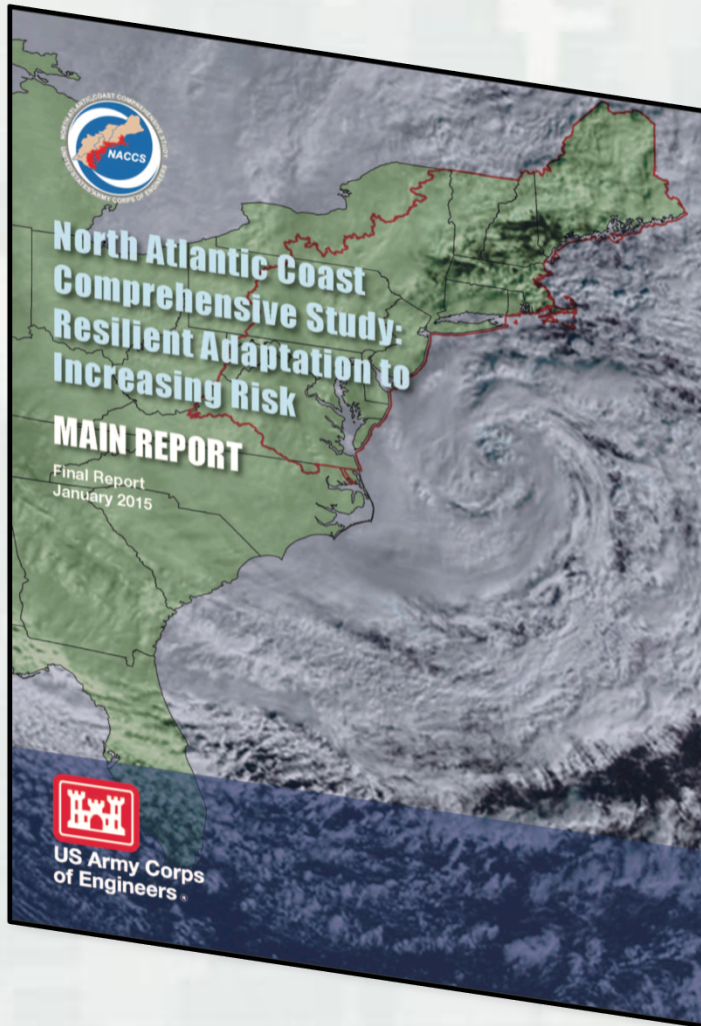
Several products, planning tools, and models were developed to assist decision makers utilizing and applying the Coastal Storm Risk Management Framework



NACCS Report

Technical Product Rollout

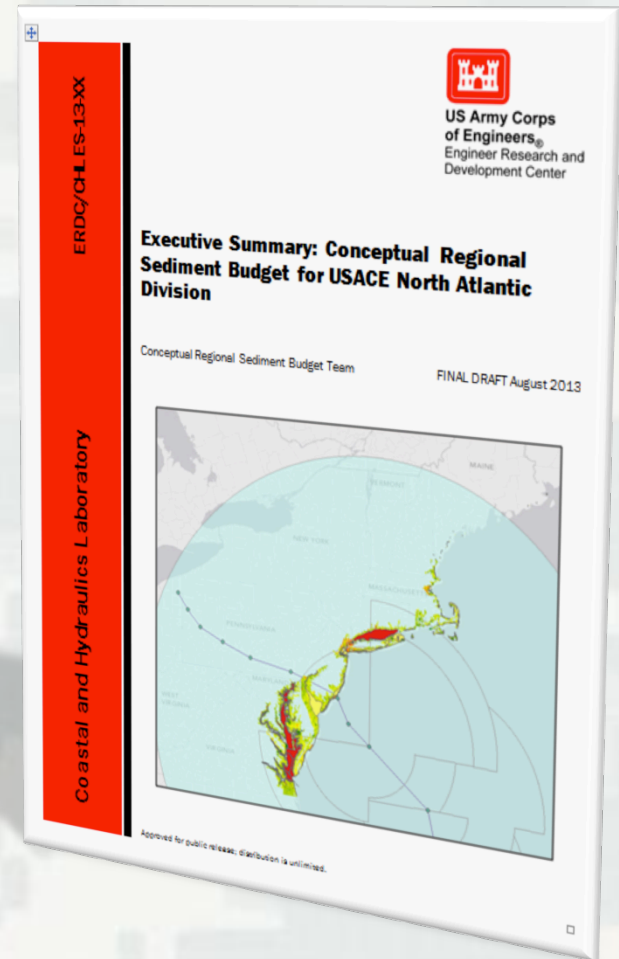
- Depth Damage Functions
- NACCS Conceptual Regional Sediment Budget
- Coastal Program Guide
- Environmental and Cultural Resources Report
- Numerical Modeling Database
- Institutional and Other Barriers Report
- Agency Communications and Collaboration Report
 - Visioning Sessions Documentation
- Website Animations
- Use of Natural and Nature-Based Features in Coastal Systems
- NACCS Extreme Water Levels



Technical Products Supporting the Framework

Conceptual Regional Sediment Budget

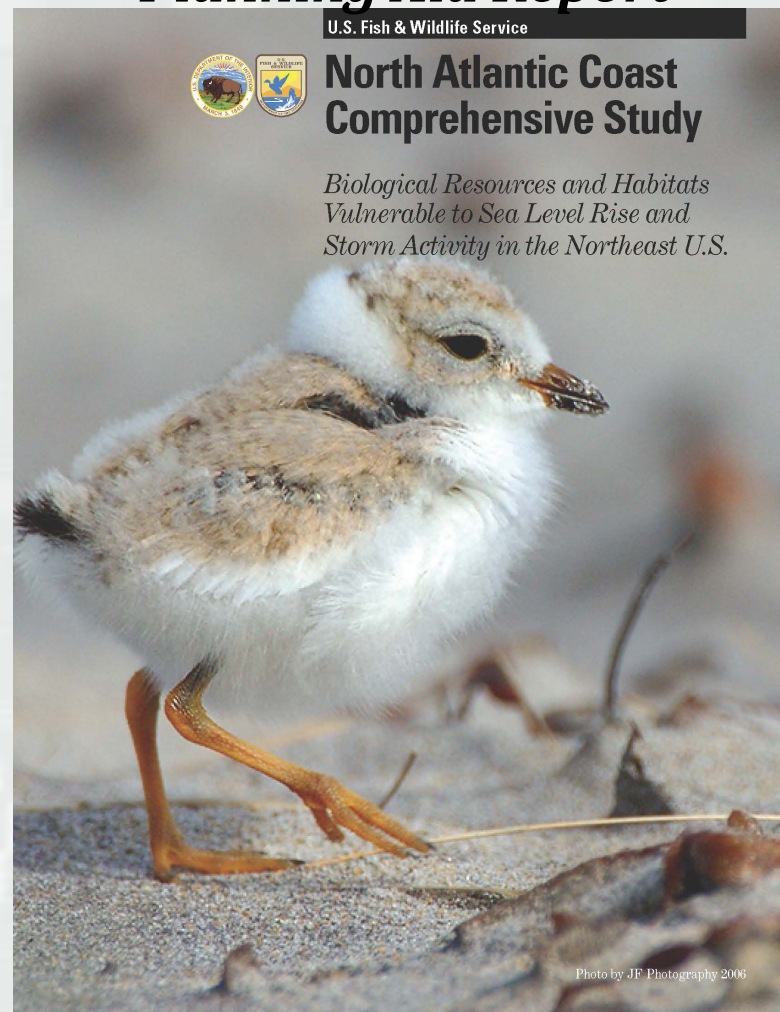
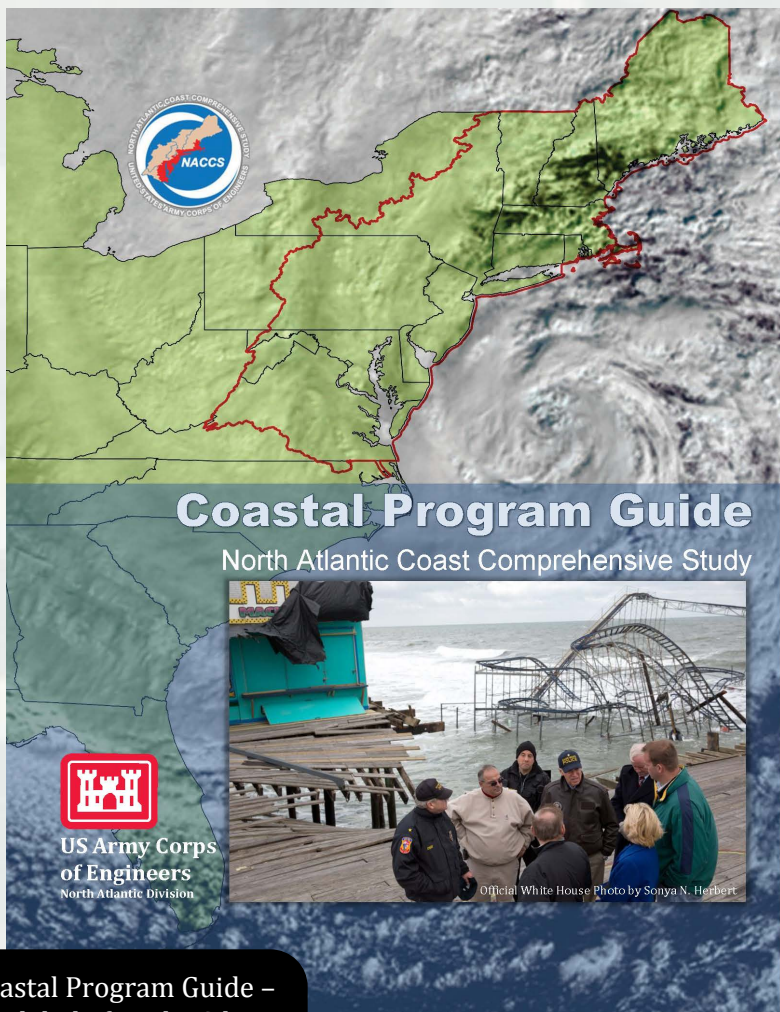
- Visualizes magnitude and direction of sediment transport
- Includes dredging data from Dredging Information System and placement site (if available)
- Based on existing knowledge or morphology
- Extends from Virginia to Maine
- Visualized in ERDC's Sediment Budget Analysis System Web Portal; overlain with Exposure/Risk/Vulnerability (ERV) database



Technical Products Supporting the Framework

Coastal Program Guide

US Fish and Wildlife Planning Aid Report



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



Coastal Storm Numerical Modeling

- ❑ Refine regional storm suites and storm surge, wave forces.
 - ❑ Waves and Water Levels for Risk Assessment and Design for future analysis and studies (historical and synthetic-hypothetical)
- ❑ Define the coastal storm probability space (tropical and extra-tropical) for the study area for coastal risk assessment and project design.
- ❑ CSTORM- DB will store storm parameters (water surface elevation, water and wind velocity, wave conditions) for future, more detailed studies, by the completion of the NACCS study (Jan 2015). Data will be available on the web.
- ❑ The product of this CSTORM-MS simulation work will serve the coastal engineering and management communities of practice from VA to ME for years to come.



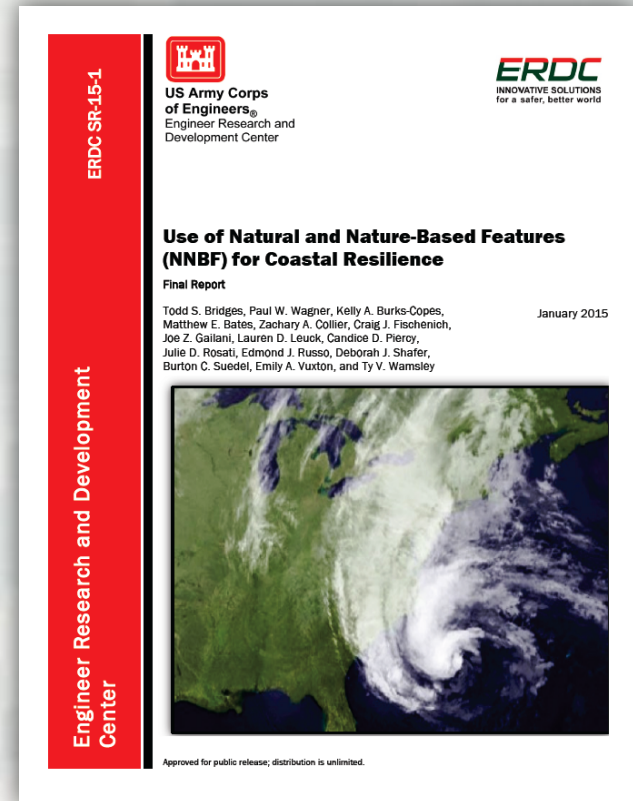
Technical Products Supporting the Use of NNBF to Promote Coastal Resiliency

Dr. Kelly A. Burks-Copes

Kelly.A.Burks-Copes@usace.army.mil

- What are NNBF and how can they contribute?
 - ▶ Characterization
 - ▶ Data Integration and Metrics for NNBFs
 - ▶ Evaluation and Case Studies
 - ▶ Policy Implications and Path Forward
- Get the entire report (480 pages):

- www.nad.usace.army.mil/CompStudy and/or
- www.EngineeringWithNature.org

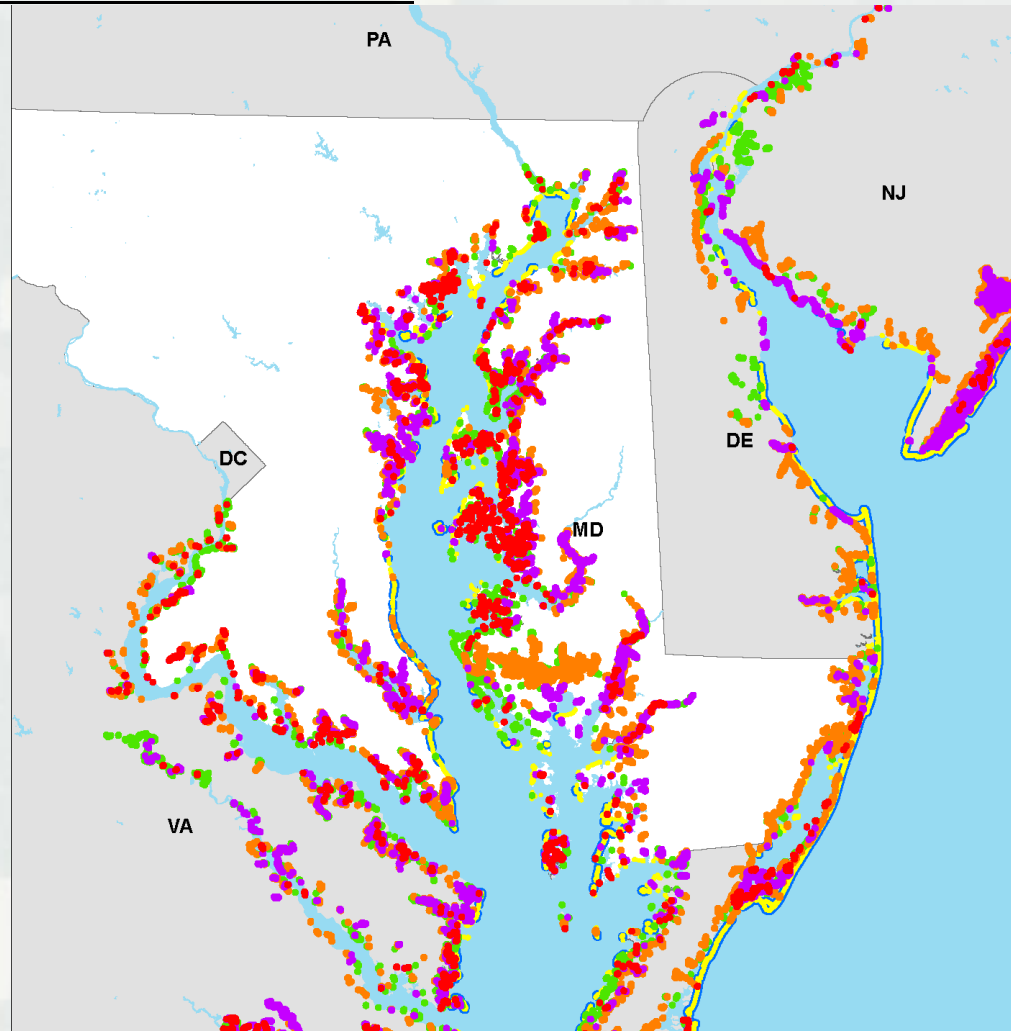


Coastal Storm Risk Management Framework:

Risk Management Measures

Natural and Nature-Based Features GIS Mapping

- Conceptual analysis of geographic applicability of NNBF measures
- Data layers and other screening criteria
 - NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, 2002)
 - Habitat type
 - Impervious cover
 - Water quality
 - Topography/bathymetry
- State appendix contains results



Opportunities: Coastal Resilience Integration

**9 Focus Areas
Integrated
Strategies**

FY16 President's Budget Request: NACCS Focus Areas New Start

USACE-Sponsor
Design and
Construction

USACE-Sponsor Feasibility Studies and/or Comprehensive Plans;

NACCS Products: Geospatial Database; Numerical Modeling of Extreme Water Levels; Economic Depth-Damage Functions; Environmental and Cultural Resources Conditions Report; Conceptual Regional Sediment Budget; Vulnerability, Resilience, Natural and Nature-Based Features Assessment and Metric Development

Regional Partnerships & Collaboration

Housing and Urban Development (HUD)

Northeast Regional Ocean Council (NROC)

Sandy Regional Infrastructure
Resilience Coordination (SRIRC)

Mid-Atlantic Regional Association
Coastal Ocean Observing System
(MARACOOS)

Northeastern Regional Association of
Coastal
Ocean Observing Systems (NERACOOS)

Department of Interior – NFWF Grants

Chesapeake Bay Resilience Co-Lead

Rebuild By Design and more...

**Integration of
Strategic
Coastal
Investments**

Ongoing USACE Activities

- *Vulnerability Assessments, Resilience and Climate Change Adaptation Planning
- *Technical Assistance to States and installations; Public-Private Partnership initiatives
- *Limited & General Reevaluation Reports
- *Continuing Authorities Program and Operation & Maintenance activities
- *Flood Control and Coastal Emergency projects
- *National Hurricane Program

ation

g & Planned Risk

tion

2013

2015

2020

2025

Measures to Increase Resilience

Prepare, Anticipate:

- Consider likely and rare future scenarios
- Establish early warning and evacuation plans
- Establish multiple evacuation routes
- Maintain/improve projects
- Educate state, local, individuals
- Evaluate weakest links in system and prepare to recover these areas rapidly
- Update resilience assessments

Adapt, Evolve, Transform,

'Bounce Forward':

- Modify evacuation and response plans
- Improve to reduce future damages
- Provide incentives for raising residential and critical infrastructure in vulnerable areas



Resist, Withstand:

- Ensure critical features are in good condition
- Relocate critical infrastructure as needed
- Monitor system performance and community response

Recover, Bounce Back:

- Repair damaged systems
- Assess and document system performance
- Implement mitigation measures and improvements



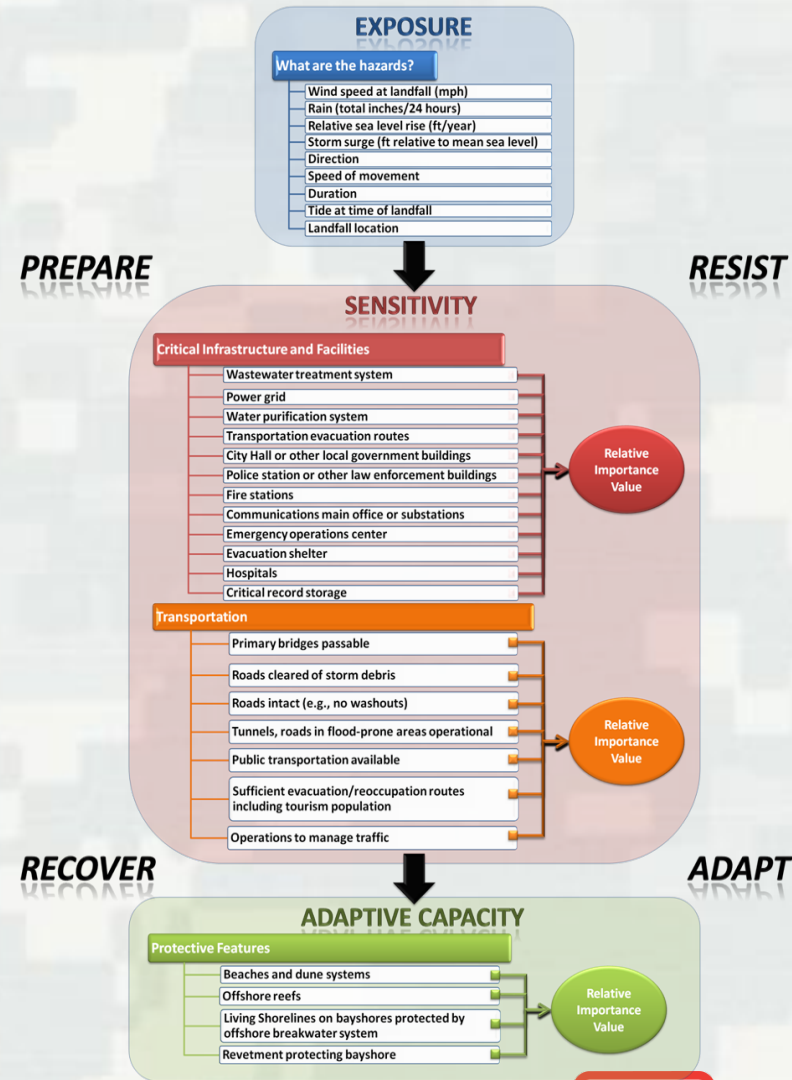
Systems Approach and Resilience

Capturing a Community's Sense of Vulnerability

➤ **Community resilience** is the capability to **anticipate** risk, **limit** impact, and **bounce back** rapidly through survival, adaptability, evolution, and growth in the face of turbulent change

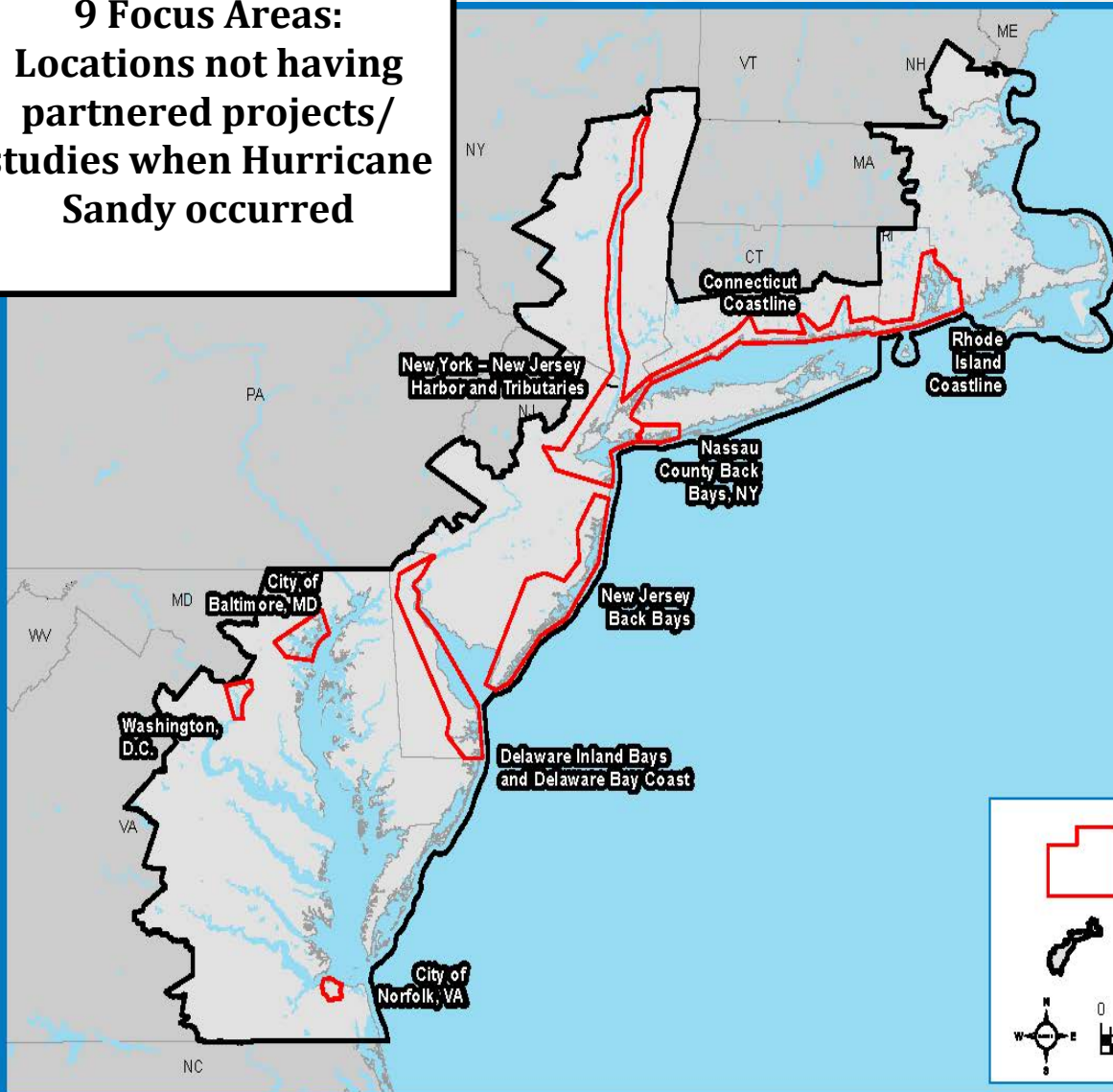
➤ **Self-Assessment Steps:**

1. Define spatial and temporal boundaries
2. Identify benchmark and future storms
3. Identify critical infrastructure and facilities and a recovery goal for each
4. Identify transportation issues
5. Identify protective features
6. Calculate the overall community resilience rating

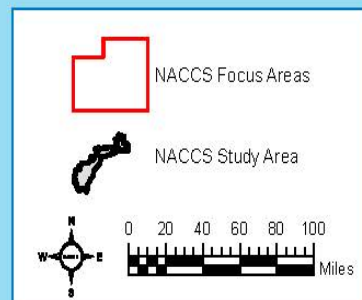


Future Opportunities: NACCS Focus Areas

**9 Focus Areas:
Locations not having
partnered projects/
studies when Hurricane
Sandy occurred**



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 Inland Bays and Delaware Bay Coast
7. City of Baltimore, MD
8. Washington, D.C.
9. City of Norfolk, VA



Summary

NACCS Saves Communities Time and Money when Planning for Resilient Adaptation to Increasing Risk!

- Consistent coastal framework – transferable
- Flood Risk Management Strategies and Measures
- New technical product/tools (closed data gaps)
- Integration with other stakeholders and *their* tools
- Able to be used by **all** (federal, state, regional, local, tribal, NGO, industry, academia, etc.)
- More robust, risk-informed decision-making



Challenge: Tough Choices



“Addressing these problems requires a paradigm shift in how we work, live, travel, and play in a sustainable manner as the extent of the area at very high risk of coastal storm damage expands.”

Preface

TOUGH CHOICES

The North Atlantic Coast is a dynamic environment that supports densely populated areas encompassing trillions of dollars of largely fixed public, private, and commercial investment. Hurricane Sandy made us acutely aware of our vulnerability to coastal storms and the potential for future, more devastating events due to changing sea levels and climate change. Changing sea levels represent an inexorable process causing numerous, significant water resource problems such as: increased, widespread flooding along the coast; changes in salinity gradients in estuarine areas that impact ecosystems; increased inundation at high tide; decreased capacity for stormwater drainage; and declining reliability of critical infrastructure services such as transportation, power, and communications. Addressing these problems requires a paradigm shift in how we work, live, travel, and play in a sustainable manner as the extent of the area at very high risk of coastal storm damage expands.

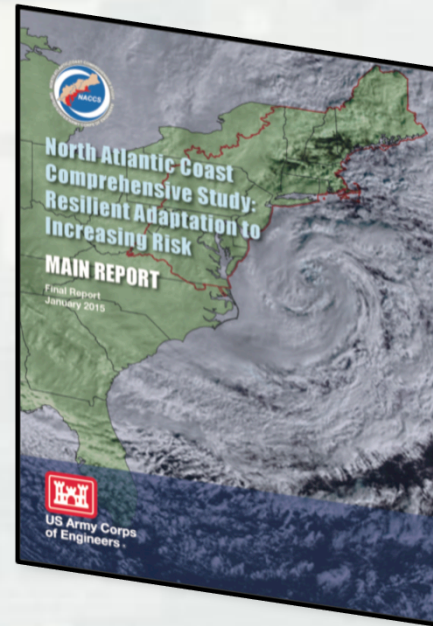


Challenge: Tough Choices

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“We have begun to take clues from communities and ecosystems, which have successfully developed over time to changing conditions, by expanding from traditional structural risk reduction measures to include more emphasis on nonstructural, natural, and nature-based systems.”

