Working with Nature in the Americas

Dr. Todd S. Bridges
Senior Research Scientist, Environmental Science

U.S. Army Engineer Research and Development Center,
U.S. Army Corps of Engineers
todd.s.bridges@usace.army.mil

PIANC World Congress
Panama City, Panama
5 May, 2018

U.S. ARMY

US Army Corps of Engineers®

ERDC
Engineer Research and Development Center

PIANC's *Working with Nature* Philosophy

- Developed as a position paper by PIANC's Environmental Commission in 2008
  - ► Supported by CEDA and IADC
- Endorsed by PIANC Executive Committee
- Aims to provide a practical framework for sustainable navigation infrastructure development

PIANC Position Paper

'Working with Nature'

October 2008; revised January 2011

What do we mean by '**Working with Nature**'?

Maximising opportunities; reducing frustrations. **Working with Nature** is an integrated process which involves working to identify and exploit win-win solutions which respect nature and are acceptable to both project proponents and environmental stakeholders. It is a philosophy which needs to be applied early in a project[1] when flexibility is still possible. By adopting a determined and proactive approach from conception through to project completion, opportunities can be maximised and - importantly - frustrations, delays and associated extra costs can be reduced.

1900-2000:
The Century of Infrastructure (US)

- 4,071,000 miles of roadway
  - 47,182 miles in the Interstate system
- 149,136 miles of mainline rail
- 640,000 miles of high-voltage transmission lines
- 614,387 bridges
- 90,580 dams
- 155,000 public drinking water systems
- 4,500 military installations
- 926 ports

Cuyahoga River; Cleveland, OH

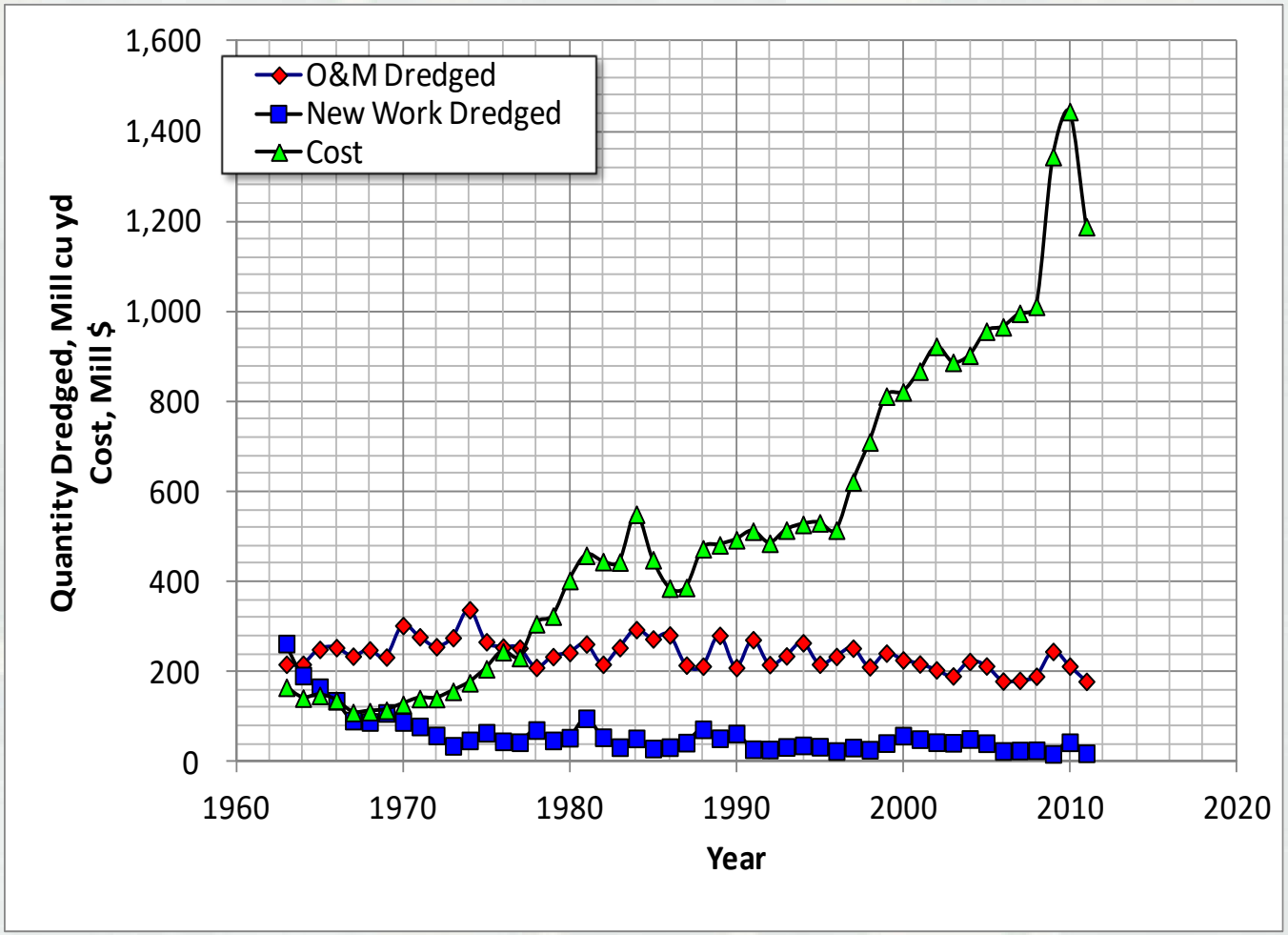
The 1970's: The Decade of Environmental Law and Regulation

- National Environmental Policy Act of 1969
- Clean Water Act 1972
- Marine Protection, Research, and Sanctuaries Act of 1972
- Coastal Zone Management Act of 1972
- Endangered Species Act of 1973
- Resource Conservation and Recovery Act of 1976
- Comprehensive Environmental Response, Compensation and Liability Act of 1980

USACE Infrastructure

- 25,000 miles of navigation channel
  - Supporting 926 ports
- 707 dams
  - 75 hydroelectric power facilities
  - 55,390 miles of shoreline
- 14,500 miles of flood levee
- 236 lock chambers at 192 lock sites
- 929 navigation structures
- 844 bridges

The Escalating Costs of Dredging



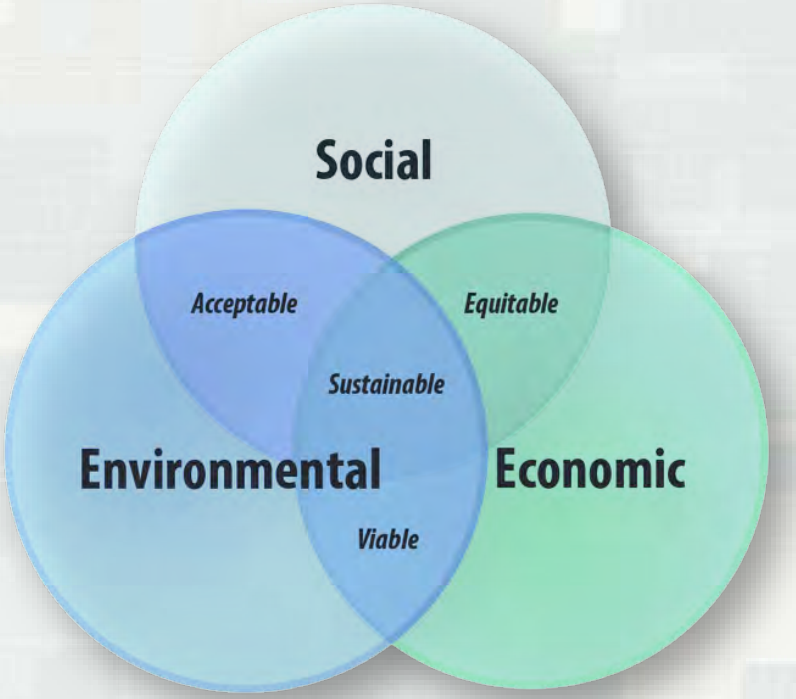

SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

U.S.ARMY

ERDC

Sustainability

Sustainability is achieved by efficiently investing resources to create present and future value



A “Sustainability Ledger” for Sediment Management

Efficiency

- Reducing sedimentation in channels & reservoirs
- Reducing transport distances for dredged material
- Reducing dredging time
- Expanding operational flexibility
- Linking multiple projects

Value Creation

- Restoring natural sediment processes to sustain landscapes
- New nature-based features that reduce flood risks
- New habitat for fish and wildlife
- New features that provide recreational and other social value
- Budget space for additional infrastructure work

Engineering With Nature®

…the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaborative processes.

Key Elements:

- Science and engineering that produces operational efficiencies
- Using natural process to maximum benefit
- Broaden and extend the benefits provided by projects
- Science-based collaborative processes to organize and focus interests, stakeholders, and partners

EWN® Across USACE Mission Space

- Navigation
  - Strategic placement of dredged material supporting habitat development
  - Habitat integrated into structures
  - Enhanced Natural Recovery
- Flood Risk Management
  - Natural and Nature-Based Features to support coastal resilience
  - Levee setbacks
- Ecosystem Restoration
  - Ecosystem services supporting engineering function
  - “Natural” development of designed features
- Water Operations
  - Shoreline stabilization using native plants
  - Environmental flows and connectivity

U.S.ARMY

ERDC

Value and Use of Natural Systems

Following Hurricane Sandy:

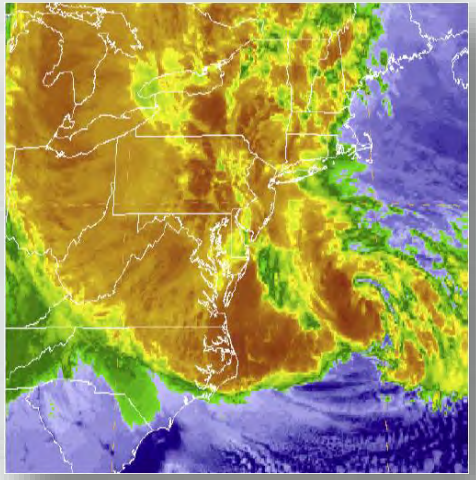
- Risk industry-based tools used to quantify the economic benefits of coastal wetlands
  - Temperate coastal wetlands saved more than $625 million in flood damages.
  - In Ocean County, New Jersey, salt marsh conservation can significantly reduce average annual flood losses by more than 20%.

COASTAL WETLANDS AND FLOOD DAMAGE REDUCTION

Using Risk Industry-based Models
to Assess Natural Defenses in the Northeastern USA

October 2016

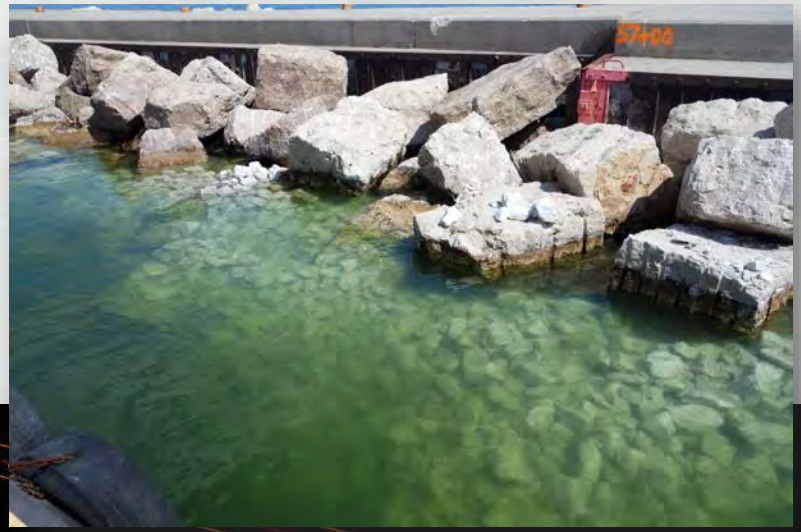
UNIVERSITY OF CALIFORNIA SANTA CRUZ · The Nature Conservancy · Wildlife Conservation Society · LLOYD'S TERCENTENARY RESEARCH FOUNDATION

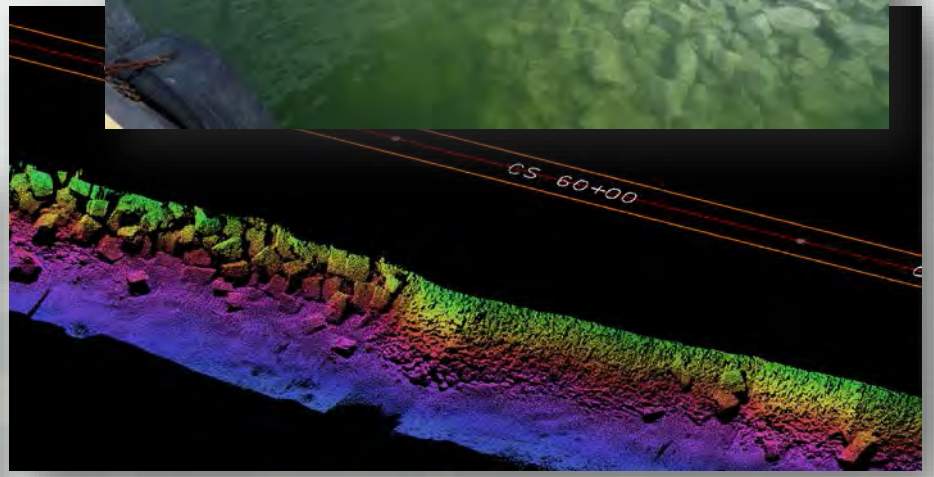


Enhancing Existing Infrastructure

Ashtabula Harbor

Milwaukee Harbor





U.S.ARMY

ERDC

Enhancing Ecosystem Value

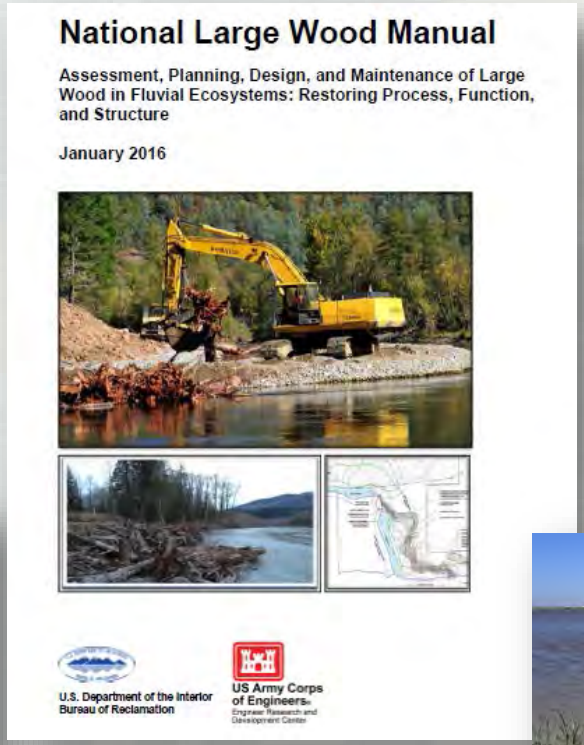
Upper Mississippi River Training Structures: Chevrons

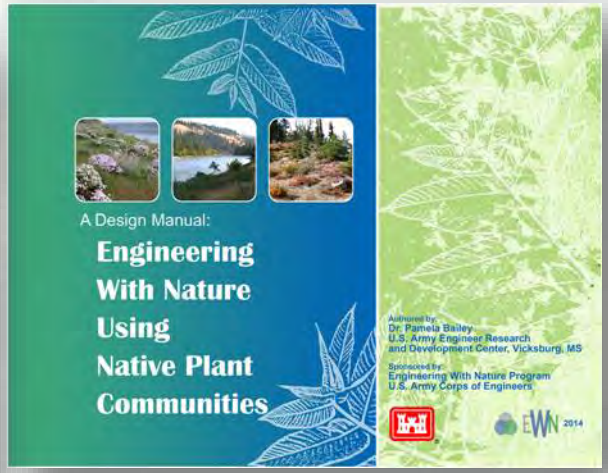
Loosahatchie Bar, Memphis

EWN at Soo Locks

ERDC

Engineering with Natural Materials





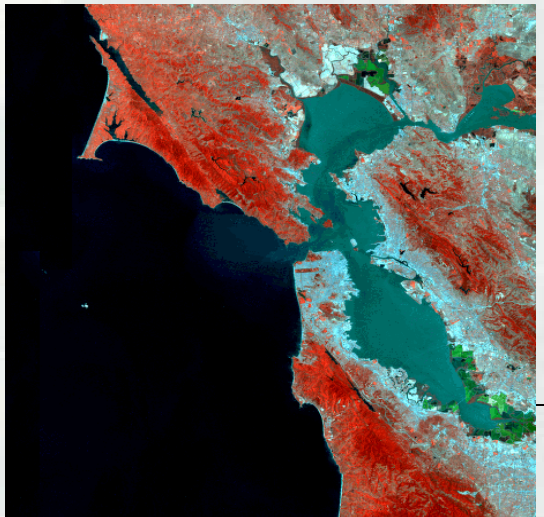
www.engineeringwithnature.org

ERDC

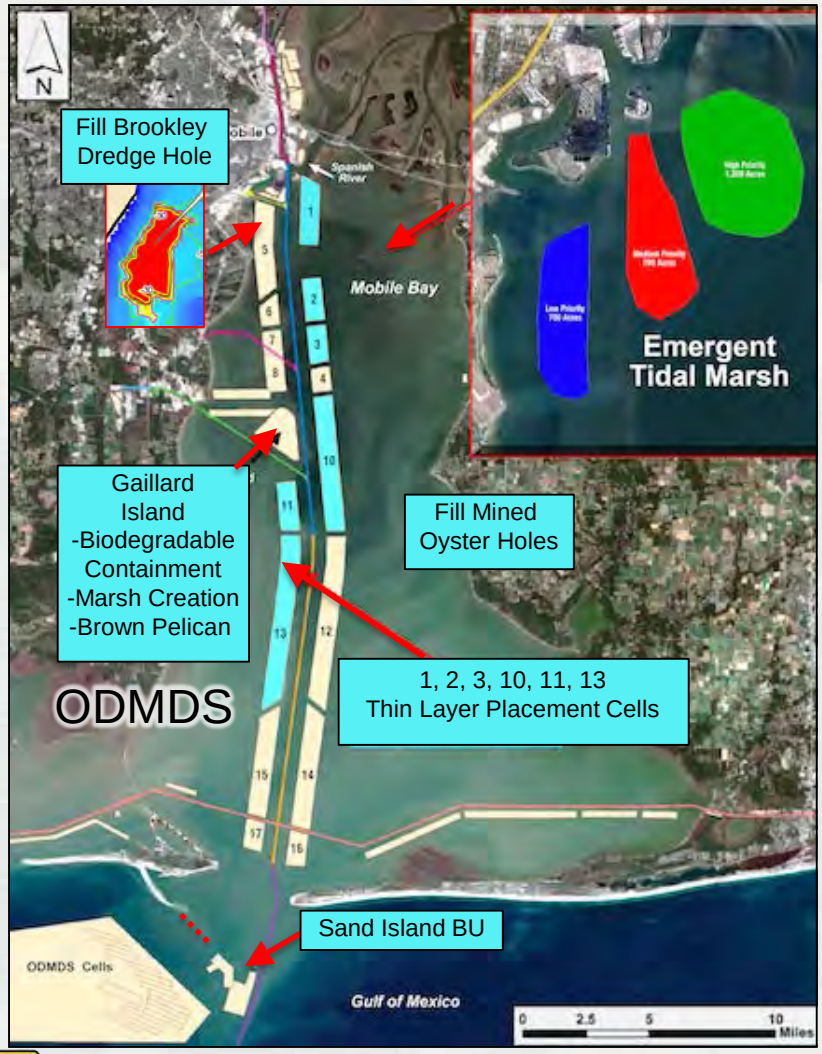
BUILDING STRONG®

Innovative solutions for a safer, better world

Hamilton and Sears Point Wetlands
San Pablo Bay, CA



Mobile Bay, AL



WRDA86:

Place all dredged sediments in ODMDS
- 4.0 Mcy/yr, Hopper Dredge, 20-Miles
- Tripled maintenance costs

2014 Decision reversed
- ERDC Tools and Technologies
- RSM Interagency Work Group

$12M annual value

Thin Layer Placement in Mobile Bay

Sand Island Beneficial Use Area (SIBUA)
- -Downdrift benefits to Dauphin Island
- -Protect lighthouse

Fill dredge holes
- -Brookley Hole, Oyster Holes

Gaillard Island
- - Biodegradable Containment
- - Marsh Creation
- - Brown Pelican

Future in-Bay placement:

Thin Layer Placement
- -1000 acre emergent marsh

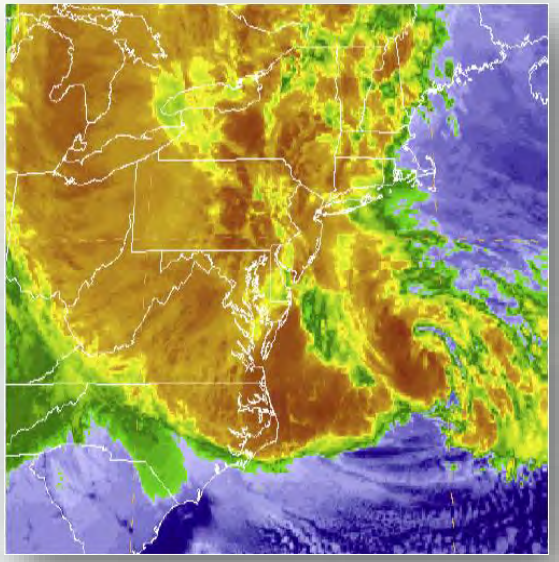
Horseshoe Bend Island, Atchafalaya River

- Options for managing DM via shore-based wetland creation were exhausted
- Strategic placement of sediment (0.5-1.8 mcy/1-3 yrs) was used to create a ~35 ha island
- Producing significant environmental and engineering benefits
- Project Awards:
  - 2015 WEDA Award for Environmental Excellence
  - 2017 WEDA Award for CC Adaption
  - 2017 DPC Award for Working, Building, and Engineering with Nature

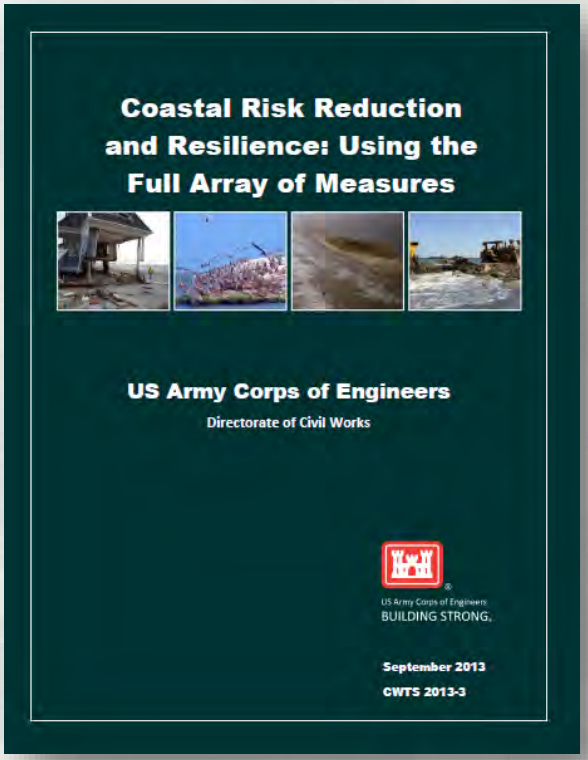
Hurricane Sandy

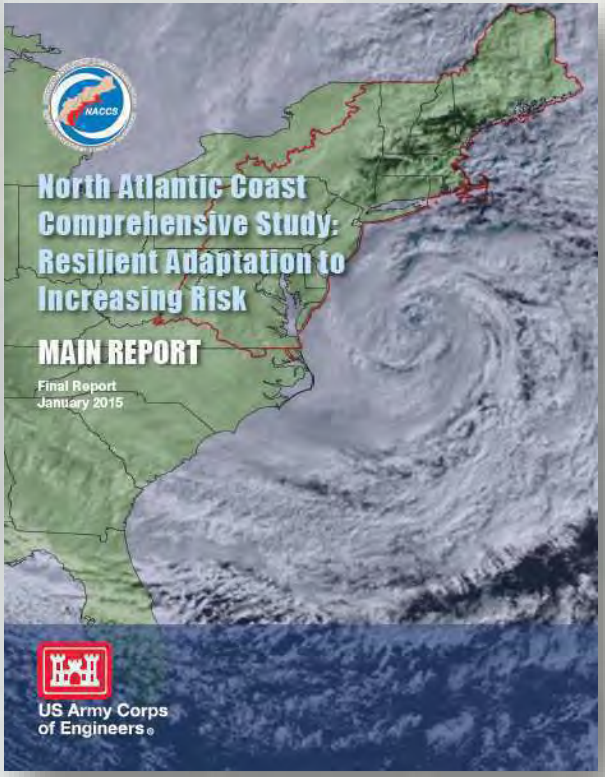
Storm Impacts and Damages: 22-29 October 2012

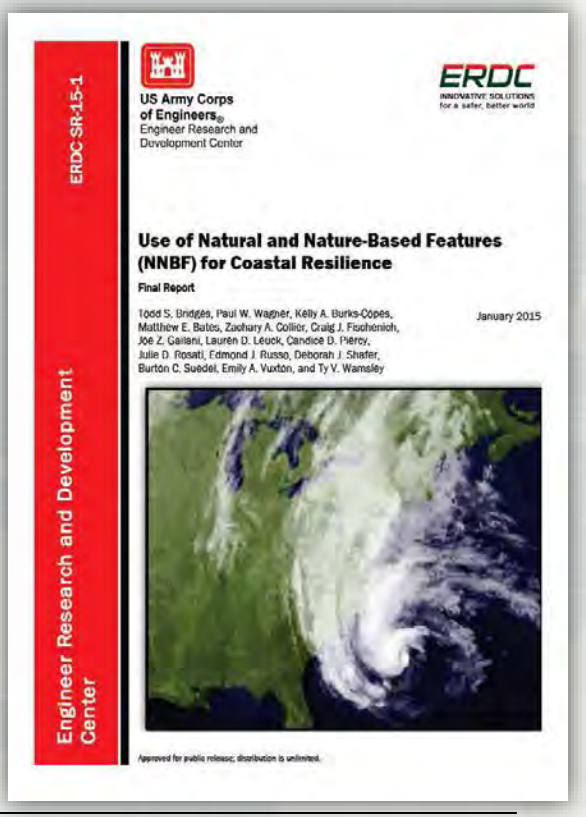
- **Human**
  - 286 people killed (159 in the US)
  - 500,000 people affected by mandatory evacuations
  - 20,000 people required temporary shelter
  - Extensive community dislocations – continuing today in some areas
- **Economic**
  - $65B in damages in the U.S.
  - 26 states affected (10 states and D.C are in the NACCS study area)
  - 650,000 houses damaged or destroyed



The North Atlantic Coast Comprehensive Study







http://www.nad.usace.army.mil/CompStudy

Engineering Performance: Nature-Based Features Work in Different Ways

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

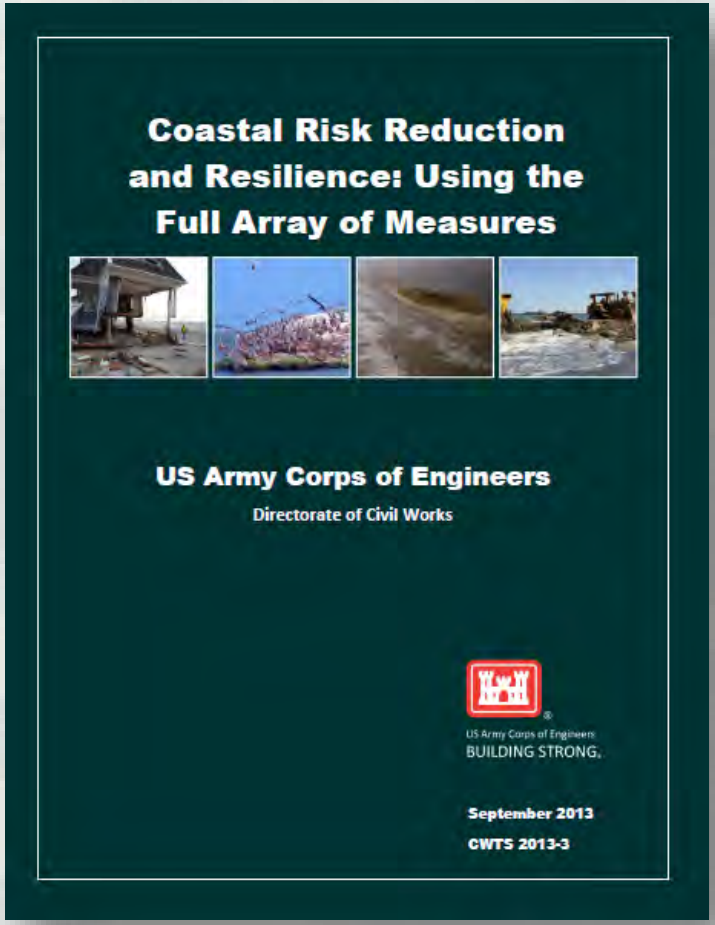
Forest dimension

Sediment composition

Platform elevation

Resilience Through Integrated Solutions

"The USACE planning approach supports an integrated strategy for reducing coastal risks and increasing human and ecosystem community resilience through a combination of the full array of measures: natural, nature-based, nonstructural, and structural. This approach considers the engineering attributes of the component features and the dependencies and interactions among these features over both the short and long term. It also considers the full range of environmental and social benefits produced by the component features."



Coastal Risk Reduction and Resilience. Todd Bridges, Roselle Henn, Shawn Komlos, Debby Scerno, Ty Wamsley, and Kate White. CWTS 2013-3. Washington, DC: Directorate of Civil Works, US Army Corps of Engineers.

http://www.nad.usace.army.mil/CompStudy

USACE Philadelphia District: Back Bay EWN

Mordecai Island

Stone Harbor

Avalon

BUILDING STRONG®

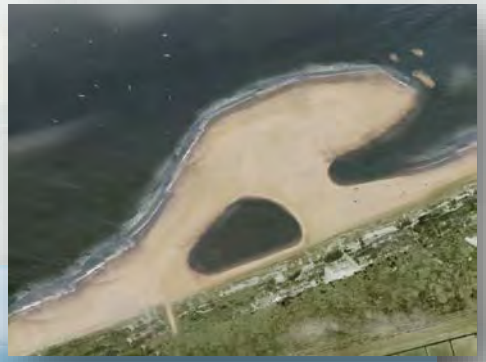
Innovative solutions for a safer, better world

Wave Attenuation by Vegetation

Mary Bryant

Dutch Sand Motor

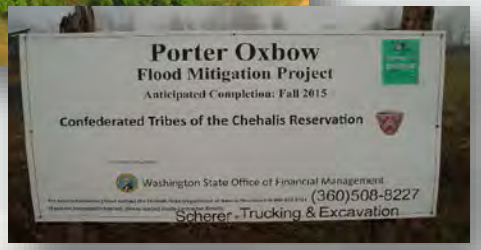
- 2011 construction
- 21.5 mcm of sand



U.S.ARMY

ERDC

Chehalis Basin Floodplain Restoration



U.S.ARMY

RAMBOLL ENVIRON

THE CHEHALIS TRIBE

BUILDING STRONG®

Collaboration with Federal Agencies

USACE – NOAA Collaboration Workshop: Natural and Nature-Based Features, Charleston, SC; 1-3 March 2016

USACE/NOAA-NMFS Collaboration Workshop Engineering With Nature, Gloucester, MA; October 5-6, 2016

www.engineeringwithnature.org (NNBF)

Collaboration with the Private Sector: Caterpillar Inc.

- Restoring Natural Infrastructure Summit; November 4th, 2015; New York City
- Natural Infrastructure Initiative – USACE Collaboration Work Streams
  1. NI Opportunity Evaluation Tool. Capitalizing on enterprise-level capability: CE Dredge DST
  2. Evaluation and Decision Making
  3. Field Application and Demonstration

ERDC

http://www.caterpillar.com/en/company/sustainability/natural-infrastructure.html

Coastal Science and Engineering Collaborative: Texas A&M *Engineering With Nature*® Curriculum

- Collaborating with Texas A&M to develop graduate curriculum in Engineering With Nature
- Spring 2018 Engineering With Nature Seminar
  - OCEN 485/685 Engineering With Nature
  - The course is scheduled for Mondays, 12:40 to 13:30. Jan 22 -- May 7

EWN and Landscape Architecture Research Collaboration

Producing Efficiencies

Exploring ways to incorporate natural infrastructure into projects (potential to reduce construction/repair cost), reduced mitigation cost, increase beneficial use of dredge material, etc.

Using Natural Processes

Increase vegetation in project master plans – improve water quality, flow characteristics, and flood storage; improve air quality; reduce urban heat through shading.

Broadening Benefits

Improved ecosystem sustainability; improved hazard mitigation; increased recreational, cultural and educational opportunities.

Promoting Collaboration

SWG, ERDC, Cornell, Auburn, USACE LA COP, and Members of Dredging Research Collaborative (DRC).

R&D: Social benefits and metrics produced by projects. Document follow-up underway in Coastal Texas Protection and Restoration Feasibility Study; incorporating EWN/LA into Existing Infrastructure.

ERDC

International Guidelines on the Use of Natural and Nature-Based Features for Sustainable Coastal and Fluvial Systems

Purpose: Develop guidelines for using NNBF to provide engineering functions relevant to flood risk management while producing additional economic, environmental and social benefits.

- Publish NNBF technical guidelines by 2020:
  - Multi-author: government, academia, NGOs, engineering firms, construction companies, etc.
  - Addressing the full project life cycle
  - Guidelines in 4 Parts
    - Overarching
    - Coastal Applications
    - Fluvial Applications
    - Conclusions

Toward Sustainable Infrastructure

- Opportunities to scale-up progress?
- How leverage partnerships across sectors and interests?
- How to consider the diverse benefits provided projects and systems?
- How to evaluate, design for and adaptively manage the engineering performance of projects
- What form of guidance is needed for different functional areas?
- How to incentivize, institutionalize and codify progress?

How sustainability gets done: humans working with other humans, across organizational boundaries, to co-develop solutions.

1906 San Francisco Earthquake

Agnews State Hospital, 1906