



NATURAL INFRASTRUCTURE: PAST, PRESENT AND FUTURE

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US Army Corps
of Engineers



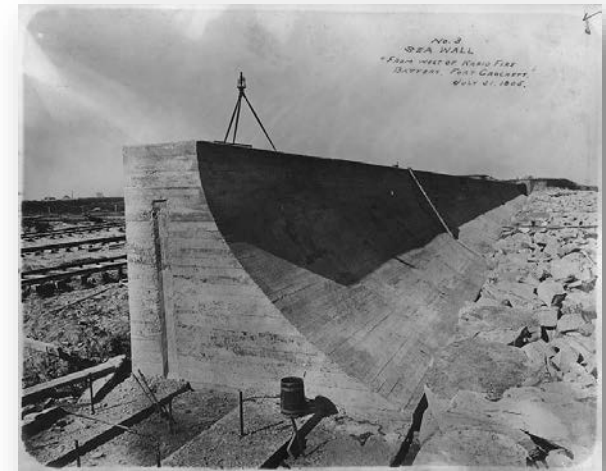
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HARD LESSONS FROM THE PAST



Galveston Hurricane (1900)

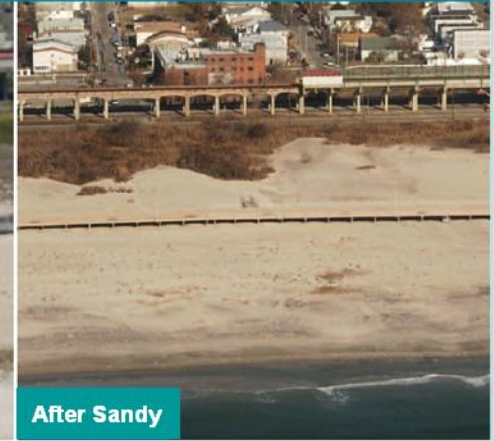
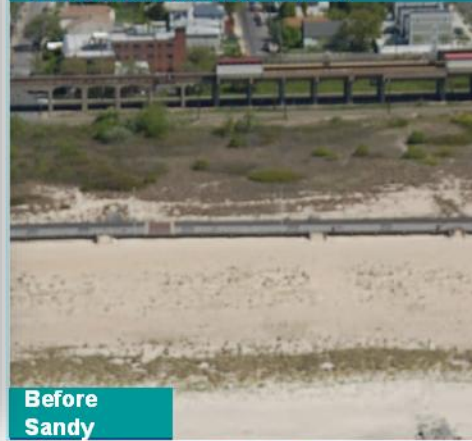
- Landfall 8 September 1900
- Estimated Category 4 Hurricane
 - ▶ 145 mph winds
- Estimated death toll: 6,000-12,000
- Galveston Seawall
 - ▶ Constructed: 1902-1963
 - ▶ >10 miles long



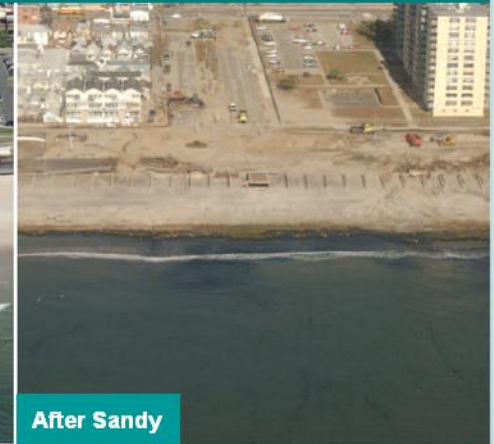
NATURE-BASED FEATURES PERFORM DURING HURRICANE SANDY



Dune Protection on the Rockaway Peninsula
With Dune (Beach 56th Street)



Without Dune (Beach 94th Street)



<http://www.nyc.gov/html/sirr/html/report/report.shtml>

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CREATING VALUE THROUGH ALIGNMENT...

- What opportunities are there to achieve better alignment of natural and engineered systems?
 - Can improved alignment reduce risks to life, property and ecosystems?
 - What range of services can be produced through such alignment?
 - What are the science and engineering needs in order to achieve better alignment?



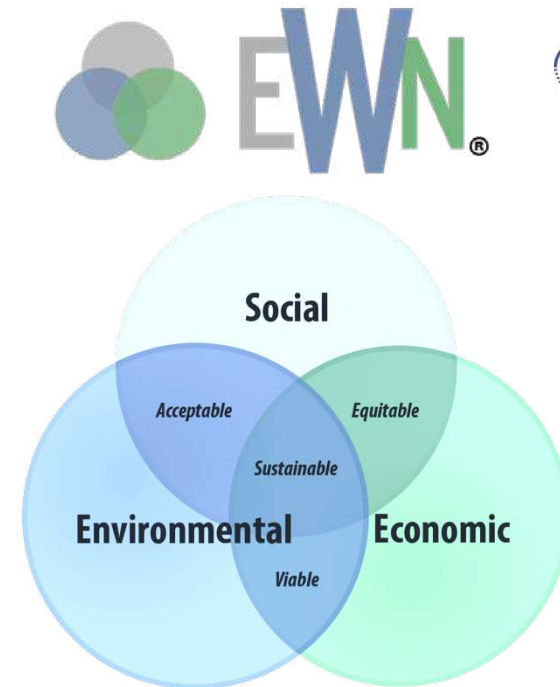
Sustainable Solutions Vision: “Contribute to the strength of the Nation through innovative and environmentally sustainable solutions to the Nation’s water resources challenges.”

Engineering With Nature®

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

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



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EWN[®] OVERVIEW

Engineering With Nature[®] initiative started within the USACE Civil Works program in 2010

- Engaging across USACE Districts (23), Divisions, HQ; other agencies, NGOs, academia, private sector, international collaborators
 - Workshops (>20), dialogue sessions, project development teams, etc.
- Guided by a strategic plan
- Informed by focused R&D
- Demonstrated with field projects
- Advanced through partnering
- Shared by strategic communications
- Marking progress
 - 2013 Chief of Engineers Environmental Award in Natural Resources Conservation
 - 2014 USACE National Award-Green Innovation
 - 2015, 2017 WEDA Awards; 2017 DPC Award



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EWN[®] ACROSS USACE MISSION SPACE

Navigation

- Strategic placement of dredged material supporting habitat development
- Habitat integrated into structures
- Enhanced Natural Recovery

Flood Risk Management

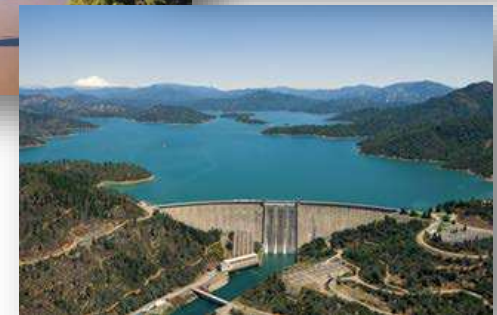
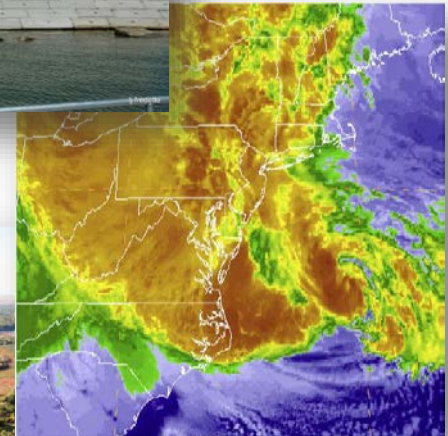
- Natural and Nature-Based Features to support FRM
- Levee setbacks

Ecosystem Restoration

- Ecosystem services supporting engineering function
- “Natural” development of designed features

Water Operations

- Shoreline stabilization using native plants
- Environmental flows and connectivity



NATURAL AND NATURE-BASED FEATURES

NNBF are landscape features that are developed to provide engineering functions relevant to flood risk management while producing additional economic, environmental and social benefits.



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

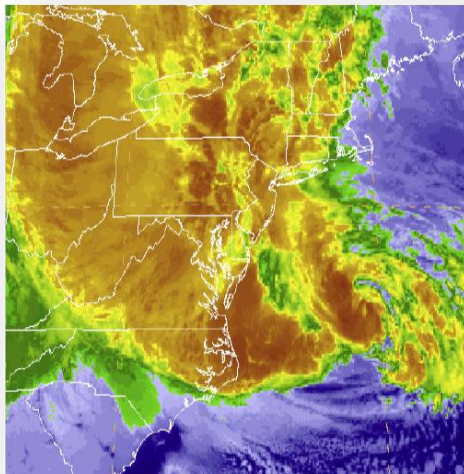
Benefits/Processes
Wave attenuation and/or dissipation
Shoreline erosion stabilization
Soil retention

Performance Factors
Vegetation height and density
Forest dimension
Sediment composition
Platform elevation

LEVERAGING NATURE FOR ENGINEERING VALUE

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



The Nature Conservancy



LLOYDS
TERCENTENARY
RESEARCH
FOUNDATION

ONEHUNGA BAY FORESHORE RESTORATION AUCKLAND, NEW ZEALAND



USACE PHILADELPHIA DISTRICT: EWN IN BACK BAY NEW JERSEY



Mordecai Island

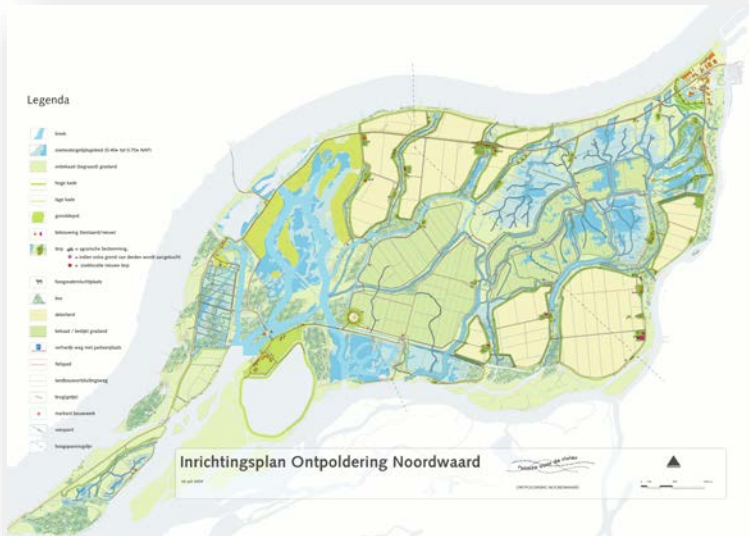


Stone Harbor



Avalon

NOORDWAARD



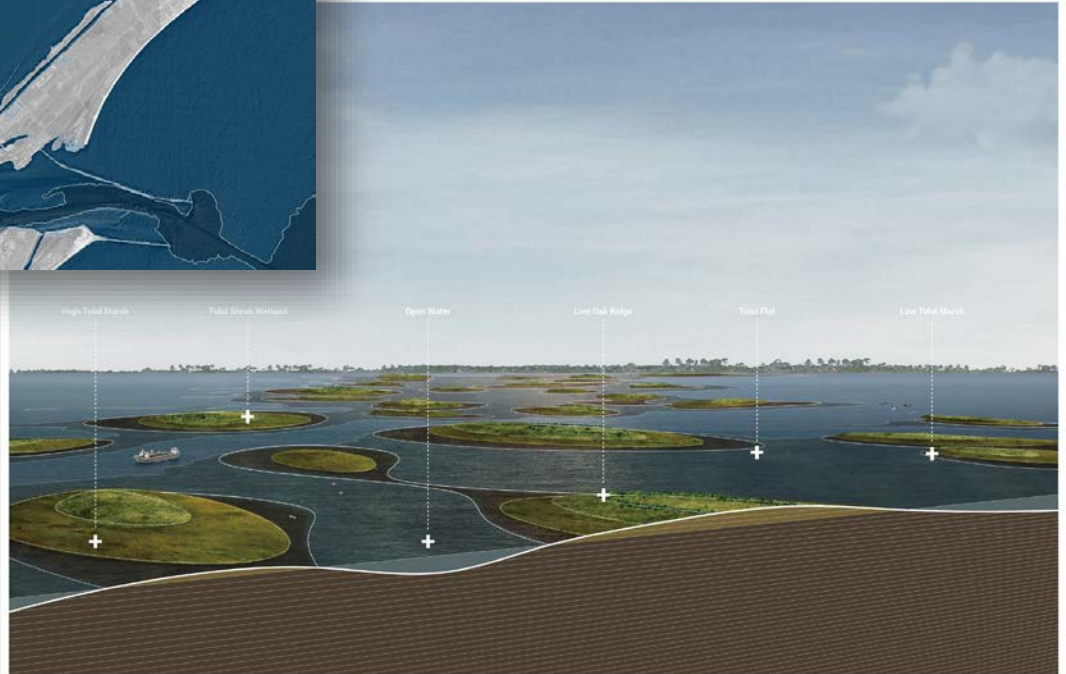
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HORSESHOE BEND ISLAND, ATCHAFALAYA RIVER

- 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



PLAN AND CREATE FOR YOUR FUTURE

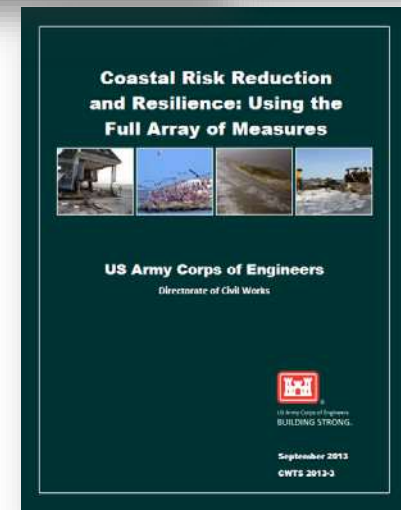
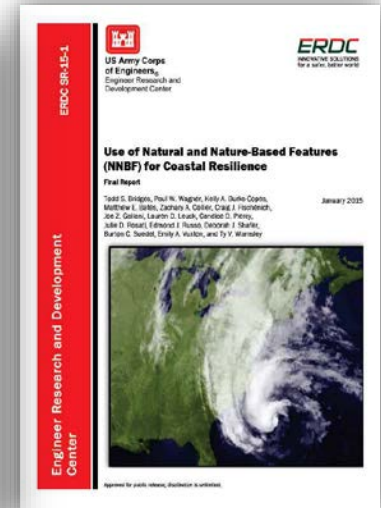
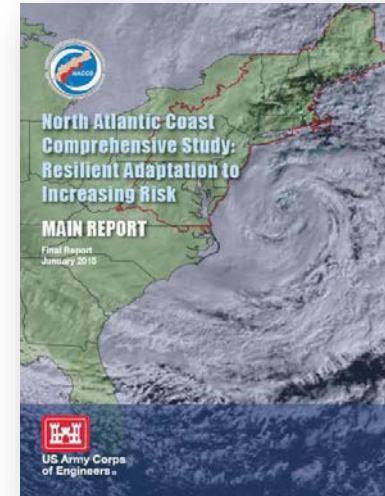


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RESILIENCE THROUGH INTEGRATED SOLUTIONS

“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.



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



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Ministry of Infrastructure
and Water Management



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WWF



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ROLE OF GUIDANCE AND STANDARDS IN INNOVATION

National Large Wood Manual

Assessment, Planning, Design, and Maintenance of Large Wood in Fluvial Ecosystems: Restoring Process, Function, and Structure

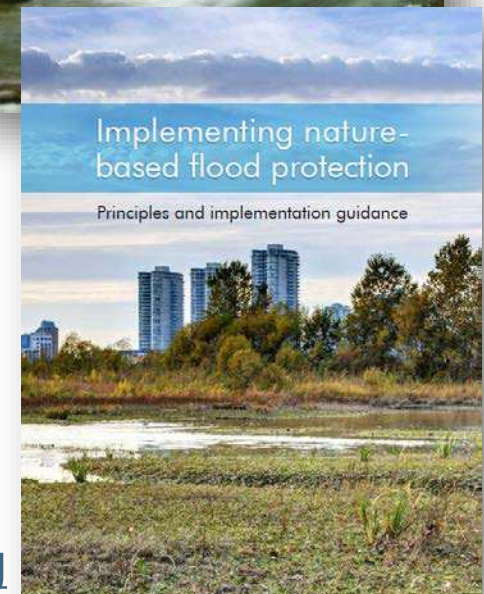
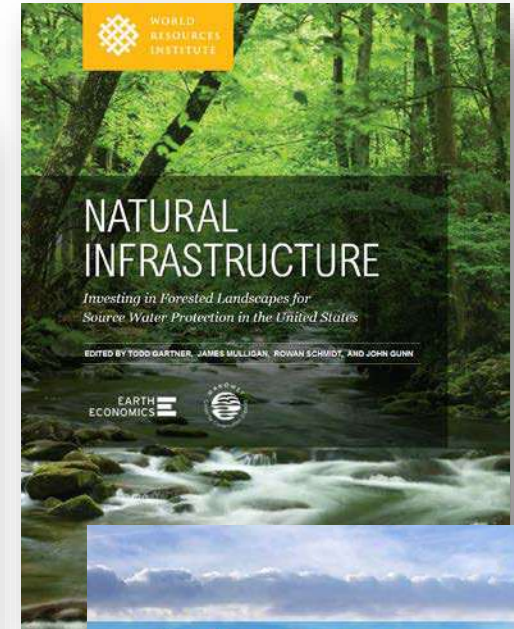
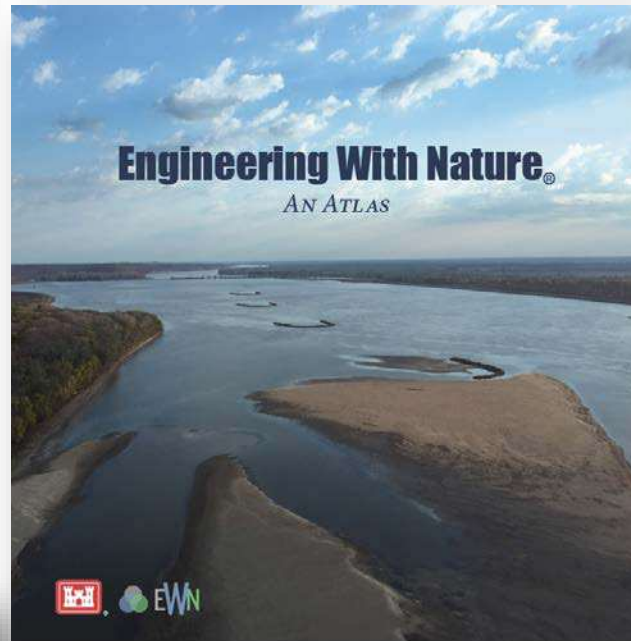
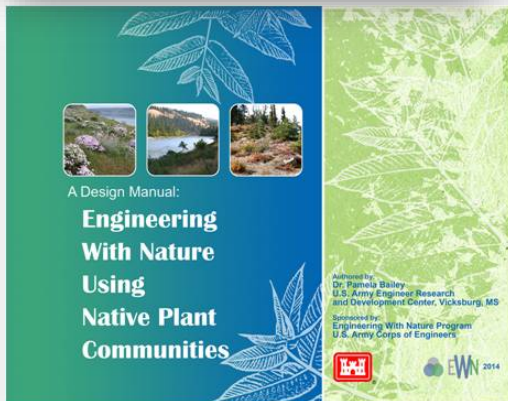
January 2016



U.S. Department of the Interior
Bureau of Reclamation



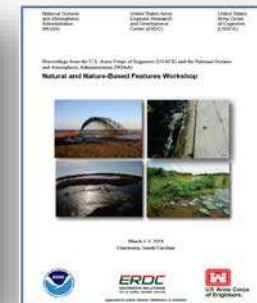
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COLLABORATION ACROSS GOVERNMENT

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

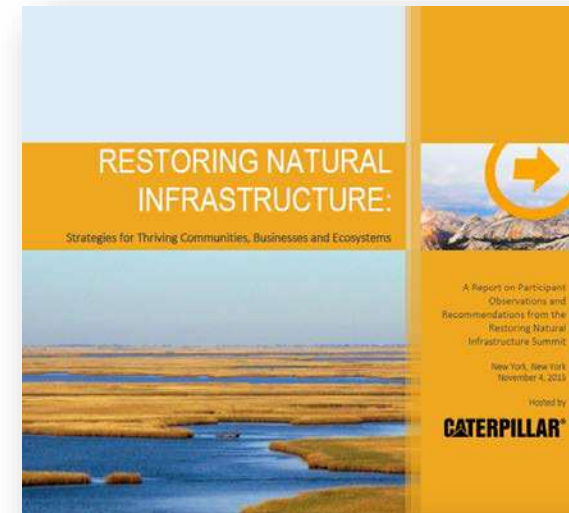


www.engineeringwithnature.org (NNBF)

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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
- Western Dredging Association (WEDA)
 - ▶ Collaborative technical workshop on engineering and construction techniques for Engineering With Nature



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

COLLABORATION WITH ACADEMIA

- Texas A&M University
 - Partnering through the Coastal Science and Engineering Collaborative (CSEC)
 - Joint research on NNBF
 - EWN Seminar spring 2018
 - Developing graduate curriculum to support EWN



- University of Georgia
 - Institute for Resilient Infrastructure Systems (IRIS)
 - CRADA and Educational Partnering Agreement
 - Multiple levels of collaboration on EWN and NNBF
 - EWN curriculum development



*Institute for Resilient
Infrastructure Systems*
UNIVERSITY OF GEORGIA



ENGINEERING WITH NATURE: OVERARCHING ISSUES

- Decision-making requirements differ
 - E.g., Planning, Engineering, Operations
- Uncertainties are addressed
 - Engineering requires decision-making under uncertainty
 - “We’ve taught ourselves to be risk averse”- Mr. James Dalton, DCW
- Function serves purpose
 - E.g., reducing erosion, waves, surge are different
- Scale is fundamental
 - E.g., deriving FRM benefits is strongly dependent on project/system scale
- Performance is adaptively managed
 - For a diverse set of benefits
- Collaboration is key
 - Working across functional areas, business lines, technical disciplines, organizations, perspectives



森林浴 *Shinrin-yoku*: “Forest Bathing”



By oliveheartkimchi - originally posted to
Flickr as Bamboo forest, Arashiyama, Kyoto