ENGINEERING WITH NATURE FOR FLOOD RISK MANAGEMENT

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Silver Jackets Webinar
5 March 2019
USACE SENIOR RESEARCH SCIENTISTS (ST)

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

Dr. Stacy Howington
Senior Research Scientist, Near Surface Phenomenology

Dr. Ed Perkins
Senior Research Scientist, Environmental Networks and Genetic Toxicology

Dr. Jane Smith
Senior Research Scientist, Hydrodynamic Phenomenon
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
- 30,000 miles of levee
- 4,500 military installations
- 926 ports
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®* began in 2010

- Engaging across USACE, other agencies, NGOs, academia, private sector, international collaborators
- Guided by a strategic plan
- Established through Proving Grounds
  - Galveston, Buffalo, Philadelphia
- 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
Engineering With Nature®

Elements

EWN Elements

Four major elements are involved in applying EWN to develop infrastructure projects:

- Using science and engineering to produce operational efficiencies
- Using natural processes to maximize benefit
- Increasing the value provided by projects to include social, environmental, and economic benefits
- Using collaborative processes to organize, engage, and focus interests, stakeholders, and partners

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HORSESHOE BEND ISLAND, ATCHAFALAYA RIVER

Project Awards:
• 2015 WEDA Award for Environmental Excellence
• 2017 WEDA Award for CC Adaption
• 2017 DPC Award for Working, Building, and Engineering with Nature
EWN ATLAS LAUNCH EVENT

10:30-12:00
January 16, 2019
National Building Museum
Washington, D.C.

“Engineering With Nature is an important initiative for the U.S. Army Corps of Engineers.” James Dalton, USACE Director Civil Works

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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%.
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.
NATURE-BASED GUIDANCE, STANDARDS, EVIDENCE

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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
NNBF GUIDELINES F2F WORKING MEETINGS

- Vicksburg, MS; Oct ‘16
- London etc., UK; Jul ‘17
- Silver Spring, MD, Oct’17
- Delft, NL; Mar ‘18
- Santa Cruz, CA; Sep ‘18
- Edinburgh, Scotland; May ‘19
SEC. 1184. Consideration of measures.
(a) Definitions.—In this section, the following definitions apply:
(1) NATURAL FEATURE.—The term “natural feature” means a feature that is created through the action of physical, geological, biological, and chemical processes over time.
(2) NATURE-BASED FEATURE.—The term “nature-based feature” means a feature that is created by human design, engineering, and construction to provide risk reduction in coastal areas by acting in concert with natural processes.
(b) Requirement.—In studying the feasibility of projects for flood risk management, hurricane and storm damage reduction, and ecosystem restoration the Secretary shall, with the consent of the non-Federal sponsor of the feasibility study, consider, as appropriate—
   (1) natural features;
   (2) nature-based features;
   (3) nonstructural measures; and
   (4) structural measures.
LANDSCAPE ARCHITECTURE WORKSHOP ON ENGINEERING WITH NATURE (25-27 JULY, 2017)

Goal: Identify opportunities to use LA approaches to advance EWN practice and projects
- 40 engineers, scientists, LAs
- Project vignettes
- Interaction breakout discussions
- Next steps
NNBF AND EWN TRAINING

ICCE, 1-day NNBF training workshop; 29 July, 2018

RAE, 1-day EWN training workshop; 13 Dec, 2018
How innovation happens: humans working with other humans, across organizational boundaries, to co-develop solutions
INCORPORATING EWN/LA TECHNIQUES AND PRACTICES INTO USACE INFRASTRUCTURE

Work on USACE Infrastructure Projects Continues with DRC Affiliates and UGA.

- Projects include:
  - Moses Lake Tide Gate Area (SWG);
  - Comite Canal Project (MVN);
  - Franklin Lock/Dam Recreation Area (SAJ);
  - Morehaven West Campground Site (SAJ);
  - Back Creek and Fishing Creek Jetties (NAB);
  - Proctor Creek (SAM); and
  - NEW: Sabine to Galveston (S2G) Project (SWG)

- Team has visited project sites and collected data
- Continue working with respective District POCs
- EWN/LA Team met JAN 19 at Auburn to work on initial renderings
- Meetings w/ USACE Districts to discuss rendering will begin in MAR 19
- Final report/renderings delivered to Districts JUL 19

Dr. Jeff King
Environmental Enhancements to Existing Infrastructure

Ashtabula Harbor

Milwaukee Harbor

Soo Locks

Dr. Burton Suedel
LEVEE SETBACKS

Dr. Dave Smith

Soldier’s Home Levee, Puyallup River, US

Alkborough, Humber Estuary, UK

Noordwaard, the Netherlands

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KRUIBEKE, SCHELDT RIVER BELGIUM

Dominiek Decleyre
TNC-USFWS RESTORATION PROJECT, BLACK WALNUT CREEK-TRIB TO ROCK RIVER, OGLE COUNTY, IL

Chris Haring

US Army Corps of Engineers • Engineer Research and Development Center
HAMILTON AND SEARS POINT WETLANDS
SAN PABLO BAY, CA

Elizabeth Murray

US Army Corps of Engineers • Engineer Research and Development Center
USACE PHILADELPHIA DISTRICT: EWN IN BACK BAY NEW JERSEY

Mordecai Island

Avalon

Stone Harbor

Dr. Candice Piercy
ENGINEERING WITH NATURAL MATERIALS

National Large Wood Manual
January 2016

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Dr. Tosin Sekoni
EROSION OF COASTAL DUNES: THE VALUE OF DUNE VEGETATION
WAVE ATTENUATION BY VEGETATION

Mary Bryant
NNBF: OVERARCHING ISSUES

- Decision-making requirements differ
  - E.g., Planning, Engineering, Operations
- Uncertainty is ubiquitous
  - 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
  - Deriving FRM benefits is strongly dependent on project/system scale
- Benefits evaluation is key to progress
  - It’s fundamental to justifying NNBF investment
- Collaboration is essential
  - Working across functional areas, business lines, technical disciplines, organizations, perspectives
EWN AND NNBF: SCIENCE, ENGINEERING, TECHNOLOGY TARGETS

**Fundamental processes**
- Sediment transport through and around NNBF
- Long-term engineering and environmental performance of features
- Benefits / Ecosystem Services provided by engineered features and structures
- Processes contributing to system-scale resilience

**Modeling systems that support broad-scale application**
- Planners, stakeholders and decision-makers
- Engineering design
- Operations and maintenance

**Reliable, cost-efficient monitoring technologies**
- Measuring system evolution
- Infrastructure/feature performance

**Guidance development and tools**
- For planning, design, construction, O&M

**Demonstration/pilot projects to innovate and learn**
- Facilitate necessary collaboration
- Evolve organizational culture and practice
- Produce credible evidence of success at field scale
- Fuel the “power of the story”
THIN-LAYER PLACEMENT

www.engineeringwithnature.org (under Tools)
COLLABORATION ACROSS GOVERNMENT


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

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

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
A SYSTEMS VIEW OF SOLUTIONS

- Retention/Detention
- Urban/Suburban Land Use
- Agricultural Land Use
- Oxbow/Island Restoration
- Flow Diversion Control Structures
- Bank Stabilization Bio-engineering
- Forested
- Leaky Dam
- Tributaries
- Low Land Coastal River
- Floodplain
- Navigable Waterways (Flood Basins)
- Infiltration for Base Flow (Land and Soil Management)
- Prairie/Forest Wetlands Restoration
- Hydrology/Hydraulic Cycle
- Organisms Access Sediment Transport Water Conveyance

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BUILDING PROGRESS

• Expand the “vision” to diversify project benefits
• Increase collaboration and cross-sector partnerships
• Commit to innovation
• Pursue realistic and affordable projects
• Document the value created
• Coordinate communication across partnering organizations for maximum impact
Urban River Parkways

An Essential Tool for Public Health

Richard J. Jackson, MD, MPH - UCLA Fielding School of Public Health
Tyler D. Watson, MPH - UCLA Fielding School of Public Health
Andrew Tsui, MPH - UCLA Fielding School of Public Health
Bianca Shulaker, MURP - USC Department of Urban Planning
Stephanie Hopp, MPH - Johns Hopkins School of Public Health
Mladen Popovic - UC Santa Barbara

July 2014

Every $1 spent on rec trails results in $3 to >$10 of direct medical benefit