Engineering With Nature®

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Honolulu Climate Change Commission  
15 June 2021
The Multi-Hazard World

- Mt. Saint Helens, 1980
- San Francisco, 1906
- New Madrid Seismic Zone
- Fukushima, 2011
- Three Mile Island, 1979
- Banqiao dam failure; China, 1975
- HABs, Lake Erie; 2008-2017
- COVID-19, 2020-X
- H1N1, 1918-1919
- Dust Bowl, 1930s
- Offutt AFB, 2019
- Camp Fire, CA 2018
- 2020 record-setting storm season

Event Dates:
- 9/11
- Civil unrest, 2020
- Medfly "bio-attack"; CA, 1989
- Beirut, Lebanon; 2020
- Deepwater Horizon, 2010
- Hurricane Katrina, 2005
- Hurricane Harvey; landfall and Houston, 2017
- Flood of 1927; Tallulah, LA
- Mt. Saint Helens, 1980
- Beirut, Lebanon; 2020
- HABs, Lake Erie; 2008-2017
- Dust Bowl, 1930s
- H1N1, 1918-1919
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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
- >30,000 miles of flood levee
- 155,000 public drinking water systems
- 4,500 military installations
- 926 ports, 25,000 miles of navigation channel

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
- Increase and diversify infrastructure value
- Science-based collaboration to organize and focus interests, stakeholders, and partners

“The mission of US Army Corps of Engineers is to deliver vital public and military engineering services; partnering in peace and war to strengthen our nation’s security, energize the economy and reduce risks from disasters. Engineering With Nature supports this mission which is why it will always be an important initiative for the Corps.” LTG Scott A. Spellman, 55th Chief of Engineers, Commanding General, USACE
Leveraging Nature for Engineering Value: *Wetlands*

Wetland Value During Hurricane Sandy:
- Risk industry tools used to quantify the economic benefits of coastal wetlands
  - Temperate coastal wetlands averted 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%.
Leveraging Nature for Engineering Value: Mangroves

Flood Risk Value of Florida Mangroves:

• Used an insurance industry catastrophe model to quantify the flood reduction benefits of mangroves across Florida
• During Hurricane Irma:
  • Mangroves averted $1.5 billion dollars in flood damages to properties
    • 25% savings in counties with mangroves
  • >600,000 people living behind mangrove forests saw reduced flooding across Florida
Leveraging Nature for Engineering Value: Coral Reefs

Coral Reefs and Flood Risk Reduction Value:

- Coral reefs line >3,100 km of US and US Trust Territory shorelines
  - Provide >$1.8B in annual flood risk reduction benefits
  - Highly developed coastlines in FL and HI receive annual benefits of $10M per km of coral reef

- Loss of the top-most meter of coral reefs:
  - An additional 50,000 people would experience flooding
  - $3B in additional damage to structures

https://www.nature.com/articles/s41893-021-00706-6.epdf?sharing_token=okXPN9-3ruX1iz_oE9QdrRgN0jAJWiEjQRG3Dy1oP341Lz-Uml8_uD-zE+hw5yVw5H6pL+btyE9duXURh1wzOBZyGeE4H4mE2ycl1Boz2xZ6MDH4a4G69N331nT1-vVM4JuLZv8z6ikW59s-bP0Zs6yK00M4yBzyls7E4+BwU7H1S6Z5U
Nature-Based Solutions

Diversified Value

- **Engineering**
  - E.g., reduced flood risk, infrastructure maintenance

- **Economic**
  - E.g., increased property values, recreation

- **Environmental**
  - E.g., sustainable habitat, biodiversity

- **Social**
  - E.g., human health, community resilience

Nature experience reduces rumination and subgenual prefrontal cortex activation

Gregory N. Bratman, J. Paul Hamilton, Kevin S. Hahn, Gretchen C. Daily, and James J. Gross

PNAS July 14, 2015, 112 (28) 8567-8572; final published June 29, 2015 https://doi.org/10.1073/pnas.1510459112
A Systems View of Solutions
Overarching Strategies

- **Hold the Line, “Hard”**
  - Galveston Seawall
  - Coast of Belgium

- **Retreat**
  - Savannah Lighthouse
  - Hamilton, Sears Point, CA
  - Belgium, Scheldt River Estuary

- **Advance**
  - New wetland, mangrove, island construction
  - New Jersey Bay Bays
  - Sabine to Galveston
Upstream Intervention in the UK: Spreading out the Flow
Puyallup River, WA: Soldier’s Home Levee and Floodplain

April 2006

June 2016
Hamilton and Sears Point Wetlands; San Pablo Bay, CA

Hamilton Army Airfield; 6 mcy BU, 500 acres
Sonoma Land Trust; 1,000-acre tidal restoration
Fort Pierce City Marina, Florida
EWN® Applied to Tyndall Air Force Base Rebuild

Tyndallcoastalresilience.com

EngineeringWithNature.org,
EWN Podcast Episode 3, BG Melancon

US Army Corps of Engineers • Engineer Research and Development Center
Defense Advanced Research Projects Agency (DARPA): REEFENSE

- **Program Vision**: Develop hybrid biological and engineered reef-mimicking structures to mitigate wave and storm damage that increasingly threaten DoD personnel and infrastructure.
- **Program Funding**: $50M over 5 years.
- **ERDC Role**: Leading Independent Verification & Validation Team.
- **3 Technical Areas**
  - Structure Design and Structure
  - Adaptive Biology
  - Ecosystem Engineering
- **5 Year Program**
  - Pre-design and Deployment (18 months)
  - Ecosystem Optimization (18 months)
  - Environmental Resilience (24 months)
- **2 Reef Habitats**
  - Oyster
  - Coral
US Coral Reef Task Force

- **Mission:** USCRTF was established in 1998 to preserve and protect coral reef ecosystems.

- **USACE Role:** USACE is a Task Force member & supporting the “restoration and intervention” working group (RIWG).

- **RIWG Initiative:** Team is creating a handbook for community-based coral reef restoration projects that reduce flood risk, including:
  - Site Selection
    - (risk – exposure – opportunities - impact)
  - Project Scoping
    - (cost benefit analysis – alternatives analysis - maintenance)
  - Application Development
    - (scope – budget – schedule - data documentation – match – administration)

- **Stakeholder Engagement:** testing the handbook with State and local partners for effectiveness and usability.

- **Project Partners:** FEMA, NOAA, USACE, USGS, UC Santa Cruz.
International Guidelines on Natural and Nature-Based Features for Flood Risk Management

NNBF Guidelines Table of Contents

• Chapter 1. Introduction
• Chapter 2. Principles, Outcomes, and Frameworks
• Chapter 3. Engaging Communities and Stakeholders in Implementing Natural and Nature-Based Features
• Chapter 4. Planning and Implementing Natural and Nature-Based Features Using a Systems Approach
• Chapter 5. NNBF Performance
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• Chapter 9. Beaches and Dunes
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• Chapter 20. The Future

NNBF Guidelines
• Publication summer 2021
• 1,000 pages
• >170 authors and contributors from >70 organizations and 10 countries

www.engineeringwithnature.org
Nature-Based Solutions

Conserving, restoring, and engineering nature for the benefit of people and ecosystems

- Project delivery—"faster, cheaper"
- Project performance—complete solutions
- Adaptability—scalable, phaseable, flexible
- Sustainability—self-repair
- Value to the Nation—multi-functional benefits
- Diversified investment—diversified value→diversified partnerships
- Social license—community and stakeholder support and participation
- Regulatory efficiency—resolving conflict through win-win solutions
The Spectrum

“Wild and Free-Flowing Nature”

“Achieving Nature-Engineering Balance”

“Tamed and Conquered Nature”

Priorities for Advancing EWN

- 21st century vision for water infrastructure
- Policy and its implementation supporting the vision
- Modernized approach to community and stakeholder engagement
- Comprehensive approach to benefits evaluation
- Incremental development of engineering guidance

Duwamish River, WA 1800s

Duwamish River, WA today

San Joaquin Valley, CA 1800s

San Joaquin Valley, CA today

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