



U.S. ARMY

# Developing a National Strategy for Nature-Based Solutions

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SFSLD Conference  
9 November 2022



US Army Corps  
of Engineers





# The Multi-Hazard World



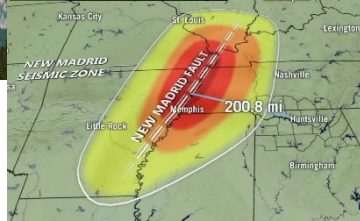
David Johnston, USGS



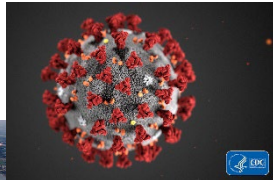
Mt. Saint Helens, 1980



San Francisco, 1906



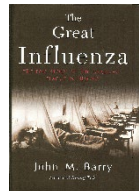
New Madrid Seismic Zone



COVID-19, 2020-X



HABs, Lake Erie; 2008-2017



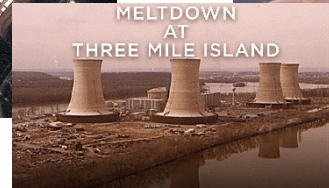
H1N1, 1918-1919



Beirut, Lebanon; 2020



Fukushima, 2011



Three Mile Island, 1979



Deepwater Horizon, 2010



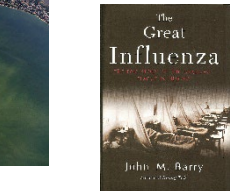
9/11



Civil unrest, 2020



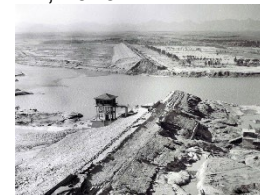
Medfly "bio-attack"; CA, 1989



Dust Bowl, 1930s



Camp Fire; CA 2018



Banqiao dam failure; China, 1975



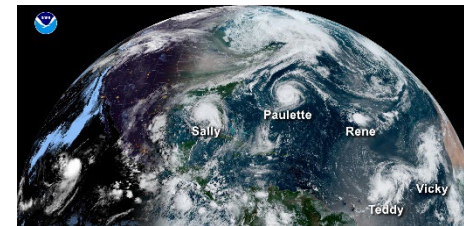
Hurricane Katrina, 2005



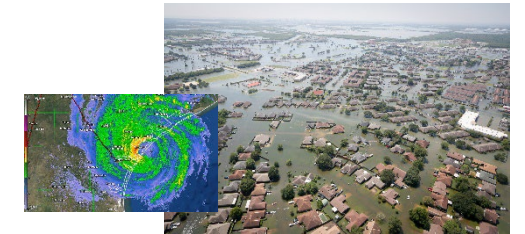
Flood of 1927; Tallulah, LA



Offutt AFB, 2019



2020 record-setting storm season

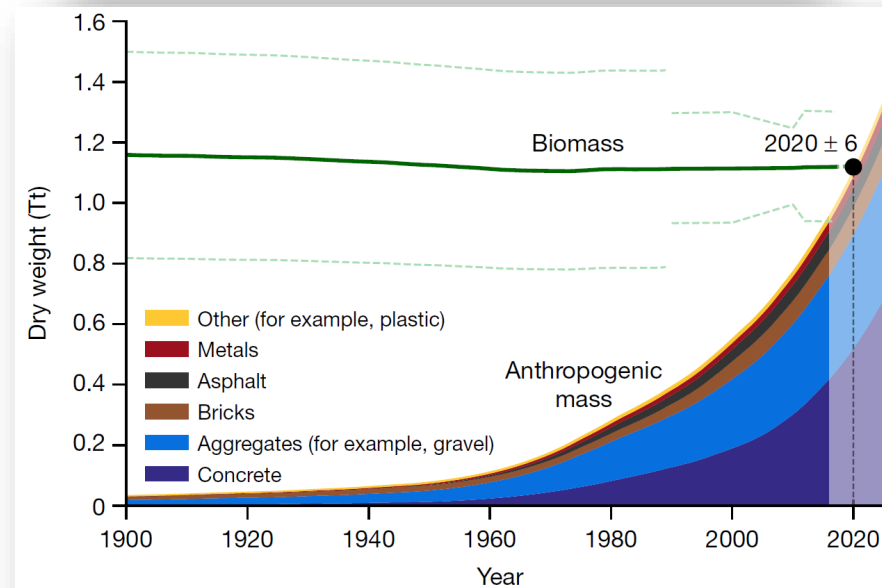


Hurricane Harvey; landfall and Houston, 2017

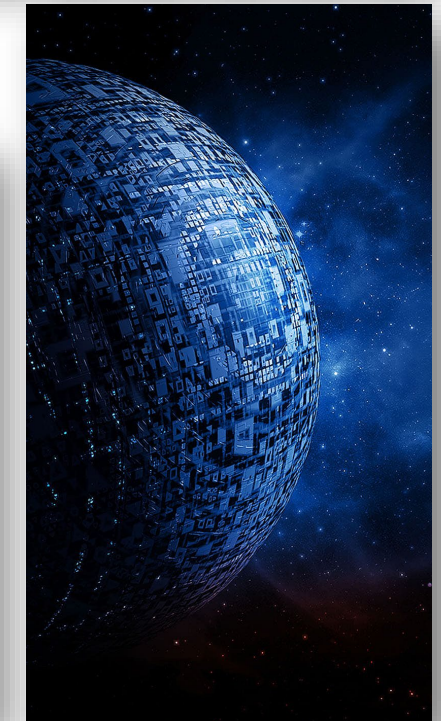


# 1900-2000: The Century of Infrastructure (US)

- 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
- ~5,000 military installations
- 926 ports, 25,000 miles of navigation channel



Elhacham et al. 2020. Global human-made mass exceeds all living biomass. Nature 588:442-444





# The LA "River"



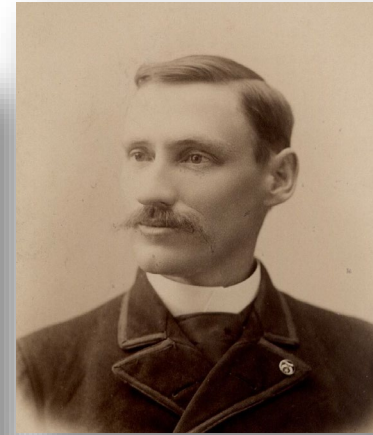
US Army Corps of Engineers • Engineer Research and Development Center



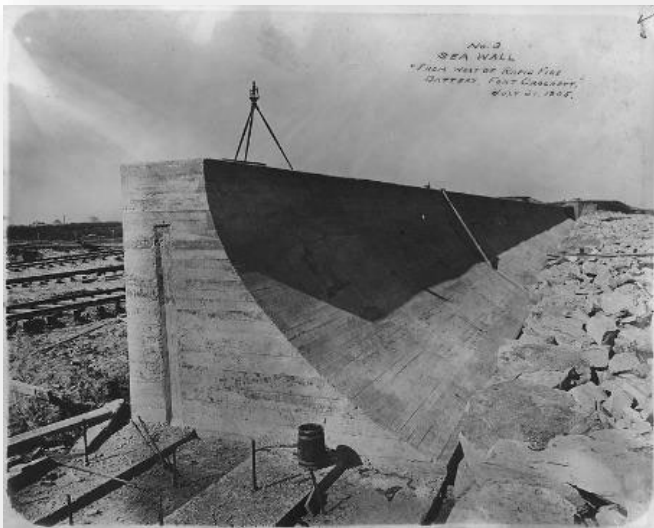
# “Hard” Lessons from the Past

## 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



Dr. Isaac Cline,  
1861-1955





# The West's Climate Change Conundrum



## Why Was Hoover Dam Built?



*The Colorado River is both friend and foe. It has the power to sustain life and ruin lives, to create opportunity and destroy prosperity.*



nature  
climate change

BRIEF COMMUNICATION

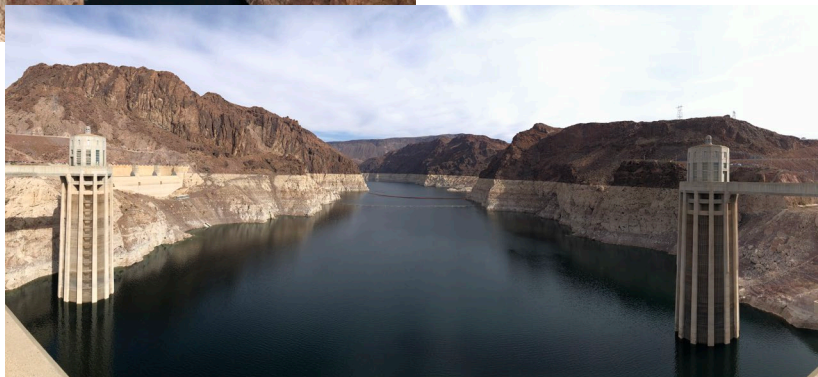
<https://doi.org/10.1038/s41558-022-01290-z>

Check for updates

## Rapid intensification of the emerging southwestern North American megadrought in 2020-2021

A. Park Williams<sup>1,2</sup>, Benjamin I. Cook<sup>2,3</sup> and Jason E. Smerdon<sup>2</sup>

A previous reconstruction back to 800 CE indicated that the 2000-2018 soil moisture deficit in southwestern North America was exceeded during one megadrought in the late-1500s. Here, we show that after exceptional drought severity in 2021, ~19% of which is attributable to anthropogenic climate trends, 2000-2021 was the driest 22-yr period since at least 800. This drought will very likely persist through 2022, matching the duration of the late-1500s megadrought.





# When wide-ranging extremes become routine...

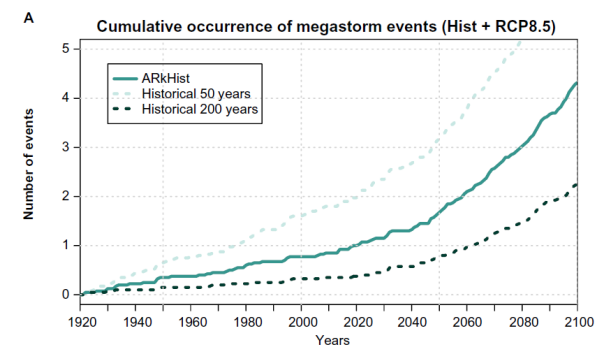
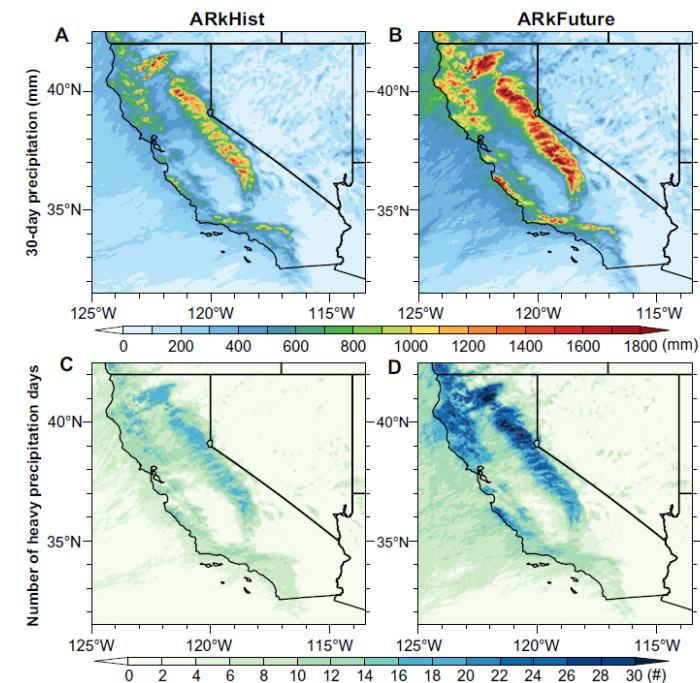
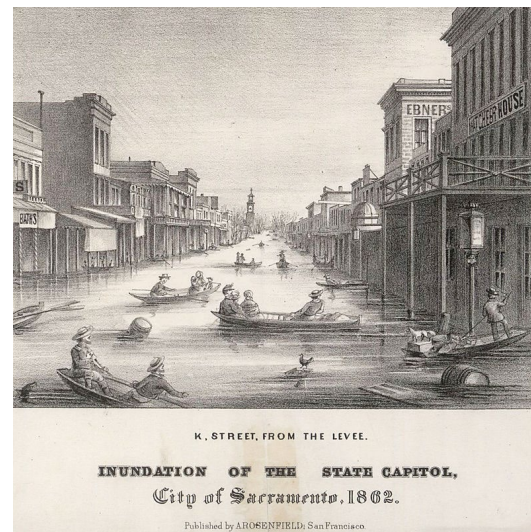
## Climate change is increasing the risk of a California megaflood Xingying Huang<sup>1\*†</sup> and Daniel L. Swain

“We find that climate change has already increased the risk of a GF1862-like megaflood scenario in California, but that future climate warming will likely bring about even sharper risk increases.”

“The strongest ARs are expected to strengthen considerably at the expense of the weakest—shifting the balance from “primarily beneficial” AR events to “primarily hazardous” ones...”

“...20th century hazard mapping, emergency response plans, and even physical infrastructure design standards may already be out of date in a warmer 21st century climate.”

“Yet, potential solutions to increasing flood risk do exist. Examples of climate-aware strategies that have the potential to mitigate harm during a 21st century California megaflood include **floodplain restoration and levee setbacks**, which would lessen flood risk in urban areas while offering environmental cobenefits;”





# “Overshot” Engineering

## *The Netherlands-*

**“We are world champions in making land dry. Now we are trying to turn that system around, because we overshot.”**

Peter van Dijk, Dutch blueberry grower

**“There is nothing natural about the Netherlands.”**

Dr. Gertjan Zwolsman, policy advisor at Dunea

*They’re ‘World Champions’ on Banishing Water. Now, the Dutch Need to Keep It.*  
Raymond Zhong, NYT Oct 10, 2022



Rhine River at Lobith, the Netherlands, in Aug 2022, when the river’s discharge hit a record low.



1,600 barges stalled along the MS River near Lake Providence, LA due to lower water; Oct 2022



Lake Oroville; July 2021



Farmers work to dam a ditch to capture water in Meijel, the Netherlands, in May 2022.



# Nature-Based Solutions: A White House Priority

2022  
Earth Day EO



BRIEFING ROOM

## Executive Order on Strengthening the Nation's Forests, Communities, and Local Economies

APRIL 22, 2022 • PRESIDENTIAL ACTIONS



OFFICE OF SCIENCE AND TECHNOLOGY POLICY

## WHITE HOUSE ROUNDTABLE – “KNOWLEDGE IN NATURE: HOW NATURE CAN HELP GROW A BETTER FUTURE”



BRIEFING ROOM

## Executive Order on Tackling the Climate Crisis at Home and Abroad

JANUARY 27, 2021 • PRESIDENTIAL ACTIONS

## *America the Beautiful 30x30*

*Justice40 Initiative*

***EO 14072, Sec. 4. Deploying Nature-Based Solutions to Tackle Climate Change and Enhance Resilience: “To further amplify the power of nature, including its ability to absorb climate pollution and increase resilience in all communities, today’s Executive Order calls for the following:”***

- 1) Report on Nature-Based Solutions***
- 2) Guidance on Valuing Nature***
- 3) First U.S. National Nature Assessment***

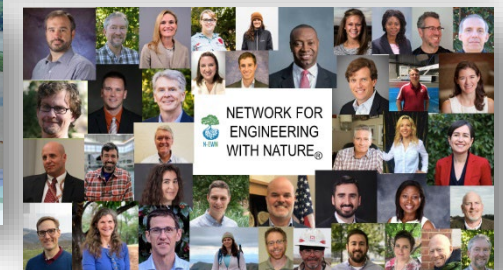
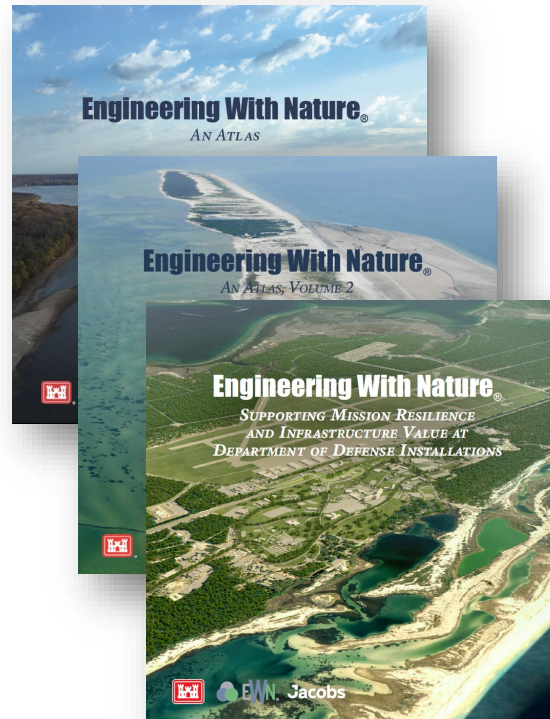


# Engineering With Nature®

*...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



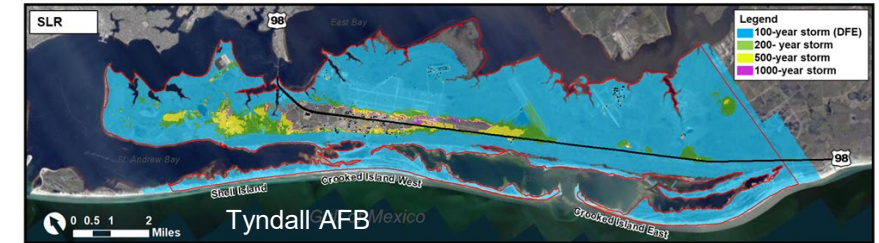
“We absolutely want to do more engineering with nature everywhere we work across the Corps, you have my commitment.”

— LTG Scott A. Spellmon, 55th Chief of Engineers, to the House Committee on Transportation & Infrastructure, Water Resources & Environment Subcommittee (24 June 2021)



# Nature-Based Solutions: *Conserving, restoring, and engineering nature for the benefit of people and nature*

- **Coastal Storm Risk Management;** e.g., an island-wetland complex that attenuates storm surge and waves.
- **Inland Flood Risk Management;** e.g., a restored inland floodplain that provides space for high flows.
- **Surface Heat Reduction;** e.g., creation of green space, forest restoration.
- **Drought and Wildfire Resilience;** e.g., restored native vegetation + grazing + 'slow-water' interventions + ecological forest management.
- **Water Resilience;** a constructed freshwater wetland that absorbs excess nutrients and recharges depleted groundwater aquifers.
- **Climate Change Mitigation;** e.g., restored native grasslands / plant communities that sequester carbon in soils.



Soil surface temperatures reveal moderation of the urban heat island effect by trees and shrubs

J. L. Edmondson, J. Stutt, Z. G. Davies, K. J. Gaston & J. R. Leake  
 Scientific Reports 6, Article number: 33708 (2016) | Download Citation |  
 1398 Accesses | 20 Citations | 17 Altmetric | Metrics »



# The Science of Nature-Based Solutions: *Using Multiple Lines-of-Evidence*

- Physical Modeling
- Numerical Modeling
- Natural Analogs
- Scaled Demonstration
- Experience
  - Project Monitoring
  - Traditional Ecological Knowledge
  - Engineering Judgment

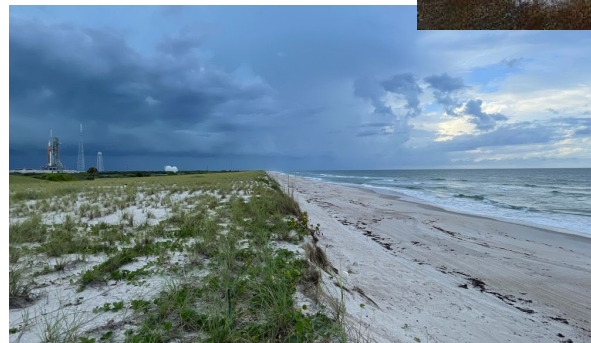


scientific reports

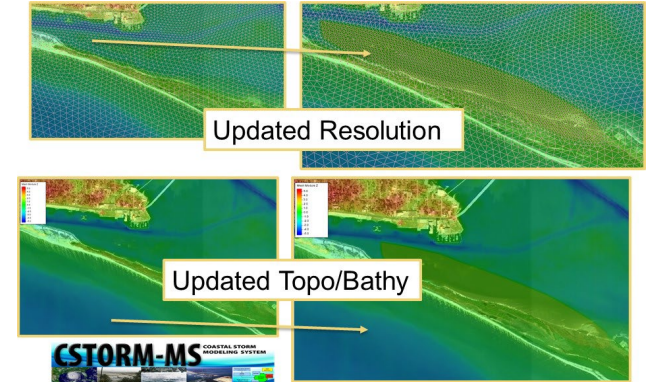
OPEN **Resistance, resilience, and recovery of salt marshes in the Florida Panhandle following Hurricane Michael**

Katherine A. Castagno<sup>1,2,6\*</sup>, Tori Tomiczek<sup>3</sup>, Christine C. Shepard<sup>4</sup>, Michael W. Beck<sup>5</sup>, Alison A. Bowden<sup>7</sup>, Kiera O'Donnell<sup>8</sup> & Steven B. Scyphers<sup>1</sup>

Characterizing the fragility, resistance, and resilience of marshes is critical for understanding their role in reducing storm damages and for helping to manage the recovery of these natural defenses. This study uses high-resolution aerial imagery to quantify the impacts of Hurricane Michael, a category 5 hurricane, on coastal salt marshes in the Florida Panhandle, USA. Marsh damage was classified into several categories, including deposition of sediment or wrack, fallen trees, vegetation loss, and conversion to open water. The marshes were highly resistant to storm damages even under extreme conditions; only 2% of the 173,259 km<sup>2</sup> of marshes in the study area were damaged— a failure rate much lower than that of artificial defenses. Marshes may be more resistant than resilient to storm impacts; damaged marshes were slow to recover, and only 38% of damaged marshes had recovered 6 months after landfall. Marsh management mattered for resistance and resilience; marshes on publicly-managed lands were less likely to be damaged and more likely to recover quickly from storm impacts than marshes on private land, emphasizing the need to incentivize marsh management on private lands. These results directly inform policy and practice for hazard mitigation, disaster recovery, adaptation, and conservation, particularly given the potential for more intense hurricane landfalls as the climate changes.



## EWN Toolkit in CSTORM



Huamantanga, Peru. People use and maintain 1,400-year-old amunas, canals. Credit: Diego Pérez/Forest Trends



# 1. Evaluate the Comprehensive Benefits of NBS: Policy Research

**Current federal alternative evaluation process does not comprehensively value economic, environmental, and social benefits. These constraints screen out or exclude Nature-Based Solutions (NBS) and could lead to outcomes inconsistent with the Administration's priorities around community resilience and equity.**



## Approach:

- **Summarize** historical and current alternative evaluation policies and practices
- **Identify** 6 historical planning studies that considered NBS alternatives suitable for case study analysis
  1. Jacksonville Harbor (NAV, South East)
  2. Jamaica Bay Reformulation (CSRM, North East)
  3. Southwest Coastal (CSRM, Gulf Coast)
  4. South Platte River and Tributaries (FRM, North West)
  5. West Sacramento (FRM, Pacific)
  6. South San Francisco Bay Shoreline (FRM, Pacific)
- **Review** updated valuation methods and planning frameworks that incorporate environmental and social benefits
- **Analyze** case studies using updated methods and exploratory analysis to look beyond current policy constraints

<https://ewn.erdcdren.mil/?p=7841>



**National Summit: *Measuring What Matters*  
November 30, 2022; Washington D.C.**



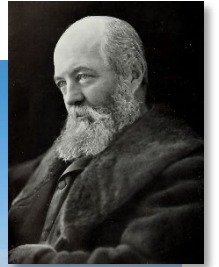
## 2. Up-Scale Partnering: SMILL

### Seven Mile Island Innovation Laboratory

- Collaboration and partnership that is building first-of-their-kind NBS projects in coastal New Jersey
  - Began in conversation
  - Accelerated by a storm (Sandy)
  - Progressed through piloting
  - Now in full-scale implementation



Engineering With Nature



Engineering With Nature  
+  
Landscape Architecture  
NJBB

a report identifying design concepts for incorporating Engineering With Nature and Landscape Architecture approaches into US Army Corps of Engineers project infrastructure



US Army Corps  
of Engineers®



Protecting nature. Preserving life.



NEW JERSEY DIVISION OF  
Fish and Wildlife



US Army Corps of Engineers • Engineer Research and Development Center



# 3. Share Knowledge: *International Guidelines on Natural and Nature-Based Features for Flood Risk Management*

## NNBF Guidelines Table of Contents

- Chapter 1. Introduction
- Chapter 2. Principles, Frameworks, and Outcomes
- Chapter 3. Community Engagement
- Chapter 4. Systems Approach
- Chapter 5. Performance
- Chapter 6. Benefits and Costs of NNBF
- Chapter 7. Adaptive Management
- Chapter 8. Introduction to Coastal Systems
- Chapter 9. Beaches and Dunes
- Chapter 10. Coastal Wetlands and Intertidal Areas
- Chapter 11. Islands
- Chapter 12. Reefs
- Chapter 13. Plant Systems
- Chapter 14. Environmental Enhancements
- Chapter 15. Introduction to Fluvial Systems
- Chapter 16. Fluvial Systems and Flood Risk Management
- Chapter 17. Benefits and Challenges of NNBF in Fluvial Systems
- Chapter 18. Fluvial NNBF
- Chapter 19. Fluvial NNBF Case Studies
- Chapter 20. The Way Forward



[https://ewn.erd.c.dren.mil/?page\\_id=4351](https://ewn.erd.c.dren.mil/?page_id=4351)

### NNBF Guidelines

- >1,000 pages, 5-year effort
- >70 multi-sector organizations
- >170 authors and contributors



[www.engineeringwithnature.org](http://www.engineeringwithnature.org)

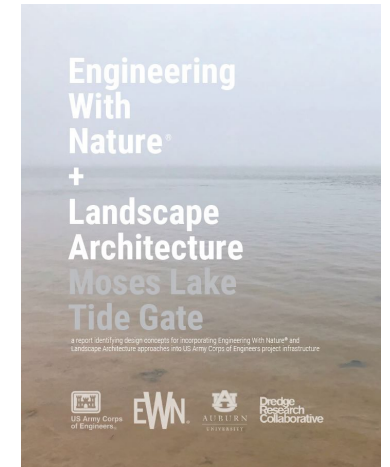


*Winner, Environment Agency Flood & Coast International Excellence Award, 2022*

“The guidelines do not contain or represent the policy commitments or policy positions of the organizations that participated in their development. Policy development is the sole purview of each organization and the laws and procedures that govern their activities.” Pages xi-xii.



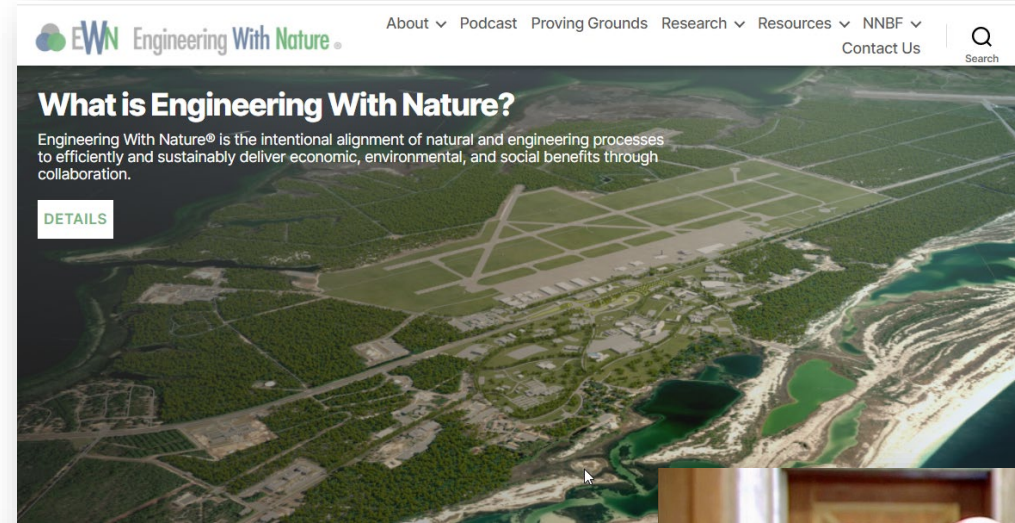
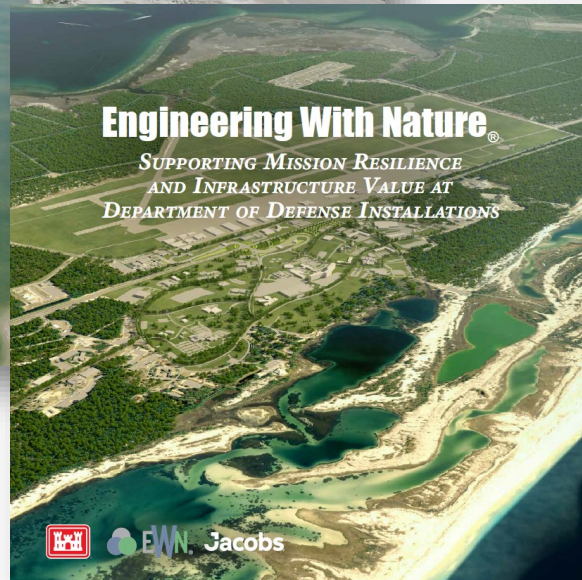
# 4. Design with Nature First!



[https://ewn.ercd.dren.mil/?page\\_id=81](https://ewn.ercd.dren.mil/?page_id=81)



# 5. Spark Conversation, Thinking, and New Ideas



<https://ewn.erdcdren.mil/?p=3586>



[www.engineeringwithnature.org](http://www.engineeringwithnature.org)

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