

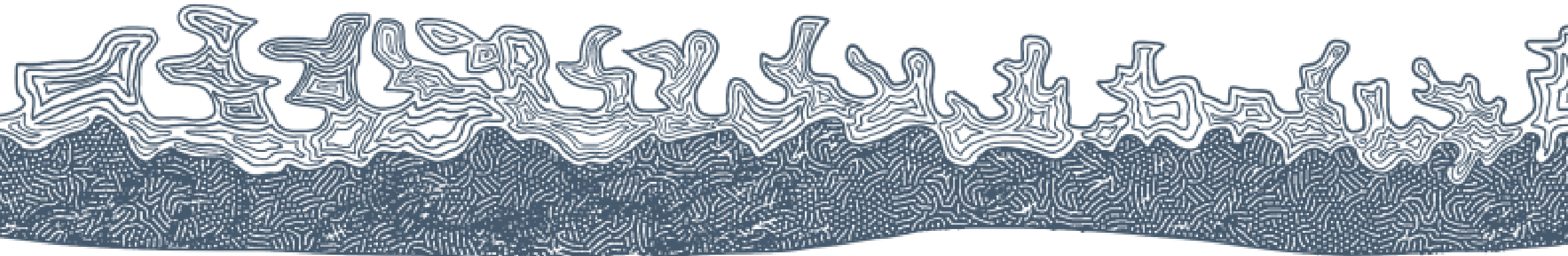


UNIVERSITY OF
GEORGIA

*Institute for Resilient
Infrastructure Systems*

Engineering With Nature for a More Resilient and Sustainable Future

Dr. Todd S. Bridges
College of Engineering
University of Georgia



A long, long time ago...I can still remember...

Engineering With Nature: Designing Navigation Infrastructure for Greater Environmental Sustainability

September 7-8, 2011

Doubletree Guest Suites Historic Charleston - Stono Ballroom
Charleston, SC

Agenda



ERDC TN-DOER-R21
September 2013

Implementing Engineering With Nature within the Corps: A Workshop

by *Cynthia J. Banks, Thomas J. Fredette, Burton C. Suedel, and Todd S. Bridges*

The Multi-Hazard World



David Johnston, USGS



Mt. Saint Helens, 1980



New Madrid Seismic Zone



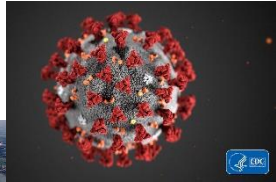
Beirut, Lebanon; 2020



9/11



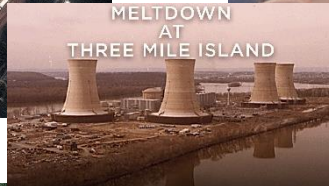
San Francisco, 1906



COVID-19, 2020-X



Fukushima, 2011



Three Mile Island, 1979



Deepwater Horizon, 2010

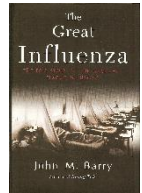


Civil unrest, 2020

Medfly "bio-attack"; CA, 1989



HABs, Lake Erie; 2008-2017



H1N1, 1918-1919



Banqiao dam failure; China, 1975



Flood of 1927; Tallulah, LA



Hurricane Katrina, 2005



Dust Bowl, 1930s



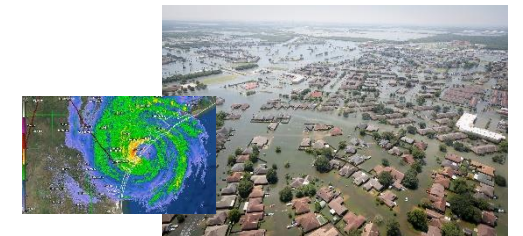
Offutt AFB, 2019



Camp Fire; CA 2018



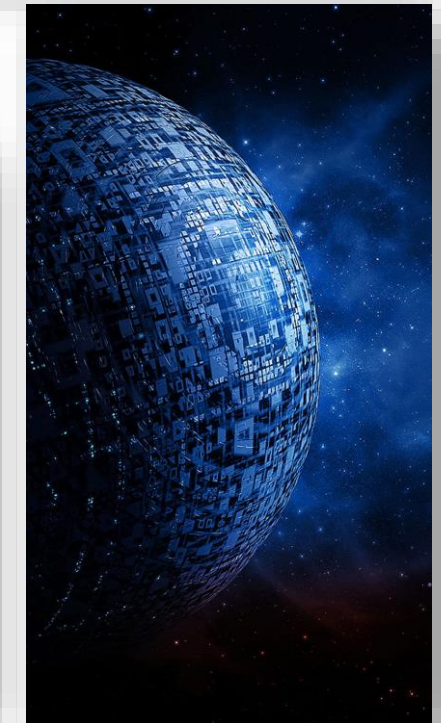
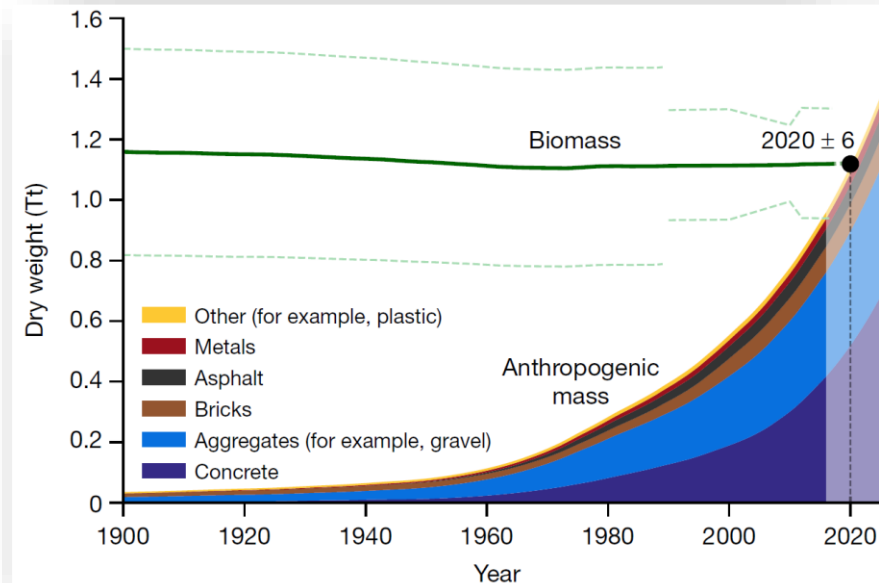
2020 record-setting storm season



Hurricane Harvey; landfall and Houston, 2017

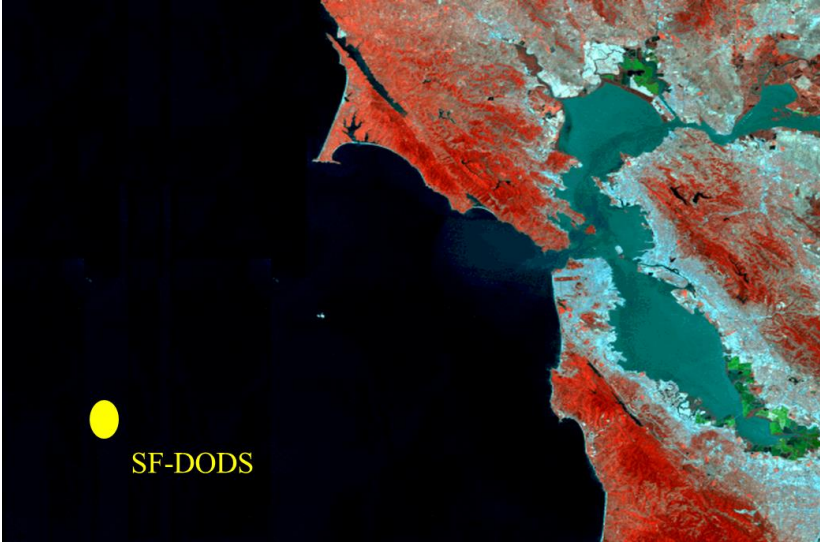
1900-2000: *The Century of Infrastructure (US)*

- 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

San Francisco Bay



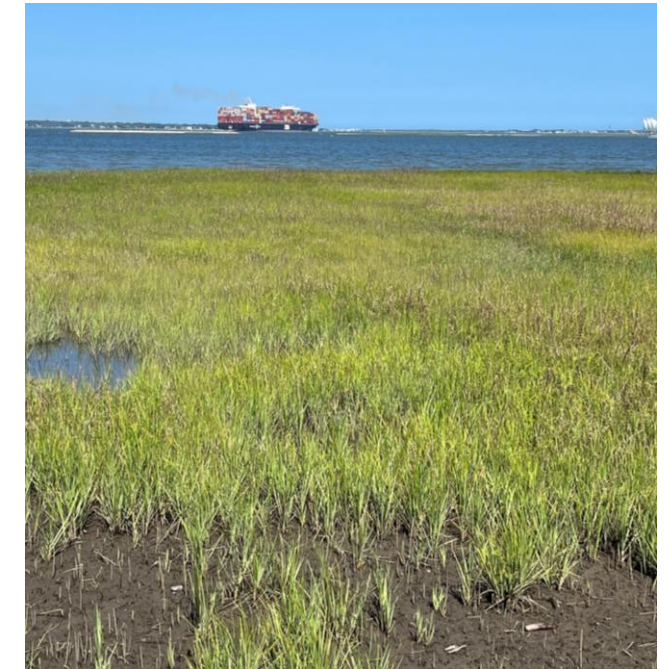
Charleston, SC



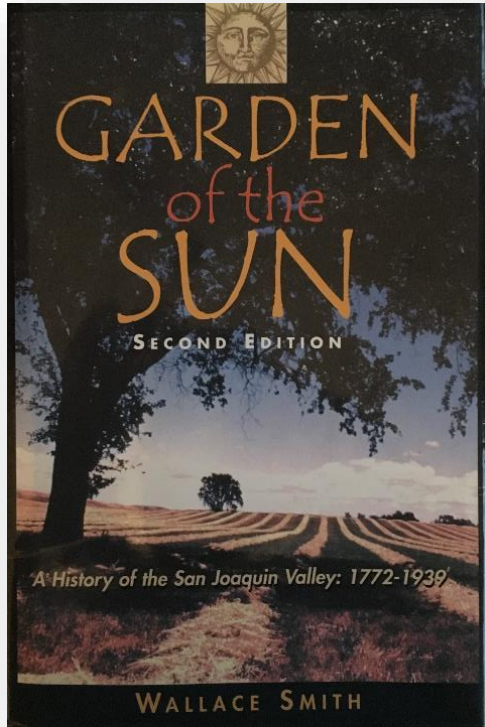
17th Century Charleston



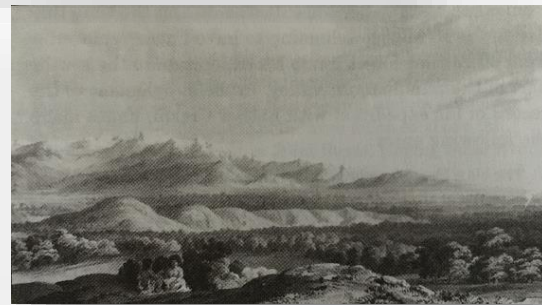
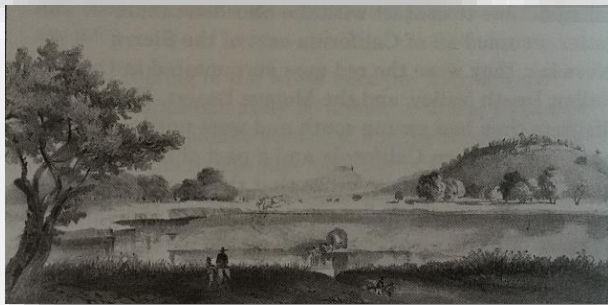
20th Century Charleston



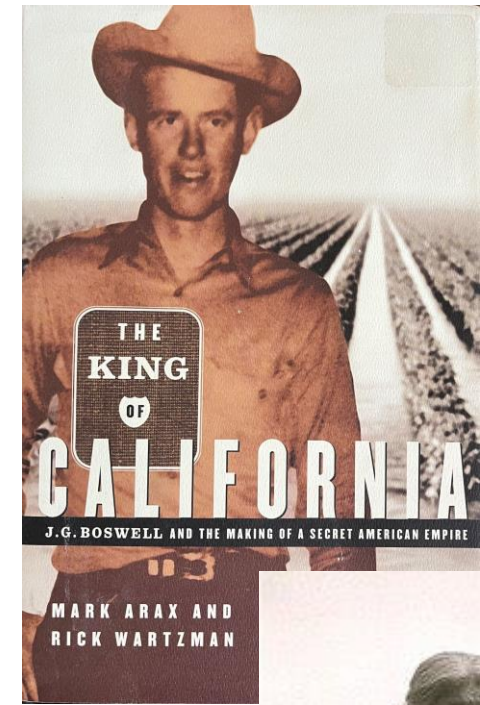
The San Joaquin Valley, California



California "Satellite" Image, ca. 1851
by Mark Clark



Tulare Lake Basin, Spring 2023



Yoimut (c. 1856-1937)

“You ask me, ‘Will Tulare Lake ever fill up again?’ I got only one thing to say. Yes. It will fill up, and everybody living down there will have to go away. I’d like to see that time for myself. I am the last full-blood Chunut left.”

<https://amp-fresnobee-com.cdn.ampproject.org/c/s/amp.fresnobee.com/news/weather-news/article273465780.html>

“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.



Lake Oroville; July 2021



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



PHOTOGRAPH BY VIT CERNY, ANADOLU AGENCY/GETTY IMAGES

Hunger Stone; Elbe River, Czech Republic; summer 2022
"Wenn du mich siehst, dann weine" ("If you see me, weep").

The Culture of Calamity

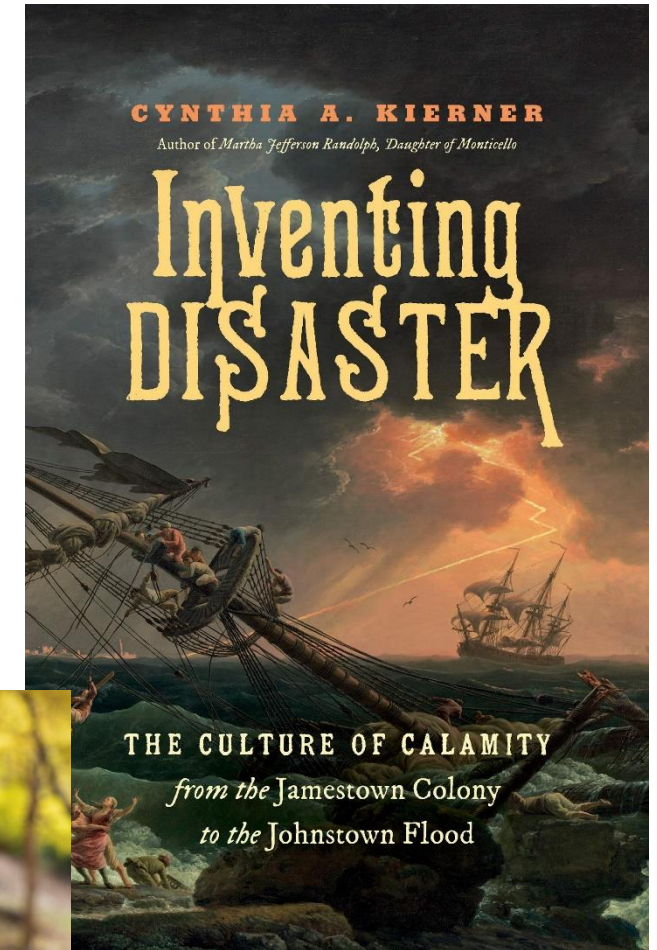
“...our modern approach to disaster is rooted fundamentally in an Enlightenment-inspired confidence in humanity’s ability to conquer and control nature.” Cynthia Kierner, 2019



Jamestown, Virginia (1607), 2020



Cynthia Kierner, Professor of History, George Mason University



The Continuum

“Wild and Free-Flowing Nature”

“Tamed and Conquered Nature”

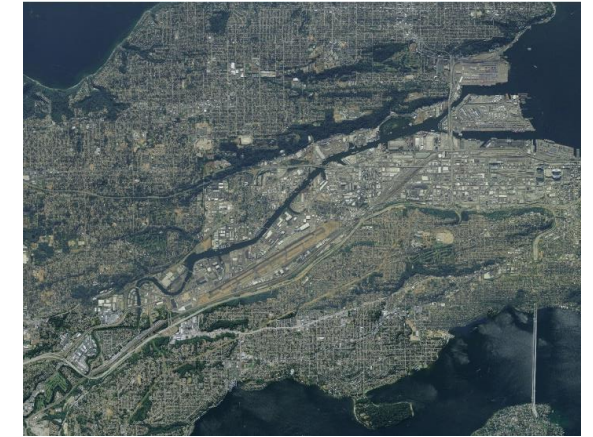


Duwamish River, WA 1800s



San Joaquin Valley, CA 1800s

Sustainability, NEPA (1969): “create and maintain conditions under which humans and nature can exist in **productive harmony**, that permit fulfilling the social, economic and other requirements of present and future generations.”



Duwamish River, WA today



San Joaquin Valley, CA today

Nature-Based Solutions: A White House Priority

2022
Earth Day EO



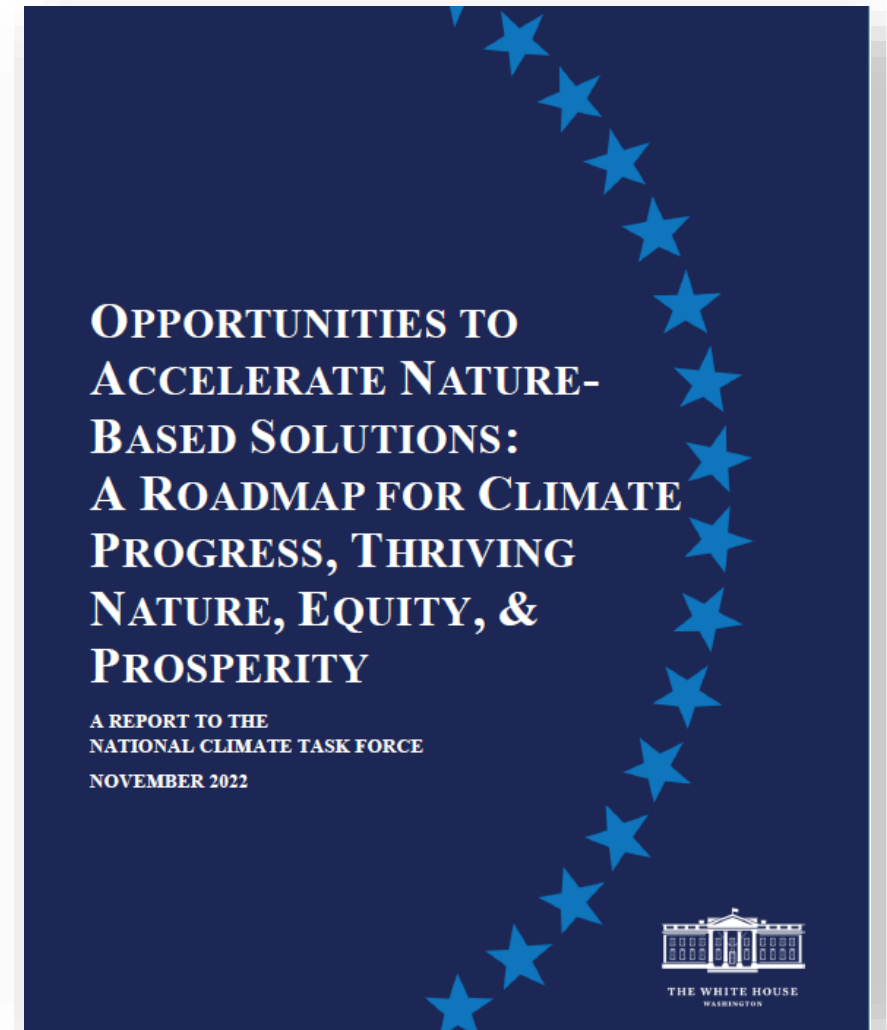
BRIEFING ROOM

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

APRIL 22, 2022 • PRESIDENTIAL ACTIONS

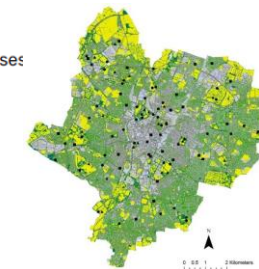
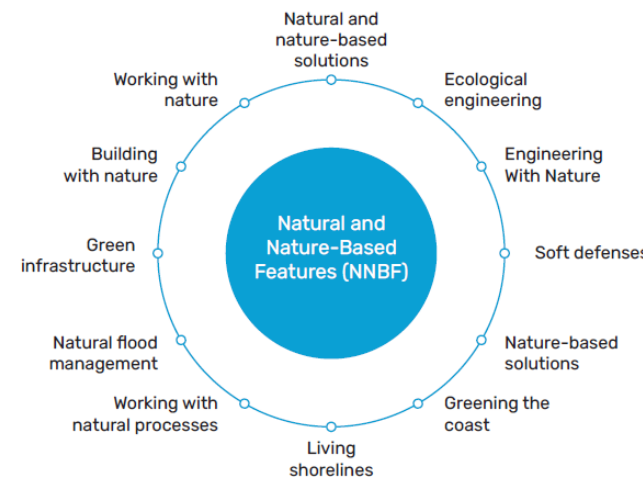
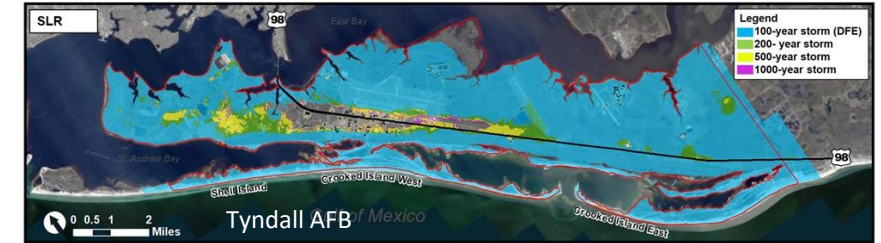
EO 14072, Sec. 4. Deploying Nature-Based Solutions to Tackle Climate Change and Enhance Resilience: *“To further amplify the power of nature, including its ability to absorb climate pollution and increase resilience in all communities, today’s Executive Order calls for the following:”*

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



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. Scott, Z. G. Davies, K. J. Gaston & J. R. Leake
 Scientific Reports 6, Article number: 33708 (2016) | Download Citation &
 1398 Accesses | 20 Citations | 27 Altmetrics | Metrics 29

Applying the Experience of Millennia



Amunas

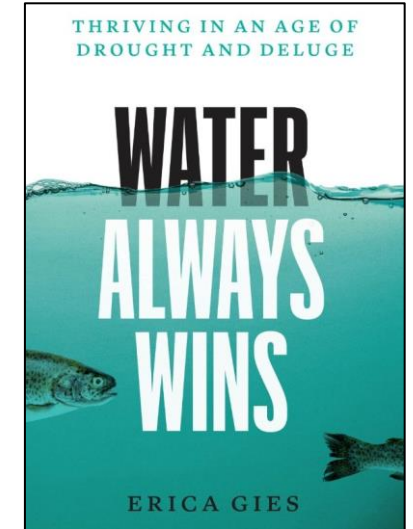
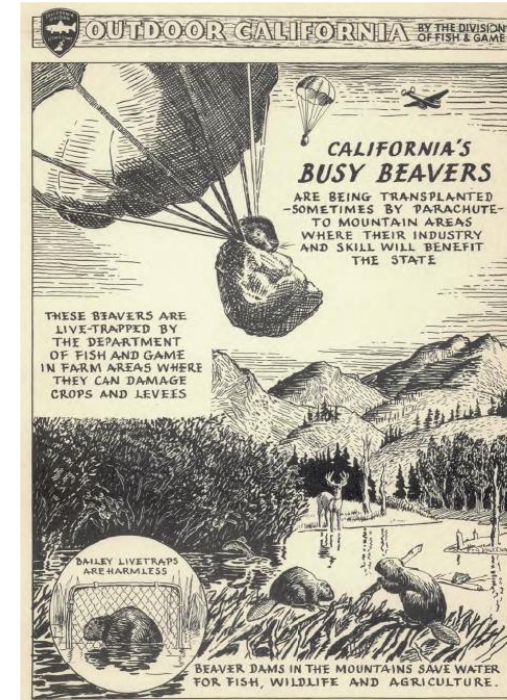
USAID/Peru



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



Check dam, Tucson



Beaver restoration, American Rivers

Ecological Engineering, 1962

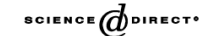
Ecological Engineering: “the practice of joining the economy of society to the environment symbiotically by fitting technological design with ecological *self design*.”
HT Odum, 2003



Port Aransas Nature Preserve



Available online at www.sciencedirect.com



Ecological Engineering 20 (2003) 339–361

ECOLOGICAL
ENGINEERING

www.elsevier.com/locate/ecoleng

Concepts and methods of ecological engineering

Howard T. Odum^a, B. Odum^{b,*}

^a Environmental Engineering Sciences, P.O. Box 116450, University of Florida, Gainesville, FL 32611-6450, USA

^b 2160 N.W. 9th Ave., Gainesville, FL 32603, USA

Received 14 June 2002; accepted 4 August 2003

Abstract

Ecological engineering was defined as the practice of joining the economy of society to the environment symbiotically by fitting technological design with ecological *self design*. The boundary of ecological engineering systems includes the ecosystems that self organize to fit with technology, whereas environmental engineering designs normally stop at the end of the pipe. For example, the coastal marsh wildlife sanctuary at Port Aransas, Texas, developed when municipal wastewaters were released on bare sands. The energy hierarchy concept provides principles for planning spatial and temporal organization that can be sustained. Techniques of ecological engineering are given with examples that include maintaining biodiversity with multiple seeding, experimental mesocosms, enclosed systems with people like Biosphere 2, wetland filtration of heavy metals, overgrowth and climax ecosystems, longitudinal succession, exotics, domestication of ecosystems, closing material cycles, and controlling water with vegetation reflectance.

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Keywords: Ecological engineering; Waste recycle; Self organization; Energy hierarchy; Energy; Transformity; Emdollars; Maximum power



Howard T. Odum, 1924–2002

1.1. Definitions

defines what *ecological* of its principles, and lication with examples Ecological engineering of cooperative environ- we applied the name system self design. By e used worldwide with Society of Ecological

Engineering is sometimes described as the study and practice of solving problems with technological designs. The sketch in Fig. 1a shows the environment and the economy coupled symbiotically by exchange of materials and services. Environmental engineering develops the technology for connecting society to the environment. But the technology is only half of the interface with environment. The other half of the interface is provided by the ecosystems as they *self organize* to adapt to the special conditions. Ecological engineering takes advantage of the ecosystems as they combine natural resources and outputs from the economy to generate useful work.

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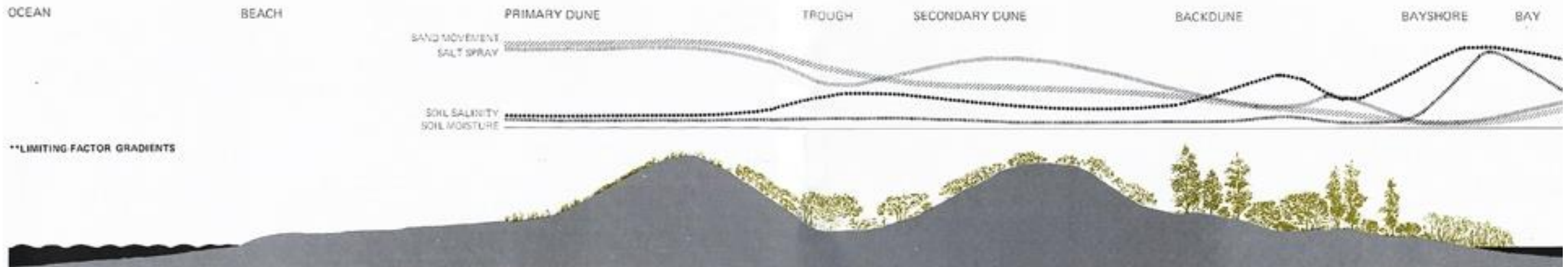
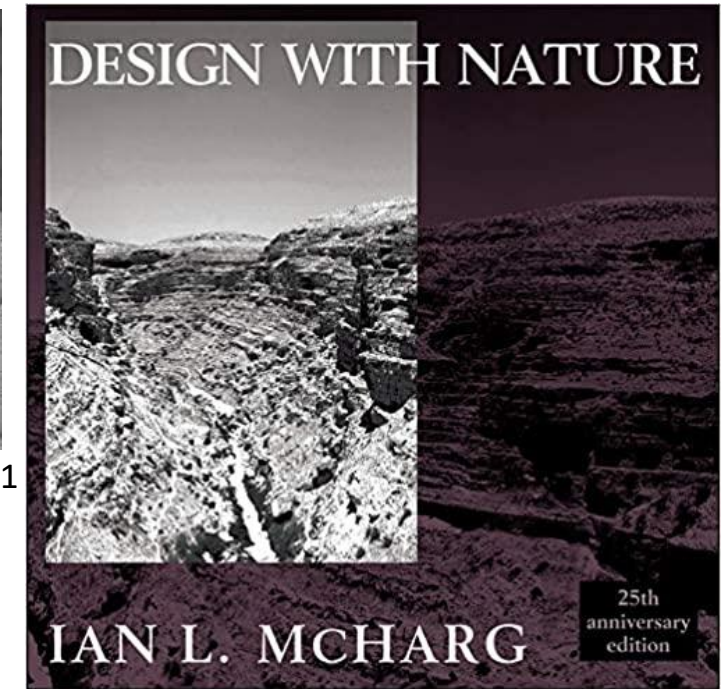
Design with Nature, 1969

“McHarg’s emphasis is not on either design or nature by itself, but upon the preposition *with*, which implies human cooperation and biological partnership. He seeks, not arbitrarily to impose design, but to use to the fullest the potentialities—and with them, necessarily, the restrictive conditions—that nature offers.”

Lewis Mumford, Introduction to *Design with Nature*



Ian McHarg, 1920-2001



“Between the sea and man stood two barriers, the one natural, the other its human surrogate: dune and dike” McHarg, *Design with Nature*

“Natural Infrastructure” in the *Infrastructure Investment and Jobs Act 2021*

- Billions invested in nature-based solutions
- 17+ references to “natural infrastructure” in the bill
- USACE: ~\$17B in appropriations, including:
 - \$2.5B for CSRM, \$1B for multi-purpose
 - \$2.5B for inland FRM, \$750M for multi-purpose
- DOT, surface transportation NI
- DOE, hydropower and FRM NI
- BoR, Western Water Infrastructure NI
- Other supporting investments with NRCS, FEMA, NOAA, EPA, USFWS, Bureau Indian Affairs



The Importance of Leadership Intent on Nature-Based Solutions...

“My vision for the future is driven by a sense of urgency. I’d like the Army Corps, a capable and talented organization, to be innovative in developing new strategies and to build climate resilience to better protect and prepare communities for some of the challenges they’re facing. We need to take advantage of nature-based infrastructure and figure out how we can bring multiple benefits to our projects so that we’re not just doing flood risk and coastal storm management but are also helping to further environmental restoration and even augment water supply where we can.”

Michael Connor, ASA(CW)
Municipal Water Leader, May 2022



“Serious consideration of NNBFs is non-negotiable.”

Eric L. Bush, SES
Chief, Planning and Policy (HQUSACE)
July, 2022

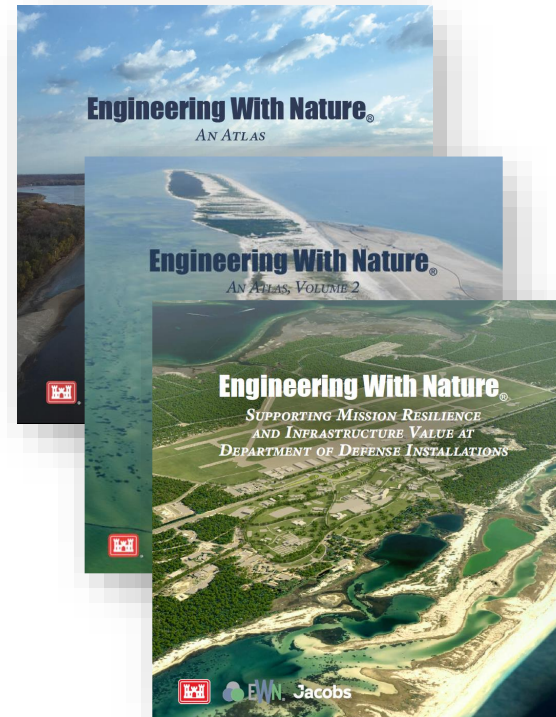


Engineering With Nature®

...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)

The Scale for NbS: *Fit for Purpose*



Living Shoreline, MD

Meters



Deer Island, MS



Hondsbossche Dunes, Netherlands

Kilometers



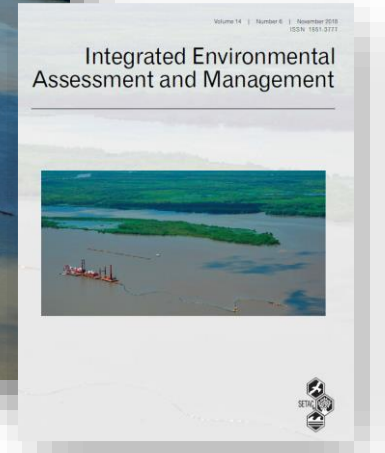
Mississippi River Basin

Millions of Hectares

Fort Pierce City Marina, Florida



Documenting NBS Benefits: Horseshoe Bend Island, Atchafalaya River, Louisiana, USA



Quantifying Wildlife and Navigation Benefits of a Dredging Beneficial-Use Project in the Lower Atchafalaya River: A Demonstration of Engineering with Nature®

Christy M Foran,[†] Kelly A Burks-Copes,[‡] Jacob Berkowitz,[‡] Jeffrey Corbino,[§] and Burton C Suedel^{*‡}

Project Awards:

- 2015 Western Dredging Association Award for Environmental Excellence
- 2017 Western Dredging Association Award for Climate Change Adaption
- 2017 Dredging and Port Construction Award for Engineering with Nature
- 2020 USACE Green Innovation Award



Katwijk Dune and Parking Garage, Netherlands

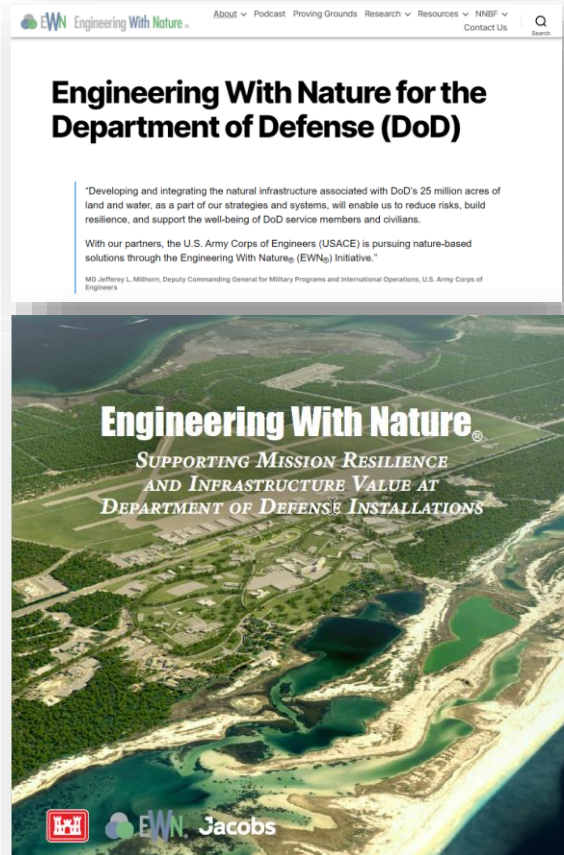


Humber Estuary; Alkborough, UK (Increased Flood Storage)

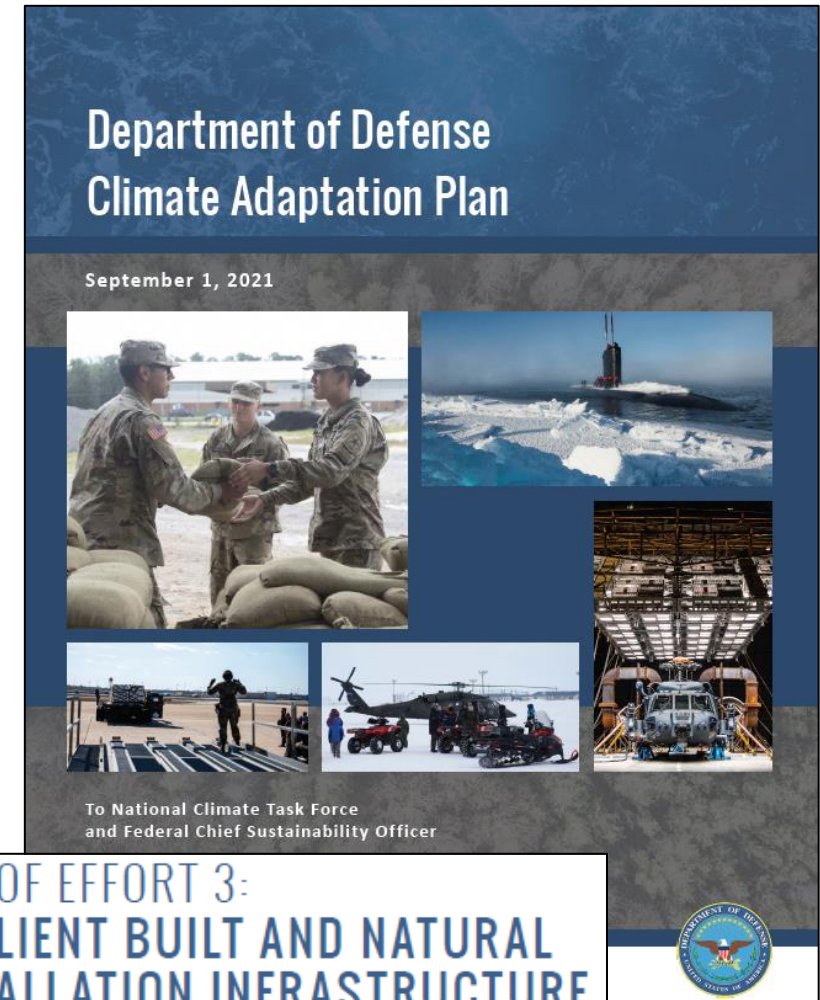


Military Installation Resilience: Built + Natural Infrastructure

“Built and natural infrastructure are both necessary for successful mission preparedness and readiness.”



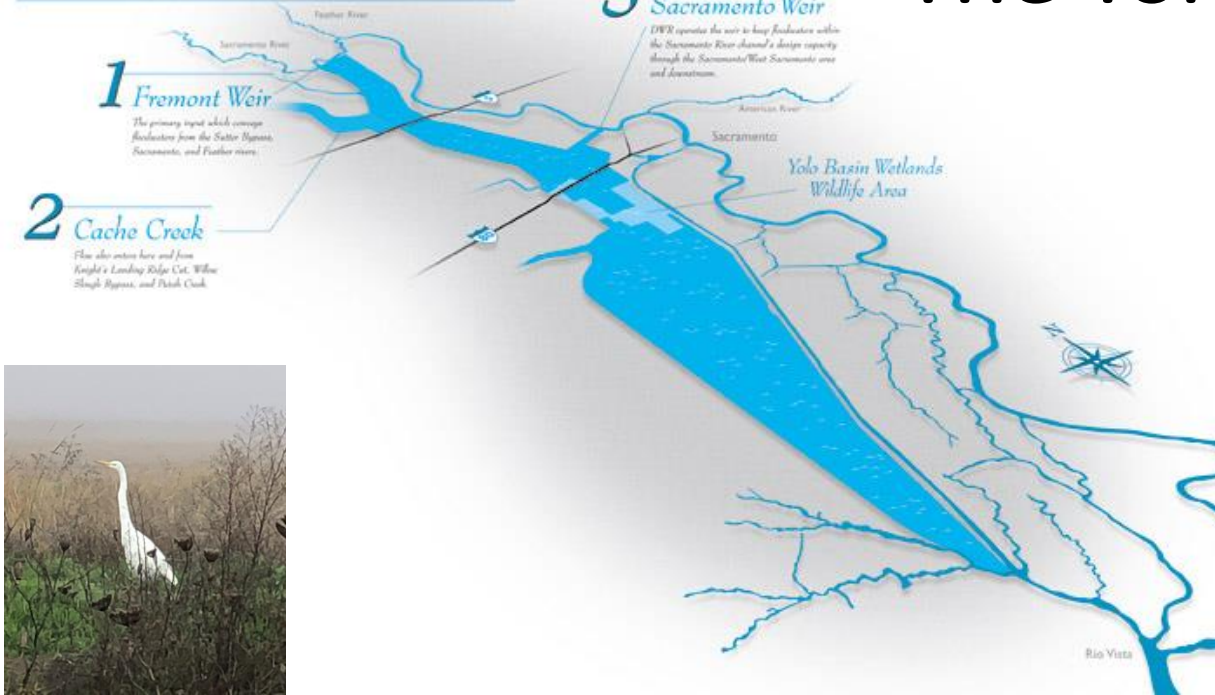
www.engineeringwithnature.org » About



LINE OF EFFORT 3:
RESILIENT BUILT AND NATURAL
INSTALLATION INFRASTRUCTURE

The Yolo Bypass, California (1911)

Yolo Bypass And Its Sources



Yolo Bypass Wildlife Area



Sacramento Weir



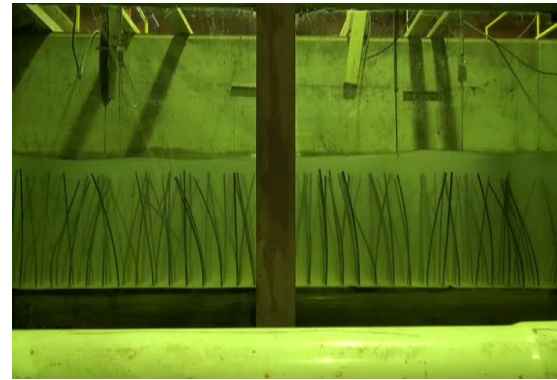
Yolo Bypass, 2017

The Belgian SigmaPlan



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

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



scientific reports

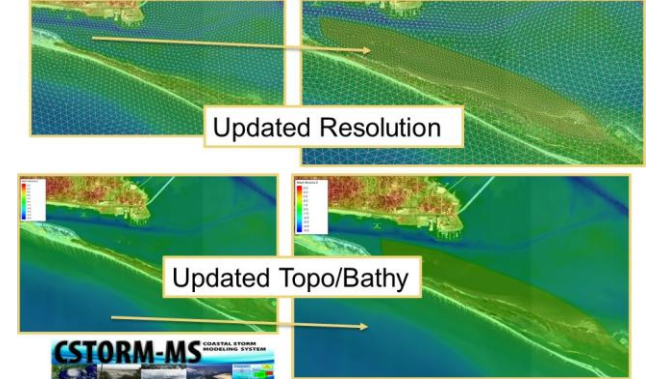
OPEN Resistance, resilience, and recovery of salt marshes in the Florida Panhandle following Hurricane Michael

Katherine A. Castagno^{1,2,6*}, Tori Tomczek³, Christine C. Shepard⁴, Michael W. Beck⁵, Alison A. Bowden⁷, Kiera O'Donnell⁸ & Steven B. Scyphers⁹

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 km² 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 16% 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



<https://ewn.erdcdren.mil/story-maps/engineering-with-nature-ewn-toolkit-for-erdcds-cstorm/>

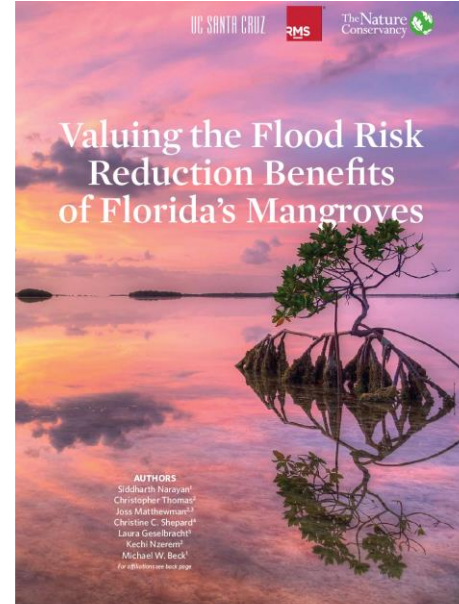


Huamantanga, Peru. People use and maintain 1,400-year-old amunas, canals. Credit: Diego Pérez/Forest Trends

Leveraging Nature for Engineering Value: *Mangroves*

Florida Mangroves Study:

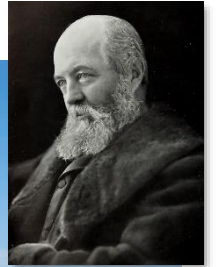
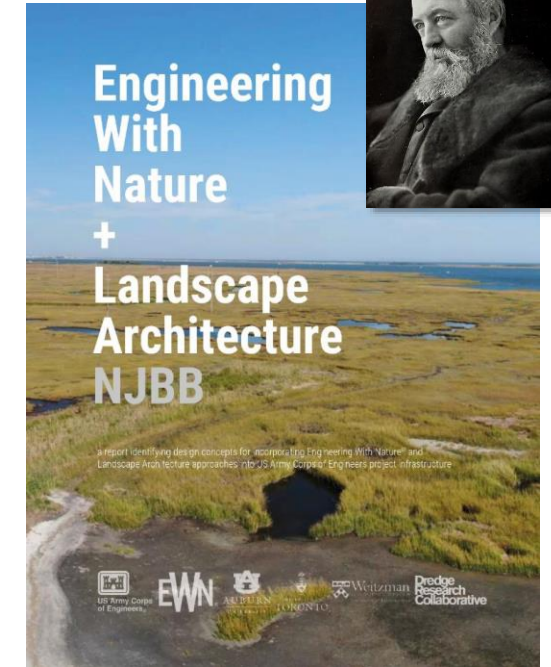
- Used an insurance industry catastrophe model to quantify the flood reduction benefits of mangroves across Florida
- During Hurricane Irma:
 - Mangroves averted \$1.5 billion dollars in flood damages to properties
 - 25% savings in counties with mangroves
 - >600,000 people living behind mangrove forests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



Create Space and Partnerships for Innovating

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




US Army Corps of Engineers®



Beneficial Use Benefits: *The USACE '70 x 30' Goal*

“Beneficial use” is using dredged sediment to achieve additional benefits beyond its removal from a channel/waterway, including other economic, environmental or social benefits.

 DEPARTMENT OF THE ARMY
HEADQUARTERS, US ARMY CORPS OF ENGINEERS
441 G STREET NORTHWEST
WASHINGTON DC 20314-1000

CECG 25 January 2023

Beneficial Use of Dredged Material Command Philosophy Notice

Teammates,

Today I am formally issuing a Beneficial Use of Dredged Material Command Philosophy Notice which outlines my vision for expanding the U.S. Army Corps of Engineers beneficial use of dredged material (BUDM) program. This philosophy notice aligns with two of my four key priorities for the organization, Partnerships and Innovate.

Dredged material is a valued resource that is not to be wasted, but instead used for benefits to the ecosystem, economy, and to deliver the USACE mission more effectively and efficiently across our portfolio of Navigation, Flood Risk Management and Aquatic Ecosystem Restoration projects.


Through a symbiotic relationship with navigation dredging, you are being called to generate productive and positive uses of dredged material. If there is a need for USACE to dredge an authorized channel, the operational strategy should inherently include beneficial use placement options. Equally, if there is a need for sediment, gravel, or rock material to implement a project, beneficial use from dredging operations within authorized channels should be considered as a source in the planning and execution strategy. We must do these things in compliance with applicable laws and regulations, including the Federal Standard for dredged material disposal or placement. A proper analysis of the total lifecycle cost of dredging and placement as well as the full benefits will result in an accurate determination of the Federal Standard.

USACE historically uses 30-40% of the sediments derived from the Navigation mission for beneficial purposes. I have established a goal for USACE to advance the practice of BUDM to 70% by the year 2030 (“70/30 Goal”).

Achieving our vision will require purposeful documentation and an innovative pursuit both internally and externally with our partners and stakeholders. You will need to leverage available solutions, strategies, and tools to the maximum extent practicable while developing and applying new approaches and technologies to address the associated engineering challenges.

Districts and divisions are hereby called upon to participate in supporting this shared vision, provide input into the actions to be undertaken, and ensure ultimate success of the BUDM program.

Now is the time to get involved. For more information on how to get involved, contact Tiffany Burroughs, Chief Navigation, HQUSACE by phone at (202) 761-4474 or by email at tiffany.s.burroughs@usace.army.mil

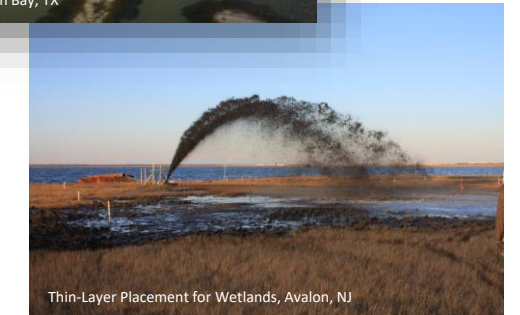
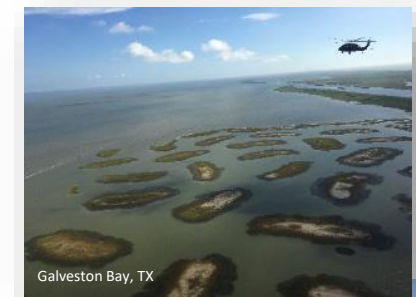
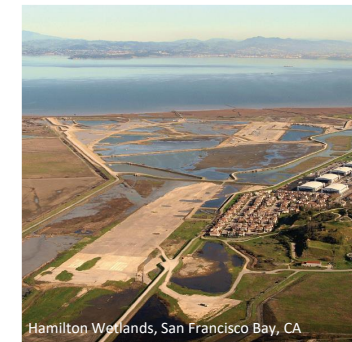
BUILDING STRONG!

SCOTT A. SPELLMON
Lieutenant General, US Army
Commanding

“Dredged material is a valued resource that is not to be wasted, but instead used for benefits to the ecosystem, economy, and to deliver the USACE mission more effectively and efficiently across our portfolio of Navigation, Flood Risk Management and Aquatic Ecosystem Restoration projects.”

“I have established a goal for USACE to advance the practice of BUDM to 70% by the year 2030 (“70/30 Goal”).”

Port of Charleston:

- 8th largest container port in US
- Supports 1 in 10 jobs in SC
- \$63B in economic impact



Evaluate Comprehensive Nature Benefits

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

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



"It matters because it matters to the President."

"Our sponsors no longer want to see 'off the shelf' solutions."

"We can't value everything, but we need to value what we can."

Michael L. Connor, ASA(CW)

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

Prepare Yourself and Your Project for *The Principles, Requirements, and Guidelines*

“Project delivery teams (PDTs) must identify and analyze benefits in total and equally across a full array of benefit categories.” RD James, ASA(CW); Comprehensive Benefits Memo, JAN 5, 2021

“We urge your immediate action... In the Water Resources Development Act of 2020, Congress directed the Corps to issue final agency procedures necessary to implement the new Principles, Requirements, and Guidelines (PR&G).” Cong. DeFazio, Napolitano, Garcia, FEB 10, 2022

“In this proposed regulation, the Corps intends to increase consistency and compatibility in Federal water resources investment decision making to include considerations such as **analyzing a broader range of long-term costs and benefits**, enhancing collaboration, including a more thorough and transparent risk and uncertainty analyses, and improving resilience for dealing with emerging challenges, including climate change.” OIRA-OMB, JUN 2022 <https://www.reginfo.gov/public/do/eAgendaViewRule?pubId=202110&RIN=0710-AB41>

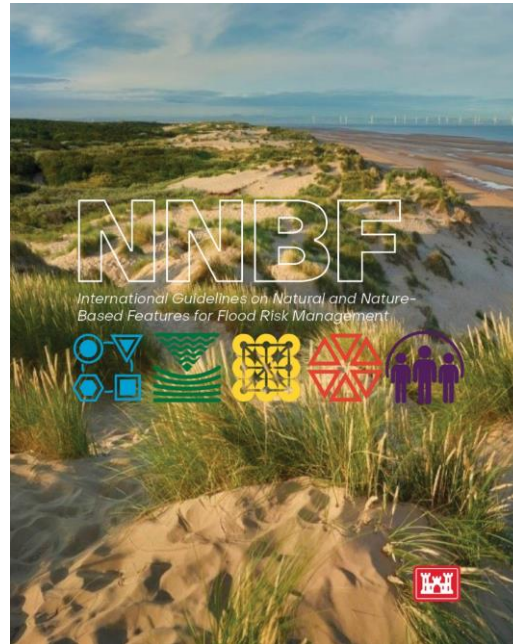
PR&G Guiding Principles

1. Healthy and Resilient Ecosystems
2. Sustainable Economic Development
3. Floodplains
4. Public Safety
5. Environmental Justice
6. Watershed Approach

Develop Guidance: *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.ercd.dren.mil/?page_id=4351



www.engineeringwithnature.org



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

NNBF Guidelines

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

Mission, Responsibility, and Codes: ASCE

- ASCE Code of Ethics, Fundamental Canons
 - “Engineers shall hold paramount the safety, health, and welfare of the public and shall strive to comply with the principles of **sustainable development** in the performance of their professional duties.”
- ASCE Policy Statement (418) on “the role of the civil engineer in **sustainable development**”
 - ASCE “defines sustainability as a set of economic, environmental, and social conditions (aka "The Triple Bottom Line") in which all of society has the capacity and opportunity to maintain and improve its quality of life indefinitely without degrading the quantity, quality, or the availability of economic, environmental, and social resources. **Sustainable development** is the application of these resources to enhance the safety, welfare, and quality of life for all of society.”
- ASCE supports the following steps to achieve a **sustainable project**:
 - Perform Life Cycle Assessment from Planning to Reuse.
 - Use Resources Wisely.
 - **Plan for Resiliency. Sustainability requires planning for the impact natural and man-made disasters and changing conditions can have on economic, environmental, and social resources.**
 - Validate Application of Principles.

Nature-based Solutions: ASCE

“Incorporating **nature-based solutions** and best practices into our infrastructure systems can contribute meaningfully to our resilience, economic health, and mitigating the impacts of climate change.”

Maria Lehman, ASCE President

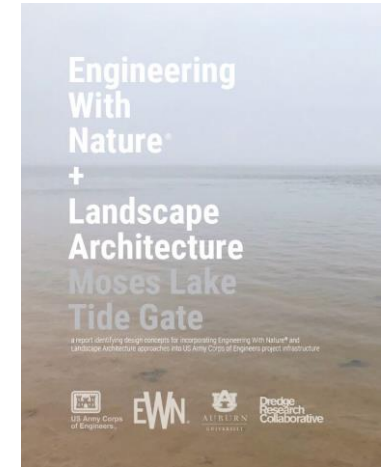
ASCE-sponsored event on National Nature Assessment, Washington DC, February 1, 2023

“Due to the significant development within the coastal zone, natural coastal resources have been adversely impacted. Restoration and protection of these **natural features are critical to future coastal resilience**. Emphasis on planning, design and development of **natural and nature-based solutions are necessary to improve community resilience** to sea level rise, increased flooding, and storm events...**Civil engineers are responsible for the built and natural infrastructure systems** that support a significant portion of our economy and a diverse natural environment...”

ASCE Policy Statement 162 - Protection and development of coastal resources

*ASCE Committee: Natural and Nature-Based Infrastructure Systems;
Co-chairs Dr. Brian Bledsoe, Dr. Jeff King

Design with 'Nature-First Thinking'

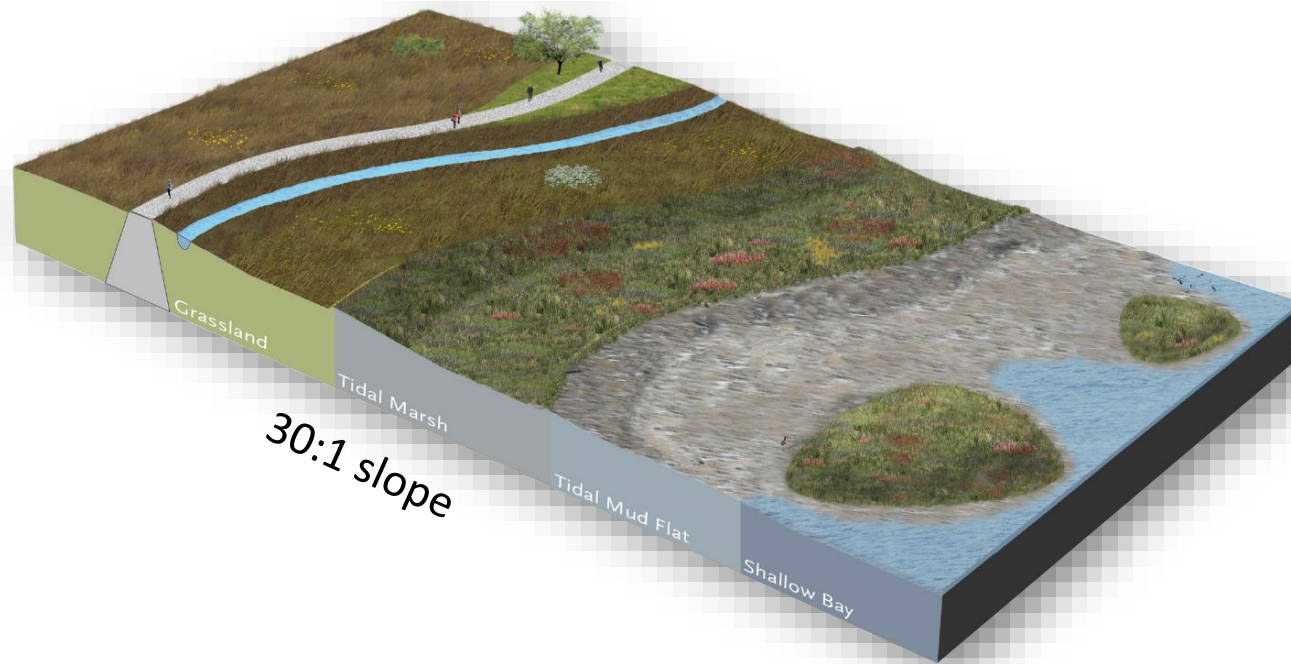


Hunter's Point, New York

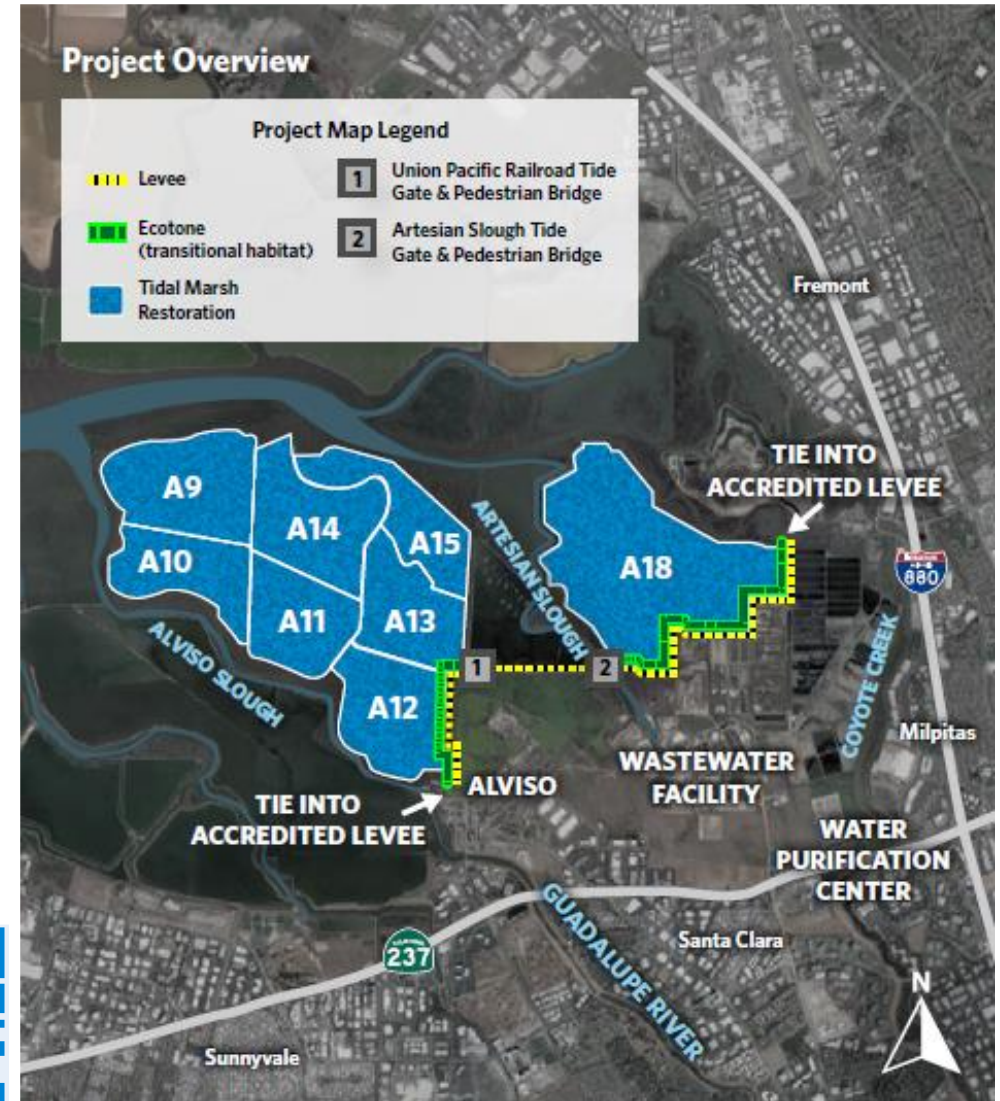


Hunter's Point, New York

Ecotone Levee

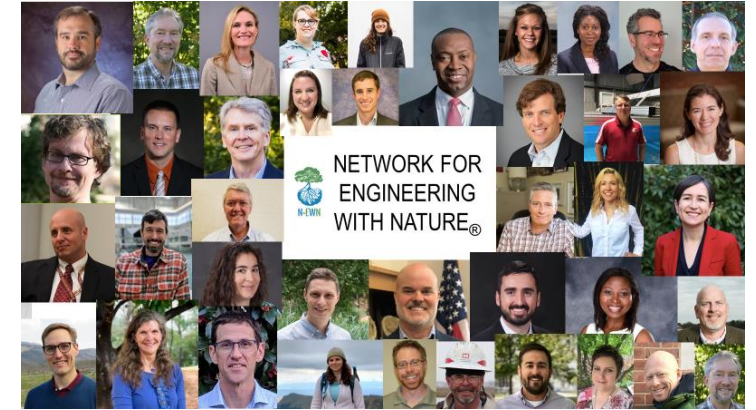


South San Francisco Bay Shoreline Project



Support Education and Progress: The Network for Engineering With Nature (N-EWN)

- Multi-sector network supporting innovation
 - Types of partners: public and private sector
 - Research – gov't, academic, private
 - Industry practitioners
 - Project owners
- Aligning research with the needs of practice
- Grounding approach in real projects
- EWN education: curricula and training
- Experiential learning for students – systems thinking, cross-disciplinary training
- Freely flowing communication and knowledge sharing
- Accelerate implementation



US Army Corps of Engineers.



Institute for Resilient Infrastructure Systems
UNIVERSITY OF GEORGIA



NYC Mayor's Office of Climate Resiliency



TRIBAL NATIONS TECHNICAL CENTER OF EXPERTISE



THE WATER INSTITUTE OF THE GULF*



UNIVERSITY OF CALIFORNIA
SANTA CRUZ

ASU
Arizona State University

NCCOS
NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

UF UNIVERSITY of FLORIDA
CENTER FOR COASTAL SOLUTIONS



SAN ANTONIO RIVER AUTHORITY

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
COASTAL RESOURCES DIVISION

Stantec

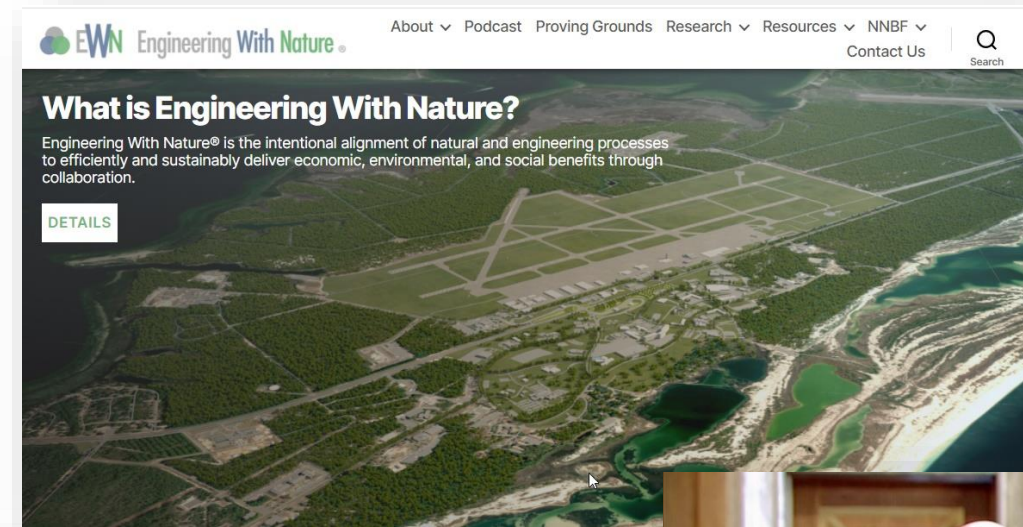
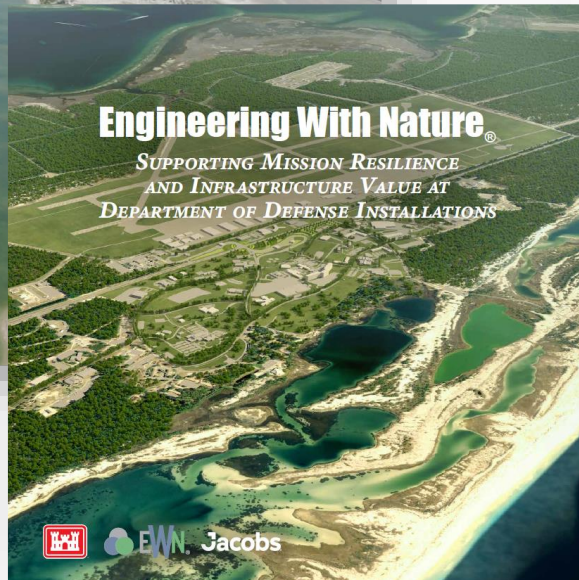
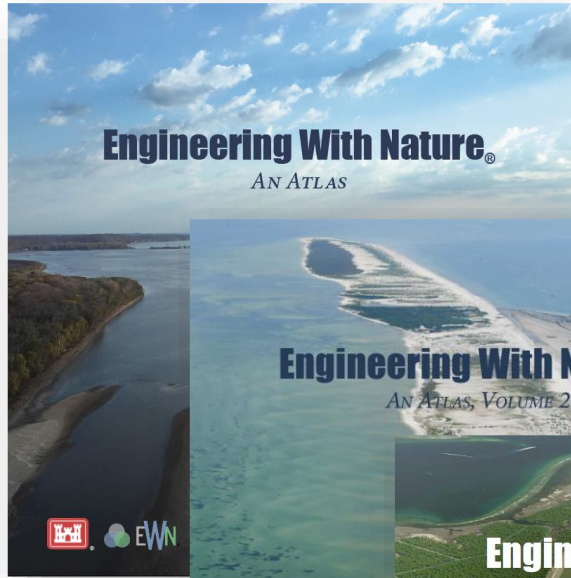


The UNIVERSITY of OKLAHOMA

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Institute for Resilient Infrastructure Systems

www.engineeringwithnature.org; <https://n-ewn.org/>

Spark Conversation, Thinking, and New Ideas



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



Nature-based Solutions...

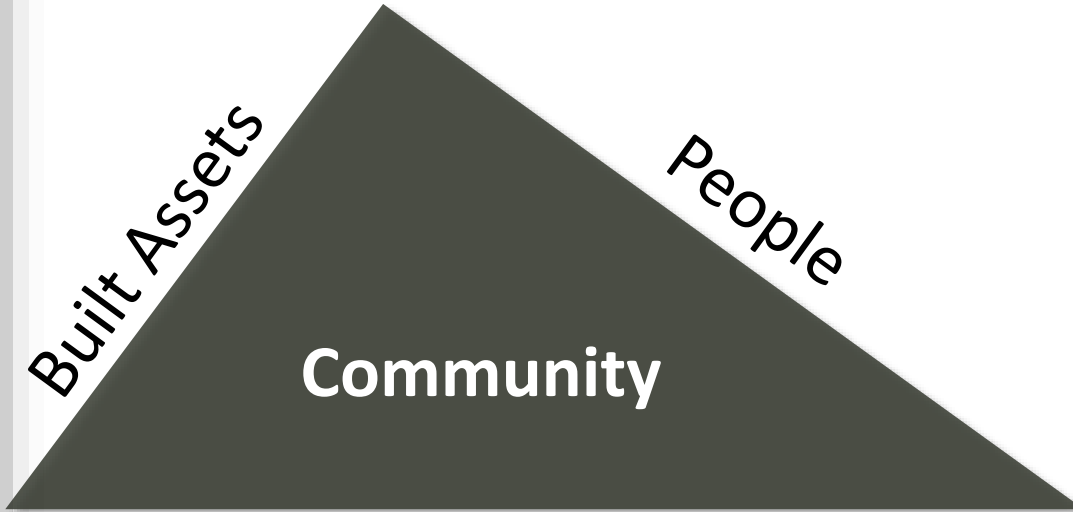
- Provide a buffer against nature's 'unruliness'
- Are a necessary component of building lasting resilience
- Are strong in their flexibility and adaptability
- Provide a means for diversifying sustainable value for communities



SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD



Comprehensive Resilience



Nature

The key to future resilience and sustainability:

- ✓ ***Blend***
- ✓ ***Balance***
- ✓ ***Benefits***

