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Supporting Mission Resilience through Natural Infrastructure

To better support the resiliency needs of defense installations into the future, the Engineering With Nature initiative within the U.S. Army Corps of Engineers has been developing and implementing nature-based solutions to infrastructure needs.

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Engineering With Nature seeks natural systems that support critical engineering functions for infrastructure, such as improving coastal resilience with sediment from navigation dredging projects. PHOTO BY HOLLY KUZMITSKI, U.S. ARMY ENGINEER RESEARCH & DEVELOPMENT CENTER **ENVIRONMENTAL ENGINEERING**





any of the challenges and opportunities that the Department of Defense (DOD) will face throughout the balance of the 21st century relate to building and sustaining the infrastructure needed for mission resilience.

Currently, DOD and its 3 million team members operate on more than 25-million-acres and nearly 5,000 sites in different regions, climates, and landscapes in the United States and around the world. Over the last five years, military installations have experienced more than \$10 billion in damage from storms, flooding, and other natural hazards. These risks are compounded by combinations of natural hazards, climate change, and aging infrastructure. Given the complexity of DOD's mission, there are not many instances where simple "silver bullet" infrastructure solutions are sufficient. Creating resilient systems requires innovation and action. Meeting this need will require new ways of thinking about complex problems, an openness to new solutions, a willingness to change, and a commitment to adaptation.

For the last 10 years, an initiative within the U.S. Army Corps of Engineers has been working to develop and implement approaches that leverage natural systems to support critical engineering functions while also delivering a diversity of economic, environmental, and social co-benefits. The progress achieved through Engineering With Nature (EWN) over the last decade has been the product of numerous projects, partnerships, technical advancements, and communication investments.

These efforts are accelerating the innovation and delivery of nature-based solutions. The natural landscapes, features, and processes situated on DOD's footprint can and will play a dynamic role in natural hazard mitigation. Through stewardship and investment, these assets comprise 25-million-acres of risk reduction potential—an opportunity that science and engineering practitioners can focus on to create nature-based solutions that support DOD readiness and resilience.

EFFECTIVE SOLUTIONS

Natural landscapes have always played an important role in military missions. In 1777, Maj. Gen. Horatio Gates of the Continental Army wrote his friend Dr. Benjamin Rush after the Battle of Saratoga about the role of a Polish-born engineer Col. Tadeusz Kosciuszko. "The great tacticians of the campaign," Gates wrote, "were hills and forests, which a young Polish engineer was skillful enough to select for my encampment."

Today, applications of nature-based solutions are being planned and implemented across installations for the U.S. Army, U.S. Navy, and U.S. Air Force. In the aftermath of Hurricane Michael, for example, Tyndall AFB in Florida embarked on a massive rebuild to create a resilient, sustainable, and smart "Installation of the Future" that includes natural infrastructure solutions. A coastal resilience plan has identified four major pilot projects that can inform large-scale implementation. This multi-pronged approach involved engaging internal and external stakeholders to identify natural infrastructure opportunities, modeling those landscape interventions (such as enhancing sand dunes), and assessing their performance with respect to the hazards (hurricanes).



The value of natural infrastructure opportunities is a function of their contributions to mission resilience, low lifecycle costs, numerous co-benefits, and extensive interest and financial support from external stakeholders and partners. The Tyndall Coastal Resilience Study received the U.K. Environment Agency Flood & Coast International Excellence Award in June 2021.

LEADING FROM THE FUTURE

In August 2021, EWN convened a two-day virtual workshop that assembled 40 participants from across DOD, government, industry, academia, and non-government organizations to identify ways to increase resilience on military installations using natural infrastructure. The workshop discussed case studies at Tyndall, as well as at Naval Base Ventura County, Calif., and Aberdeen Proving Ground, Md., to disprove common myths about natural and conventional infrastructure, including "conventional engineering is adequate to combat future challenges" and "total lifetime costs of natural infrastructure are greater than conventional infrastructure."

At Naval Base Ventura County, modeling of impacts on natural habitats indicated that, if built assets are defended in place with conventional armoring, beaches will erode away while mudflats and salt marsh habitats will submerge and convert to open water.

These natural areas need to be connected with natural water and sediment flows to allow them to accrete sediments and grow vertically to keep pace with rising seas. Armoring prevents these natural processes from occurring and impedes the ability of habitats to migrate inland. Working with nature will improve natural habitat function and resilience, enhancing the protective services they provide.

Aberdeen Proving Ground in the Chesapeake Bay is expected to experience some of the highest levels of relative sea level rise along the Atlantic coast. A project led by the Joint Land Use Study Work Group in 2019 has proposed using sediment from navigation dredging projects to improve coastal resilience and mission assurance in a way that will reduce costs for regional adaptation and navigation infrastructure operations.

Sand fencing is a technique that was used in the past on the barrier islands fronting Tyndall AFB to support sand dune development. This approach is again being implemented following Hurricane Michael as a widely used and affordable intervention for accelerating dune development that makes use of natural processes like windborne transport of sand.

The EWN workshop also immersed participants in three future scenarios that were designed to explore the value of natural infrastructure on installations in 2050. By exploring these scenarios, participants identified potential applications of natural infrastructure for mission resilience, the outcomes created by these solutions, and the value accrued by installations, the surrounding communities, and personnel and their families.

Workshop participants analyzed these futures to identify intermediate steps and actions for implementing natural infrastructure to provide mission assurance, installation resilience, positive quality-of-life impacts, and environmental benefits. Participants identified the need for guidance, standards, policy, and culture change as categories of enabling action. Finally, they identified a series of next steps that DOD could undertake in the near-term to make progress toward implementing natural infrastructure to meet installation needs.

- Engage leaders across DOD, individual installations, and government in active dialogue about natural infrastructure.
- Develop strategic engagement materials that highlight current natural infrastructure projects that document return on investment.
- Develop supporting technical tools and templates.
- Facilitate the development of natural infrastructure standards of practice, such as a Unified Facilities Criteria for natural infrastructure.

It was clear from the substantive dialogue at the workshop that natural infrastructure has an important part to play in resilience thinking within DOD as a means to produce practical, costeffective, and beautiful resilience solutions.

Following the workshop, in September, the Corps of Engineers published International Guidelines on Natural and Nature-Based Features for Flood Risk Management. Developing the guidelines was a broad, five-year, multi-sector collaborative effort that included over 75 organizations from around the world sharing their knowledge and experience to document best practices in conceptualizing, planning, designing, engineering, operating, and maintaining natural and nature-based features as a part of flood risk management systems. This document is a key step in advancing broad acceptance of nature-based solutions

SHARING THE LOAD

DOD faces a complex set of challenges related to developing and sustaining the infrastructure needed for mission resilience. Bases will always be needed near coastlines, waterways, and in the path of risks. Geographic stresses, such as areas with frequent drought or wildfires, cannot be an inhibitor to ensuring readiness.

The path of innovation does not, and cannot, be traveled alone. It requires collaboration with multi-sector partners ready to share the load in regard to natural infrastructure.

EWN looks forward to engaging, collaborating, and partnering across DOD and all sectors to develop natural infrastructure that supports readiness and resilience into the future.

At the recent USACE Innovation Summit in October 2021, Maj. Gen. Jeffrey Milhorn, USA, put EWN into perspective and outlined its role to play: "It wasn't that long ago that engineering with nature was, in fact, considered innovative; and I would say today, that it probably still is in a lot of these areas. But I will tell you even more so today, we have to consider and find additional, resilient, and long-standing nature-based solutions beyond even what we've already developed. They apply not only internal to our own infrastructure, but also to the military installations of the future."

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