

Written statement of

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Before the Subcommittee on Coast Guard and Maritime Transportation
of the Committee on Transportation and Infrastructure
U.S. House of Representatives

“Coast Guard and Port Infrastructure: Built to Last?”

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Chairman DeFazio, Chairman Maloney, and Ranking Member Gibbs, thank you for the opportunity to testify today on the importance of port infrastructure resilience within the United States Coast Guard. I am pleased to provide testimony today on the role university-based research can play in providing the Coast Guard with tools to build and maintain resilient and adaptive port infrastructure to fulfill its mission.

I am a professor in the College of Engineering at Oregon State University and have been conducting research in coastal engineering for more than 30 years, including the impacts of extreme coastal storms and tsunami on critical infrastructure. Since 2014, I have served as an associate director of the Center for Risk-Based Community Resilience, headquartered at Colorado State University and supported through the National Institute for Standards and Technology. This center has supported me and other researchers to investigate coastal impacts on infrastructure, including critical facilities and lifelines such as electric power networks, water, communication, and transportation network that are essential for immediate response and recovery. Our work combines engineering, social science, economics and computer science to create metrics to assess community resilience and to develop open-source computation tools for risk-informed decision-making to enable better strategies for hazard mitigation. I am also a member of the Center Resilience Center, headquartered at the University of North Carolina, and funded through the Department of Homeland Security. Through the National Science Foundation’s Natural Hazards Engineering Research Infrastructure program, I am supported as the principle investigator of the O.H. Hinsdale Wave Research Laboratory at Oregon State University, which serves as the Nation’s shared-used experimental facility for coastal engineering research. I am a member of several committees of the American Society of Civil Engineers, including the chair of ASCE 7-22 Chapter 5 Flood Load subcommittee. Our subcommittee provides improvements to building codes to ensure the safe design of structures subjected to riverine flooding and to coastal surge and waves.

Overview

This testimony provides perspective on the importance of and opportunity for the Coast Guard to access and utilize science-based, risk-informed decision-support tools to further promote resilient

port infrastructure, including adaptive planning for port infrastructure, advanced materials and health monitoring, natural and nature-based features (NNBF), as well as the importance of graduate educational programs for workforce development.

Risk-informed Decision-support Tools for Resilient Port Infrastructure

Resilience is the ability to absorb and recover quickly from a sudden stress. During extreme threats posed by coastal hurricanes and tsunami, it is essential that Coast Guard port facilities be able to absorb and recover quickly because these facilities are essential for emergency response, search and rescue, and for the early stages of recovery. Modern, risk-informed decision support tools have been developed that can be used to predict the consequences of extreme coastal events on port infrastructure and can be used to develop optimized solution strategies. Probabilistic tools, rather than scenario-based planning tools, can capture the uncertainties in both the hazard and system response, and can be used to identify highest-risk conditions for developing effective mitigation strategies.

These tools should be considered for resilient port infrastructure design, maintenance and operation. The US Naval Station at Norfolk VA, for example, has been studied extensively using risk-based approaches to determine which types of loading (wind, wave, and surge) were threats to the various assets; identify the most likely infrastructure failure modes; and generate the probability of damage based on the capacity and demand. These studies can also be conducted relevant to the Coast Guard or other critical port infrastructure to inform performance-based design of critical port infrastructure and improve risk communication and urgency for port infrastructure improvements. Additionally, work by the NIST-funded Center for Risk-Based Community Resilience is producing open-source modeling tools to enable better strategies for hazard mitigation. Further, the DHS-funded Coastal Resilience Center is creating better hazard prediction tools and related damage functions to predict infrastructure damage due to hurricane surge and waves, and can be used in conjunction with for decision-support tool such as HAZUS-MH. Work by the American Society of Civil Engineers is updating design standards for critical facilities to withstand floods, hurricane wave and surge, and tsunamis and can be used to make port facilities more resilient to these extreme events. These examples underscore the increasing access to and utility of decision-support tools and building design standards that are available to planners that can effectively promote enhanced resiliency of our critical federal and coastal infrastructure.

Adaptive Planning for Port Infrastructure

In concert with developing effective mitigation strategies for extreme events, the Coast Guard must consider port infrastructure under the chronic conditions related to sea level rise and changing storm in patterns. Nuisance flooding and other hazards associate with chronic coastal conditions can impact the Coast Guard's mission, impacting readiness and operation. The Coast Guard should consider adaptive planning to improve port infrastructure and account for future sea level uncertainties and associated short- and long-term vulnerabilities. For example, studies conducted on US Naval ports along the Pacific Coast, quantify the number of days per year when operational thresholds will be exceeded for critical infrastructure such as bridges and other lifeline networks due to combinations of future sea level rise, El Nino events, and changes in

weather patterns. Investing in studies and analyses to make these future projections would allow port planners to compare elevation, relocation, and other adaptive mitigation strategies.

Advanced Materials and Health Monitoring for Port Infrastructure Rehabilitation

Changes in water levels will also affect, and in some cases accelerate, the deterioration of port infrastructure. This deterioration can be reduced by improving the corrosion resistance of steel in reinforced concrete, potentially improving the service life of the infrastructure, and allowing adaptive strategies to be enacted. Service life models can be used to better document what remaining life a facility may have and improve decision-making on infrastructure rehabilitation. Improved models relating exposure conditions from extreme surge and waves on long term performance can be used to provide better service life prediction, and advances in high performance concrete can be used to improve new construction.

Natural and Nature-Based Features (NNBF) for Port Infrastructure

Natural and nature-based features can be used to protect port infrastructure and to provide ecological benefits to adjacent areas. Research has demonstrated that NNBF can reduce wave and surge conditions acting on exposed port infrastructure, and biocementation can be used to mitigate effects of erosion and scour under extreme storm conditions. Specifically, research relying on field observations after major storms combined with laboratory testing and numerical modeling confirms the role that NNBF can play in reducing the hazards associated with coastal storms on the built environment. At Oregon State University, through support of the National Science Foundation and the Natural Hazards Engineering Research Infrastructure program, and in collaboration with 5 other universities, we recently conducted one of the first comprehensive studies of the role of NNBF for coastal protection against hurricane wave and surge. This new research allows engineers to quantify the benefits of NNBF in the design of coastal infrastructure and to use NNBF in conjunction with traditional structures. This not only lowers the overall cost of infrastructure projects: it can also improve the permitting process by providing co-benefits for marine habitat and recreation. The US Army Corp of Engineers was also a partner on this project and has accelerated research and practical application of NNBF to mitigate coastal hazards. Similarly, the Coast Guard should consider the role of natural and nature-based features in the rehabilitation of existing infrastructure and future projects, including ways in which NNBF can supplement and integrate with more traditional infrastructure for better meeting objectives for adaptation and resilient planning.

Graduate Educational Programs for Workforce Development

The Coast Guard and other areas of the federal government need a workforce trained in understanding issues of port infrastructure adaptation and resilience. Some of these training programs are already in place. At Oregon State University, for example, we are engaging with Coast Guard and Navy students at the graduate education level. We provide a rigorous academic program combined with hands-on research projects tailored to the missions of these agencies. We encourage the Coast Guard to continue and enhance their workforce training at the graduate level in the area of coastal engineering to build and maintain resilient and adaptive port infrastructure.



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Summary

In closing, I thank the Subcommittee for your efforts to consider the role of university-based research and education can play in providing the Coast Guard with tools to build and maintain resilient and adaptive port infrastructure to fulfill its mission. I would be pleased to answer any questions.

Sincerely,

A handwritten signature in blue ink that reads "Dan Cox".

Daniel Cox
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