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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

HEARING ON
AN EXAMINATION OF FEDERAL FLOOD MAPS IN A CHANGING CLIMATE

BEFORE THE
HOUSE COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
SUBCOMMITTEES ON ENVIRONMENT AND INVESTIGATIONS AND OVERSIGHT

FEBRUARY 27, 2020

INTRODUCTION

Good afternoon Chairwoman Sherrill and Chairman Foster, Ranking Members Marshall and Norman, and members of the Subcommittees. My name is Mark Osler and I am the Senior Advisor for Coastal Inundation and Resilience in the National Oceanic and Atmospheric Administration's (NOAA) National Ocean Service. I collaborate across federal agencies and with our respective partners to guide NOAA's work in providing data, tools and expertise that reduce risks and inform efforts to respond to changing environmental conditions such as sea level rise and coastal storms.

Thank you for inviting me to testify today. It is my honor to be here along with my colleagues from the Federal Emergency Management Agency (FEMA), the Association of State Floodplain Managers, and industry.

I appreciate the Subcommittee's interest in exploring how flooding and sea level rise affect American property owners, communities, and economies. My testimony today will highlight how NOAA provides world class science and decision support services to U.S. taxpayers, empowers national and local decision makers to enact science-informed policies, and serves as a convener and supporter of an "all of government" approach to how federal agencies can support one another to reduce impacts from flooding on our Nation's citizens and economy.

THE COASTAL CHALLENGE

If the U.S. coastal counties were an individual nation, it would rank third in the world in gross domestic product, surpassed only by the United States and China. Annually, our coastal counties produce more than $8.3 trillion in goods and services, employ 56 million people, and pay $3.4 trillion in wages. Forty percent of the U.S. population lives along the coast. The coastal and ocean economy -- also called the blue economy -- is the fastest growing segment of our economy. This engine of American prosperity is being placed under unprecedented stress from the impacts of extreme weather and sea level rise. If not properly addressed, these threats will undermine our national security as well as our economic security.[1]

Our coasts face threats from all sides. The impacts from rising seas and coastal storms are increasing. These forces, combined with upland development and increased riverine flooding are speeding the erosion of natural features like shorelines, beaches and wetlands that protect our coastal infrastructure and support fish and wildlife habitat. When our natural defenses are overwhelmed, our communities and businesses become vulnerable to disruption. Frequent or widespread disruptions impact our Nation's economic vitality and national security.

The threats to our coasts are real and increasing. Global sea level has risen seven to eight inches since 1900, with almost half of this rise occurring since 1993. We are likely to see an additional rise of several inches in the next 15 years, and increases of one to four feet by 2100.[2] Communities from Texas to New England and along parts of the Pacific are already experiencing more frequent high-tide flooding events and associated impacts such as flooded streets and business fronts, damage to critical infrastructure, and increasing impediments to commerce and daily life. These higher water levels also result in greater impacts from powerful hurricanes and coastal storms. Coastal inundation also threatens other coastal dependent uses, such as port operations, military readiness, commercial fishing, tourism, and recreation.

Coastal states, counties and communities are being asked by their citizens to take action to protect their economies and way of life from severe weather and high tide flooding in the short-term and from sea level rise in the long-term. Yet, local governments have limited resources and expertise to address these complex issues. Increasingly, they are turning to NOAA as a trusted source of science, information and expertise as they consider major investments in infrastructure upgrades and other activities to make their communities more resilient to impacts from flooding and inundation. NOAA is utilizing its vast amounts of environmental monitoring data to provide communities with meaningful information to inform decision making. NOAA is helping to build local knowledge and capacity that communities can use to solve local issues, enabled by and built upon consistent and authoritative science.

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[1] https://coast.noaa.gov/states/fast-facts/economics-and-demographics.html

[2] https://tidesandcurrents.noaa.gov/publications/techrpt83_Global_and_Regional_SLR_Scenarios_for_the_US_final.pdf & https://science2017.globalchange.gov/chapter/executive-summary/

NOAA's science, data and services are critical to predicting environmental change, the impacts of these changes on our communities, and to help to continue to sustainably grow our economy. Just as we have built a more Weather Ready Nation, we too must work to strengthen partnerships and provide the services necessary to build more resilient coastal communities, economies and ecosystems. Coordinated federal science, partnered with local government insight, and private sector and academic innovation, is the only way we can effectively address this complex and increasingly urgent issue of coastal inundation in ways that are both locally and nationally relevant. Our coastal communities sorely need more data to sustain and grow their economies and livelihoods, as well as more and detailed surveys, maps and observations. We also need a more integrated and detailed system of disseminating standardized information across our entire national coastline so that communities and businesses can use it to make informed decisions.

Such an undertaking will require an inclusive effort across federal, state, local, tribal and territorial governments, and directed partnerships within academia, private sector, non-governmental and philanthropic organizations. While building seawalls and erecting levees are viable options in some circumstances, they can be costly and, in some cases, can inadvertently impact wildlife and habitats. In some instances, nature-based solutions may provide more efficient, effective and longer-term solutions. NOAA is already working with partners to coordinate efforts and resources to develop multidisciplinary approaches and an integrated suite of economic, social, engineering, and science alternatives to meet these emerging challenges. Scientific and technological advances are already providing a means to develop and deliver these services and will continue to do so into the future.

Today, I would like to highlight some of NOAA's most relevant programs and services along with some exciting new initiatives. I will also highlight several of our engagements with FEMA.

RECENT COMMITMENTS AND INITIATIVES

Before providing updates on several long-standing NOAA programs and missions, there are several recent efforts that will further NOAA and the Nation's capabilities across many mission areas, including observing, mapping, modeling and forecasting flooding and coastal change.

In November, the White House convened the Summit on Partnerships in Ocean Science and Technology (Ocean S&T Summit). The Summit brought together over 100 leaders and experts to identify opportunities for partnerships to develop and employ science and technology (S&T) for the conservation, management, and balanced use of America's oceans.

Following the Ocean S&T Summit, President Trump issued a Presidential Memorandum titled, "Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore of Alaska." It directs federal agencies to develop a national strategy to map the United

States Exclusive Economic Zone and a strategy to map the Alaskan coastline to advance our understanding of our oceans and coastlines and to promote efficient permitting related to ocean exploration activities. Last fall, NOAA also announced new draft strategies to dramatically expand the agency's application of four emerging science and technology focus areas:

- Unmanned Systems Strategy: The NOAA Unmanned Systems Strategy provides a framework to provide requirements-driven, safe, cost-effective, and compliant Unmanned Systems services across the agency and prioritize strategic partnerships and investments.
- Artificial Intelligence Strategy: The NOAA Artificial Intelligence (AI) Strategy promotes use of AI to advance NOAA's requirements-driven mission priorities. Through this strategy, NOAA seeks to reduce the cost of data processing, and provide higher quality and more timely scientific products and services.
- 'Omics Strategy: "'Omics" is a new term referring to a suite of leading-edge methods used to analyze materials such as DNA, RNA, or proteins; it is used in such study fields as genomics and proteomics. The NOAA 'Omics Strategy recognizes the opportunities and challenges presented by emerging tools to analyze these materials and provides a framework to advance the application of 'omics to address mission priorities.
- Cloud Strategy: NOAA's Cloud Strategy will build on NOAA's robust experience with cloud applications in areas such as satellite data products and services, numerical weather prediction, ocean models, and big data analysis, storage and dissemination. Cloud services will be further leveraged to expand benefits in these and other areas.

The Weather Research and Forecasting Innovation Act of 2017 (Weather Act) instructs NOAA to prioritize improving weather data, modeling, computing, forecasting and warnings for the protection of life and property and for the enhancement of the national economy. The National Integrated Drought Information System Reauthorization Act of 2018 builds upon the Weather Act and instructs NOAA to establish the Earth Prediction Innovation Center (EPIC) to accelerate community-developed scientific and technological enhancements into the operational applications for numerical weather prediction. EPIC will accelerate community-developed scientific and technological advancements into the operational applications for numerical weather prediction by supporting a Unified Forecast System community model. NOAA is working closely with entities in the weather enterprise (public, private, and academic) to inform the planning, development, and strategy for EPIC. The draft EPIC strategic plan was released on January 10, 2020, and NOAA anticipates the Request For Proposal for EPIC will be released in the next few months.

RELEVANT NOAA PROGRAMS AND ACTIVITIES

From Coast to Coast: NOAA's National Spatial Reference System

The Earth is constantly changing. Tectonic motion of the earth's plates, including earthquakes, can cause significant and immediate terrestrial shifts. But there are also ongoing, more gradual changes. In some places the earth's surface is rising (uplift), in others it is sinking (subsidence). NOAA's National Geodetic Survey's mission is to define and provide access to a consistent, underlying coordinate framework across the Nation – known as the National Spatial Reference System (NSRS). Elements of the NSRS include - but are not limited to - defining latitude, longitude, elevation, gravity, and shoreline position. The NSRS defines the foundation for all geospatial datasets that support surveying, mapping, and charting and many activities including construction, transportation, and agriculture. NSRS enables scientists, engineers, and surveyors to combine different datasets and provide geospatially aligned floodplain mapping products. Floodplain mapping would be impossible without an accurate NSRS.

As surveying and positioning technologies continue to improve, so does the accuracy of the NSRS's foundational elevation and positioning information. NOAA is in the process of modernizing the NSRS, which will improve the accuracy of known points to one or two centimeters. Planned for completion by 2022, this represents an excellent opportunity for all surveyors, mapping and geospatial data providers to adopt a singular and much more accurate and uniform version of the NSRS across the Nation.

NOAA Coastal Products and Services

Shoreline and Coastal Mapping

NOAA's Coastal Mapping Program defines the Nation's 95,000-mile shoreline. This shoreline dataset is used to define the territorial limits of the United States and has many other purposes. For example, an up-to-date shoreline is an integral component of NOAA's nautical charts and informs a wide range of coastal management applications, such as flooding modeling, habitat characterization, coastal management, and damage assessment following coastal storms. Collecting shoreline data that is georeferenced both to NSRS and to tidal and sea level change is also essential to monitoring coastal change over time.

NOAA and its contract partners use remote sensing technologies (imagery, Lidar, radar, etc.) from various sources (aircraft, satellites) and continually assess new technologies. Data collection is coordinated across agencies, like FEMA, through the Interagency Working Group on Ocean and Coastal Mapping with an understanding that the carefully georeferenced data will have to be transformed to the modernized NSRS in a few years. This data is publicly available and can be used in floodplain mapping products. NOAA and FEMA also work closely with and contribute funding to the U.S. Geological Survey (USGS) 3-D Elevation Program. This program

collects high accuracy Lidar data nationwide. Lidar is a primary base dataset used to support FEMA floodplain mapping activities.

FEMA also turns to NOAA to collect and rapidly disseminate aerial imagery and Lidar data in response to manmade and natural disasters, such as hurricanes, floods, and tornados. FEMA uses the imagery to assess impacts, direct emergency response efforts, and inform decisions on federal assistance. For example, during the 2017 hurricane season, NOAA received eight mission assignments from FEMA to collect imagery in response to hurricanes Harvey, Irma, and Maria. NOAA collected 64,848 images, covering an area of 24,279 square kilometers. In a powerful example of how important this imagery can be, NOAA quickly processed imagery after Hurricane Michael and noticed someone had spelled "HELP" on the ground. The location was readily identified, and rescue aid was provided.

Tides and Water Levels

In addition to providing the framework for land-based positioning through the NSRS, NOAA maintains the Nation's foundational coastal water level data and datums. This ensures the accuracy of hydrographic surveys, nautical charts, shoreline mapping, and marine boundary determinations and supports many coastal activities, including navigation, dredging, construction, marine civil works, and coastal restoration projects. These core services, and products such as NOAA's Seasonal High Tide Bulletins and Annual High Tide Flooding Outlooks, are increasingly valued by coastal communities to inform actions to address increased occurrences of tidal flooding and inform plans to help them mitigate and adapt to sea level rise and coastal change.

At the core is the National Water Level Observation Network (NWLON), the Nation's permanent observing system consisting of more than 200 long-term continuously operating water level gauges throughout the coastal United States, its territories, and the Great Lakes. NWLON is the source for accurate real-time and historical water levels for governments, the commercial navigation sector, and recreational users. NWLON data provide irreplaceable design insights to civil engineers, environmental engineers, city planners, and the insurance industry, enabling each to quantify risk along the coast today and in the future.

Hydrography, Bathymetry and Nautical Charting

NOAA's Office of Coast Survey is the Nation's leader in seafloor mapping, i.e., hydrographic surveying, which is studying the physical features of water bodies, and bathymetric surveying, which is studying the depths and shapes of underwater terrain. Accurate surveys of available depths and the location of obstructions is essential to NOAA's mission to produce and maintain the Nation's nautical charts for safe and efficient marine navigation. NOAA also deploys navigation response teams to address specific needs and conduct emergency hydrographic surveys to reopen ports following hurricanes and other coastal disasters. Today, NOAA has transformed its nautical charting mission to digital formats and is meeting the need for precision navigation information to support marine commerce where vessels can exceed 1,300 feet in

length and plunge as many as 80 feet below the surface. Coastal/nearshore bathymetry is an important component to inform models and predictions of storm surge and coastal flooding.

NOAA Storm Surge and Coastal Flooding Forecasts and Warnings

NOAA's National Hurricane Center (NHC) specializes in forecasting hurricane hazards and their associated impacts on the public and infrastructure. As it pertains to coastal flooding from storm surge, the NHC's Storm Surge Unit specializes in three areas/missions: (1) real-time forecasts and warnings, including the provision of high-resolution inundation mapping and specialized Geographic Information System (GIS) support to emergency managers; (2) pre-computed storm surge flooding risk maps utilized for planning and mitigation; and (3) post-storm hindcasts and inundation mapping utilized to enable fast, efficient damage threshold assessments, emergency response and recovery, and disaster declarations. NHC's coastal flood modeling and mapping is used exclusively for life-safety and life-saving decision-making (i.e. evacuations, evacuation planning, mitigation, etc.) and focuses exclusively on flooding potential from the combined effects of coastal storm surge, waves, and tide.

The National Hurricane Program (NHP) is a Federal Partnership Program among FEMA, the U.S. Army Corps of Engineers (USACE), and NOAA. The NHP is mandated by federal law (Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-707) to conduct Hurricane Evacuation Studies (HES) for the U.S. Gulf of Mexico and Atlantic coastlines as well as U.S. territories and tribal lands. A HES consists of several related analyses (Hazards, Vulnerability, Shelter, Behavioral, and Transportation) that develop technical data concerning hurricane hazards, vulnerability of the population, public response to evacuation advisories, timing of evacuations, and sheltering needs for various hurricane threat situations. Their purpose is to provide emergency management officials with critical information and tools that assists them in hurricane evacuation planning and decision making.

One of the primary inputs required to conduct a HES is identification of the storm surge risk, namely identification of areas most vulnerable to storm surge, within the HES area. NOAA, specifically the National Weather Service's NHC, provides high-resolution inundation risk maps under varying scenarios. These maps include thousands of hurricane simulations spanning intensities from Category 1 storms through Category 5 major hurricanes. The resulting catalogue of flood risk maps allow decision-makers and emergency managers to quickly and easily access their flood risk potential from all possible scenarios including derivation of worst-case flooding from extreme and rare events. This information is then provided to the NHP for application in the HES. In addition to aiding hurricane evacuation decision-making, these maps are also provided to Federal, State, Local, and Tribal Emergency Managers to assess coastal inundation flood

risk and take mitigation actions long before a hurricane threatens. This data also provides critical information days in advance of a threatening storm allowing the pre-positioning of recovery assets in strategic and safe locations. Emergency managers also find these studies very effective in public awareness, training, and hurricane preparation presentations in advance of hurricane season.

This risk mapping also provides critical infrastructure and economic planning capabilities to vulnerable coastal communities. Examples include prioritizing hospital backup power requirements, power plant salt water ingress mitigation projects, power grid resiliency improvements, road work project planning and residential community project planning, to name a few. These data represent a compliment to FEMA's Flood Insurance Rate Maps (FIRMs), which primarily depict the one-percent-annual chance flooding scenario. NOAA's risk mapping data provides a broader spectrum of risk (i.e. worst-case scenarios), thus allowing a more graduated analysis of flood risk. By enabling a comprehensive analysis of flood risk, critical decisions can be made well before a hurricane threatens to ensure minimal loss of life. For example, the American Red Cross uses this data to perform shelter analyses and develop policies to prevent the use of flood-prone shelters during land-falling hurricanes.

Digital Coast

In addition to providing core data and services such as NSRS, NWLON, and shoreline mapping, NOAA continues to create and improve our services in response to the needs of coastal communities, particularly with regard to decision support and providing highly complex information in formats and tools that are more readily understood and actionable. NOAA is committed to working with state partners and other federal agencies to help provide information and services, such as the Digital Coast and many others, in cost-effective ways that meet the diverse needs of these communities.

Before 2007, and before the development of Digital Coast, coastal planners, managers, and other decision-makers did not have ready access to data relevant to coastal issues. The Digital Coast, created by NOAA's Office of Coastal Management, leverages technology to meet user needs and operates under three guiding principles: (1) Inform coastal decision-making; (2) Provide value for the target audience and for the nation; and (3) Evolve continuously and sustainably. Several of Digital Coast's tools, such as the Coastal Flood Exposure Mapper and the Sea Level Rise Viewer, help communities assess their coastal hazard risks and vulnerabilities by creating customized maps that show the people, places, and natural resources exposed to coastal flooding.

ADDITIONAL COLLABORATIONS WITH FEMA AND OTHER NOAA PARTNERSHIPS

In carrying out its mapping, navigation, observing, positioning and flood-related missions, NOAA works with many agencies, including the USGS, the Bureau of Ocean Energy Management, the United States Coast Guard, the USACE, and of course FEMA. In addition to the instances already described, there are many examples of coordination between NOAA and FEMA, including efforts to sustain long-term partnerships with coastal states and communities in "boots on the ground" efforts to promote resilient communities.

NOAA's Emergency and Disaster Coordination with FEMA
NOAA works closely with FEMA on a daily basis and during emergencies. NOAA has staff assigned to FEMA headquarters and provides meteorological and other support before, during, and after emergency declarations. NOAA and FEMA have pre-scripted agreements in place for NOAA to provide meteorological, mapping, hydrographic, geodetic, oil and chemical spill, and marine debris support to FEMA response efforts.

Coastal management, natural resource, weather, and water experts, and other staff are often dispatched to support FEMA-led longer-term recovery efforts. For example, NOAA, FEMA, and the Department of the Interior worked on coral reef restoration following Hurricanes Irma and Maria.

NOAA's Partnerships and Interagency Work with FEMA
Various NOAA offices represent the agency on different FEMA groups such as the Community Rating System Task Force, the Federal Interagency Floodplain Management Task Force, and the Mitigation Framework Leadership Group. NOAA has a representative on FEMA's Technical Mapping Advisory Council where NOAA provides subject matter expertise and recommendations for FEMA's flood hazard mapping program. That Council's 2020 priority activities include working with stakeholders in order to recommend elements of a future Flood Hazard Mapping Program. NOAA looks forward to working with FEMA on this effort and tying it to our new 2022 vertical datum.

One of NOAA's hallmark and unique roles in the Federal Government is our extensive network of partners and constituents, especially along the coast. These partnership efforts have extensive networks of state and academic experts in place to collaborate on hazards and resilience planning issues and projects, often involving coordination and engagement with FEMA.

Conclusion

NOAA will continue to do what we have done successfully for more than 50 years: providing world class science and decision support services to U.S. taxpayers, empowering decision-

makers to understand how they can relate these science and services to local values and priorities, and by serving as a convener and supporter of an "all of government" approach to reducing impacts from flooding, and major storm events. Much has been accomplished to enable more informed decisions. However, there are additional gaps to fill, needs to address, and partnerships to enhance as we work to sustain and support our coastal communities and economies now and for the future. NOAA stands ever ready to rise to these challenges. Thank you again for the opportunity to testify today. I appreciate the Subcommittee's time and attention and look forward to answering any questions you may have.

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Mark Osler is the Senior Advisor for Coastal Inundation and Resilience for the U.S. National Oceanic and Atmospheric Administration (NOAA). His leadership advances coastal inundation science and the ability of decision makers to prepare for and respond to changes affecting the nation's coastlines. He serves as senior advisor to NOAA leadership on defining research, applied science, and policy priorities related to understanding and reducing impacts of coastal risk to the public, our national security, and our nation's economy.

Mark's inter-agency leadership includes:
US Government representative to the G7's Ocean Risk and Resilience Action Alliance
NOAA representative within various White House interagency fora including the National Security Council, Office of Science and Technology Policy, and the Council on Environmental Quality.

Prior to joining NOAA Mark worked for 17 years in the private sector. He holds a bachelor's degree in civil engineering from Lehigh University and a master's degree in coastal engineering from the University of Delaware's Center for Applied Coastal Research.