COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
U.S. HOUSE OF REPRESENTATIVES

HEARING CHARTER

The Need for Resilience: Preparing America's Transportation Infrastructure for Climate Change

Tuesday, May 21, 2019
10:00 a.m.
2318 Rayburn House Office Building

PURPOSE

On Tuesday, May 21, 2019, the Subcommittee on Investigations and Oversight will hold a hearing to examine the threat to transportation assets posed by climate change; assess the current state of federal research on transportation infrastructure climate resilience; and explore strategies by which the federal research enterprise can complement state and local efforts on transportation climate resilience more effectively.

WITNESSES

- **Ms. Susanne DesRoches (Duh-ROWSH)**, Deputy Director for Infrastructure and Energy, Office of the New York City Mayor.

- **Mr. Gregory D. Winfree (WIN-free)**, Director, Texas A&M Transportation Institute (TTI).

- **Mr. Jason Averill (AV-ur-ill),** Chief, Materials and Structural Systems Division, Engineering Laboratory, National Institute of Standards and Technology.

- **Mr. Scott Reeve (REE-vuh),** President, Composite Advantage.

KEY QUESTIONS

- How do climate impacts threaten transportation infrastructure?
- What are the risks to public investment when we fail to plan for climate considerations?
- What is the federal research enterprise currently doing to support increased climate resilience in transportation infrastructure?
- What are state and local governments doing to strengthen the climate resilience in transportation?
- How can the federal research enterprise help cities, states, planning organizations and codes and standard bodies accommodate climate considerations more effectively?

BACKGROUND

Defining Climate Resiliency

The American Society of Civil Engineers defines resilience as "the infrastructure system's capability to prevent or protect against significant multi-hazard threats and incidents," as well as its ability "to quickly recover and reconstitute critical services with minimum consequences for public safety and health, the economy, and national security."[1] For the purposes of this hearing discussion, the Committee defines climate resilience in transportation infrastructure to include how assets are able to avoid and minimize destruction, degradation and service interruptions when they encounter climate change impacts like extreme weather and flooding (that is, the ability to sustain), and the ability for assets to be restored to service more quickly and at lower cost when they are damaged or destroyed (that is, the ability to recover). Sometimes the former concept is referred to as robustness or reliability.

The Impacts of Climate Change on Transportation Infrastructure

As a result of greenhouse gases accumulating in the atmosphere, global average temperatures are about 1.8° F (1° C) higher today than in 1880.[2] The effects of this rapid change are numerous. The rising incidence of extreme weather patterns are degrading, destroying or limiting access to our roads, bridges, tunnels, ports, airports and railways - punctuated by devastating weather events such as Hurricane Sandy. While climate conditions are already changing rapidly in the 21st century, most transportation infrastructure in the U.S. was designed and built with an assumption of a static, 20th century environment. Particularly because transportation assets are designed for long life spans that will extend well past mid-century and potentially even beyond 2100, it is important for transportation planners to accommodate a changing climate as they invest taxpayer dollars in new projects and project enhancements.

The symptoms affecting transportation infrastructure most directly and immediately are outlined below. Different regions have varying degrees of vulnerability to different aspects of climate change, and the impact on transportation infrastructure will vary accordingly.

- **Sea Level Rise and Storm Surge**: Since 1880, average global sea levels have increased ~9 inches.[3] The National Climate Assessment of 2018 projects an additional 1-4 feet by 2100 under a moderate greenhouse gas emissions scenario, but as many as 8 feet is possible.[4] As a result, coastal infrastructure is exposed to a far greater "baseline" risk of flooding, with particularly acute consequences when storm surges push seawater inland. NOAA has found nuisance flooding occurs 300-900% more frequently than 50 years

[1] American Society of Civil Engineers, "What Makes A Grade?" 2019, accessed here: https://www.infrastructurereportcard.org/making-the-grade/what-makes-a-grade/.
[2] Intergovernmental Panel on Climate Change, "Global Warming of 1.5°C," October 2018, accessed here: https://www.ipcc.ch/sr15/.
[3] Fourth National Climate Assessment, "Chapter 12: Transportation," November 2018, accessed here: https://nca2018.globalchange.gov/chapter/12/.
[4] *Id.*

ago.[5] Bridges, ports, airports, and more than 60,000 miles of coastal roadways are at risk from sea level rise and storm surge; more than 7,500 miles of roadway on the East Coast alone – along with critical rail and bridge assets – are susceptible to high-tide flooding.[6]

- **Extreme Weather Events:** Climate change increases the frequency and severity of hurricanes and tropical storms, which in turn increases the vulnerability of coastal transportation assets to flooding. Climate-driven volatility is also leading to more frequent and severe non-coastal weather events, such as hail storms and extreme rains, which can drive inland flooding.[7] More aggressive climate models estimate that 4,600 inland bridges are vulnerable to increased precipitation levels by 2050, while a greater likelihood of mudslides and landslides threatens both coastal and inland roadways.[8]

- **Extreme Temperatures:** Railroad tracks experience thermal expansion during extreme heat that can lead to buckling and warping under rail traffic, requiring rail operators to slow or temporarily stop trains during heat waves.[9] Bridge construction projects have required modifications as a result of warping steel from extreme temperatures during construction. In air travel, hotter air is less dense, and it therefore becomes harder for aircraft to achieve the loft needed to take off safely. Extreme summer heat waves have already caused an increase in flight delays and cancellations in the Southwest.[10]

- **Effects on building materials.** Shifts in temperature and rainfall amounts are altering regional freeze-thaw cycles, affecting the durability of infrastructure building materials such as asphalt and concrete.[11] More frequent freeze-thaw episodes and extreme heat waves lead to more potholes in roadways and reduce the service life of concrete and steel bridges.[12] In addition, the metals and concrete traditionally used in construction corrode when exposed to sea water. As more coastal assets are exposed to storm surge and flooding, some tunnels, bridges, and rail assets will see accelerated degradation.

Federal Participation in Transportation Planning

States are the primary decision-makers on all transportation infrastructure choices, including how and whether to accommodate changing environmental conditions like coastal flooding. However, the federal government has an interest in supporting transportation climate resilience in order to protect public safety, minimize disruptions to its investments in transportation assets via grants made to states and planning organizations, and reduce the financial burden of future transportation disaster relief. The federal investment in transportation infrastructure nationwide

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[5] ClimateWatch, "Climate Change: Global Sea Level," August 2018, accessed here: https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level.
[6] Fourth National Climate Assessment, "Chapter 12: Transportation," November 2018, accessed here: https://nca2018.globalchange.gov/chapter/12/.
[7] *Id.*
[8] *Id.*
[9] *Id.*
[10] *Id.*
[11] *Id.*
[12] Federal Highway Administration, "Planning for Systems Management & Operations as part of Climate Change Adaptation," February 2017, accessed here: https://ops.fhwa.dot.gov/publications/fhwahop13030/chap3.htm.

is substantial. The Highway Trust Fund, administered through the DOT Federal Highway Administration (FHWA), represents the lion's share of federal spending on surface transportation generally. The Highway Trust Fund's projected outlays for FY2021 are $58 billion, with an estimated $41 billion coming from federal gas tax revenues and the balance presumably sourced from the Treasury's general fund.[13]

Federal policy generally does not require state and local governments to incorporate climate resilience into their transportation planning in order to receive federal assistance.[14] Other sectors have made it compulsory to consider climate predictions at certain stages of infrastructure planning. For example, the National Defense Authorization Act of 2019 requires the Department of Defense to construct all buildings at least two feet above the base flood elevation.[15] Similarly, the National Flood Insurance Program requires communities to adopt adequate floodplain management measures before it will make flood insurance available for residential and commercial buildings in that region.

By contrast, climate considerations are accommodated in the transportation sector when states and municipalities prioritize their own expenditures. Under the FAST Act, states may choose to obligate DOT grant funding for protection of transportation assets against extreme events and to enhance resilience generally.[16] There are also a number of relatively modest competitive grant programs within DOT and other agencies that are dedicated to helping communities minimize the impacts of future floods and other disasters. For example, the Federal Emergency Management Agency (FEMA) hosts the Hazard Mitigation Grant Program and Pre-Disaster Mitigation grants programs.

Climate resilience and other "smart growth" considerations are also incorporated in transportation planning and restoration via industry-based codes and standards. Codes and standards organizations develop technical guides and make them available to states and local jurisdictions, product manufacturers, and project developers, who then elect whether to adopt the model codes as compulsory. For example, the American Society of Civil Engineers (ASCE) develops standards for construction of roads and bridges, the "Green Book" from the American Association of State Highway and Transportation Officials (AASHTO) dictates geometric design of highways and streets, and ASTM International establishes standards for the durability of cement and concrete. The decision to follow various codes and standards can have implications for issues such as how much it costs to finance an asset, and whether the engineers that design the asset can procure liability insurance.

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[13] Congressional Research Service, "Funding and Financing Highways and Public Transportation," October 2018, accessed here: https://crsreports.congress.gov/product/pdf/R/R45350.

[14] Kevin DeGood, "Testimony Before the House Transportation and Infrastructure Committee," February 2019, accessed here: https://transportation.house.gov/imo/media/doc/DeGood%20Testimony.pdf.

[15] John S. McCain National Defense Authorization Act for Fiscal Year 2019, Public Law 115-232, August 2018, accessed here: https://www.congress.gov/115/bills/hr5515/BILLS-115hr5515enr.pdf.

[16] Fixing America's Surface Transportation Act (FAST Act), Public Law 114-94, December 2015, accessed here: https://www.congress.gov/114/plaws/publ94/PLAW-114publ94.pdf.

Federal Participation in Asset Restoration

The federal government has an important role in restoring communities who are affected by extreme weather, flooding or other disasters. Federal spending on disaster relief has surged in recent years, largely due to more frequent natural disasters: the United States averaged 6 weather-related disaster events with a cost of at least $1 billion annually between 1980 and October 2018, but it experienced fifteen such events in 2016, sixteen such events in 2017, and 11 such events through October 2018.[17] U.S. DOT spent $10 billion on disaster relief between FY 2005 and FY 2014, of which 94% came from the agency's own budget and only 6% originated with FEMA.[18]

Federal policies that require climate considerations to inform planning in disaster relief and infrastructure restoration are relatively minimal. For example, when FEMA funds are used to rebuild an asset destroyed in a flood or other disaster, it must be rebuilt as it was, even if its vulnerability to future flooding is well understood.

Federal Research and Information Sharing on Transportation Infrastructure Climate Resilience

The federal research enterprise can support climate resilience in transportation in three general ways today:

- Developing and sharing climate predictions and mapping of future conditions;
- Supporting research on advanced materials that can better tolerate changing climate conditions; and
- Providing technical assistance to states and planning organizations, including vulnerability assessments and adaptation studies.

Relevant Department of Transportation (DOT) Research Activities

DOT does not have a coordinated institutional framework dedicated to climate resilience research, planning and education. Annual dedicated funding for climate resilience appears to be no more than several million dollars across the Department, although exact funding amounts are difficult to calculate due to a lack of precise categorization.[19]

U.S. DOT does support relevant research activities across its various program offices, including the Office of the Assistant Secretary for Research and Technology (OST-R) in the Office of the Secretary and within each of the major modal operating administrations (highways, transit, rail and aviation). Each office has a relatively broad set of research priorities, within which climate resilience is only one consideration. These programs provide modest support for materials research, primarily through the pavement and materials research and development program led

[17] Congressional Research Service, "The Disaster Relief Fund: Overview and Issues," February 2019, accessed here: https://crsreports.congress.gov/product/pdf/R/R45484.
[18] Pew Charitable Trusts, "Federal Disaster Assistance Goes Beyond FEMA," September 2017, accessed here: https://www.pewtrusts.org/-/media/assets/2017/09/federal-disaster-goes-beyond-fema_final.pdf.
[19] Government Accountability Office, "Climate Change: Analysis of Reported Federal Funding," April 2018, accessed here: https://www.gao.gov/assets/700/691572.pdf.

by the FHWA.[20] The University Transportation Centers (UTC) program, administered by OST-R but funded by FHWA, has made a handful of grants to universities specifically dedicated to research on sustainability and resilience in transportation.

DOT programs also work with cities and states to develop targeted vulnerability and adaptation studies focused on specified locations. DOT's primary effort in this regard is FHWA's Sustainable Transportation program, which encourages sustainability and resilience planning in the maintenance of road and highway systems.[21] The Sustainable Transportation program has partnered with state and local DOTs in five rounds of pilot programs to develop state and local capabilities regarding a range of transportation resilience planning activities.[22] The Federal Aviation Administration (FAA) also oversees an Airport Sustainability program that provides grants to airports to encourage long-term sustainability planning on the part of airport operators.[23]

DOT helps support the development of technical information and best practices by AASHTO, a nonpartisan association of the highway and transportation departments of all 50 states. DOT and AASHTO jointly operate a Center for Environmental Excellence that provides a range of programs related to environmental issues in transportation policy, including a Resilient and Sustainable Transportation Systems Technical Assistance Program.[24] DOT funds are also used to support the Transportation Research Board (TRB) at the National Academies. TRB plays an important role in convening technical experts, evaluating and sharing information about many transportation issues, including resilience solutions, and providing advice to federal, state and local decision-makers via its policy studies.

Relevant NIST Research Activities

NIST supports transportation climate resilience through materials research. The Materials and Structural Systems Division (MSSD) leads NIST efforts to study the weathering and aging of materials and structures in order to both predict their service life with accuracy and understand how to protect structures from natural hazards.[25] As an example, the Accelerated Weathering Laboratory under MSSD uses a device called SPHERE to expose various materials to UV light under controlled conditions in order to develop performance models for their service life. MSSD's research and the reference materials they develop are used by private codes and standards bodies to improve their own test standards. MSSD also leads NIST's efforts on making communities more resilient. Its Community Resilience Planning Guide is a set of technical tools

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[20] Federal Highway Administration, "Pavement and Materials," November 2018, accessed here: https://highways.dot.gov/infrastructure/pavements-and-materials/pavement-and-materials#materials.
[21] Federal Highway Administration, "Sustainable Transportation," August 2018, accessed here: https://www.fhwa.dot.gov/environment/sustainability/.
[22] Federal Highway Administration, "Resilience Pilots," March 2019, accessed here: https://www.fhwa.dot.gov/environment/sustainability/resilience/pilots/.
[23] Federal Aviation Administration, "Airport Sustainability," April 2019, accessed here: https://www.faa.gov/airports/environmental/sustainability/.
[24] Center for Environmental Excellence by AASHTO, "Resilient and Sustainable Transportation Systems Technical Assistance Program," 2019, accessed here: https://environment.transportation.org/center/rsts/.
[25] National Institute of Standards and Technology, "Materials and Structural Systems Division," https://www.nist.gov/el/materials-and-structural-systems-division-73100.

that communities can use to assess their vulnerability to extreme weather risk and inform science-based investment decisions. The guide contains a chapter dedicated to bolstering the resilience of transportation systems.[26]

NIST's Applied Chemicals and Materials Division (ACMD) in Boulder, Colorado evaluates measurement standards to complete lifetime models and predictions for various materials.[27] ACMD work on pressurizing devices, fracture and fatigue of materials has broad applications across all manner of building materials, including steel, concrete, and advanced composites.

[26] National Institute of Standards and Technology, "Community Resilience Planning Guide for Buildings and Infrastructure Systems," May 2016, accessed here: https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1190v2.pdf.
[27] National Institute of Standards and Technology, "Applied Chemicals and Materials Division," accessed here: https://www.nist.gov/mml/acmd.