

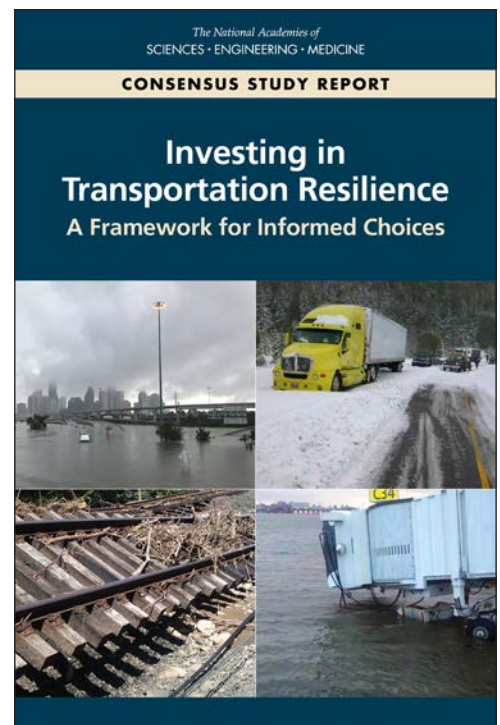


# Investing in Transportation Resilience: A Framework for Informed Choices

*Natural hazards—from hurricanes to earthquakes—too often become disasters that wreak havoc on transportation systems. Damaged infrastructure is expensive to repair, restore, and replace, and travel disruptions adversely affect the economy and people’s quality of life. Resilience is a powerful concept that can be used to diminish these harms, but most assuredly when it is made a routine and deliberate part of transportation infrastructure planning and investment decision making.*

For transportation systems, resilience—the ability to prepare for and adapt to changing conditions and to withstand and recover rapidly from disruption—is vitally important, but increasingly challenging. Long-lived—with design lives of more than 50 years—and ubiquitous, transportation systems have always been exposed to a wide range of natural hazards and their inevitable extremes. However, climate change is compounding the intensity and expanding the scale of natural hazards. It is increasing the likelihood of cascading events, where multiple hazards interact, and it is creating new stressors on transportation assets constructed for different temperature and precipitation norms. Meanwhile, the smooth and safe functioning of transportation infrastructure is being stressed from everyday use. Across the country, many major transportation assets have outlasted their planned service lives by decades yet continue to be essential for accommodating traffic flows at levels unimagined in their original planning and design. Under these circumstances, ensuring that transportation systems are resilient—able to withstand and recover rapidly from adverse conditions and events—has become vitally important but increasingly challenging.

At the request of Congress, a special committee of the National Academies of Sciences, Engineering, and Medicine was charged with identifying and developing metrics that can be used to make more informed choices for investments in transportation system resilience. The committee’s consensus study report, *Investing in Transportation Resilience: A Framework for Informed Choices*, offers recommendations to Congress and the U.S. Department of



Transportation (DOT) aimed at strengthening the resilience practices and capabilities of thousands of state, regional, and local transportation agencies.

The report explains how the country's transportation system, along with the hazards it faces, are too varied for a single metric, or even a small set of metrics, to have universal application in guiding resilience investments. However, the committee's review of both practice and research suggests that more can be done to make the calculus of resilience a more deliberate part of transportation asset management and investment decision making. Benefit-cost analysis is key to this calculus because investing in resilience requires spending funds, or incurring costs, today to gain benefits that may or may not be realized in the future. Estimating the prospective benefits of resilience investment options, therefore, can be particularly challenging, but essential. The report describes a framework for doing so that begins with transportation agencies inventorying their existing and planned assets, assessing the characteristics and likelihood of natural hazards occurring in the future, and predicting the vulnerability of the inventoried assets to disruption, damage, and destruction from those hazards. Having done this, agencies should make judgments about the criticality, or value, of each asset's role or function in the transportation system. These steps are needed for estimating the likelihood and consequences of damages and disruptions to the asset, tantamount to estimating the benefits of investing in resilience.

The report points out how transportation agencies need high-quality data and analytic tools to estimate the benefits of investing in resilience, including

- information on the characteristics of natural hazards and their likelihood in the location of existing and planned assets,
- science-based and updated projections about future impacts of climate change on natural hazards and on temperature and precipitation norms in these locations,
- strong asset management programs that include evaluations of asset vulnerabilities and estimation of functional criticality,
- mode-specific data and modeling tools to estimate the direct and indirect consequences of asset damage and functional losses, and
- data and modeling tools that can reveal the economic and social importance of the asset to users, directly affected communities, and the broader region.

The report also emphasizes the importance of pilot activities for showing how resilience evaluations can be made a routine part of investment decision making and for demonstrating the application of these data and tools for this purpose.

## **ADVICE TO CONGRESS AND DOT**

The report makes these following five recommendations. While the recommendations are directed to Congress and DOT, their purpose is to strengthen the resilience practices and capabilities of thousands of state, regional, and local transportation agencies.

### **Recommendation 1**

To ensure the routine and deliberate consideration of resilience to support the selection of major transportation investments, Congress should consider a requirement for which all projects that involve long-lived assets and that are candidates for federal funding undergo well-defined resilience assessments that account for changing risks of natural hazards and environmental conditions stemming from climate change. These assessments could be integrated into environmental impact assessments or other project evaluation efforts, such as during benefit-cost analysis. The level of analytical effort expected in these resilience assessments should be reasonably related to the cost of the project being considered.

### **Recommendation 2**

The Office of the Secretary of Transportation should promote the use of benefit-cost analysis for project justifications that take into account the resilience benefits estimated using the multi-step analytic framework recommended

above. The benefits from adding resilience, in the form of reduced future losses, in relation to the life-cycle costs of doing so should be promoted as the basis for selecting investments in resilience.

### **Recommendation 3**

The Office of the Secretary of Transportation should provide guidance to the U.S. Department of Transportation modal administrations on the development of analytic methods and tools for estimating resilience benefits that are applicable to transportation agencies in their respective modes.

### **Recommendation 4**

Congress should direct, and appropriately resource, the Office of the Secretary of Transportation to conduct a study to (1) define the types of data that transportation agencies need for resilience analysis in accordance with the framework recommended above, (2) identify potential sources of these requisite data, and (3) advise on possible means for making the data more suitable to this purpose, including filling key data gaps and ensuring timely data updates.

### **Recommendation 5**

The Office of the Secretary of Transportation should coordinate with the modal agencies on the design and conduct of structured pilots to assess and demonstrate the applicability of each agency's guidance and suggested tools for estimating resilience benefits according to the recommended multi-step analytic framework.

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