One of the many ways that climate change will impact the economy is by causing disruptions to America’s rapidly aging transportation systems. At the center of the problem is how transportation networks—including rail, surface, air and marine—were originally engineered. In the U.S., transportation systems have been typically designed with a 50-year lifespan and to withstand local weather and climate (e.g., 100-year storm).

However, due to climate change, historic events no longer are a reliable predictor of future impacts. In fact, 100-year events are occurring with more frequency. According to climate scientists, Hurricanes Katrina and the Perfect Storm (the combination of the 1991 Nor’easter and Hurricane Grace, which caused more than $200 million in damage and killed 13 people) were considered 100-year storms—even though they occurred within a seven-year interval.

Simply put, climate change is projected to increase the frequency and intensity of extreme weather events. Heat waves likely will be more severe, sea-level rise likely will amplify storm surges in coastal areas, and storms such as hurricanes and tornados likely will be more intense. Other climate-change-related events have the potential to impact transportation networks. For example, extreme rainfall events have the potential to flood subways, railways and airports.

Looking Ahead
To plan and respond appropriately to challenges associated with climate change, transportation agencies must know what they can expect. Because owners, operators and scientists alike can’t predict the exact impacts of climate change, scientists have developed climate models to project plausible scenarios for the coming century and beyond.
The Impact of Climate Change on Transportation Infrastructure

Step 1: Establish Climate Scenarios and Areas of Focus
The first step to a solid climate response is to develop climate-change projections and scenarios, which take into account various data points. If climate-change projections are unavailable, transit authorities also can turn to academic partners to model regionalized climate projections. Below are just a few examples of potential risk by various mode of transportation:

- **Aviation**—Increased floods, sea-level rise, storm-surge inundation and rain may force entire airports to close or cause significant damage to facilities, including airstrips; Extreme heat may cause airplanes to face cargo restrictions, flight delays and cancellations.
- **Marine**—Ports and infrastructure may need to be raised and/or hardened to accommodate higher tides, sea-level rise and storm surges.
- **Rail**—High temperatures can cause rail tracks to expand and buckle, leading to speed restrictions and track repairs; Coastal railways and subways may be subjected to inundation from sea-level rise and storm surges.
- **Roadways**—Heat waves and humidity may limit construction activities, increasing the cost of building and maintaining roadways; Flooding and extreme snow events may shorten the life expectancy of highways and roads, requiring more-frequent repairs and rebuilding.

Step 2: Assess Impacts
After the projections have been evaluated and the critical assets identified, stakeholders should work together to conduct vulnerability and risk assessments. The assessments evaluate the susceptibility of individual assets based on climate projections and combine that with the probability and consequence of the climate event occurring. The resulting data identifies and prioritizes the most at-risk assets.

Vulnerability to climate change is expressed as a function of exposure, sensitivity and adaptive capacity. Coupled with the vulnerability assessment, risk assessments identify and analyze the most-vulnerable elements and rank assets based on probability of occurrence and consequence of impact.

Step 3: Long-Term Planning
There are three broad categories of overall adaptation strategies: 1) maintain and manage, 2) abandon, or 3) strengthen and protect existing infrastructure. Strategies for maintaining and managing climate-change impact can be fairly straightforward (e.g., improving drainage, increasing pumping capacity, raising bridges. Conversely, the abandonment approach often is unrealistic, as the financial, economic, social and environmental consequences may make this approach unworkable in the short term.

For most, learning to live with climate impacts will be the most-effective approach. For example, strategies for responding to high heat may include the use of shade shelters or heat-resistant materials, while airports, could add plantings and retaining walls to slow or divert storm surges away from critical assets.

Moving Forward
Global climate change and its impacts are a real and present threat to all transportation networks. Owners and operators should start preparing for what lies ahead—likely higher sea levels, increased flooding events and higher temperatures. This will require an integrated approach in which leading-edge science is translated into practical solutions for near- and longer-term planning horizons. Teaming with climate-risk experts will allow transportation agencies to assess vulnerability, identify the most at-risk structures, and develop cost-effective preparedness actions that can be integrated into maintenance and capital investment plans to provide for continuity in the face of climate change.