As the global climate continues to shift, transportation systems will encounter challenges without historic precedent. The complete extent of these challenges remains to be seen, but already the built environment is experiencing increased stress from climate change, including more frequent and intense heat events, droughts, and storms.

The aviation industry has undertaken significant efforts to reduce the rate of climate change by decreasing greenhouse gas (GHG) emissions, notably by increasing fuel efficiency and the use of biofuels. A sustainable future, however, also requires resiliency—the ability to plan for, recover from, and respond dynamically to hardship, change, or disasters in a way that has limited impact on operations.

At their own facilities, airports have made progress toward climate resiliency by emphasizing on-site infrastructure improvements and stakeholder collaboration to identify solutions. In addition, the aviation industry has contributed to resiliency at the local, regional, industry, and global levels, and the potential for new and evolving roles is great. Although some opportunities may be uniquely available to aviation, other transportation sectors can replicate many of the aviation industry’s measures to increase the resiliency of the network as a whole.

Local and Regional Initiatives

Emergency Hubs
As a benefit to their local communities and to their broader geographic regions, airports can provide a portal for regional emergency services, offering food, water, medical care, and shelter during extreme events. For example, airports can work with emergency services to create on-airport public safety stations. These stations consolidate emergency services with the airport’s resources, providing a range of equipment and capabilities to streamline coordination.

Arnold Palmer Regional Airport near Latrobe, Pennsylvania, recently opened a Regional Emergency Operations Center, which covers 13 counties in Western Pennsylvania, includes ambulance services,
and serves as a coordination center for local, county, state, and federal emergency operations. The airport also acts as a communications hub and 911 center to maintain communications during emergencies. The airport was chosen as the hub because of the strategic access to emergency services, supplies, and communications, as well as the availability of a large pavement area for the staging of resources.

**Ensuring Continuity**
Airports also can supplement regional ground transportation networks and leverage these services during climate-related events or can increase their services as needed to compensate and balance the system as a whole. Because of the independence of air travel from ground-based infrastructure beyond the airport facilities, aviation can fill the voids left by major infrastructure failures or blockages affecting other transportation modes.

For example, military aircraft can land in extreme conditions to deliver supplies when roadways are blocked. In addition, cargo services at airports can expand to assist with the movement of critical goods or to minimize the effects of network disruptions on the gross domestic product.

**Collaborative Adaptations**
In addition to coordinating emergency services and supplementing transportation networks, many airports are engaging with regional stakeholders to address climate change, offering valuable support that draws on experience in risk management. Airport Cooperative Research Program (ACRP) Synthesis 33, Airport Climate Adaptation and Resilience, published in 2012, detailed this coordination, assembling findings from a survey of practices and procedures at North American and United Kingdom airports.1

Of the survey respondents, 38 percent reported working with regional community emergency planning groups or regional planning authorities to address weather disruptions and related impacts strategically. For example, the San Diego County Regional Airport Authority actively participated in an effort led by ICLEI–Local Governments for Sustainability and two other local organizations to develop an adaptation strategy for sea level rise.

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1 www.trb.org/Main/Blurbs/167238.aspx.
Airports have experience in addressing and planning for unique risks, such as safety, security, and volatility in cash flow. The lessons learned at individual facilities can be indispensable to other organizations planning for climate-related risks.

**Industry Involvement**

Airports also can play important roles at the industry level in adapting to climate change. For example, airports are involved in sponsoring research and in sharing the findings and the lessons learned that contribute to the aviation system’s resilience.

**Information Sharing**

ACRP has completed several climate-related projects in addition to ACRP Synthesis 33, and others are in process. ACRP Report 147 provides guidance on airport risk assessments, and ACRP Project 2-74 is investigating ways to integrate climate risk into airport management systems. Completed projects


Influencing Supply Chains

In a recent initiative, airports and airlines are influencing their supply chains to reduce climate impacts. Airports not only are undertaking their own efforts but are passing these commitments along to business partners via strategic partnerships, operating methods, or requirements and guidelines for building. Across the country, airports have begun engaging stakeholders in GHG mitigation through programs that convert airport vehicles to less GHG-intensive fuels and that encourage the use of preconditioned air at airline gates to reduce the fuel used by aircraft auxiliary power units. Some airports have gone a step farther by integrating resilient infrastructure development measures into their tenant guidelines. The Massachusetts Port Authority has required use of its Floodproofing Design Guide by all staff, tenants, and contractors during the planning, design, and construction of projects at Boston Logan Airport. As airports exert their influence in communications, disaster preparedness, and business practices, tangible benefits can be realized throughout the industry.
Global Effects

On a global level, new technology is addressing climate change by improving the operational efficiency of the aviation sector. The U.S. NextGen program, for example, involves a transition from ground-based to satellite-based navigation and surveillance, as well as other upgrades, to increase the efficiency of the airspace system.

The completed NextGen system can contribute to climate change mitigation by reducing overall GHG emissions associated with air travel—routes will be more direct, reducing travel distances—and to the resilience of the aviation system. During extreme storm events, for example, the rerouting of flights would not depend on ground-based navigational aids; this change should alleviate some delays caused by climate-related weather events that can lead to systemwide issues.

Delays of a few minutes within the U.S. system can have regional and international effects, including missed connections. Alleviating delays would ease some pressures on the international system and contribute to more dynamic and efficient operations globally.

Forthcoming Opportunities

Aviation has the potential to play additional roles in supporting the resiliency of the transportation system. For example, airports can serve in the “canary” role—that is, detecting problems early. Because of their sensitivity to weather events, such as changing temperatures, airports often can identify risks or trends toward extremes before other industries.

For example, as the climate changes, airport pavements may be subject to more punctuated freeze-thaw cycles, as well as to higher temperatures; the cycles affect the pavement’s service life. A long exposure to high heat, for instance, can make some pavement soft. At Reagan National Airport in Arlington, Virginia, an aircraft became stuck in a pavement soft spot produced by high temperatures over the course of a week. By tracking airport pavement condition nationwide, emerging trends and lessons learned could benefit the entire transportation system—including roadways—and allow a more informed and proactive response in planning, budgeting, and setting design standards.

In addition, the aviation industry can shape the use of rapidly growing technologies related to unmanned aerial vehicles, or drones, to assist in resiliency—for example, by using drones to conduct emergency service functions that normally require ground-based transportation and access. In extreme events, emergency service providers could use drones to assess the damage to vital resources, such as roadways, other transportation systems, supply caches, wastewater facilities, and the like, and to provide emergency support to areas that have been cut off.

Dynamic Response

The ability to respond dynamically to climate challenges is vital. The aviation industry and its technologies provide many opportunities for positive developments in this arena, linking communities and the aviation system nationwide and globally, and providing opportunities for coordinated and shared approaches to improving adaptation, resilience, and emergency response measures. The result will be a more efficient, resilient, and beneficial system.