U.S. Department of Transportation
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Transportation System Resilience to Extreme Weather and Climate Change

Resilience: The ability to prepare for changing conditions and withstand, respond to, and recover rapidly from disruptions.

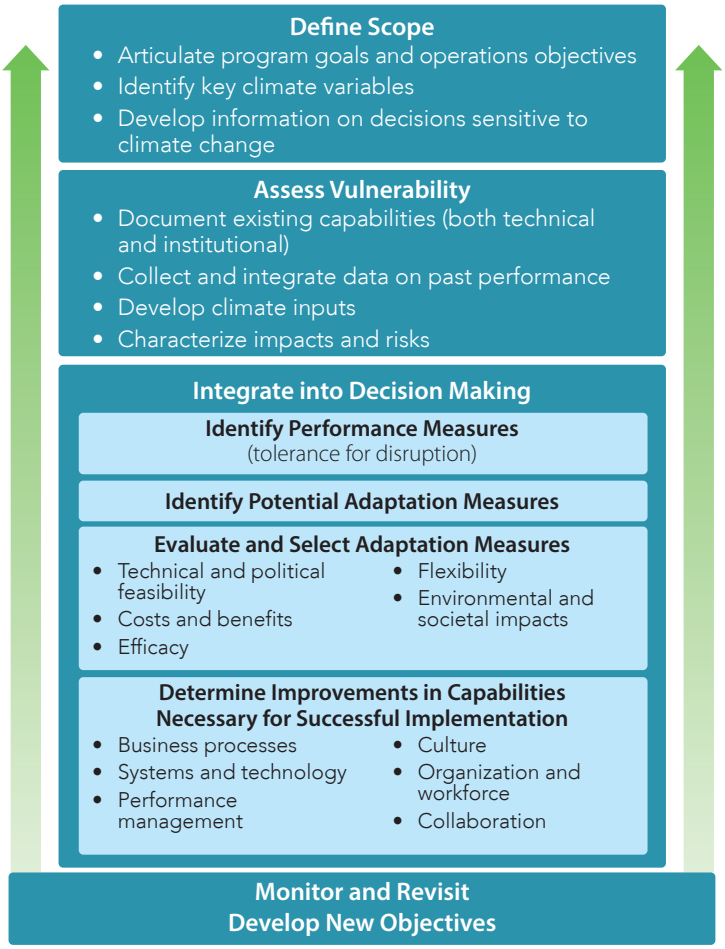
The ability of transportation agencies' to effectively manage, operate, and maintain a safe, reliable transportation system is being threatened by a changing climate. Extreme weather events are becoming more frequent and intense due to climate change, and long-term climatological trends are slowly but inexorably changing how transportation systems need to be planned, designed, operated, and maintained. A "new normal" is evolving and State departments of transportation (DOTs) are turning their focus toward building resilience.

Climate change will necessitate adjustments by DOT transportation systems management and operations (TSMO) and maintenance managers to ensure the resilience of activities such as traffic monitoring and management, providing traveler information, traffic incident management, and maintenance management.

Take Action to Increase Resilience

TSMO and maintenance functions at DOTs are often responsive to conditions as they arise. There are nevertheless some activities that, if done in advance, can enhance the resilience of the transportation system overall and with greater efficiency to the public agency than if actions had not been taken. Adapting TSMO and maintenance programs is largely about improving capability rather than a major technology development and deployment initiative. Many of the technology elements used to support safety, congestion mitigation, and traveler information objectives are already in place. To adapt to climate change, agencies need to consider how these existing capabilities that already help to improve operations and reliability need to evolve to meet the new and emerging requirements of a changing climate.

The framework shown at right provides an overview of how TSMO and maintenance managers can begin to take action through steps to: define the scope of adaptation efforts; assess vulnerabilities to inform the development of adaptation strategies; and integrate climate change into decision making. The checklist that follows provides further detail on these steps. Additional information, including additional steps, sub-steps, and details, are found in the Federal Highway Administration (FHWA) *Climate Change Adaptation Guide for Transportation Systems Management, Operations, and Maintenance.*



✓ Checklist for Technical Staff

Define Scope

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- ☐ Define TSMO or maintenance program goals and operations objectives that could be sensitive to climate change.
- ☐ Identify the extreme weather events and trends that could affect the agency's TSMO and maintenance programs.

Assess Vulnerability

- ☐ Document current capabilities (both technical and institutional).
- ☐ Review traffic incident reports, maintenance records, after-action reports, emergency reimbursement forms, and other sources to determine how extreme weather events have affected performance in the past.
- ☐ Interview staff across departments about extreme weather-related vulnerabilities (e.g., "what keeps you up at night?").
- ☐ Identify points and thresholds where extreme weather affects TSMO and maintenance decisions (e.g., establishing future workforce needs, weather response budgeting, setting operational objectives).
- ☐ Document how TSMO and maintenance practices relate to different weather thresholds (e.g., place sandbags when forecast calls for X amount of rain).
- ☐ Gather information on historic trends in relevant weather variables and/or how those variables may change in the future.
- ☐ Characterize extreme weather risks via data-driven or workshop-based qualitative or quantitative analysis.

Integrate into Decision-Making

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- ☐ Identify performance measures and targets (i.e., the acceptable level of operational performance if threat occurs).
- ☐ Identify potential adaptation strategies (selected examples provided below – see more in Tables 6 and 8 of the FHWA *Climate Change Adaptation Guide for Transportation Systems Management, Operations, and Maintenance*).

Policy-based strategy examples

- ☐ Review and update performance measures in light of extreme weather vulnerabilities.
- ☐ Establish work order codes for weather events or use other methods to improve tracking of labor, equipment, and materials costs over time.
- ☐ Develop a strategy for incorporating weather trends in budget-setting processes.
- ☐ Require after-action reports with clear recommendations for improvement following extreme events.
- ☐ Update emergency response plans to factor in potential for greater frequency of extreme weather events.
- ☐ Improve cross-training across staff (including across operations, maintenance, and emergency management).

Source: Fotolia

Source: Fotolia

- ☐ Establish regular coordination between on-the-ground staff and other departments to discuss vulnerabilities and inform investment decisions based on past performance.
- ☐ Establish transition plans for retiring staff to maintain institutional knowledge.
- ☐ Modify current design and procurement criteria to favor durable materials and designs.

Operational and maintenance strategy examples

- ☐ Establish stand-by contracts for extreme event response.
- ☐ Improve intra-agency coordination and information sharing about conditions, closures, resources, etc.
- ☐ Improve inter-agency coordination to promote establishment of resource-sharing agreements and information sharing about plans, initiatives, risks, and resources (e.g., include key stakeholders in routine communications to streamline process during emergency events).
- ☐ Invest in redundant communications systems and data servers.
- ☐ Expand both coverage and quality of fixed and mobile monitoring capabilities.
- ☐ Modify procurement specifications to ensure performance over a wider range of conditions.

Maintenance strategy examples

- ☐ Purchase equipment, factoring in likely future needs based on extreme weather events or climate changes (e.g., versatile equipment in Alabama to double as snow plows, mobile stockpiles of traffic control devices).
- ☐ Stockpile materials (e.g., culvert pipe, temporary bridge components, fuel) and equipment (e.g., generators, chain saws, traffic control devices) and stage them in strategic areas prior to events.
- ☐ Increase or change vegetation control practices to keep pace with climate changes (e.g., increase trimming frequency or plant more drought- or heat-tolerant species).
- ☐ Review and consider mitigating vulnerabilities when conducting scheduled maintenance activities.

Emergency management strategy examples

- ☐ Incorporate changes in extreme event frequency into emergency management planning, including anticipated staffing, training, and equipment needs.
- ☐ Establish stand-by contracts for extreme event response.
- ☐ Conduct tabletop exercises and use routine events to drill emergency management protocols.

Adaptive management strategy examples

- ☐ Develop a system to track weather-related trends and costs over time (e.g., number of potholes repaired, snow removal costs, number of emergency event triggers, labor hours devoted to weather preparation, response, and recovery), such as through designated "weather-related" charge codes.
- ☐ Use asset management systems to track relevant information to inform decision-making over time.
- ☐ Configure asset management or maintenance systems to issue alerts when vulnerable assets are due for maintenance, repair, or replacement.
- ☐ Develop and track performance metrics related to extreme weather (e.g., number/duration of weather-related road closures).
- ☐ Evaluate and select adaptation strategies based on factors such as technical and political feasibility, costs and benefits, efficacy, flexibility, and sustainability.
- ☐ Determine improvements in agency capabilities necessary for successful implementation of adaptation strategies (e.g., improvements in business processes, systems and technologies, performance management, culture, organization and workforce, and collaboration).

Monitor progress and revisit

- ☐ Establish a plan for monitoring and evaluating progress toward extreme weather resilience.
- ☐ Engage stakeholders needed to support monitoring and evaluation efforts.
- ☐ Monitor trends in extreme weather events and their impacts (e.g., frequency of particular events, weather-related costs and disruptions).
- ☐ Analyze data on weather trends and impacts to inform decision making about future strategies.
- ☐ Continually revisit TSMO, maintenance, and emergency programs in light of extreme weather and climate trends.

For More Information

Additional information, including more detailed checklists, strategies, and "getting started" resources are available in the FHWA *Climate Change Adaptation Guide for Transportation Systems Management, Operations, and Maintenance* at http://www.ops.fhwa.dot.gov/publications/fhwahop15026/index.htm.

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