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U.S. DOT Gulf Coast Study, Phase 2

Engineering Case Study 11: Operations and Maintenance Activity Exposure to Climate Change and Extreme Weather Events

This is one of 11 engineering case studies conducted under the Gulf Coast, Phase 2 Project. This case study focuses on the vulnerability of operations and maintenance (O&M) activities to a range of climate change stressors and extreme weather events.

Introduction

O&M activities will play a critical role in adapting to a changing climate. In fact, O&M activities are already affected by extreme weather and a changing climate. This case study evaluates how weather and climate may influence O&M activities and how current activities may be adapted to reduce the vulnerability of transportation systems to weather- and climate-related risks.

Operations and maintenance are each two distinct components that make different contributions to responding to climate-related stressors. Operations primarily pertain to the management of traffic flow and safety of the traveling public despite disruptions – in this case, as a result of climate change or extreme weather events. Examples of operations activities include emergency response protocols, pre-deployment of emergency supplies and equipment, use of Intelligent Transportation Systems (ITS) to disseminate critical information to travelers, or established procedures for emergency closures of roads or bridges. Maintenance refers to the process of maintaining or preserving transportation assets (e.g., bridges, pavement, embankments, signage). Maintenance activities can be characterized as either "planned" (including preventive and routine maintenance) or "on-demand" (reactive or corrective maintenance).

Figure 1: Photo of maintenance activities

Climate Stressors and Scenarios Evaluated and Impacts on the Facility

Climate change can affect O&M activities in a number of ways. First, increases in severe weather can slow down the completion of O&M activities. Virtually all activities performed by maintenance crews are exposed to weather to some degree. In some cases, the work cannot be completed due to weather events; for example, painting cannot be completed in the rain, and worker safety can be compromised under high heat situations. Table 1 illustrates highway maintenance activities affected by various climate stressors.

Second, as the severity of weather events increases, response and recovery efforts become more complicated and costly. With greater extreme events (either in frequency or intensity), more organizations and communities are impacted and there is an increased need for coordination across state and local transportation agencies, emergency management agencies, emergency responders, enforcement agencies, public health officials, and humanitarian relief organizations. This need for a coordinated response was demonstrated following weather-related natural disasters

Maintenance Activity	Heavy Precipitation	Drought	Strong Wind	Lightning	Low empature	High Tempature
Maintain or Rehabilitate Concrete	•		•	•	•	•
Schedule Crews	•		•	•		•
Clear Drainage	•	•		•		
Repair Embankments	•	•	•	•	•	
Prevent Erosion and Sedimentation	•		•	•		
Excavation	•			•	•	
Fencing	•		•	•	•	
Painting	•		•	•	•	•
Paving	•				•	
Bridge Work	•		•	•		
Maintain Vegetation	•	•	•		•	•

Table 1: Maintenance Activities Impacted by Various Climate Stressors

in recent history such as Super Storm Sandy, Hurricane Katrina, Tropical Storm Irene, tornados in Oklahoma, and landslides in Washington.

Finally, changing climate conditions will also impact O&M budgets. On-demand activities may increase with increased weather events, climate changes, an aging system, and greater traffic levels. When funds are directed to on-demand activities, resources for planned activities, including preventive and routine maintenance, become increasingly constrained, undermining the lifecycle management of transportation infrastructure and leaving the system more vulnerable to climate change and extreme weather events over the long term.

Identification and Evaluation of Adaptation Options

O&M activities have always contended with weather and adapted, by necessity, to changes in infrastructure condition, traffic levels, regulatory structures, and (knowingly or not) climate; however, with shifting climates, new areas are becoming exposed to a variety of climate stressors. These areas will need resources – both financial and personnel – to be prepared to meet these new challenges. Determining the appropriate role for O&M activities in addressing climate change involves considering what can be done within the confines of budgets, staffing, technology, and available information. Table 2 presents examples of potential adaptive O&M practices and options.

Mobile's Course of Action

In the city and county of Mobile, emergency operations and training have become vital components of O&M programs. Emergency response and operations training occurs annually and is embedded in the work culture. In the event of an emergency, response operations become a highly collaborative effort among the city, county, and state departments of transportation.

At the state level, Alabama Department of Transportation (ALDOT) stations equipment and supplies at different locations around Mobile to expedite the deployment of equipment and to be prepared in the event one location becomes inaccessible in an emergency situation. ALDOT is also building a new asset management system that will

Potential Maintenance Adaptation Actions	Potential Operations Adaptation Actions
Consultation with designers about more durable materials and designs (e.g., paints, paving materials, drainage features) to better withstand climate changes	Development and testing of a "play book" for emergency operations and, in particular, evacuation protocols; include other emergency response agencies
Integration of maintenance workers' knowledge and work order system with a GIS based asset management system to provide a record of historic failures and repairs to inform future maintenance decisions and justify budget requests	Inclusion of key stakeholders (e.g., the state emergency operations agency, police, fire, schools, hospitals, government personnel agencies) in routine information dissemination so that all will be in sync during an emergency
Stand-by contracts to increase response capacity and shorten reaction times	Cross-training of operations staff with maintenance staff to facilitate coordination in emergency situations
Improved weather information systems, typically employed in snow-belt states, may be applied for year-round use to monitor precipitation and flooding	Hardening of communications and power systems for emergency use; ensuring that communication equipment can operate independent of cell service
Greater cross-training of staff, perhaps from across the agency, so the ability to adapt, mobilize, respond, and recover from emergency situations is enhanced	Supplementation of ITS resources for disaster monitoring and response
Stockpiling of materials (e.g., culvert pipe, temporary bridge components, fuel) and equipment (e.g., generators, chain saws, traffic control devices) in various locations to provide access during and following extreme events	Establishment of detours and signage for evacuation routes
Structured work logs and emergency response expenditures for ease of submission for reimbursement under federal aid qualified weather-related emergencies	Requiring cross-agency after-action reports with recommendations for improvement to preparation and response efforts
Monitoring of asset condition over time to determine if climate change affects performance. It is commonly the low intensity, high frequency events that contribute to failure of already stressed assets rather than extreme events causing catastrophic failure	Budgeting and planning for extreme events and running operations "like a business" to maximize the limited funding

Table 2: Potential Adaptation Measures

have condition information (A to F) and other characteristics of each asset. The system is also expected to be available to cities and counties.

Mobile and ALDOT are continuing to improve their O&M practices to be more resilient to climate change. Some of the strategies identified in Table 2 have been implemented by both agencies while others are currently under consideration.

Lessons Learned

Heavy precipitation, lightning, extreme temperatures, storms, and strong winds affect operations and maintenance activities. Severe storms will disrupt most O&M activities and even a light rain or moderate wind can be enough to delay activities like painting or sign replacement.

In addition to such direct impacts, indirect, secondary, and synergistic climate and weather effects can also be of concern. For example, drought and wildfire conditions associated with climate change can increase sediment loading

resulting in clogged culverts. Further, if it rains following a wild fire event, flooding and flash flood events can post significant impacts on the transportation system and the safety of its users.

The reality of fixed and finite budgets and the press of other demands besides climate change can make it exceedingly difficult for O&M organizations to be as proactive as they would like to be.

Advanced asset management and systems that integrate climate change risk and monitoring can support prioritization and integration of adaptation into existing O&M activities.

O&M personnel in the Gulf Coast region have effectively coped with unique and continued challenges from extreme weather and climate change. They have noted the importance of early collaboration and preparation, both of which could help other locations in addressing climate change.

For More Information

Resources:

Gulf Coast Study:
Engineering Assessments of Climate Change Impacts and Adaptation Measures

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