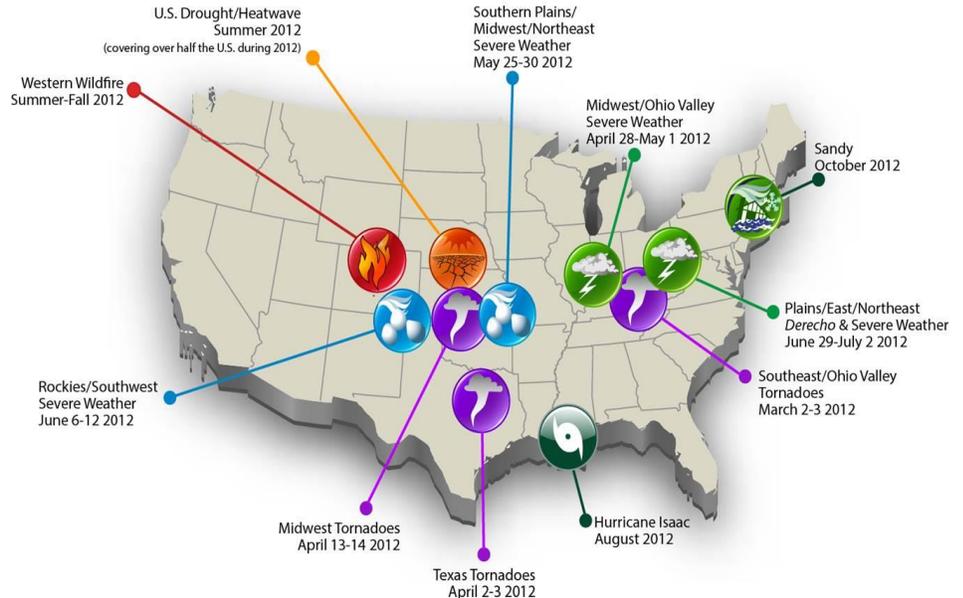




## How Do Extreme Weather Events Impact Transportation Systems Management and Operations (TSM&O)?

Extreme weather events affect nearly every state in the U.S. In 2012, a total of 133 disaster events<sup>i</sup> occurred resulting in about \$881 billion in damages<sup>ii</sup> (see NOAA NCDC graphic<sup>iii</sup> at right). Events ranged from hurricanes, droughts, heat waves, severe local storms, non-tropical floods, and winter storms, to wildfires and freezes. Transportation system managers and operators are often at the front line preparing for and managing the impacts of these events. Examples of impacts are reduced construction hours, electrical system malfunctions or brownouts, freight disruptions, icing, and road closures and detours due to flooding, wash-outs, or wildfires. There is strong evidence that events related to heat, heavy precipitation, and coastal flooding will grow in frequency and severity in coming decades and we will likely continue to experience droughts and tropical storms.

U.S. 2012 Billion-dollar Weather and Climate Disasters



## How Can TSM&O Managers Prepare for Extreme Weather Events?

Although DOT experience with operations will vary by state and topic, below is a "Top 10" list of suggestions for TSM&O managers and staff to better prepare for extreme weather.

1. **Contingency Plans:** Have contingency plans for power outages, detours, debris clearance, and routing for overweight or disabled trucks - to include pre-approved contractors and funds.
2. **Evacuation & Emergency Routes:** Operate effective evacuation routes in high risk areas.
3. **Traveler Information:** Develop effective public and traveler information systems/services to inform travelers of travel options (including social media tools, mobile apps, and collecting real time conditions through vehicle technology).
4. **Drill & Test:** Use response to "routine emergencies" to test staffing, deployment, and communications. Also, coordinate in advance with partners at the local, state, and Federal level in the event response is required.
5. **Pre-Positioning Materials & Equipment:** Develop strategies for responding to transportation system disruptions due to weather-related events, including pre-positioning replacement materials (culverts, etc.) in vulnerable areas.
6. **Back up Communications:** Prepare backup communications such as satellite phones, portable highway advisory radios, truck radios, and alternative networks.
7. **Risk Reduction Strategies:** Identify facility locations vulnerable to risks (flooding, landslides etc.), and develop appropriate strategies to minimize such risk.
8. **Early Warning Indicators:** Incorporate "early warning indicators" for potential extreme weather-related risks into asset and maintenance management systems.
9. **Harden the System:** Prepare for events with backup power generators, "hardened" sign structures and traffic signal wires, pre-positioned variable message sign boards and support vehicles trucks.
10. **Workforce Protection:** Protect workers from extreme temperatures and weather during day-to-day and response activities.



U.S. Department  
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**Federal Highway  
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## TSM&O Resources for Extreme Weather Preparedness

### PUBLICATIONS

- **Climate Change, Extreme Weather Events and the Highway System** (NCHRP Report 750, Volume 2, 2014). This report presents guidance for practitioners on adaptation strategies to likely impacts of climate change in the planning, design, construction, operation, and maintenance of infrastructure assets in the U.S.
- **Planning for Systems Management & Operations as part of Climate Change Adaptation** (FHWA, March 2013). This white paper presents effects associated with climate trends and events, how those effects will impact transportation system management and operations, and how agencies can assess the vulnerability of transportation systems and proposed changes to make its operations more resilient to climate change.
- **Expedited Procurement Procedures for Emergency Construction Services** (NCHRP Synthesis 438, November 2012). This report explores procurement procedures being utilized by State DOTs in coordination with Federal agencies to repair and reopen roadways in emergency situations.
- **Transportation Research Record Journal No. 2234: Critical Infrastructure Protection and Resilience: Emergency Evacuation** (February 2012). This issue includes 14 research papers on issues including improving the resilience of critical infrastructure systems post-disaster.
- **Lessons Learned from Irene: Vermont RPCs Address Transportation System Recovery, National Association of Development Organizations** (June 2012). The report provides lessons learned from this collaborative effort for future disaster preparedness and recovery.

### FEDERAL GUIDANCE AND RULES

- **SAFETEA-LU, Section 1201 – Real-Time System Management Information Program** (Nov. 8, 2010). Rule establishes provisions and parameters for real-time information programs that provide accessibility to traffic and travel conditions information pursuant to the Safe, Accountable, Flexible, Efficient Transportation Act: A Legacy for Users (SAFETEA-LU).
- **Eligibility of Activities To Adapt To Climate Change and Extreme Weather Events Under the Federal-Aid and Federal Lands Highway Program** (Sept. 24, 2012) – Memo clarifies activities eligible for FHWA funding, including vulnerability assessments, design and construction of projects or features to protect assets from damage associated with climate change.
- **MAP-21, Section 1315 – USDOT Final Rule on Categorical Exclusions (CE) for Emergency Repair Projects** (Feb. 19, 2013). Rule revises the existing CE for emergency repair projects under Moving Ahead for Progress in the 21st Century Act (MAP-21).
- **MAP-21, Section 1511 – Special Permits During Periods of National Emergency Implementation Guidance, Revised** (June 2013). Section provides policy direction on special permits for divisible loads and guidance describing the program's purpose, permit requirements, and ineligible activities.

### WEBSITES

- **AASHTO Transportation and Climate Change Resource Center:** Extreme Weather Symposium, 2013. Materials on recent extreme weather events, costs, and how DOTs can manage them. [climatechange.transportation.org/symposium/](http://climatechange.transportation.org/symposium/)
- **FHWA Climate Change Adaptation Website:** [www.fhwa.dot.gov/environment/climate\\_change/adaptation/](http://www.fhwa.dot.gov/environment/climate_change/adaptation/)
- **Center for Climate and Energy Solutions:** Interactive map depicting extreme weather events, 1990-2012. [www.c2es.org/science-impacts/maps/extreme-weather](http://www.c2es.org/science-impacts/maps/extreme-weather)

### OTHER RESOURCES

**AASHTO's Sustainable Transportation: Energy, Infrastructure, and Climate Solutions (STEICS) Technical Assistance Program** provides timely information, tools, and technical assistance to State DOTs to manage challenging issues associated with extreme weather events. ([http://climatechange.transportation.org/about/steering\\_committee.aspx](http://climatechange.transportation.org/about/steering_committee.aspx))

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<sup>i</sup> "Disaster events" in this context have been defined as tropical cyclones (e.g., hurricanes), droughts/heatwaves, severe local storms, non-tropical floods, winter storms, wildfires, and freezes.

<sup>ii</sup> Smith and Katz, *Natural Hazards*, June 2013, Volume 67, Issue 2, pp. 387-410.

<sup>iii</sup> Source: NOAA NCDC at [www.ncdc.noaa.gov/billions/summary-stats](http://www.ncdc.noaa.gov/billions/summary-stats)