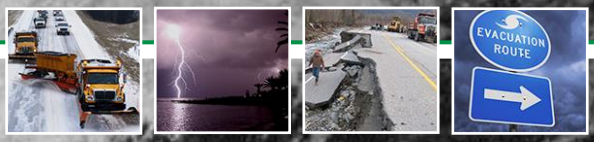

Extreme Events 101: Heat Waves

Heat waves can damage transportation infrastructure and pose challenges for maintenance and construction. Higher temperatures can put stress on bridge infrastructure through thermal expansion of bridge joints and paved surfaces, and deterioration of steel, asphalt, protective cladding, coats and sealants. Extreme heat can accelerate the deterioration or threaten the integrity of some types of asphalt pavement through softening, rutting, and migration of liquid asphalt. Hotter summer days can pose risks to the health and safety of maintenance and construction crews, limiting working hours. Vehicle overheating and tire deterioration can also occur during extreme heat events.

REGIONAL TRENDS

While many regions experienced significant heat in the 1930s, heat waves have generally become more frequent across the U.S. during the last three decades (see Fig. 1).[1]

Recent summers along the West Coast (2014), in the Midwest (2012), and in Texas and the Southwest (2011) have exhibited record-breaking heat. July 2014 was one of the top-five warmest on record for California, Oregon, and Washington; July 2012 was the hottest month in the contiguous United States on record; and 2011 was the hottest summer on record in New Mexico, Texas, Oklahoma, and Louisiana. Over 350 weather stations tied or broke all-time record high maximum temperatures during 2012, and 99.1 million people experienced 10 or more days of temperatures that reached or exceeded 100°F.[2] In 2011, parts of Texas and the Southwest experienced over 70 days of temperatures that reached or exceeded 100°F.[3]

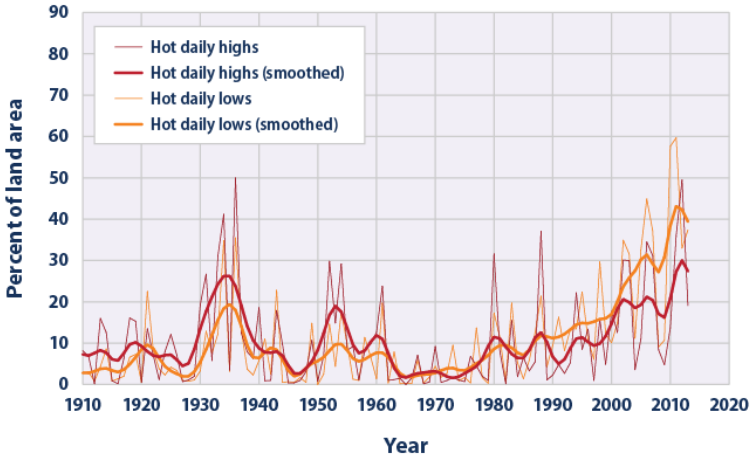

Fig. 1. Area of the contiguous U.S. with unusually hot daily high and low temperatures during the summer months. Thin lines represent individual years, while thick lines show a nine-year weighted average. Red lines represent daily highs, while orange lines represent daily lows. Source: EPA Climate Change Indicators in the United States

REGIONAL PROJECTIONS

In the future, the broad trends in extreme heat are expected to continue – heat waves are expected to become more intense and more frequent.[4]

The maps in Figure 2 demonstrate the increase in intensity that could occur by the end of the 21st century. For the rapid emissions reductions map (Fig. 2 – left), in which less warming occurs, the hottest days would increase by up to 4°F; the continued emissions increases map (Fig. 2 – right) shows that the hottest days could increase by more than 10°F if more warming occurs in the 21st century.[5]

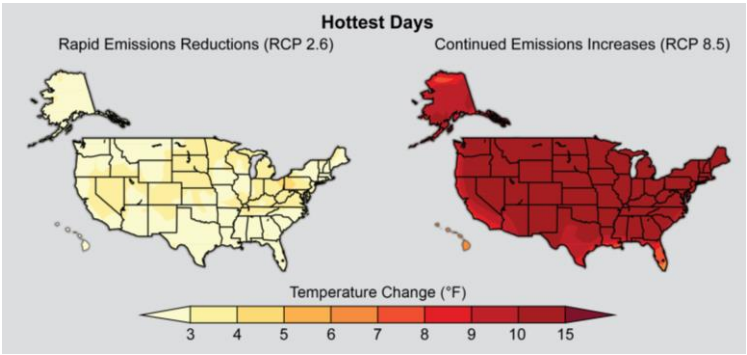

Fig. 2. Estimated changes in the average temperature of the hottest days at the end of this century (2081-2100) relative to the turn of the last century (1986-2005). Source: 2014 National Climate Assessment

To provide an example about changes in frequency, models indicate that by the year 2100 what was previously a hot day occurring once-in-20-years will occur once every two or three years across most of the country.[6] In other words, extremely hot days will become more commonplace.

[1] Figure 1 source: http://www.nesdis.noaa.gov/technical_reports/NOAA_NESDIS_Tech_Report_142-9-Climate_of_the_Contiguous_United_States.pdf (p.24)
[2] http://www.ncdc.noaa.gov/sotc/national/2012/13/supplemental/page-9/
[3] http://www.nesdis.noaa.gov/technical_reports/NOAA_NESDIS_Tech_Report_142-9-Climate_of_the_Contiguous_United_States.pdf (p.17)
[4] Information on the projections for future heat wave length and frequency for the U.S. can be found at: http://www.nesdis.noaa.gov/technical_reports/NOAA_NESDIS_Tech_Report_142-9-Climate_of_the_Contiguous_United_States.pdf
[5] The "rapid emissions reductions" (RCP 2.6) pathway assumes immediate reductions in emissions and would limit globally-averaged warming to about 2.5°F during this century. The "continued emissions increases" (RCP 8.5) pathway is projected to lead to more than 8°F globally-averaged warming by 2100, with a high-end possibility of more than 11°F. (National Climate Assessment, p. 26)

RESPONSES

Some state departments of transportation (DOTs) and local governments are addressing the risks of extreme heat through various activities. Examples include:

- **Caltrans** is exploring ways to prepare for and cope with extreme heat, including increasing monitoring of infrastructure during extreme heat events, overlaying with more rut-resistant asphalt, increasing maintenance, and shifting to evening construction schedules. Caltrans is also developing a specification for "cool pavements" that can help to minimize the urban heat island effect.[7]
- **Michigan DOT** is intensifying monitoring of pavement conditions during extreme heat periods and encouraging more night work to prevent premature cracking.[8]

Image: Extreme pavement rutting.
Source: FHWA (www.asphaltwa.com)

- **Alabama DOT** switches maintenance crews to earlier start times in the summer when there are more frequent extreme heat events.[9]
- As one of the Federal Highway Administration's (FHWA) Climate Resilience Pilot Projects, the **North Jersey Transportation Planning Authority** conducted a vulnerability assessment of assets in two geographic areas in the state. The assessment found that temperatures higher than 95°F would increase the risk of rail kinks and sagging of overhead wires. However, highways would be potentially less sensitive to heat because the state is already using higher grade binders and newer mixes to mitigate the impacts of temperature.[10]

RESOURCES

- **AASHTO Extreme Weather Events Symposium:** This site provides presentations and a summary white paper from the May 2013 national symposium on the impacts of extreme weather events on transportation. http://climatechange.transportation.org/symposium/
- **FHWA Tools for Adaptation:** FHWA has developed various reports and tools that can be used by transportation planners and engineers, including guidance about regional climate impacts, vulnerability assessments, and case studies. http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/summary/index.cfm
- **Transportation Research Board Special Report 90: Potential Impacts of Climate Change on U.S. Transportation**: This report summarizes current and future climate changes on U.S. transportation infrastructure and operations, and identifies potential adaptation options. http://onlinepubs.trb.org/onlinepubs/sr/sr290.pdf
- **Third National Climate Assessment, Climate Change Impacts in the United States:** This report assesses the impacts of climate change across the country, including impacts for various sectors (including transportation) and regions, as well as potential responses to these impacts. http://nca2014.globalchange.gov/
- **National Oceanic and Atmospheric Administration (NOAA) Technical Reports on Regional Climate Trends and Scenarios:** These reports describe the observed climate trends and future climate scenarios for the various regions of the United States. This work helped inform the National Climate Assessment, but the NOAA reports provide greater detail for each region. http://www.nesdis.noaa.gov/technical_reports/142_Climate_Scenarios.html

CONTACTS

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[6] 2014 National Climate Assessment, p. 39
[7] http://www.dot.ca.gov/hq/tpp/offices/orip/climate_change/documents/Caltrans_ClimateChangeRprt-Final_April_2013.pdf
[8] http://glisa.umich.edu/media/files/NCA/MTIT_Transportation.pdf
[9] http://www.fhwa.dot.gov/environment/climate_change/adaptation/publications_and_tools/transportation_projects/transportationprojects.pdf
[10] http://www.fhwa.dot.gov/environment/climate_change/adaptation/case_studies/new_jersey/index.cfm