



Extreme Events 101: Heavy Rainfall and Flooding

Heavy rainfall events can disrupt transportation services and damage infrastructure and facilities. During or following periods of heavy rainfall, inundation and washouts can block transportation routes, damage facilities, and interrupt power supplies. High flows exacerbate erosion and scour, compromising infrastructure near or across rivers and streams. High flows can also deliver sediment and debris, posing problems for roads, bridges, and culverts. Heavy rains can destabilize slopes and contribute to landslides especially if wildfires have occurred in the area previously. Debris from flooding and landslides can block drainage systems, which in turn exacerbates flooding. Heavy rains can also complicate stormwater management goals, introducing nutrients, sediment, and sewage into water bodies and reducing water quality.



Image: Heavy rains in November 2012 resulted in the closure of State Route 4 in Washington. Source: WSDOT Flickr

REGIONAL TRENDS

Across the country, heavy rainfall events have become more frequent and more intense (Fig. 1) during the last several decades.

It is important to note that trends in flooding have not always tracked with trends in heavy rainfall. In many parts of the Northeast and Midwest, there has been a trend toward more intense flooding in the past century; however, other regions have shown little change or a decrease in the intensity of floods. Flooding trends can be influenced by more than just rainfall during a one- or two-day period; antecedent rainfall and soil moisture can play an important role. In addition, flooding trends can be affected, up or down, by changes in the local land surface (e.g., conversion of forests to developed land) and the installation of structures that affect streamflow (e.g., dams, channelization).

REGIONAL PROJECTIONS

For the future, the broad trends in heavy rainfall are expected to continue – heavy rainfall events are expected to become more frequent and more intense across the United States. However, the changes in frequency and intensity may vary from location to location. The maps in Figure 2 show that the once-in-20-year event would become more frequent by the end of the 21st century. For the rapid emissions reductions map (Fig. 2 – left), in which less warming occurs, these rare events would occur approximately once per decade; the continued emissions increases map (Fig. 2 – right) shows that these events would be once every 4 or 5 years if more warming occurs in the 21st century.¹

Observed Change in Very Heavy Precipitation

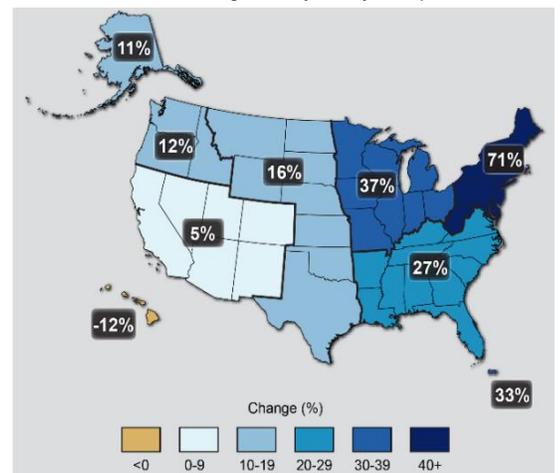


Fig. 1. Percent changes in the amount of precipitation falling during very heavy events (the wettest 1% of days in the data record) from 1958-2012. Source: 2014 National Climate Assessment

Projected Change in Heavy Precipitation Events

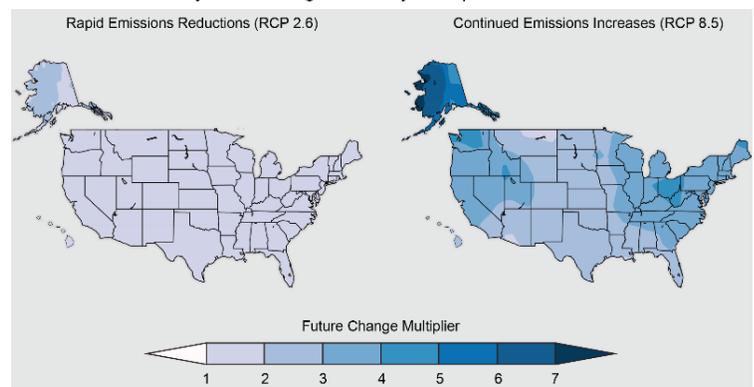


Fig. 2. Change in the frequency of rare precipitation events. Source: 2014 National Climate Assessment

¹ 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 heavy rainfall and flooding risks through various activities, including:

- **Maine DOT** is adapting to changing precipitation and flooding conditions. As part of the Sustainability Solutions Initiative, Maine DOT is creating decision tools to help map culvert locations, schedule maintenance, re-size culverts, and analyze replacement needs and costs.²
- As one of the Federal Highway Administration's (FHWA) Climate Resilience Pilot Projects,³ **Washington State DOT** (WSDOT) became the first DOT to conduct a statewide vulnerability assessment. WSDOT is currently in the second phase of the pilot project, developing solutions to address corridor flooding and other hazards in the Skagit River Basin.⁴
- **Minnesota DOT** (MnDOT) is currently undertaking a vulnerability assessment to measure the sensitivity of the state's trunk highway system to flash flood events in two districts. The project, one of FHWA's Climate Resilience Pilots, will include a focused analysis of adaptation options at specific high-risk facilities identified in the system-level assessment.



Image: The Sustainability Solutions Initiative is working with Maine communities to assess risks to culverts and plan for future flooding events. Source: University of Maine

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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² <http://umaine.edu/mitchellcenter/helping-communities-weather-the-storms/>

³ http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/vulnerability_assessment_pilots/index.cfm

⁴ <http://www.wsdot.wa.gov/sustainabletransportation/adapting.htm>