

Chapter 25: Floods



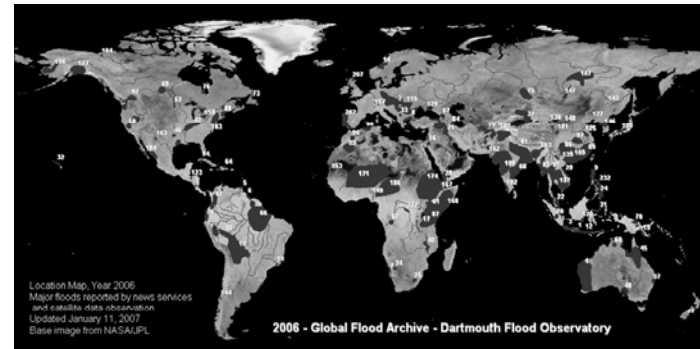
Courtesy of the United States Coast Guard

- **Magnitude of Flood**
- **Types of Floods**



ESS124
Prof. Jin-Yi Yu

Worldwide Locations of Significant Floods during 2006



- Flooding is the number one weather-related cause of property damage in the United States and the number two weather-related cause of death worldwide (drought is number one).
- The duration and intensity of floods depend on many factors, only some of which are related to the weather.



ESS124
Prof. Jin-Yi Yu

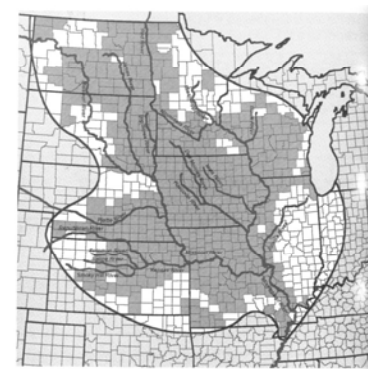
Magnitude of Flood

- Hydrologists often use terms like “100-year flood” or “500-year flood” to convey the idea of a flood’s magnitude.
- These numbers are developed by extrapolating historical data to longer time periods.
- The term “100-year flood” means that, in any given year, there is a one in 100 chance of a flood of that particular magnitude.
- In other words, the probability of a flood of that particular magnitude in any given year is 1/100 or 1 percent.
- The actual amount of water that causes a particular flood (e.g., a 100-year flood) varies from river to river.



ESS124
Prof. Jin-Yi Yu

The Great Flood of 1993



Courtesy of NOAA

- One of the greatest floods in the history of the US occurred in 1993 along the Mississippi River.
- The flood, identified as a 500-year event, inundated more than 20 million acres of land in nine states.
- Economic losses were estimated between \$15 and \$20 billion.



ESS124
Prof. Jin-Yi Yu

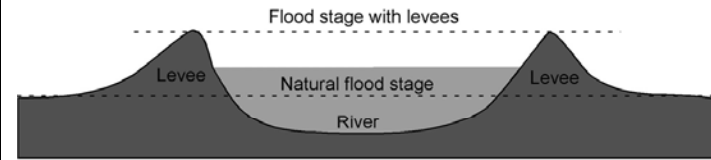
Three Types of Floods

- **Flash floods:** occur rapidly with little or no warning and if often caused by slow-moving thunderstorms.
- **Widespread floods:** occur when a large amount of rain falls over a watershed for many days.
- **Coastal floods:** occur when a rise in the ocean surface due to storm surge develops during hurricanes and strong extratropical cyclones.
- It is possible, and not uncommon, for a particular flood event to be comprised of a combination of these flood types.



ESS124
Prof. Jin-Yi Yu

Watersheds



©Kendall/Hunt Publishing

- The geographic area that drains into a river or stream is called a watershed.
- The Mississippi River watershed covers much of the central United States.
- The height of the water surface of a river is called its stage.
- A river's stage naturally fluctuates as rain falls and drainage occurs within a watershed.
- When a river raises to a level where it begins to flood, the river is said to be at flood stage.
- Hydrologists often use flood stage as a reference level to express the intensity of a flood.



ESS124
Prof. Jin-Yi Yu

North American Flood Weather Patterns

- A common feature of many of the weather patterns that affect North America is their slow movement, a characteristic that leads to rainfall over a watershed for a long duration.
- Flooding following landfall of tropical cyclones.
- Flooding from Mesoscale Convective Systems.
- Flooding from frontal overrunning.
- Flooding compounded by snowmelt.
- Flash floods of the Desert Southwest.
- Flash floods along the east slope of the Rocky Mountain.
- West Coast floods.



ESS124
Prof. Jin-Yi Yu

The Regions of US Affected by Flooding from Tropical Cyclones



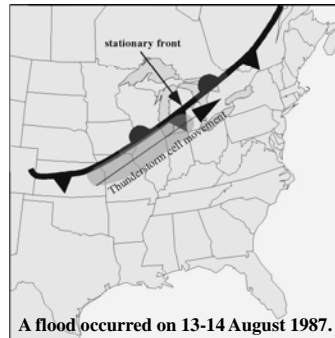
©Kendall/Hunt Publishing

- Between June and November in North America, tropical cyclones affect the Gulf Coast of the US, the east coast of the US, Canada, Mexico, and Central American, as well as the Caribbean Islands.
- These storms are well known to cause storm surge and associated coastal flooding.
- A tropical cyclone does not need to achieve hurricane intensity to cause substantial flooding.



ESS124
Prof. Jin-Yi Yu

Flooding from Mesoscale Convective Systems – Squall Line

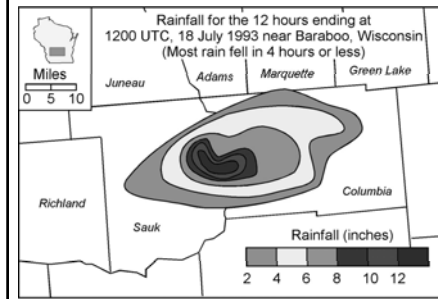


©Kendall/Hunt Publishing

- Thunderstorms organized as either frontal squall lines or mesoscale convective systems (MCSs) most commonly generate floods between Rocky Mountains and the Appalachian mountains.
- Flash floods associated with frontal squall lines occur when the frontal boundary is nearly stationary and the winds, both at the surface and aloft, flow essentially parallel to the front.
- Individual thunderstorm cells move along the front producing rain over the same location in a process called **training**, similar to boxcars of a train pass over the same location along the front.

ESS124
Prof. Jin-Yi Yu

Flooding from Mesoscale Convective Systems – MCS

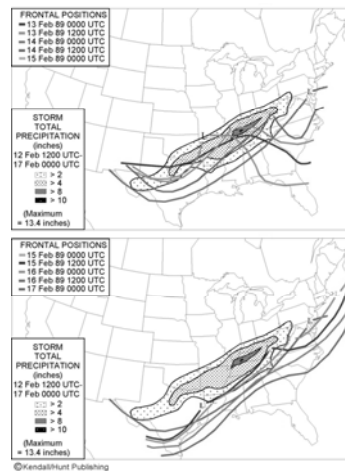


©Kendall/Hunt Publishing

- Mesoscale convective systems (MCSs) can also cause flash floods.
- MCSs can move very slowly, particularly in summer when the upper tropospheric flow is weak.
- New thunderstorm cells in the storm complexes are triggered by the gust front outflow boundaries of older thunderstorms.
- In this way, thunderstorms keep regenerating, and a heavy rain accumulation over a localized area.

ESS124
Prof. Jin-Yi Yu

Flooding from Frontal Overrunning



©Kendall/Hunt Publishing

- During the cold season, east-west oriented warm fronts often develop across the southeastern US.
- Sometimes these fronts stall, or moves so slowly that they are essentially stationary.
- When such a front present, warm, moist air originating over the Gulf of Mexico flows northward over the cool air-mass north of the front.
- This process, called frontal overrunning, produces clouds and rains north of the frontal boundary.
- Heavy rain and thunderstorms can develop north of the surface frontal position.
- If the front is present over a region for several days, the rain accumulated can lead to local flash flooding or even widespread flooding.

ESS124
Prof. Jin-Yi Yu

Flooding Compounded by Snowmelt



Courtesy of the U.S. Army Corp of Engineers

- Many damaging widespread floods in the northern US occur when the rapid melting of a winter snowpack enhances runoff from heavy spring rains.
- Heavy rain and rapid snowmelt often occur together when a subtropical moist airmass moves over a snow-covered region during the late winter or early spring.
- The ground is often frozen beneath the snow, preventing infiltration and enhancing runoff.
- The situation is often made worst by ice jams on rivers that have accumulated significant ice cover over the proceeding weeks or months.

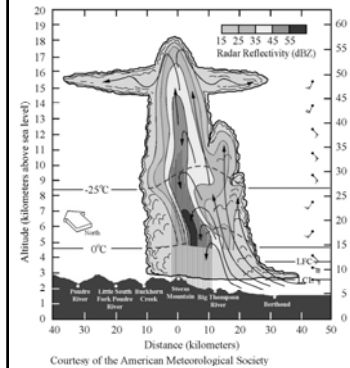
ESS124
Prof. Jin-Yi Yu

Flash Floods of the Desert Southwest

- Most of the year, the southwest deserts of the US are hot, dry, and sunny and receive very little rainfall.
- In the summer months, thunderstorms develop over the southwestern US following the onset of the North American Monsoon.
- These thunderstorms can produce short-duration, very high intensity rainfall.
- In much of the desert, rain runs off quickly and channels rapidly into very narrow canyons.
- Within the canyons, the height of the water often builds rapidly, forming a wall of water that roars down the canyons with no warning.



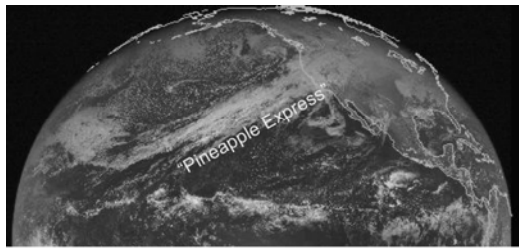
Flash Floods along the East Slope of the Rocky Mountains



- Water from the Rocky Mountains drains eastward through a number of deep canyons.
- In summertime, either when weak low pressure develops on the plains southeast of the mountains, or high pressure develops to the northeast, the flow on the plains east of the Rockies become easterlies.
- Afternoon heating can combine with the moist easterly flow toward the mountains to produce towering thunderstorms that anchor over the foothills just east of the mountain peaks.
- When these storms remain near-stationary over the foothills, flash floods can be produced from these heavy rainfall events.



West Coast Floods



© Kendall/Hunt Publishing

- While summer flooding is typical of the eastern Rockies, wintertime flooding is the greatest danger in the mountains along the West Coast.
- Flash flooding in the river valleys of the Sierra Nevada, cascade, and Coastal ranges often leads to more widespread flooding in the larger valleys at the base of these ranges.
- For California, Pineapple Express bring the heaviest precipitation, whose freezing level is high and most of the precipitation falls as rain in the mountains.

