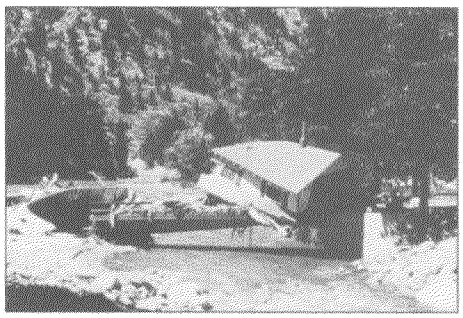
Floods

Floodplains are, by definition, lands that are formed by and continually subject to inundation by water. Depending on the location, topography, soils, and weather conditions, that flooding can take a variety of forms. Riverine floods can result not only from heavy rainfall and rapid snowmelt but also from dam and levee failure, ice jams, and channel migration Coastal flooding can be caused by hurricanes, winter storms, tsunamis, and rising sea level. Individual storms and long-term climate variations cause flooding around lakes. Other floodprone areas include alluvial fans, unstable and meandering channels, and areas affected by land subsidence and ground failure. In addition, flooding due to surface runoff and locally inadequate drainage can be a major problem, particularly in rapidly urbanizing areas.

Riverine Flooding

Riverine flooding—overflow of water from the channel onto the adjacent floodplain—is the most common type of flood. Hundreds occur each year in the United States.

- *Flash flooding* occurs in all 50 states: in narrow, steep valleys, on alluvial fans, on denuded areas, and along urban drainage courses, usually as a result of high intensity, short duration storms occurring on steep gradient streams. Flash floods can be more dangerous than other floods because of their suddenness, the velocity of the water, and the large amount of debris carried by the flood waters.



Big Thompson Canyon, Colorado, following flash flood, July 1976

Examples of Recent Flash Floods Causing Serious Loss of Life

February 1972, Buffalo Creek, West Virginia—125 killed and hundreds of homes washed away when a dam made of coal mine waste material gave way after heavy rains.

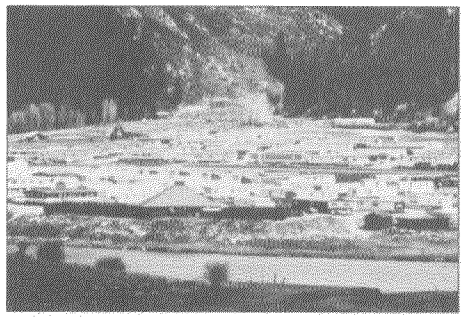
June 1972, Rapid City, South Dakota and adjacent areas—236 dead and $100 million in property damage after a large, slow-moving thunderstorm unleashed heavy rain on the slopes of the Black Hills.

July 1976, Big Thompson Canyon, Colorado—139 killed and millions of dollars in property damage after a thunderstorm inundated the western third of the canyon with 12 inches of rain in less than six hours.

July 1977, Johnstown, Pennsylvania—77 dead and more than $200 million in property damage when violent thunderstorms produced 11 inches of rain over a seven-county area in nine hours. Several dams failed, compounding the stream flooding and causing 40 of the deaths.

September 1977, Kansas City, Missouri, and adjacent areas—25 killed and $90 million in property damage when thunderstorms turned several streams into raging torrents, including "gentle" Brush Creek, which flows through the heart of Kansas City.

Source: Federal Emergency Management Agency



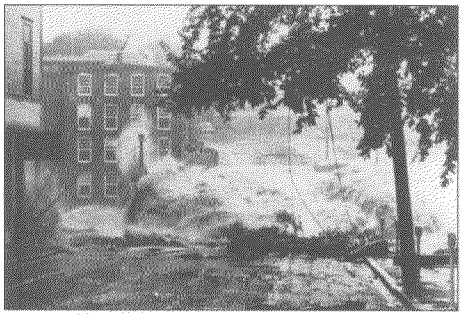
Alluvial fan flooding at the mouth of ravines or the foot of mountains occurs throughout the United States, but is most prevalent and poses the greatest hazard in the arid West

Mobile home park, Colorado river, near Parker, Arizona

- *Alluvial fan flooding* can cause great damage because of the high velocities, large amounts of sediment and debris, and wide area covered by the flood waters. Alluvial fans occur mostly along the base of mountains in the western states. An estimated 15-25% of the arid West, including Los Angeles and Las Vegas, is covered by alluvial fans.
- *Unstable and meandering stream channels* are also frequently flooded. Many of them are the product of several decades of human activities, particularly in the arid and semi-arid West. Overgrazing, mining, forestry, urbanization, gravel and sand extraction, and the construction of railroads,

Storm drainage is a significant problem in many large urban areas, particularly if development has been rapid and not well planned. Drainage systems must be designed to handle infrequent, but potentially catastrophic, events.

Concrete-lined artificial channel carrying flood waters, Baton Rouge, Louisiana



Hurricanes can result in flooding of various kinds, from flash flooding and slow-rise riverine flooding due to heavy precipitation, to coastal flooding due to storm surge.

Quinebaug River, Putnam, Connecticut, 1955, following Hurricane Diane

Hurricanes can cause severe damage due to the combined effects of several agents—high winds, increased wave action, heavy precipitation, storm surge and other types of flooding

Damage near Charleston, South Carolina, following Hurricane Hugo, September, 1989

highways, dams, and irrigation facilities all have changed the vegetative cover, altered surface water patterns, changed the movement of sediments, and lowered water tables. These changes have made water movement during floods difficult to predict.

- *Ice jams,* which affect 35 states, cause a rapid rise of water both at the point of the jam and upstream; when the jam breaks, sudden downstream flooding results. Because the waters are higher and their velocities greater, damages usually exceed those that would have occurred without the jam. Additional damage can be caused by the force of the ice, as it builds in volume and expands overbank during the jam and then crashes downstream when the jam breaks.

Flooding from Surface Runoff

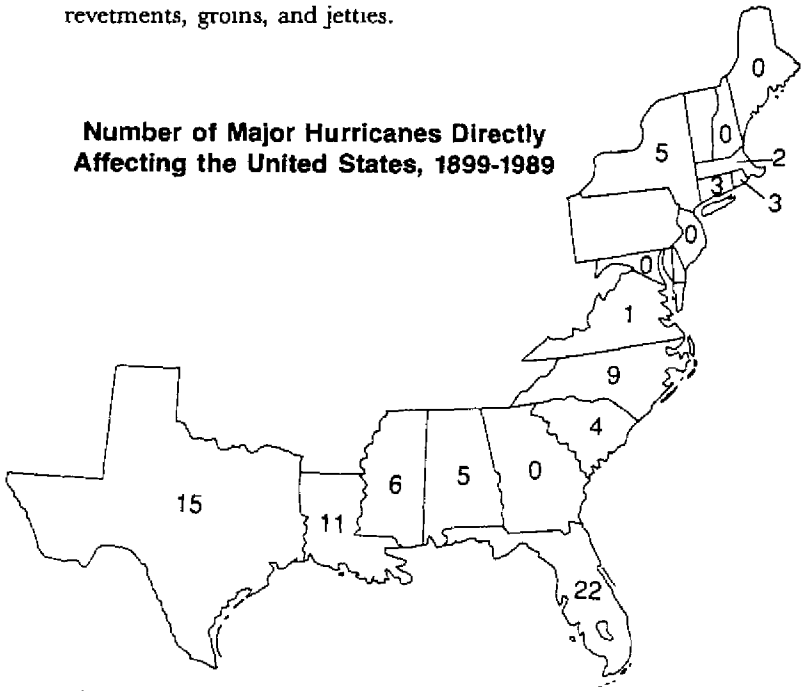
The runoff from heavy precipitation can overtax inadequate local drainage systems and result in flooding outside of normal floodplains. These kinds of flooding problems generally intensify as areas become more urbanized. Frozen ground and heavy accumulations of snow can exacerbate the problem

Coastal Flooding and Erosion

Coastal flooding and erosion result from storm surge (the rise in the water surface due to barometric pressure and the piling up of water as a result of wind) and wave action (the combination of wave set-up and wave runup). The frequency and magnitude of flooding and erosion vary considerably across the country.

- From 1899 to 1989 a total of 148 *hurricanes* and 135 *tropical storms* crossed or passed adjacent to the U.S. mainland.
- *Northeasters*—extratropical storms accompanied by strong winds—cause flooding along the north Atlantic coast
- *Tsunamis* are sea waves generated by undersea earthquakes of over R6.5, they are very long-period, are of low height at sea, and can travel over 500 mph. The entire Pacific coast of the United States, including Alaska and Hawaii, is subject to tsunamis.
- *Shoreline erosion* occurs either when storm surge and wave action move sediment offshore or when the alongshore flow of sediment is interrupted by natural forces or human activities Natural erosion may be accelerated by partial or inadequate structural or nonstructural measures intended to protect short reaches of eroding shoreline—such as beach nourishment, artificial dunes, breakwaters, seawalls, bulkheads, revetments, groins, and jetties.

Number of Major Hurricanes Directly Affecting the United States, 1899-1989



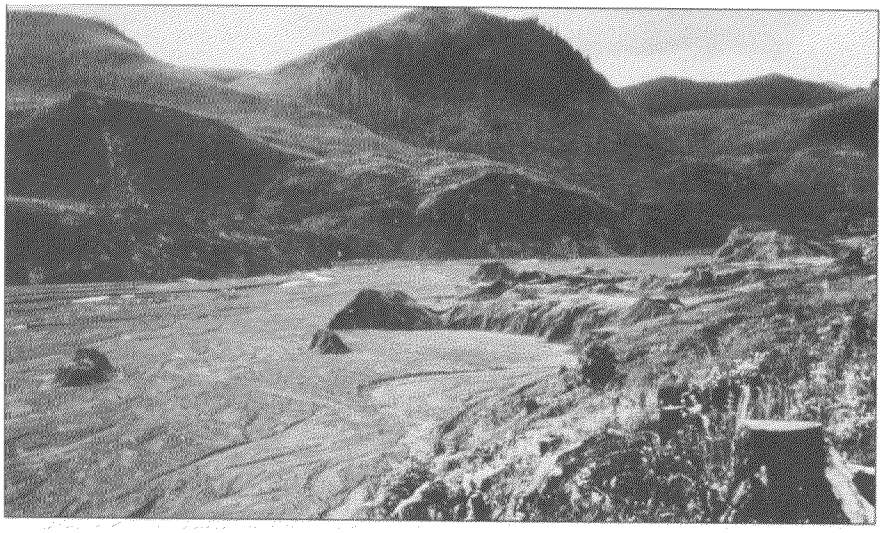
Source National Hurricane Center, National Weather Service

Ground Failure

Areas subject to ground failure often suffer from *mud flows* and *mud floods*, two forms of landslides. Urban development alters hillslope configurations and upsets established equilibrium, triggering the natural instability of many slopes and sometimes reactivating old landslides. Mud and debris may fill drainage channels and sediment basins, causing flood waters to suddenly inundate areas outside the floodplain. Mud flows and mud floods may cause more severe damage than other flooding because of the force of the debris-filled water and the combination of debris and sediment.

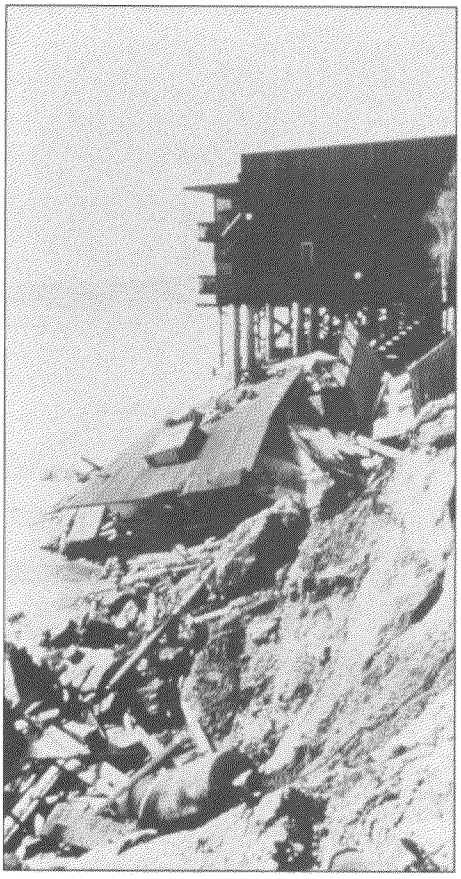
Both natural and human-induced *subsidence* can increase flood damage in areas of high groundwater, tides, storm surges, or overbank stream flow. It can also block or otherwise alter drainage patterns, leading to deeper or unexpected flooding Subsidence occurs in at least 38 states.

Liquefaction is a type of ground failure triggered by seismic waves passing through unconsolidated and saturated soil. Depending on the character of the soil, the amount of water, and the drainage potential, the soils may sink or become liquid. This can result in serious flooding of structures built on fill or saturated soils—as in parts of San Francisco and Anchorage.



Mud flows and mud floods are two types of landslides that can be aggravated by human development Additionally, they can result from other natural hazards, such as earthquakes and volcanic eruptions

Toutle River. Washington State, following the eruption of Mt St Helens, May 1980



Natural coastal erosion can be greatly accelerated by wave action during storms and hurricanes. Combined with inappropriate construction in coastal areas, this natural process can result in disaster.

Big Rock Beach, Malibu, California, following Pacific winter storm, 1983