



*Survivors of a deadly flood in Ecuador struggle to salvage their belongings in knee-deep waters. (Xinhua/Landov)*

## Floods and flood control

**CATEGORIES:** Environment, conservation, and resource management; geological processes and formations

*Floods can have both devastating and positive effects on natural resources and human infrastructure.*

### BACKGROUND

Floods happen with any high flow of surface waters that overtop normal confining banks and cover land that is usually dry. Floods occur naturally along most river systems. Low-lying areas and areas downstream of dams are most at risk. Flooding causes loss of human and animal life; structural damage to bridges, buildings, roadbeds, and utilities; soil erosion; destruction of property; and destruction of livestock and crops that provide food for people. As a result, famines may follow floods, with large numbers of people dying from starvation. Floodwaters are typically contaminated with raw sewage, including both hu-

man and animal waste, and may contain dangerous levels of bacteria, leading to outbreaks of waterborne illness.

Floods also can have positive impacts. Floods recharge natural ecosystems; provide abundant fresh water for agriculture, health, and sanitation; and deposit nutrient-rich sediment on floodplains, enhancing crop yields. The importance of floods to aquatic ecosystems is demonstrated by the artificial flooding in the Grand Canyon of the Colorado River in the United States.

However, floods are the most devastating of all geological agents, surpassing earthquakes and volcanic eruptions in terms of loss of life and property damage. In developing countries, floods cause a large number of deaths, whereas in developed countries, floods cause billions of dollars worth of property damage. Each year there are between fifty and three hundred inland floods worldwide, impacting an estimated 520 million people and causing as many as 25,000 deaths. Since 1985, inland floods have killed approximately 130,000 people (not including loss of life from storm

surge and tsunami-related floods). Floods and other water-related disasters cost the world economy as much as \$50 to \$60 billion per year. Globally, the greatest potential for flooding exists in Asia, where more than 1,200 floods occurred between 1900 and 2006, claiming an average of 5,300 lives and costing up to \$207 billion in losses. As urbanization increases, particularly in flood-prone areas, the potential for flooding rises because of land-use changes (such as deforestation and the covering of once-permeable ground with concrete, asphalt, and buildings). Climate change and sea-level rise also lead to increased flooding. Nearly 1 billion people, about one-sixth of the world's population, live in areas prone to flooding. Many of these people are among the world's poorest inhabitants, depending on fertile floodplain soils and wetlands for agriculture and economic opportunity.

#### FLOODPLAINS

Most streams are naturally bordered by flat, low-lying areas known as floodplains. Floodplains have been carved into the landscape by stream erosion and are covered in fine-grained sand, silt, and clay deposited by floodwaters. Some streams have natural levees, moundlike deposits of sediment that border the stream channel. Natural levees form as floodwaters leave the channel and spread onto the floodplain. As rushing water leaves the channel, its velocity drops, and coarser sediment is deposited adjacent to the stream. Man-made levees may be built along streams in an attempt to control flooding. However, if the water in a stream is allowed to spread over its natural floodplain, the impact of downstream flooding is lessened.

#### TYPES OF FLOODS

Floods occur when a drainage basin (or watershed) receives so much water that stream and river channels cannot handle the flow. After a rain, some water infiltrates the soil, some evaporates or is used by plants, and the remainder (about 30 percent) becomes runoff, flowing across the ground surface.

Riverine floods occur when heavy rainfall or spring thaws (melting snow and ice) increase water levels in a drainage basin. Heavy rainfall may be the result of a hurricane, a tropical cyclone, a monsoonal rain, or a prolonged period of unusually wet weather, as in the case of the Great Midwest Flood of 1993 in the central United States, which impacted nine states along the

Mississippi River and lasted more than four months.

In cold climate areas where rivers freeze in the winter, spring thaws bring ice jams and associated flooding. Rising water levels lift river ice, which breaks into large sheets that float downstream and pile up near narrow passages or against obstructions such as bridges. When the ice stops moving because of a jam, floodwaters rapidly spread over the riverbanks upstream from the jam and may cover vast areas of usually dry land, flooding roads and causing property damage. When the ice jam breaks, a sudden flood of water is released. Ice jam flooding occurs in Canada, the northern United States, Europe, Russia, Kazakhstan, China, and other countries.

Flash floods are associated with intense storms that release large amounts of rain into small drainage basins in a relatively short period of time. Flash floods occur with little or no warning and can reach peak levels within minutes, carrying a deadly cargo of rocks, trees, and other debris. Fifteen centimeters of swiftly moving water can sweep people off their feet, and cars can be swept away by 0.6 meter of water. A notable flash flood occurred July 31, 1976, along the Big Thompson River near Denver, Colorado, after an unusually heavy rainstorm. A wall of water 5.8 meters high roared down a canyon where people were camping. The flood killed 140 people and caused millions of dollars in property damage. Flash floods may even occur in dry streambeds on sunny days when small but heavy rainstorms occur upstream kilometers away.

Storm surge floods (coastal floods) occur when on-shore winds and hurricanes cause the sea level to rise over low-lying coastal areas. If storm surges happen during high tide, leading to a tidal surge, the devastation can be catastrophic. Sometimes during hurricanes coastal areas are affected simultaneously by storm surges and riverine floods. In May, 2008, Cyclone Nargis struck Myanmar (Burma) with storm surge, flooding up to 4 meters in the densely populated Irrawaddy Delta region. The death toll was estimated to be more than 100,000.

Coastal flooding can also occur as a result of a tsunami or seismic sea wave following an earthquake. On December 26, 2004, a magnitude 9.3 earthquake off the coast of the Indonesian island of Sumatra produced a tsunami in the Indian Ocean that flooded coastal areas across Southeast Asia, Sri Lanka, India, and other nations bordering the Indian Ocean, including Australia and several African countries. The tsunami, which was up to 25 meters high, killed nearly