## Tsunamis

Tsunamis are caused by earthquakes, volcanic activity, and landslides on the sea floor which generate enormous waves. Because of the length, depth, and velocity of these waves they are difficult to detect and monitor.

About 80% of tsunamis occur in the Pacific Ocean, but there have been significant events in the Caribbean too. In 1692, 3,000 people were killed by an earthquake and tsunami at Port Royal, Jamaica. As the result of an earthquake off the Virgin Islands in 1867 and the 1918 Puerto Rico earthquake, tsunamis did extensive damage. Tsunamis present a real threat to islands that make a substantial living from tourism along their shores and for countries like Guyana and Suriname that are below sea level. One of the most serious tsunamis in recent history was one set off by the 1960 earthquake in Chile. It not only obliterated fishing villages in Chile, but caused the deaths of hundreds in Hawaii, Japan, and the Philippines. In 1992 a 7.2 magnitude earthquake off the western coast of Nicaragua generated waves over 10 m high that left 116 dead and over 40,000 homeless (see Box 3.1).

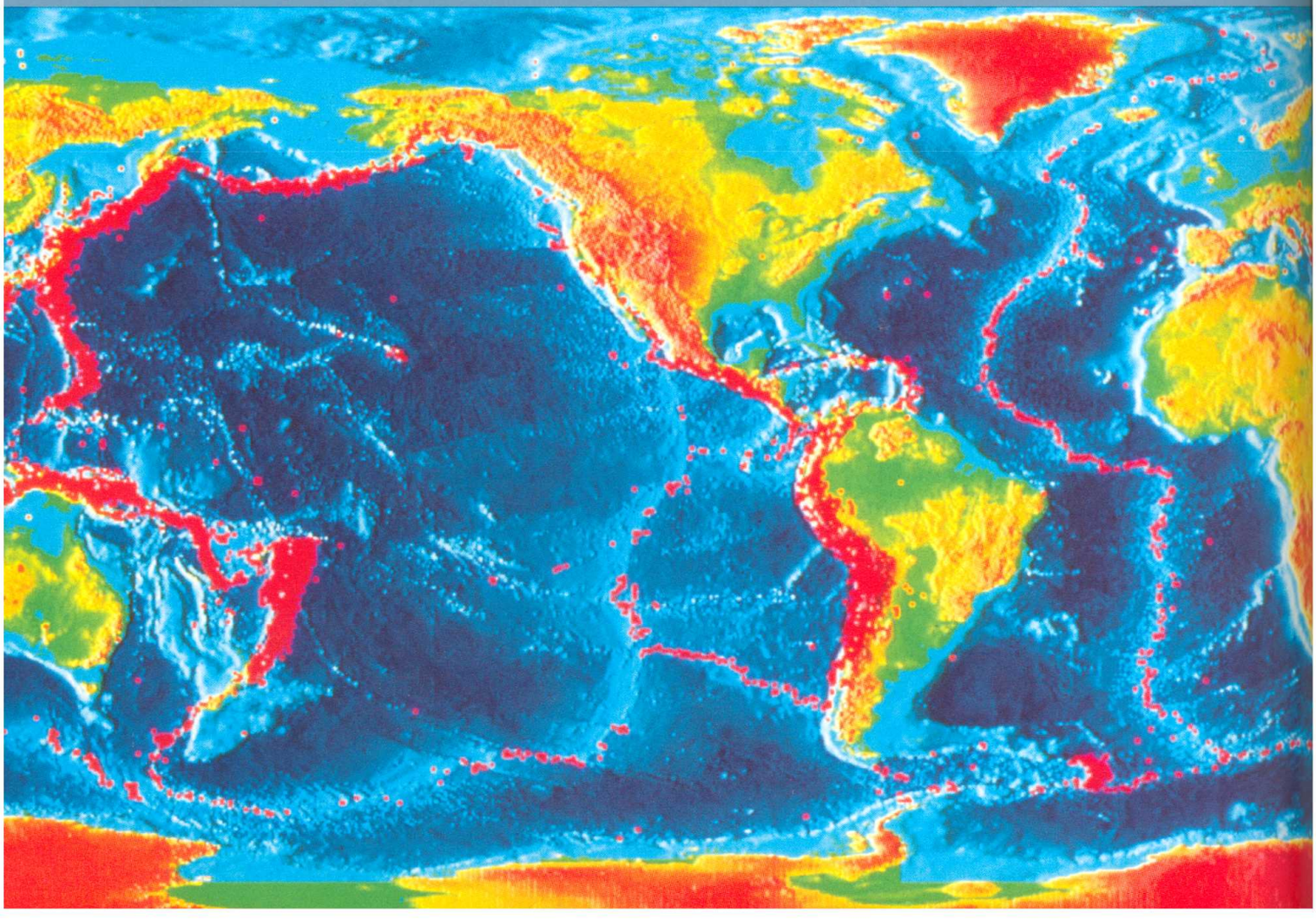
**Figure 3.1. Map showing epicenters of earthquakes, magnitude ≥ 5 since 1980.**

Map courtesy of NOAA, U.S. Geophysical Data Center.

## Volcanoes

For centuries, those who have inhabited the Americas have been well aware of the hazards posed by volcanoes. Guatemala, for example, is known as the country of lakes and volcanoes, but this nickname could be applied to other

Figure 3.1



**Box 3.1**

## WHEN THE EARTH MOVES UNDER THE SEA

***A Double Hazard in Chile.*** In May 1960 Chile was ravaged by a triple catastrophe—two earthquakes and a tidal wave—that affected 13 of the country's 25 provinces, leaving a profound mark on the population and causing severe deterioration in the economy. In just a few minutes, hundreds of lives were lost, dwellings were demolished, gas and water pipes broken, communications interrupted, industries destroyed, livestock lost, agriculture ruined, and roads and railroads left impassable. In several areas the topography was changed: part of the coastline sank into the sea, new islands appeared and others were demolished by the tidal wave. Three landslides covered the natural dam of Lake Rinihue, causing an avalanche that almost demolished the small towns that lay along the banks of the San Pedro River and the low lying areas of Valdivia. Chilean engineers carried out the nation's largest emergency engineering task; in two months they opened an evacuation channel from the lake, thus avoiding the destruction of a rich agricultural, livestock, and industrial area, with a population of approximately 100,000.

Source: R. Urrutia and C. Lazcano, 1993.

***Tumaco, Colombia.*** In 1979, a tsunami ravaged the Pacific coast of Colombia, destroying 80% of the important maritime and fishing port of Tumaco. The vulnerability of this area was well-known; in 1906 this city had been totally destroyed by one of the strongest tsunamis of the century. The damages were extensive because a large part of the urban area was built at sea level on loose saturated sands, which produced the phenomenon known as soil liquefaction.

Source: DHA, Geneva.

***Callao, Peru.*** In October 1966 a magnitude 6.3 earthquake occurred off the coast of central Peru. A tsunami followed, hitting the port city of Callao in mid-afternoon, with waves that reached a height of 3.4 meters. Callao had already been destroyed once, in 1746, by an earthquake believed to have registered 8.5 on the Richter scale, that was also followed by a tidal wave that decimated the population; only 200 of the 5,000 inhabitants survived. At that time, the sea penetrated 1.5 km inland, dragging with it several ships that were anchored in the port. Eighty percent of the buildings in the neighboring city of Lima, capital of Peru, were damaged.

Source: Instituto Nacional de Defensa Civil, Peru, 1994.

countries in Central America, the Caribbean, and South America as well. As far back as colonial times, El Salvador's Izalco volcano was called the "Lighthouse of the Pacific." Yet although there are numerous active volcanoes in the Region, destructive volcanic eruptions have been less frequent than other types of natural disasters in this century.

In 1902, three major volcanoes erupted with great force in the Caribbean and in Central America. The tragedy began with the explosion of Mount Pelée in Martinique that discharged a dense emulsion of incandescent lava and boiling gases that ran downhill to the port of St. Pierre. Thirty thousand persons were suffocated. Twenty-four hours later, the Soufrière volcano on the neighboring island of Saint Vincent, 150 km away, erupted in a similar manner, causing the death of 1,500 people. Later that same year, the Santa María (Santiaguito) volcano in Guatemala, took the lives of 6,000 people. Three quarters of a century later, in 1979, the Soufrière exploded again, causing extensive damage and making communication impossible

**Box 3.2**

## THE SNOW-CAPPED ANDES INSPIRE RESPECT. . . AND FEAR

After almost 150 years of inactivity, the Nevado del Ruiz volcano, located 120 km northwest of Santafé de Bogotá, Colombia, erupted violently on 13 November 1985. The intense heat and the seismic activity that accompanied the eruption melted only a small portion of volcano's icecap, but this was enough to send a devastating current of mud, rocks, and ashes down the riverbeds that descended its slopes, burying almost completely the city of Armero at its base.

After several days of intense search and rescue efforts, hindered because the only access to the disaster site was by air, the death toll reached 23,000. The disaster affected a 1,000 square km area in what was one of the country's most important agricultural areas. Other affected cities included Chinchiná, where 2,000 persons perished, Mariquita, where it was necessary to evacuate 20,000 people, and Guayabal. Thousands of homes, roads, and bridges were destroyed.

These mud flows, originating from volcanic eruptions, are known as lahars, and their descent can reach speeds of 100 km per hour. They occur frequently and equal or surpass the strength of incandescent avalanches, the principal cause of volcanic destruction.

In January 1986, the volcano began again to spew toxic gasses on the affected area. Forty thousand people in a 50 km radius around the volcano had to be evacuated.

Source: PAHO/WHO, Colombian Government reports

between the northern and southern parts of the island of Saint Vincent.

In March 1982, the Chichonal volcano in the state of Chiapas in southeast Mexico came to life with a tremendous explosion that launched a column of ash and gases 15 km high. Several days later, there was an even more violent eruption. Pyroclastic flows demolished the village of Francisco León and other nearby towns, damming up rivers and streams and forming lakes of boiling water. When one of these natural reservoirs opened, the banks of the Magdalena, Syula, and Grijalva rivers overflowed. An estimated 1,770 lives were lost as a result of this eruption.

After a prolonged period of inactivity, an exceptionally violent explosion of Costa Rica's Arenal volcano in 1968 launched rocks upon a nearby village, claiming 64 lives. Between 1963 and 1965 the Irazú volcano, southeast of the capital of San José, discharged such a large quantity of ash that the coffee crop and the country's economy in general were seriously affected.

Presently six volcanoes in Nicaragua—Concepción (Ometepe), Santiago, Momotombo, Pylas, Cerro Negro, and Telica—are in varying states of activity, from the emission of gases to the explosion of ash accompanied by lava flows. The eruption of the Cerro Negro volcano in 1992

spewed ash over a 200 km radius.

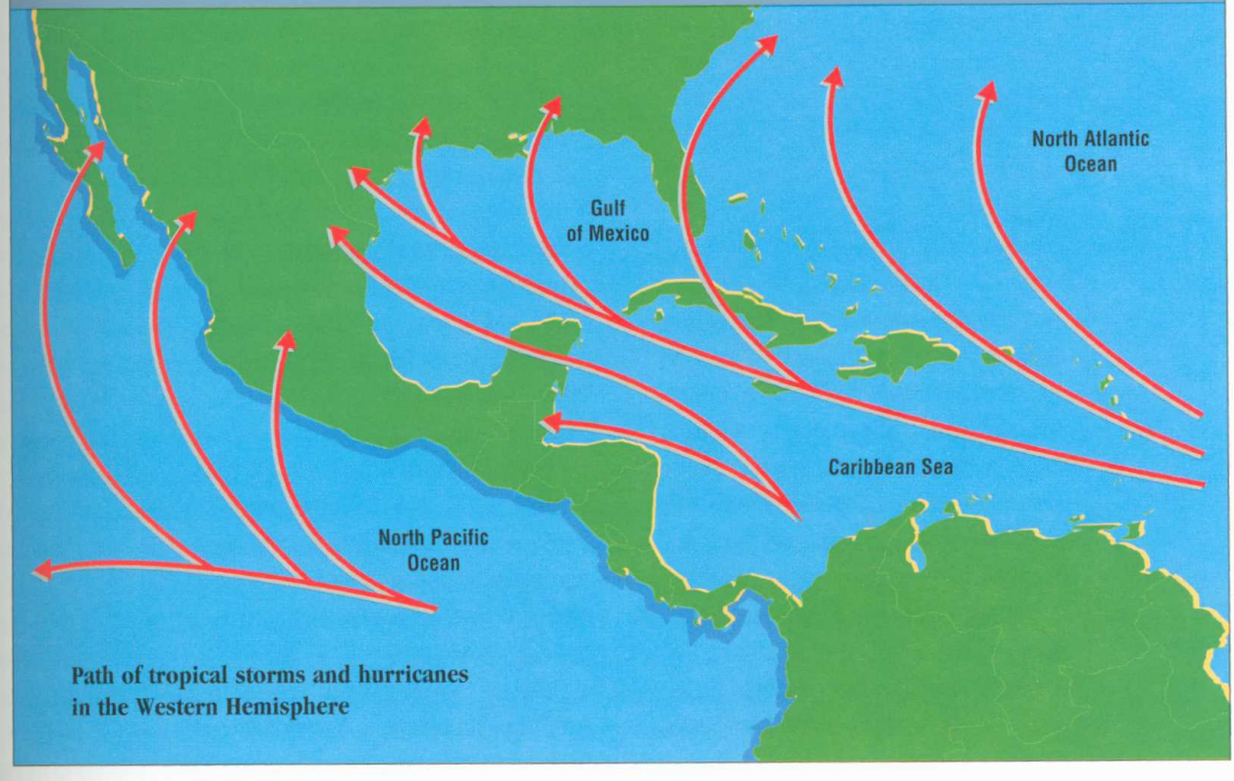
In South America, most of the volcanoes that erupted in past centuries were too far removed from densely populated areas to cause much havoc. However, the eruptions of Cotopaxi (Ecuador) in 1877 and Villarica (Chile) in 1936 melted large volumes of ice and snow that caused avalanches affecting vast urban and agricultural areas. The case of the Nevado del Ruiz volcano in Colombia was similar (see Box 3.2). The eruption of the Mt. Hudson volcano in southern Chile in 1991 affected some 62,000 people and caused serious damage to livestock and agriculture in Chile and Argentina.

## HYDROMETEOROLOGICAL HAZARDS

### Hurricanes

Annually some 80 cyclones—or hurricanes as they have come to be known in the Western Hemisphere from the indigenous term "Hura Kan," or "winds of the Gods"—form over warm tropical waters during the summer months. Each year it is estimated that some 20,000 people lose their lives to tropical storms worldwide; the material losses can surpass billions of dollars. The Simpson/Saffir Scale is used to categorize hurricanes (see Figure 3.2).

Figure 3.2




Map adapted from OAS, 1991.

**Simpson/Saffir Scale**

| CATEGORY | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Wind speed (Km/hour) and damages | 119 -151 Minimum | 152 -176 Moderate | 177 - 209 Strong | 210 - 248 Severe | >248 Catastrophic |

*Between 1990 and 1992, approximately two million people in Bolivia were seriously affected by both heavy flooding and drought.*

According to the OAS, between 1960 and 1989 hurricanes claimed 28,000 victims, altered the lives of another 6 million, and destroyed property valued at close to US$16 billion in the Caribbean Basin alone, without counting losses caused by those storms in Latin America, the United States, and its possessions.

More than 4,000 tropical storms have occurred in the last 500 years in the Caribbean, half of which have been become hurricanes. The most devastating of all happened in October 1780, striking practically every island in the Caribbean, beginning with Tobago, continuing through the Leeward Islands, and across Hispaniola. Almost 20,000 people perished.

An average of 10 hurricanes threaten the West Indies and the east coast of Central America and Mexico between June and November every year. In 1988 Hurricane Gilbert dealt a devastating blow to the Caribbean, leaving hundreds of thousands of people without shelter in Jamaica before cutting across the Yucatán peninsula and ravaging the Mexican city of Monterrey (see Box 3.3). Barely two months later, after striking the Caribbean coasts of Venezuela and Colombia, Hurricane Joan left a trail of destruction from coast to coast in Nicaragua and other Central American countries. The next year, Hurricane Hugo ravaged the Leeward Islands, causing serious damages in Antigua, Guadeloupe, Montserrat, Saint Kitts and Nevis, Puerto Rico and the U.S. Virgin Islands. The storm ended by slamming into the eastern coast of the United States, heavily damaging the city of Charleston, South Carolina.

In August 1992 Hurricane Andrew tore across Eleuthera and other islands in Bahamas before delivering its most forceful blow on the Atlantic and Gulf of Mexico coasts of the U.S., devastating southern Florida and, to a lesser degree, Louisiana. Property damages in the United States were estimated at US$30 billion.

**Floods**

Floods are, perhaps, the most frequent and among the most ruinous type of natural disaster; however, they almost never receive the same immediate attention, for example, that an earthquake or a hurricane does. Almost every country in Latin America and the Caribbean is affected by the problem of floods.

During sudden-onset natural disasters, the different stages—impact, emergency response, and rehabilitation/reconstruction—are clearly delineated. However, with slow-onset floods, the boundaries are less clear. Months can pass before the authorities realize that an emergency exists. The isolation period may be prolonged and rehabilitation or reconstruction may overlap with the next flood.

The phenomenon known as *El Niño* has caused cycles of heavy rains and drought in many parts of the world. The effects of *El Niño* in 1982-83 in South America were among the most devastating (see Box 3.4).

The principal river cities of Paraguay were affected during the winter periods of 1982, 1983, and 1987, and more than 3,000 families had to be relocated. Because of its topography, large areas of Argentina and Uruguay also experience periodic flooding.

Between 1990 and 1992, approximately two million people in Bolivia were seriously affected by both heavy flooding and drought. The floods at the beginning of 1992 in the northeast part of the country affected more than 40,000 people in 160 communities. Agricultural and livestock losses were estimated at more than

**Box 3.3**

## A HIGH-RISK SEASON: HURRICANE GILBERT

At 5:00 a.m. on 9 September 1988, Jamaica's National Meteorological Service issued its first hurricane alert. Two days later, the alert had become a warning. But a majority of Jamaica's population had never experienced the direct consequences of a hurricane, and were exceedingly conservative in heeding the warning. There would be time enough in the morning to make preparations, they thought.

That was not to be the case. Only three hours of daylight remained on the afternoon the warning was issued, and during the night wind speeds accelerated. Hurricane Gilbert, a storm of colossal proportions, made landfall on the eastern end of Jamaica on September 12 at 10:00 a.m. During its trek across the island from east to west, it gathered speed and turned into a Category 5 hurricane—the most severe.

Jamaica's last experience with a hurricane was Hurricane Charlie in 1951. Hurricane Gilbert differed from Charlie in several respects. Unlike Charlie, Gilbert's eight-hour rampage crossed the entire length of the island. Gilbert was also the largest cyclonic system ever observed in the western hemisphere, and one of the wettest, although fortunately for Jamaica, most of the precipitation fell on the sea.

Photo Gaspard PAHO/WHO

**Princess Margaret Hospital in Jamaica was one of the hospitals damaged by Hurricane Gilbert.**

The impact of Hurricane Gilbert was devastating for all sectors of the society and the economy. Damage was estimated at US$4 billion, with the damage to agriculture accounting for over 40% of this total. Ninety-five percent of all health facilities suffered damage. Of the 25 public hospitals only two escaped with minimal damages. Two were destroyed and eleven suffered severe damage. There are 377 Health Centers in the island and 55% of these were severely damaged. The cost of emergency repairs was estimated at US$13 million with roughly 55% of this representing the cost of repairs to secondary care facilities.

The National Water Commission managed the storage and distribution of domestic water. The hurricane damaged over 50% of these facilities to a degree which varied from minor to complete destruction. Pipelines, storage tanks, pump and chlorinator houses were all affected. There were instances in which rivers changed their courses, threatening supplies and facilities.

The response from the international community was immediate and large quantities of supplies flooded the country. Daily meetings were held to coordinate donor response and the needs of the country. This achieved some measure of success. However, it was felt that prearranged needs lists would have speeded up the process of acquiring necessary supplies. Moreover, the major part of the relief effort centered around the transportation of goods. The cost of mobilizing distribution was, at times, greater than the value of the goods. A great deal of time was also spent in clearing, documenting and sorting the donations.

Source: PAHO/WHO