Geological and Man-Made Disasters

The two least common categories of disaster-related declarations used by FEMA are geological and man-made. This classification is somewhat different from the terminology used by the UNISDR, which aims to promote common usage of disaster risk reduction concepts in order to assist in the disaster risk reduction efforts of stakeholders. Both FEMA and the UNISDR classify geological processes or phenomena in the same way; they include internal earth processes, such as earthquakes, volcanic activity, and emissions, and related geophysical processes, such as landslides, rockslides, and surface collapses. Instead of man-made, the UNISDR uses technological; that is, a disaster originating from technological or industrial conditions, including accidents, dangerous procedures, infrastructure failures, or specific human activities. Examples of technological hazards include chemical spills, dam failures, fires, factory explosions, industrial pollution, nuclear radiation, transport accidents, and toxic wastes.

Under man-made disasters, FEMA lists chemical/biological, dam/levee breaks, explosions, radiation leaks, technological, terrorism, and virus threats. Nationwide, there were 38 geological and 22 man-made major disasters between 1953 and 2014. Combined, they averaged about one occurrence each year during these six decades. Humans cannot usually predict geological disasters, but man-made disasters can be avoided and prevented.

While geological and man-made disasters have been infrequent, the associated DUA weeks compensated for three of them ranked in the top 15 of the disasters that occurred between 1983 and 2014. As noted in Chapter 3, information on DUA only commences in 1983. One of these three top-ranked events was the civil unrest that erupted on April 29, 1992, in Los Angeles. This event is classified by FEMA as California Fire During a Period of Civil Unrest (DR-942), with an incident period from April 29, 1992, to May 28, 1992. The major disaster declaration was made on May 2, 1992. Fifty-two people lost their lives when violent mobs stormed through the city of Los Angeles. When the rioting
was over, approximately 2,500 people were injured and an estimated $1.0 billion in property was damaged.\(^1\)

The second event was the *California Northridge Earthquake* (DR-1008). The incident period was January 17, 1994, to November 30, 1994, with the major disaster declaration made on January 17, 1994. The third event was the *New York Terrorist Attack* (DR-1391). The incident period was September 11, 2001, with a major disaster declared the same day.

This chapter begins by considering the 38 major disasters based on three geological hazards between 1953 and 2014: earthquakes, volcanic eruptions, and tsunamis. The focus of the discussion is on these specific geological hazards and does not consider the related geophysical processes, which would include disasters associated with landslides, mudslides, meteorology, and oceanography. The second section examines the 22 man-made major disasters between 1953 and 2014. The economic losses associated with these disasters are outlined in this section together with the weeks compensated under the DUA program. Generally, nearly all the man-made disasters have resulted in modest financial losses compared to catastrophic natural disasters. The third section examines the role of private insurance in covering geological risk. In California, for example, about 20 private insurance carriers sell and service earthquake insurance policies. Similarly, the provision of insurance against man-made risks has remained within the domain of private insurance, discussed in the fourth section of the chapter. In contrast, terrorism insurance arrangements since the September 11, 2001, attacks have seen the addition of a major element of government participation. The chapter then looks at the provision of terrorism insurance and the legislation associated with its delivery, and ends with concluding comments.

**GEOLOGICAL DISASTERS**

Three types of geological hazards—earthquakes, volcanic eruptions, and tsunamis—resulted in 38 major disaster declarations since 1953, with earthquakes accounting for 27 of them. As stated above, the discussion in this section focuses on geological events.\(^2\) The vast major-
ity (32 of 38) of these events occurred in the five states in the Pacific division, with California and Hawaii accounting for 14 and 10 events, respectively.

1) Earthquakes. Three major disasters due to a geological hazard occurred east of the Mississippi River, and all three were earthquakes. One was the New York Earthquake (DR-1415), with the incident occurring on April 20, 2002, and the major disaster declaration made on May 16, 2002. The second and third declarations were made for the same earthquake event. The incident period for the Virginia Earthquake (DR-4042) was from August 23, 2011, to October 25, 2011, with the major disaster declaration made on November 04, 2011. The third was the District of Columbia (DC) Earthquake (DR-4044), with an incident period of August 23, 2011, to August 28, 2011; the major disaster declaration was made on November 08, 2011.

2) Volcanic eruptions. Three of the five volcanic eruptions occurred in Hawaii, but the Mount St. Helens eruption of 1980 resulted in major disaster declarations in two states, Idaho and Washington. The incident period of the Washington Volcanic Eruption, Mt. St. Helens (DR-623) was May 21, 1980, and its major disaster declaration was made on May 21; the Idaho Volcanic Eruption, Mt. St. Helens (DR-624) has an incident period of May 22, 1980, and a major disaster declaration on May 22.

3) Tsunamis. A tsunami is a great sea wave that originates from a submarine earth movement or volcanic eruption. The six tsunami-related declarations were declared for Hawaii (three in the state), California (two), and Alaska (one).

Thus, all three types of geological hazards that led to disaster declarations were concentrated in the five states that border the Pacific Ocean. To date, the post-1953 disasters originating from geological hazards have been of modest scale in terms of their effects on economic output. Not one of these events incurred more than $1.0 billion in estimated costs as measured by the NOAA billion-dollar disasters between 1980 and 2013. The two most serious events from available data on DUA weeks compensated were the California Loma Prieta Earthquake (DR-845) and the California Northridge Earthquake (DR-1008).
Loma Prieta earthquake had an incident period of October 17, 1989, to December 18, 1989, with 16,262 weeks compensated in the DUA program. The Northridge earthquake had an incident period of January 17, 1994, to November 30, 1994, with DUA weeks compensated of 81,405. Since the DUA data on weeks compensated are available only since 1983, it is possible that the Mount St. Helens volcanic eruption of 1980 or some other pre-1983 disaster may have caused a larger number of DUA weeks compensated and/or had estimated costs of more than $1.0 billion. From the available data, however, it is clear that the disasters originating from geological hazards of the past six decades have had relatively smaller consequences compared to other disasters, such as hurricanes and drought.

MAN-MADE DISASTERS

While geological disasters fall into obvious categories, man-made disasters take a wider variety of forms. As stated above, FEMA lists chemical/biological, dam/levee breaks, explosions, radiation leaks, technological, terrorism, and virus threats as possible man-made disasters. Our discussion of 22 major disasters since 1953 identifies four categories: flooding from dam and levee failures (10 events), large industrial accidents (3 events), large urban fires (including domestic disturbances, 5 events) and terrorist acts (4 counts). The four terrorist acts were the New York World Trade Center Explosion (DR-984) on February 26, 1993, with the major disaster declaration on April 02, 1993; the Oklahoma Explosion at Federal Courthouse in Oklahoma City (DR-1048) on April 19, 1995, with the major disaster declaration on April 26, 1995; and the simultaneous major disaster declarations on September 11, 2001, for the New York Terrorist Attack (DR-1391) and the Virginia Terrorist Attack (DR-1392).

The two September 11, 2001, major disasters incurred more than $200 billion in financial costs. The estimated costs of the other two events fell below the $1.0 billion threshold used by NOAA in their classification of billion-dollar disasters. It should also be noted that FEMA classified the Boston Marathon bombing of April 2013 as an emergency
declaration and not as a major disaster: *Massachusetts Explosions* (EM-3362), emergency declaration declared on April 17, 2013.

Nearly all the man-made disaster declarations in the FEMA historical record have relatively modest estimated financial costs. Eight of the 22 events occurred after DUA compensation data for individual major disasters became available in 1983. The two major disaster events on September 11, 2001, caused 74,857 DUA weeks compensated (ranking 11th in DUA weeks compensated) and $13.9 million in DUA payments. The Los Angeles civil disturbances and fires (DR-942) of 1992 caused 69,584 DUA weeks compensated and $6.0 million in DUA payments. The total estimated cost of this event may or may not have been less than $1.0 billion. Since the NOAA loss estimates are measured in terms of 2013 dollars, the inflation factor would be 1.66 times the actual costs measured in 1992 prices. Regardless of the estimate from this 1992 event, it is obvious that the costs of the September 11, 2001, disaster events were very large, larger even than those arising from Hurricane Katrina, which NOAA estimated to be $149 billion (2013 dollars). The single disaster on September 11, 2001, resulted in estimated costs of between one-fourth and one-fifth of all the billion-dollar natural disasters between 1980 and 2013.

Terrorist acts in the United States between 1953 and 2014 have been limited to the four incidents previously noted. Two other potential types of man-made major disasters, however, can also be identified: nuclear, biological, chemical, and radiological (NBCR); and cyber. Accidents or deliberate acts in any of these NBCR risk areas could potentially trigger a major disaster. To date, the partial meltdown of the nuclear power plant at Three Mile Island, Pennsylvania, in 1979 has been the most serious nuclear power incident on record in the United States. While this man-made disaster was not classified by FEMA as a major disaster, there was a major evacuation in the area around Three Mile Island and the plant was eventually closed. There have been other domestic incidents involving nuclear power plants that could have had more disastrous outcomes.

An analysis of the potential hazards associated with the storage of chemicals in six midwestern states was recently completed by the Center for Effective Government (2015). An explosion at a fertilizer plant in West, Texas, in 2013 that killed 10 first responders prompted
increased awareness of chemical hazards. In its report, the Center for Effective Government identified more than 3,000 sites in the six midwestern states with large volumes of stored chemicals and included several recommendations to assure greater safety of stored chemicals.

An increase in measles cases linked to an amusement park in California in 2015 is the most recent example of disease-related risks in the United States. Although the Centers for Disease Control and Prevention (CDC) does not identify the source, the outbreak probably originated with a person who became infected with measles while overseas and then visited the amusement park while contagious. That year, 189 people from 24 states and D.C. were reported to have measles. Since the CDC announced measles elimination in 2000, the largest number of cases was in 2014, with 667 cases in 27 states.7

In April 2016 the CDC reported 358 cases of travel-associated Zika virus in the 50 states and D.C., but the number of locally acquired vector-borne cases is zero.8 In American Samoa, Puerto Rico, and the U.S. Virgin Islands the CDC reported 475 Zika virus cases: 4 travel-associated cases and 471 locally acquired vector-borne cases.

Earlier examples of disease-related risks include the Spanish flu pandemic of 1918, the polio epidemic of the early 1950s, and the HIV/AIDS epidemic in the 1980s. In short, biological risks are always potentially present as pathogens evolve, develop immunities to vaccines, and hinder public health interventions.

A technology company’s experience in 2014 offers a vivid example of cyber risks. A group calling itself the Guardians of Peace hacked its way into Sony Pictures, taking valuable insider information and leaving the Sony network inoperable for days. As the U.S. economy evolves toward increased reliance on information technology and the Internet, these risks seem slated to grow in the foreseeable future. More broadly, avoidance of NBCR risks will become increasingly important as the U.S. economy continues to evolve. Insuring against geological and man-made disasters will undoubtedly constitute an important element in our defense against these various risks.
INSURANCE AGAINST GEOLOGICAL DISASTERS

Private markets exist for the purchase of insurance against geological risks. In California, for example, about 20 private insurance carriers sell and service earthquake insurance policies, which are sold as add-ons to basic homeowners insurance policies. Premium rates vary by geographic area within the state.

Oversight of earthquake insurance is the responsibility of the California Earthquake Authority (CEA), a public, not-for-profit entity established with private funding in 1996 following the Northridge earthquake of 1994. The CEA has a five-person governing board with three voting members (the governor, the state treasurer, and the insurance commissioner), and two nonvoting members (the speaker of the assembly, and the chair of the Senate Rules Committee). Policies can be purchased through CEA or with private carriers. About three-quarters of the approximately 800,000 insured Californian homeowners have coverage through CEA policies. The authority also educates and encourages homeowners to increase preparedness for future earthquakes. Thus, its mission encompasses education and other measures to promote resiliency as well as property-loss protection.

Insurance protection against most types of man-made disasters can also be secured through private insurance carriers. The federal government, however, oversees insurance against terrorist acts. Terrorism insurance is discussed in later in this chapter.

INSURANCE AGAINST MAN-MADE DISASTERS

As noted above, man-made disasters can result from deliberate acts such as a terrorist bombing or from an accident. Only five notable incidents of successful terrorist acts have occurred in the United States since 1993. It should also be observed that the distinction between geological and man-made disasters is somewhat artificial. Thirty-four nuclear reactors in the United States are located downstream from a large dam (see Lochbaum, Lyman, and Strahan [2014]). For example, three reactors of the Oconee Nuclear Power Plant in South Carolina are down-
stream from the Jocassee Dam on the Keowee River. If an earthquake were to breach the dam and flood the power facility, then the cause of the disaster would have both geological and man-made elements.

Catastrophic losses from geological disasters, such as earthquakes, and man-made disasters, such as nuclear radiation and terrorism, have affected the willingness of private insurers to provide coverage against these perils. Insurance arrangements currently exist for two types of man-made disasters identified previously: NBCR risks, including nuclear accidents and cyber attacks. All providers of nuclear power are required to purchase accident insurance from private carriers. Insurance coverage of the other components of NBCR risks can be purchased through private carriers who quote rates for the separate NBCR risks. Insurance against cyber attacks can be purchased as part of a commercial property insurance policy. The extent of coverage is not fully known, but it is believed to exceed half of all companies with a higher coverage rate among larger firms.

Because the historical experience of losses from NBCR and cyber incidents has been limited, and losses have not been “large,” provision of insurance against these risks has remained within the domain of private insurance. In contrast, since September 11, terrorism insurance arrangements have changed, with the addition of a major element of government participation.

**TERRORISM INSURANCE**

Prior to the 2001 attacks, private insurance carriers provided insurance against terrorist acts as part of standard commercial property insurance policies. The cost of coverage for this specific risk was not explicitly shown in these policies. The attacks resulted in $44 billion of insured losses for insurance carriers and their reinsurers. Following these attacks, carriers started to exclude terrorist acts from coverage, which exerted a negative influence on new commercial and real estate investments.

Against this background, the U.S. Congress passed and the president signed into law the Terrorism Risk Insurance Act (TRIA). There were two main provisions in the legislation. First, carriers were man-
dated to offer terrorism coverage in their commercial insurance policies and on the same terms as other insurance risks. Second, the legislation established a loss-sharing arrangement among three parties: companies, insurance carriers, and the federal government.

The legislation was planned as a short-run “fix” to assure coverage of businesses and to provide time for the insurance industry to develop private coverage vehicles. These expected developments did not occur, and the original law was succeeded by extensions enacted in 2005, 2007, and 2015. The most recent legislation of January 2015 extended TRIA to the end of December 2020. Four important provisions of TRIA were amended. First, the primary administrative responsibility resides with the U.S. Treasury Department. Second, the composition of the three-person committee that makes the determination (certification) of whether an incident is a terrorist act replaced the secretary of state with the secretary of homeland security. the composition of the committee in the 2002 legislation was the secretary of the treasury, the attorney general, and the secretary of state.

Third, provisions in the legislation define a set of financial thresholds: a minimum threshold for what constitutes a terrorist act, a minimum threshold for federal participation in the compensation of survivors of the terrorist act, a deductible level covered by insurance carriers, and a government-carrier sharing formula for losses that exceed the deductible. The 2015 extension placed all these thresholds on a sliding scale so that their levels in 2020 are considerably higher than in 2015. The federal share above the deductible threshold is to gradually decline from 85 percent in 2015 to 80 percent in 2020. Finally, TRIA is intended to be budget neutral. Federal government compensation to claimants is to be recouped through later assessments on insurance carriers.

The provision of terrorist insurance faces multiple challenges. The infrequency of terrorist acts means potential losses are highly indeterminate, making it uncertain how to appropriately price terrorist insurance policies. In addition, coverage boundaries are not clear. Workers’ compensation and fire insurance are probably liable for certain losses that arise from terrorist acts. A successful cyber attack might be covered by cyber insurance. Furthermore, basic information on terrorist insurance coverage, costs, and pricing is incomplete. The 2015 TRIA legislation mandates the Government Accountability Office to conduct studies to close these various information gaps.
It is currently estimated that TRIA covers about 60 percent of private employers. The Government Accountability Office (2014) finds that the price of terrorist insurance policies has stabilized since 2010, and premiums are relatively constant at about 2.0 percent of overall property insurance premiums. It appears that TRIA has stabilized in recent years.

CONCLUSIONS

With guiding principles from the government, the insurance industry could provide insurance against the full range of geological and man-made disasters. The information presented here indicates that geological and man-made disasters are low-probability events; therefore, providing insurance for them is a particular challenge. Because decision-makers have limited experience with low-probability events, there is considerable uncertainty about the likelihood of their occurrence. There is a tendency to either ignore a potential disaster or overreact to a recent one. As a consequence, people and insurance providers tend to focus on the losses from a worst-case scenario without adequate reflection on the likelihood of the event occurring in the future.

If a private-public insurance program were to be provided then it would need to be linked with other initiatives. Given the reluctance of individuals to voluntarily purchase insurance against losses, regulations could require insurance coverage for all individuals who face similar risk. Insurance premiums would be risk based to provide appropriate price signals about the hazards individuals face and enable insurance providers to lower premiums for properties where mitigation is undertaken.

Chapter 10 discusses the provision of insurance for geological and man-made disasters. It outlines potential problems and offers suggestions for national disaster policies, such as proposals for legislation and administrative practices for improved planning and responses to disasters.
Notes

2. Given our focus in this chapter, geophysical processes such as the landslide in Oso, Washington, are not discussed. In the FEMA disaster-related declarations list this event is recorded as Washington Flooding and Mudslides (DR-4168), an incident period from March 22, 2014, to April 29, 2014, with a major disaster declaration on April 2, 2014.
3. The time period under discussion refers only to events since 1953. The earthquakes in New Madrid, Missouri, of 1811, and San Francisco of 1906 fall outside the scope of the discussion in this book.
4. See, for example, http://www.iags.org/costof911.html, from the Institute for the Analysis of Global Security (accessed July 21, 2016). The first 11 items of its 12-item list of loss categories total $242 billion. No attempt has been made to compare the Institute's methodology for estimating losses with the NOAA methodology.
5. The benefits totaled $13.7 million for New York and $0.2 million for Virginia.
6. See Lochbaum, Lyman, and Strahan (2014). Chapters 9 and 10 in that volume provide details of other nuclear power incidents in the United States that could have had more serious consequences under differing circumstances. Chapter 12 describes the regulatory interface between the Nuclear Regulatory Commission and the nuclear power industry.
7. The number of measles cases reported to CDC is updated weekly at http://www.cdc.gov/measles/cases-outbreaks.html (accessed July 21, 2016).
9. The New York World Trade Center Explosion (DR-984) in 1993; the Oklahoma Explosion at Federal Courthouse in Oklahoma City (DR-1048) in 1995; the two terrorist attack on September 11, 2001 (DR-1391 and DR-1392); and the Massachusetts Explosions (EM-3362) in 2013.
10. See Kunreuther et al. (2014, section 1). Reinsurers paid for about two-thirds of the losses from the September 11, 2001, disaster.