1

Knowing What to Expect

Hazards, Vulnerability, and Disasters

STARTING POINT
Pretest to assess your knowledge on hazards, vulnerability and disasters. *Determine where you need to concentrate your effort.*

What You'll Learn in This Chapter

- The possibility and probability of disasters.
- General emergency management responsibilities.
- Types of natural, technological and anthropogenic hazards.
- The interaction of hazards and vulnerability.
- Anticipated changes and demands after disasters.
- The need for response and recovery operations.

After Studying This Chapter, You'll Be Able To

- Understand the impact and scope of various disaster levels.
- Differentiate among the diverse hazard categories.
- Comprehend the relation among hazards, vulnerability and disasters.
- Examine the relationship between response and recovery functions.
- Identify needs to be addressed during and after disaster.

Goals and Outcomes

- Compare and contrast different disaster magnitudes.
- Define and use basic disaster and emergency management terminology.
- Evaluate distinct types of hazards as well as common disaster characteristics.
- Predict changes resulting from disasters and resulting implications.
- Advocate for the importance of response and recovery operations.

Disaster Response and Recovery: Strategies and Tactics for Resilience, Third Edition. David A. McEntire.

Companion website: www.wiley.com/go/mcentire/disasterresponse

INTRODUCTION

Welcome to the intriguing disaster discipline and the indispensable emergency management profession! As a current/future emergency manager or related specialist, it is vital that you are aware of the important concepts and principles relating to your duties and responsibilities that must be performed when disasters occur. It is especially imperative that you are able to distinguish among differing hazard types as well as the factors that lead to and exacerbate these devastating events. For instance, it is vital that you understand natural, technological, and civil/conflict triggering agents as well as how they interact with the vulnerabilities people and organizations create in society. Comprehending the causes and consequences of disasters and the changes that become visible when they unfold is likewise necessary if you are to be able to react to them effectively. Being cognizant of the goals pertaining to response and recovery operations will also help you become a successful emergency manager. These are a few of the topics addressed in this introductory chapter of *Disaster Response and Recovery: Strategies and Tactics for Resilience*.

1.1 The Occurrence of Disasters

Everyday people around the world are impacted by events that produce injuries, cause death, damage buildings/infrastructure, destroy personal belongings and interrupt daily activities. These disturbing experiences are categorized as accidents, crises, emergencies, disasters, calamities or catastrophes. Such incidents adversely affect individuals, groups, communities and even nations. Each of these events is similar in that they require action from government officials, businesses, nonprofit organizations, citizens/bystanders, and the victims and survivors themselves. However, these occurrences vary dramatically in terms of magnitude, extent of duration and scope. For example, a routine traffic accident can typically be handled within minutes or hours by a few police officers who file reports and a tow truck that removes wreckage. A structural conflagration may require one or two fire departments, but it can displace the resident or family for weeks or months. When a mass shooting occurs, resources are needed to neutralize the threat, investigate the incident, and address the longer-term psychological toll that may possibly result from these intentional acts of violence. Alternatively, an airplane crash may necessitate the participation of firefighters and emergency medical service (EMS) personnel as well as airline officials and government employees such as a coroner or public information officer. If the plane crash does not take the lives of all of the passengers and crew, the victims and survivors of the ordeal may be injured or permanently disabled and require long-term medical care. Finally, when a major earthquake or hurricane affects an urban area, many organizations will become involved. Besides first responders, additional personnel will be needed to remove debris, repair utilities, provide relief assistance and coordinate rebuilding endeavors that could take years. Thus, the impact of a minor accident is both quantitatively and qualitatively different than a major disaster or catastrophe (see Table 1-1) (Quarantelli, 2006). While this book does discuss common emergencies and less frequent catastrophes, it focuses most of its attention on larger disasters and how to deal with them in a more effective manner.

1.1.1 Important Concepts

Disasters are defined as deadly, destructive, and disruptive events that occur when a hazard interacts with human vulnerability. Disasters are significant societal events that injure and kill people, damage structures/infrastructure and personal belongings, and complicate the

Table 1-1 Comparison of Event Magnitude.

	Accidents	Crises	Emergencies/ disasters	Calamities/catastrophes
Injuries	Few	Many	Scores/hundreds	Thousands/more
Deaths	Few	Many	Scores/hundreds	Thousands/more
Damage	Minor	Moderate	Major	Severe
Disruption	Minor	Moderate	Major	Severe
Geographic impact	Immediate area	Local community	Regional	National/international
Availability of resources	Abundant	Sufficient	Limited	Scarce
Number of responders	Few	Many	Scores/hundreds	Thousands/more
Time to recover	Minutes/ hours/days	Days/weeks	Months/years	Years/decades

routine activities people undertake on a daily basis (e.g., sleeping, bathing, cooking, traveling, going to school, working, etc.).

In the simplest of terms, there are two categories of variables that interact to produce a disaster. A **hazard** is the risk, trigger or threat that initiates a disaster. Hazards include natural, technological or anthropogenic (human-induced) agents like earthquakes, industrial explosions, or even terrorist attacks that negatively affect people or critical infrastructure. **Vulnerability**, on the other hand, refers to the proneness of people to disasters based on factors such as their geographic location, exposure of property, level of preparedness, income and/or other social variables. The ability of individuals, organizations, and communities to deal with disaster also determines the degree of vulnerability. Vulnerability is therefore the human element of disasters, while hazard agents may or may not always have a direct social cause.

Although disasters result from the interaction of both hazards and vulnerability, the two concepts have distinct implications for practical application. Because it is not always possible to prevent or control hazards, people and organizations should give extra attention to efforts that reduce their vulnerability to disasters (McEntire 2005). For this reason, the knowledge and expertise of individuals that are employed in emergency management and related professions are required to deal effectively with mass emergencies, disasters, calamities and catastrophes (Figure 1-1).

From an academic standpoint, **emergency management** "is the study of how humans and their institutions deal with hazards, vulnerabilities and the events that result from their interaction" (Jensen, 2013). The emergency management discipline accordingly seeks to create and disseminate knowledge about what people and organizations can do to diminish the frequency and impact of disasters. From a practical perspective, **emergency management** "is the managerial function charged with creating the framework within which communities reduce vulnerability to hazards and cope with disasters" (Blanchard et al., 2007, p. 4). This suggests the need for highly educated and trained individuals who are given the responsibility to advance the goals of reducing disasters and reacting to them in an effective manner. These professionals are known as emergency managers; they have a keen "interest in

Figure 1-1 Emergency management personnel often attend meetings to prepare for future disasters. Michael Rieger/FEMA. http://www.spc.noaa.gov/faq/tornado/ef-scale.html

disasters and a strong desire to alleviate the suffering of those impacted" by these adverse events (Phillips, Neal and Webb 2017, p. 106).

Put differently, **emergency managers** are public servants that help jurisdictions reduce the liabilities that lead to disasters. These employees (governmental and even non-governmental) also work closely with many concerned stakeholders and endeavor to build capabilities to deal more effectively with hazards and disasters. Such activities are commonly described as the disaster life cycle or the four phases of emergency management. These proactive and reactive efforts include mitigation, preparedness, response and recovery:

- **Mitigation** refers to several priorities and actions, including risk reduction, loss minimization, and/or the alleviation of potential negative impacts associated with disasters. Careful land-use planning, improvements in building design and construction, and a reliance on insurance to cover the costs associated with disasters are examples of mitigation activities.
- **Preparedness** implies efforts to increase readiness for a disaster. Examples of preparedness initiatives include the creation of laws/ordinances, the acquisition of grants or other resource s, and various measures such as planning, training, exercises and community education.

These two phases - mitigation and preparedness - should be given the highest priority in the emergency management profession today. For this reason, emergency managers must not be seen solely as an extension of first responders— our wonderful police, fire, and emergency medical personnel who serve so valiantly when emergencies occur. The goals of emergency managers are more proactive and encompassing than emergency response, even if they do overlap with the objectives and operations of these heroic public servants at times.

However, because it is impossible to eliminate all disasters, emergency managers must also be involved in disaster response and recovery operations. **Disaster response** includes actions "taken immediately before, during, or directly after an emergency occurs, to save lives [and] minimize damage to property" (Godschalk, 1991, p. 136). Examples of disaster response functions include

- Warning people of severe weather
- Evacuating those who are assumed to be at risk
- Sheltering the affected population

During response operations, it may also be necessary to provide emergency medical care, relay information to the public, and manage the arrival of donations and volunteers.

Disaster recovery, in contrast, consists of actions "to return vital life support systems to minimum operating standards and long-term activity designed to return life to normal or improved levels" (Godschalk, 1991, p. 136). This incorporates efforts to repair homes damaged by disaster and rebuild community infrastructure such as power lines, roads, and courthouses.

Each of the phases described in this section is closely related to the others (Neal, 1997). For instance, it is difficult to separate mitigation from preparedness as both are proactive measures to reduce the impact of disaster. Preparedness also has a significant influence upon the success of post-disaster management since it enables a community to anticipate response and recovery needs. In addition, it is difficult to determine when response ends and when recovery begins. For instance, are damage assessment and debris removal response functions or part of disaster recovery operations? Also, during recovery, it is vitally important that steps be taken to prevent future disasters or minimize their potential impact. Instead of simply rebuilding homes that have been damaged by a flood or a tornado, it may be necessary to relocate these structures to safer areas or implement more stringent construction requirements (e.g., improved anchors, hurricane straps, safe rooms, etc.). For these reasons, the word "phases" may be somewhat misleading. With this in mind, it may be advisable to substitute "phases" with the term "functional areas" or "functional activities." Also, these "phases" or functional areas or activities of emergency management do not appear or proceed in a neat, linear fashion. They occur and unfold with a degree of complexity, so it is sometimes difficult to separate them conceptually.

It is also imperative that emergency managers are aware of other important terminology related to their profession. Due to the rising threat of terrorism and the advent of homeland security, new lexicon was introduced in emergency management. After the 9/11 terrorist attacks, **Homeland security** was defined as "a concerted national effort to prevent terrorist attacks within the United States, reduce America's vulnerability to terrorism, and recover from and minimize the damage of attacks that do occur" (Office of Homeland Security, 2002, p. 2). It is easy to see that this concept is related to emergency management. But, this concept is slightly different in that it also encompasses other distinct terms such as prevention and protection. **Prevention** refers to efforts to stop the commission of terrorist attacks. It includes the gathering of intelligence, counterterrorism operations, and border control functions among others. **Protection**, on the other hand, is more concerned about actions that discourage attacks through increased security measures or efforts to minimize damage if such attacks cannot be always prevented in the first place. The reliance on guards, fences, video surveillance, and access control to sensitive locations falls into this category. As can be seen, it is likely that emergency managers and others in

homeland security will work together to deal with all types of emergencies, disasters and terrorist attacks.

1.1.2 Preview of Disaster Response and Recovery

As indicated by the title, this book describes strategies and tactics to improve the management of disaster response and recovery operations. This decision is not meant to deny the value of functions relating to mitigation, preparedness, prevention and protection. It is instead based on the assumption that there is a need for a comprehensive textbook about post-disaster activities. Although there are great works on this subject already, it is necessary to have more current information and not just approach the material from a pure academic or practical standpoint only. For instance, it is important to note that response and recovery operations have changed significantly over the past few decades and even substantially in recent years. The informative research generated by disaster scholars over the past several decades likewise must also be integrated with the lessons gained from the extensive experience of professional emergency managers. Furthermore, there is a dire need to further educate government leaders and public servants in order to avert the repetition of mistakes made after many disasters. Nevertheless, this book may also be of use to corporate leaders or humanitarian workers who are also involved in response and recovery operations.

In order to meet these goals, *Disaster Response and Recovery: Strategies and Tactics for Resilience* will provide a comprehensive discussion about post-disaster management issues and recommendations for their improvement. Chapter 2 will help you as an emergency manager identify the actors involved in response and recovery operations. This includes government officials and agencies as well as corporations, nonprofit organizations, and even everyday people and the victims themselves. Chapter 3 discusses human behavior in time of disaster. It dispels widely held myths and illustrates typical social reactions to collective stress. Chapter 4 compares alternative theoretical stances regarding the management of disasters. It acknowledges the strengths and weaknesses of traditional and professional approaches. Chapter 5 covers initial response measures, and it provides ideas on how to protect people through hazard detection, warning, evacuation, and sheltering. Chapter 6 lists steps that can be taken to care for those who have been adversely affected by a disaster. This chapter shares information about search and rescue, emergency medical care, fatality management and psychological stress. Chapter 7 shares recommendations on how to manage public relations and community resources. In particular, it discusses how you can effectively manage the media, donations and volunteers after a disaster. The transition from response to recovery is the subject of Chapter 8. It reviews functions such as damage assessment, disaster declarations and debris removal. In Chapter 9, disaster assistance programs are discussed along with ways to reduce vulnerability. This chapter provides information on recovery and how this post-disaster activity must be linked to mitigation. The challenges of response and recovery are exposed in Chapter 10. This section will help you understand difficulties associated with communications, decision making, transportation, politics, special populations, legal issues and record keeping. Chapter 11 points out tools that can be utilized and employed during response and recovery operations. These include technological equipment as well as organizational arrangements (e.g., incident command, emergency operation centers) that will improve coordination. Chapter 12 covers lessons from prior disasters along with new threats and reasons for rising vulnerability. It attempts to help you think critically about how to deal with the disasters that will confront you and likewise consider the changes that must

take place to improve the future of emergency management. Chapter 13 illustrates ways to foster disaster resilience. This final chapter of the book discusses various aspects of disaster preparedness in addition to the importance of improvisation, spontaneous planning, leadership, and professionalism among emergency managers.

Before proceeding with the outlined direction of the book, the remainder of this initial chapter will provide additional information about the types of hazards and how they interact one with another. It also describes the impact of disasters and what you as an emergency manager can expect in their aftermath.

Self-Check

- What types of disruptive events can occur on a daily basis?
- How are hazard events different from one another?
- What is a disaster and what are their causes?
- What is emergency management?
- How is response defined?
- What is disaster recovery?

1.2 Types of Hazards

As an emergency manager who may be involved in disaster response and recovery operations, you must understand the nature of hazards if you are to be successful with your assigned responsibilities. As discussed earlier, a **hazard** is a physical, technological, or anthropogenic agent such as an earthquake, a chemical release or a violent act. These hazards and their resulting disasters occur in the United States and around the world. Floods, tornadoes and earthquakes occur, leaving buildings in rubble and other property damage. Vehicles collide due to careless drivers or in conjunction with poor weather conditions. Trains derail due to a failure of the tracks or human error by the engineer. Petrochemical facilities contain large amounts of hazardous materials, which sometimes leads to an explosion at the industrial complex. Terrorists detonate improvised explosive devices, producing carnage and fear in their wake. Hazards occur for many different reasons. Some hazards occur naturally in the environment, while others are the result of human activity, neglect of safety precautions, careless mistakes or malicious intent.

1.2.1 Natural Hazards

Natural hazards are those events originating from the physical environment, typically because of radiation from the sun, heat flow within the earth or the force of gravity. These natural hazards occur in and across three arenas of action (Mileti 1999):

- The atmosphere (the air surrounding the earth that is made up of various gasses)
- The hydrosphere (the earth's water system)
- The lithosphere (the earth's crust)

Natural hazards are classified as having atmospheric, geologic, hydrologic, seismic, volcanic and wildfire origins. There are also other types of natural hazards that will be described in Sections 1.2.2–1.2.7.

Figure 1-2 Hurricane Sandy struck the northeast and destroyed this roller coaster on the boardwalk in Seaside Heights, NJ. Liz Roll/FEMA. Adapted from http://www.nhc.noaa.gov/aboutsshws.php

1.2.2 Atmospheric Hazards

An **atmospheric hazard** is a hazard agent that is produced in or by the earth's atmosphere. A hurricane is one type of atmospheric hazard (Figure 1-2). Hurricanes begin as tropical depressions in the Atlantic Ocean and form as low-pressure systems due to the warm water that fuels them. When wind speeds top 74 mph, such tropical depressions become known hurricanes. In the Indian Ocean, these tempests are known as cyclones, and in the Pacific Ocean they are labeled typhoons. The eye or center of these storms is somewhat calm, but it is surrounded by circling cloud bands that produce rain in large amounts. Some hurricanes may have winds in excess of 100 or even 200 mph, and they may produce a storm surge that could reach up to 24 feet. The strength of a hurricane is described under the Saffir–Simpson scale. The **Saffir–Simpson scale** is a descriptive tool to explain the magnitude of a hurricane in terms of wind and storm surge. It includes five categories. Category 1 is the weakest, while Category 5 is the strongest (see Table 1-2).

This scale also estimates potential property damage. On the lower end of the scale, category 1 and 2 storms are smaller, but could nevertheless be dangerous and still require preparatory measures. Hurricanes reaching Category 3 and higher are considered major storm systems because of their potential for significant loss of life and damage. In the western North Pacific, the term "super typhoon" is used for tropical cyclones with sustained winds exceeding 150 mph.

In the Northern Hemisphere, hurricanes rotate in a counterclockwise direction and travel in a west–northwesterly direction. They frequently hit Atlantic states and those along the Gulf Coast. Florida is one of many states that frequently experiences hurricanes. For

Table 1-2 Saffir–Simpson Hurricane Scale.

Category	Sustained winds	Types of damage due to hurricane winds
1	74–95 mph 64–82 kt 119–153 km/h	**Very dangerous winds will produce some damage:** well-constructed frame homes could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96–110 mph 83–95 kt 154–177 km/h	**Extremely dangerous winds will cause extensive damage:** well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111–129 mph 96–112 kt 178–208 km/h	**Devastating damage will occur:** well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130–156 mph 113–136 kt 209–251 km/h	**Catastrophic damage will occur:** well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	157 mph or higher 137 kt or higher 252 km/h or higher	**Catastrophic damage will occur:** a high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: Adapted from Saffir-Simpson Hurricane Wind Scale, NOAA. http://www.nhc.noaa.gov/aboutsshws.php.

instance, Hurricane Andrew made landfall on August 24, 1992, and its strong winds devastated the Miami-Dade area. This hurricane produced dozens of deaths and left thousands of people without power and shelter. Weak building codes and poor enforcement resulted in major structural collapses and a debris management nightmare. Hurricane Andrew's impact on Florida was surpassed by the combined four hurricanes and one tropical storm that hit Florida in 2004. This was one of the worst hurricane seasons on record, but such storms have become even more problematic over the past few decades.

- In 2008, Hurricane Ike affected Mississippi, Louisiana, and Texas. It killed nearly 200 people and resulted in over $37 billion in damages.
- "Superstorm Sandy," as one of the largest hurricanes in history, made landfall north of Atlantic City in 2012 and decimated many buildings near the coast. The storm flooded subway stations in New York City and caused $65 billion in damages in many of the other northeastern states.
- In 2017, Hurricane Harvey pounded Texas and Louisiana, resulting in $125 billion in losses. That same year, Hurricane Maria impacted Puerto Rico with loss estimates over $90 billion.

- In August 2018, Hurricane Florence struck North Carolina and killed an estimated 3.4 chickens and 5,500 pigs. A month later, Hurricane Michael flattened structures in Mexico Beach, Panama City, and Port St. Joe with its 160 mph winds and 9- to 14-foot storm surge. Hurricane Michael killed 16 people and produced $25 billion in losses.
- Hurricane Ida affected Louisiana in 2021. It caused serious devastation and resulted in 1 million people without power. The remnants produced major flooding in New York and New Jersey. Nearly 80 individuals died in the United States.

Although the above storms were problematic, all of these hurricanes combined did not result as many deaths as a cyclone that hit Bangladesh in 1970. It tragically killed as many as 300,000 people and illustrated that hurricanes can be particularly devastating in developing nations.

For Example

The 2020 Hurricane Season

The year 2020 was the most active hurricane season ever with 30 named storms and 13 major hurricanes. Twelve of these affected the continental United States with a 1–2 punch in Louisiana from Hurricanes Marco and Laura. These two storms were only separated by about 48 hours, which complicated response operations. While Marco was not as bad as anticipated, Laura produced 77 deaths and $19 billion in losses. Other storms, including Hurricane Sally, had major impacts on Alabama due to strong winds, storm surge flooding, and at least 20 inches of rain. The total amount of damage from the 2020 Hurricane season is estimated to be over $60 billion.

A thunderstorm is another atmospheric hazard. Thunderstorms are produced when warm, moist air rises through convection (otherwise known as thermal uplift). These storms also occur along cold and warm fronts where different air masses collide or when clouds traverse mountain chains (i.e., orographic lifting). When a thunderstorm cell forms (with cumulus and cumulonimbus clouds), air rises and then descends quickly leading to rain, sometimes in copious amounts. This precipitation can lead to severe flooding and mudslides (which will be discussed further in sections 1.2.3 and 1.2.4).

Depending on weather conditions and temperatures, the vertical movement of air also freezes water droplets that fall to the earth as hail. Most hail is small (e.g., pea size), but it can be larger at times (e.g., baseball or even grapefruit size). Hail can damage the roofs of buildings, destroy car windshields, and even kill those that are struck by it. Hailstorms can be costly natural disasters such as the one that hit Fort Worth, Texas, during a 1995 Mayfest celebration. The event resulted in at least $1 billion in losses. Over 100 people had to be taken to area hospitals after being struck by softball-sized hailstones.

Thunderstorms also result in downdrafts and **straight-line winds** (which travel down to the ground and then move horizontally along the earth's surface). Such winds move quickly and can slam airplanes to the ground as was the case of USAir Flight 1016 on approach to the Charlotte-Douglas International Airport in 1994. This crash resulted in 37 fatalities and injury to another 20 passengers. Downdrafts and straight-line winds may also severely impact homes, barns, fences, etc. On August 10–11, 2020, a major and widespread

windstorm (called a "derecho") impacted several states including Wisconsin, Iowa, Nebraska, Illinois, and Indiana. Winds, ranging from 70 to 140 mph, created utility disruptions, decimated corn and soybean crops, and produced losses upwards of $11 billion dollars.

Severe thunderstorms are not just common to the mid-western portions of the United States. There are over 16,000 thunderstorms per year in all locations excluding the North and South Poles. Such storms also generate lightning, which is the emission of electrical bolts from clouds as a result of the interaction of positively and negatively charged fields. Approximately 6,000 lightning strikes occur every minute around the world. Lightning often hits buildings, trees and the ground. Homes and forests may be ignited with fire due to lightning. Because the temperature of the bolt is extremely hot (perhaps up to 50,000 degrees Celsius), people can be killed as well. Burns, respiratory failure, and cardiac arrest result from lightning strikes.

Tornadoes are another type of atmospheric hazard. Tornadoes are closely associated with thunderstorms. In fact, the name "tornado" stems from the Spanish name for such storms. As warm, moist air collides against cool, dry air, winds may move in a circular or rotating direction. One portion of the rotating air shaft drops, while the other portion moves upward in a vertical manner. If this air shaft touches down on lakes or oceans, it is known as a waterspout. When the resulting funnel reaches the ground, it becomes known as a tornado. The velocity of winds is the factor used to describe the strength of tornadoes under the Enhanced Fujita Scale. The **Enhanced Fujita Scale** is a scale used to categorize the size of a tornado, including the affiliated wind speed (see Table 1-3). Small tornadoes (e.g., F0 or F1) are very common and possess slower wind speeds (e.g., 65 mph). Large tornadoes (e.g., F4 or F5) are infrequent, but their wind speed may reach over 200 mph. At such high speeds, windows are broken, roofs are ripped from walls, and even foundations can be sucked from their moorings. Glass, brick, two-by-fours, and even cars become projectiles and may penetrate other structures. The destruction from tornadoes can be extremely severe. For instance, the large F5 tornado that struck Joplin, Missouri in

Table 1-3 Enhanced Fujita Scale for Tornado Damage.

	Fujita scale		Derived EF scale		Operational EF scale	
F number	Fastest 1/4 mile (mph)	3 second gust (mph)	EF number	3 second gust (mph)	EF number	3 second gust (mph)
0	40–72	45–78	0	65–85	**0**	**65–85**
1	73–112	79–117	1	86–109	**1**	**86–110**
2	113–157	118–161	2	110–137	**2**	**111–135**
3	158–207	162–209	3	138–167	**3**	**136–165**
4	208–260	210–261	4	168–199	**4**	**166–200**
5	261–318	262–317	5	200–234	**5**	**Over 200**

Important note about enhanced F-scale winds: The enhanced F scale still is a set of wind estimates (not measurements) based on damage. It uses 3 second gusts estimated at the point of damage and wind estimates vary with height and exposure. The 3 second gust is not the same wind as in standard surface observations. Standard measurements are taken by weather stations in open exposures.
Source: National Oceanic and Atmospheric Administration, implemented in the U.S. on 1 February 2007. http://www.spc.noaa.gov/faq/tornado/ef-scale.html.

May 2011 became the costliest tornado in U.S. history. Damages in this disaster amounted to over $2.5 billion. St. John's Regional Medical Center was one of the larger building structures that received extensive damage. Over 150 people were killed due to dangerous winds associated with this massive tornado.

Tornadoes are very common to the Midwest portion of the United States due to the movement of the jet stream and the collision of air from Canada and the Gulf of Mexico. In fact, 90% of the world's tornadoes take place in the United States. Although a typical year sees roughly 1,000 tornadoes, in 2011 there were 1,691 twisters, which killed 700 people and produced $25 million in damages.

Oklahoma is one of the states that is frequently impacted by tornadoes, as was the case on May 3–5, 1999. Fifty-nine tornadoes were reported in central Oklahoma during this period, and many of them lasted several minutes and traveled great distances. At least 40 people were killed during the outbreak and 675 people were injured. Over 10,000 homes were also damaged or destroyed. Losses were estimated at $1.2 billion. Throughout history Oklahoma has experienced numerous tornadoes, including three that traveled virtually the same paths in the City of Moore. For this reason, Oklahoma and many other midwestern states are considered part of "tornado alley" - the central portion of the country that is frequently prone to these types of storms. However, it should be pointed out that tornadoes have occurred in many locations around the United States including in California, Florida, Utah and many others.

Winter storms are atmospheric hazards that occur mainly in December, January and February in the United States. Such seasonal storms include snow, sleet and ice, and are associated with extremely cold temperatures (Figure 1-3). Snowstorms include fluffy flakes of water that have frozen as they fall to the ground. While snow is often described as a "winter wonderland," excessive snow can be a problem. On January 28, 1977, Buffalo, New York, received 93 inches of snow. This is an amount greater than the average for that area during the entire year!

When accompanied by high winds, these events can turn into blizzards. Such storms can leave several inches or feet of snow on the ground, making transportation difficult as was the case in Denver in October 1997. Up to 31 inches of snow fell in some locations and drifts were as high as 10 feet on the plains to the east of this city. Hundreds of cars had to be abandoned, and countless roads were shut down for a few days before plows could clear them.

When snow falls on steep slopes, the potential for avalanche may result. Avalanches are quick and violent movements of snow down the mountainside. They occur around the world and result in the loss of 150 lives each year. In one case, a major avalanche in Central Italy hit the 4-story Rigopiano Hotel on the afternoon of January 18, 2017. The snow slide, which may have resulted from a series of earthquakes, moved the hotel more than 33 feet and killed 29 people. In the United States, avalanches are common in Alaska, California, Washington and states located in the Rocky Mountain region. The characteristics of snow, changing temperatures, wind, and presence of skiers and snowmobiles can trigger avalanches. In 2021, nine individuals died from avalanches while participating in winter sports in the mountains of Utah, Colorado, and New Hampshire.

Although snow and avalanches create several challenges including property destruction and fatalities, the cold temperatures associated with winter storms may also produce hypothermia in individuals who are exposed to such weather. In some cases, the heating or lighting of homes with open flames during winter storms may lead to fires that also cause death and destruction.

Figure 1-3 *The 2021 Valentine Storm resulted in snow and ice on a beach near the San Louis Hotel in Galveston, Texas (National Weather Service/Michael Garske)* https://www.weather.gov/hgx/2021ValentineStorm

Sleet is another type of winter storm and it is sometimes difficult to distinguish from ice storms (even though sleet has more water in liquid state than ice storms). In any case, sleet and ice storms will cause very dangerous conditions when they accumulate on trees, power lines and the ground. Although winter storms occur most frequently in the northern, central, and western portions of the United States, it is possible for lower states to receive snow and experience ice storms periodically. For instance, Oklahoma experienced a major ice storm on October 27, 2020. This event knocked out power and destroyed countless trees/tree limbs. Making matters worse, southern states may have extra challenges dealing with ice storms since they often lack necessary snow removal/de-icing equipment. Such storms can create major traffic problems as was the case from Amarillo to the Dallas-Fort Worth metropolitan area in January 2007. Cars and semi-trucks were stranded on the highway for hours and even days. Sadly, the slippery roads can prove deadly. During the early morning hours of February 11, 2021, the I-35W freeway iced-over just to the north of Fort Worth Texas. At least 5 people died when 133 vehicles were involved in a pile up that spanned a half a mile. The incident required that 65 people be treated at local hospitals.

For Example

Freezing Temperatures in College Station Texas

People may not give much consideration to freezing temperatures, but the consequences can be disastrous. During the historic winter outbreak in Texas in February 2021, extremely cold temperatures along with snow, sleet, and freezing rain impacted the entire state. Many records were shattered during this unprecedented "Valentines" storm system. In College Station, Texas, the coldest temperature was 5 degrees Fahrenheit at 7:26 on February 16, 2021. The coldest windchill was −8 degrees Fahrenheit at 8:53 on February 15, 2021. The longest stretch of freezing temperatures was 86 consecutive hours from 3:53 pm on February 13, 2021 to 5:53 am on February 17, 2021. As a result, many water pipes froze, and this damaged many buildings and produced significant property losses.

One of the most-damaging and disruptive ice storms was experienced along the U.S.–Canadian border in January 1998. Ice piled up several times higher than prior records, and many power lines and transmission towers collapsed due to the excessive weight of thick ice. Widespread blackouts occurred in this region. A similar event occurred in Texas in February 2021. The combination of ice and extremely cold temperatures impacted the state for multiple days. The power grid was damaged and disrupted, and as many as 4 million people were without electricity over an extended period of time. Water mains in the street and water lines in homes broke across the state, and people were left without drinking water. Grocery stores also ran out of food and supplies, and deaths were reported due to hypothermia. Both of these storms reveal just how vulnerable infrastructure can be to the forces of nature.

Fog and dust storms are other hazards that result from atmospheric conditions. Fog occurs near the ground when water vapor condenses as warm and cold air interact. In 2017, dense fog accumulated between the cities of Hanford and Lemoore in California. Visibility became problematic and a series of accidents along Highway 198 involved more than 50 vehicles.

Dust storms (also known as sandstorms) occur in arid and semi-arid locations such as the Sedan in Africa. They are also common in states like Arizona—particularly in April. Known as "haboobs," these events make visibility problematic and likewise create many traffic accidents. Haboobs can also create respiratory problems since the fine dust will inevitably end up in people's lungs.

A final atmospheric hazard to be discussed here is a heat wave. A heat wave is a prolonged period of high temperatures that may also be coupled with excessive humidity. Heat waves create loss of agricultural crops and also stress humans to the point that they cannot cool their bodies through the normal process of sweating. If relief from the weather or medical care is not given, coma, paralysis and death will follow. For instance, around 700 deaths (mainly among the elderly) resulted from a prolonged heat wave in Chicago in July 1995. The danger of such events requires constant communication with the public to alert them of such dangers. One of the things that needs to be relayed to the public is the **heat index**, which describes the severity of the situation. This index incorporates both temperature and humidity into a scale. It is used by meteorologists to help warn people to stay inside and drink lots of water.

For Example

Heat Wave in France

In August 2003, France experienced some of the highest minimum and maximum daily temperatures recorded in history. Because several families and physicians had taken time off from work during this typical vacation period, many elderly individuals were left at home or without sufficient care in hospitals and nursing facilities. The lack of air-conditioning units in France combined with temperatures up to 104 degrees Fahrenheit and insufficient fluid intake resulted in the death of as many as 15,000 people. Heat waves such as this one are not always recognized as significant hazards, but their impact can be extensive as France discovered.

1.2.3 Hydrologic Hazards

Hydrologic hazards are closely related to atmospheric hazards and these agents have a specific impact on the earth's water systems. There are several types of hydrologic hazards, one of them being floods. Floods are the most prevalent of any hazard around the world and in the United States—whether natural or otherwise. They are also among the costliest. Episodes of flooding occur when there is too much precipitation or where there is an inability for soil to absorb water that has fallen to the ground. Flooding can also result from melting snowpack and ice jams. Soil type, topography, deforestation and level of development all have bearing on flooding. For instance, clay soils are more likely to produce runoff in comparison to sandy soils. Hills, valleys, and the use of cement or asphalt on streets and parking lots in highly urbanized areas may also contribute to this type of hazard.

The 1993 great Midwestern flood is the most widespread and costly flood in U.S. history. Months of unusually wet weather and the seasonal snowmelt overwhelmed the Mississippi River Basin with water. Dykes, locks, and dams were eventually filled to capacity, and many of them were breached. The water emitted from broken levees only added to the flooding downstream. Thousands of people had to be evacuated and property losses totaled in the billions of dollars.

For Example

Other Causes of Flooding

Dams and dam failures can also lead to flooding. One of the most-deadly events occurred in Italy. In 1960, the Vajont Dam was constructed, and it was one of the tallest dams in the world. Unfortunately, when the dam was filled up this caused the neighboring mountainside to become water-logged. Although the dam was drained 1/3 the capacity, a massive mudslide created a wave that overtopped the dam. 50 million cubic meters of water rushed down into the Piave Valley below, and 1,900–2,500 people lost their lives in this disaster.

In the United States, a flash flood occurred in Idaho on June 5, 1976. The Teton Dam suffered a catastrophic failure. The rushing water killed 11 people and over 13,000 cattle. In 2017, the Oroville Dam in California almost collapsed and forced the evacuation

of nearly 200,000 people. The repairs cost over $1 billion. Sadly, many of the dams in the United States are aging and even reaching the end of their lifespan. In fact, in a recent assessment, 91,000 dams in the United States received a D-letter grade. There is concern that more episodes of flooding will result.

Storm surges and coastal erosion may result from hurricanes or other types of phenomena in the hydrosphere (e.g., low-pressure systems, strong winds, high tides, etc.). A storm surge is a temporary rise in the water level of an ocean or river estuary. Flooding is a product of storm surges, and it can take days and weeks for water to recede after such events. Coastal erosion may also occur as a result of storm surges, and it often damages roads, bridges, dunes and beaches. Louisiana and Florida are frequently affected by storm surges and coastal erosion associated with hurricanes. Losses can amount to millions of dollars.

Droughts are another kind of hazard related to the hydrologic system. Low amounts of rainfall and high evaporation rates due to warm or hot temperatures lead to conditions of drought. Dust storms, desertification, and salinization of soil also result from droughts. Drought can have a negative impact on agricultural output. The Great Depression was triggered, in part, by severe drought. However, droughts do not typically result in a substantial shortage of the overall food supply in the United States (although the provision of individual crops may be extremely low). In contrast, famines in other countries can be especially deadly. The lack of adequate food intake has resulted in malnourishment and the spread of fatal diseases in Ethiopia in the 1980s and Niger in the mid-2000s.

For Example

The Sahel Drought and Famine

From 1961 to 1990, several countries in the Sahel region of Africa experienced a significant decrease in rainfall. This transition zone between the Sahara Desert to the north and the tropical area to the south became even more arid, causing a sharp decline in agricultural production in this region. The large nomadic population, coupled with the overgrazing of animals, could not be sustained by the vegetation of the area. By 1974, over $350 in relief assistance had been provided by the international community. Nonetheless, 5 million head of livestock died due to the drought conditions. The situation was particularly devastating in that an estimated 300,000 people perished from the famine.

1.2.4 Geologic Hazards

Geologic hazards are those hazard agents associated with the earth's soil and rock surfaces. Landslides are the most damaging kind of geological hazards. This movement of earth occurs due to a number of variables such as slope angle, moisture content of the soil, and physiology of rock. The absence of vegetation may also be a reason why landslides occur. A lack of root systems from trees and plants may make the soil more unstable. Landslides may move swiftly and occur without warning or creep at a slow and perhaps unnoticeable pace. Such events are possible in any hilly or mountainous area but are probably most common along the Rocky Mountain region and the Pacific Coast. In 1983, a major landslide blocked a

major highway in Thistle, Utah. The sediment and rock created an earthen dam that backed up a river and flooded a city. In 2005, a sizable portion of the mountain separated in La Conchita, California, and fell to the valley floor below. It buried 15 homes, damaged 16 others, and killed several individuals. And, on March 22, 2014, the Oso mudslide in Washington killed 43 people and destroyed or damaged 49 homes and other structures. Sadly, there had been many warnings about slope instability in this area for many decades. The risk was not taken seriously, and lives and property were lost as a result.

Besides landslides, there are also geologic hazards related to subsidence and expansive soils. Subsidence occurs when the water table or underground rivers erode the soil around them and the earth collapses. This type of sinkhole is common in Florida (see Figure 1-4). In August 2013, a sinkhole on Florida's surface swallowed parts of the Summer Bay Resort near Walt Disney World. The sinkhole was about 60 feet wide and 15 feet deep. Fortunately, those vacationing in the area were able to evacuate quickly as the building started to crumble and fall into the sinkhole. Another cause of subsidence is the mining for coal and ore, dredging canals or the pumping of groundwater out of a certain geographic area. New Orleans and Mexico City are both sinking due to these latter activities. In contrast to subsidence, expansive soils may actually rise due to the presence of moisture in ground. This hazard is especially prevalent in locations that have clay soils. Although expansive soils are found most

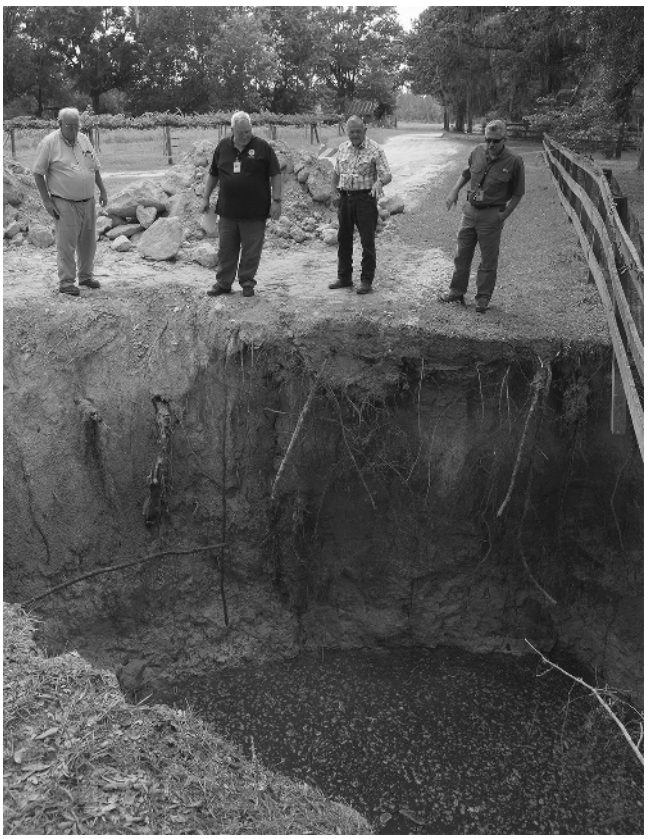


Figure 1-4 This 45-foot deep sinkhole formed in Monticello, FL, after Tropical Storm Debby produced excessive rains and flooding. David Fine/FEMA.

often in the south and west, they can be present in many parts of the United States. Expansive soils do not necessarily kill people, but they can create a large amount of property damage (especially to the foundations of buildings).

1.2.5 Seismic and Volcanic Hazards

Seismic hazards are hazard agents produced by the movement of tectonic plates that float on magma. Earthquakes occur along fault lines where landmasses move apart, collide or slide against each other laterally. When this movement occurs, waves travel in and on top of the earth. These waves emanate from the geographic origin of the earthquake, known as a focal point. The location on the earth's crust directly above the focal point is called the epicenter. The intensity of an earthquake is described by use of the **Richter scale**, a measurement of the registered shaking amplitudes. In contrast, the **Mercalli scale** is used to denote the physical observation of damages that result from the displacement of the earth's crust (e.g., broken windows, cracked walls, falling pictures, etc.).

Earthquake risk is probability the highest in locations surrounding the ring of fire (i.e., countries positioned around the Pacific Rim). For instance, Japan has earthquakes on a constant basis and Chile has had the most powerful earthquake recorded in history, registering an amazing 9.5 on the Richter scale. Nevertheless, earthquakes occur in many locations around the world, and they can be extremely damaging and deadly. Tens of thousands and even hundreds of thousands have perished in earthquakes in Mexico City, Russia, India, and Iran. Haiti suffered a 7.0-magnitude quake in 2010, which killed between 200,000 and 300,000 people. In 2013, the Sichuan province in China was the epicenter of a major earthquake. The movement of tectonic plates coupled with poor construction took the lives of 200 people. Building codes have historically been weak in such countries, resulting in structural collapses and the crushing of their inhabitants.

In the United States, there are major fault lines in California, Utah, Illinois, South Carolina and in New England. While some of these fault lines are not active, earthquake faults along the Pacific Coast slip frequently and have destroyed gas and water lines, roads and bridges, and homes and other structures. The 1989 Loma Prieta and 1994 Northridge earthquakes killed scores of individuals. In the Midwest, the New Madrid fault stretches from Arkansas to Missouri and Tennessee. Earthquakes in this area have changed the course of the Mississippi River in the past. Additional destructive slips in this area are projected to occur in the future.

Earthquakes may trigger other natural hazards. For instance, while tsunamis may be associated with underwater landslides and asteroids that impact the oceans, they result most often from earthquake hazards. If fault lines slip under the ocean, the accompanying seismic waves displace water, which races vertically and horizontally away from the focal point. When these "harbor" or "tidal" waves reach land, they become amplified on the surface. The resulting waves or series of waves may travel hundreds of feet to a few miles inland. They move rapidly (as fast as 500 mph) and may reach one or two stories in height. The waves consequently level many of the buildings and much of infrastructure that lies in their path.

Tsunamis result in a number of drownings and may sweep their victims out to sea as they recede. Hawaii and the northwestern coast of the United States are prone to tsunamis. One tsunami struck Hilo, Hawaii in 1946 and another affected Alaska in 1964. Several deaths resulted in each event. However, the most powerful tsunami in history occurred on January 4, 2005. The Sumatra earthquake registered over 7.0 on the Richter scale; it sent powerful tsunami waves to over 12 countries surrounding the Indian Ocean. Over 300,000 people died

from this tragic event. Another major tsunami occurred after an earthquake struck Japan in 2011. The tsunami that was generated had waves reaching over a 100 feet in some locations. The Tohoku earthquake and tsunami damaged the Fukushima nuclear power plant and caused the release of radioactive material into the air. Almost 16,000 people were killed as a result of these combined hazards. This event illustrates how complex some disasters can be.

Volcanic activity is another type of natural hazard and it is closely related to earthquakes and the movement of magma within the earth's crust. Magma may bubble up through fissures in the earth surface, creating a cone with a reservoir of lava. These mountainous craters may vent superheated gasses and emit lava flows down the side of the cone. In the United States, volcanic activity is present mainly in the Northwest and in Hawaii.

Volcanic eruptions can be particularly deadly, as was the case with Mt. St. Helens in 1980 (Figure 1-5). A bulge developed over time on the north face of Mt. St. Helens and eventually the growing pressure gave way in a violent explosion. Tons and tons of soil, lava, and mud were sent down the side of the mountain and into the valley and rivers below. Fifty-seven people were killed in the incident, being vaporized immediately, buried under volcanic debris or drowned in lahars (violent mudflows). Volcanic ash also rained down on communities around the volcano and even in nearby states. This made some vehicles inoperable and caused a cleanup nightmare. In addition, the logging industry in this area was severely disrupted for a period of time due to the Mt. St. Helens eruption.

Not all volcanoes result in violent eruptions similar to Mt. St. Helens. Some produce ongoing lava flows that can also be problematic. For instance, the Kilauea volcano is one of the most active volcanoes in the world. It has been emitting lava since 1983. In 2018, the lava flows from Kilauea traveled great distances and destroyed trees and vegetation. The flows covered roads and destroyed over 700 homes in Leilani Estates, as well as in the Vacationland and Kapoho Beach Lots subdivisions among others. About 2,500 people were displaced.

Figure 1-5 This picture of Mt. St. Helens on May 18, 1980, illustrates the significant risk posed by volcanic eruptions. NOAA News Photo. http://www.fema.gov/media-library/assets/images/37848

While most volcanoes don't have widespread impacts, some volcanic eruptions have had notable international consequences. The eruptions of Mount Tambora in 1815 and the explosion of Krakatoa in 1883 (both located in Indonesia) may have produced so much ash in the atmosphere that sunlight was partially blocked for an extended period of time. This may have reduced temperatures and prolonged winter-like conditions, which impacted agriculture output and resulted in food shortages. In other cases, the dangerous chemicals that are released may kill people and livestock. More recently, the Eyjafjallajokull eruption in Iceland in April 2010 caused serious problems for air travel since the resulting ash could damage aircraft engines. Many flights had to be diverted as a result.

For Example

Nevado Del Ruiz

In November 1985, the 17,716 feet Nevado del Ruiz volcano in Western Columbia erupted, emitting an ash cloud that rose over 45,000 feet in the air. Superheated lava poured out of the crater, melting the snowcapped volcanic cone. The ash, lava, and water turned into a river of mud (known as a lahar) that raced down the mountainside toward the valley floor. This liquid avalanche was as high as 50 feet and moved up to 30 mph. It buried the city of Armero. Buildings were either covered with tons of volcanic debris or demolished and carried down the river channel. When all was said and done, at least 20,000 were dead or missing. This volcanic hazard triggered one of the worst disasters in Columbia's history.

1.2.6 Wildfire Hazards

Wildfires are hazards that often result from lightning strikes and they can quickly envelop hundreds of acres of forest. However, humans may also play a role in the ignition of wildfires due to carelessness with matches, cigarettes, grills, campfires and even towing chains. High temperatures, low humidity, consistent drought conditions that parch grasses and fields, and strong winds can also cause fires to spread rapidly. Such wildfires are known by different names in various parts of the world. For instance, in Australia, these hazards are called brushfires and they can be especially dangerous. From September 2019 to March 2020, multiple fires burned 46,000,000 acres in the southeastern part of the country. Because they destroyed nearly 6,000 homes and killed 34 people, the brushfire season became to known as "Black Summer."

Many forest fires around the planet and in the United States occur in largely isolated areas (e.g., Yellowstone National Park). However, wildfires increasingly threaten people's settlements due to the urban–wildland interface. For instance, in October 2007, wildfires in Southern California were extremely devastating. Some of the fires were started by power lines that were damaged due to strong Santa Ana winds or by a truck that overturned (causing sparks). Others were ignited by an arsonist and a boy who was playing with matches. The extreme fire conditions at this particular time of year scorched over 500,000 acres in counties from as far north as Santa Barbara all the way down to San Diego. The fires destroyed over 1,500 homes and required the evacuation of up to 950,000 people. In addition, over 12,000 people had to be sheltered at Qualcomm Stadium. Many roads had to be closed as a result of

the fast-moving flames, and responders from CAL FIRE, the National Guard, and even Canada were called in to extinguish the fires. Both ground and air crews were needed to get the fires under control, which occurred by November 6.

California has experienced many deadly fires since this time and the risk appears to be increasing. In December 2017, the Thomas fire severely impacted Ventura and Santa Barbara Counties. It burned 281,000 acres and destroyed 1,000 homes. The following November, the Camp Fire was ignited by a faulty power transmission line. Due to the loss of cell towers and inadequate warnings, 85 people perished in Paradise City. A few years later, California witnessed the worst fire season in history. In 2020, over 9,600 fires burned 4,397,809 acres and destroyed over 10,000 homes. These fires were blamed on inadequate forestry policies (e.g., lack of fuel thinning and controlled burning), climate change, and even arson. Fortunately, such wildfires fires may be extinguished with the help of ground crews and air tanker support. They may also die out as a result of topographic conditions (e.g., a gulch or river), weather changes (e.g., lower temperatures and rain), and the lack of fuel (e.g., scarcity of trees and undergrowth).

For Example

Danger Facing Wildland Fire Crews

Wildfires can be extremely dangerous—even for experienced firefighting personnel. On June 28, 2013, lightning started the Yarnell Hills fire in Arizona. The Granite Mountain Hotshots, part of the Prescott Fire Department, were dispatched to respond to the conflagration. While fighting the blaze, radio communications were problematic. Making matters worse, the weather shifted unexpectedly and closed off an escape route for the wildland fire crew. Nineteen members of the crew were tragically killed, and their story was depicted in the film "Only the Brave." The movie is a good reminder that wildfire must be respected and that crews should undertake cautious measures to ensure safety.

1.2.7 Biological Hazards

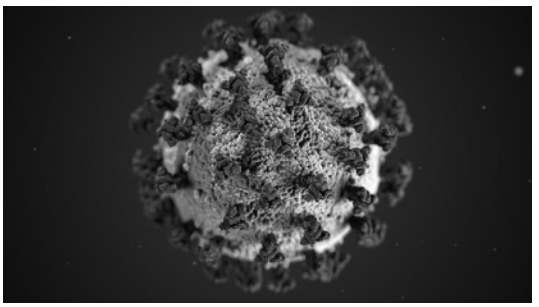
Biological hazards are agents that spread disease or are otherwise harmful to life. Such hazards pose a grave threat to humankind, and millions of people have died by coming in contact with them. Biological hazards may be broken down into two categories: pathogens and toxins. **Pathogens** are organisms that spread disease and may include anthrax, smallpox, plague, hemorrhagic fever and rickettsia. **Toxins** are poisons created by plants and animals. Ricin and botulism are examples of such toxins. This category of biological hazards is not likely to kill many people at a time. However, pathogens are far more devastating. For instance, the 1918 Spanish influenza pandemic killed more people in the United States than had died in combat in World War I. These disease epidemics are especially problematic when people are malnourished due to famines. Biological hazards have become a major concern due to outbreaks in the past decade and as a result of Covid-19.

In recent decades, there have been growing agricultural and public health concerns related to hantavirus, hoof and mouth disease, SARS, and West Nile virus. The avian "bird" flu has also been a serious concern in Asia, Europe, and Africa. These biological hazards have created many worries for farmers and public health officials, particularly in light of

our agricultural commerce, highly transient populations and the ease of modern travel around the world. Some of these biological hazards can be particularly deadly and disruptive.

At the conclusion of 2013, a major Ebola outbreak occurred in Guinea and Liberia. The disease spread rapidly in Africa and killed over 11,000 people on that continent. A man named Thomas Duncan unknowingly brought the disease to the United States from Liberia in 2014. He sadly could not survive the virus, and the agent spread to others (mainly in Texas). Fortunately, the spread was contained without any further fatalities in this nation. But even when death does not occur, biological hazards can pose shocking problems. Starting in July 2016, the Zika virus appeared in Florida. It spread through vectors (mosquitos). Although the disease is generally mild, it may produce serious complications for developing fetuses when women are infected. It is estimated that over 3,700 birth defects (e.g., microcephaly, eye abnormalities, and developmental disabilities) were attributed to Zika.

The worst biological hazard in recent history is Covid-19. The severe respiratory virus named Covid-19 was discovered in Wuhan City, China, toward the end of December 2019. While the exact source is debated (wet market vs. biological lab), Covid-19 soon became a major concern in China and around the world. Common symptoms of Covid-19 are similar to the flu and include fever, chills, fatigue, headache, muscle aches, sore throat, congestion, runny nose, diarrhea, and vomiting. The virus may also impact smell and taste, and it can lead to other very serious respiratory complications. Because Covid-19 is highly infectious and deadly, the World Health Organization (WHO) declared a global pandemic in March 2020. President Trump instituted a proactive travel ban against passengers from China, but the disease quickly spread throughout the United States anyway. Dr. Anthony Fauci (the Director of the National Institute of Allergies and Infectious Diseases) and other medical personnel and spokespersons were initially unclear about the threat and the importance of wearing masks. Even after the risk was recognized and conveyed, President Trump was vague about the need to wear masks and he seemed to actively oppose them at times too. Personal Protective Equipment (PPE) and ventilators were initially in short supply during the Covid-19 pandemic, and public health and medical personal were overwhelmed with needy patients. These are a few of the many reasons why 45.4 million Americans have been infected and over 736,000 people have died in the United States (at the time of this writing). Much more clearly needs to be done to prepare for these types of biological hazards.



Source: U.S. Department of Health & Human Services, https://phil.cdc.gov/default.aspx

Covid-19 required a massive mobilization of antiviral medications such as Remdesivir for Covid-19 patients in Texas hospitals. Julie Joseph/FEMA.
https://www.fema.gov/news-release/20200522/photos-whole-america-covid-19-response

For Example

The Locust Plague of 2019/2020

It is difficult to know how to categorize a locust plague. Regardless of how it is labeled, the presence of millions or even billions of locusts (a type of large grasshopper) may produce serious devastation to crops as has been witnessed in Africa for centuries. In 2019 and 2020, the infestation was particularly problematic in East Africa, the Arabian Peninsula, and India. The swarms of locusts (spreading out over miles and miles) are migratory and can devour crops quickly and threaten food supplies. It is one of many reasons why there is a food shortage in many African nations today.

Self-Check

- What is a natural hazard?
- What are the types of natural hazards?
- Are atmospheric and hydrological hazards related?
- Is there a connection between geologic and seismic hazards? If so, how?
- What are the effects of biological hazards?

1.3 Technological Hazards

Technological hazards are hazard agents related to manufacturing, nuclear materials, the built environment and transportation systems. These hazards abound in our modern, industrial world, and they range from hazardous materials releases and environmental degradation to structural failures and beyond.

1.3.1 Industrial Hazards

Industrial hazards are hazard agents produced by the extraction, creation, distribution, storage, use and disposal of chemicals. Chlorine, benzene, insecticides, plastics, fuel and other materials are released into the atmosphere when regulations are ignored, employees are untrained or careless, and equipment fails. Such materials in solid, liquid, or gas state may be corrosive, toxic, flammable or explosive. They may react in very complex ways depending on temperature and the presence of water, oxygen or other chemicals.

The release of methyl isocyanate (MIC) in Bhopal, India, from the Union Carbide Company is regarded to be the most-deadly industrial accident in history. While the cause of this event has been under debate, it is believed that poor maintenance at the chemical plant resulted in an accidental chemical release. Forty-five tons of gas was emitted into the city, killing anywhere between 2,500 and 10,000 people. Although there is continued disagreement about the extent of fatalities and the cause of this hazard, the event had a profound impact on hazardous materials regulations in the United States and elsewhere (i.e., the creation of the Emergency Planning and Community Right-to-Know Act or EPCRA in 1986).

Unfortunately, industrial hazards have been and continue to be a in the United States and around the world. For instance, on April 16, 1947, a fire broke out on the SS Grandcamp, which was docked in the port of Texas City; 2,300 tons of ammonium nitrate set off a series of fires and explosions that killed nearly 600 people. A major fire broke out at the Alon refinery in Big Spring, Texas, on February 18, 2008. One of the pumps at the Propylene Splitter Unit released a liquid, which was ignited by a nearby flame. While no one was injured in the explosion, toxic fumes were released into the air and I-20 had to be shut down while fire fighters battled the blaze for more than 4 hours.

On October 4, 2010, a dike surrounding a reservoir at the Hungarian Aluminum Production and Sales facility broke and released 1 million cubic meters of alkaline water and red sludge. It traveled down a creek and settled in three communities. The noxious flood killed 10 people, injured 286, and affected 358 homes (Ministry of the Interior, 2011).

On August 6, 2012, a Chevron refinery in Richmond, California, experienced a rupture of a pipe in the #4 Crude Unit. Flammable hydrocarbon fluid was released in a large vapor cloud, which then was ignited by an open flame. Many workers saved their lives by evacuating. Even though a shelter-in-place order was given for nearby cities, over 15,000 people suffered from respiratory ailments and some had to be admitted to hospitals.

A year later, a major industrial accident occurred in Texas (Figure 1-6). A stockpile of ammonium nitrate at the West Fertilizer Company exploded and killed 15 people, including many volunteer firefighters. Damage from the 2013 blast destroyed a school, a nursing home, and numerous homes and businesses in a 37-block area. The event prompted an

Figure 1-6 The April 20, 2013, West Texas fertilizer plant explosion produced major damages, including to this apartment complex. Earl Armstrong/FEMA. http://www.fema.gov/media-library/assets/images/70270

investigation by the Chemical Safety Board and underscores the importance of land-use planning and emergency preparedness.

An even more devastating explosion occurred in Beirut on August 4, 2020. 2,750 tons of ammonium nitrate were stored unsafely at a port warehouse for more than 6 years. For whatever reason the materials ignited, and a blast resulted equivalent of 1 kiloton of TNT. The explosion registered 3.3 magnitude on the Richter scale and was felt in Israel, Syria, Turkey, and even some parts of Europe. The disaster killed 204 people, injured 6,500, and left 300,000 homeless. Several protests occurred afterwards because of the lax safety standards. Unfortunately, such events may not only result from mistakes; some may be intentional. There is always a potential that industrial hazards could be triggered by terrorists seeking to cause death and destruction. In fact, some governmental officials initially believed the explosion was due to a terrorist attack.

1.3.2 Environmental Hazards

Careless industrial activity may have other negative effects. Pollution, degradation, and overuse of natural resources are types of ecological or environmental hazards**. Environmental hazards** are agents (such as pollution) that result in the degradation of our physical surroundings and pose a risk to people's health and well-being. Sometimes these environmental hazards are naturally occurring. For instance, red tide—a harmful algae bloom in the Gulf of Mexico—kills fish and makes shellfish dangerous to eat. However, there is some evidence that fertilizers from farms may wash down rivers and have an impact on the presence of red tide in the ocean.

For Example

Phosphate Plant in Florida

In late March 2021, a 77-acre retaining pond at the old Piney Point phosphate mine in Florida developed a leak that threatened nearby residence and the environment. Governor Ron DeSantis declared a state of emergency due to the significant risk of failure. The 77-acre pond holds millions of gallons of water and it contains phosphorous, nitrogen, and radioactive materials. There was concern that the polluted water would flood neighborhoods if the leak were to break open further. Officials worked tirelessly to plug the seepage while they pumped water out of the pond to minimize pressure on the plastic and earthen walls. While the worst-possible disaster was fortunately averted, there is still concern that the wastewater pumped into Piney Creek will produce or exacerbate harmful algae blooms like red tide in Tampa Bay.

Pollution is one type of environmental hazard that involves the emission of wastes into our physical surroundings. This may include the distribution of solid, liquid, and gas wastes into landfills, rivers, and the atmosphere. Such activities harm the soil, contaminate water supplies and poison the air. Pollution can also impact farming and lead to various health problems. As an example, during the 1940s, the Hooker Chemical Company dumped 21,800 tons of toxic chemicals in Love Canal (a neighborhood in Niagara Falls, New York). The benzene, dioxin, and other substances made the soil poisonous in the area, and people started to suffer from miscarriages, birth defects, seizures, nervous disorders, and cancer. A necessary investigation took place and the findings resulted in a massive relocation of 800 families while the area was being remediated. More recently, the City of Flint Michigan experienced a public health crisis due to the presence of lead in the jurisdiction's drinking water. The community changed its water source from Lake Huron to the Flint River. Lead from the older pipes contaminated the water supply and adversely impacted about 100,000 residents. The toxic water may have been a contributing factor of Legionnaires' disease that killed 12 people and harmed another 87. Besides prompting a lawsuit, this situation caused the government to return to the Detroit Water Systems in October of 2015.

Although some may dispute the causes and consequences of a dynamic climate, it has been suggested that the emission of methane, carbon dioxide or nitrous oxide gasses into the atmosphere may add to global warming (which will be discussed further in Chapter 12). In spite of this debate, alterations in climate logically affect weather patterns and the nature of storms. For instance, flooding could become more severe and locations that had sufficient water in the past may later find themselves amid drought in the future.

There are many other forms of environmental degradation. One of the most salient concerns is over fracking, which is a process of drilling into the earth and injecting a mixture of water, salt, sand and other elements to obtain natural gas. While the search for cleaner fossil fuels is warranted, some believe chemicals injected into the soil may contaminate groundwater. Furthermore, there is growing evidence that fracking and the disposal of waste fluids may be linked to the triggering of small earthquakes. Numerous examples have become increasingly visible in Texas since 2008 and Oklahoma experienced a recent temblor in 2019. Additional studies about the advantages and disadvantages of fracking are warranted.

Other types of environmental hazards include desertification and the salinization of the soil, which may accompany over-farming. These types of environmental hazard limits the

production of agricultural goods and could lead to widespread famines in the future. While the depletion of natural resources is not always considered a primary issue for emergency management, the depletion of oil, gas, and coal would limit the heating of homes during the winter or the use of air conditioning during summer. This could put many lives in jeopardy, especially if renewable resources do not replace the fossil fuels we rely on currently.

For Example

Mining Accidents

As evidenced by the number of accidents that have occurred throughout history, mining can be particularly deadly to those who are working to extract coal and various minerals. Besides the danger posed by noxious fumes and the potential for fires, mining tunnels may also flood or collapse. Mining accidents can be particularly deadly. In 1906, a dust explosion at a mine in France killed over 1,000 workers. In 1942, the Benxihu coal mine in China took the lives of over 1,500 people. Other notable events that have resulted in hundreds of deaths have occurred in Wales, Japan, South Africa, and India. One of the worse mining disasters in the United States occurred in West Virginia in 1907; 500 miners were killed in a series of explosions. Sadly, these events continue to occur. Over the past few decades, there have been deadly mining accidents in Alabama, Colorado, Kentucky, Pennsylvania, Utah, Virginia, and in many other states.

1.3.3 Nuclear Hazards

A **nuclear hazard** results from the presence and potential threat of radioactive material. Nuclear power plants provide electricity for communities, businesses and individual citizens. Although these facilities produce nuclear wastes that must be disposed of, they pollute less than the power plants running off of coal. Nevertheless, nuclear wastes are also a problem and these nuclear hazards can also be extremely deadly and troublesome. Nuclear power plants create health risks because radiation can injure or kill people if it is accidentally released into the environment. This potential was witnessed in 1979 at the Three Mile Island nuclear power plant in Harrisburg, Pennsylvania. Because of a leak in the equipment that purifies water entering the turbines, a backup system should have been activated. Unfortunately, an employee had shut this secondary system off during maintenance, which caused the system to overheat. A warning light did not illuminate as it should have, and radioactive material was released into the containment building. In time, an employee noticed what was taking place and closed a valve to reverse the unfolding chain of events. No one was killed in the incident. However, the public became extremely alarmed at the lack of information during the warning and evacuation process. The limited impact on humans was not the case at the Chernobyl reactor in the former Soviet Union. After various mistakes and mechanical failures, many of those responding to the hazard died and thousands had to be evacuated. Nearby areas are still somewhat dangerous today, and cancer has affected those that failed to leave as requested by the government.

As mentioned earlier in this chapter, the Fukushima disaster was a significant event that involved a nuclear power plant in central Japan in 2011. The damages caused by a prior earthquake and tsunami resulted in a power failure and flooding of the reactors. The loss of generators and circulating pumps created a nuclear meltdown and hydrogen explosion. A fear of the

unfolding radiation leak necessitated the evacuation of 154,000 people. Workers were able to resolve the issue, but only after 2 employees died and 20 others were injured and exposed to dangerous radiation levels. This event illustrated the inherent dangers of industrial hazards.

1.3.4 Structural Fire Hazards

Fires that impact buildings and homes may also be labeled as technological hazards. These fires result from smoking, cooking, and carelessness with fireplaces. Others are caused by arsonists. Besides decimating structures, these events can kill scores or hundreds of people. The disturbing list of such fires throughout history includes the Richmond Theater Fire in 1811, the Triangle Shirtwaist Factor fire in 1911, the Coconut Grove fire in 1942, the Mercy Hospital Fire in 1950, the Warrenton Nursing Home fire in 1957, the Golden Age Nursing Home fire in 1963, the Sennichi Department Store fire in 1972, the Beverly Hills Supper Club fire in 1977, the Dupont Plaza Hotel fire in 1986, the Happy Land fire in 1990, the Dabwali fire in 1995, and the Ycua Bolanos Supermarket fire in 2004. Other fires have resulted from the improper use of fireworks such as the Mesa Redonda fire in 2001, the Lame Horse fire in 2009, the Puttingal temple fire in 2016, the San Pablito market fire in 2016, the Tultepec explosion in 2018, and the Ontario explosion in 2021. Notable fires have also occurred for various reasons at the National Museum of Brazil fire in 2018 and the Notre Dame fire in 2019.

While many of these fires are accidental or intentional, others result from improper wiring of equipment or facilities. A conspicuous example is the MGM Hotel fire in Las Vegas, Nevada, that occurred on 21 November 1980. The electrical connection for a pastry display case sparked due to a faulty ground connection. Wire connections lacked plastic insulation and the vibration from the fan caused the bare electrical conductors to arch. The combustible material in the seats and other materials in the restaurant caused quick acceleration of burning. No sprinkler suppression systems were installed in this part of the hotel and many of the fire escape doors were locked. Smoke quickly filled the building through the ventilation system. Eighty-five people died and another 650 were injured. Poisoning from carbon monoxide on upper floors were the main cause of death, which prompted a major investigation. Code changes were implemented in Nevada and the reconstruction of the MGM in 1981 included additional sprinkler systems, a speaker system for warning, and a new air-conditioning system.

1.3.5 Structural Collapse Hazards

The collapse of structures is another potentially deadly hazard. **Structural collapses** are hazards that occur when gravity and poor engineering interact and result in the failure of buildings, roads or other construction projects. These collapses may include the breaking of dams and dykes or the crashing down of buildings. As an example, there have been numerous dam failures throughout the history of the United States, including those in Johnstown, Pennsylvania (1889); Buffalo Creek, West Virginia (1972); and Teton, Idaho (1976). The failure of dikes and retaining devices also occurred in the 1993 Midwest floods and after Hurricane Katrina in New Orleans. Thousands of lives, considerable property and large amounts of infrastructure have been lost due to such hazards.

Structural failures are not limited to water retaining devices alone, however. Buildings, parking garages and bridges have also suffered from problematic engineering, inadequate construction and improper use. For instance, poor design, insufficient steel reinforcement,

and an improper mix of concrete resulted in a building collapse in Kuala Lumpur in 1968 (Aini et al., 2005). The event killed 7 people and injured 11 others. But, this collapse was minimal as compared to others that have occurred. In 1995, the Sampoong Department Store collapsed in Seoul, Korea. This structure was built quickly during a construction spree prior to the 1988 Summer Olympics. The mall was located on an existing landfill and lacked sufficient support columns and crossbeams. Warning signs (i.e., cracks in the structure) became visible and experts noted that the building was at risk of collapse. A leader of Sampoong refused to request an evacuation. The collapse occurred a short time later. It killed 502 people and injured over 900 more.

Two notable structural failures in the United States include the 1981 Hyatt Skywalk collapse and the 2021 Surfside condominium collapse. While a dance was held in the Hyatt hotel atrium, a suspended walkway broke loose from and this killed over 100 people as it fell to the floor. In spite of concerns raised about land subsidence and cracks in support columns, no renovations were made at the Surfside Condominium. 98 people died when a portion of the 12-story building crashed to the ground. Sadly, these collapses occur when construction is not taken seriously.

Another structural failure occurred in August 2007 over the Mississippi River near Minneapolis. During rush hour traffic, the I-35W bridge suddenly gave way due to what is speculated as a design flaw. The bridge and cars plummeted to the river below. Nearly 150 people were injured and 13 were killed. In May 2013, a parking structure that was under construction collapsed at Montgomery Mall in Maryland. This event left one person dead and another injured. Structural failures are often fatal, and they are very costly too (Figure 1-7).

In similar fashion, a pedestrian bridge at Florida International University gave way and fell to the road below. The collapse, which occurred on March 16, 2018, crushed cars and killed six individuals. After an investigation, it was determined that design errors were to

Figure 1-7 The aftermath of the I-35W bridge collapse is seen in this picture from Minneapolis, MN. Todd Swain/FEMA. http://www.fema.gov/media-library/assets/images/51546

blame for this failure. And, on September 12, 2020, a parking structure in Atlanta partially collapsed while it was under construction; 10 floors pancaked to the ground and resulted in a pile of concrete and a big cloud of dust. Although only one person was injured in the event, it also illustrated how serious structural collapses can be.

1.3.6 Transportation Hazards

Because of the ease of moving people, goods, and services around the world, we are faced with several transportation hazards. A **transportation hazard** is an accident that occurs on roads or railways, at sea or in the air. Such incidents may result from adverse meteorological circumstances, human error or mechanical failure. For example, there may be a massive vehicle accident owing to wet and wintery weather. At other times, tired or careless drivers may overturn their tankers on freeways, which carry hazardous materials and force the evacuation of neighborhoods and portions of cities. Train derailments may also occur and may result from reckless young drivers trying to beat the safety gates, animals grazing on the tracks, and the expansion or contraction of rails due to heat and freezing temperatures. Disturbing mistakes may also occur. In July 2013, the conductor of a train in Spain was talking on a cell phone and failed to slow down as necessary for an approaching curve. The wreck claimed the lives of 79 people. On April 2, 2021, Taiwan experienced its worst rail accident in seven decades. A train traveling 80 mph near the city of Hualien hit a construction vehicle that was mistakenly parked on the rails. The eight-carriage train then derailed inside a tunnel. At least 50 people were killed, and 200 others were injured. Besides deaths, train derailments can also emit hazardous materials into the environment and create a cleanup nightmare for rail companies and surrounding communities.

Instances of cruise ships and ferries sinking, vessels crashing into docks, or oil tankers hitting jagged rocks and puncturing their hulls are transportation hazards that have occurred in the past and in more recent years too. Almost everyone is aware of the sinking of the Titanic, which killed over 1500 people in 1912. The event illustrated the impact of careless navigation, the danger posed by icebergs, and the need for a sufficient number of lifeboats on ships. Unfortunately, there continue to be many other examples of shipping accidents at sea.

On December 6, 1917, two ships – the Mont-Blanc and the SS Imo collided in the Halifax Harbor in Canada. Barrels of benzol on the Mont-Blanc caught fire and TNT in the hull soon exploded. The resulting blast was devastating, destroying many nearby buildings and killing about 2,000 people. It required a massive international relief effort on the part of the Canadian and U.S. governments.

In January of 2012, the captain of the Costa Concordia deviated from the designated route in the Mediterranean Sea and struck rocks. The Italian cruise liner sunk and 32 people died as a result. The sinking of ferries is also common in places like India or the Philippines, where they are often overloaded with people and supplies. On other occasions, captains have lost control of ships in harbors in New York and Canada. One of the most notorious incidents was the 2003 Staten Island Ferry crash. The vessel ran into a concrete pier, killing 11 people and injuring over 70. In some cases, extreme environmental damage may result from shipping accidents. The most notable transportation-related oil spill in U.S. history occurred on March 24, 1989, in Prince William Sound, Alaska. When the Exxon Valdez ran aground, more than 240,000 barrels of oil were deposited into the seawater, polluting the beach and killing thousands of animals.

For Example

Ferry Sinking in Bangladesh

In July 2003, a ferry traveling to the southeast from the capital of Dhaka sank. The vessel encountered turbulent waters where two rivers merge. The boat, carrying between 500 and 800 people, capsized and quickly took on water. About half of those on the ship were rescued by fishermen or managed to swim to shore about 75 yards away. The overcrowded ferry and strong currents produced one of the deadliest transportation disasters in Bangladesh ever.

Wreckage from the Asiana Airlines Boeing 777 that crashed on July 6, 2013 while landing at San Francisco International Airport.

Airplane crashes are surprisingly less frequent than most other types of transportation accidents, but they may happen when wind shear occurs, when runways are icy or wet, when planes are not meticulously engineered and maintained, and when pilots overshoot or undershoot runways. Regardless of the cause, plane crashes can be particularly lethal. In certain cases, all passengers onboard will be killed. In November 2001, an Airbus A300-600 broke apart over Queens, New York, due to problems associated with the stress placed on the vertical stabilizer. Each of the 260 passengers and crewmembers died, and much of the fuselage landed in a neighborhood, which only added to the adverse consequences. In other cases, passengers may be fortunate to survive plane crashes. A Boeing 777 originating from

South Korea crashed on July 6, 2013, at the San Francisco International Airport when it hit the seawall just short of the runway. The pilot was not sufficiently trained on the aircraft he was flying, and the guidance system was disabled at the airport at the time. While there were only 3 fatalities, nearly 200 people were injured. It is certainly amazing the outcome was not more severe. On different occasions, two Boeing 737 Max aircraft experienced fatal accidents due to software issues. Lion Air Flight 610 and Ethiopian Airlines Flight 302 crashed in 2018 and 2019, respectively. These air disasters resulted when incorrect data from a sensor forced the nose of the aircraft down; 346 passengers and crew were killed, and this resulted in the grounding of such aircraft for many airlines around the world until the software could be fixed in November 2020.

For Example

The Space Shuttle Columbia

Although the break-up of the Space Shuttle Columbia is not considered a disaster, it was definitely a crisis situation that required the involvement of many personnel including emergency managers. During the launch, a piece or pieces of the foam insulation broke off the external tank and hit the left wing of the space shuttle. Upon re-entry into the earth's atmosphere on February 1, 2003, hot gasses damaged the heat shield further and caused the shuttle to become unstable. Due to extreme forces, the space craft broke apart and debris was scattered from Fort Worth, Texas, to the western portions of Louisiana. As the recovery operation began, information about what had occurred was shared with the public. The 2,000+ debris fields had to be protected from people who might have been curious about the pieces from space shuttle. The debris and bodies of the astronauts had to be collected for investigation. These and other activities required the involvement of NASA, state officials, fire fighters, police officers, amateur radio operators, and many other volunteers. Emergency managers helped to coordinate many of the recovery efforts.

Self-Check

- What is a technological hazard?
- What are the types of technological hazards?
- Why do technological hazards occur?
- How does industry and commerce influence hazards?
- What can be done to better prevent or deal with technological disasters?

1.4 Civil/Conflict Hazards

There are several types of **civil/conflict hazards,** which suggests competitive behavior or violent acts between individuals and groups of people. Panic flight, mass shootings, riots, terrorism and war fall into this category. Each will be discussed in the following section.

1.4.1 Panic Flight

Panic flight, or the fleeing of many individuals from what appears to be imminent harm, is extremely rare. However, when panic flight does occur, it has resulted in death and injuries under certain situations. Panic flight is most likely to occur when large crowds gather at concerts, sporting venues and other large public gatherings. An example took place on February 20, 2003, in West Warwick, Rhode Island. The rock band Great White was performing at a nightclub in this city. The road manager used pyrotechnics inside the building, causing the ceiling to catch on fire. As the fire spread quickly, occupants headed for the doors. Because most people exited the same way they entered the building, a bottleneck ensued, and many were trampled or became stuck. Around 100 people died in the blaze and over 180 were injured. The tragedy consequently prompted a review of fire exits and sprinkler systems around the nation. Such events have occurred elsewhere around the world.

For Example

Stampedes and Crowd Crushes

Concerts may result in serious emergency situations. In 2013, a fire broke at the Kiss nightclub in Santa Maria, Brazil, when a flare was lit on stage. More than 200 people died during the panicked evacuation. Another 150 were injured while leaving the burning nightclub. In 2021, more than 50,000 people attended the Astroworld festival in Houston where Travis Scott was performing. Nine individuals died and another 300 people were injured when the crowd compressed toward the stage. These events illustrate the dangers of panic flight, overcapacity, and the lack of signage and security personnel.

Other examples of panic flight have been witnessed during large religious gatherings. In 2005, 841 people were killed and another 323 were injured while attending a religious gathering at the Al Kadhimiya Mosque in Baghdad. Someone falsely reported the presence of a suicide bomber, and people began to evacuate the building and nearby area. Hundreds of people stampeded toward a bridge, which broke and fell into the Tigris River. A similar situation took place in Mecca, Saudi Arabia in 2006. 363 people were crushed and killed on the final day of the Hajj (pilgrimage). The incident began when some individuals accidentally tripped over their luggage. This created some fear in those nearby and caused them to scatter. Panic flight does not occur very often, but it can turn deadly as these cases suggest.

1.4.2 Riots

Riots are another type of civil/conflict hazards. **Riots** are large disturbances where people engage in antisocial behavior. They may begin as social protests but they are different than political demonstrations since this conduct includes rock throwing, looting, tipping over vehicles, starting fires and attacking law enforcement personnel. That is to say, social protesters and their opponents may peaceful protests initially, but the tense emotions may sometimes spark riots. These riots reveal serious disagreements about political decisions, economic

circumstances, racial tensions and/or cultural conflict. Other factors, such as drunk fans after the Super Bowl, may also trigger riots. Whatever the cause, these events can damage property, disrupt business activities and hurt the economy. They may also produce a large number of injuries and even death.

There have been several notable riots in the United States, including the Watts Riot in Los Angeles in 1965. This episode began when an officer pulled over an African American man who was alleged to have been driving erratically. In another racially charged situation, four police officers appeared to have used excessive force against Rodney King in Sylmar, California on March 3, 1991. The incident was caught on tape, but the police officers were not convicted of any crime. Many people believed that the police beating was both unnecessary and brutal. Others believed the legal system was biased when the verdict was made public. As a result, on April 29, 1992, thousands of people took to the streets to illustrate their dismay. Fifty individuals were killed, hundreds were injured, and over 12,000 people were arrested. Damage was in the millions of dollars.

Another riot occurred in Seattle in 1999 when environmentalists and others protested the policies of the World Trade Organization. During a 4-day period, people not only marched and heckled police but disabled busses and broke windows. As the violence ensued, it became apparent that law enforcement agencies in Seattle were not fully prepared. They were caught off guard by the demonstration that turned violent. The situation after the George Zimmerman trial in 2013 was dramatically different. The resulting protests were limited in number and were generally peaceful. The police in Florida and around the nation were better prepared for potential riots after the tragic death of a young black man.

https://www.shutterstock.com/image-photo/los-angeles-may-30-2020-police-1745189957

In 2020 and 2021, a series of riots affected the United States and the nation's capital. After decades of systemic institutional racism and a police officer's kneeling on George Floyd's neck on May 25, 2020, which resulted in his death, thousands of people took to the streets and some of the demonstrations turned violent in Minneapolis-Saint Paul. Two people were killed and over $500,000 in property damage resulted from looting and arson. The situation prompted similar protests around the country for several months. Perhaps as many as 25 people died and countless others were injured during these protests and accompanying riots. Damages from vandalism, arson, and looting may have tallied as much as $2 billion during the summer months in 2020. In a counter-protest or riot due to the Republican loss of the November 2020 Presidential election, many of Donald Trump's supporters marched on the capitol building in Washington, D.C. Some even stormed this important landmark and institution, which caused police to use weapons to protect House and Senate representatives. Five people were killed in the clash (one from a shooting, one from being hit in the head with a fire extinguisher, and the others from a stroke, heart attack, and other medical emergency). These events clearly illustrate the need for further planning and preparedness for mass violence if political protests take a turn for the worse.

1.4.3 Mass Shootings

Mass shootings are one example of civil/conflict hazards. Because of constitutional rights, people have armed themselves with weapons in the United States. Unfortunately, a small portion of these individuals have shot others due to disagreements or for unknown reasons. It appears that these events have sadly become more common over the past two decades. Shootings at schools occurred frequently in the late 1990s in Pearl, MS; Paducah, KN; Jonesborough, AR; Springfield, OR.; Conyers, GA; Atlanta, GA and Pelham, AL. Other events have been especially devastating:

- On April 20, 1999, two disgruntled students entered Columbine High School in Jefferson County, Colorado. Besides placing and detonating several bombs in and around this educational facility, the students fired into the crowded cafeteria and library areas. By the time the perpetrators committed suicide, 12 students and 1 teacher were killed, and 24 others were injured. The incident prompted a national review of how to respond to mass shootings, and the lessons gleaned have had a major impact on law enforcement policies and procedures.
- On September 15, 1999, a gunman walked into youth rally and discharged to weapons into the congregation at a church in Fort Worth, Texas. Seven people were killed. Numerous others were injured and had to be quickly taken to area hospitals.
- In October of 2002, there were several sniper shootings that occurred over a period of several weeks at numerous locations in Maryland, Virginia, and Washington, DC. One man and one minor were responsible for killing 10 people and injuring 3 others. These serial murderers prompted a massive investigation and illustrated the difficulty of capturing those involved in such episodes of violence.
- On July 20, 2012, a mass shooting occurred inside a movie theater in Aurora, Colorado. A gunman used multiple weapons of weapons to attack his victims, ultimately killing 12 people and wounding over 50 others.
- On December 14, 2012, a horrific school shooting took place in Connecticut at Sandy Hook Elementary. Twenty children and six adults were murdered by a 20-year-old gunman. Those that survived the mass shooting and some emergency personnel that rushed to the scene to help have had an extremely difficult time coping with this traumatic event.

- On September 16, 2013, a man who was discharged from the military entered a Washington Navy Yard. He opened fire, killing 12 and injuring several others.
- On February 14, 2018, a lone gunman used a semi-automatic rifle to shoot numerous people at the Majory Stoneman Douglas High School in Parkland, Florida. This event became the deadliest school shooting in U.S. history and promoted many reforms in gun laws in this state and elsewhere across America.
- One December 29, 2019, a man pulled out a shotgun in a church in White Settlement, Texas. The man shot and killed two individuals and would have likely killed others, but he was taken out by two volunteer members of the church's security team who returned fire with their own weapons. The Texas Department of Public Safety described their quick actions as "heroic."

Each of these events has prompted additional discussion about mental health and gun control issues. They have also created a need for better prepared police officers and emergency medical technicians. Mass shootings illustrate that emergency managers must not overlook the potential impact of deranged individuals who take pleasure in inflicting mass death upon others.

For Example

Las Vegas Shooting

During October 1, 2017, Stephen Paddock opened fire from the 32nd floor of the Mandalay Bay Hotel onto the crowd below that was enjoying the Route 91 Harvest Music Festival. The 64-year-old man used multiple rifles to shoot over 1,000 rounds of ammunition. Sixty people died and 411 were wounded from this mass shooting, and scores of others were injured as they tried to escape and protect their life. This event is the deadliest mass shooting in the United States, and it prompted the ban of "bump stocks" which produce rapid fire almost equivalent to automatic weapons. Paddock's motive remains unknown to this day.

1.4.4 Terrorism

Terrorism has been one of the most-deadly civil/conflict hazards throughout history, and it has become even more pronounced over the past few decades. **Terrorism** is the threat or use of violence to intimidate someone or a government. The perpetrators usually have ideological motives and a political objective to achieve. For instance, terrorists engage in threatening and violent behavior to seek independence, promote their religion, protest abortions, or protect the environment. Terrorists have used guns, arson, bombings, and other measures to kill and disrupt the activities of others. Their attacks have occurred around the world and often target busses, trains or other highly populated areas. Suicide bombings are common in the Middle East, particularly in Israel. Other major attacks with bombings have occurred in Spain, Germany, Russia, the United Kingdom, Iraq, Afghanistan, and Kenya.

Several terrorist attacks have directly affected the United States and were perpetrated by American citizens. For instance, Eric Rudolph planted bombs at the Centennial Olympic Park in Atlanta on July 27, 1996. The blast killed 1 person but injured more than 100 others. Timothy McVeigh bombed the Alfred P. Murrah Building in Oklahoma City in 1995. His attack killed 168 people, which included many children at a daycare in the building.

Other terrorist events have been perpetrated by foreign and/or religious extremists. In 1993, the World Trade Center in New York City was attacked with a bomb placed in a van in an underground parking lot. During the 2013 Boston Marathon, two brothers used

homemade bombs made out of pressure cookers to cause mayhem, death, and injuries near the finish line of the race. On December 2, 2015, a married couple entered the Inland Regional Center in San Bernardino, California, during a combined County Public Health Training event and Christmas party. They shot and killed 14 people and injured 22 others. About 4 hours later, police confronted the perpetrators and they were killed in a shootout. On June 12, 2016, Omar Mateen killed 49 people and injured over 50 others in a mass shooting at the Pulse nightclub in Orlando, Florida.

Of course, the worst case of terrorism in the United States was on September 11, 2001. Islamic extremists hijacked four planes and used them as missiles against buildings symbolic of U.S. political, military, and economic interests. The World Trade Centers were the main targets of the planes. The towers collapsed after the ignited jet fuel weakened the structure. Thousands of people died and several buildings in New York were turned into a pile of broken glass, twisted metal, and other dangerous and unhealthy debris. The Pentagon was also struck during the attack, but fewer people died in this building than in the World Trade Centers in New York. One plane was also intentionally crashed in Pennsylvania, and it is assumed that this aircraft was headed to the White House or Capitol Hill.

Criminals and terrorists increasingly seek novel ways to attack their enemies, including through the use of weapons of mass destruction (e.g., nerve, blister, blood, and choking and incapacitating agents). A significant terrorist attack in 1995 involved the use of sarin gas by the Aum Shinrikyo cult in Japan. This event, which occurred in a subway, resulted in the death of several people. It also created massive medical care needs—whether real or imagined—for thousands of others. The use of Sarin gas illustrated the grave potential of biological, chemical and nuclear weapons. Sadly, others have followed suit. Shortly after 9/11, envelopes containing anthrax were sent via mail to the headquarters of a newspaper in Florida and to Congressional leaders in Washington, DC. This attack disabled the postal service for days and killed a handful of people. In April 2013, a woman from East Texas sent an envelope containing ricin to President Obama. The individuals involved in these incidents were identified. The first person committed suicide and the other has been imprisoned for her actions.

Not all future terrorist attacks will involve weapons of mass destruction. Recently, some far-right groups and white supremacy organizations tried to kidnap the Governor of Michigan and they have driven vehicles into peaceful protestors. Many of their plans have been foiled, but the FBI is concerned about terrorist attacks emanating from these and other extremists in the future. Regardless of the cause, the rising threat of terrorism has prompted a significant reorganization of the U.S. government and the establishment of the Department of Homeland Security. Billions of dollars have been poured into first responder training and public health preparedness measures as a result.

For Example

Manchester Bombing

In June 1996, terrorists parked a vehicle near a major intersection in the commercial district of Manchester, England. A local television station received word that an explosive would be detonated. A bomb squad was brought in, but team was not able to dismantle the explosives. However, the city was able to evacuate 80,000 people from the area. No one died in the attack, but it did injure over 200 people who were cut by glass, impaled by objects or otherwise affected by the blast. Several buildings were damaged or destroyed, and many businesses and apartment dwellers lost office space or residences. This intentional disaster cost millions of dollars in direct and indirect losses. It prompted a major emergency response and criminal investigation.

1.4.5 War

Conflict has occurred throughout history between different tribes, ethnic groups, and nation-states. Millions of people have been killed due to serious disagreements when negotiations break down and violence ensues. With the advent of modern weaponry, however, the stakes of fighting have become much higher. For instance, entire cities have been leveled. Such was the case in World War II when London, Dresden, Hiroshima, and Nagasaki were bombed with conventional or nuclear explosives. Shortly thereafter and during the Cold War, the fear of a nuclear attack from the Soviet Union prompted the United States to invest heavily in civil defense initiatives. The goal was to prepare for such an attack, stockpile supplies, and evacuate and shelter citizens if required.

Perhaps there are fewer world wars today as compared to the past, but notable exceptions exist. There has been a great deal of intrastate fighting as in places such as Somalia, Yugoslavia, Rwanda, Libya and Syria. These internal civil wars are known as "complex emergencies." They typically involve ethnic cleansing, a failed government, and economic turmoil that are sometimes combined with natural and environmental disasters and especially famines. Those responding to such events have been targeted by the warring factions. For example, relief workers in Iraq have been kidnapped and killed by the belligerent parties.

The 9/11 terrorist attacks caused the United States to intervene in Iraq to depose Saddam Hussein. It also pushed back the Taliban in Afghanistan. While these conflicts were protracted, there is a potential for even greater conflict in the Middle East due to ongoing tensions between Israel and its enemies (particularly Iran). And, there is also fear the United States will experience inter-state conflicts with North Korea, China and Russia in the future. Tensions have been mounting and it is unknown if and when something might trigger hostilities.

Self-Check

- What is a civil/conflict hazard?
- What are the types of civil/conflict hazards?
- What is the role of humans in civil/conflict hazards?
- How is each type of civil/conflict hazard related to the other? Are they different? If so, how?

1.5 The Complexity of Disasters

Although it is useful to classify hazards in order to understand their unique features, it is important for you to recognize that hazards are not mutually exclusive. In other words, each hazard may interact with others in convoluted and perhaps even unpredictable ways. The examples are numerous:

- An earthquake may break a dam, cause a building collapse, and produce landslides. It may also a **Natech disaster** which results from a combination of natural and technological hazards).
- Degradation of the environment (e.g., deforestation) could exacerbate flash flooding and create mudslides that are typically only related to severe storms.
- Flooding could lead to the spread of certain communicable diseases.
- A train derailment could result in the spill of dangerous chemicals and harm the natural habitat and pose danger to nearby populations.
- Those participating in mass shooting and riots may trigger panic flight behavior.
- Terrorism may have a significant negative impact on critical infrastructure, public health and psychological well-being.

These are not hypothetical situations. Compound disasters occur more frequently than people think. For instance, on February 7, 2021, a glacier broke off a Himalayan mountain near Uttarakhand in Northern India. The massive displacement of ice, rock, and water broke a dam and flooded the Rishiganga, Dhauliganga and Alaknada Rivers. The water rushed downstream and subsequently damaged two other hydroelectric projects, as well as a number of roads and bridges. Several villages were impacted, and at least 36 people died and more than 200 were categorized as missing.

In addition, human vulnerability will complicate and exacerbate the impact of hazards/triggering agents. Studies reveal that disasters are not caused by a "single factor;" instead they are often the result of "accumulation of complex chains" of actions and events (Aini 2005, 56). For instance, warnings may not be heeded due to language barriers or cultural misunderstandings. Poverty may limit people's options for evacuation and sheltering. A lack of preparedness may complicate emergency actions to save lives and treat the injured. Health disparities may exacerbate the spread of disease among vulnerable populations. Insufficient training may slow down damage assessment activities. Conflict over recovery policies may halt rebuilding efforts for an extended period of time. The diverse ways vulnerability interacts with hazards are almost limitless. The complexity of disasters is not always understood or appreciated.

The major point to consider from this section is that a single hazard is not the only thing you need to be concerned about as an emergency manager. You must appreciate the complex interaction of multiple hazards and diverse vulnerabilities as these relationships can have serious impacts upon response and recovery operations. In most cases, you will be responding to multiple hazards and vulnerabilities in any given disaster. This creates serious challenges that you must be ready to deal with at a moment's notice.

For Example

Hurricane Katrina was a Complex Disaster

Hurricane Katrina will long be remembered as a complex disaster. In September 2005, Hurricane Katrina—a category four storm—slammed into the coastal areas of Louisiana, Mississippi, and Alabama. Each of these states suffered severe losses. However, it was New Orleans that gained national and international attention. The winds of the hurricane damaged structures in the "Big Easy" and affected power and phone service. Nevertheless, it was the storm surge and heavy rains that were most problematic. Lake Pontchartrain rose to historic levels and the levees set up to keep the waters from inundating the below-sea-level community were breached. New Orleans was flooded. Water, sewer, and gas lines were broken. The contents of numerous petroleum and hazardous chemical tanks were released. Homes and businesses were under water. Making matters worse, some antisocial behaviors including looting and violent conflict were reported around the city. The local, state, and federal response was slow and inadequate. The reaction was also hampered further when criminals began firing weapons at rescue helicopters and relief workers. Many evacuees sought shelter in the superdome where supplies were inadequate, and conditions quickly became filthy. Disaster victims were becoming increasingly concerned about the conditions prior to the arrival of federal aid arrived at the superdome. The delivery of assistance was delayed because flooding severely affected the transportation system. Public health workers feared an outbreak of disease due to the squalid living conditions and requested an evacuation of the city. However, the required exodus was complicated by poor planning before the hurricane and insufficient communication during response and recovery operations (Figure 1-8). Katrina therefore involved natural, environmental, biological, technological, and civil hazards. And, the consequences are Hurricane Katrina are still being felt to this day.

1.5.1 The Impact of Disasters

As mentioned earlier, when a hazard or multiple hazards interact with humans and the vulnerability they create, disasters occur. The consequences may be staggering. People may be injured or killed as a result of these destructive events, and the impact is often significant. From 2001 to 2012, natural disasters killed 1.9 million people worldwide and affected another 2.9 billion (UNISDR, 2013). Deaths have also been significant in the United States. For instance, an admittedly dated study "estimated that natural hazards killed over 24,000 people between January 1, 1975 and December 31, 1994" (Mileti, 1999, p. 66). These statistics were collected from fires, flooding or other hazards, and these numbers do not include the toll of disease outbreaks, which are also substantial. The number of injuries from disasters should not be overlooked either, as it averages about 100 per week in the United States (Mileti, 1999, p. 66). Such injuries may include superficial cuts from flying glass in a tornado or serious internal wounds due to the collapse of a building after an earthquake.

Property is likewise damaged or destroyed in disasters, costing billions of dollars each year. Homes and belongings are decimated by landslides, fishing vessels are sunk in hurricanes, and businesses are flattened by strong winds. Furniture, clothing, televisions and cars are ruined in disasters. Losses average about $1 billion per week in the United States, and these figures are rising exponentially each decade (Mileti, 1999, p. 66). Hazardous materials spills, nuclear accidents, and other events can likewise degrade the natural environment, thereby affecting the health and well-being of people beyond the current generation.

Disasters also disrupt individuals and society as a whole. Routine activities such as cooking, sleeping, and bathing may be hindered due to the damages of one's appliances, bed, or home. Jobs are also lost, business transactions are prohibited, and traffic is snarled when hazards impact corporations and transportation systems. Disasters are also accompanied by building collapses, road closures, and downed power and phone lines. The infrastructure is

Figure 1-8 This picture of boats impacting infrastructure illustrates why Hurricane Katrina was one of the most complex disasters to in U.S. history. Robert Kaufmann/FEMA. http://www.fema.gov/media-library/assets/images/47341

often severely impacted. Simple tasks such as mailing a letter or having your trash hauled away cannot be performed because the government is also adversely affected by the event(s). Disasters, including terrorist attacks, cause economic decline and can sometimes jeopardize mental health. Disasters of all types have even led to political turmoil at times and have changed the direction of policy in the United States (e.g., the creation of the Department of Homeland Security after 9/11). There is no doubt that disasters have a bearing upon taxes, insurance rates, and many other aspects of our lives.

For Example

Disasters and Community Lifelines

FEMA created the "Community Lifelines" concept in order to better comprehend the consequences of disasters and improve communication of those impacts to the public and all pertinent parties involved in emergency management. Community Lifelines are fundamental services that are required to maintain routine operations in society. The lifelines that can be severely disrupted in disasters may include: 1. Safety and Security (including fire service, search and rescue, government service, and community safety); 2. Food, Water, and Shelter (including agriculture); 3. Health and Medical (including medical care, public health, patient movement, medical supply chain, fatality management); 4. Energy (including power grid and fuel); 5. Communications (including infrastructure, responder communications, alert warnings and messages, finance, 911, and dispatch); 6. Transportation (including highway/roadway/motor vehicle, mass transit, railway, aviation, and maritime); and 7. Hazardous materials (including facilities, HAZMAT, pollutants, and contaminants). The Community Lifelines concept was tested in many disasters since 2018, and it is now formalized in the 4th edition of the National Respond Framework (see Chapter 11).

1.5.2 Changes Associated with Disasters

Because of the impacts that become apparent during the immediate emergency period of a disaster, several significant changes may occur, and these could complicate the job of an emergency manager. Tom Drabek, a very well-known disaster sociologist, has summarized six of them that have been identified in the literature (1986, 46-47). These include:

1) **Uncertainty**. In the immediate aftermath of disaster, there is a lack of information about what has happened, why it occurred, the number of injured or dead, the extent of the devastation, and what should be done to deal with these problems.
2) **Urgency**. As the situation becomes clear and as needs arise, most leaders and citizens desire to act quickly to issue warnings, treat injuries and clear roads of debris among other things.
3) **Emergency consensus**. Individuals, groups, businesses, government departments, and political leaders agree that major problems have to be addressed and generally work together to overcome them (at least in the immediate aftermath of a disaster).
4) **Expansion of citizen role**. People are not only more willing to cooperate in a disaster, but they are also likely to be involved in searching for neighbors trapped under debris, transporting the wounded to hospitals, and providing relief supplies to victims through donations to charitable organizations.

5) **De-emphasis of contractual relationships**. Because victims' needs must be met as soon as possible, written agreements are not relied upon. Verbal arrangements are made instead. Accounts and debts are settled when the situation calms down. It is also likely that supplies will be donated with no thought of reimbursement.
6) **Convergence**. People and material resources will flow to the scene of a disaster. This may include evacuees returning to the location and those wanting information about victims. It may also include volunteers, reporters, researchers, people wanting to take advantage of the situation, groups cheering on the emergency workers, and others mourning those who have died in the event (Kendra and Wachtendorf, 2003).

The above changes can have a dramatic impact on those involved in the management of disasters. Decision making becomes difficult and post-disaster operations are stressful. Poor communications in disasters complicate the sharing of information. Many agencies and volunteers help to get things done quickly, but the arrival of too many organizations and donations can add to the overwhelming nature of disaster. Resources may be available in a warehouse, but they may not be shipped or tracked in an ineffective manner. Later on, blame may be placed on those considered to be at fault. Disagreements might arise about recovery policies, particularly in regard to disaster assistance and rebuilding priorities. Some of the changes that take place after a disaster have positive features while others are negative. In most cases, the changes resulting from disasters will provide benefits and drawbacks for those working in emergency management and related professions. For instance, more political and financial support may be given to emergency management after a disaster. However, disasters may require long hours, night shifts and even working weekends for those involved in this important endeavor.

1.5.3 The Need for Response and Recovery Operations

Because of the significant consequences of disasters, you must be aware of the goals of response and recovery operations if you are to be an efficacious emergency manager. Such objectives include protecting lives, limiting property loss and overcoming the disruption that disasters cause. There are other priorities that must be considered as well. For instance, you must ensure care for special populations such as those in nursing homes. You must help to coordinate the efforts of all types of disaster participants, regardless if they are affiliated with the government or not. Another desire is to reduce further deterioration of the environment when a disaster occurs and rebuild with future hazards in mind. As you participate in post-disaster operations, you may rely on both predetermined organizational arrangements and technology to complete these responsibilities. In most disasters, multiple activities will require your focused attention as well as flexibility. Resources should be tracked to help cover expenses. Extreme care should be taken to avoid possible lawsuits. It will be important to record what has transpired so you can learn from your successes and shortcomings.

As can be seen, your job during response and recovery operations is extremely challenging. There are many demands that have to be addressed, and two of them have been identified by Ronald Perry (1991, p. 201):

- **Agent-generated demands** are the needs made evident by the hazard (e.g., problems resulting from the disaster agent itself). These demands appear immediately as the disaster unfolds, and some examples include sandbags to fight flooding, shelters to care for those made homeless and the restoration of electricity owing to power outages.

Figure 1-9 The damage of electricity infrastructure (an agent-generated demand) in Crystal Beach, TX, after Hurricane Ike created the need to replace power poles (a response-generated demand). Greg Henshall/FEMA. http://www.fema.gov/media-library/assets/images/54764

- **Response-generated demands** are the needs that are made evident as individuals, organizations, and communities attempt to meet agent-generated demands. They are visible as people and agencies try to deal with the impact of flooding, earthquakes, and other hazards.

Acquiring sandbags, finding suitable shelter sites, and obtaining portable generators or electricians are examples of response-generated demands. Response-generated demands thus deal with the logistical issues pertaining to the reaction of people and organizations to agent-generated demands (Figure 1-9).

In addition to these demands, the author would add a few other expectations placed upon you after a disaster:

- **Normalcy-generated demands** are the pressures to quickly get things back to pre-disaster conditions. Returning people to their homes and restarting business activity are types of normalcy-generated demands.
- **Mitigation-generated demands** are the desires to prevent a recurrence of the disaster. Creating more stringent building codes and relocating residences to less-hazardous areas are examples of mitigation-generated demands.
- **Preparedness-generated demands** are expectations that the mistakes made evident in response and recovery operations will not be repeated in the future. Improvements in planning, training, exercises, and the allocation of additional resources fall into this category.

All of these disaster-related demands create priority problems for emergency managers. Normalcy-generated demands sometimes run in opposition to the mitigation and preparedness-generated demands. As an example, people wish to return to their homes even when it would be best to remove them permanently from the floodplain. Government officials may also desire to give attention to rebuilding schools rather than invest in emergency management personnel or planning activities. Too much attention on preparedness could limit necessary actions related to mitigation. In spite of these conflicts and challenges, you must take advantage of the increased public concern disasters provide to promote change during response and recovery. All of these immediate objectives and long-term functional activities should be directed toward the goals of disaster resilience. **Resilience** may be described as the ability to react effectively and efficiently in time of disaster. It is the overarching goal of the remainder of this book.

Self-Check

- Do hazards interact with each other?
- What do we call hazards that occur in conjunction with other hazards?
- How are disasters different from hazards?
- What changes occur in society after a disaster?
- Why are response and recovery operations needed?
- What demands do emergency managers face after a disaster?

SUMMARY

As an emergency manager, you should be aware of important concepts such as hazards, vulnerability, disasters, emergency management, response, recovery and resilience. You must understand what types of hazards may occur including their natural, technological, and civil/conflict variants. It is also imperative that you comprehend how hazards interact with each other and vulnerability as well as how a myriad of variables may determine the impact of disasters. Successful emergency managers should know what changes to expect when a disaster occurs. They must effectively meet the demands that confront them and deal with the aftermath of a disaster in a proactive but adaptable manner.

KEY TERMS

Agent-generated demands	The needs made evident by the hazard (e.g., problems resulting from the disaster agent itself).
Atmospheric hazards	A hazard agent that is produced in or by the earth's atmosphere.
Biological hazards	Agents that spread disease or are otherwise harmful to life.
Civil/conflict hazards	Hazards resulting from panic flight, riots, mass shootings, terrorism and war.
Compound hazards	Multiple hazards that react to each other in chaotic fashion.
Disasters	Deadly, destructive, and disruptive events that occur when a hazard (or multiple hazards) interacts with human vulnerability.

Emergency management	From an academic standpoint, "the study of how humans and their institutions deal with hazards, vulnerabilities and the events that result from their interaction." From a practical perspective, "the managerial function charged with creating the framework within which communities reduce vulnerability to hazards and cope with disasters."
Emergency managers	Public servants that help jurisdictions reduce the liabilities that lead to disasters. They also help built community disaster capabilities.
Enhanced Fujita Scale	A scale used to categorize the size of a tornado, including the affiliated wind speed.
Environmental hazards	Agents that involve the degradation of the environment, such as pollution, that pose a risk to people's health and well-being.
First responders	Public safety personnel such as police officers, fire-fighters and emergency medical technicians.
Geologic hazards	Hazard agents associated with the earth's soil and rock.
Hazard	A physical, technological, or intentional agent such as an earthquake, industrial explosion, or terrorist bombing.
Heat index	Incorporates both temperature and humidity into a scale to help warn people to stay inside and drink lots of water.
Homeland security	"A concerted national effort to prevent terrorist attacks within the United States, reduce America's vulnerability to terrorism, and recover from and minimize the damage of attacks that do occur."
Hydrologic hazards	Hazard agents that occur with the earth's water systems.
Industrial hazards	Hazards produced by the extraction, creation, distribution, storage, use, and disposal of chemicals.
Mercalli scale	A scale used to describe the physical observation of damages that result from the movement of the earth's crust (e.g., broken windows, cracked walls, falling pictures, etc.)
Mitigation	Risk reduction, loss minimization, or the alleviation of potential negative impacts associated with disasters.
Mitigation-generated demands	The desire to learn from the disaster and avoid making similar mistakes in the future.
Na-tech hazards	A combination of natural–technological hazards.
Natural hazards	Those events originating from the physical environment, typically because of radiation from the sun, heat flow within the earth, or the force of gravity.
Normalcy-generated demands	The pressures to get things back to pre-disaster conditions.
Nuclear hazards	A hazard resulting from the presence of radioactive material.

Pathogens	Organisms that spread disease which may include anthrax, smallpox, plague, hemorrhagic fever, and rickettsia.
Preparedness	Efforts to increase readiness for disaster response and recovery operations.
Preparedness-generated demands	Expectations that the mistakes made evident in response and recovery will not be repeated in the future. Improvements in planning and the allocation of additional resources fall into this category.
Prevention	Refers to actions to stop the occurrence of terrorist attacks and includes the gathering of intelligence, counterterrorism operations, and border control functions.
Protection	Refers to actions that discourage attacks through increased security measures or effor to minimize damage if such attacks cannot be prevented in the first place. The reliance on guards, fences, video surveillance, and access control falls into this category.
Recovery	Activity to return the affected community to pre-disaster or, preferably, improved conditions.
Richter scale	A measurement of the registered shaking amplitudes of an earthquake.
Resilience	The ability to react effectively and efficiently in time of disaster.
Response	Activity in the immediate aftermath of a disaster to protect life and property.
Response-generated demands	The needs that are made evident as individuals, organizations, and communities attempt to meet agent-generated demands.
Riots	Large disturbances where people engage in antisocial behavior.
Saffir–Simpson scale	A descriptive tool to explain the magnitude of a hurricane in terms of wind and storm surge.
Seismic hazards	Hazard agents produced by the movement of tectonic plates that float on magma.
straight-line winds	strong winds that travel down to the ground and then move horizontally along the earth's surface.
Structural collapse hazards	Hazards that occur when gravity and poor engineering result in the failure of buildings, roads, or other construction projects.
Technological hazards	Hazard agents related to industry, structures, hazardous materials, computers, and transportation systems.
Terrorism	The threat or use of violence to intimidate someone or a government.
Toxins	Poisons created by plants and animals.

Transportation hazards	An accident that occurs in the air, on roads or railways, or at sea.
Vulnerability	Proneness to disasters or the inability of individuals, organizations, and communities to prevent them or deal with them effectively.
Wildfire hazards	Hazards that result from lightning strikes, which can quickly envelop hundreds of acres of forest and brush.

ASSESS YOUR UNDERSTANDING

Posttest to evaluate your knowledge on hazards and disasters.
Measure your learning by comparing pretest and posttest results.

Summary Questions

1. A crisis is a much bigger problem than a catastrophe. True or false?
2. A disaster occurs when a hazard interacts with human vulnerability. True or false?
3. Emergency management is a profession that attempts to reduce the probability of disasters and prepare a community to respond and recover effectively if they cannot be prevented. True or false?
4. There is no relation or overlap between response and recovery operations. True or false?
5. Hurricanes may damage homes and other structures, but they do not impact animals on farms. True or false?
6. The straight-line winds that damaged crops in the Midwest was known as the "Derecho" storm. True or false?
7. An earthquake is an example of a geological hazard. True or false?
8. The "Camp Fire" illustrated problems associated with inadequate warnings. True or false?
9. Mass shootings and riots are civil/conflict hazards. True or false?
10. Disasters are not characterized by the disruption they cause to people's daily, routine activities. True or false?
11. "Community lifelines" are fundamental services in society that could be negatively affected by disasters. True or false?

12 A normalcy-generated demand is a desire to prevent the recurrence of a disaster. True or false?

13 Resilience is concerned about the effectiveness of emergency management, but not the efficiency of response and recovery operations. True or false?

14 A disaster is:
- **(a)** Smaller than an accident
- **(b)** Smaller than a crisis
- **(c)** Larger than an emergency
- **(d)** Larger than a calamity
- **(e)** Larger than a catastrophe

15 Tornadoes may be classified as:
- **(a)** An atmospheric hazard
- **(b)** A hydrologic hazard
- **(c)** A biological hazard
- **(d)** A civil/conflict hazard
- **(e)** A geologic hazard

16 A chemical release is an example of:
- **(a)** A natural or atmospheric hazard
- **(b)** A technological hazard
- **(c)** A civil/conflict hazard
- **(d)** All of the above
- **(e)** None of the above

17 The riots in 2020 and 2021 would fall under which category of hazard?
- **(a)** A social hazard
- **(b)** A civil/conflict hazard
- **(c)** An environmental hazard
- **(d)** A technological hazard
- **(e)** None of the above

18 Disasters are complex because:
- **(a)** One hazard may trigger another hazard.
- **(b)** A hazard interacts with human vulnerability.
- **(c)** Low preparedness levels may exacerbate impact.
- **(d)** Answers a and b.
- **(e)** Answers a, b, and c.

19 Uncertainty:
- **(a)** Is defined as an urgent situation.
- **(b)** Results from an expansion of the citizen role.
- **(c)** Is associated with a lack of information.
- **(d)** Is equated to a de-emphasis of contractual relationships.
- **(e)** Answers a and b.

Review Questions

1. Explain the difference between an accident and a catastrophe.
2. Define the term disaster and note its relation to hazards and vulnerability.
3. What is an emergency manager and what does he or she do?
4. What are the four phases or functional areas of emergency management? How do these relate to homeland security?
5. List the major categories of hazards.
6. Provide one or two examples of hazards under each category identified in question 5.
7. Explain why Covid-19 could be considered a complex disaster.
8. What are the major changes an emergency manager can expect after a disaster?
9. What are the goals of disaster response and recovery?
10. What is an agent-generated demand?
11. What is a response-generated demand?
12. What is a normalcy-generated demand?
13. What is a mitigation-generated demand?
14. What is a preparedness-generated demand?
15. What is resilience?

Applying This Chapter

1) After responding to a major apartment fire in Boise, Idaho, you become aware of the fact that a sprinkler system would have prevented much of the damage. How can you link recovery activities to the goals of mitigation?
2) Suppose you are expecting the arrival of a hurricane in Charleston, South Carolina. What hazards might be present along the coast, and how would they interact with each other? Give two examples.
3) A terrorist has just blown up a courthouse in Seattle, Washington. What changes might occur when this takes place? What can you as an emergency manager do to effectively deal with the unique challenges associated with such a disaster?
4) The mayor and city manager in Birmingham, Alabama, are questioning you about the value of your position in the government. Explain what types of disasters could occur in your city and justify the need for response and recovery operations.

5) A flood has destroyed many homes and businesses in Greenville, Mississippi. How can you help your community recovery from disaster while also promoting the necessary changes to prevent a recurrence in the future?
6) As an emergency manager, you are frequently invited to speak to various organizations in your community. While discussing the goals of response and recovery to a group of Boy Scouts, one of those in attendance asks, "What is resilience?" How would you define it to the young man and explain why it is necessary to pursue after disaster strikes?

YOU TRY IT

How Can I Get Information About Hazards?

Answer the following questions by providing a list of organizations and their contact information: If you wanted information about hurricanes, who could you contact? If you desire details about the impacts of earthquakes, who could assist you? If you need to learn more about volcanic hazards, what government agency could assist you? If you sought to understand tornadoes better, who could answer your questions? What if you required a better comprehension of hazardous materials incidents? Who could provide such information? What about terrorism? Who could help you understand terrorist behavior more fully or accurately?

What Would I Do?

Suppose your community was affected by a tornado. What are the possible consequences of this hazard if it interacts with human vulnerability? What would you need to do to respond? What considerations should be taken into account for recovery?

The Interaction of Hazards

You are the emergency manager for New Orleans. Hurricane Katrina has just struck your community. What are the hazards? Are the hazards related? If so, how? What are the implications of compound or natech hazards?

Disasters and Change

Disasters result in a great deal of change. What are some of the changes you can expect? Are these good or bad? How would they impact your job as an emergency manager? Why is it important to be aware of them?

Meeting Demands

What are agent-generated demands, response-generated demands, normalcy-generated demands, mitigation-generated demands, and preparedness-generated demands? Make a list of the demands placed on you and categorize them. How do these impact your job as an emergency manager? Do they present difficulties for you? How could you overcome them?

References

Aini MS, Fakhru'l-Razi A, Daud M, Adam NM, Abdul Kadir R. (2005) Analysis of royal inquiry Report on the collapse of a building in Kuala Lumpur: Implications for developing countries. *Disaster Prev Manag*, 14 (1):55–79.

Blanchard Wayne B, Canton LG, Cwiak CL, Goss KC, McEntire DA, Newsom L, Selves MD, Sorchik EA, Stenson K, Turner III JE, Waugh Jr WL, West D. (2007) *Principles of Emergency Management Supplement*. Emmitsburg: Federal Emergency Management Agency. Available at http://training.fema.gov/EMIWeb/edu/emprinciples.asp. Accessed June 18, 2014.

Drabek TE. (1986) *Human system responses to disaster: An inventory of sociological findings*. Springer: New York.

Godschalk DR. (1991) Disaster mitigation and hazard management. In: Hoetmer GJ, Drabek TE, editors. *Emergency Management: Principles and Practice for Local Government*. Washington, DC: ICMA.

Jensen J. (2013, August 15) Report of the 2013 disciplinary purview focus group: scholarship and research to ground the emerging discipline of emergency management. Available at http:// www.ndsu. edu/fileadmin/emgt/Jensen_-013_REPORT_DISCPLINE_ISSUES_ WHITE_ PAPER_FOCUS_GROUP 2_.pdf. Accessed June 27, 2014.

Kendra JM, Wachtendorf T. (2003) Reconsidering convergence and converger legitimacy in response to the World Trade Center disaster. In: Clarke L, editor. *Terrorism and Disaster: New Threats, New Ideas*. Research in Social Problems and Public Policy 11. New York: Elsevier. p 97–122.

McEntire DA. (2005) Revisiting the definition of 'Hazard' and the importance of reducing vulnerability. *J Emerg Manag*, 3 (4):9–11.

Mileti DS. (1999) *Disasters by Design: A Reassessment of Natural Hazards in the United States*. Washington, DC: Joseph Henry Press.

Ministry of the Interior. (2011) *Red Sludge: Hungary 2010*. Budapest: Ministry of the Interior.

Neal DM. (1997) Reconsidering the phases of disaster. *Int J Mass Emerg Disasters*, 15 (2):239–264.

Office of Homeland Security. (2002) *National Strategy for Homeland Security*. Washington, DC: Office of Homeland Security.

Perry RW. (1991) Managing disaster response operations. In: Drabek TE, Hoetmer GJ, editors. *Emergency Management: Principles and Practice for Local Government*. Washington, DC: ICMA. p 201–223.

Phillips BD, Neal DM, Webb GR. (2017) *Introduction to Emergency Management*. Second Edition. Boca Raton: CRC Press.

Quarantelli EL. (2006) Catastrophes are different than disasters: some implications or planning and management drawn from Hurricane Katrina. In: *Understanding Katrina Perspectives from the Social Sciences*. New York: Social Science Research Council.

UNISDR. (2013) Global assessment report on disaster risk reduction. Available at http://www. preventionweb.net/english/hyogo/gar/ 2013/en/home/index.html. Accessed on June 18, 2014.