Chapter 2

# Hazards, Vulnerability, and Disaster Risk

## *Chapter Objectives*

- Analyze hazards, vulnerabilities, and risks.
- Understand hydrologic, geophysical, biological, and technological hazards.
- Identify causes and effects of different types of hazards, including floods, earthquakes, tsunamis, hurricanes, tornados, and wildfires.
- Understand and contrast physical, structural, and social vulnerabilities.
- Discuss how community hazards and vulnerability analyses are conducted and identify emergency management interventions.

## Introduction

This chapter describes the principal environmental, technological, and human-made hazards that are of greatest concern to emergency managers in communities throughout the United States and Europe. Each of these hazards is described in terms of the physical processes that generate it, the geographical areas that are most commonly at risk, the types of impacts and typical magnitude of hazard events, and hazard-specific issues of emergency response. The chapter also describes how pre-impact conditions act together with event-specific conditions to produce a disaster's physical and social consequences, which ideally can be mitigated by emergency management interventions. In addition, this chapter discusses how emergency managers can assess the pre-impact conditions that produce disaster vulnerabilities within their communities, before concluding with a discussion of vulnerability dynamics and methods for disseminating hazard/vulnerability information.

# Hazards

Hazards are potentially damaging physical events, phenomena, or human activities that cause loss of life, injury, property damage, social and economic disruption, or environmental degradation (Makoka & Kaplan, 2005). They are external factors that affect the society or elements at risk, whereas vulnerabilities are the internal factors that affect the transformation of hazards into disasters. In other words, vulnerabilities determine a hazard's impact on the society or element at risk (Birkman, 2007; Lauire, 2003). Although communities might experience any of numerous hazards, it is important for a region to be aware of those threats that are most likely to affect the community most severely. Ordinarily, a differentiation will be made between "natural" and "human-made" hazards. Hazards that fall within the natural classification are those that occur as part of our environment; human-made hazards are those that arise directly from human activity.

The term "natural disaster" is widely described by scholars as a misnomer, as it can confuse perceptions and divert courses of action (Alexander, 1997; Apthorpe, 1998). This potential is due to the necessity to discriminate between a hazard and a disaster; whereas a hazard can be an environmental event, a disaster is the culmination of a hazard and the existing human vulnerabilities. Thus the categorization here refers explicitly to natural hazards rather than disasters to avoid conflicting understandings.

Natural hazards—floods, earthquakes, tsunamis, volcanic hazards, hurricanes, tornados, and wildfires—can have varying levels of predictability that some human-made disasters lack. For example, modern technology has allowed us to know when hurricanes have formed in the open ocean and the general direction in which these hurricanes are heading. Although predicting these paths can be difficult, residents can nevertheless be alerted ahead of time to start preparations. Furthermore, other naturally occurring phenomena such as floods and volcanic eruptions can be anticipated on some level. In contrast, just like many terrorist incidents, natural hazards can strike with very little or no warning. Examples include earthquakes, tornados, and flash floods.

Natural hazards are impossible to prevent. Human control over the occurrence of natural events is very limited, necessitating a focus on the mitigation, preparedness, response, and recovery actions for natural hazards rather than prevention. Prevention is possible for human-made hazards, as they include an inherent human factor. Technological threats are not as frequent as natural ones, but it is still vitally important that communities be prepared for them. Even though these threats come to fruition less frequently, they often result in higher casualties and greater fallout due to the high danger to individuals' lives that they pose (Bullock, Haddow, Coppola, Ergin, Westerman, & Yeletaysi, 2006; Lauire, 2003).

Finally, human-made disasters, in general, can be categorized as either technological or sociological. Technological disasters are the results of failure of technology, such as engineering or structural failures, transport disasters, nuclear accidents, or environmental disasters. Sociological disasters have a strong human motive, such as workforce violence, criminal acts, stampedes, riots, and war (Alexander, 1997, 2002; Waugh, 2000).

# Principal Hazards in the United States and Europe

Hazards vary in every region in the world, depending on geographical characteristics. Due to the vast areas they cover, the diversity in their climates, and political issues, the United States and Europe are subject to several different types of hazards. It is vitally important for both the public sector and the private sector in all areas to be aware of the kinds of threats that are most common in their geographic region and to prepare for the occurrence of such hazards. This awareness allows a community to be fully engaged and educated as to how its members might be affected by an emergency. Otherwise, the human, physical, and financial capital of emergency management authorities may prove inadequate for effective emergency management. This section highlights the predominant hazards that threaten the United States and Europe.

## Earthquakes

Earthquakes are inevitable, unstoppable, and unpredictable geophysical natural events that occur on the earth's surface. They have devastating effects and cause remarkable impact on the lives of people. An earthquake may inflict high costs in the form of casualties, injuries, and enormous physical damage if it occurs in close proximity to an urban area. The primary threats from an earthquake are ground shaking, surface faulting, and ground failure (Lindell, Prater, & Perry, 2007). Ground shaking can cause a building to collapse if it is not built to withstand the motion of a quake. Surface faulting is the appearance of cracks on the earth's surface, which is a relatively less dangerous and largely avoidable threat. If buildings, utilities, and other facilities are built away from fault lines, the risk associated with surface faulting will be minimized; however, it is not always possible to predict the location of a surface fault. Ground failures entail the subsidence of tracts of land due to plate movement; they can cause buildings to collapse or tilt, as well as provoke landslides. Note that an earthquake itself causes relatively low numbers of casualties, if any; rather, the environment, buildings, and other vulnerabilities exacerbate the consequences of an earthquake.

Tsunamis, landslides, dam failures, hazardous material spills, and fires are secondary hazards that can result from an earthquake. These kinds of disasters can lead to more casualties than the initial earthquakes themselves (Lindell et al., 2007). The destruction of infrastructure as a result of an earthquake can constrain the activities of first responders, whose effectiveness relies upon rapid action, as the majority of the injured people trapped under collapsed buildings will lose their lives if they do not receive aid within 24 hours.

Earthquakes affect both the United States and Europe to a significant extent. Approximately 75 million people living in 39 U.S. states are considered "at risk" from moderate to great earthquakes. In Europe, Greece, Italy, and Turkey are particularly prone to this hazard.

In 1964, the United States experienced the strongest earthquake in its history in Alaska, with 128 people losing their lives as a result of this disaster. The 9.2-magnitude quake initiated a tsunami, taking 15 and 113 lives, respectively (U.S. Geological Survey [USGS], 2009b). The deadliest earthquake, however, was in 1906 in San Francisco, California; it caused the loss of approximately 3000 lives and $524 million in property damage (USGS, 2009a). The most recent fatal earthquakes occurred in California in 1989 and 1994. In 1989, a quake in California's Santa Cruz Mountains in 1989 resulted in 63 deaths, 3757 injuries, and $6 billion in property damage (USGS, 2009c). The 1994 Northridge earthquake in California caused 60 deaths and more than 7000 injuries, left 20,000 people homeless, and cost $20 billion, making the incident the most expensive seismic disaster in U.S. history (FEMA, 2009a; Pacific Earthquake Engineering Research Center [PEER], 2005).

The European continent has records of earthquakes dating back to ancient history, and it continues to suffer their effects to this day. Most recently, in 2009 a 6.3-magnitude quake in L'Aquila, Italy, killed 308, injured 1000, and left 40,000 homeless (USGS, 2009d). The most devastating earthquake in recent years was the 1999 earthquake in Marmara, Turkey. In a country where 65% of the population lives in high-earthquake-risk areas, the Marmara earthquake was the most powerful of the 20th century, killing 17,127, injuring 43,000, and destroying 75,000 buildings (Özerdem & Jacoby, 2006). Other significant events include the earthquake in southern Italy in 1980, which produced 4689 casualties and 7700 injured persons, and that in Bucharest, Romania, in 1977, in which 1581 people were killed and 10,500 were injured (National Geophysical Data Center [NGDC], 2010).

In recent years, some countries have experienced a great deal of destruction and damage due to earthquakes. **Table 2-1** provides a snapshot of the five most destructive earthquakes in terms of fatalities from 2001 until 2011.

Table 2-1 *Five Most Destructive Earthquakes from 2000-2010*

| Year | Magnitude | Fatalities | Region |
|---|---|---|---|
| 2004 | 9.1 | 227,898 | Off west coast of northern Sumatra |
| 2010 | 7.0 | 222,570 | Haiti |
| 2008 | 7.9 | 87,587 | Eastern Sichuan, China |
| 2005 | 7.6 | 80,361 | Pakistan |
| 2003 | 6.6 | 31,000 | Southern Iran |

Credit: U.S. Geological Survey Department of the Interior/USGS

## Hurricanes

Hurricanes are some of the most dangerous, destructive, and deadly meteorological events. The most severe type of tropical storm, they occur due to a marked temperature increase on the ocean surface. Depending on the category of the hurricane (**Table 2-2**), the wind speed may range from 74 miles/hour to 150 miles/hour or more. Hurricanes are also called cyclones or typhoons in other parts of the world; specifically, Atlantic or Eastern Pacific storms are referred to as hurricanes, Western Pacific storms are called typhoons, and Southern Pacific storms are called cyclones.

A hurricane can cause secondary hazards such as tornadoes, storm surges, flooding, and local ponding (Lindell et al., 2007). Every year, on average, of 10 tropical storms occurring, 6 of them turn into hurricanes. Every three years, 5 hurricanes hit the U.S. coast (Atlantic), and 2 of these 5 hurricanes are classified in Category 3 or higher. These storms can result in millions or even billions of dollars of damage (Federal Emergency Management Agency [FEMA], 2009b). Hurricanes, which are well understood in terms of their occurrence and movement, caused relatively fewer casualties in the 20th century than in previous centuries, but the physical damage attributable to them has increased dramatically in recent decades (Lindell et al., 2007). The development of hurricane modeling and the relatively slow speed at which these storms travel also provide more opportunities for citizens and authorities to prepare for this hazard. Technology assists emergency managers in monitoring potential hurricane activity and issuing warnings, if necessary, although the storms may sometimes develop rapidly. Despite the greater advance warning of their impending arrival, increases in population and urbanization in

Table 2-2 *Categories of Hurricanes*

| Category | Speed Range | | Description |
|---|---|---|---|
| | Mi/Hr | Km/Hr | |
| 1 | 74–95 | 119–153 | Very dangerous, some damage |
| 2 | 96–110 | 154–177 | Extremely dangerous, extensive damage |
| 3 | 111–130 | 178–209 | Devastating damage |
| 4 | 131–155 | 210–249 | Catastrophic damage |
| 5 | >155 | >249 | Catastrophic damage |

Courtesy of NOAA

hurricane-prone coastal areas have augmented the property damage caused by hurricanes (Lindell et al., 2007).

In the United States, the hurricane with the most disastrous consequences in terms of human fatalities occurred in 1900 in Galveston, Texas, when 6000 persons lost their lives out of a community of 18,000. Hurricane Katrina in 2005, however, was the single most catastrophic natural disaster in U.S. history. More than $6 billion has been provided directly to victims of Hurricane Katrina for housing and other needs through the Individuals and Households Assistance Program. The U.S. Small Business Administration provided $10.4 billion in disaster loans, and the National Flood Insurance Program paid more than $15.3 billion to policy holders in the wake of Katrina (FEMA, 2006). More significantly, the impotence of the authorities in the face of disaster led to criticism that the U.S. response to Katrina was more akin to that of a developing country than the world's foremost superpower (Brodie, Weltzien, Altman, Blendon, & Benson, 2006).

## Tornadoes

According to FEMA (2010), tornadoes are the most violent type of storm seen in nature. Tornadoes form through the replacement of descending cold air with rising warm air. Approximately 900 tornadoes occur in the United States annually (Lindell et al., 2007). Texas, Kansas, Arkansas, Oklahoma, Missouri, Florida, and Louisiana are the most tornado-prone U.S. states. Five metropolitan areas in Florida alone are in the top 10 tornado-prone areas ("Colo., Texas Lead the Top 10 Most Tornado Prone Areas," 2009). Tornadoes are frequently reported in the Rocky Mountains as well. In general, the tornado season starts in spring and lasts until summer. Tornadoes may also occur along with hurricanes, but their prediction is not possible. A tornado can form within a few hours without any warning or sign and can cause significant damage within a short period of time. The majority of deaths from these storms occur in mobile homes and poorly constructed buildings (Kusenbach, Simms, & Tobin, 2009).

The deadliest tornado in the U.S. occurred in 1925, impacting three towns in the states of Missouri, Illinois, and Indiana, killing 695 people, and injuring 2027. In 2007, a mile-wide tornado struck Greensburg, Kansas, killing at least 10 people and devastating 95% of the town (Tornado Project, 1999). The number of observed tornadoes throughout the United States has increased in recent years as the mid-section and southern parts of the country, commonly referred to as Tornado Alley, have experienced an increase in population (Johnson, April 28, 2011). Six southern states in the United States were impacted by the April 26-28 Tornado outbreak in 2011, making it the biggest natural disaster in the United States since Hurricane Katrina. More than 300 people died across six states (Alabama, Tennessee, Mississippi, Georgia, Virginia and Kentucky) with the highest death toll in Alabama, and thousands were left injured and homeless (Bacon & O'Keefe, 2011). Not all deaths and injuries were caused directly by the tornadoes but were a result of the straight-line winds, hail, flash-floods, and thunderstorms that accompanied the tornadoes. The devastation of these tornadoes is being compared to that caused by Hurricane Katrina, and more than 1,680 people spent April 27, 2011 in Red Cross shelters (Robertson & Severson, April 28, 2011).

## Floods

Several different types of floods are distinguished. Riverside flooding occurs when surface runoff rises to flood level, while flash flooding happens when surface runoff becomes a flood in less than 6 hours. Alluvial fan flooding, in contrast, occurs at the foot of steep valleys where deposits of alluvium accumulate. Dam failures are the consequence of accumulated downstream water rising the stream bank. Surface ponding occurs when surface waters cannot drain away, so that they accumulate in a limited area. Fluctuating lake levels can result in seasonal short-term flooding. Lastly, control structure (dams or levees) failures can lead to flooding (Lindell et al., 2007).

Flood risk is assessed based on the number of floods expected every 100 years, based on their incidence over the last century (Lindell et al., 2007). Note that this index does not actively predict flood incidence, but rather acts as a guide to identify flood-prone areas.

Floods are the most common natural hazards in the United States, with 75% of Presidential Disaster Declarations being ordered for such incidents (Lindell et al., 2007). Every year, 100 motorists die in the United States because of floods (Frech, 2005). Figures from the last 30 years indicate that, on average, 127 people lose their lives every year due to flooding in the United States. When compared to the last 30 years' average number of deaths caused by lightning (73 deaths), tornadoes (65 deaths), and hurricane (16 deaths) hazards, the severity of flooding becomes evident (National Oceanic and Atmospheric Administration [NOAA], 2009). Overall, more than 10,000 people have lost their lives in the United States because of floods since 1900. On average, floods cause $2 billion of property damage every year (NOAA, 2009). More than $100 billion damage after Hurricane Katrina was a result of hurricane and flood damage caused by the storm in New Orleans (NOAA, 2009).

The FEMA Mitigation Directorate manages the national Flood Insurance Program (NFIP) to address preparation for and the consequences of flood hazards in the United States. Approximately 20,000 communities participate in this voluntary program by implementing floodplain management. An estimated $1 billion in flood damage has been prevented as a result of NFIP projects and property owners' flood insurance purchases (FEMA, 2009c).

In the period from the 1950s to the 1990s, the number of floods in European river basins dramatically increased, from 11 per decade to 64 per decade (van Alphen, Martini, Loat, Slomp, & Passchier, 2009). During this period and into the early

2000s, there was growing concern about the threat of flooding, as the incidence of such events continued to rise. In August 2002, Europe witnessed its most devastating flooding in recent history, affecting both the Elbe and Danube river basins and resulting in an estimated $16.5 billion of damage. These particular floods were caused by a "Genoa cyclone"—a familiar low-pressure weather system known to have precipitated severe flooding over the last centuries (Becker & Grünewald, 2003). However, similar levels of flooding had been recorded in the past to much less effect, with the difference in damage experienced being attributed to recent settlement development on floodplains. In response to these widespread floods and more recent incidents, the European Commission and national governments have consolidated their approach to mitigating and preparing for floods, including the development of a European Flood Alert System (Elliott & Macpherson, 2010; European Commission, 2008).

## Wildfires

Wildfires pose a significant risk to people living close to or using facilities in the wilderness. Wildfires can be classified into three groups: (1) Wildland fires burn nothing except vegetation as fuel; (2) interface fires influence both natural life and built structures; and (3) firestorms are distinguished from other fires by the severity at which they burn, which makes them almost impossible to extinguish (Lindell et al., 2007).

Wildland fires can be further parsed in three groups. First, surface fires are low-intensity hazards, usually burning light fuels with little damage. Second, crown fires usually occur as a result of surface fires and burn down the upper branches of trees, which may fall and cause the fire to spread. Third, ground fires are the least common, yet most dangerous type of fire; they destroy all living creatures on the surface of the ground (U.S. Fire Administration, 2001).

Equally importantly, secondary hazards following wildfires include landslides, erosion, flooding, debris flow, deterioration in water quality, and the introduction of invasive species. These developments exacerbate the consequences of wildfires and hinder recovery actions. In the long term, wildfires' effects include reduced access to recreational areas, damage to community infrastructures, and diminished cultural and economic resources (USGS, 2006).

National forests and grasslands in the United States constitute 193 million acres, an area equivalent to state of Texas (U.S. Forest Service, 2008). From 1960 to 2008, more than 5.3 million wildfires burned through more than 190 million acres. Thus an average of 108,000 wildfires burned approximately 4 million acres every year (National Interagency Fire Center, n.d.). These fires tend to take place in the arid West and Southeast regions. In the western United States, wildland–urban interface (WUI) areas have expanded significantly in the last few decades, as 38% of new home construction has occurred close to WUI areas (U.S. Fire Administration, 2002).

As more people build housing in WUI areas, the job of fire fighters becomes more complex and difficult.

Wildfires are also a common summer threat in southern Europe, predominantly affecting the Iberian peninsula, Italy, and the Balkans (European Commission, 2010). For example, in 2009, bush fires in Greece destroyed 12,000 hectares of forest and a large number of properties. The average area burned every year in Europe is 500,000 hectares (1.2 million acres), by 50,000 fires (European Commission, 2001). Recognizing the dangers and disruption caused by these fires, the European Commission (2000) funds a number of projects to identify high-risk areas, develop accurate systems for fire detection, and coordinate solutions for the control and reduction of fires and restoration of the affected areas.

## Human-Made Hazards

Human-made hazards can be the result of an accident, such as an industrial chemical leak or oil spill, or an intentional act. In general, these threats have an element of human intent, negligence, or error, or involve a failure of a human-made system (which is usually a complex one). Such disasters can affect the safety, health, and welfare of people, and cause damage or destruction to property. Overall, they are classified into four groups summarized by the acronym CBRNE: chemical, biological, radioactive/nuclear, and explosive. These hazards include terrorist attacks, which usually have political purposes and target civilians and critical infrastructures. Human-made disasters are the least frequent types of disasters, but can have the most traumatic and remarkable impact on peoples' lives.

Chemical weapons are produced for the purpose of killing, injuring, and incapacitating people. First utilized during World War I, they are relatively easy to produce with readily available chemicals. These substances can be used along with explosives and aerosol devices, and can affect targeted individuals through inhalation, drinking, eating, or direct contact (Bullock et al., 2006; Department of Homeland Security, 2002).

Biological weapons are living organisms that are targeted at humans, crops, and livestock, and cause disease. They not only inflict casualties, but can also result in a large amount of economic damage. The effects of biological weapons may not become evident until a long time after their use, which makes this kind of hazard especially dangerous. Such weapons may also use readily available chemicals, and can be used alongside explosives. To disperse a biological agent effectively through explosives, it is important that a low-order explosive be used so that the biological agent is not completely consumed within the explosion. When an individual is infected by a biological agent, that person may then become contagious to others, multiplying the effect of the initial biological attack (Bullock et al., 2006).

Nuclear and radiological weapons are the most destructive and most difficult to acquire of the CBRNE categories. A nuclear weapon devastates living creatures, infrastructure, and buildings, and it contaminates natural sources such as water and soil. The initial loss of life and enduring effects on victims may be dramatic, and the economy of the affected area may be severely damaged. Radioactive weapons are explosives that emit dangerous radioactive materials, commonly known as dirty bombs. Their impact is directly related to the proximity of the victims to the source of the radioactive contamination (Bullock et al., 2006; Department of Homeland Security, 2002).

Another type of human-made hazard stems from political tensions, when combatants use readily available chemicals to construct CBRNE weapons that can be used alongside explosives. Terror incidents usually target humans, infrastructure, or symbols that are important for people. Terrorist events also occur less frequently than natural hazards, but in some cases their political, economic, and human consequences might be much more devastating than those attributable to any other type of hazard. For example, sabotage to nuclear facilities is a potential nuclear/radioactive hazard that requires relatively little technical expertise, but can inflict remarkable damage to people and economy. Thus the security of these facilities has great importance. Conventional armaments and explosives remain the most commonly used means of terrorist attack.

Although human-made hazards occur relatively infrequently in the United States and Europe, they carry significant impact because of their political nature. People may eventually get used to living with natural disasters, so that a natural event might not attract notable attention. In contrast, even an unsuccessful attempt at a terrorist attack can alter the focus of a population and political circles to a different point. Hence, it appears likely that human-made disasters will remain at the top of the emergency management agenda. Additionally, technological advancements have led to the emergence of cyberthreats and other issues that raise concerns about countries' ability to maintain their national security. For example, today it is possible for someone to break into air traffic control systems or banking systems electronically, thereby causing a lot of harm and mayhem in a country.

Perceptions of the threat from human-made disasters have shifted rapidly in recent decades. After World War II, the main focus of emergency management in the United States was civil defense. In the 1960s, concerns about natural disasters outweighed civil defense needs, and emergency preparedness shifted from nuclear war to natural hazards. During the 1970s, disaster management was introduced to the national political agenda, as FEMA was established by the Carter administration in 1979. Priorities were heavily dominated by Cold War fears under Reagan during the 1980s, which were characterized by an emphasis on nuclear attack preparation. When James Lee Witt took control of FEMA during the Clinton administration, however, the vision and direction of the organization changed again. Witt was the first director of FEMA who had emergency management experience; with him at the helm of FEMA, the focus of national emergency management shifted to natural disasters once more.

The September 11, 2001 terrorist attacks were a milestone for emergency management systems in the United States and the world. The attention of the global community turned to terrorism-related hazards, and human-made disasters moved to the top of the agenda again, as President George W. Bush established the Department of Homeland Security (DHS) following the attacks. It was declared that "to ensure security of our people and preserve our democratic way of life" was the top priority of this new Cabinet-level department (Department of Homeland Security, 2002, p. 7). The 1993 World Trade Center attack in New York, the 1995 Murrah Federal Building bombing in Oklahoma City, and the September 11, 2001 attacks are the most infamous human-made attacks that the United States has experienced.

The heightened threat of terrorism has not only been significant for the United States, but also for several other countries that have dealt with attacks. The 2003 Istanbul bombings, 2004 Madrid bombing, 2005 London bombings, and 2008 Mumbai bombing have all contributed to growing concerns about global terrorism since September 11, 2001.

In addition to terrorist threats, political violence in the form of civil strife or armed conflicts is another human-made hazard that needs to be considered, particularly in the context of Europe. In the mid-1990s, the bloody disintegration of Yugoslavia and the ethno-religious wars in Bosnia-Herzegovina and Croatia showed that war as human-made disaster is never far from Western civilization. The North Atlantic Treaty Organization (NATO) intervention in Kosovo in 1999 was undertaken to protect against mass human right abuses and to alleviate security concerns of the ethnic Albanian population. As recently as 2008, Russia intervened militarily in South Ossetia, an autonomous region in Georgia. The frozen armed conflict in Nagorno-Karabakh (an area between Azerbaijan and Armenia), the Transnistria-Moldova territorial dispute, the Kurdish separatism movement in Turkey, and the ongoing division of Turkish and Greek sides of Cyprus are other examples of political violence as human-made hazards that continue to have considerable socioeconomic and political impacts in Europe. Since early 2011, a number of countries in the Middle East and North Africa (MENA), such as Bahrain, Egypt, Libya, Syria, Tunisia, and Yemen have experienced a wave of political transformation that is often referred as the 'Arab Spring.' It has already resulted in deathly political violence, mass displacement, and widespread socio-economic and physical destruction in many of these countries. While Saudi Arabia has assisted the Sunni-led government of Bahrain to quash its Shia rebellion by deploying its troops in the country, NATO has undertaken an extensive military intervention against Muammar Gaddafi's regime in order to support the national insurgency movement. As of June 2011, the MENA region was still experiencing a high level of political turmoil, insurgency, and external military interventions.

## Impacts

A disaster's impact can be interpreted in six different spheres: physical, social, psychological, demographic, economic, and political (Lindell, 2002, as cited in Lindell et al., 2007). The physical impacts of a disaster are the primary forms of destruction—casualties and damage—and are clearly visible in comparison to other types of impact. They are the sole determinant of a disaster: Without any actual or potential physical impact, there is no disaster. All other impacts are possibilities, but are by no means necessary for the classification of a disaster. Put simply, a disaster is a "situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance . . . that causes great damage, destruction and human suffering" (EM-DAT, 2007). Different people or groups may cite a variety of combinations of effects in categorizing an event as a disaster, but they predominantly refer directly to physical impact as the essential criterion.

Alexander (1997) identifies four commonly used elements in the definition of a disaster to be the number of deaths, the value of damage and losses, the impact on the social system, and geophysical definitions. Some sources go as far as relying on quantifiable damage to declare a disaster. For example, the Centre for Research on the Epidemiology of Disasters will term an event a "disaster" only if it results in 10 or more deaths, 100 people affected, a declaration of a state emergency, and a call for international assistance (United Nations International Strategy for Disaster Reduction [UNISDR], 2006). Different hazards may have a range of physical impacts, which can be divided into human and nonhuman categories. For instance, a biological disaster will affect only people, leaving the inanimate infrastructure unscathed. Similarly, an oil spill may destroy marine life, yet not physically affect the nearby human population. The majority of disasters, however, involve a conjunction of these impacts, whereby loss of human life is often inseparable from destruction of the built and natural environments.

A population can be affected socially by disasters, which can act to aggravate or create tensions between different social groups or, conversely, to bridge former divisions. As discussed throughout this book, Hurricane Katrina is known to have affected poor, black residents proportionally more severely than it did the affluent, white subset of the population. This is no surprise; the disparity between global disaster deaths is split by the north/south division of development and prosperity, such that the less fortunate fare worse, with an average fatality count of 1000 compared to the north's meager 10 deaths (Pelling, Özerdem, & Barakat, 2002). The intriguing aspect of Hurricane Katrina, however, was that it occurred in a large city in a developed country, and the racial divergence reignited entrenched divisions in United States society.

Just as a disaster can have positive and negative effects upon development, as explored by Özerdem (2003), disasters are not entirely destructive in their social impacts. Conflict in Aceh ended with unexpected rapidity in the eight months following the 2004 Indian Ocean tsunami, and similar effects have been experienced internationally in the past, albeit on a varying scale (Le Billon & Waizenegger, 2007).

The existing demography can be drastically altered through the displacement of populations from an affected area or from deaths. Lindell et al. (2007) provide a formula to assess the demographic change following a disaster:

$$Pa - Pb = B - D + IM - OM$$

In this equation, "Pa is the population size after the disaster, Pb is the population size before the disaster, B is the number of births, D is the number of deaths, IM is the number of immigrants, and OM is the number of emigrants" (Lindell et al., 2007, p. 160). Smith and McCarty (1996) demonstrate the demographic change due to Hurricane Andrew in Dade County, Florida. They note that of the 353,000 people who were forced to leave their residences, more than 40,000 did not return to Dade County. Similarly, Stivers (2007) has investigated the demographic impact of Hurricane Katrina, stating that more white residents than black residents have returned to New Orleans. Preceding the hurricane, African Americans constituted two-thirds of the city's population, but their share dropped to 46% following the disaster (Nossiter, 2006, as cited in Stivers, 2007).

A popular measure of a disaster is its economic impact—that is, the significant costs associated with repairing damaged property and reestablishing commerce. Rebuilding homes, replacing property, resuming employment, restoring businesses, and rebuilding infrastructure constitute the economic impact (Bullock et al., 2006). According to Bullock et al. (2006), FEMA spent more than $25.4 billion on declared disasters and emergencies between 1990 and 1999. This figure was estimated at $3.9 billion for the 1980–1989 period, although Lindell et al. (2007) point out that there is no organization that calculates total spending on this activity. If critical infrastructure such as a power plant or communications center were to be damaged in a disaster, the economic consequences would be catastrophic. However, the economic impacts of disasters are not limited to property damage, as disasters may also alter people's spending patterns and decrease consumption (Lindell et al., 2007).

In terms of political impacts, catastrophic disasters in the United States have influenced and resulted in federal-level policy and program changes in managing emergencies. For example, the September 11, 2001 attacks led to revisions and improvements in the Federal Response Plan, which in turn prompted the development of a National Response Plan and the creation of the Department of Homeland Security (Kapucu, 2006). Federal-level changes in disaster management programs and policies are also greatly influenced by the role of presidential emergency management. According to Kapucu (2009), the role of presidential management of disasters has often been important in the United States because the strengths and weaknesses in disaster management and response "often [determine] the political future of presidents and their administrations" (p. 768). President George W. Bush was greatly criticized for the weak and slow federal response to Hurricanes Katrina and Rita. Currently, in the wake of the BP oil spill crisis in the Gulf of Mexico, prospective changes and reviews are being considered in the National Response Framework and the National Incident Management System (NIMS) under President Barack Obama's administration.

Thus disasters are becoming increasingly politicized, and as such can unite individuals who share a common grievance in a challenge against their government due to poor handling of a recovery or the lack of mitigating action prior to a disaster. Lindell et al. (2007) emphasize that the recovery period can trigger many political tensions.

For example, re-zoning attempts in disaster-stricken areas may irritate property owners because their property values could decline and they might not be able to reconstruct their property to pre-disaster conditions. With growing awareness of the potential political cost of disasters, there is an intensified pressure for leaders to appear to be in control during an emergency. In this respect, President Obama has been keen to avoid the BP oil spill disaster being portrayed as equivalent to President Bush's Hurricane Katrina failures.

## Vulnerability

As indicated previously, natural hazards are affected by regional variations in environment, but all areas are vulnerable to human-made hazards. Emergency managers tend to specialize in mitigating the risks associated with the particular hazards they are most likely to encounter, but must also prepare for an unlikely occurrence. For instance, a region prone to hurricanes should also have plans in place for radioactive spills and biological hazards, as the high winds associated with a hurricane may damage industrial assets within the community. In some instances, hazards can create secondary ones. Lightning spawned by a run-of-the-mill thunderstorm in Florida's summer months may set fire to wooded areas and endanger homes. Drought-like conditions present another factor for emergency managers to deal with, so they must work together with forestry departments to ensure that the loss of woodlands and property is minimized.

Lindell et al. (2007) have investigated the effects of pre-disaster conditions in conjunction with existing conditions on disasters. A disaster can be analyzed by determining the three pre-impact conditions: hazard exposure, physical vulnerability, and social vulnerability.

A community's hazard exposure is determined by the geographical location of its people and the events that threaten their lives.

Vulnerability can generally be described as the potential for loss, although consensus is lacking on a more detailed definition (Cutter, 1996; Cutter, Boruff, & Shirley, 2003). In the past, vulnerability has been limited to physical susceptibility; however, understanding of this concept is now becoming more comprehensive, to include susceptibility, exposure, coping capacity, adaptive capacity, social inequalities, and physical, institutional, and economic weaknesses (Bender, 2002; Birkman, 2007). Different scholars typically add different phenomena to the definition of vulnerability based on their own perspectives, making the concept rather indistinct. Nevertheless, if vulnerability is considered from hazards perspective, it is possible to define it as "the likelihood that an individual or group will be exposed to and adversely affected by a hazard . . . the indication of hazards of place (risk and mitigation) with the social profile of communities" (Cutter, 1993, as cited in Cutter, 1996, p. 532).

Physical vulnerability is defined as "the properties of physical structures that determine their potential damage in case of a disaster (e.g., material type and construction quality)" (Ebert, Kerle, & Stein, 2008, p. 277). Physical vulnerability represents the culmination of human vulnerability, agricultural vulnerability, and structural vulnerability. In essence, humans are vulnerable to events that threaten their physical body, food source, and surrounding environment.

Social vulnerability is defined by Wisner et al. (2004, p. 11, as cited in Lindell et al., 2007) "as people's capacity to anticipate, cope with, resist and recover from the impacts of a natural hazard." Cutter et al. (2000) identify the factors influencing social vulnerability to natural hazards as lack of access to resources, including information and knowledge; limited access to political power and representation; certain beliefs and customs; weak buildings or individuals; and infrastructure and lifelines.

Hurricane Katrina drew attention to the political choices that were made in response to the disaster without focusing on the long-term vulnerability of the city and their people. While the idea of social vulnerability is not new to emergency management, the U.S. population has experienced an awakening concerning their social vulnerability to disasters. Given the greater focus on reducing communities' social vulnerability, emergency managers will have greater success in preventing disasters (Enarson, 2007). Of course, social vulnerability is not the only facet of a community's composition to be considered when planning for disasters.

Some social scientists have argued that Hurricane Katrina was not a "natural disaster," but rather a social catastrophe in which some of society's groups suffered disproportionately (Sylves, 2008). While many may debate the accuracy of this statement, Hurricane Katrina did shine a spotlight on the wide range of vulnerabilities that exist within a community.

## Assessment of Vulnerability and Disaster Risk

Vulnerability assessment is a broad concept that can be discussed in several different contexts. Vulnerabilities vary according to the hazards, human ecology, and social changes involved. The International Federation of Red Cross and Red Crescent Societies (IFRC) underlines the importance of answering the question, "Vulnerabilities to what?" (IFRC, n.d., p. 12). Every disaster and every geographical location have unique circumstances; as a consequence, it is not possible to propose a single vulnerability assessment methodology. Each hazard poses different risks to communities at different levels. Nevertheless, a general idea of vulnerability assessment can be formulated as an equation of physical and social vulnerabilities. This section discusses a number of important vulnerable groups that must be addressed by emergency managers: the elderly, the poor, and ethnic minorities.

Elderly people are one of the most vulnerable social groups in the society. Gibson and Hayunga (2006) underline that the majority of the 1330 people who lost their lives in Hurricane Katrina were elderly people. In Louisiana, 71% of all victims were older than age 60, and 47% were older than age 75 . Sixty-eight people were found dead in nursing homes after the hurricane. Also, many of the elderly people evacuated were taken to inappropriate places without considering their special needs (Gibson & Hayunga, 2006).

Elderly people are considered vulnerable because many of them have physical disabilities, chronic illnesses, personal sensitivities, and functional limitations. Aldrich and Benson (2008) note that approximately 80% of U.S. adults aged 65 or older have at least one chronic health condition. Nearly half of the adults at the age of 65 or older have hypertension, 20% have coronary heart disease and 9% have experienced a stroke. It is important to consider effective planning and communication, identify who will need help and what kind of need, and develop evacuation practices for the elderly people to mitigate their vulnerabilities in the setting of a disaster (Bender, 2002; Gibson & Hayunga, 2006).

Poverty remains an intimidating obstacle for a resilient community in terms of effective emergency preparedness and mitigation. Poverty-stricken people more likely focus on their daily survival; preparing for potential disasters remains a distant idea for them. McMahon (2007) notes that one reason why some people did not evacuate New Orleans before Hurricane Katrina came ashore was a lack of proper means of transportation. McMahon (2007) adds that 50% of the poor households in New Orleans did not have sufficient transportation to exit the city.

Poor communities are also more prone to the effects of disasters. They cannot afford to build strong infrastructures that would not be destroyed by a disaster. As noted earlier, the majority of the life losses during tornadoes occur in mobile houses. Simmons and Sutter (2008) underline this point by noting that, between 1985 and 2006, 42% of tornado fatalities occurred in mobile homes. These houses are preferred by poor people because they are more affordable, but offer unreliable protection against disasters.

Minority-dominated and ethnically diverse communities are also more vulnerable to disasters. Kemp (2007) emphasizes that marginalization of groups in a society is a result of classification in social structure. According to Cutter and Emrich (2006), a community's demographic characteristics, social capital, and access to lifelines are factors that can either increase or decrease the susceptibility of people to disasters. Due to their lack of political representation, minorities' conditions and cultural differences might not be stressed in the local emergency management plans. Moreover, lack of political empowerment and discrimination can exacerbate the conditions for minorities and widen the gap between these groups and the majority population (Lemyre, Gibson, Zlepnig, Meyer-Macleod, & Boutette, 2009).

Stivers (2007) underlines the racial issues that became evident in the wake of the Hurricane Katrina disaster. Pre-Katrina New Orleans was dominated by African American people. According to Stivers (2007), discrimination by public officials against this population exacerbated the impacts of Hurricane Katrina, in part as a result of the racial difference between the victims and the responders. Elliot and Pais (2006) mention race issues along with economic status and poverty as factors determining the severity of Katrina's effect. According to these authors, the average black worker in New Orleans was four times more likely to lose his or her job after the storm than the average white worker. As a result of these complex factors and racial concerns, African American people were less inclined to evacuate the city than white people (Elliot & Pais, 2006). As Kemp (2007) notes, when the humane aspect of disaster responses and recovery is ignored, minorities and ethically diverse groups tend to become more vulnerable to the hazards and in return this would have the potential to trigger future disasters.

To prepare for and mitigate disasters, measuring community vulnerabilities and assessing the risks to which communities are exposed is vital. In the United States, FEMA has mandated implementation of risk and vulnerability assessment in state mitigation plans for state governments. Money, through grants, is used as the primary motivator by FEMA to encourage states to implement mitigation strategies including vulnerability assessments. Cutter et al. (2000) list characteristics of vulnerabilities as population and structure (measured, for example, as total population or total housing units), differential access to resources or greater susceptibility to disasters due to physical weaknesses (e.g., number of females, minorities, people younger than age 18, and people older than age 65), wealth and poverty (e.g., mean house values), and level of physical and structural vulnerability (e.g., number of mobile homes).

Chakraborty et al. (2005) developed a formula for assessing the social vulnerability in an evacuation context, particularly for hurricane-prone regions such as Florida. In their research, these authors identified variables indicating social vulnerabilities related to population and structure, differential access to resources, and populations with special evacuation needs. They developed a Social Vulnerability for Evacuation Assistance Index (SVEAI) and formulated it as follows:

$$\text{SVEAI} = \sum \text{SVEAIi}/n$$

In this equation, SVEAIi stands for the social vulnerability for evacuation assistance index of each variable and $n$ stands for the number of vulnerabilities (Chakraborty et al., 2005).

Moreover, the impact of a disaster is directly related to the risk that a community faces. Birkman (2007) has adopted four parameters from Davidson (1997) and Bollin et al. (2003) to determine the level of risk that a community faces: exposure, hazard frequency or severity, local capacity, and vulnerability. Communities' physical planning, social capacity, economic capacity, and management potential also influence the risks that they face and the way they respond to those risks (Bollin & Hidajat, 2006).

Calculating the risks that communities face is possible by measuring each individual factor; overall risk can be reduced by acting upon these results. The prevention/mitigation phase of emergency management deals with hazards before they present themselves. These efforts aim to stop the hazards from emerging or reduce their impact via the application of certain methods, so that exposure to disaster will be reduced. Unfortunately, some disasters are inevitable and unstoppable, such as hurricanes and earthquakes. In these cases, reduction of vulnerabilities can help to significantly decrease the risks that communities are exposed to in the case of a disaster.

Vulnerabilities differ depending on geographical location, population characteristics, and the types of hazards to which an area may or may not be subject to (e.g., a house in Florida may not have to withstand a snowstorm, but it needs to withstand hurricane-force winds). Population characteristics usually become a factor when an area has a sizable population of one of the preidentified most vulnerable groups (e.g., elderly, children, lower-income population). Structural vulnerabilities can usually be easily foreseen and prevented (such as building homes outside of floodplains). In other instances, the risks cannot be easily determined (e.g., a levee system built using substandard materials, such as poor soil). Most of these risks can be mitigated by passing and enforcing strict building codes (which would include government oversight at every level) and following zoning laws. This, however, is not where mitigation should end.

Because individual preparedness has long been seen as a major cornerstone of pre-impact planning, emergency managers should address what they can do to help households prepare for such events. Localities should focus on helping prepare their residents for the types of disasters that their area might face. For example, if an area has a nuclear facility nearby, it must prepare its residents for a potential meltdown. Likewise, if an area could be considered a target for terrorists, community leaders must train the residents about what to do in case of an attack. Oftentimes, many emergency managers focus on the type of disaster most likely to occur, while neglecting others that might potentially occur (e.g., gearing responses toward natural threats, instead of adopting an all-hazards approach to planning), which can leave them exposed to unexpected threats. One of the best ways for emergency managers to help their communities, including their most vulnerable residents, is to get a better understanding of their needs and the needs of the individual situations that they may face. A number of ways to do so have been proposed (Enarson, 2007):

1. Build on local community knowledge of disasters.
2. Prepare and deliver effective warning messages (news that will reach all diverse populations, including blind, deaf, and minority individuals).
3. Develop shelters.
4. Anticipate the need for translators, child care, medical equipment, and other resources.
5. Avoid wasting resources on unnecessary supplies due to bias.

Assessing risk, training staff, and facilitating coordination will enable managers to handle the particular hazards to which their regions are prone. Technology can aid in mitigation, of course, but in some cases is not adequate. Not all hazards are known in advance, yet must still be anticipated. Lindell et al. (2007) emphasize that the variables in the risk assessment equation are quite weak in power (there are few historical data) and uncertain (a changing environment and habitats will influence the hazard's impact). Further, it is not possible to predict the physical impact and the magnitude of a hazard before it occurs. Citizens should be prepared to heed warnings when at all possible and should take measures to protect property and family members from danger. All parties should be aware that principal hazards can create other dangerous circumstances, as seen with the New Orleans levees.

Lindell et al. (2007) identify intervention measures as including hazard mitigation, emergency preparedness, and recovery preparedness; these practices are intended to reduce the physical and social effects of a disaster by limiting casualties and damage, and by providing financial and material resources as emergency relief and to support recovery. In addition, these authors recommend a Hazard/Vulnerability Assessment (HVA) to increase understanding of how hazard characteristics produce physical and social impacts. The knowledge gained through an HVA can be then utilized in developing emergency management interventions. While they demonstrate that public resources are under-utilized, Lindell et al. conclude that federal and state agencies need to put more data on their websites and make them more accessible to the public in the United States.

Likewise, advances in technological tools are giving emergency managers an ever-increasing ability to foresee the effects of a natural hazard, and in some cases to foresee the disaster itself. This increased knowledge can greatly improve the way a community mitigates disaster during calm periods as well as improve the recovery efforts after a disaster has occurred. Sylves (2008) describes how science plays a role in the formation of disaster policy and politics. Science and technology can be used in all phases of disaster management, including modeling to assist in the development of mitigation and preparedness procedures. For example, flood models can be created using elevation data to predict storm surge and inland flooding scenarios.

Geographical Information Systems (GIS) are widely used tools for mapping and visualizing the vulnerabilities of disaster-prone areas. Flax, Jackson, and Stein (2002) explain how the Community Vulnerability Assessment Tool (CVAT) can be used to assess vulnerabilities via GIS systems. In their case study, Hannover County, North Carolina, used GIS systems to identify the spatial relationships between critical resources and hazards. As part of the CVAT analysis, GIS applications enabled county officials to identify critical facilities located in high-risk areas. Furthermore, with the help of GIS, the officials realized that some critical services such as fire and police would be unable to respond to certain locations in an emergency due to the effects of certain hazards such as floods (Flax et al., 2002).

One of the most interesting components of the science and technology role in emergency management can be found by reviewing the Department of Homeland Security organizational chart. While Department of Homeland Security itself has an Under Secretary of Science and Technology, most of the governmental agencies that have a role in disaster research are found outside of this department. Examples include the U.S. Geological Service, the Army Corps of Engineers, and the National Oceanic and Atmospheric Administration. Thus, regardless of the amount of technology used in disaster research, relationship building will play a key role in ensuring effective disaster management at the federal level. These agencies must learn to work together to be effective. Essentially, emergency management depends on a blend of different disciplines to be successful in identifying and mitigating hazards as well as preventing disasters. As McEntire (2004) emphasizes, vulnerabilities are the only variable in the disaster equation that can be controlled by humans.

Furthermore, assessment of vulnerabilities can be made at the national level as well as at the local level. Birkman (2007) discusses the vulnerability index developed by United Nations as an example (UNDP, 2004, as cited in Birkman, 2007). United Nations (UN) efforts to assess vulnerability and risk focus on this issue from both the national and international perspectives. The organization's own studies use mortality data as the basis for risk analysis. This analysis equalizes hazards based on the number of casualties they might potentially inflict and tries to understand why societies with similar levels of exposure to natural hazards can be more or less at risk, or experience a higher or lower level of fatalities (Birkman, 2007). By using the local-level perspective, vulnerabilities assessment can achieve success with the participation of all stakeholders to the process. Participation of business owners, public agencies, nonprofit organizations, and civil society organizations is necessary for better assessment of vulnerabilities and development of mitigation strategies (Flax et al., 2002; Wood, Good, & Goodwin, 2002).

Although abundant research was available to New Orleans' government prior to August 2005, there was a sense of complacency and lack of urgency among local government officials concerning the threat posed by a large hurricane. Both local and Louisiana state authorities also failed to act on the data provided by the Army Corps of Engineers (Daniels, Kettl, & Kunreuther, 2006). It is clear that politics played a pivotal role in the failures in response to Hurricane Katrina. In 2004, the Weather Research Center predicted that in 2005 the Louisiana–Alabama coast had a 40% chance of experiencing a land-falling tropical storm or hurricane based on its Orbital Cyclone Strike Index (OCSI). Moreover, in 2001, the Center predicted that the chance of a landfall event within the next year in the same area was 70%. Reasonable actions in response to this information would have included strengthening the levees or better planning the mass evacuation of the city. Thus, while science and technology can be very accurate in predicting different disaster scenarios and the situation in which a structural asset fails, it still takes politicians and emergency managers to act on these predictions to mitigate any one of many potential disasters.

# Conclusion

On many levels, emergency managers are the soothsayers of disaster planning. They must predict what their vulnerabilities are, which hazards will affect them (some being obvious, others less so), and which decisions can be made to decrease the impact of disaster on their community. They must remember to use every tool available, including technology and the social sciences, to make the best, most well-educated decisions under the most immense pressure. In the end, the fate of the community rests on the decisions they make, and they must be prepared to make decisions for the entire community. One of the most delicate balances they will have to face is making sure that they apply equal time to all hazards and do not focus entirely on the single risk they believe will affect them most. Likewise, they must understand that one plan will not work for everyone in the community. In this regard, emergency managers can rely on past experiences, technological advances, social science studies, and community involvement to develop the "best practices" approach for their locality.

## *Review Questions*

1. If you were asked to improve and redesign the U.S. hurricane response in terms of evacuation housing efforts and short-term housing in the wake of Hurricane Katrina, what would you propose be done? Your answer here requires that you review and discuss the flaws of the current U.S. hurricane disaster response and evacuation policy. You also need to consider how the governmental response to Hurricane Katrina proceeded. Are the reforms currently taking place in the Department of Homeland Security and FEMA enough to correct the problems with the Katrina response? If a Katrina-scale disaster were to hit New Orleans next year, what has been done since 2005 to provide for the needs of those who are unable to evacuate the city? Has the United States learned its lesson from its mistakes in the original Katrina disaster?
2. You are the emergency manager for a coastal town that has seen hurricane activity in the past. You have been asked to prepare a presentation on flooding. What would you include in your plan? Which types of flooding are important to discuss? Discuss the presentation you would put together.
3. This is a flood disaster assignment; you are asked to select your hometown if it has experienced a flood or, if it has not, to select the city of your choice that has experienced a flood disaster. Flood disasters are not new. Why has flood vulnerability been so long tolerated in the United States and Europe? Was flood vulnerability tolerated in your municipality of interest before it was flooded? Are local governments in flood-prone areas fundamentally responsible for their own protection, or are they conditioned to entrust higher-level governments with that authority? Levee construction and maintenance have been alleged to be weak, and some claim that

incompetent jurisdictions have been left with responsibility for floodworks that are capable, if they fail, of devastating their own communities and communities outside their own jurisdictions. What should be done about this issue?

4. Who is responsible in the municipal flood disaster you are addressing (see Question 3)? What is the role of the National Flood Insurance Program in this municipality? Was the program in effect well before the municipal flood disaster? Has it failed in abating flood disasters? Explain.
5. The U.S. Army Corps of Engineers (USACE) is an agency with a very long history of work in construction, operation, and maintenance of infrastructural works (e.g., dams, levees, revetments) and nonstructural, disaster mitigation works. The USACE also owns, operates, and maintains other massive infrastructure systems (e.g., lock systems, navigable waterways, bridges, ports). Consequently, USACE became an important player in the U.S. system of emergency management, particularly in the 1980s and 1990s. Explain the role of the USACE in disaster management. Does this agency occupy an influential organizational position in the Pentagon? Is the USACE politically important or powerful? Is it effective as a flood-fighting organization? Is it culpable in any way for the levee failures around New Orleans during and after Hurricane Katrina? Is structural mitigation of the type advanced by the USACE outmoded given the U.S. societal emphasis on nonstructural mitigation? Should all U.S. floodworks be nationalized and made the responsibility of the USACE?
6. Think about engineering in the context of disaster policy. Are U.S. disasters often a manifestation of failed infrastructure that is poorly engineered, poorly maintained, and poorly designed for the hazards the structures are likely to face over their operating lives? Has the federal disaster infrastructure rebuilding policy been hijacked by state and local officials, as well as by the building trades and contractors, in such a way that subnational governments engage in moral hazard to exploit federal reconstruction relief? How has engineering helped mitigate disasters, and how have engineers pressed the public and their elected officials to act on their mitigation recommendations? How do environmental and structural engineers engage the political process, and do disasters give them any advantage in this engagement?
7. How might the information you gained from this chapter affect you personally and professionally?

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