

Chapter 2

Natural and Technological Hazards and Risk Assessment

A hazard is defined as a “source of danger that may or may not lead to an emergency or disaster and is named after the emergency/disaster that could be so precipitated.” Hazards have associated risk, represented by the likelihood of an event occurring and the consequences expected to result. A disaster is what results when an event does occur, and the response requirements exceed the capabilities of those established emergency services in one or more critical areas for a particular local government, region, or other jurisdictional unit. And ultimately, when the response requirements in one or more critical areas of assistance are unable to be met at all levels of government responding, the incident is classified as a catastrophe.

Hazard identification is the foundation of all emergency and risk management activities. When hazards interface with the human or built environments, it is risk that results. Understanding the risk posed by identified hazards guides the process for preparedness planning and mitigation. Risk, when realized, becomes a disaster that prompts emergency response and recovery activities. All emergency management activities are predicated on the identification and assessment of hazards and risks.

Natural Hazards: Natural hazards are sources of risk exposure that derive from the natural environment and pose a threat to human populations and communities, and these hazards are often exacerbated by irresponsible human development. The following are the most common natural disasters:

- Floods are the most frequent and widespread disaster in many countries, caused by several factors including prolonged precipitation (most common), intense thunderstorms, snowmelt, ice jams, and dam failures. Exposure to floods is great due to historical human settlement around rivers and ports
- Earthquakes are sudden, rapid shaking of the earth caused by the shifting of the Earth's crustal plates. These hazards often spark secondary hazards such as landslides, tsunamis, fires, and floods. Millions of people live in active seismic zones around the world, ranging in vulnerability based primarily upon the construction type of the buildings within which they live and work. The Richter and Modified Mercalli scales have been developed to measure earthquakes' intensities and consequences.
- Hurricanes evolve from tropical storms, and strike with winds greater than 74 mph, storm surges, and heavy rains. In general, hurricanes occur between June 1 and November 30th, peaking in August and September. The destructive power of a hurricane can be spread over wide territories in a relatively short period of time. Modern hurricane tracking technology has improved prediction and mitigation capabilities and reduced the loss of life. However, financial consequences from these storms continue to increase. Hurricane intensity is measured according to the Saffir-Simpson Scale.
- Storm surges are rises in sea levels caused by meteorological forces that generate destructive, erosive waves and flooding.
- Tornadoes are rapidly rotating funnels of air spawned by thunderstorms that occur approximately 1,000 times each year. The few that touch ground cause extensive destruction when they interact with humans or the built environment. Building collapse and flying debris are the principal causes of death and injury. The greatest incidence of tornadoes exists

in the Midwestern ‘tornado alley’, striking primarily from March through August, and in the afternoon or early evening. Tornado prediction technology has improved warning ability significantly, while safe-room construction has reduced consequences. Tornadoes are measured according to the Fujita-Pearson Tornado Scale.

- Wildfires are classified as surface-, ground-, or crown-fires, these hazards continue to threaten residential areas to a continually increasing degree. Land charring can lead to secondary landslides, mudflows, and floods, and widespread erosion. Severe drought conditions and detritus buildup contribute to the ‘fuel’ availability that determines risk.
- Mass movements are a general category of hazards that have a common characteristic of horizontal or lateral movement of large quantities of physical matter. They may be activated by storms, fires, seismicity, human interaction, or natural erosive processes. Speed and size varies significantly by the type of mass movement, which might result from a landslide, mudflow, lateral spread, liquefaction, rock fall, avalanche, land subsidence, or expansive soil.
- Tsunamis are masses of water generated by undersea disturbances such as earthquakes, landslides or volcanoes that are capable of traveling thousands of miles at astonishing speed. Tsunamis become dangerous when they reach developed ocean coasts, most significantly those areas that are below 50 feet elevation and within one mile of the shoreline.
- Volcanic Eruptions result when pressurized magma or gasses are expelled through the Earth's crust. Eruptions can be persistent or explosive, and often cause numerous secondary disasters such as mudslides, floods, tsunamis, and earthquakes, among others.
- Severe Weather Storms consist of extreme cold, heavy snow or ice, as well as high winds if the storm is a blizzard. These storms’ origins depend upon where they are formed.
- Droughts are slow onset hazards characterized by a severe shortage of water.
- Extreme Temperatures include both extreme heat (defined as being 10 degrees or more above the local average that last for several weeks) and extreme cold (for which no standard measure comparable to that of heat exists). Both are increasing in prevalence and severity on account of a changing global climate.
- Coastal Erosion is measured as the rate of change in the position or horizontal displacement of a shoreline over a period of time, generally associated with severe coastal storms.
- Thunderstorms are generated by atmospheric imbalance and turbulence and cause flash flooding, winds, hail, lightning, and tornadoes.
- Hail is frozen atmospheric water that falls to earth. It often causes severe crop damage, breaks windows, and destroys other property resulting in about \$1 billion damages annually.

Technological Hazards: Technological hazards are an inevitable product of technological innovation and human development that are associated with the failure, misuse, or unintended consequences of engineered structures, technologies, manufacturing processes, and other aspects of modern life.

- Structure Fires are fires that affect one or more of the different structural components of a residential, commercial, industrial, or other type of building.
- Dam Failures result in the unplanned and uncontrolled release of mass volumes of stored water.
- Hazardous Materials Incidents involve the release or misuse of chemical substances that can threaten life, property, and the environment.

- Nuclear and Radiation Accidents result in the release of radioactive material into the environment that have the potential to harm or kill humans and animals through ionization or incineration.
- Terrorism is the use of force or violence against persons or property, generally for the purpose of inciting fear to instigate civil unrest or draw attention to a cause. Terrorism, and war, can involve potentially catastrophic Chemical, Biological, Radiological, and Nuclear Weapons, often identified as CBRN or called “Weapons of Mass Destruction” (WMDs).

Hazards Risk Management is the processes by which individuals, organizations, communities, and countries deal with the hazard risks they face. Assessments can be qualitative or quantitative, and are dependant upon data accuracy. The process involves hazard identification, hazard risk assessment, hazard risk analysis, and hazard risk treatment. Risk treatment technologies have improved our ability to manage risk considerably over the past fifteen years, and has included such things as imaging and sensing systems, modeling, communication systems, and mapping.

Social and Economic Risk Factors can greatly influence hazard risk. Little has been done to address social and economic risk factors domestically, as risk assessments generally consider populations to be homogeneous. The importance placed on considering the special needs of certain ‘special populations’ has grown since hurricane Katrina brought such topics to light.

Multiple Choice Questions

1. Which of the following can be defined as “a source of danger that may or may not lead to an emergency”?
 - a. *Hazard
 - b. Disaster
 - c. Contingency
 - d. Risk
2. Which of the following is not known to be a contributor to flooding?
 - a. Dam failure
 - b. Snowmelt
 - c. Ice jam
 - d. *None of the above
3. Which of the following disasters is the most frequent and widespread disaster in the United States, and in many other countries around the world?
 - a. Hurricanes
 - b. Severe winter storms
 - c. *Floods
 - d. Tornadoes
4. Historically, which of the following have been the principal contributors to the loss of life and injuries and the property and infrastructure damage caused by hurricanes?

- a. *Storm surge and high winds
 - b. Flooding and civil disobedience (including looting)
 - c. High winds and erosion
 - d. Overtopping and breaching of levees and business interruption
5. Which of the following is a secondary hazard caused by earthquakes?
- a. El Nino
 - b. *Tsunamis
 - c. Pyroclastic Flows
 - d. Tornadoes
6. Which of the following is used to measure earthquake intensity?
- a. Saffir-Simpson Scale
 - b. Fujita-Pearson Scale
 - c. *Modified Mercalli Scale
 - d. None of the above
7. A tropical storm officially becomes a hurricane when sustained wind speeds exceed how many miles per hour?
- a. 54
 - b. 64
 - c. *74
 - d. 84
8. Hurricane season runs annually during which of the following periods?
- a. *June 1 through November 30
 - b. May 1 through September 30
 - c. May 1 through August 31
 - d. November 1 through June 30
9. Hurricanes are commonly described using which of the following scales?
- a. Fujita-Pearson Scale
 - b. Modified Mercalli Scale
 - c. *Saffir-Simpson Scale
 - d. Richter Scale
10. Which of the following is not a stage in the development of a hurricane?
- a. Tropical Wave
 - b. *Tropical Inversion
 - c. Tropical Depression
 - d. Tropical Storm
11. Which of the following describes a storm surge?
- a. A rise in river levels caused by very low atmospheric pressure present before a tornado
 - b. A subsurface wall of water generated by an earthquake, volcano, or other disturbance

- c. *A rise in coastal sea levels generated by a tropical storm, hurricane, or other meteorological disturbance
- d. All of the above

12. Which of the following hazard scales, which describes tornadoes, was recently enhanced to more accurately describe associated damage?

- a. Saffir-Simpson Scale
- b. Modified Mercalli Scale
- c. Richter Scale
- d. *Fujita-Pearson Scale

13. People living in which of the following areas have the greatest exposure to damage from tornadoes?

- a. People living on the crests of hills
- b. People living in the floodplain
- c. *People living in valleys
- d. People living on flat land

14. Tornadoes tend to occur with greatest frequency in which of the following times?

- a. From August until March
- b. *In the afternoon and evening
- c. Neither a nor b
- d. Both a and b

15. An effective method that can be used to survive a tornado is which of the following?

- a. *A 'Safe Room'
- b. A 'Strong Box'
- c. A Dangerfield Device
- d. A levee

16. Which of the following is not typically considered a contributor to social vulnerability?

- a. Religion
- b. Laws
- c. Beliefs
- d. *Geography

17. Liquefaction is commonly caused by which of the following hazards?

- a. Tornadoes
- b. Volcanoes
- c. Floods
- d. *Earthquakes

18. Which of the following is not a way in which drought differs from other natural hazards?

- a. A drought's onset and end are difficult to determine because the effects accumulate slowly and may linger even after the apparent termination of an episode

- b. The absence of a precise and universally accepted definition adds to the confusion about whether a drought exists, and if it does, the degree of severity
 - c. *The consequences of drought can be fully mitigated if early warning signs are recognized
 - d. Drought effects are less obvious and spread over a larger geographic area
19. On average, how many people are killed by lightning each year in the United States?
- a. Lightning almost never causes fatalities in the United States
 - b. *75-100
 - c. 800-1000
 - d. 5,000 – 10,000
20. Which of the following is not included in the definition of risk?
- a. The probability and frequency of a hazard occurring
 - b. The effects or costs, both direct and indirect, of exposure
 - c. The vulnerability of people and property to the hazard
 - d. *The perception of those who are directly exposed
21. Which of the following is not a step in the risk assessment process?
- a. Identify and characterize the hazard
 - b. Evaluate the hazard for severity and frequency
 - c. *Mitigate the hazard
 - d. Estimate the risk

True or False Questions

1. By focusing development in the floodplain, a community would be effectively minimizing its flood risk.
a. True b. False*
2. Human development has historically trended towards development in areas of high flood risk due to the presence of some economic or quality-of-life benefit, even where the knowledge that risk of injury to humans or property exists.
a. True* b. False
3. River and stream gauges can provide information used to determine the need for sandbagging or dyke construction.
a. True* b. False
4. Earthquakes can occur at any time of the year but tend to strike with greatest frequency during the hot summer months.
a. True b. False*
5. With modern technology, earthquakes are easy to predict and rarely come as a complete surprise to emergency managers.
a. True b. False*
6. The Richter scale is a measure of the consequences of an earthquake.
a. True b. False*
7. All hurricanes begin as tropical storms.
a. True* b. False
8. Financial well-being is an effective indicator to determine whether an individual or society will take protective action from the possible damaging effects of a hazard or hazards.
a. True b. False*
9. In recent years, significant advances have been made in hurricane tracking technology, to the extent that they can be tracked from the moment they form as tropical waves off the coast of West Africa to their landfall in the United States.
a. True* b. False
10. Cyclonic storms, including hurricanes, can start in the Southern hemisphere and cross the equator into the Northern hemisphere.
a. True b. False*
11. The height of an astronomical tide can impact the severity of a storm surge.
a. True* b. False
12. Approximately 120 tornadoes touch ground in the United States each year.

a. True b. False*

13. NESIS scale assigns a numerical value to winter storms based upon the area and population affected, and the amount of snow that accumulates.

a. True* b. False

14. Building collapse and falling debris are the principal causes of death and injuries by tornadoes.

a. True* b. False

15. Crown fires are usually spread by lightning.

a. True b. False*

16. Wildfires can cause landslides, mudflows, and floods.

a. True* b. False

17. Hurricane Katrina is the most expensive natural disaster to have ever occurred worldwide.

a. True b. False*

18. Lava ash makes the land it falls upon barren for decades following the volcanic eruption.

a. True b. False*

19. An episode of cold weather qualifies as extreme cold once the temperature reaches 10 degrees or more below the average low temperature for the region and lasts for 24 hours.

a. True b. False*

20. Terrorism is the use of force or violence against persons or property for purposes of intimidation, coercion, or ransom.

a. True* b. False

21. The validity and use of any risk assessment are independent of the quality and availability of data.

a. True b. False*

Essay Questions

1. Define the terms *Hazard*, *Risk*, and *Disaster*.

2. Compare and contrast natural and technological hazards, providing examples to illustrate your answer.

3. Explain whether exposure to hazards is increasing or decreasing in the United States.

4. Explain how social and economic factors contribute to increases or decreases in the vulnerability of a population.

5. List and describe the four steps of Hazard Risk Management as defined in this chapter.