



Introduction to



EMERGENCY MANAGEMENT

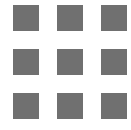


FOURTH EDITION



George D. Haddow **Jane A. Bullock** **Damon P. Coppola**

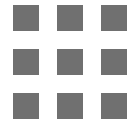




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Fourth Edition

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George D. Haddow

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This book is dedicated to Lacy Suiter. Lacy taught us all the responsibility, privilege, and honor of serving people as emergency managers. He singlehandedly made emergency management an important discipline to the safety of our citizens. He was a gentleman, a mentor, a teacher, a cheerleader, and an impromptu singer, but most of all, he was the best friend anyone could ever have.

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Foreword

In 1993, when I took over leadership of the Federal Emergency Management Agency (FEMA), emergency management was not a very well known or respected discipline. Many in the profession were hold-overs from the days of civil defense, and most elected officials did not see the value of emergency management until they had a major disaster in their community; and even then, the value was transitory. Throughout the 1990s, as the United States and the world experienced an unprecedented number of severe disasters, the critical role emergency management plays in protecting the social and economic stability of our communities was evidenced. Emergency management began to grow beyond the response environment and focus on risk analysis, communications, risk prevention/mitigation, and social and economic recovery. This required a new skill base for emergency managers, and colleges and universities added courses and degrees in emergency management to their offerings. This resulted in a better educated, multidisciplinary, proactive approach to emergency management. Emergency managers were valued members of a community's leadership. Emergency management became an important profession. It allowed me as Director of FEMA, to work with our state, local, and private partners to build one of the most respected emergency management systems in the world.

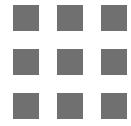
As the tragic outcome of Hurricane Katrina so vividly demonstrated, a strong emergency management system is vital to the safety of all of our citizens. There is no time in our recent history when the need for and understanding of the discipline of emergency management have been more important. The current risk environment we live in, from potential bioterrorist threats, increasingly severe hurricanes and floods, and more frequent wildfires, has dramatically increased the skills and knowledge required to be an effective emergency manager in today's world.

Introduction to Emergency Management is the authoritative guide on today's discipline of emergency management. It takes the reader through the historical context of emergency management to the present day evolution into the world of homeland security. This book focuses on the elements of an emergency management process while providing the policy underpinnings that support that process. It provides a comprehensive case study that examines the events and issues surrounding Hurricane Katrina. While focusing on the current changes happening to the United States system for emergency management, it provides readers with a solid background in international practices and policies for disaster management/homeland security. This book gives the reader practical, real world experiences through documented case studies and provides extensive references and Internet sites for follow up research.

My philosophy about emergency management has always been that we need to take a common-sense, practical approach to reducing the risks we face and protecting our citizens and our communities. We need to identify our risks, educate and communicate to our people about those risks, prepare as best we can for the risks, and then, together, form partnerships to take action to reduce those risks. This approach applies whether we are dealing with a flood, a tornado, a hazardous materials spill, a wildfire, a potential suicide bomb explosion, or a pandemic flu outbreak. George Haddow and Jane Bullock were my Deputy Chief of Staff and my Chief of Staff, respectively, when I was Director of FEMA. Together we worked to apply this approach to making our citizens and communities more disaster resistant and safer throughout the world. As you read and learn from this book, I hope you will keep those ideals in mind.

—James Lee Witt, James Lee Witt Associates

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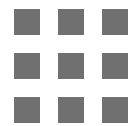
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This book could not have been completed without the assistance of a series of valuable partners. We would like to thank Wayne Blanchard, whose vision, encouragement, and insights on effective education in emergency management have improved our work and the work of emergency managers everywhere. We are also grateful to the Institute for Crisis, Disaster, and Risk Management at The George Washington University, and its codirectors, Dr. Jack Harrald and Dr. Joseph Barbera, for their support. Greg Shaw's humor helped us to keep things in perspective.

We thank the many professors, students, and practitioners who gave us valuable feedback on different aspects of the book and provided suggestions to make the text more relevant and useful.

Finally, the authors wish to thank their respective spouses, Kim Haddow and Mary Gardner Coppola, for their enduring good humor and patience.

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Introduction

No country, community, or individual is immune to the impacts of disasters. Disasters, however, can be and have been prepared for, responded to, and recovered from, and have had their consequences mitigated to an increasing degree. The profession (and academic discipline) that addresses this “management” of disasters is called *emergency management*, and this book is designed to provide the reader with a comprehensive foundation on the history, structure, organization, systems, and concerns that shape the management of disasters and other emergencies. Contained within are details and descriptions of contemporary emergency management practices and strategies, as well as descriptions of the key players involved in emergency management both within the United States and around the world. Our intent is to provide the reader with a working knowledge of how the functions of comprehensive emergency management operate and the influence they can have on everyday life.

This fourth edition represents a documentation of the current status of the discipline as it gravitates toward a state of equilibrium. The 2001 terrorist attacks set in motion a series of events that forever changed not only the way government jurisdictions at all levels (federal, state, and local) addressed the terrorism hazard but also the way members of the public, non-governmental organizations, and businesses prepare for disaster events independent of and in concert with these agencies. Popular opinion is that these actions were mostly knee-jerk in nature and failed to preserve the positive lessons of previous years—especially those from the highly regarded James Lee Witt years of 1992 to 2000. In 2005, the failed response to Hurricane Katrina confirmed such fears, and it had the effect of recalibrating our comprehensive approach to all-hazards risk assessment by reminding all emergency management practitioners that regardless of the public, policy, and media agendas, emergency management must be guided by scientific and statistical risk analysis.

Since the third edition of this book was published, FEMA has regained many of the programs and offices it lost as a result of the creation of the Department of Homeland Security (DHS) and Secretary Chertoff’s Six-Point Agenda. FEMA has regained its status as the agency responsible for the bulk of the nation’s emergency management policy, direction, and federal-level operations, yet it remains stifled under the umbrella of an organization dedicated to security-based concerns. Within DHS, FEMA is subject not only to indirect access to the president and a diminished decision-making authority, but it must also conform to the strategic focus of an agency whose fundamental mission is markedly different from its own.

In 2005, we saw a national system of emergency management—once regarded as one of the most effective and emulated systems in the world—proven incompetent in responding to an event that had been long predicted, planned for, and studied: Hurricane Katrina. Five years later, FEMA is still struggling to rediscover its role while the recovery along the Gulf Coast

steadily progresses. This edition examines how FEMA has evolved as a result of the legislation enacted in the aftermath of Hurricane Katrina and how a change in administrations and political ideologies has helped to direct these changes.

While the book emphasizes the U.S. domestic system of emergency management, many of the experiences discussed, lessons learned, and emerging trends are replicable to emergency management systems around the world. Emergency management in the United States has experienced every form of disaster: natural, man-made, and intentional. The lessons learned from these experiences, the changes made in response to these events, and how the system continues to evolve because of climate changes and other emerging threats provide a solid landscape to examine what emergency management is or could be.

This book, however, does not focus exclusively on FEMA. State and local emergency management organizations are the subjects of many of the case studies, and their collaborative affiliations with FEMA are discussed at length throughout the text. One full chapter, in fact, is dedicated to how emergencies are managed at the international level when the capacity of whole countries or regions falls short of what is required to manage the disaster at hand. With greater frequency, events such as the 2004 Asian earthquake and tsunami, cyclone Nargis in Burma in 2008, and the Sichuan earthquake that same year have highlighted the need for a more robust international emergency management system, and governments across the globe have focused more attention on the issue. A detailed case study of the response to the 2001 earthquake in Gujarat, India, is provided to illustrate these systems.

Chapter 1 includes a brief discussion of the historical, organizational, and legislative evolution of emergency management in the United States by tracing the major changes triggered by disasters or other human or political events, including the creation of the Department of Homeland Security. The chapter includes an analysis of the organizational, legislative, and policy changes made in emergency management both pre- and post-Hurricane Katrina. Chapter 2 identifies and defines the hazards confronting emergency management. Chapter 3 discusses the function of mitigation and the strategies and programs emergency management or other disciplines use to reduce the impacts of disaster events. Chapter 4 catalogues the broad range of programs and processes that comprise the preparedness function of modern emergency management. Chapter 5 breaks from the more traditional approach to emergency management and focuses on why communication with the public, the media, and partners is critical to emergency management of the twenty-first century. Chapter 6 focuses on the essential functions and processes of responding to a disaster event. Chapter 7 describes the broad range of government and voluntary programs available to assist individuals and communities in rebuilding in the aftermath of a disaster. Chapter 8 provides an overview of current activity in international emergency management through an examination of selected international organizations. Chapter 9 describes how the events of September 11, 2001, have altered the traditional perceptions of emergency management. Chapter 10 looks at the post-9/11, post-Katrina environment and provides insights, speculations, recommendations, and three options on where emergency management is or should be headed in the future.

Our goal in writing this book was to provide readers with an understanding of emergency management, insight into how events have shaped the discipline, and thoughts about the

future direction of emergency management. The events of September 11 and the failures of Hurricane Katrina demonstrate the critical need for and value of emergency management. The evolving threats, the realities of global climate change, and our changing social, economic, and political environment demand new and innovative approaches and leadership. We hope this text will motivate each reader to accept the challenge.

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The Historical Context of Emergency Management

What You'll Learn

- The early roots of emergency management
- The modern history of emergency management in the United States
- How FEMA came to exist and how it evolved during the 1980s, 1990s, and the early twenty-first century
- The sudden changes to modern emergency management that resulted from the 9/11 terrorist attacks and Hurricane Katrina
- Changes made by post-Hurricane Katrina legislation and a new administration in Washington, D.C.

Introduction

Emergency management has its roots in ancient history. Early hieroglyphics depict cave dwellers trying to deal with disasters. The Bible speaks of the many disasters that befell civilizations. In fact, the account of Moses parting the Red Sea could be interpreted as the first attempt at flood control. As long as there have been disasters, individuals and communities have tried to find ways to fix them, but organized attempts at disaster recovery did not occur until much later in modern history.

This chapter discusses the historical, organizational, and legislative history of modern emergency management in the United States. Some of the significant events and people that have shaped the emergency management discipline over the years are reviewed. Understanding the history and evolution of emergency management is important because at different times, the concepts of emergency management have been applied differently. The definition of *emergency management* can be extremely broad and all-encompassing. Unlike other, more structured disciplines, it has expanded and contracted in response to events, congressional desires, and leadership styles.

Recently, events and leadership, more than anything else, have brought about dramatic changes to emergency management in the United States. The terrorist attacks of September 11, 2001, led to massive organizational changes and programmatic shifts in emergency management. Many believe that these changes undermined the effective national system of emergency management that had evolved during the 1990s and led to the profound failure of all levels of emergency management in response to Hurricane Katrina in 2005.

2 INTRODUCTION TO EMERGENCY MANAGEMENT

A simple definition for emergency management is “a discipline that deals with risk and risk avoidance.” Risk represents a broad range of issues and includes an equally diverse set of players. The range of situations that could possibly involve emergency management or the emergency management system is extensive. This supports the premise that emergency management is integral to the security of everyone’s daily lives and should be integrated into daily decisions and not just called on during times of disasters.

Emergency management is an essential role of government. The Constitution gives the states the responsibility for public health and safety—hence the responsibility for public risks—with the federal government in a secondary role. The federal role is to help when the state, local, or individual entity is overwhelmed. This fundamental philosophy continues to guide the government function of emergency management.

Based on this strong foundation, the validity of emergency management as a government function has never been in question. Entities and organizations fulfilling the emergency management function existed at the state and local levels long before the federal government became involved. But as events occurred, as political philosophies changed, and as the nation developed, the federal role in emergency management steadily increased.

In the aftermath of the failed response to Hurricane Katrina, extensive discussion about emergency management, particularly the response and recovery functions, has taken place. An ever-increasing presence of nonprofit organizations delivering support to their particular constituencies after Katrina has given rise to interest on the part of the nonprofit community to take on increased responsibilities for disaster response. To date this has not materialized, but steps have been taken at the federal level to apply a top-down approach to emergency management functions, particularly relative to planning for disasters. While the Post-Katrina Emergency Management Reform Act detailed changes to how federal emergency management functioned, many of the changes included in this legislation were overlooked or were slow to be adopted by the leadership at the Federal Emergency Management Agency (FEMA) and the Department of Homeland Security (DHS). With the election of Barack Obama as president in 2008, both Congress and the emergency management community looked forward to positive changes and support for a struggling discipline.

Early History: 1800–1950

In 1803, a congressional act was passed that provided financial assistance to a New Hampshire town that had been devastated by fire. This was the first example of the federal government becoming involved in a local disaster. It was not until Franklin Roosevelt’s administration used government as a tool to stimulate the economy that the federal government began to make significant investments in emergency management functions.

During the 1930s, the Reconstruction Finance Corporation and the Bureau of Public Roads were both given the authority to make disaster loans available for repair and reconstruction of certain public facilities after disasters. The Tennessee Valley Authority was created during this time to produce hydroelectric power and, as a secondary purpose, to reduce flooding in the region.

A significant piece of emergency management legislation was passed during this time. The Flood Control Act of 1934 gave the U.S. Army Corps of Engineers increased authority to design and build flood-control projects. This act has had a significant and long-lasting impact on emergency management in this country. This act reflected the philosophy that humans could control nature, thereby eliminating the risk of floods. Although this program would promote economic and population growth patterns along the nation's rivers, history has proven that this attempt at emergency management was both shortsighted and costly.

The Cold War and the Rise of Civil Defense: the 1950s

The next notable time frame for the evolution of emergency management was during the 1950s. The era of the Cold War presented the principal disaster risk as the potential for nuclear war and nuclear fallout. Civil defense programs proliferated across communities during this time. Individuals and communities were encouraged to build bomb shelters to protect themselves and their families from nuclear attack from the Soviet Union.

Almost every community had a civil defense director, and most states had someone who represented civil defense in their state government hierarchy. By profession, these individuals were usually retired military personnel, and their operations received little political or financial support from their state or local governments. Equally often, their civil defense responsibilities were in addition to other duties.

Federal support for these activities was vested in the Federal Civil Defense Administration (FCDA), an organization with little staff or financial resources whose main role was to provide technical assistance. In reality, the local and state civil defense directors were the first recognized face of emergency management in the United States.

A companion office to the FCDA, the Office of Defense Mobilization was established in the Department of Defense (DOD). The primary functions of this office were to allow for quick mobilization of materials and production and stockpiling of critical materials in the event of a war. It included a function called *emergency preparedness*. In 1958, these two offices were merged into the Office of Civil and Defense Mobilization.

The 1950s were a quiet time for large-scale natural disasters. Hurricane Hazel, a Category 4 hurricane, inflicted significant damage in Virginia and North Carolina in 1954; Hurricane Diane hit several mid-Atlantic and northeastern states in 1955; and Hurricane Audrey, the most damaging of the three storms, struck Louisiana and North Texas in 1957. Congressional response to these disasters followed a familiar pattern of ad hoc legislation to provide increased disaster assistance funds to the affected areas.

As the 1960s started, three major natural disaster events occurred. In a sparsely populated area of Montana, the Hebgen Lake earthquake, measuring 7.3 on the Richter scale, was proof that states other than California were at risk for severe earthquakes. Also in 1960, Hurricane Donna hit the west coast of Florida, and Hurricane Carla blew into Texas in 1961. The incoming Kennedy administration decided to make a change to the federal approach to such disasters. In 1961 it created the Office of Emergency Preparedness inside

the White House to deal with natural disasters. Civil defense responsibilities remained in the Office of Civil Defense within the DOD.

Changes to Emergency Management: the 1960s

As the 1960s progressed, the United States would be struck by a series of major natural disasters. The Ash Wednesday storm in 1962 devastated more than 620 miles of shoreline on the East Coast, producing more than \$300 million in damages. In 1964, an earthquake measuring 9.2 on the Richter scale in Prince William Sound, Alaska, became front-page news throughout America and the world. This quake generated a tsunami that affected beaches as far down the Pacific Coast as California and killed 123 people. Hurricane Betsey in 1965 and Hurricane Camille in 1969 killed and injured hundreds of people and caused hundreds of millions of dollars in damage along the Gulf Coast.

As with previous disasters, the response was passage of ad hoc legislation for funds. However, the financial losses resulting from Hurricane Betsey's path across Florida and Louisiana raised the issue of disaster insurance against future floods and a potential method to reduce continued government assistance after such disasters. Congressional interest was prompted by the unavailability of flood protection insurance on the standard homeowner policy. If this type of insurance was available, it was cost-prohibitive. These discussions eventually led to the passage of the National Flood Insurance Act of 1968, which created the National Flood Insurance Program (NFIP).

Congressman Hale Boggs of Louisiana is appropriately credited with steering this unique legislation through Congress. Unlike previous emergency management/disaster legislation, this bill sought to do something about the risk *before* the disaster struck. It brought the concept of *community-based mitigation* into the practice of emergency management. In simple terms, when a community joined the NFIP, in exchange for making federally subsidized, low-cost flood insurance available to its citizens, the community had to pass an ordinance restricting future development in its floodplains. The federal government also agreed to help local communities by producing maps of their community's floodplains.

ADDITIONAL RESEARCH

In October 2006, a report entitled *Costs and Consequences of Flooding and the Impact of the National Flood Insurance Program* was issued, which provided an overview of what the NFIP had accomplished. It is available at www.fema.org.

The NFIP began as a voluntary program as part of a political compromise that Boggs reached with the then senator Tom Eagleton of Missouri. As a voluntary program, few communities joined. After Hurricane Camille struck the Louisiana, Alabama, and Mississippi coasts in 1969, the goals of the NFIP to protect people's financial investments and to reduce government disaster expenditures were not being met. Change would not occur until Hurricane Agnes devastated Florida in 1972.

George Bernstein, who was brought down from New York by President Nixon to run the Federal Insurance Administration (FIA) within the Department of Housing and Urban Development (HUD), proposed linking the mandatory purchase of flood insurance to all homeowner loans that were backed by federal mortgages. This change created an incentive for communities to join the NFIP because a significant portion of the home mortgage market was federally backed. This change became the Flood Insurance Act of 1972.

It is important to note how local and state governments chose to administer this flood risk program. Civil defense departments usually had the responsibility to deal with risks and disasters. Although the NFIP dealt with risk and risk avoidance, responsibilities for the NFIP were sent to local planning departments and state Departments of Natural Resources. This reaction is one illustration of the fragmented and piecemeal approach to emergency management that evolved during the 1960s and 1970s.

CRITICAL THINKING

Can you think of any positive or negative aspects of disaster-driven evolutionary changes in the United States' emergency management system? What about for changes that occur in the absence of initiating disaster events?

The Call for a National Focus on Emergency Management: the 1970s

In the 1970s, the responsibility for emergency management functions was evident in more than five federal departments and agencies, including the Department of Commerce (weather, warning, and fire protection), the General Services Administration (continuity of government, stockpiling, and federal preparedness), the Treasury Department (import investigation), the Nuclear Regulatory Commission (power plants), and HUD (flood insurance and disaster relief).

With the passage of the Disaster Relief Act of 1974, which was prompted by the previously mentioned hurricanes and the San Fernando earthquake of 1971, HUD possessed the most significant authority for natural disaster response and recovery through the NFIP under the FIA and the Federal Disaster Assistance Administration (disaster response, temporary housing, and assistance). On the military side were the Defense Civil Preparedness Agency (nuclear attack) and the U.S. Army Corps of Engineers (flood control); however, taking into account the broad range of risks and potential disasters, more than 100 federal agencies were involved in some aspect of risk and disasters.

This pattern continued down to the state and, to a lesser extent, local levels. Parallel organizations and programs added to the confusion and the turf wars that especially occurred during disaster response efforts. The states and the governors grew increasingly frustrated over this fragmentation. In the absence of one clear federal lead agency

in emergency management, a group of state civil defense directors led by Lacy Suiter of Tennessee and Erie Jones of Illinois launched an effort through the National Governors Association to consolidate federal emergency management activities in one agency.

With the election of a fellow state governor, President Jimmy Carter of Georgia, the effort gained steam. President Carter came to Washington committed to streamlining all government agencies and seeking more control over key administrative processes. The state directors lobbied the National Governors Association (NGA) and Congress for a consolidation of federal emergency management functions. When the Carter administration proposed such an action, it was met with a receptive audience in the Senate. Congress already had expressed concerns about the lack of a coherent federal policy and the inability of states to know whom to turn to in the event of an emergency.

The federal agencies involved, however, were not as excited about the prospect. A fundamental law of bureaucracy is a continued desire to expand control and authority, not to lose control. In a consolidation of this sort, there would be both losers and winners. There was a question of which federal department/agency should house the new consolidated structure. As the debate continued, the newly organized National Association of State Directors of Emergency Preparedness championed the creation of a new independent organization, an idea that was quickly supported by the Senate.

In the midst of these discussions, an accident occurred at the Three Mile Island nuclear power plant in Pennsylvania, which added impetus to the consolidation effort. This accident brought national media attention to the lack of adequate off-site preparedness around commercial nuclear power plants and the role of the federal government in responding to such an event.

On June 19, 1978, President Carter transmitted to Congress the Reorganization Plan Number 3 (3 CFR 1978, 5 U.S. Code 903). The intent of this plan was to consolidate emergency preparedness, mitigation, and response activities into one federal emergency management organization. The president stated that the plan would establish the Federal Emergency Management Agency (FEMA) and that the FEMA director would report directly to the president.

Reorganization Plan Number 3 transferred to FEMA the National Fire Prevention Control Administration (Department of Commerce), the Federal Insurance Administration (HUD), the Federal Broadcast System (Executive Office of the President), the Defense Civil Preparedness Agency (Department of Defense), the Federal Disaster Assistance Administration (HUD), and the Federal Preparedness Agency (GSA). The following emergency preparedness and mitigation functions were also transferred to FEMA:

- Oversight of the Earthquake Hazards Reduction Program (Office of Science and Technology Policy)
- Coordination of dam safety (Office of Science and Technology Policy)
- Assistance to communities in the development of readiness plans for severe weather-related emergencies
- Coordination of natural and nuclear disaster warning systems

- Coordination of preparedness and planning to reduce the consequences of major terrorist incidents

Reorganization Plan Number 3 articulated the following fundamental organizational principles:

1. Federal authorities who were to anticipate, prepare for, and respond to major civil emergencies should be supervised by one official who is responsible to the president and given attention by other officials at the highest levels.
2. An effective civil defense system requires the most efficient use of all available resources.
3. Whenever possible, emergency responsibilities should be extensions of federal agencies.
4. Federal hazard mitigation activities should be closely linked with emergency preparedness and response functions.

Subsequent to congressional review and concurrence, the Federal Emergency Management Agency was officially established by Executive Order 12127 of March 31, 1979 (44 FR 19367, 3 CFR, Comp., p. 376). A second Executive Order, 12148, mandated the reassignment of agencies, programs, and personnel into the new entity, FEMA.

Creating the new organization made sense, but integrating the diverse programs, operations, policies, and people into a cohesive operation was a much bigger task than realized when the consolidation began. It would take extraordinary leadership and a common vision. The consolidation also created immediate political problems. By consolidating these programs and the legislation that created them, FEMA would have to answer to 23 committees and subcommittees in Congress with oversight of its programs. Unlike most other federal agencies, it would have no organic legislation to support its operations and no clear champions to look to during the congressional appropriations process.

In addition, President Carter had problems finding a director for this new organization. No large constituent group was identified with emergency management, and at the time the administration was facing major problems with Congress and the public because of the Iranian hostage crisis. President Carter finally reached into his own cabinet and asked John Macy, then head of the Office of Personnel Management (OPM), to become director of FEMA.

John Macy's task was to unify an organization that was not only physically separated—parts of the agency were located in five different buildings around Washington—but also philosophically separate. Programs focused on nuclear war preparations were combined with programs focused on a new consciousness of the environment and floodplain management. Macy focused his efforts by emphasizing the similarities between natural hazards preparedness and civil defense by developing a new concept called the Integrated Emergency Management System (IEMS). This system was an all-hazards approach that included direction, control, and warning as functions common to all emergencies from small, isolated events to the ultimate emergency of nuclear attack. For all his good

efforts, FEMA continued to operate as individual entities pursuing their own interests and answering to their own congressional bosses. It was a period of few major disasters, so virtually nobody noticed this problem of disjointedness.

Civil Defense Reappears as Nuclear Attack Planning: the 1980s

The early and mid-1980s saw FEMA facing many challenges but no significant natural disasters. The absence of the need for a coherent federal response to disasters, as was called for by Congress when it approved the establishment of FEMA, allowed FEMA to continue to exist as an organization of many parts.

In 1982, President Reagan appointed Louis O. Giuffrida as director of FEMA. Mr. Giuffrida, a California friend of Ed Meese, who was one of the president's closest advisors, had a background in training and terrorism preparedness at the state government level. General Giuffrida proceeded to reorganize FEMA consistent with administration policies and his background. Top priority was placed on government preparedness for a nuclear attack. Resources within the agency were realigned, and additional budget authority was sought to enhance and elevate the national security responsibilities of the agency. With no real role for the states in these national security activities, the state directors who had lobbied for the creation of FEMA saw their authority and federal funding declining.

Giuffrida also angered one of the only other visible constituents of the agency: the fire services community. Giuffrida diminished the authority of the U.S. Fire Administration by making it part of FEMA's Directorate of Training and Education. The newly acquired campus at Emmitsburg, Maryland, was intended to become the preeminent National Emergency Training Center (NETC).

During Giuffrida's tenure, FEMA faced several unusual challenges that stretched its authority, including asserting FEMA into the lead role for continuity of civilian government in the aftermath of a nuclear attack, managing the federal response to the contamination at Love Canal and Times Beach, Missouri, and the Cuban refugee crisis. Although Giuffrida managed to bring the agency physically together in a new headquarters building in Washington, D.C., severe morale problems persisted.

Dislike of Giuffrida's style and questions about FEMA's operations came to the attention of U.S. Representative Al Gore of Tennessee, who then served on the House Science and Technology Committee. As the congressional hearings proceeded, the Department of Justice and a grand jury began investigations of senior political officials at FEMA. These inquiries led to the resignation of Giuffrida and top aides in response to a variety of charges, including misuse of government funds, but the shake-up marked a milestone of sorts: FEMA and emergency management had made it into the comic strip "Doonesbury."

President Reagan then selected General Julius Becton to be director of FEMA. General Becton, a retired military general and former director of the Office of Foreign Disaster Assistance in the State Department, is credited uniformly with restoring integrity to

the operations and appropriations of the agency. From a policy standpoint, he continued to emphasize the programs of his predecessor, only in a less visible manner. Becton expanded the duties of FEMA when he was asked by the DOD to take over the program dealing with the off-site cleanup of chemical stockpiles on DOD bases. This program was fraught with problems, and bad feelings existed between the communities and the bases over the funds available to the communities for the cleanup. FEMA had minimal technical expertise to administer this program and was dependent on the DOD and the Army for the funding. This situation led to political problems for the agency and did not lead to significant advancements in local emergency management operations, as promised by the DOD.

At one point in his tenure, General Becton ranked the programs in FEMA by level of importance. Of the more than 20 major programs, the earthquake, hurricane, and flood programs ranked near the bottom. This priority seems logical based on the absence of any significant natural hazards, but this situation is noteworthy in the context that it continued the pattern of isolating resources for national security priorities without recognizing the potential of a major natural disaster.

This issue was raised by then senator Al Gore in hearings on FEMA's responsibilities as lead agency for the National Earthquake Hazards Reduction Program (NEHRP). Senator Gore, reacting to a scientific report that up to 200,000 casualties could result from an earthquake on the New Madrid fault, believed that FEMA's priorities were misplaced. The legislation that created the NEHRP called on FEMA to develop a plan for how the federal government would respond to a catastrophic earthquake. This Federal Response Plan would later become the standard for all of the federal agencies' response operations. Senator Gore concluded that FEMA needed to spend more time working with its federal, state, and local partners on natural hazards planning.

An Agency in Trouble: 1989–1992

As Congress debated, and finally passed, major reform of federal disaster policy as part of the Stewart McKinney–Robert Stafford Act, FEMA's potential and its ability to support a national emergency management system remained in doubt. As the 1980s closed, FEMA was an agency in trouble. It suffered from severe morale problems, disparate leadership, and conflicts with its partners at the state and local levels over agency spending and priorities.

With a new administration in place, President George H.W. Bush named Wallace Stickney as director of FEMA. Mr. Stickney was from New Hampshire and was a friend of John Sununu, who was Bush's chief of staff. Mr. Stickney came to the director's position having been a staff person at the New England Regional Office of the Environmental Protection Agency and as a volunteer firefighter. His emergency management credentials were minimal, and his selection was poorly received by many of the state directors. At the same time, the political appointees who were named to FEMA's regional director

positions—the first line of FEMA’s response system—were equally lacking in emergency management experience. These appointments would prove to have dire consequences for both FEMA and the American public.

In 1989, two devastating natural disasters called the continued existence of FEMA into question. In September, Hurricane Hugo slammed into North Carolina and South Carolina after first hitting Puerto Rico and the Virgin Islands. It was the worst hurricane in a decade, with more than \$15 billion in damages and 85 deaths. FEMA was slow to respond, waiting for the process to work and for the governors to decide what to do. Less than a month later, the Bay Area of California was rocked by the Loma Prieta earthquake as the 1989 World Series got under way in Oakland Stadium. FEMA was not prepared to deal with the catastrophe.

A few years later, FEMA was not so lucky. In August 1992, Hurricane Andrew struck Florida and Louisiana, and Hurricane Iniki struck Hawaii only a few weeks later. Again, FEMA wasn’t ready, but with Hurricane Andrew, it was not only FEMA that failed the people of Florida, but the process and the system as well. Starting with Hurricane Hugo, public concern over natural disasters was high. People wanted, and expected, their government to be there to help in their time of need. FEMA seemed incapable of carrying out the essential government function of emergency management.

In the aftermath of Hurricanes Andrew and Iniki, there were calls for abolishing FEMA. But the incoming Clinton administration realized how important an effective response and quick recovery were to communities and to voters and was determined to fix the emergency management system.

The Witt Revolution: 1993–2001

When President Clinton nominated James Lee Witt to be director of FEMA, Witt breathed new life into FEMA and brought a new style of leadership to the troubled agency. Witt was the first director of FEMA with emergency management experience. He was from the constituency who had played a major role in creating FEMA but had been forgotten: the state directors. With Witt, President Clinton had credibility and, more important, a skilled politician who knew the importance of building partnerships and serving customers.

Witt came in with a mandate to restore the trust of the American people that their government would be there for them during times of crisis. He initiated sweeping reforms inside and outside the agency. Inside FEMA, he reached out to all employees, implemented customer service training, and reorganized the agency to break down bottlenecks. He supported the application of new technologies to the delivery of disaster services and focused on mitigation and risk avoidance. Outside the agency, he strengthened the relationships with state and local emergency managers and built new ones with Congress, within the administration, and with the media. Open communications, both internally and externally, were the hallmarks of the Witt years at FEMA.

Witt’s leadership and the changes he made were quickly tested as the nation experienced an unprecedented series of natural disasters. The Midwest floods in 1993 resulted

in major disaster declarations in nine states. FEMA's successful response to these floods brought the opportunity to change the focus of postdisaster recovery by initiating the largest voluntary buyout and relocation program to date in an effort to move people out of the floodplain and out of harm's way.

The Northridge, California, earthquake quickly followed the Midwest floods in 1994. Northridge tested all of the new streamlined approaches and technology advancements for delivery of services and created some more. Throughout the next several years, FEMA and its state and local partners would face every possible natural hazard, including killer tornadoes, ice storms, hurricanes, floods, wildfires, and drought.

When President Clinton made Witt a member of his cabinet, the value and importance of emergency management was recognized. Witt used this promotion as an opportunity to lobby the nation's governors to include their state emergency management directors in their cabinets.

The Oklahoma City bombing in April 1995 represented a new phase in the evolution of emergency management. This event, following the first bombing of the World Trade Center in New York City in 1992, raised the issue of America's preparedness for terrorism events. Because emergency management responsibilities are defined by risks and the consequences of those risks, responding to terrorist threats was included. The Oklahoma City bombing tested this thesis and set the stage for interagency disagreements over which agency would be in charge of terrorism.

While this debate continued, FEMA took an important step in its commitment to disaster mitigation by launching a national initiative to promote a new community-based approach called Project Impact: Building Disaster-Resistant Communities. This project was designed to mainstream emergency management and mitigation practices into every community in America. It went back to the roots of emergency management. It asked a community to identify risks and establish a plan to reduce those risks. It asked communities to establish partnerships that included all of the stakeholders in the community, including, for the first time, the business sector.

ADDITIONAL RESEARCH

"Project Impact Initiative to Create Disaster Resistant Communities Demonstrates Worth in Kansas Years Later" (www.emergencymgmt.com/disaster/ProjectImpact-Initiative-to.html). This article documents how preventive measures, taken by communities in Kansas as part of the Project Impact program, saved lives years later when devastating tornadoes struck across Kansas.

By building a disaster-resistant community, the community would promote sustainable economic development, protect and enhance its natural resources, and ensure a better quality of life for its citizens. Figure 1-1 shows the effects of mitigation during Hurricane Ike. As the decade came to an end, FEMA was still recognized as the preeminent emergency management system in the world. It was adopted in other countries, and Witt became an ambassador for emergency management overseas.



FIGURE 1-1 Gilchrist, Texas, August 16, 2009. These stilt homes were the only structures still standing in the town of Gilchrist after Hurricane Ike destroyed it. FEMA is still working with local, state, and federal agencies to rebuild the town.
Photo by Patsy Lynch/FEMA.

Terrorism: 2001

With the election of George W. Bush, a new FEMA director, Joe Allbaugh, was named to head the agency. As a former chief of staff to Bush when he was governor of Texas and Bush's campaign manager in the 2000 presidential race, Allbaugh had a close personal relationship with the president. As demonstrated by Witt and Clinton, this was viewed as a positive for the agency. His lack of emergency management background was not an issue during his confirmation hearings.

Allbaugh got off to a rocky start when the administration decided to eliminate funding for the popular Project Impact. Immediately after this decision was announced, the 6.8 magnitude Nisqually earthquake shook Seattle, Washington. Seattle happened to be one of the most successful Project Impact communities. The mayor of Seattle appeared on national television and gave Project Impact credit for the minimal damage from the quake. When then vice president Dick Cheney was asked why the program was being eliminated, he responded that there had been doubts about its effectiveness. As FEMA's budget proceeded through the appropriations process, Congress put funding back into Project Impact.

As part of the major reorganization of the agency, Allbaugh recreated the Office of National Preparedness (ONP). This office was first established in the 1980s during the Giuffrida reign for planning for World War III and had been eliminated by Witt in 1992. This action raised some concerns among FEMA's constituents and FEMA staff. However, this time the mission of the office was focused on terrorism.

As the events of September 11, 2001, unfolded, FEMA activated the Federal Response Plan, and response operations proceeded as expected in New York and Virginia.

The strength of the U.S. emergency management system was proven, however, as hundreds of response personnel initiated their operations within just minutes of the onset of events.

The Department of Homeland Security: 2001–2005

Almost immediately after the terrorist attacks on the World Trade Center, the president created by executive order the Office of Homeland Security within the White House. The same day that announcement was made, Tom Ridge, the governor of Pennsylvania, was sworn in to lead the office with the title Assistant to the President.

In March 2002, President Bush signed Homeland Security Presidential Directive-3 (HSPD-3), which stated the following:

The Nation requires a Homeland Security Advisory System to provide a comprehensive and effective means to disseminate information regarding the risk of terrorist acts to federal, state, and local authorities and to the American people. Such a system would provide warnings in the form of a set of graduated “threat conditions” that would increase as the risk of the threat increases. At each threat condition, federal departments and agencies would implement a corresponding set of “protective measures” to further reduce vulnerability or increase response capability during a period of heightened alert.

This system is intended to create a common vocabulary, context, and structure for an ongoing national discussion about the nature of the threats that confront the homeland and the appropriate measures that should be taken in response. It seeks to inform and facilitate decisions appropriate to different levels of government and to private citizens at home and at work.

What resulted was the widely recognizable five-color Homeland Security Advisory System code. On November 25, 2002, President Bush signed into law the Homeland Security Act of 2002 (HS Act) (Public Law 107-296) and announced that Tom Ridge would be appointed secretary of a new Department of Homeland Security (DHS) to be created through this legislation. This act, which authorized the greatest federal government reorganization since President Harry Truman joined the various branches of the armed forces under the Department of Defense, was charged with a threefold mission of protecting the United States from further terrorist attacks, reducing the nation’s vulnerability to terrorism, and minimizing the damage from potential terrorist attacks and natural disasters.

The sweeping reorganization into the new department, which officially opened its doors on January 24, 2003, joined together over 179,000 federal employees from 22 existing federal agencies under a single, cabinet-level organization. The creation of DHS was the culmination of an evolutionary legislative process that began largely in response to criticism that increased federal intelligence interagency cooperation could have prevented the September 11 terrorist attacks. The White House and Congress both had recognized that a

Homeland Security czar would require both a staff and a large budget in order to succeed, and thus began deliberations to create a new cabinet-level department that would fuse many of the security-related agencies dispersed throughout the federal government.

For several months during the second half of 2002, Congress jockeyed between different versions of the Homeland Security bill in an effort to establish legislation that was passable yet effective. Efforts to incorporate many of the intelligence-gathering and investigative law enforcement agencies—the National Security Agency (NSA), the Federal Bureau of Investigation (FBI), and the Central Intelligence Agency (CIA)—into the legislation failed.

Despite these delays and setbacks, after the 2002 midterm elections, the Republican seats gained in both the House and Senate gave the president the leverage he needed to pass the bill without further deliberation (H.R., 299-121 on November 13, 2002; Senate, 90-9 on November 19, 2002). Although the passage of this act represented a significant milestone, the implementation phase presented a tremendous challenge—a concern expressed by several leaders from the agencies that were to be absorbed. On November 25, 2002, President Bush submitted his Reorganization Plan (as required by the legislation), which mapped out the schedule, methodology, and budget for the monumental task.

Although a handful of these agencies remained intact after the consolidation, most were fully incorporated into one of four new directorates: Border and Transportation Security (BTS), Information Analysis and Infrastructure Protection (IAIP), Emergency Preparedness and Response (EP&R), and Science and Technology (S&T). A fifth directorate, Management, incorporated parts of the existing administrative and support offices within the merged agencies. Secretary Ridge was given exactly one year to develop a comprehensive structural framework for DHS and to name new leadership for all five directorates and other offices created under the legislation.

In addition to the creation of the Department of Homeland Security, the HS Act made several changes to other federal agencies and their programs and created several new programs. On March 1, 2003, Joe Allbaugh, in a memo to FEMA staff, announced that he was resigning as FEMA director. Michael Brown, formerly general counsel to FEMA and acting deputy director, was named as the acting director of FEMA within the DHS Emergency Preparedness and Response directorate. Mike Brown came to FEMA because of his long, personal friendship with Allbaugh. His academic training was in law, and prior to coming to FEMA he had been the executive director of the Arabian Horse Association based in Colorado.

With the DHS establishment moving forward, in 2004 FEMA was faced with four major hurricanes that assaulted Florida. Because of that election year's overall political nature, and with Florida being regarded as key in deciding the outcome of the presidential election (as well as the fact that the president's brother Jeb was the governor of Florida), a great deal of effort was expended to ensure that the federal response to the hurricanes was efficient and effective. However, everyone was well aware that Florida had one of the most effective state emergency management systems in the country and that it was actually "calling the shots."

ADDITIONAL RESEARCH

DHS Office of the Inspector General, 2005. Audit of FEMA's Individuals and Households Program in Miami-Dade County, Florida, for Hurricane Frances.

http://www.dhs.gov/xoig/assets/mgmtrpts/OIG_05-20_May05.pdf

One of the many issues that arose in the aftermath of the hurricanes was the allegation of widespread fraud in the handling of people receiving aid from FEMA even when they had suffered no damages to or loss of their homes. The DHS inspector general, an independent oversight group that investigates government waste, fraud, and abuse of federal programs, investigated the allegations, and this report summarizes their findings.

On November 30, 2004, Ridge announced his resignation. On February 16, 2005, Michael Chertoff was unanimously confirmed by the Senate to lead the Department of Homeland Security. On July 13, 2005, Michael Chertoff released a six-point agenda that would be used to guide a reorganization of the department aimed at streamlining its efforts. According to the six-point agenda, the following changes were to be made:

- Increase overall preparedness, particularly for catastrophic events
- Create better transportation security systems to move people and cargo more securely and efficiently
- Strengthen border security and interior enforcement and reform immigration processes
- Enhance information sharing (with partners)
- Improve financial management, human resource development, procurement, and information technology within the department
- Realign the department's organization to maximize mission performance

As part of the proposed reorganization, virtually all of the remaining preparedness capabilities in FEMA, including the U.S. Fire Administration, were moved to the new Office of Preparedness. The exception was the Emergency Management Institute (EMI). Although the EMI training function was always considered part of preparedness, the senior-level FEMA officials argued that its courses supported response and recovery. A new FEMA office was to focus exclusively on response and recovery.

Under the initial DHS organization (Figure 1-2), the Emergency Preparedness and Response directorate contained most of the pre-DHS FEMA functions and staff. Under the Chertoff reorganization, EP&R was eliminated, and the director of FEMA, who was formerly the undersecretary for EP&R, would become an office director. The reorganization was somewhat unclear regarding who would be in charge in a disaster, since the responsibility for the new National Incident Management System (NIMS) was actually vested in the director of Operations Coordination.

Under the Chertoff reorganization, the structure of federal emergency management and disaster assistance functions was returned to pre-FEMA status. The responsibilities

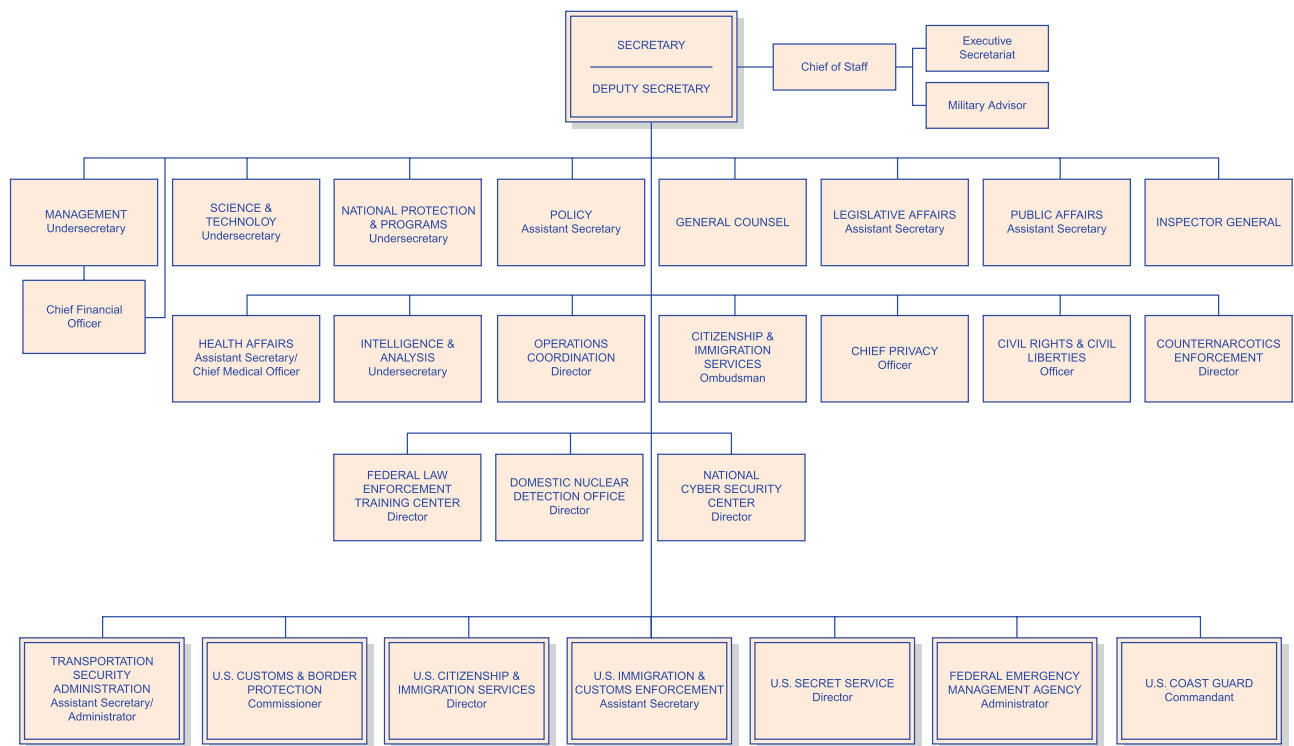


FIGURE 1-2 DHS organizational chart.

and capabilities for mitigation, preparedness, response, and recovery would now be spread out among several entities within the Department of Homeland Security. Policy decisions were exercised to focus most of the human and financial resources on catastrophic threats of bioterrorism and terrorism.

The situation at the time was very similar to the one that existed prior to the creation of FEMA in 1979. Federal emergency management and disaster assistance capabilities were located in numerous federal departments and agencies scattered across the federal government and in the White House. This time, however, instead of being scattered across the federal government, they were scattered within the fledgling Department of Homeland Security. Before this reorganization, FEMA programs were constantly being tasked and taxed to provide financial and human resources to support higher-priority programs in DHS. By taking apart the core programs of FEMA, it became even easier to reassign its resources and diminish its mission within DHS.

The Hurricane Katrina Debacle: 2005

As Secretary Chertoff proceeded with his reorganization, scientists like Max Mayfield (the director of the National Hurricane Center) predicted another active hurricane season. As always, the greatest fear was that a major storm would hit the Gulf Coast, particularly low-lying New Orleans.

Under James Lee Witt, a Category 5 hurricane impacting New Orleans was considered one of the three possible worst-case disaster scenarios. In fact, since the 1980s, FEMA funds had been used to contract multiple evacuation studies of the New Orleans area. In 1995, a national exercise of the Federal Response Plan entitled “Response 95” used a New Orleans hurricane scenario. This particular exercise was never completed because on the first day of play, a major flood event impacted the Gulf Coast (including the site of the exercise play, New Orleans) and abruptly ended the exercise.

Another disaster exercise termed “Hurricane Pam” was convened and completed in July 2004 with appropriate follow-up requirements to correct the problems and deficiencies discovered during the previous exercise. Unfortunately, the funding to support these corrective actions, which had been adequately budgeted by FEMA, became part of a funding reallocation requested of FEMA by DHS management to support other DHS priorities.

The “Senate Report on Katrina” best describes what occurred during those fateful hours and days in late August. The specific danger Katrina posed to the Gulf Coast became clear on the afternoon of Friday, August 26, when forecasters at the National Hurricane Center and the National Weather Service saw that the storm was turning west. Phone calls were immediately made to Louisiana emergency management officials, and in their 5 p.m. EDT Katrina forecast and accompanying briefings, the meteorologists alerted both Louisiana and Mississippi that the track of the storm was expected to shift significantly to the west of its original track to the Florida panhandle. The National Hurricane Center warned that Katrina could be a Category 4 or even 5 by landfall. By the next morning, Weather Service officials confirmed that New Orleans was squarely at risk.

Over the weekend, the drumbeat of warnings continued. FEMA held videoteleconferences on both days, discussing the potential dangers of Katrina and especially the risks to New Orleans. Max Mayfield of the Hurricane Center called the governors of the affected states, something he had only done once before in his 33-year career, and President Bush took the unusual step of declaring a disaster in advance of an emergency event for the states in the projected impact zone.

Hurricane Katrina made landfall in Buras, Louisiana, on Monday, August 25, 2005. At the time it was reported as a Category 4 storm when it made landfall. The National Hurricane Center would later downgrade it to a Category 3 storm. In any event, it was considered an extremely dangerous storm by weather forecasters and the National Hurricane Center. It impacted a broad geographic area stretching from Alabama to coastal Mississippi and southeast Louisiana, an estimated 90,000 square miles. In May 2006, the death toll from the storm was 1,856, with another 705 individuals listed as missing (Figure 1-3).

The storm impacted over 1.5 million people and displaced more than 800,000 citizens. The U.S. Coast Guard rescued over 24,273 people, and FEMA search and rescue teams rescued nearly 6,600 persons. Federal government disaster relief expenses are expected to exceed \$100 billion, and the insurance losses are expected to exceed \$35 billion. The National Flood Insurance Program paid more than \$16.1 million to over 205,000 people who filed claims related to Katrina. Forty-four states and the District of Columbia received emergency declarations to cover their expenses for sheltering millions of evacuees who had to be transported out of the Gulf.



FIGURE 1-3 New Orleans, Louisiana, on September 18, 2005. This shows the damages to homes and property in the lower ninth ward due to Hurricane Katrina. The markings on these houses were made by the search and rescue teams who looked for survivors after the storm. Searchers wrote the date the house was searched, the time, which search party was involved, any survivors found, and any animals that were still in the house. From Andrea Booher/FEMA.

By any account, Hurricane Katrina was a massive storm, deadly and destructive. It served to expose severe cracks in the nation's emergency management system and its ability to respond to a catastrophic event. Government after-action reports, which are done after most disasters, and media accounts have judged the response a failure, and the recovery phase is considered to show the same level of incompetence. Changes that had been made to Louisiana's coastal landscape, particularly the loss of wetlands and increased channelization, made New Orleans and the Louisiana coast more vulnerable to hurricanes. Design and construction decisions on the levee system and inadequate maintenance of that system contributed to the impacts of Katrina.

The storm challenged the capacities and capabilities of emergency management operations at all levels of government. The lack of planning for the Superdome as the designated shelter of last resort for New Orleans and the subsequent problems that occurred in that facility provided the most visible demonstration of the failed capacities. Many of the problems of the immediate response exposed the impacts of priority focus on terrorism and homeland security in recent years and may have contributed to the decrease in these capacities and capabilities.

Elected officials at all levels of government stumbled badly as they tried to provide leadership in the face of this disaster. The business community, voluntary agencies, and nongovernmental organizations (NGOs) stepped up to provide extraordinary services to storm victims. The general public, corporations, unions, and foundations donated billions of dollars for disaster relief.

Despite the understanding of the Gulf Coast's particular vulnerability to hurricane devastation, officials braced for Katrina with full awareness of critical deficiencies in their plans and gaping holes in their resources. While Katrina's destructive force could not be denied, state and local officials did not marshal enough of the resources at their disposal. Adding to these shortfalls, years of inadequate funding of federal, state, and local emergency functions left them incapable of fully carrying out their missions to protect the public and care for victims.

ADDITIONAL RESEARCH

In the aftermath of Katrina, both houses of Congress held extensive hearings on what went wrong. The Senate report, "The Senate Committee on Homeland Security and Governmental Affairs. 2006. Hurricane Katrina: A Nation Still Unprepared," provides insight into the results of the hearings and deliberations.

http://hsgac.senate.gov/_files/Katrina/ExecSum.pdf

More than 1,800 people died from Hurricane Katrina, and tens of thousands were displaced and suffered for days in places like the Superdome, on freeway ramps, and on tops of roofs while waiting to be rescued. Thousands lost their homes and were separated from loved ones. The dislocation, chaos, and desperation that lingered for months after the storm were direct results of the failure of government at all levels to plan, prepare for, and respond aggressively to the storm. Failure can be assessed at all levels, but when

President Bush signed the federal declaration of disaster and announced it *before* Katrina even made landfall, the federal government, through DHS/FEMA, assumed the primary responsibility for the stewardship of the response to this storm's aftermath. And by any objective evaluation of the response, it was a colossal failure.

The Steps Leading to the Katrina Debacle

In many respects, FEMA's failures after Katrina were a predictable outgrowth of steps that were taken in the aftermath of September 11. FEMA lost its status as an independent agency—and its direct access to the president—when it was absorbed into the newly created Department of Homeland Security (DHS). The director of FEMA was no longer on the same level as the cabinet secretaries whom FEMA had to task and direct during disasters. At the state level, many states created their own offices of homeland security that subsumed emergency management or were competitive structures, further complicating emergency response organization.

FEMA personnel and funds, including money for preparedness and mitigation intended for state and local agencies, were redistributed to support other higher priorities within DHS. The result of these actions was that the agency was even further hollowed out. The federal response plan was restructured into the National Response Plan to accommodate the new DHS arrangements and the operational oversight role of the department's secretary. A new level of bureaucracy was added with the creation of the principal federal officer (PFO) as the new coordinator in a disaster. Where previously the director of FEMA had maintained a clear line of authority and accountability, the existence of a new PFO created confusion over who would be in charge in a disaster. As a result, the necessary civilian and military assets were not deployed to facilitate the evacuations and provide supplies to the evacuation shelters before Katrina hit.

FEMA also failed to work with the governors on how to use the National Guard. Another factor in the post-Katrina fiasco was the dramatic post-9/11 change from a focus on "all-hazards" management—in which responders prepare for calamities according to plans that apply regardless of their precise nature—to a focus on terrorism that led to significantly weakened national capabilities. At all levels of government, approximately 75 percent of available resources for emergency management activities were applied to terrorism. Preparing, mitigating, or responding to natural disasters like floods, tornadoes, or hurricanes was subordinated to a narrow, if understandable, focus on terrorism. That reprioritization depleted the capabilities to respond to disasters at all levels of government.

Post-Katrina Changes

In the rush to examine and investigate what went wrong and to take corrective actions, both the House of Representatives and the Senate engaged in extensive hearings and investigations. The White House dispatched Frances Townsend, assistant to the president

ADDITIONAL RESEARCH

The Bush administration's report, "The Federal Response to Hurricane Katrina: Lessons Learned," was released in February 2006. It was a weighty document and included 125 recommendations and 11 critical actions that needed to be completed by June 1, the start of the 2006 hurricane season. Most of its recommendations have still not been implemented, but it remains a unique assessment of the federal government's role in disaster relief as far as the Bush administration was concerned.

for Homeland Security, to conduct a thorough review of what went wrong and to generate corrective recommendations.

These organizational and leadership issues were not easily swept under the rug. Senators Clinton and Mikulski introduced legislation to restore FEMA to its independent status and make the director's position a cabinet post. This legislation went nowhere. Powerful forces on the Senate Committee on Homeland Security blocked these efforts, particularly Senator Joe Lieberman, who had been instrumental in the DHS's creation and clearly did not want his creation tampered with. Lieberman was joined by Republican Committee Chair Susan Collins, who would not even consider moving FEMA out.

The 109th Congress, in response to hearings and reports, passed legislation that revised federal emergency management policies that vested more power in the president, reorganized FEMA, and enhanced and clarified the mission, functions, and authorities of both the agency and its parent organization, DHS.

Six statutes enacted by the 109th Congress are notable in that they contain changes that apply to future federal emergency management actions. These public laws include the following:

- The Post-Katrina Emergency Management Reform Act of 2006
- The Security and Accountability for Every Port Act of 2005, known as the SAFE Port Act
- The Pets Evacuation and Transportation Standards Act of 2006
- The Federal Judiciary Emergency Special Sessions Act of 2005
- The Student Grant Hurricane and Disaster Relief Act
- The John Warner National Defense Authorization Act for Fiscal Year 2007

Most of these statutes contain relatively few actual changes to federal authorities related to emergencies and disasters. The Post-Katrina Emergency Management Reform Act of 2006 (commonly known as PKEMRA), however, contains many changes that have long-term consequences for FEMA and other federal entities. That statute reorganizes FEMA, expands its statutory authority, and imposes new conditions and requirements on the operations of the agency. In addition to the public laws just listed, Congress enacted supplemental appropriations, one-time waivers of requirements, and temporary extensions solely associated with Hurricanes Katrina, Rita, and Wilma.

ADDITIONAL RESEARCH

The Congressional Research Service's publication "Federal Emergency Management Policy Changes after Hurricane Katrina—A Summary of Statutory Provisions" is an excellent report that identifies the requirements and changes for FEMA, DHS, and federal emergency management policies and programs under PKEMRA.

<http://www.fas.org/sgp/crs/homesecc/RL33729.pdf>

In summary, PKEMRA requires that DHS reconsolidate all of the emergency management functions (including preparedness) into FEMA, elevates the status of FEMA within the department, protects the FEMA assets from reassignment within DHS, and gives FEMA enhanced organizational autonomy. In addition, the act provides for FEMA to maintain ten regional offices. It adds to FEMA a National Advisory Council, Regional Advisory Councils, a disability coordinator, a small state and rural advocate, and regional strike teams. They provide autonomy for the FEMA administrator (formerly director) to communicate directly with Congress.

After Mike Brown resigned (or was terminated), David Paulison became FEMA administrator. Paulison had served as U.S. Fire Administrator and had a long and distinguished career in the fire service in Florida. His elevation to the top position was well received by the fire service constituencies, who had long felt that they had not received their due within FEMA and the emergency management community. Harve Johnson, a former admiral in the Coast Guard, was appointed deputy administrator.

The new leadership came with the firm mandate to prevent another Katrina. To do so, FEMA leadership took a very different approach to the emergency management partnership with both state and locals. FEMA instituted the "new FEMA"—a top-down approach in which federal requirements for response planning and operations were imposed on state and local emergency management operations as a condition of receiving federal resources.

The Integrated Planning System that was created included different planning parameters than those used by state and local emergency planners in their certifications. State and local compliance with the National Information Management System (NIMS) was made a condition for continued funding. The old system in which the federal government supplemented state and local efforts and worked in partnership was replaced by a system where in a major disaster the federal government took charge and supplanted state and local authorities. To support this change, FEMA was able to substantially increase its staff in both its headquarters and the regions, and many of the new senior managers who were hired came from organizations such as the Coast Guard and the military, where federal supremacy and authority were the normal operational parameters.

At the direction of DHS leadership, at the federal level, FEMA concentrated on remaking the National Response Plan into a National Response Framework (NRF) that blurred the lines of responsibility among the federal partners in responding to disasters. Under the

new NRE, DHS/FEMA assumed many more responsibilities such as acting as the lead federal agency for Mass Care, an Emergency Support Function (ESF) previously led by the American Red Cross (ARC). On the other hand, DHS/FEMA used the PKEMRA requirements to deflect problem areas such as postdisaster housings.

PKEMRA called for a new strategy for disaster housing, and FEMA engaged other federal agencies, specifically the Department of Housing and Urban Development (HUD), in development of this strategy and taking on a major role in providing postdisaster housing. This change in responsibility was piloted during the Texas disasters of 2008 to mixed results. A more complete discussion of this follows in later chapters of the text. Although the new FEMA was never really tested, problems persisted. Major portions of the Katrina recovery continued to languish, especially in New Orleans, the morale in FEMA was at an all-time low, and a federal, state, and local partnership on emergency management still did not exist.

CRITICAL THINKING

What do you think could have been done in the years preceding hurricane Katrina to better prepare the states to deal with this kind of event? Do you think that this event was so large that only a federal response could have managed it? Explain your answer.

The Future Environment of Emergency Management

Emergency management issues did not play a prominent role in the presidential election of 2008. The issue of the failed response to Katrina and the slow recovery were certainly a part of the campaign dialogue, and both presidential nominees visited New Orleans and vowed to speed up the recovery. Barack Obama's election represented a change from the past, including a change for emergency management. Although Obama's administration discussed removing FEMA from DHS and returning it to its former position as an independent agency, this was not to be. Janet Napolitano, secretary of DHS, strongly believed that FEMA was an essential part of DHS. She was committed to finding the right administrator for FEMA and chose W. Craig Fugate, former state director of Emergency Management from Florida (Figure 1-4). Fugate brought excellent credentials and extensive operational experience to the position. Florida was one of the premier state emergency management organizations in the United States, and although Fugate had been a strong proponent of moving FEMA out of DHS, he accepted the position and was easily confirmed by the Senate.

At his confirmation hearing and in subsequent speeches, Fugate has said that he wants to make a culture of preparedness—especially personal preparedness—a hallmark of his FEMA tenure. As a result, he has changed the vocabulary of disasters, referring to individuals impacted by disasters as “survivors” instead of “victims.”

His team includes several veterans of the 1990s Witt years, and he strongly supports rebuilding the partnership with state and local emergency management organizations.



FIGURE 1-4 Washington, D.C., August 10, 2009. FEMA administrator W. Craig Fugate makes opening remarks at the 2009 Conference on Community Preparedness in Arlington, Virginia. FEMA/Bill Koplit.

His ability to rebuild FEMA into a strong, well-managed, and responsive organization, however, has yet to be determined. The 2009 hurricane season was one of the calmest in decades, and the H1N1 flu outbreak was addressed, so Fugate's agency has not yet responded to a major disaster. The recent reorganization seems to indicate a consolidation of the response-and-recovery functions under a single directorate led by Bill Carwile, an ex-federal coordinating officer with substantial response experience.

Yet, questions remain about Fugate's strategic vision for the agency. Although a strong supporter of mitigation while in Florida, the political head of the mitigation division remains unfilled a year after the presidential election, and Fugate has expressed concerns about the NFIP, whose floodplain management requirements in exchange for subsidized insurance coverage remain a primary implementing program for community mitigation.

FEMA's future role in disaster housing and long-term recovery is also cloudy. FEMA initiated activities to develop a national disaster recovery framework to complement the national response framework and to support the requirements of PKEMRA. At the same time, the White House established a White House Working Group on Recovery, with a report due to the president in early 2011. The White House Working Group is cochaired by the secretaries of DHS and HUD. If one wanted to speculate, it would be easy to see that certain, if not all, recovery programs may be moving over to HUD sometime in the future. This is an interesting turn, since many of these programs were taken out of HUD because they couldn't execute them and didn't have the connections at the state level to make them work.

Another factor that will influence the Fugate term as administrator is the continuing question of the role of the military, particularly the Northern Command (NORTHCOM), in future disasters. NORTHCOM is actively working with, and in some cases supplying

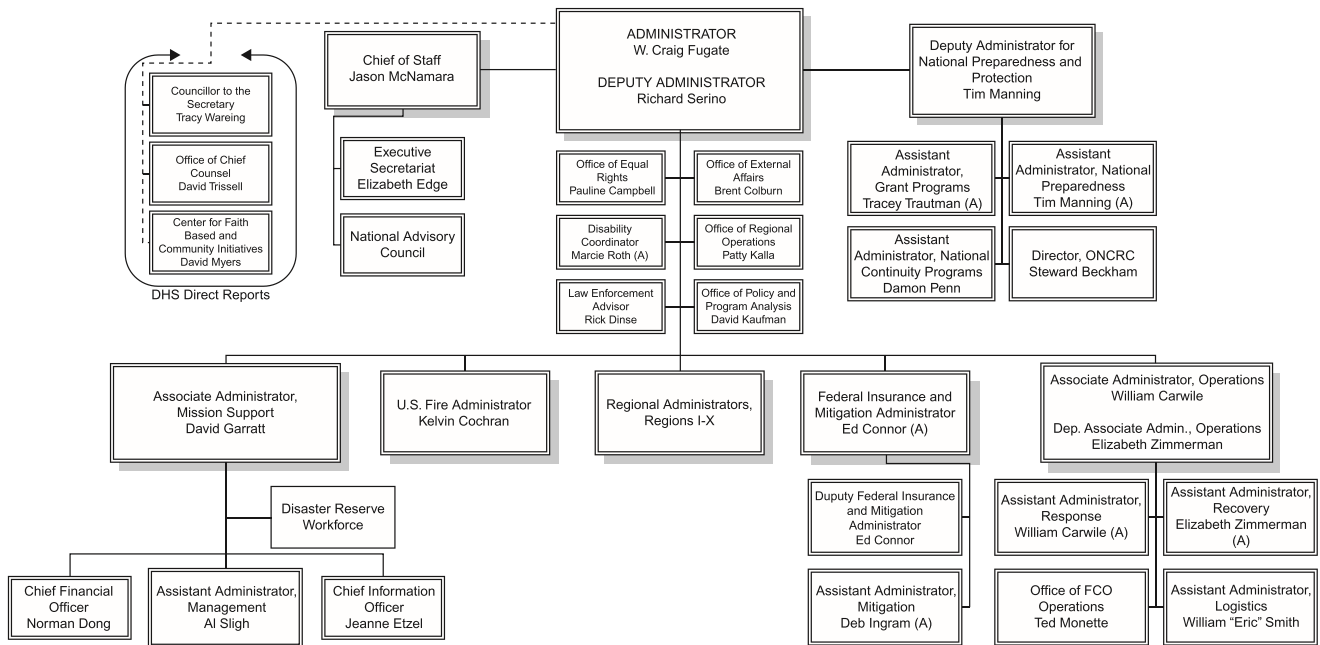


FIGURE 1-5 FEMA organizational chart.

personnel to, the states to do catastrophic planning. Whether they are looking to support disaster in other than the typical role of logistical support as performed by the Army Corps of Engineers is still in question.

In the last chapter, we will explore historical context and what recent actions and policies may suggest for the future of emergency management. The chapter will discuss possible trends that may make emergency management a more viable, proactive discipline as opposed to the reactive discipline that changes only in response to major events or disasters. Finally, as we have done in previous editions of this book, we will speculate on what the future may hold for the discipline based on the authors' combined experience of over 100 years of working in emergency management.

Important Terms

Civil defense
 Department of Homeland Security
 Emergency management
 Federal Emergency Management Agency

Self-Check Questions

1. What are some of the first examples of emergency management?
2. According to the Constitution, does the federal government have a primary or secondary role in managing public risks?
3. What is the significance of the Flood Control Act of 1934?
4. How did the Cold War era contribute to the evolution of modern emergency management?
5. What disaster led to the creation of the National Flood Insurance Program?
6. Describe the events of the 1970s that led to the creation of FEMA.
7. Why was FEMA an agency in trouble at the close of the 1980s?
8. How did James Lee Witt improve FEMA?
9. What changes did the creation of the Department of Homeland Security bring about for the federal emergency management capacity?
10. List the steps involved in the creation of the Department of Homeland Security.
11. Why was the response to Hurricane Katrina so ineffective?
12. How did the poor response to the Hurricane Katrina disaster change emergency management in the United States?
13. What area of emergency management did DHS/FEMA seek to emphasize in 2009?
14. What changes to disaster recovery programs were being proposed in 2009?

Out-of-Class Exercise

Investigate how civil defense and emergency management evolved in your state or city. Look at such factors as when it was created, its original purpose, and what it accomplished. Find out how this organization changed following the creation of FEMA. Find out who your local or state emergency manager is, and where he/she falls within the organizational diagram of your municipal or state leadership. Is there an online profile or biography for this person? If so, what emergency management experience does he/she have that makes him/her qualified for the job?

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Natural and Technological Hazards and Risk Assessment

What You Will Learn

- The range of natural hazards that affect the United States
- Scales and systems used to measure the magnitude of hazards and disasters
- Technological hazards and their causes and effects
- The terrorist threat, including weapons of mass destruction
- How hazard risks are assessed
- Social and economic risk factors and how they influence a community's risk profile

Introduction

A *hazard* is defined as a “source of danger that may or may not lead to an emergency or disaster” (National Governors Association, 1982), and it is named after the emergency/disaster that could be so precipitated. Each hazard carries an associated *risk*, which is represented by the likelihood of the hazard leading to an actual disaster event and the consequences of that event should it occur. The product of realized hazard risk is an emergency event, which is typically characterized as a situation exhibiting negative consequences that require the efforts of one or more of the emergency services (fire, police, EMS, public health, or others) to manage. When the response requirements of an emergency event exceed the capabilities of those established emergency services in one or more critical areas (e.g., shelter, fire suppression, mass care), the event is classified as a *disaster*.

Hazard identification is the foundation of all emergency management activities. When hazards react with the human or built environments, their associated likelihood and consequence risk factors can be assessed. Knowledge about the risk posed by identified hazards becomes the basis of preparedness planning and mitigation actions. And it is the realization of risk, such as what occurs when an earthquake, tornado, flood, or other hazard event is experienced, that emergency response and recovery capabilities and resources are called upon. In modern emergency management, all activities are predicated on the accurate and effective identification and assessment of hazards and risks.

This chapter discusses the full range of existing hazards, both natural and technological, and the methods by which associated hazard risk may be assessed. For each hazard, a brief description of the hazard and its effects is provided, as well as information on hazard detection and classification.

Natural Hazards

Natural hazards are those that exist in the natural environment as a result of hydrological, meteorological, seismic, geologic, volcanic, mass-movement, or other natural processes, and that pose a threat to human populations and communities. Natural hazards are often intensified in scope and scale by human activities, including development and modification of the landscape and atmosphere. For example, the construction of communities in the floodplain or on barrier islands almost always increases risk associated with hurricane-force winds, flooding, and storm surge. When structures are constructed on or around seismic faults, the likelihood that they will be destroyed in a future earthquake event is greatly increased. Through better understanding of natural hazards, and the processes by which they affect the human and built environments, societies can better plan for these stressors and reduce vulnerability (Chapter 3 examines how humans can better live with hazards).

Floods

A flood is an overabundance of water that engulfs dry land and property that is normally dry. Floods may be caused by a number of factors, including heavy rainfall, melting snow, an obstruction of a natural waterway, and other generative factors. Floods usually occur from large-scale weather systems generating prolonged rainfall or onshore winds, but they may also result from locally intense thunderstorms, snowmelt, ice jams, and dam failures. Floods are capable of undermining buildings and bridges, eroding shorelines and riverbanks, tearing out trees, washing out access routes, and causing loss of life and injuries. Flash floods usually result from intense storms dropping large amounts of rain within a brief period, occur with little or no warning, and can reach full peak in only a few minutes (Figure 2-1).

Floods are the most frequent and widespread disaster in many countries around the world, including the United States, due to the prevalence of human development in the floodplain. The close relationship between societies and water is the result of commerce (the transportation of goods has most commonly been conducted by water), agriculture, and access to drinking water. The adverse implication of this relationship has been a global increase in exposure to flood events. FEMA estimates that approximately 8 to 10 million households are at risk from flooding in the United States alone, which sustain an average of \$2 billion to \$3 billion in losses each year. Flood losses paid by FEMA's National Flood Insurance Program in the 1990s totaled in the billions of dollars (Table 2-1).



FIGURE 2-1 Georgia, September 22, 2009. Floodwaters covered parts of roller coasters at the Six Flags Over Georgia amusement park following heavy rain on September 20–21.
Photo by Bruce Kinney.

Table 2-1 Top Ten U.S. Flood Disasters, 1900–2009 (by Total Cost of National Flood Insurance Program Losses Paid)

Event	Date	Number of Paid Losses	Amount of Paid Losses
Hurricane Katrina	August 2005	166,792	\$16,075,081,110
Hurricane Ike	September 2008	45,244	\$2,468,281,985
Hurricane Ivan	September 2004	27,599	\$1,575,656,693
Tropical Storm Allison	June 2001	30,662	\$1,103,774,388
Louisiana Flood	May 1995	31,343	\$585,072,008
Hurricane Isabel	September 2003	19,853	\$491,844,143
Hurricane Rita	September 2005	9,480	\$465,070,605
Hurricane Floyd	September 1999	20,439	\$462,270,253
Hurricane Opal	October 1995	10,343	\$405,528,543
Hurricane Hugo	September 1989	12,843	\$376,493,066

Source: FEMA. 2010. *Significant Flood Events: 1978–January 2010. National Flood Insurance Program.* <http://www.fema.gov/business/nfip/statistics/sign1000.shtm>

Floods are typically measured according to their elevation above standard water levels (of rivers or coastal water levels). This elevation is translated into the annualized likelihood of reaching such heights. For example, a flood depth that has a 1 percent chance of being reached or could be expected to occur once across a 100-year period would be considered a “100-year flood event.” Typically, structures that are contained within areas likely to experience flooding in a 100-year flood event are considered to be within the

ADDITIONAL RESEARCH

The following reports provide supplemental information about annualized flood losses in the United States:

Compilation of Flood Loss Statistics (The National Weather Service):

http://www.nws.noaa.gov/hic/flood_stats/Flood_loss_time_series.shtml

Flood Damage in the United States, 1926–2000—A Reanalysis of National Weather Service Estimates (Pielke, Roger A., Mary W. Downton, and J. Zoe Barnard Miller, 2002):

<http://www.flooddamagedata.org/flooddamagedata.pdf>

floodplain. Governments in many countries maintain river and stream gauges to monitor floodwater elevations and to provide information on rising water for use in sandbagging and dyke construction. Such information also allows for early warning and evacuation to occur.

Earthquakes

An earthquake is a sudden, rapid shaking of the earth's crust that is caused by the breaking and shifting of rock beneath the earth's surface. This shaking can cause the collapse of buildings and bridges; cause disruptions in gas, electric, and phone service; and trigger landslides, avalanches, flash floods, fires, and huge, destructive ocean waves (tsunamis). Structures constructed on unconsolidated landfill, old waterways, or other unstable soil are generally at greatest risk unless seismic mitigation has been utilized. Seismicity is not seasonal or climate dependent and can therefore occur at any time of the year (Figure 2-2).

Each year, knowledge about the location and behavior of the earth's seismic zones increases thanks to improvements in seismic detection and monitoring. Over one billion people worldwide live in seismic zones. Earthquake damage can be extensive, especially when buildings have been constructed without incorporation of seismic-resistant materials and designs. Earthquakes can cause secondary fire hazards when gas lines are severed and flammable materials storage sites are compromised. These fires can spread rapidly among damaged buildings because water systems may be damaged and fire services are either unable to access the fire or are overwhelmed by other response requirements. Fire was a leading cause of thousands of deaths in 1995 when an earthquake struck Kobe, Japan, because debris from damaged and destroyed buildings blocked many access points for firefighters and equipment.

Earthquakes are sudden, no-notice events despite scientists' and soothsayers' best efforts to predict when they will occur. Seismic sensing technology is effective at measuring and tracking seismic activity, but it has yet to accurately predict a major seismic event with any degree of accuracy.



FIGURE 2-2 Atascadero, California, January 25, 2004. This home slid two feet off its foundation due to the 6.5 San Simeon earthquake.

Photo by Dane Golden/FEMA News Photo.

Each year hundreds of earthquakes occur in the United States, though the vast majority are barely perceptible. As earthquake strength increases, its likelihood of occurrence decreases. Major events, which are greater than 6.5 to 7 on the Richter scale, occur only once every decade or so, but such events have been among the most devastating in the experience of the United States. The Northridge earthquake that struck California in 1994, for instance, is the second most expensive natural disaster to ever occur in the United States as ranked by FEMA relief costs, resulting in almost \$7 billion in federal funding (and second only to Hurricane Katrina).

The strength and effects of earthquakes are commonly described by the Richter and Modified Mercalli Intensity (MMI) scales. The Richter scale, designed by Charles Richter in 1935, assigns a single number to quantify the strength and effect of an earthquake across the entire area affected according to the strength of ground waves at its point of origin (as measured by a seismograph). Richter magnitudes are logarithmic and have no upper limit. The MMI also measures the effects of earthquakes, but rather than applying a single value to the event, it allows for site-specific evaluation according to the effects observed at each location. The MMI (Table 2-2) rates event intensity using Roman numerals I through XII. Determinations are generally made using reports by people who felt the event and observations of damages sustained by structures.

CRITICAL THINKING

It is possible to assign Modified Mercalli Intensity values to historical earthquakes, but Richter magnitudes cannot be retroactively assigned. Why do you think this is true? Which of these scales is more useful in terms of disaster planning? Why?

Table 2-2 Modified Mercalli Intensity Scale

MMI Intensity	Damages Sustained and Sensations Experienced	Richter Scale Equivalent
I–IV (Instrumental to Moderate)	No damage sustained. Sensation ranges from imperceptible to that of a heavy truck striking the building. Standing motor cars may rock.	≤ 4.3
V (Rather Strong)	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.	4.4–4.8
VI (Strong)	Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.	4.9–5.4
VII (Very Strong)	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.	5.5–6.1
VIII (Destructive)	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.	6.2–6.5
IX (Ruinous)	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.	6.6–6.9
X (Disastrous)	Most masonry and frame structures/foundations destroyed. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Sand and mud shifting on beaches and flat land.	7.0–7.3
XI (Very Disastrous)	Few or no masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Widespread earth slumps and landslides. Rails bent greatly.	7.4–8.1
XII (Catastrophic)	Damage nearly total. Large rock masses displaced. Lines of sight and level are distorted. Objects are thrown into the air.	≥ 8.1

Source: USGS, 2009. Magnitude/Intensity Comparison. Earthquake Hazards Program. http://earthquake.usgs.gov/learn/topics/mag_vs_int.php

Hurricanes

Hurricanes are cyclonic storms that begin as tropical waves and grow in intensity and size. Tropical waves continue to progress in size and intensity to tropical depressions and tropical storms as determined by their maximum sustained wind speed. The warm-core tropical depression becomes a tropical storm when the maximum sustained surface wind speeds range from 39 miles per hour to 73 miles per hour (mph). Tropical cyclonic storms are defined by their low barometric pressure, closed-circulation winds originating over tropical waters, and an absence of wind shear. Cyclonic storm winds rotate counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

A hurricane is a cyclonic tropical storm with sustained winds measuring 74 mph or more. Hurricane winds extend outward in a spiral pattern as much as 400 miles around

Table 2-3 The Saffir–Simpson Scale

Category	Conditions	Effects
1	Wind Speed: 74–95 mph Storm Surge: 4–5 feet above normal	Primary damage to unanchored mobile homes, shrubbery, and trees. Some coastal flooding and minor pier damage. Little damage to building structures.
2	Wind Speed: 96–110 mph Storm Surge: 6–8 feet above normal	Considerable damage to mobile homes, piers, and vegetation. Coastal and low-lying area escape routes flood 2–4 hours before arrival of hurricane center. Buildings sustain roofing material, door, and window damage. Small craft in unprotected mooring break moorings.
3	Wind Speed: 111–130 mph Storm Surge: 9–12 feet above normal	Mobile homes destroyed. Some structural damage to small homes and utility buildings. Flooding near coast destroys smaller structures; larger structures damaged by floating debris. Terrain continuously lower than 5 feet above sea level (ASL) may be flooded up to six miles inland.
4	Wind Speed: 131–155 mph Storm Surge: 13–18 feet above normal	Extensive curtain wall failures, with some complete roof structure failure on small residences. Major erosion of beaches. Major damage to lower floors of structures near the shore. Terrain continuously lower than 10 feet ASL may flood (and require mass evacuations) up to 6 miles inland.
5	Wind Speed: Over 155 mph Storm Surge: Over 18 feet above normal	Complete roof failure on many homes and industrial buildings. Some complete building failures. Major damage to lower floors of all structures located less than 15 feet ASL and within 500 yards of the shoreline. Massive evacuation of low-ground, residential areas may be required.

Source: FEMA.

a relatively calm center of up to 30 miles in diameter known as the “eye.” Hurricanes are fed by warm ocean waters. As these storms make landfall, they often push a wall of ocean water known as a “storm surge” over coastal zones. Once over land, hurricanes cause further destruction by means of torrential rains and high winds. A single hurricane can last for several weeks over open waters and can run a path across the entire length of the eastern seaboard.

Hurricane season runs annually from June 1 through November 30. August and September are peak months during the hurricane season. Hurricanes are commonly described using the Saffir–Simpson scale (Table 2-3).

Hurricanes are capable of causing great damage and destruction over vast areas. Hurricane Floyd in 1999 first threatened the states of Florida and Georgia, made landfall in North Carolina, and damaged sections of South Carolina, North Carolina, Virginia, Maryland, Delaware, New Jersey, New York, Connecticut, Massachusetts, and Maine. The damage was so extensive in each of these states that they all qualified for federal disaster assistance. Single hurricanes can affect several countries, as was the case with Hurricane Mitch, which brought death and destruction to Nicaragua, Guatemala, El Salvador, and Honduras.

Table 2-4 Top Ten Most Expensive U.S. Hurricanes, 1900–2006 (Ranked by FEMA Relief Costs)

Hurricane	Year	Category	Damage (in billions)
Hurricane Katrina—FL, AL, LA, MS	2005	3	\$29,319
Hurricane Rita—TX, LA	2005	5	\$3,750
Hurricane Ivan—AL, FL, GA, LA, MS, NJ, NY, NC, PA, TN, WV	2004	3	\$2,431
Hurricane Georges—AL, FL, MS, PR, VI	1998	4	\$2,245
Hurricane Wilma—FL	2005	5	\$2,111
Hurricane Charley—FL, SC	2004	4	\$1,885
Hurricane Andrew—FL, LA	1992	5	\$1,814
Hurricane Francis—FL, GA, NY, NC, OH, PA, SC	2004	4	\$1,773
Hurricane Jeanne—DE, FL, PR, VI, VA	2004	3	\$1,407
Hurricane Hugo—NC, SC, PR, VI	1989	4	\$1,307

Sources: FEMA, 2009. "Most Expensive Presidentially Declared Disasters." <http://www.fema.gov/hazard/hurricane/top10hu.shtml>; FEMA, 2009. "Top Ten Natural Disasters Ranked by FEMA Relief Costs." <http://www.fema.gov/hazard/topten.shtml>.

The costliest disaster in U.S. history in pure dollar figures (approximately \$80 billion; Reuters, 2009) and one of the deadliest in terms of lives lost and injuries sustained (1,836 killed) was Hurricane Katrina (Table 2-4). Katrina reached Category 5 status with sustained winds of over 175 mph—making it the fourth strongest hurricane recorded at the time—before making landfall as a Category 3 hurricane along the Gulf of Mexico coast. With strong winds and a storm surge reaching 28 feet, Katrina devastated coastal communities in Alabama, Florida, Mississippi, and Louisiana. Flooding and near total destruction was sustained in almost 80 percent of New Orleans and much of Biloxi/Gulfport, Mississippi. The storm went on to cause further destruction in several other states as it made its way north toward Canada. Four years later, many of the Gulf Coast areas—especially hard-hit New Orleans—are still reeling from this disaster event, with full recovery years or even decades away.

CASE STUDY: THE IMPACT OF THE STORM

Hurricane Katrina impacted different areas in different ways. Along the Mississippi Gulf Coast, Katrina generated a 25- to 30-foot tidal surge that swept away structures and vehicles in its path. Hotels and casinos located on the Gulf were severely damaged, and in some cases entire communities disappeared. In New Orleans, the principle impact was the flooding caused by the breaches in the levees that left almost 80 percent of the city underwater for up to six weeks.

However, some sections of the city—notably those areas closest to the river such as the French Quarter—experienced very little if any flooding. Tidal surge was only a factor in the Lower Ninth Ward section of the city, which, together with St. Bernard Parish, experienced the tidal surge that traveled up the Mississippi River Gulf outlet. Wind and rain caused considerable damage to homes and businesses throughout the region.

Over 1.3 million people evacuated before Katrina even made landfall, and an estimated 800,000 people were displaced for an extended period of time. As of April 2010, the Census Bureau estimated the population of the city of New Orleans to be just under 355,000, or just three-quarters its pre-Katrina size (Robertson, 2010). However, the true size will not be known for certain until the 2010 Census results are released in early 2011.

Critical infrastructures such as water, power, communications, schools, hospitals, and child care were severely damaged and disrupted in all impacted areas. Government facilities and private industry suffered massive losses. The White House report on Katrina, “The Federal Response to Hurricane Katrina: Lessons Learned,” estimated damage to housing at \$67 billion, business property suffered \$20 billion in damages, and government property suffered an estimated \$3 billion in damages (Townsend, 2006). Insured losses from Katrina are estimated to be the greatest ever in U.S. history.

THE HURRICANE KATRINA TIMELINE

The following is a timeline of events starting with the initial formation of Hurricane Katrina as Tropical Depression 12 through the first days following Katrina making landfall on August 29, 2005. This timeline was compiled from several sources including FEMA, The Brookings Institution, and CNN. The U.S. Senate prepared an after-action report entitled “Hurricane Katrina: A Nation Still Unprepared.”

- *Tuesday, August 23:* Tropical Depression 12 forms about 200 miles southeast of the Bahamas; what was to become Hurricane Katrina is first recognized as a potential hazard.
- *Thursday, August 25:* Tropical Storm Katrina becomes Hurricane Katrina. A Category 1 hurricane with sustained winds in excess of 74 mph moves across South Florida and into the Gulf of Mexico. Katrina is now over the warm waters of the Gulf, where it begins to strengthen, and early tracks by the National Hurricane Center show Katrina making landfall “between Mobile, Alabama, and Grand Isle, Florida.”
- *Friday, August 26:* The hurricane track shifts twice during the day; first projected to make landfall on the Mississippi-Alabama border and later in the day projected to make landfall on the Louisiana-Mississippi border. The governors of both Louisiana and Mississippi declare a state of emergency and activate their state National Guards.
- *Saturday, August 27:* Katrina, now a Category 4 or 5 storm, is expected to hit New Orleans, and Governor Blanco requests a declaration of a federal state of emergency for Louisiana, which President Bush approves that same day. New Orleans Mayor Nagin declares a state of emergency, and evacuations begin in Louisiana and Mississippi.
- *Sunday, August 28:* Mayor Nagin issues a mandatory evacuation order. The Superdome opens as a shelter of last resort, and by the end of the day 10,000 people and 150 National Guardsmen are in the Dome; evacuation all along the Gulf Coast continues.
- *Monday, August 29:* Katrina, now a Category 4 hurricane with 145 mph winds makes landfall in lower Plaquemines Parish, Louisiana, between 6:00 and 7:00 a.m. CST. Major disaster declarations are signed by President Bush, levees in New Orleans are breached, and floodwaters begin to fill sections of the city. The Coast Guard begins rescue operations in New Orleans.

- *Tuesday, August 30:* Floodwaters cover up to 80 percent of the city. An estimated 50 to 100,000 people are trapped in the city, including the Superdome and Convention Center. Governor Blanco issues an order to evacuate the Superdome. The Coast Guard rescue continues, and widespread looting is reported.
- *Wednesday, August 31:* Governor Blanco and President Bush discuss military assistance and decide who should be in charge of the National Guard. The Houston Astrodome prepares to receive evacuees from Katrina.
- *Thursday, September 1:* 45,000 people are now housed in the Superdome and the Convention Center; bus evacuation of populations in New Orleans begins. DHS secretary Chertoff and FEMA director Brown indicate they were unaware of any problems at the Convention Center.
- *Friday, September 2:* President Bush makes his first visit to the disaster area, meeting with both governors and Nagin. The number of National Guard troops deployed is increased, and Congress approves \$10.5 billion in immediate relief.
- *Saturday, September 3:* 40,000 National Guardsmen are now deployed to the Gulf Coast. President Bush orders 7,200 active duty military to the Gulf, and the evacuations of the Superdome and the Convention Center are completed.
- *Monday, September 5:* The gap in the levee is closed, but more levee repairs are required. The Bush-Clinton Fund is announced, and President Bush dispatches 4,700 additional active military troops.
- *Tuesday, September 6:* The Corps of Engineers begins pumping water out of New Orleans, and Mayor Nagin authorizes troops and police to remove individuals from the city.
- *Thursday, September 8:* Congress approves President Bush's request for \$52 billion in additional aid.

In recent years, significant advances have been made in hurricane tracking technology and computer models. The National Hurricane Center in Miami, Florida, now tracks tropical waves from the moment they form off the coast of West Africa through their development as a tropical depression. Once the tropical depression grows to the strength of a tropical storm, the Hurricane Center assigns the storm a name. After the sustained wind speed exceeds 74 mph, the storm officially becomes a hurricane. The National Hurricane Center uses aircraft to observe and collect meteorological data on the hurricane and to track its movements across the Atlantic Ocean. It also uses several sophisticated computer models to predict the storm's path. These predictions are provided to local and state emergency officials to help them make evacuation decisions and to predeploy response and recovery resources.

Historically, high winds and flooding caused by storm surge have been the principal contributors to the loss of life and injuries and the property and infrastructure damage caused by hurricanes. Inland flooding caused by hurricane rainfall has also resulted in large losses of life and severe property damage, especially in zones of hilly or mountainous topography. Damage to the environment is another important factor related to hurricane-force winds and flooding. For instance, storm surges cause severe beach erosion, most

notably on fragile barrier islands. Inland flooding from Hurricane Floyd inundated waste ponds on hog farms in North Carolina, washing the hog waste into the Cape Fear River and ultimately into the ocean. The storm surge created by Hurricane Katrina has had a profound impact on the environment—in some cases completely erasing or altering coastal areas. Dauphin Island was literally pushed toward the land by the force of the surge, and the Chandeleur Islands were completely destroyed. Breton National Wildlife Refuge, one of 16 wildlife refuges damaged by the storm, lost over half of its area. Much of this land lost served as breeding grounds for marine mammals, reptiles, birds, and fish.

Storm Surges

Storm surges, defined as masses of water that are pushed toward the shore by meteorological forces, are the primary cause of the injuries, deaths, and structural damages associated with hurricanes, cyclones, nor'easters, and other coastal storms. When the advancing surge of water coincides with high tides, the resulting rise in sea level is further exacerbated. Storm surges may reach several dozen feet under the right conditions, as was the case in Hurricane Katrina. Wind-driven turbulence becomes superimposed on the storm tide, thereby causing further damage to structures that are inundated through wave action (each cubic yard of water results in 1,700 pounds of pressure on affected structures). The surge height at landfall is ultimately dictated by the expanse and intensity of the storm, the height of the tide at the time of landfall, and the slope of the sea floor approaching land. The longer and shallower the sea floor, the greater the storm surge will be.

Because much of the United States' densely populated Atlantic and Gulf Coast coastlines lie less than ten feet above mean sea level, storm surge risk is extreme. Hurricane Katrina served as a reminder of the speed and intensity of the storm surge threat that persists in greatest part due to increasing coastal development. After crossing southern Florida, Katrina followed a westward track across the Gulf of Mexico before turning northwest toward the Gulf Coast. The storm made its second landfall as a strong Category 4 hurricane in Plaquemines Parish, Louisiana, on August 29, 2005. When the storm made its third and final landfall along the Mississippi/Louisiana border, its hurricane-force winds extended up to 190 miles from the center of the storm, and tropical storm-force winds extended for approximately 440 miles. The strength and wide geographical area affected by the storm resulted in a surge greater than anything previously recorded along the Gulf Coast. A 30-foot storm surge, combined with very strong wave action and constant high winds, resulted in a magnitude of destruction never before experienced in the United States. The enormous pressure by the force of the storm surge on the levee system that protected New Orleans caused several breaches that flooded the city with as much as 20 feet of water in some areas. *USA Today* developed an animation showing how a hurricane causes a storm surge: <http://www.usatoday.com/graphics/weather/gralgsurge/flash.htm>.

The National Hurricane Center operates a computerized model, called SLOSH (Sea, Lake, and Overland Surges from Hurricanes), to estimate storm surge heights and

winds resulting from historical, hypothetical, or predicted hurricanes. When making calculations, SLOSH takes into account pressure, size, forward speed, track, and wind.

The model's output is a color-coded map indicating storm surge heights for defined areas in feet above the model's reference level. These calculations are applied to a specific locale's shoreline, incorporating the unique bay and river configurations, water depths, bridges, roads, and other physical features. When SLOSH is used to estimate storm surge from predicted hurricanes, forecast data are entered every 6 hours over a 72-hour period and updated as new forecasts become available. SLOSH is accurate within a range of 20 percent plus or minus what is actually observed. The model accounts for astronomical tides, but it does not consider rainfall, riverflow, or wind-driven waves. However, this information can be combined with the model's output to create a more accurate analysis of at-risk areas.

Tornadoes

A tornado is a rapidly rotating vortex or funnel of air extending groundward from a cumulonimbus cloud, exhibiting wind speeds of up to 300 miles per hour. Approximately 1,200 tornadoes are spawned by thunderstorms each year in the United States. Most tornadoes remain aloft, but the few that do touch the ground are devastating to everything in their path. The forces of a tornado's winds are capable of lifting and moving huge objects, destroying or moving whole buildings, and siphoning large volumes from bodies of water and ultimately depositing them elsewhere. Because tornadoes typically follow the path of least resistance, people living in valleys have the greatest exposure to damage.

Tornadoes have been measured using the Fujita-Pearson Tornado Scale since its creation in 1971 (Table 2-5). In 2006, research indicated that tornado damage was occurring from winds of much weaker intensity than previously thought, so the National Weather Service created an enhanced scale to measure them (Table 2-6). First used in January 2007, this scale expands upon the original system's measure of damage to homes by adding 18 new damage indicators, including those that affect trees, mobile homes, and several other structures (giving a total of 28 indicators studied in the classification of a tornado). Under the enhanced Fujita-Pearson scale, a tornado that does not affect houses can still be classified.

Tornado damage occurs only when the funnel cloud touches down on land. In the United States, the states with the greatest tornado risk are Texas, Oklahoma, Arkansas, Missouri, and Kansas. Together these states occupy what is commonly known as "tornado alley." In recent years, however, tornadoes have struck in cities that are not regularly frequented by tornadoes, including Miami, Nashville, and Washington, D.C. Tornadoes can also touch down in several places in succession, as occurred in Washington, D.C. in 2001. In that event, a single tornado first touched down in Alexandria, Virginia, just south of the city and then again in College Park, Maryland, just north of D.C. Tornado season generally falls between March and August, although tornadoes can occur at any time of the year. Tornadoes tend to occur in the afternoon and evening, with more than 80 percent of all tornadoes striking between noon and midnight.

Table 2-5 Original Fujita-Pearson Tornado Scale

Category	Conditions	Effects
F-0	40–72 mph	Chimney damage, tree branches broken
F-1	73–112 mph	Mobile homes pushed off foundation or overturned
F-2	113–157 mph	Considerable damage, mobile homes demolished, trees uprooted
F-3	158–205 mph	Roofs and walls torn down, trains overturned, cars thrown
F-4	207–260 mph	Well-constructed walls leveled
F-5	261–318 mph	Homes lifted off foundation and carried considerable distances, autos thrown as far as 100 meters

Table 2-6 Enhanced Fujita-Pearson Tornado Scale

Category	Conditions	Effects
F-0	65–85 mph	Minor to light damage to structures and vegetation
F-1	85–110 mph	Moderate damage to structures and vegetation
F-2	111–135 mph	Heavy damage to structures and vegetation
F-3	136–165 mph	Severe damage to structures and vegetation
F-4	166–200 mph	Extreme damage to structures and vegetation
F-5	Over 200 mph	Complete destruction of structures and vegetation

Building collapse and flying debris are the principal factors behind the deaths and injuries tornadoes cause. Early warning is key to surviving tornadoes, as warned citizens can protect themselves by moving to structures designed to withstand tornado-force winds. Doppler radar and other meteorological tools have drastically improved the ability to detect tornadoes and the amount of advance warning time available before a tornado strike. Improved communications and new technologies have also been critical to giving people advanced warning.

Buildings that are directly in the path of a tornado have little chance of surviving unless they are specifically designed to withstand not only the force of the winds but also that of the debris “missiles” that are thrown about (Figure 2-3). “Safe room” technology developed by FEMA and Texas A&M University, which retrofits a portion of a structure to withstand such winds through engineered resistant design and special resilient materials, offers those in the path of a tornado much greater survival likelihoods (Figure 2-4). Safe rooms are often the most cost-effective way to mitigate tornado risk in communities that are already heavily developed, since they can be built into an existing (or new) structure for a small cost (estimated between \$3,000 to \$5,000).

In order to greatly expand the mitigation benefits of safe rooms, similar technology is being developed for use in community mass-care shelters. New technologies in building design and construction are also being developed by FEMA and others to reduce the damage to buildings and structures not located directly in the path of a tornado. Many of the same wind-resistant construction techniques used effectively in high-risk hurricane



FIGURE 2-3 Mena, Arkansas, April 15, 2009. Volunteers from a faith-based organization undertake the task of cleaning up the debris from an elderly woman's home that was destroyed on the evening of April 9 by an F3 tornado. Several western Arkansas counties were struck by five documented tornadoes that caused widespread damage that Thursday evening.
FEMA Photo by Win Henderson.



FIGURE 2-4 Tulsa, Oklahoma, November 23, 2001. Disaster Ally in the Eastland Mall. Safe rooms can be designed with many different materials. Shown are concrete block walls, formed concrete walls, and a special ceiling framing.
Photo by Kent Baxter/FEMA News Photo.

areas have been found to be equally effective when applied to new and retrofitted structures located in tornado-prone areas.

Wildfires

Wildfires (often called “wildland fires”) are classified into three categories: *surface fires*, the most common type, which burn along the floor of a forest, moving slowly and killing

or damaging trees; *ground fires*, which are usually started by lightning and burn on or just below the forest floor; and *crown fires*, which burn through the forest canopy high above the ground and therefore spread much more rapidly due to wind and direct contact with nearby trees. Wildland fires are an annual and increasing hazard due to the air pollution (primarily smoke and ash that travel for miles, causing further hazards to health and mechanical or electrical equipment), risk to firefighters, environmental effects, and property destruction they cause.

As residential areas expand into relatively untouched wildlands (called the “wildland-urban interface”), the threat to the human population increases dramatically. Protecting structures located in or near the wildland poses special problems and often stretches firefighting resources beyond capacity. Wildland fires also cause several secondary hazards. For instance, when heavy rains follow a major fire, landslides, mudflows, and floods can strike on or downhill from the newly unanchored soil. These fires can also severely scorch the land, destroying animal habitats and causing barren patches that may persist for decades, increasing the likelihood of long-term erosion.

Several terms are used to classify the source and behavior of wildland fires:

- *Wildland fires*. Fueled almost exclusively by natural vegetation, these fires typically occur in national forests and parks, where federal agencies are responsible for fire management and suppression.
- *Interface or intermix fires*. These fires occur in or near the wildland-urban interface, affecting both natural and built environments and posing a tactical challenge to firefighters concerned with the often conflicting goals of firefighter safety and property protection.
- *Firestorms*. Events of such extreme intensity that effective suppression is virtually impossible, firestorms occur during extreme weather and generally burn until conditions change or the available fuel is exhausted.
- *Prescribed fires and prescribed natural fires*. These are fires that are intentionally set or selected natural fires that are allowed to burn for the purpose of reducing available natural fuel.

Severe drought conditions and the buildup of large quantities of “fuel” (dead trees and flammable vegetation) on the forest floors have led to a steady increase in the prevalence of wildfires in the United States. Since the National Interagency Fire Center began tracking the number and acreage of fires in 1960, the average number of fires has fallen (presumably due to fire-prevention programs), while the annual acreage burned has risen. In other words, the fewer fires that are occurring are larger and more destructive on average. Before 2004, no year had seen more than 7 million acres burned, and few experienced greater than 4 or 5 million acres burned. Yet, from 2004 to 2007, each year exceeded 8 million, and both 2006 and 2007 exceeded 9 million acres burned. In 2008 the number fell to just over 5 million, and 2009 saw approximately 6 million burned (NIFC, 2009).

Mass Movements

The general category of mass movements includes several different hazards caused by the horizontal or lateral movement of large quantities of physical matter. Mass movements cause damage and loss of life through several different processes, including the pushing, crushing, or burying of objects in their path, the damming of rivers and waterways, the subsequent movement of displaced bodies of water (typically in the form of a tsunami), destruction or obstruction of major transportation routes, and alteration of the natural environment in ways in which humans are negatively impacted. Mass-movement hazards are most prevalent in areas of rugged or varied topography, but they can occur even on level land, as in the case of subsidence. The following are the categories of mass-movement hazards:

- *Landslides.* Landslides occur when masses of relatively dry rock, soil, or debris move in an uncontrolled manner down a slope. Landslides may be very highly localized or massive in size, and they can move at a creeping pace or at very high speeds. Many areas have experienced landslides repeatedly since prehistoric times. Landslides are activated when the mechanisms by which the material was anchored become compromised (through a loss of vegetation or seismic activity, for example).
- *Mudflows.* Mudflows are water-saturated rivers of rock, earth, and other debris that are drawn downward by the forces of gravity. These phenomena develop when water rapidly accumulates in the material that is moved, like during heavy rainfall or rapid snowmelt. Under these conditions, solid or loose earth can quickly change into a flowing river of mud, or “slurry.” These flows move rapidly down slopes or through channels, following the path of least resistance, and often strike with little or no warning. Mudflows have traveled several miles in many instances, growing in size as they pick up trees, cars, and other materials along the way.
- *Lateral spreads.* Lateral spreads occur when large quantities of accumulated earth or other materials spread downward and outward due to gradual hydrologic and gravitational forces. Spreads can affect rock, but they also occur in fine-grained, sensitive soils such as clays.
- *Liquefaction.* When saturated solid material becomes liquid-like in constitution due to seismic or hydrologic activity, it can exacerbate lateral spreading.
- *Rockfalls.* Rockfalls occur when masses of rock or other materials detach from a steep slope or cliff and descend by freefall, rolling, or bouncing. Topples consist of the forward rotation of rocks or other materials about a pivot point on a hill slope. Rockfalls can occur spontaneously when fissures in rock or other materials cause structural failure or due to seismic or other mechanical activity (including explosions or the movement of heavy machinery).
- *Avalanches.* An avalanche is a mass of ice or snow that moves downhill at a high velocity. Avalanches can shear trees, cover entire communities and highway routes, and level buildings in their path. Avalanches are triggered by a number of processes, including exceeding critical mass on a steep slope or disturbances caused by seismicity or human activity. As temperatures increase and snowpack becomes unstable, the

risk of avalanches increases. The primary negative consequences associated with avalanches are loss of life (mostly to backcountry skiers, climbers, and snowmobilers) and obstruction of major transportation routes. Around 10,000 avalanches are reported each year in the United States. Since tracking began in 1790, an average of 144 people have become trapped in avalanches annually, and of these an average of 14 sustain injuries and 14 die. The average annual value of structural damage is \$500,000, though the secondary costs associated with disrupted commerce can be much greater.

- *Land subsidence.* Land subsidence is the loss of surface elevation caused by the removal of subsurface support. Subsidence can range from broad, regional lowering of large landmasses to severe localized collapses. The primary cause of this hazard is human activity, including underground mining, extraction of groundwater or petroleum, and the drainage of organic soils. The average annual damage associated with subsidence in the United States is estimated to be at least \$125 million.
- *Expansive soils.* Soils and soft rock that tend to swell or shrink when their moisture content changes are referred to as expansive soils. These changes are extremely detrimental to transportation routes (including highways, streets, and rail lines) and structures that are built above the affected soils. The most extensive damage affects highways and streets. Two rock types that are particularly prone to expansion and that are prevalent in the United States (primarily in the West) are aluminum silicates (e.g., ash, glass, and rocks of volcanic origin) and sedimentary rock (e.g., clay and shale).

Tsunamis

A tsunami is wave or series of waves that is generated by a mass displacement of sea or lake water. The most common generative factor behind tsunamis is undersea earthquakes that cause ocean floor displacement, but large tsunamis have been caused by volcanic eruptions and landslides as well. Tsunami waves travel outward as movements of kinetic energy (rather than traveling water) at very high speeds in all directions from the area of the disturbance, much like the ripples caused by a rock thrown into a pond. As the waves approach shallow coastal waters, wave speed quickly decreases and the water is drawn upward and onto land. Tsunamis can strike at heights of up to and over 100 feet and extend onto land for a mile or more (depending upon topography). The force of the water causes near total destruction of everything in its path.

The areas at the greatest risk from tsunamis are those lying less than 50 feet above sea level and within one mile of the shoreline. Successive crests (high water) and troughs (low water) can occur anywhere from 5 to 90 minutes apart. Tsunamis travel through deep water at approximately 450 miles per hour, so the areas closest to the point of origin experience the greatest destruction and have the least amount of forewarning. Most tsunami-related deaths are the result of drowning, while the loss of services and related health problems associated with the incredible destruction of the infrastructure (including the loss of hospitals and clinics, water pollution, contaminated food and water stocks, and damaged transmission lines) adds to these statistics.

ADDITIONAL RESEARCH

The Woods Hole Oceanographic Institute has developed a highly illustrative website about the causes and dynamics of tsunamis. This website also provides significant information about mitigation techniques, historical tsunami events, warning systems, modeling, and much more. The site can be accessed at <http://www.whoi.edu/home/interactive/tsunami/>.

CASE STUDY: RECENT MAJOR TSUNAMI EVENTS

On December 26, 2004, following an earthquake off the coast of the Banda Aceh region of Indonesia that measured 8.9 on the Richter scale, a series of tsunamis devastated vast coastal regions in 11 countries as far as East Africa. The earthquake was the most powerful to occur in four decades, and it generated waves reaching as high as 60 feet on coastal shorelines. The devastation from this event in terms of the geographical range and number of people affected within the brief time frame is virtually unprecedented in modern history.

Due to an almost complete lack of regional tsunami warning capabilities, little advanced notice of the presence or severity of these impending waves was possible for the affected populations, many of whom included foreign tourists. As a result, most people had no opportunity to move to higher ground—an action that surely would have prevented the high number of injuries and fatalities that occurred. While the exact number of people killed will never be known, it is assumed to be greater than 150,000 and possibly more than 200,000. Over 500,000 injuries were reported, and ten times as many people were left homeless.

Almost five years after this terrible event, another quake struck in the nearby South Pacific region, causing large tsunamis in the islands of Samoa, American Samoa, and Tonga. These events were caused by an 8.0 magnitude earthquake near the Samoan Islands on September 29. While significant infrastructure had been put into place to detect tsunamis and warn the at-risk populations, communication failures prevented many people from being informed. Upon personally observing now-familiar telltale signs of a coming tsunami, including the earthquake itself, and changing off-tide water levels, many residents fled to higher ground. However, 189 people still lost their lives, most of whom lived in hardest-hit Samoa.

Five years after the Indian Ocean tsunami, widespread disparity exists in the rates of recovery between the affected countries and even within each affected country from region to region. Assistance from national and international development agencies and organizations, including the U.S. Agency for International Development (USAID), the Australian Agency for International Development (AUSAID), the United Nations, and others, has helped to speed recovery and ensure that tsunami-mitigation measures and practices are incorporated into rebuilding efforts. Many of USAID's recovery projects have already concluded, including work in Indonesia, Sri Lanka, India, and Thailand, while others are still working to bring about recovery.

The U.S. government is just one of many national governments that helped to bring about recovery in the affected countries, contributing over \$650 million in aid, primarily to Indonesia (\$405.7 million) and Sri Lanka (\$134.6 million) (USAID, 2009). Recovery from the 2009 tsunami events is also expected to take time, but due to the much more limited geographic

area affected and the much smaller populations on the islands that were struck, recovery will not see the complexities of the 2004 events. In fact, the U.S. government dedicated only \$50,000 in assistance to Tonga and \$100,000 to Samoa to assist with the cost of recovery. FEMA provided USG federal assistance to American Samoa because the islands are U.S. territory and therefore under the coverage of Stafford Act assistance. For information on USAID and FEMA involvement in these events, visit <http://www.usaid.gov/locations/asia/tsunami/>, http://www.usaid.gov/our_work/humanitarian_assistance/disaster_assistance/countries/samoa/template/index.html, and http://www.usaid.gov/our_work/humanitarian_assistance/disaster_assistance/countries/tonga/template/index.html.

Volcanic Eruptions

A volcano is a break in the earth's crust through which molten rock from beneath the earth's surface (magma) erupts. Over time, volcanoes will grow upward and outward, forming mountains, islands, or large, flat plateaus called "shields." Volcanic mountains differ from mountain chains formed through plate tectonics (movement of the earth's crustal plates) because they are built through the accumulation of materials (lava, ash flows, and airborne ash and dust) rather than being pushed up from below. When volcanic material exits the earth, it is called lava, and the nature of its exit determines the land formations that result. Thinner lava typically moves quickly away from the source and becomes a large shield (as in the case of the Hawaiian Islands), while thicker lava and other materials form steeper volcanic formations.

When pressure from gases and molten rock becomes strong enough to cause an explosion, violent eruptions may occur. Gases and rock shoot up through the opening and spill over or fill the air with lava fragments. Volcanoes cause injuries, death, and destruction through a number of processes, including direct burns, suffocation from ash and other materials, trauma from ejected rocks, floods and mudflows from quickly melted snow and ice, burial under burning hot "pyroclastic" ash flows, and others. Airborne ash can affect people hundreds of miles away from the eruption and influence global climates for years afterward.

Volcanic ash contaminates water supplies, causes electrical storms, and can cause roofs to collapse under the weight of accumulated material. Eruptions may also trigger tsunamis, flash floods, earthquakes, and rockfalls. Sideways-directed volcanic explosions, known as "lateral blasts," can shoot large pieces of rock at very high speeds for several miles. These explosions can kill by impact, burial, or heat. They have been known to knock down entire forests. Most deaths attributed to the Mount St. Helens volcano were a result of lateral blast and trees that were knocked down. Volcanic ash also has some positive implications because it can be used for construction or road building, as abrasive and cleaning agents, and as raw materials for many chemical and industrial uses. Ash-covered land is also rich in mineral nutrients and ideal for agricultural production.

Severe Winter Storms

Severe winter storms occur when extremely cold atmospheric conditions coincide with high airborne moisture content, resulting in rapid and heavy precipitation of snow and/or ice. When combined with high winds, the event is known as a blizzard. In the United States, these hazards originate from four distinct sources:

- In the Northwest, cyclonic weather systems originate in the North Pacific Ocean or the Aleutian Island region.
- In the Midwest and Upper Plains, Canadian and Arctic cold fronts push ice and snow deep into the heart of the nation—in some instances, traveling as far south as Florida.
- In the Northeast, lake-effect snowstorms develop when cold weather fronts pass over the relatively warm surfaces of the Great Lakes.
- The eastern and northeastern states are affected by extratropical cyclonic weather systems in the Atlantic Ocean and the Gulf of Mexico that produce snow, ice storms, and occasional blizzards.

On January 1, 2006, the federal government began to use a new scale, similar to the scales used to measure the magnitude and intensity of hurricanes and tornadoes, to measure severe winter storms. The Northeast Snowfall Impact Scale (NESIS) provides a numerical value to storms based on the geographical area affected, the amount of snow accumulation, and the number of people affected. The minimum threshold for a storm's inclusion in the scale is 10 inches of snow falling over a wide area.

NESIS values range from 1 to 5 and include associated descriptors (from most to least severe) of Extreme, Crippling, Major, Significant, and Notable. The NESIS scale differs from other meteorological indices in that it considers population data. It uses the following formula:

$$\text{NESIS} = \sum_{n=4}^{x=30} \left[\frac{n}{10} \left(\frac{A_n}{A_{\text{mean}}} + \frac{P_n}{P_{\text{mean}}} \right) \right]$$

where A equals the area affected and P equals the population affected. Table 2-7 shows the categories assigned to severe winter storms using this formula.

Drought

Drought is defined as a prolonged shortage of available water, primarily due to insufficient rain and other precipitation or because exceptionally high temperatures and low humidity cause a drying of agriculture and a loss of stored water resources. Drought hazards differ from other natural hazards in three ways:

1. A drought's onset and conclusion are difficult to determine because the effects accumulate slowly and may linger even after the apparent termination of an episode.
2. There is no precise or universally accepted determination of what conditions constitute official drought conditions or the degree of drought severity.
3. The drought's effects are less obvious and spread over a larger geographic area.

Table 2-7 NESIS Values

Category	NESIS Value	Description
1	1–2.499	Notable
2	2.5–3.99	Significant
3	4–5.99	Major
4	6–9.99	Crippling
5	10.0+	Extreme

Source: NOAA, 2006. <http://www.ncdc.noaa.gov/oa/climate/research/snow-nesis/>

In very poor countries, drought is associated with famine, which is widespread starvation brought about by limited access to food resources. However, in the United States, where mechanisms are in place to move resources quickly from region to region, the threat of famine no longer exists.

The Climate Prediction Center of the National Weather Service monitors nationwide drought conditions and provides visual reports on a weekly basis and seasonal reports on a monthly basis. A report of current drought conditions in the United States, referred to as the United States Drought Monitor, can be viewed at http://www.cpc.noaa.gov/products/expert_assessment/drought_assessment.shtml.

Extreme Temperatures

Major diversions in average seasonal temperatures can cause injuries, fatalities, and major economic impacts when they are prolonged or coincide with other natural or technological events. Extreme heat, called a heat wave, occurs when temperatures of ten or more degrees above the average high temperature persist across a geographic region for several days or weeks. Humid or muggy conditions, which add to the discomfort of high temperatures, can occur when a “dome” of high atmospheric pressure traps hazy, damp air close to the ground. Excessively dry conditions that coincide with extreme heat can provoke wind and dust storms.

When little rain occurs in conjunction with extreme heat, droughts are likely to occur. Prolonged periods of heat have resulted in hundreds of thousands of deaths in single instances, including 600 in the Chicago area in 1995 and almost 37,500 in Europe in 2003. In most years, over 1,500 people die from exposure to excessive heat in the United States, making it the number one weather-related killer of humans.

While there is no widely accepted standard for extreme cold temperatures, periods of colder than normal conditions exhibit a range of negative consequences, depending on where they occur and exactly how cold temperatures fall. Any time temperatures fall below freezing, there is the risk of death from hypothermia to humans and livestock, with the degree to which populations are accustomed to those temperatures a primary factor in resilience. Extreme cold can also lead to serious economic damages from frozen water pipes; the freezing of navigable rivers, which halts commerce and can cause ice dams; and the destruction of crops.

Coastal Erosion

Coastal erosion, which is the loss of land bordering a body of water, is measured as the rate of change in the position or horizontal displacement of a shoreline over a period of time. It is generally associated with storm surges, hurricanes, windstorms, and flooding hazards, and it can be exacerbated by human activities such as boat wakes, shoreline hardening, and dredging. The primary concern with coastal erosion is the economic damages that occur to properties constructed very close to the eroding coasts, which lose their natural protection from the water and waves.

Environmental impacts from erosion include the loss of animal habitats and aesthetic losses. Fishing industries that are dependent on coastal habitats can suffer great losses from changes caused by coastal erosion, and the loss of tourism can result in similar economic impacts. Coastal features like dunes and mangroves also provide a natural defense against several hazards, including tsunami waves and storm surges, so their loss may signal an increase in vulnerability from these hazards.

Thunderstorms

Thunderstorms are meteorological events that bring heavy rains, strong winds, hail, lightning, and tornadoes. Thunderstorms are generated by atmospheric imbalance and turbulence caused by a combination of several conditions, including: unstable, warm air rising rapidly into the atmosphere; sufficient moisture to form clouds and rain; and upward lift of air currents caused by colliding weather fronts (cold and warm), sea breezes, or mountains.

A thunderstorm is classified as severe if its winds reach or exceed 58 mph, it produces a tornado, or it drops surface hail at least 0.75 inch in diameter. Thunderstorms may occur singly, in clusters, or in lines. Thus, it is possible for several thunderstorms to affect one location in the course of a few hours. These events are particularly devastating when a single thunderstorm affects one location for an extended period. Such conditions lead to oversaturation of the ground and subsequent flash flooding and slope erosion.

Lightning is a major secondary threat associated with thunderstorms. In the United States, between 75 and 100 Americans are hit and killed by lightning each year. Many air disasters have been linked to thunderstorms due to the unpredictable and turbulent wind conditions they cause and the threat of electronic or mechanical failure caused by lightning strikes. When humans or structures are hit by lightning, the effect is devastating to both.

Hail

Hail is frozen atmospheric water that falls to the earth. Moisture in clouds becomes frozen into crystals at high temperatures and begins to fall under its own weight. Typically, these crystals melt at lower temperatures, but in the right conditions they pick up more moisture as they fall and are then lifted to cold elevations, which causes refreezing. This

cycle may continue until the individual hailstones reach several inches in diameter under the right conditions. Because of the strength of severe thunderstorms and tornadoes, both can cause this cyclic lifting, and therefore they are often accompanied by hail. Hailstorms occur more frequently during late spring and early summer when the jet stream migrates northward across the Great Plains. When they fall, they can damage crops, break windows, destroy cars and other exposed properties, collapse roofs, and cause other destruction totaling nearly \$1 billion each year in the United States.

CRITICAL THINKING

- Are you aware of the hazards faced by your community, including those that may only happen once every few decades (and therefore may not have occurred in your lifetime)?
- Have any of your community's natural hazards resulted in a major disaster requiring state or federal assistance?
- Do any natural hazards affect your community routinely? If so, what actions has the community taken to mitigate these recurrent hazards? Have these actions been successful in reducing the consequences or likelihood of the hazards?
- Are there any natural hazards that you or your community can ignore because your geographic location precludes you from risk? What are those hazards, and why can you ignore them?

Technological Hazards

Technological, or man-made, hazards are an inevitable product of technological innovation and human development. These hazards, which can occur after the failure of existing technology, tend to be much less understood than their natural counterparts and are increasing in number as the scope of and dependence on technology expands. The most common technological hazards arise from various components of transportation, infrastructure, industry, and buildings/structures.

Structural Fires

Studies have shown that civilizations have been fighting structural fires using coordinated governmental resources since the first century AD (Coppola, 2006). Structural fires can be triggered or exacerbated by both natural processes, including lightning, high winds, earthquakes, volcanoes, and floods, or by human origins, including accidents and arson, for example. Lightning is the most significant natural contributor to fires affecting the built environment. Buildings with rooftop storage tanks for flammable liquids are particularly susceptible. There were 1,415,500 fires in the United States in 2008. Of these, 48.3 percent were outside and “other” fires, 35.4 percent were structure fires, and 16.3 percent were vehicle fires.

Residential fires represented 27.7 percent of all fires and 78.3 percent of structure fires. 83.7 percent of all civilian fire fatalities occurred in the home, where a home is defined as a one- or two-family dwelling or an apartment. Of those, approximately 72.5 percent occurred in single-family homes and duplexes. Intentionally set structure fires occurred 30,500 times and represented 5.9 percent of structural fires and \$866 million in structural property losses. Over 17,500 vehicle fires were deliberately set, causing an estimated \$139 million in property damage (Karter, 2008).

Dam Failures

Dams are constructed for many purposes, the most common being flood control and irrigation. When dams retaining large quantities of water fail, there exists the potential for large-scale uncontrolled releases of stored water downstream. Dam failures pose the most extreme flood risk due to the sudden and severe impacts that can result. Dams most often fail as a result of maintenance neglect, overtopping (as in the case of a flood), poor design, or structural damage caused by a major event such as an earthquake, collision, or blast. Dams are both publicly and privately owned and maintained, so their monitoring can pose a challenge to offices of emergency management charged with assessing associated hazard risk. The United States boasts the second greatest number of dams nationwide, exceeded only by China.

Hazardous Materials Incidents

Hazardous materials are chemical substances that if released or misused can pose a threat to the environment or personal health. Such chemicals are prevalent in many industries and products, including agriculture, medicine, research, and consumer product development. Hazardous materials may be explosive, flammable, corrosive, poisonous, radioactive, or otherwise toxic or dangerous. Releases typically occur as a result of transportation accidents or accidental releases at production and storage facilities. Depending on the nature of the chemical, the result of a release or spill can include death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property.

While hazardous materials spills occur most commonly in homes, the quantities released are almost always too small to cause more than a highly localized hazard. It is the transportation or industrial use of such products that leads to major disaster events upon release. At present, hazardous materials are manufactured, used, or stored at an estimated 4.5 million facilities in the United States—from major industrial plants to local dry cleaning establishments or gardening supply stores.

Nuclear Accidents

Radioactive materials have provided significant benefits since their discovery, including the generation of power, scientific treatments and experiments, new detection, and

imaging technologies, among many others. However, because the radiation emitted from these materials can cause immediate and lasting tissue damage to humans and animals upon exposure, these materials must be handled and contained using specialized techniques, materials, and facilities. National and international law strictly dictates who may possess these materials, how they can be used, and how and where they must be disposed of.

Exposure to radiation can be the result of an accidental or intentionally caused spill, breach of the containment vessel, escape of gasses, or an explosion. Nuclear material remains radioactive until it has shed all of its ionizing particles, called radio nuclides. This process, called radioactive decay, is the primary source of health risk to life. When released quickly, dust or gasses may rise into the atmosphere in a characteristic “plume,” which carries the contaminants far from the point of origin with atmospheric currents, depositing it as radioactive fallout along its course.

In the United States, the greatest threat of exposure to radioactive materials comes from an accident or sabotage at one of the nation’s many nuclear power plants. As the distance to a nuclear power plant decreases, the risk of exposure increases, and the likelihood of surviving in the event of a large-scale release of materials decreases. Since 1980, utilities operating commercial nuclear power plants in the United States have been required to maintain on- and off-site emergency response plans as a condition of maintaining their operating licenses. On-site emergency response plans are approved by the Nuclear Regulatory Commission (NRC). Off-site plans (which are closely coordinated with the utility’s on-site emergency response plan) are evaluated by FEMA and provided to the NRC, who must consider the FEMA findings when issuing or maintaining a license.

A catastrophic failure of a nuclear reactor is called a meltdown, indicative of the failure of the reactor’s containment due to the incredibly high heat caused by a runaway nuclear reaction. The worst nuclear accident to date was the result of a reactor core meltdown that occurred in at the Chernobyl Nuclear Power Plant in the Ukraine on April 26, 1986. So great was the radioactive plume and resultant fallout, which traveled as far as and landed primarily in neighboring Belarus, that over 336,000 people had to be evacuated and permanently resettled. Over 20 years later, the area is still uninhabitable.

In the United States, the most dangerous radioactive event, which was ultimately contained (thereby preventing any realized threat to human life), was the partial core meltdown at the Three Mile Island Nuclear Generating Station in Pennsylvania on March 28, 1979. The accident happened when a system that cooled the nuclear reaction, and therefore controlled the temperature of the reactor core, failed to operate correctly. While some nuclear material was released, the effect on people exposed was similar to that of receiving one or two medical x-rays. The public reaction to this event, however, significantly changed the course of the nuclear power industry in the United States, as expansion abruptly ended.

ADDITIONAL RESEARCH

The Nuclear Regulatory Commission released a report on the Three Mile Island nuclear accident. This report provides a summary of the events that occurred on March 29, 1979, and describes the health effects of the resulting release. Most significantly, it provides insight into the changes that the event ultimately had on the industry and on society's perception of the safety of nuclear power. This report site may be accessed at <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html>.

Terrorism

Terrorism is defined as the use of force or violence against individuals (civilians) or property for purposes of intimidation, coercion, or spreading fear in order to attain political, religious, or ideological goals. Radical or militant political and religious groups, which include or have included (for example) al Qaeda, the Khmer Rouge, the Revolutionary Armed Forces of Colombia (FARC), and Sendero Luminoso, typically lack the military means or public support to bring about societal change in favor of their representative views. These groups turn to the use of terrorism as a low-cost way to raise awareness of their message and influence the attitudes and actions of those presumably at risk from subsequent attacks. Terrorism, like war, is an influential tool that has been used by civilizations since the dawn of recorded history, and it will likewise always exist as a threat that must be mitigated and likewise managed.

Terrorism has been prevalent in the United States since long before the September 11, 2001 attacks on New York and the Pentagon, but the vast majority of these events originated from individuals or domestic organizations, used simple explosives, and were small in scale and effect. Some of the most notorious terrorists and groups that were labeled as “terrorist organizations” are the McNamara Brothers (bombed the *LA Times* building in 1910), the so-called “Unibomber” (Theodore Kaczynski), Eric Rudolph (the “Centennial Olympic Park bomber”), Timothy McVeigh (the mastermind behind the Oklahoma City bombing), the Animal Liberation Front, the Ku Klux Klan, and the Army of God.

The al Qaeda terrorists who performed the simultaneous terrorist attacks in Arlington, Virginia; New York City; and Shankville, Pennsylvania, elevated the perception of terrorism as a hazard risk and placed terrorism as a topic high on the public, policy, and media agendas due to the highly graphic, violent, and devastating impact of the attacks (which killed almost 3,000 people, caused billions of dollars in damages, and had immeasurable effects on the national and world economies). However, it is important that communities and governments remember the persistent threat that remains from domestic terrorist organizations and individuals, which have been successful in bringing about several attacks since 9/11, including the 2001 anthrax attacks, the Washington, D.C. sniper attacks in 2002, and many bombings and shootings at courthouses, abortion clinics, research centers, military recruitment centers, and others.

The primary method by which governments manage the terrorist threat is through both covert and overt intelligence gathering. Monitoring methods have expanded greatly with the advent of surveillance technologies, and statutory authorities have been expanded to allow for monitoring of phone calls, bank transactions, and other activities (to the dismay of civil rights groups who oppose such controls). Clearly, the ability of a government to monitor the terrorist risk is a delicate balance between knowing what its citizens are doing and allowing citizens the freedom of personal privacy.

Containment of the terrorist threat is another method of control, exhibited in the form of checkpoints (like in commercial airports worldwide), barriers at public and secure buildings, and security cameras and personnel placed in strategic locations. The U.S. government has developed agreements with many other national governments to coordinate transnational terrorism through the use of ports safety initiatives, traveler tracking, and monitoring of groups known to harbor terrorist intentions against the United States.

The Federal Bureau of Investigations (FBI) is the government agency in charge of tracking and preventing terrorist activities in the United States. The FBI categorizes terrorism according to two subgroups: (1) domestic terrorism, which involves groups or individuals whose terrorism activities are directed at elements of government or population without foreign direction; and (2) international terrorism, which involves groups or individuals whose terrorist activities are foreign-based and/or directed by countries or groups outside the United States or whose activities transcend national boundaries.

CBRN Incidents

One class of weapons has the potential to bring about an extraordinary degree of deaths, injuries, and property destruction. Several names have been given to this group of weapons, including weapons of mass destruction, NBC (nuclear, biological, and chemical) weapons, and ABC (atomic, biological, and chemical) weapons, but the conventional acronym used in contemporary practice is CBRN (pronounced “see-burn”), representing the acronym formed by the first letters of the chemical, biological, radiological, and nuclear devices that the category includes. Although these weapons are considered weapons of mass destruction because of their potential for creating such widespread destruction, it should be noted that they can also be distributed in such a way as to harm or kill only one or a very few individuals.

CBRN weapons may be possessed and used by both terrorists and foreign national governments. The processes by which control and containment are conducted, however, differ greatly between the two. In the case of official governments, mitigation is generally performed through the use of diplomacy, international agreements, and sanctions. With terrorist groups such measures have little or no effect, so control must be performed through the use of raw materials regulation and monitoring, surveillance and other intelligence gathering, and, at times, military action (usually not until all other options have failed).

Chemical

Chemical weapons are naturally occurring or man-made liquids, gasses, or solids (typically in the form of dust) that exhibit toxic effects on humans, animals, plants, or property upon exposure. Chemical agents are most commonly created for the sole purpose of killing, injuring, or incapacitating people. Chemical agents must be delivered onto or around intended victims to be effective, and there are a number of ways to do this. For instance, chemical agents may be aerosolized, dropped, splashed, poured into water supplies or foods, released by bombs, or sprayed from containers or vehicles (including aircraft, boats, or vehicles).

One of the greatest challenges facing emergency management and response officials is the detection of chemical agents that have been delivered via covert means. Chemical weapons can be invisible, odorless, and tasteless, and they may have an immediate identifiable effect (a few seconds to a few minutes) or have a delayed effect. The presence of a chemical agent is often easy to detect because of several telltale signs, including a sudden difficulty breathing; nausea; a burning sensation in the skin, eyes, or lungs; disorientation or loss of consciousness; or seizures.

In the case of common chemicals, such as chlorine gas, personnel familiar with the chemical's characteristics can often identify what chemical was released by smell or sight and the presence of certain effects as just listed (as well as the presence of specific containers or delivery mechanisms). However, with most chemical agents, identification of the specific chemical once detection has occurred is only possible using advanced technology. Because different chemicals have unique processes by which they are neutralized or their effects treated, identification is key to response and remediation.

These are the six primary categories of chemical agents, distinguished by their effect on humans:

- Pulmonary, or “choking,” agents
- Blood agents
- Vesicants or blister agents
- Nerve agents
- Incapacitating agents
- Irritants (typically used for riot control but capable of spreading panic when used by terrorists)

Biological

Biological agents are either live organisms or the toxins produced by live organisms, either naturally occurring or genetically engineered, that can kill or incapacitate people, livestock, and crops. Biological agents are grouped into three primary categories: bacteria, viruses, and toxins.

As with chemical agents, biological agents can be delivered covertly or overtly. However, most biological agents do not have immediate effects, and it may be days or

weeks before the presence of an attack involving a biological agent is recognized. This is especially true with bacteria and viruses, which have an initial period of incubation following infection where no symptoms are present in victims. Toxins, on the other hand, typically exhibit the same rate of effect as seen with chemical agents.

Recognition of a biological attack is typically made by the public health service, which monitors illnesses and deaths nationwide, and which would likely catch a rapid upsurge in strange or unidentifiable sources of similar illnesses and deaths. Other methods of detection include threat identification, the discovery of the agent or delivery and production materials, and intelligence gathering.

Biological agents are difficult to grow and maintain. Although many of these agents decay rapidly when exposed to sunlight and other environmental factors, others (such as anthrax spores) are resilient and can survive for decades or longer even in harsh conditions. Biological agents are particularly dangerous when they involve transmissible illnesses, such as smallpox, because the effect can quickly spread beyond the initial group of people exposed by contagion between affected and unaffected individuals.

Human-to-human transmission has been the primary source of infection in past epidemics that involved pathogens capable of use as a biological weapon, including smallpox, plague, and the Lassa virus. When biological agents target plants or animals, they can devastate economic sectors (including agriculture and livestock) and instill fear equal to that of agents that affect humans and can have crossover effects on humans. For instance, in 1918, the German army spread anthrax and other diseases by distributing infected livestock and animal feed.

As with chemical weapons, the primary defense lies with rapid and accurate recognition and identification. Each agent has a highly specific treatment and decontamination method associated with it. Biological agents are grouped into three categories: category A agents are those that have great potential for causing a public health catastrophe and are capable of being disseminated over a large geographic area. Examples of category A agents are anthrax, smallpox, plague, botulism, tularemia, and viral hemorrhagic fevers. Category B agents are those that have low mortality rates but may be disseminated over a large geographic area with relative ease. Category B agents include salmonella, ricin, Q fever, typhus, and glanders. Category C agents are common pathogens that have the potential for being engineered for terrorism or weapon purposes. Examples of category C agents are hantavirus and tuberculosis.

Radiological

Radiological agents are those that cause harm by exposing victims to the damaging energy emitted by unstable radioactive materials. Radiological agents require very little technological innovation to use, since the materials dispersed are naturally hazardous. However, the materials are rare in nature and highly controlled and are therefore difficult to obtain. The most common sources of radiological materials are research laboratories, medical institutions, and hazardous waste containment facilities.

The greatest threat from a radiological agent would occur if a terrorist group dispersed radiological material using either an explosive device (commonly called a “dirty bomb”) or another nonexplosive method, including spraying or aerosolization, which is called a “radiological dispersion device,” or RDD. It is well known that the greatest physical risk from a dirty bomb would be from the blast rather than the radiological materials themselves. However, the fear and panic that would result from the detection of radioactive materials on the victims and in the debris generated could have far-reaching economic impacts in the immediate area of the attack and throughout the country—or even the world.

An alternative to a dirty bomb or RDD that is of great concern to the U.S. government is the possibility that terrorists may attack a nuclear facility for the purpose of dispersing radiological materials and likewise instilling mass hysteria. While most nuclear facilities were designed to withstand great impacts and large explosions (including several constructed to withstand a direct hit by a commercial airliner), the possibility of sabotage on safety and cooling systems or the use of an explosive strong enough to breach containment exists. Additionally, the radioactive waste produced at these facilities is usually stored on-site. While this material is of little use for power generation, it would be extremely valuable to a terrorist who wanted to cause harm.

Nuclear

Nuclear agents are those that cause great harm through the activation of a fission or fusion chain reaction that is possible only through the most advanced weapons technology and using only the most refined nuclear materials (and in quantities necessary to sustain a blast effect). A nuclear blast is an explosion that emits intense light, heat, and damaging pressure and disperses radioactive debris over a widespread area, leading to the contamination of air, water, and ground surfaces for miles around. While the likelihood of a terrorist organization developing an operational nuclear weapon is almost nil, there is always the possibility that rogue states known to support terrorist organizations or states unable to monitor and protect their nuclear weapons caches could become a source of such weaponry for terrorist groups with great financial means.

The effect of successful terrorist use of a nuclear weapon would surely be the death of thousands and the destruction of billions of dollars in property, especially if it was detonated in a major urban center. The detonation of atomic weapons in Hiroshima and

CRITICAL THINKING

- What technological hazards affect your community? What are the sources of those hazards?
- Society accepts certain technological hazards because they enjoy the benefits associated with the action or process that causes the hazard. For instance, nuclear power plants produce inexpensive electricity with very little emissions. However, in the event of an accident, a major disaster could result. What benefits does your community enjoy despite the existence of associated technological hazards, and what are those hazards?

Nagasaki give insight into the power of a nuclear weapon, given that those two relatively small bombs resulted in the death of over 220,000 people and almost total destruction of the city centers in these two metropolises (see www.ready.gov, www.dhs.gov).

Hazards Risk Management

The process by which individuals, communities, and countries deal with the hazard risks they face is known as hazards risk management. Risk management is a primary function of government, and many different methodologies have been developed in the United States and throughout the world to manage hazards risk. Even within the United States, different government agencies may perform hazards risk management using different methods, as is the case with FEMA and the Department of Defense, for instance. However, almost all hazards risk management methodologies operate according to a four-step process:

1. Identify the hazards.
2. Assess the risks for each hazard identified.
3. Analyze the hazards risks in relation to one another.
4. Treat the hazards risk according to prioritization.

It is the differences in terminology, technologies, application of stakeholder input, and other issues that differentiate these various methods that have emerged.

Hazard identification, as the name suggests, is the process through which all hazards that have or could affect an area of focus are identified and described. This is done through a number of methods, including historical study, brainstorming, scientific analysis, and subject matter expertise. For more common hazards, such as snowstorms or tornadoes, the presence of the hazard will be obvious. However, for new or changing hazards, such as many technological hazards and intentional hazards (including terrorism), only the knowledge or opinion of experts can provide insight into the presence and range of these rare, yet real, hazards. Hazard identification results in a list of hazards that is exhaustive if done properly, irrespective of known likelihood or severity. To be comprehensive, a hazards risk management effort must look not at each hazard individually and irrespective of the others but rather at the entire hazards portfolio as interconnected and as each hazard having an influence on the effects and risks of the others.

Hazard description, or profiling as it is also called, is a component of hazard identification wherein the particular way each hazard exists within the studied area is defined. To describe a hazard, the following characteristics are often investigated:

- General description of the hazard
- The location of the hazard and spatial extent of its effects
- The duration of an event caused by the hazard
- Seasonal or other time-based patterns followed by the hazard
- Speed of onset of an actual hazard event
- Availability of warnings for the hazard

Hazard risk assessment is the process through which the threat posed by each identified hazard is investigated. Risk is calculated according to two equal factors: hazard likelihood and hazard consequence. Together, these factors inform us of how concerned we should be about the existence of a hazard and what we can do to prevent or treat the hazard. Generally, high-likelihood/high-consequence hazards are of greatest concern, while low-likelihood/low-consequence hazards are of least concern, and all of the others fall in between. However, the relationships between hazards and their associated risks are incorporated into the risk assessment and analysis processes in order to allow communities or countries to employ a comprehensive risk management program that results in the greatest reduction in lives lost and property damaged.

There are various approaches to developing a risk assessment methodology, ranging from qualitative to quantitative, as well as several computer-based models for natural hazard risk assessment that have been developed for individual hazards such as earthquakes, floods, hurricanes, and landslides. The validity and utility of any risk assessment outcome is defined by the quality and availability of data. Emergency managers must rely on a range of sources to develop accurate determinations of likelihood and consequence, despite the fact that these factors are constantly changing as a result of increased development, access to new information, changes in climates and community characteristics, and many other factors that can complicate the equations. Furthermore, it can be impossible to extrapolate exact numerical values that are representative of these two factors for each, or even any, of the hazards that have been identified.

As mentioned previously, there are many different methodologies that have been developed to overcome the difficulties that exist in the assessment of hazards risk. In the United States, Australia, and New Zealand, for instance, various qualitative assessment systems have been developed to measure likelihood and consequence values. Rather than relying on specific mathematical calculations to determine exact values, qualitative systems limit the possible values to a smaller defined range (typically five to seven values) into which each hazard is more easily placed. For example, it may be difficult to calculate the rate of return for an ice storm to the specific year (e.g., one event every 35 years), but it is much more possible to determine whether that storm will occur once or more every year or once every two to ten years. Qualitative systems are not exact, but they facilitate a process that might otherwise be too difficult or time-consuming and therefore disregarded.

Another risk assessment method is the Composite Exposure Indicator (CEI) approach, which is based on the effects of a single or multiple hazards on a series of indicator variables focused primarily on infrastructure, such as roads, pipelines, hospitals, public water supply, and so on. This system, which relies on databases maintained by FEMA and other sources, is a measure of exposure of 14 variables that produces a number that is then correlated to the population affected.

Hazard risk analysis is performed in order to determine the relative seriousness of hazard risks that have been identified and assessed. Using the processes just listed to identify the hazards that threaten the community or country, to characterize them, and to determine their likelihoods and consequences, emergency managers will have gathered all of

the information necessary to determine how these risks compare to one another. For this reason, by the time the risk evaluation process begins, each hazard must have been identified, described, mapped, and analyzed according to its likelihood of occurrence and its consequences should a disaster occur.

Hazard risk analysis is so important because while all communities face a range of natural, technological, and intentional hazards—each of which requires a different degree of mitigation and risk reduction—most communities have a range of competing budgetary pressures and are therefore unable to fully mitigate all hazard risks. The goal, as a result, is to lower the number of deaths, injuries, and damage to property and the environment associated with hazards to an acceptable degree, so they must ensure that their time and other resources are dedicated to the actions and activities that give them the greatest results overall.

Risk analysis is most commonly conducted through the use of a risk matrix. To create a risk matrix, emergency managers create a graph that represents risk likelihood and consequence on the *x*- and *y*-axes, with the highest of both falling in the upper right quadrant and the lowest in the bottom left. If a quantitative system has been used, the defined values selected for each of the two risk factors are transferred onto this matrix. Otherwise, if quantitative representations of likelihood and consequences have been used, the minimum and maximum of all hazards analyzed represent the high and low limits of the two graph axes. Then, all of the hazards are plotted onto this matrix together, thereby providing a visual illustration of a community or country's hazard risks in relation to one another. Using the results of the risk matrix, a prioritized ranking of risks is created. This list becomes the basis of the final step, which is the treatment of identified hazard risks.

The value of the risk analysis process in prioritizing risks is significantly improved when performed in conjunction with supplemental methodologies. For instance, a vulnerability analysis can help to determine what is causing risks, why certain risks rank above others, and what can be done to increase resilience or decrease vulnerability through the various risk treatments identified in the fourth and final step.

Risk vulnerability looks at four factors, including social vulnerability, environmental vulnerability, physical vulnerability, and economic vulnerability. Risks can also be prioritized according to the acceptability of the population at risk. For instance, despite the fact that more people are exposed to a particular risk or that it causes more fatalities or damages each year, it might still be more palatable to the exposed population than another much less dangerous or damaging risk due to the benefits that would be lost if the risk was partially or fully mitigated. For example, transportation accidents have caused more fatalities in the United States and worldwide than nuclear power accidents. Yet, most people are much more willing to accept the risk of transportation accidents than nuclear accidents because the loss of automobiles would have a much more personal and profound impact.

The SMAUG methodology is only one of the systems developed to gauge these issues. SMAUG is an acronym that stands for the five factors according to which hazard risks are analyzed by risk managers using the system: seriousness, manageability, acceptability, urgency, and growth.

Hazard risk treatment is the process by which either the likelihood of a disaster risk is reduced or eliminated or measures are taken to reduce the impacts of those hazard events that do actually occur. Hazard risks are treated through hazard mitigation and disaster preparedness (the topics of Chapters 3 and 4, respectively). The selection of risk treatment options takes the risk assessment methodology beyond process to decision making and action. At this point, risk reduction options have been analyzed not only for their cost effectiveness but also for their acceptability by society and their long-term positive and negative impacts. The treatment process then becomes a technical and political one by which funds are finally dedicated, laws are changed or enacted and likewise enforced, and solutions are implemented.

Risk Management Technology

The nation's ability to manage and reduce hazards risk has significantly improved in the last 15 years. Through vast technological advancement, emergency managers are better able to perform all four of the previous steps. Imaging and sensing technology, including satellite imagery and aircraft-based systems (such as radar, LIDAR, and FLIR), allow for much better identification and spatial mapping of hazards risk across risk zones.

Risk modeling, including software such as the FEMA-developed HAZUS-MH (Hazards United States—MultiHazard) program, allows not only predisaster estimation of impacts and response requirements but also early disaster estimation of likely damages and needs (before actual assessment data can be collected). The connectivity of the Internet has allowed greater sharing of information and ideas across regions where similar problems are encountered and mitigated.

GIS mapping software enables the plotting of risks and resources using layers of information that would have required much more difficult resources to obtain only decades ago. Even commonly used web-based programs such as Google Earth have increased the ability of emergency managers with few resources to better understand the nature of the risk their communities face, including the plotting of floodplains and the proximity of various structures to known hazards. The research and scientific agencies of the federal government and the university community continue to develop new approaches to measuring, mapping, and predicting natural hazards. Since the September 11, 2001, attacks, federal and university-based funding dedicated to the advancement of emergency management technology has reached into the billions and is helping to develop even more methods to detect, understand, and treat natural, technological, and, most notably, terrorist hazards.

Social and Economic Risk Factors

It has long been recognized that a strong correlation exists between disasters and poverty. Because of several factors, including the inability to afford preparedness and mitigation measures, the lower rental and purchase costs associated with high-risk land and a general lack of knowledge concerning risk and its sources, the poor are more vulnerable

to disasters and therefore find themselves repeatedly subject to them. While this is much more apparent in the developing countries, where the bulk of annual disaster deaths occur, risk factors based on poverty and social conditions also exist within countries.

In the United States, little has been done to address the social and economic factors of risk that make one group more vulnerable than another. Risk assessments have generally considered populations to be homogeneous for risk-planning purposes, thereby neglecting to address individual problems of certain social and economic groups that may not benefit as much, or at all, from the plans and capacities that are developed. Social advocacy groups have been working for years to raise awareness of the increased disaster vulnerability of “special populations” (which include, among others, the disabled, the elderly, the poor, children, and immigrants) with mixed success. However, Hurricane Katrina brought the reality of the socioeconomic vulnerability divide into every living room in the country via the mass media. Numerous social and political groups contend that it was poverty that caused Katrina’s high number of victims and that the poor shouldered an undue portion of the region’s risk, while the wealthy escaped relatively unharmed (a claim that was later refuted). Others called it a race disaster, claiming that the government neglected to bring about a more significant immediate response because a majority of the victims were African American. Regardless of the validity of these claims, it is clear that the majority of the people who failed to leave New Orleans did so because they had no access to transportation, they were afraid to leave their meager possessions behind, or they had no resources with which to shelter themselves away from the risk zone. And in the aftermath of this disaster, it has become painfully apparent that these same social and economic risk factors further hamper the poorer victims as they attempt recovery.

ADDITIONAL RESEARCH

A study conducted by Columbia University one year after the hurricane found that the poorest victims continued to suffer from significant income loss, higher than normal incidence of chronic illnesses, and a proportionally higher rate of mental health problems in children. This report, “The Recovery Divide: Poverty and the Widening Income Gap Among Mississippi Children and Families Affected by Hurricane Katrina,” can be accessed at http://www.ncdp.mailman.columbia.edu/files/recovery_divide.pdf.

The social makeup of a population is based on a diverse set of factors that include education, culture, local government, social interaction, values, laws, beliefs, and other aspects of society. Within most communities, the hazard vulnerability of different groups varies due to a range of sociocultural factors that help or prevent individuals in those groups from taking mitigative or preparative actions to protect themselves. The behavior of epidemics among different groups, and the people of different countries, can be heavily influenced by social factors specific to each group or country that result in much closer interactions or greater “social distancing.” Certain religious, cultural, or traditional practices and beliefs can also help or hinder disaster management practices.

Religious beliefs that label disasters the “will of God” are less likely to influence positive mitigation and preparedness behavior than those that promote the responsibility of individuals and governments to protect life from dangers that exist in the environment. And though it may not be evident to the people practicing such behaviors, their mitigative or preparatory actions may be the product of a previous social adjustment to a hazard. Disaster managers must be able to recognize when social interactions are either helping or hindering people in reducing their vulnerability to hazards, and they must recognize what aspect of that social process is causing the alteration.

Financial status also deeply affects a population’s and individuals’ abilities to protect themselves from the consequences of disaster. Financial well-being, however, does not indicate that an individual or society *will* protect themselves; rather, it is just a measure of their ability to do so. Other factors may be learned from this economic profile. Trends and tendencies associated with wealth, or the lack thereof, can be deduced. For instance, the poor are often marginalized and forced to live on more dangerous land. Their housing is more likely to be constructed of materials that are unable to withstand environmental pressures. They are more likely to have zero tolerance to delays in basic necessities that often follow disasters.

When considering the definition of a disaster and the concept of vulnerability, it is easy to understand why the poor are more vulnerable. Because an event only becomes a disaster when the capacity to respond to the event is exceeded, requiring external assistance to manage the consequences, the poor—who survive on the brink of disaster each day—are much quicker to exhaust their resources when unforeseen events arise.

CRITICAL THINKING

- Select a hazard that affects you or your community. Describe the characteristics of the hazard (how it would affect you or the community, including strong winds, ground shaking, etc.). Assess the risk associated with this hazard for you or your community, including the frequency of the hazard affecting you and the consequences if a disaster were to occur.
- What aspects of a community’s geographic profile influence the hazards they face (e.g., proximity to a coast, slope of terrain)? What human practices influence these hazards (e.g., damming of rivers, filling in wetlands)? What natural processes influence these hazards (e.g., annual rainfall, temperature)?

Conclusion

In the process by which hazard risks are managed, often called hazards risk management, the identification of hazards is the key factor that determines what preparative and preventive measures will be taken by the community. In other words, a community needs to know their risks to manage them.

Through the monitoring of hazards, emergencies, and disaster throughout the world, and research conducted into the mechanism by which natural, technological, and

intentional hazards operate, a greater understanding of risk is being achieved. Without this collection of valuable information, societies would be much less able to manage the consequences of the low-incidence, high-catastrophe events, such as tsunamis or weapons of mass destruction, that have traditionally gone unaddressed or have been handled in a haphazard manner. In sum, information is power, and with information about hazards, societies will have the power to act effectively to reduce or eliminate their risk.

Of course, with increased knowledge comes increased responsibility. The provision of hazard information and management tools to states and communities is but one necessary step in the risk-reduction process. Success of these efforts requires that they assume responsibility and take appropriate action. Emergency management provides the impetus for incorporating these considerations into the planning and governing of our communities.

Hazards will persist. Some, particularly technological hazards, may be reduced by our efforts, but our ability to control or eliminate natural hazards is questionable. Recent efforts to undo some of the former channelization and flood control projects undertaken by the U.S. Army Corps of Engineers, once thought to be an effective measure to eliminate flood risk, are vivid examples of our inability to control nature. However, there is still a strong argument for an increased emphasis on improved science in hazard identification and increased financial support for hazards mapping, both of which have been effective components in community hazards risk management efforts.

As our knowledge about hazards continues to expand, the economic and social logic of applying long-term solutions for reducing the risks posed by these hazards through mitigation and preparedness will gain momentum. The cost-to-benefit ratios of mitigation and preparedness efforts will become more attractive to local political bodies, and, eventually, disaster losses will begin to fall substantially. However, each and all of these local successes will be wholly dependent on the leadership potential and motivational abilities of an emergency management professional, who will be the driving force behind any such positive momentum that exists.

Important Terms

- Avalanche
- Blizzard
- CBRN weapons
- Coastal erosion
- Dam failure
- Disaster
- Earthquake
- Expansive soil
- Extreme cold
- Extreme heat
- Flood

Hail
Hazard
Hazardous materials
Hazards risk management
Hurricane
Landslide
Lateral spread
Mass movement
Mudflow (or debris flow)
Natural hazard
Risk
Rockfall
Safe room
Severe winter storm
Storm surge
Technological hazard
Terrorism
Thunderstorm
Tornado
Tropical cyclone
Tropical storm
Tsunami
Volcano
Wildland fire (or wildfire)

Self-Check Questions

1. How is a hazard different from a disaster?
2. What is the most frequent and widespread disaster-causing hazard?
3. What scale is commonly used to describe the effects of earthquakes?
4. How are earthquakes measured?
5. Describe the process by which hurricanes form.
6. What scale is used to describe the intensity of hurricanes?
7. What are the various ways that hurricanes cause damages to a community?
8. What is a SLOSH model used to measure?
9. Why was the Fujita-Pearson Tornado Scale updated in 2006, and what changes were made?
10. What are the three categories of wildland fires?
11. How are severe weather storms measured?
12. What single disaster type caused nine of the top ten natural disasters ranked by FEMA relief costs?
13. What is the source of most hazardous materials incidents?

14. List and describe four categories of weapons of mass destruction.
15. What six steps are common to most risk assessment methodologies?
16. Name several of the social factors emergency managers must consider when assessing a community's risk.
17. What are some of the factors that make up a community's economic profile? How do these factors influence that community's disaster risk?

Out-of-Class Exercises

Visit FEMA's disaster declaration archive at http://www.fema.gov/news/disaster_totals_annual.fema. View the disaster declarations for your state. Beginning with 1998 and moving forward to the present time, view the disaster declarations to determine what disasters affected your county. What hazards affected your county during this time? How many times did each occur? If possible, determine what assistance the federal government provided in response to the disaster.