FUNDAMENTALS OF EMERGENCY MANAGEMENT

LibreTexts™

Fundamentals of Emergency Management

The LibreTexts libraries are Powered by NICE CXOne and are supported by the Department of Education Open Textbook Pilot Project, the UC Davis Office of the Provost, the UC Davis Library, the California State University Affordable Learning Solutions Program, and Merlot. This material is based upon work supported by the National Science Foundation under Grant No. 1246120, 1525057, and 1413739.

This text was compiled on 03/19/2025

TABLE OF CONTENTS

Licensing

1: Introduction to Emergency Management

- 1.1: Introduction
- 1.2: Fundamental Theories of Disaster
- 1.3: Hazards, Emergencies, Disasters, and Catastrophes
- 1.4: The Development and Tasks of the Emergency Management System
- 1.5: Characterizing Emergency Management Activities
- 1.6: Visions of Emergency Management

2: Emergency Management Stakeholders

- 2.1: Definition of a "Stakeholder"
- 2.2: Community Stakeholder Groups
- 2.3: Decision Levels
- 2.4: Stakeholders and Power
- 2.5: The Emergency Management Policy Process
- 2.6: Involving Stakeholders in Emergency Management
- 2.7: Case Study: The Politics of Hazard Mitigation
- Appendix 2: Federal Agencies and Their Responsibilities Under the National Response Plan

3: Building and Effective Emergency Management Organization

- 3.1: Introduction
- 3.2: The Local Emergency Management Agency
- 3.3: Determinants of Emergency Management Effectiveness
- 3.4: LEMC Activities
- 3.5: Case Study: Emergency Management in Smith Hill

4: Risk Perception and Communication

- 4.1: Introduction
- 4.2: The Classical Persuasion Model
- 4.3: The Protective Action Decision Model
- 4.4: Risk Communication During the Continuing Hazard Phase
- 4.5: Risk Communication During an Escalating Crisis or Emergency Response
- 4.6: Case Study: Risk Perception and Warning of the Mt. St. Helens Eruption

5: Principal Hazards in the United States

- 5.1: Introduction
- 5.2: Meteorological Hazards
  - test
- 5.3: Hydrological Hazards
- 5.4: Geophysical Hazards
- 5.5: Technological Hazards

Index

Glossary

Detailed Licensing

Licensing

A detailed breakdown of this resource's licensing can be found in ***Back Matter/Detailed Licensing****.*

CHAPTER OVERVIEW

1: Introduction to Emergency Management

This chapter provides an overview that describes the basic types of hazards threatening the United States and provides definitions for some basic terms such as hazards, emergencies, and disasters. The chapter also provides a brief history of emergency management in the federal government and a general description of the current emergency management system—including the basic functions performed by local emergency managers. The chapter concludes with a discussion of the *all-hazards* approach and its implications for local emergency management.

1.1: Introduction

1.2: Fundamental Theories of Disaster

1.3: Hazards, Emergencies, Disasters, and Catastrophes

1.4: The Development and Tasks of the Emergency Management System

1.5: Characterizing Emergency Management Activities

1.6: Visions of Emergency Management

1.1: Introduction

There are many ways to describe emergency management and the importance of the tasks emergency managers perform. Indeed, in some respects, it hardly seems necessary to explain the need for a profession whose purpose is saving lives and property in disasters. It is likely that, while many people recognize their communities are exposed to environmental threats requiring a systematic program of protection, only a few appreciate the magnitude and diversity of the threats. One can introduce the study of emergency management by noting losses from disasters—in the United States and the rest of the world—have been growing over the years and are likely to continue to grow (Berke, 1995; Mileti, 1999; Noji, 1997b). Losses can be measured in a variety of ways—with deaths, injuries, and property damage being the most common indexes. The 1995 Kobe, Japan, earthquake killed more than 6000 people and left another 30,000 injured. In the previous year, the Northridge, California, earthquake resulted in approximately $33 billion in damages. These individual events are impressive enough, but the losses are even more dramatic when accumulated over time. Between 1989 and 1999, the average natural disaster loss in the US was $1 billion each week (Mileti, 1999, p. 5). Furthermore, many costs must be absorbed by victims—whether households, businesses, or government agencies—because only about 17% of losses are insured. Spectacular as they are, these past losses pale in comparison to potential future losses. Major earthquakes in the greater Los Angeles area or in the midwestern New Madrid Seismic Zone, which are only a matter of time, could generate thousands of deaths, tens of thousands of injuries, and tens of billions of dollars in economic losses.

Indeed, the daily news seems to suggest the world is plagued by an increasing number and variety of types of disasters, an impression that is certainly heightened by what seem to be frequent, very large scale natural disasters—including earthquakes, floods, hurricanes, volcanic eruptions, and wildfires—all over the globe. When we add to these events a wide range of severe storms, mudslides, lightning strikes, tornadoes, and other hazard agents affecting smaller numbers of people, one might conclude that natural disasters are increasing. Technological activities also initiate disasters. Hazardous materials are transported via road, rail, water, and air. When containment is breached, casualties, property loss, and environmental damage can all occur. Some technologies, such as nuclear power plants, pose seemingly exotic risks, whereas more commonplace technological processes such as metal plating operations use chemical agents that are very dangerous. Even the queen of American technology, the space program, has experienced disaster associated with system failures. Finally, we see terrorists operating on US soil—made forever visible by the attacks on the World Trade Center on September 11, 2001.

At times, it seems as if humankind is living out the script of a Greek tragedy, with the natural environment exacting retribution for the exploitation it has suffered and an unforgiving modern technology inflicting a penalty commensurate with the benefits that it provides. Though such a perspective might make fine fiction—disaster movies are recurrent box office successes despite their many major scientific errors—it does not accurately portray events from a scientific and technological view. The natural environment is, of course, not "getting its revenge". Geophysical, meteorological, and hydrologic processes are unfolding as they have for millennia, beginning long before humans occupied the earth and continuing to the present. Given the eons-long perspective of the natural environment, it would be very difficult to identify meaningful changes in event frequency for the short time period in which scientific records are available on geological, meteorological, and hydrological phenomena. Event frequency, from an emergency management perspective, is not really the issue. It is certainly true that, over the years, more people have been affected by natural disasters and losses are becoming progressively greater. The significant feature driving these observations, however, is the extent of human encroachment into hazard prone areas. With increasing population density and changing land use patterns, more people are *exposed* to natural hazards and consequently our accumulated human and economic losses are increasing. Much of this exposure is a matter of choice. Sometimes people choose hazardous places, building houses on picturesque cliffs, on mountain slopes, in floodplains, near beautiful volcanoes, or along seismic faults. Sometimes people choose hazardous building materials that fail under extreme environmental stresses—for example, unreinforced masonry construction in seismically active areas. Some exposure results from constrained choices; the cheap land or low rent in flood plains often attracts the poor. The point is that one need not precisely estimate event frequency to understand rising disaster losses in the United States. As Mileti (1999) writes in *Disasters by Design*, the increasing numbers of humans, our settlement patterns, the density with which we pack together, and our choices of location for homes, work, and recreation place more of us at risk and, when disasters occur, exact an increasing toll.

The pattern observed among technological disasters is somewhat different. Certainly more people are affected by technological threats simply because there are more people, and we often make unfortunate choices (as was the case with natural hazards) about our proximity to known technological hazards. However, the nature of the threat from technological sources also appears to be changing. The potential for human loss from technological sources increases with the growth and change of existing technologies and with the development of new technologies. For example, risks are rising from the increasing quantity and variety of hazardous materials used in industry, as well as from energy technologies such as coal and nuclear power plants and liquefied natural gas facilities. Such facilities and the processes they use pose a variety of risks for both employees who work in the facilities and those who live in nearby neighborhoods. Furthermore, as technologies develop it is sometimes found that what was thought not to be hazardous a decade ago does, in fact, have deleterious effects upon health, safety, and the environment. Yet, unlike natural events, advancing technology often produces an improved capability to detect, monitor, control, and repair the release of hazardous materials into the environment. Ultimately, as technologies grow, diversify, and become increasingly integrated into human life, the associated risks also grow.

Although terrorism has a long history (Sinclair, 2003), it has been a low priority that only recently become prominent on emergency managers' lists of threats to their communities (Waugh, 2001). Recent events, especially the 1995 bombing of the Murrah Federal Building in Oklahoma City and the 2001 attacks on the World Trade Center and Pentagon, have made it obvious that the outcomes of at least some terrorist attacks can be considered disasters. Although some consider terrorism to be a hazard, this is not a very useful conceptualization. According to the Federal Emergency Management Agency (1996a, p. PH2.11), the Federal Bureau of Investigation defines terrorism as "the unlawful use of force against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives". That is to say, terrorism is a strategy, not a hazard agent. Most of the technological hazard agents (chemical, radiological/nuclear, or explosive/flammable) that could threaten American communities in terrorist attacks can also occur by means of accidents. As Winslow (2001) notes, terrorists have typically used explosive agents, sometimes used chemical agents, and have the potential to use radiological or biological agents. Thus, although radiological materials have not yet been used in terrorist attacks, emergency managers should be prepared to respond to their deliberate or accidental release. Similarly, concern has been expressed about terrorist attacks using biological agents, but these can also occur naturally. Biological hazards are normally the concern of public health agencies, but emergency managers should be knowledgeable about them because terrorist attacks involving these agents will require coordination between the two types of agencies.

It remains to be seen precisely how terrorism will be fitted into the lexicon of disaster research. Already, definitions of terrorism vary between the academic community and emergency managers (Buck, 1998). Nonetheless, emergency managers must address the consequences of terrorist attacks using the same basic approaches that are used in other emergencies and disasters. One major difference between most terrorist attacks and many other types of disasters such as floods and hurricanes is the uncertainty about the time, place, and magnitude of the event. Advance detection is a prerequisite for forewarning, but experience to date indicates detection accuracy is not high even for the timing of an attack, let alone the place, magnitude, and type (chemical, biological, radiological/nuclear, explosive/flammable) of agent involved. At the present, emergency management efforts must focus on prompt detection once an incident has occurred, along with preparedness for a timely response and recovery. Even these strategies are complicated because it is so difficult to anticipate the competence of the terrorists. For example, the Aum Shinrikyo cult's attempt to disperse the nerve agent sarin in the Tokyo subway during 1995 underscored the importance of agent quality and diffusion effectiveness. Cult members carried bags of the liquid form of the agent onto subway cars and cut the containers as a means of initiating the release. Although Sarin is extremely lethal, the attack resulted in only twelve deaths and approximately 1,046 patients being admitted to hospitals (Reader, 2000). If the Sarin had been effectively aerosolized, the death and injury rates could have been phenomenal. Ultimately, whether terrorism and its consequences are increasing or not seems to be a matter of many factors that defy meaningful measurement at this time.

Given the increasing toll from disasters arising from natural hazards, technological accidents, and terrorist attacks using technological agents, American society must decide whether the risks are "acceptable". Moreover, given the limited amount of time and resources that can be devoted to risk management, decisions must be made about which risks to address (Lowrance, 1976). When individuals, organizations, or political jurisdictions reach consensus that a given risk is unacceptable, resources can be marshaled to reduce the risk to some level deemed more acceptable. Such resources can be used to attempt to eliminate the source of the danger, or, alternatively, change the way people relate to the source of danger. For example, building dams or channeling streams can eliminate the risk of seasonal floods (at least for a time). Alternatively, people and dwellings can be relocated outside the floodplain, or a warning and evacuation system could be devised to provide population protection (but generally not property) in times of acute flood threat. Emergency management is rooted in this process of identifying unacceptable risks, assessing vulnerabilities, and devising strategies for reducing unacceptable risks to more acceptable levels. Of course, emergency managers cannot perform all of these activities by themselves. However, as later chapters will show, they can act as "policy entrepreneurs" that propose strategies and mobilize community support for risk reduction.

In general terms, emergency management is "the discipline and profession of applying science, technology, planning and management to deal with extreme events that can injure or kill large numbers of people, do extensive damage to property, and disrupt community life” (Drabek, 1991a, p. xvii). Thus, emergency managers identify, anticipate, and respond to the risks of catastrophic events in order to reduce to more acceptable levels the probability of their occurrence or the magnitude and duration of their social impacts. In the United States, emergency management traditionally has been conceptualized as the job (if not the legal responsibility) of government—local, state and federal. Particularly since the middle of the 20th Century, private business organizations have taken an increasingly active interest in emergency management, especially as it relates to their own business continuity. Certainly as the 21st Century begins, emergency management is best conceived as relying on alliances among all levels of government and the broader private sector (including for-profit and nonprofit organizations with a wide range of missions).

Many factors have contributed to the increasing salience of emergency management in American society. One important factor lies in changes in the principle of sovereign immunity at the state level in the last quarter of the 20th Century and the establishment of levels of tort liability for local and state governments (Pine, 1991). Although some levels of immunity persist, it is important that government liability can be established under state and federal law, particularly in cases where negligence (failure to plan where appropriate) can be contended successfully. Another factor promoting the importance and visibility of the emergency management is the professionalization of emergency managers. A recognition of the need for specialized training and development for emergency managers has led to the establishment of professional associations, the use of training certifications (e.g. technician certificates for hazardous materials and emergency medical expertise, and general certificates in incident management systems), and of professional credentialing processes such as the Certified Emergency Manager program promoted by the International Association of Emergency Managers. These developments have contributed to the growth of an organized body of specialists who understand how to appraise and cope with a range of environmental threats. Still a third factor is a growing sensitivity to hazards on the part of the public-at-large that is driven by media attention to periodic catastrophes associated with the forces of nature and technology. Finally, private businesses have become increasingly sensitive to the fact that disaster losses can have significant negative consequences on business plans and performance, sometimes forcing bankruptcy, closure, or the loss of significant market share (Lindell & Perry, 1998). With such significant potential consequences, vulnerability assessment and disaster preparedness have become both imbedded in business planning and thriving businesses in themselves. Collectively, these factors have generated a social environment in which governments' ethical and legal obligations to protect citizens, and private sector interest in self-protection, have attracted attention to emergency management.

1.2: Fundamental Theories of Disaster

Over the centuries, there have been four fundamental theories about disasters. These four theories have conceived of disasters as:

· Acts of fate/acts of God,

· Acts of nature,

· Joint effects of nature and society, and

· Social constructions.

Acts of Fate/Acts of God

For millennia, disasters were considered to arise from impersonal and uncontrollable forces—either from unfortunate alignments of stars and planets or as acts of God that were beyond human understanding. Both forms of this theory viewed a disaster as predetermined and, thus, completely beyond the victim's control. A variation on this theory was that disasters were cosmic or divine retribution for human failings—personal disasters for personal failings and collective disasters for societal failings.

Acts of Nature

Over time, increased scientific knowledge led many people to substitute natural causes for supernatural ones. Thus, floods occurred because the large amount of rainfall from a severe storm exceeded the soil's capacity to absorb it. The rapid runoff exceeded the river basin's capacity, so the excess spilled over the river banks, flooded buildings, and drowned people and animals. Accordingly, the term *natural disaster* came to refer to "an outside attack upon social systems that 'broke down' in the face of such an assault from outside" (Quarantelli, 1998, p. 266). The resulting conception of *man against nature* has been especially potent as the driving force behind attempts to "tame" rivers by straightening their channels and building dams and levees.

Interactive Effects of Nature and Society

Still later, it was proposed that hazards arise from the interaction of a physical event system and a human use system. Thus, it takes *both* a hazardous physical event system *and* a vulnerable human use system to produce disasters. If either one is missing, disasters do not occur. According to Carr (1932, p. 211)

Not every windstorm, earth-tremor, or rush of water is a catastrophe. [S]o long as the levees hold, there is no disaster. It is the collapse of the cultural protections that constitutes the disaster proper.

According to this view, human societies adapt to the prevailing environmental conditions (e.g., temperature, wind speed, precipitation, seismic activity) at a given location. Unfortunately, they fail to anticipate the variation in those environmental conditions. Consequently, their adaptation to normal conditions usually is inadequate for extreme events—blizzards, heat waves, tornadoes, hurricanes, and floods. This perspective is perhaps best illustrated by earthquake damage and casualties. As earthquake engineers are fond of saying, earthquakes don't kill people, collapsing buildings kill people. According to this view, people can avoid disasters if they stay out of seismically active locations or, if they do move there, they must build structures that resist the extreme environmental events that will eventually occur.

Social Constructions

Most recently, researchers have recognized that disasters are quite systematic in the types of people they harm, as well as the types of geographic locations and human use systems they strike. To the *interactive effects* theory's concerns about hazard exposure at specific locations and physical vulnerability of specific structures, social construction theory calls attention to the social vulnerability of specific population segments. To say that hazard vulnerability is *socially constructed* does not mean people are vulnerable because they think the wrong thoughts—as most people would now categorize the belief that floods are caused by the alignment of the planets and stars. Rather, socially vulnerable population segments emerge because our psychological, demographic, economic, and political processes tend to produce them. Of course these processes have produced many good things. Many residents of the US, in particular, have good jobs, comfortable lives, and we have enjoyed one of the most democratic governments in the world. Nonetheless, all of these conditions have changed over time—life now is much improved from what it was a century ago and there are many ways in which it can be improved still further. Of particular concern to emergency managers should be the many ways in which our institutions can reduce the hazard vulnerability of those who have the least psychological resilience, social support, political power, and are the poorest economically.

Theoretical Comparisons

These theories have, in one sense, succeeded each other over time as scholars have found later theories to provide a better account of the data from their research. However, scientific acceptance is different from popular acceptance. Each of the four theories is currently believed by at least some members of society. Indeed, the most cynical version of the *Acts of fate/acts of God* theory uses it to avoid responsibility for actions that are substantially within human control. For example, representatives of the coal company that built a dam across Buffalo Creek West Virginia claimed the dam's collapse was an "Act of God" because the dam was "incapable of holding the water God poured into it" (Erikson, 1976, p. 19). This was clearly a feeble attempt to avoid admitting the company negligently built a non-engineered dam from unstable materials, thus risking the lives of downstream residents to maintain company profits.

Each community throughout the world probably has at least some believers in each theory. Because each theory has different implications for environmental hazard management, the prevalence of each theory has significant implications for policy at the local, state, national, and international levels.

1.3: Hazards, Emergencies, Disasters, and Catastrophes

Hazards, emergencies, and disasters afflicted human societies much longer than either the profession of emergency management or academic disaster research has existed. Thus, many vernacular terms have arisen that refer to the negative consequences of environmental events—accident, emergency, crisis, disaster, catastrophe, tragedy, and calamity, to name a few. Over the years, many of these terms have become embedded in the American vocabulary, often introduced through the mass media or literary usage. As such events have become the focus of academic study and professional emergency management, it has also become necessary to devise technical—as opposed to vernacular—meanings for them to communicate a standardized meaning for each of these terms. For the purposes of this introduction to emergency management, it is important to distinguish the meaning of three terms: hazards, disasters, and emergencies.

Hazards

The environment humans occupy consists of natural and technological components, each of which contains elements that pose a variety of risks to the human occupants and their property. These risks include both health and safety dangers for the occupants themselves and dangers to the physical or material culture created by the occupants. The risks arise from the intrusion of the human use system into natural and technological processes. The term *hazard* captures the notion that, to the extent that people co-exist with powerful natural and man-made processes, there is a non-zero probability that the natural variation in these processes will produce extreme events having very negative consequences (Burton, Kates & White, 1993; Cutter, 2001). The human danger posed by these hazards varies with the level of human intrusion and the knowledge and technology associated with the hazard (Lindell & Perry, 1992). Tsunami (seismic sea waves) hazard is nonexistent in Ames, Iowa, because human occupancy at that location is so far from the runup zones near the ocean shore, but tsunami hazard is very significant along the Pacific coast—especially the Hawaiian islands. Hazards are inherently probabilistic; they represent the potential for extreme environmental events to occur. Thus, hurricane hazard refers to the potential for hurricanes to affect a given location. Hurricane hazard does not describe the condition when a hurricane strikes a coastal community causing death, injury, and property destruction. Of course, to achieve long-term survival, humans must adjust to or accommodate both natural and man-made processes in some fashion. The classic definition of hazard adjustment focuses upon the modification of human behavior (broadly speaking, to include even settlement patterns) or the modification of environmental features to enable people to live in a given place (or with a given technology) under prevailing conditions (Lindell & Perry, 2004).

Emergencies

The term *emergency* is commonly used in two slightly different but closely related ways. The first usage of the term refers to an event involving a minor consequences for a community—perhaps a few casualties and a limited amount of property damage. In this sense, emergencies are events that are frequently experienced, relatively well understood, and can be managed successfully with local resources—sometimes with the resources of a single local government agency. Emergencies are the common occurrences we see uniformed responders managing—car crashes, ruptured natural gas pipelines, house fires, traumatic injuries, and cardiac crises. They are managed via (usually government, but sometimes private) organizations with specially trained, specially equipped personnel. One commonly associates emergencies with fire departments, police departments, and emergency medical services (EMS) organizations. These events are "routine" in the sense that they are well understood and, thus, elicit standardized response protocols and specialized equipment (Quarantelli, 1987). Nonetheless, it is important to understand each emergency can present unique elements; experts caution there is no such thing as a "routine" house fire. The belief that each new fire will be like all the previous ones has a high probability of producing firefighter deaths and injuries (Brunacini, 2002).

The second usage of the term emergencies refers to the imminence of an event rather than the severity of its consequences. In this context, an emergency is a situation in which there is a higher than normal probability of an extreme event occurring. For example, a September hurricane approaching a coastal community creates an emergency because the probability of casualties and damage is much greater than it was in March before hurricane season began. The urgency of the situation requires attention and, at some point, action to minimize the impacts if the hurricane should strike. Unlike the previous usage of the term emergency, the event has not occurred but the consequences are not likely to be minor and routine methods of response are unlikely to be effective if the event does occur.

Disaster

The term *disaster* is reserved for the actual occurrence of events that produce casualties and damage at a level exceeding a community's ability to cope. As Table \(\ref(1) |) indicates, a disaster involves a very specific combination of event severity and time/probability. Unlike the uncertain time of impact associated with a hazard (whether or not the impact would exceed community resources), a disaster reflects the actuality of an event whose consequences exceed a community's resources. Unlike imminent emergencies, the consequences have occurred; unlike routine emergencies having minor impacts, disasters involve severe consequences for the community. By extension, a *catastrophe* is an event that exceeds the resources of many local jurisdictions—in some cases crippling those jurisdictions' emergency response capacity and disrupting the continuity of other local government operations. Hurricane Katrina's destruction of the local emergency response agencies and disruption of other local government agencies in Louisiana, Mississippi, and Alabama certainly qualifies for this designation.

Prince's (1920) study of an explosion in Halifax, Nova Scotia was the first modern piece of disaster research, but it was twelve years later that Carr (1932) made the first attempt at a formal definition of disaster. Presently, disaster is commonly defined as a nonroutine event in time and space, producing human, property, or environmental damage, whose remediation requires the use of resources from outside the directly affected community. This definition captures the two features that are minimally (and traditionally) cited as features of disasters: they are out of the ordinary events whose consequences are substantial enough to require that extra-community resources be marshaled to respond to and recover from the impact (Quarantelli, 1984; Perry, 1991; Tierney, Lindell & Perry, 2001). There are many different definitions of disaster present in the professional and academic literature, but most of them include the dimensions listed in this definition. In addition, some of the other definitions specify the mechanism that generates the event such as acts of God, social injustice, acts of nature, aspects of social organization, etc. As will be discussed later in this chapter, there are important distinctions to be made among different types of disasters and the ways in which emergency management strategies vary with the source of the disaster (Drabek, 1997). Whether one believes God, nature, social injustice, or purposeful encroachment produce disasters certainly affects the attitude we express toward victims. The academic community, in particular, is still debating the details of such distinctions and consensus about the specific details of different meanings is still developing (Quarantelli, 1998). However, in the profession of emergency management, the focus is typically on the assumption that disasters are caused by the overlap of human use systems with natural and technological processes and the charge is to minimize the negative consequences. At least on this applied level, emergency managers can operate on a concise definition of disasters, while remaining cognizant that the concept can be extended in a variety of ways and has myriad dimensions.

Table 1.3.1 *Relationships Among Hazards, Emergencies, Disasters, and Catastrophes.*

		Time/probability		
		Uncertain	Imminent	Occurred
Demand compared to community capacity	Less than	Hazard	Emergency	Emergency
	Greater than	Hazard	Emergency	Disaster/catastrophe

1.4: The Development and Tasks of the Emergency Management System

Most hazard/disaster researchers and emergency managers would probably agree that it presumes much to claim that an *integrated* emergency management system exists in the United States. Certainly this is so if by an integrated system one means a well-defined and clearly differentiated structure of components with mutually agreed upon roles interacting over time in a coordinated manner to achieve common goals (see Katz & Kahn, 1978, for a discussion of the systems perspective on organizations). However, there is a *loosely-coupled* collection of organizations that perform relatively differentiated roles in planning for, responding to, and recovering from disasters. Indeed, a basic understanding of the emergency management system and the demands that shape it has existed only since the late 1970s. Even this basic conception of emergency management continues to change and the rudiments of what may yet become an integrated system for managing emergencies continues to evolve. Clearly, even after the intense efforts to enhance the system after the 2001 attack on the World Trade Center and the Pentagon, much of what currently exists remains both fragmented and incomplete. In many respects, the old adage that "disasters are a local problem" seems as true now as it was thirty years ago (Perry, 1979). What is different today is the fact that there is a greater degree of consensus regarding how to assess and respond to the risks of natural and technological hazards. Concomitantly, there appears to be increasing agreement regarding the goals and structures by which federal, state, and local governments work with private organizations and the general public to develop an integrated emergency management system.

By focusing upon an ideal emergency management system, the current state of the art, imperfect as it may be, can be described and placed into historical perspective. Since the primary aim here is to describe rather than evaluate, the purpose of the following section is to provide a picture of the organizations comprising the system as it has changed over time. To some extent, the discussion will include *what might be* with respect to an emergency management system as well as *what is*. Consequently, instances will be noted in which organizational links are tenuous at best and where functions assigned to agencies (particularly at the federal level) are minimally fulfilled or in some cases completely ignored. What follows, then, is an attempt to describe in a very short space what is really a very complex and extensive constellation of agencies, programs, and interrelationships. Although the limited space available here requires compressing and simplifying many complex issues, the next two sections will describe the history of emergency management organizations, followed by a discussion of the functions that comprise emergency management.

A Brief History of Federal Emergency Management

Since the founding of the United States, the responsibility for and the locus of emergency and disaster management has moved from one agency to another within the federal government (and the same is true for many state and local governments). Except for two pieces of legislation, however, very little systematic work was done that resembles modern emergency management until the 1930s. Drabek (1991b, p. 6) reports that the first national disaster management effort was the 1803 Fire Disaster Relief Act, which made funds available to help the city of Portsmouth and the state of New Hampshire recover from extensive fires. The next piece of legislation came 125 years later when the Lower Mississippi Flood Control Act of 1928 was passed as a means of responding to the lower Mississippi River flooding in 1927 (Platt, 1998, p.38). It is important to note that both of these pieces of early legislation *followed* a disaster and were aimed at supporting *recovery* because this is a pattern that has been continued to the present day. An emphasis on reconstruction after disaster has characterized emergency response efforts at the federal level even in the 21st Century.

Federal disaster management, if we characterize it as concerted attempts to manage the negative consequences of natural forces, really began when President Franklin Roosevelt created the Reconstruction Finance Corporation in 1933 and authorized it to make loans for repairing public buildings damaged by earthquakes (Drabek, 1991b). In addition, many New Deal social programs provided services and various types of financial aid to natural disaster victims. Aside from individual programs, the National Emergency Council operated within the White House between 1933 and 1939, primarily to cope with the Great Depression, but also to oversee natural disaster relief. The Flood Control Act of 1936 established the Army Corps of Engineers as an important agency in the management of American waterways. In 1939, when the worst part of the Great Depression had begun to subside, the National Emergency Council was moved to the Executive Office of the President and renamed the Office for Emergency Management. Natural disaster relief continued to be centered in this agency, which functioned as a crisis management team for national scale threats of various types.

The beginning of World War II demanded the full attention of the Roosevelt administration in much the same way as the Depression had previously. In addition to its responsibilities for natural hazards, the Office for Emergency Management became the President's agency for developing civil defense plans and addressing war-related emergencies on the home front. Many programs devised by the Office for Emergency Management were based in the Department of War, under the Office of Civil Defense (directed by Fiorello La Guardia). This office was abolished in 1945, leaving the Office for Emergency Management again as the principal federal emergency agency (Yoshpe, 1981, p.72).

Following World War II, President Harry Truman initially resisted pressures to establish another civil defense agency, believing that civil defense should be the responsibility of the states (Perry, 1982). An Office of Civil Defense Planning was created in 1948 under the year-old Defense Department, and the Office for Emergency Management was again left to concentrate on natural disasters and other domestic emergencies. This separation of planning for civil defense versus natural and domestic disasters continued for nearly two years, but has reappeared over the decades with subsequent reorganizations of federal efforts. After the Soviet Union tested its first atomic bomb in the summer of 1949, Truman relented and created the Federal Civil Defense Administration within the Executive Office of the President as a successor to the Office for Emergency Management. Responsibility for federal assistance in the case of major natural disasters became the responsibility of the Housing and Home Finance Administration. Legislation quickly followed with the passage of the Federal Civil Defense Act of 1950 and the Disaster Relief Act of 1950 (Blanchard, 1986, p. 2). It is noteworthy that this legislation continued to assign responsibility for civil defense and disasters to the states and attempted to spell out specific federal obligations. At the end of President Truman's administration on January 16, 1953, Executive Order 10427 removed natural disaster relief responsibility from Housing and Home Finance and added it to FCDA (Yoshpe, 1981, p.166).

This arrangement of functions and agencies persisted through both Eisenhower administrations, though the primary agency name changed first to the Office of Defense and Civilian Mobilization and then to the Office of Civil Defense Mobilization. The Office of Civil Defense Mobilization was the first emergency organization to be given independent agency status (in 1958) rather than being under another cabinet department or the White House. On the policy side, the Federal Civil Defense Act was amended in 1958 to make civil defense a joint responsibility of the federal government and state and local governments. This amendment also provided for federal matching of state and local government civil defense expenditures, which actually began to be funded in 1961 under the administration of President John F. Kennedy. Thus, the Kennedy era saw the first rapid expansion of civil defense agencies at the state and local level. President Kennedy again separated federal responsibility for domestic disasters and civil defense in 1961 when he created the Office of Emergency Planning (in the White House) and the Office of Civil Defense (in the Defense Department). Kennedy's successor, Lyndon B. Johnson, moved the OCD to the Department of the Army in 1964, signaling a reduction in importance (and funding) for this function. This general separation of functions was maintained until 1978, although the Office of Civil Defense became the Defense Civil Preparedness Agency in 1972. Beginning with the creation of the Office of Emergency Preparedness under the Executive Office of the President in 1968, programs dealing with natural and technological hazards began to be reconstituted and parceled out among a variety of federal agencies. For example, the Federal Insurance Administration was established in 1968 as part of the Department of Housing and Urban Development. In 1973, President Richard M. Nixon dismantled the Office of Emergency Preparedness and assigned responsibility for post-disaster relief and reconstruction to the Federal Disaster Assistance Administration in the Department of Housing and Urban Development. General management and oversight of federal programs was assigned to the Office of Preparedness, which was moved to the General Services Administration and, in 1975, became the Federal Preparedness Agency.

Throughout the 1970s, as new federal legislation or executive orders mandated federal government concern with different aspects of natural and man-made hazards, new programs were created within a variety of federal offices and agencies. These were included in the Department of Commerce's National Weather Service Community Preparedness Program (1973) and the National Fire Prevention and Control Administration (1974). Following the 1972 havoc wreaked by Hurricane Agnes, the Disaster Relief Act of 1974 was passed granting individual and family assistance to disaster victims (administered through the Federal Disaster Assistance Administration). In the late 1970s, four major programs were established within the Executive Office of the President: Dam Safety Coordination, Earthquake Hazard Reduction Program, Warning and Emergency Broadcast System, and Consequences Management in Terrorism. Other technological hazards programs also involved such agencies as the Environmental Protection Agency, Nuclear Regulatory Commission, and the Departments of Energy and Transportation.

This diffuse assignment of responsibilities for emergency management programs to a diverse set of federal agencies persisted through the late 1970s and, as time passed, created a growing concern in the executive branch and the Congress that federal programs for disaster management were too fragmented. Similar concerns by state and local governments became the focus of the National Governors' Association (NGA) Disaster Project in the late 1970s. The project's staff traced many state and local problems in emergency management back to federal administrative arrangements. They argued that federal fragmentation hampered effective preparedness planning and response, masked duplicate efforts, and made national preparedness a very expensive enterprise. The Director of the Federal Preparedness Agency, General Leslie W. Bray, acknowledged that when the emergency preparedness function was taken out of the Executive Office of the President and assigned sub-agency status, many people perceived that the function had been downgraded to a lower priority, and his job of coordinating became more complicated. The states argued that their job of responding to disasters was hampered by being forced to coordinate with so many federal agencies. In 1975, a study of these issues sponsored by the Joint Committee on Defense Production (1976, p. 27) concluded:

> *The civil preparedness system as it exists today is fraught with problems that seriously hamper its effectiveness even in peacetime disasters. . . It is a system where literally dozens of agencies, often with duplicate, overlapping, and even conflicting responsibilities, interact.*

In addition to the administrative and structural difficulties, there was also concern the scope of the functions performed as part of emergency management was too narrow, too many resources were devoted to post-disaster response and recovery, and too few resources devoted to the disaster prevention. When the federal response to the nuclear power plant accident at Three Mile Island was severely criticized, calls for reorganization became very loud (Perry, 1982).

Responding to these concerns in 1978, President Jimmy Carter initiated a process of reorganizing federal agencies charged with emergency planning, response, and recovery. This reorganization resulted in the creation, in 1979, of the Federal Emergency Management Agency (FEMA), whose director reported directly to the President of the United States. Far from being an entirely new organization, FEMA was a consolidation of the major federal disaster agencies and programs. Most of FEMA's administrative apparatus came from combining the three largest disaster agencies: the Federal Preparedness Agency, Defense Civil Preparedness Agency, and Federal Disaster Assistance Administration. Thirteen separate hazard-relevant programs were moved to FEMA, including most of the programs and offices created in the 1970s (Drabek, 1991b). These moves gave FEMA responsibility for nearly all federal emergency programs of any size, including civil defense, warning dissemination for severe weather threats, hazard insurance, fire prevention and control, dam safety coordination, emergency broadcast and warning system, earthquake hazard reduction, terrorism, and technological hazards planning and response. Where FEMA did not absorb a program in its entirety, interagency agreements were developed giving FEMA coordinating responsibility. These agreements included such agencies as the Environmental Protection Agency (EPA), Department of Transportation (DOT), National Oceanic and Atmospheric Administration (NOAA), and Nuclear Regulatory Commission (NRC).

At least on paper, the Executive Order made FEMA the focal point for all federal efforts in emergency management. Although FEMA remained the designated federal *lead agency* in most cases, there were 12 other independent agencies with disaster responsibilities. The EPA is the largest of these agencies, but others included the Federal Energy Regulatory Commission (FERC), the National Transportation Safety Board (NTSB), NRC, Small Business Administration (SBA), and the Tennessee Valley Authority (TVA). Because disaster related federal relief programs were so scattered through the government, many small programs remained in their home agencies. For example, the Emergency Hay and Grazing program allows federal officials to authorize the harvesting of hay for emergency feed from land assigned for conservation and environmental uses under the Conservation Reserve Program. This program is operated in the Farm Service Agency of the US Department of Agriculture. Ultimately, some emergency or disaster related programs remained in thirteen cabinet level departments, including Agriculture, Commerce, Defense, Education, Energy, Health and Human Services, Housing and Urban Development, Interior, Justice, Labor, State, Transportation and Treasury. Certainly the creation of FEMA moved federal emergency management to a much more central position than it had ever been given previously, but it was not possible to completely consolidate all federal programs and offices within the new agency.

The FEMA Director is appointed by the President of the United States and, until the establishment of the Department of Homeland Security, was part of the cabinet. The organization has a regional structure composed of ten offices throughout the United States plus two larger area offices. Although by far the most comprehensive effort, the establishment of FEMA represented the third time that all federal disaster efforts and functions were combined; the first was the National Emergency Council (1933-1939), followed by the Office of Civil Defense Mobilization (1958-1961). The early history of FEMA was dominated by attempts to define its mission and organize its own bureaucracy. John Macy, the agency's first director, was faced with organizational consolidation as a most pressing task: converting thirty separate nation-wide offices to 16 and eight Washington, D.C. offices to five (Macy, 1980). Ultimately, creating a single bureaucracy (with a \$630 million budget) from thirteen entrenched organizations proved to be a herculean task.

The efforts to obtain an optimal structure for FEMA continued over the next two decades; later directors undertook major reorganizations of headquarters and FEMA's mission, like its structure, continued to evolve. The early years of FEMA saw much significant legislation and activity. In 1979, the NGA Disaster Project published the first statement of Comprehensive Emergency Management (CEM, the notion that authorities should develop a capacity to manage all phases of all types of disasters), and the concept was subsequently adopted by both the NGA and FEMA. In 1980, the Federal Civil Defense Act of 1950 was amended to emphasize crisis relocation of population (evacuation of people from cities to areas less likely to be Soviet nuclear targets), signaling a fundamental change in US civil defense strategy. Also in 1980, the Comprehensive Environmental Response, Compensation, and Liability Act (called the Superfund Law) was passed, precipitated by the 1978 dioxin contamination of Love Canal, New York (Rubin, Renda-Tanali & Cumming, 2006—www.disaster-timeline.com). In 1983, FEMA adopted the concept of Integrated Emergency Management System (IEMS) as part of the strategy for achieving CEM (Blanchard, 1986; Drabek, 1985). The basic notion was to identify generic emergency functions—applicable across a variety of hazards—and develop modules to be used where and when appropriate. For example, population evacuation is a useful protective technique in the case of hurricanes, floods, nuclear power plant accidents, or a wartime attack (Perry, 1985). Similar generic utility exists is developing systems for population warning, interagency communication, victim sheltering, and other functions. Thus, in the early 1980s, FEMA was formed, shaped by organizational growing pains, and also shaped through the adoption of new philosophies of emergency management. While FEMA's basic charge of developing a strategy and capability to manage all phases of all types of environmental hazards remained, the precise definitions of hazards, the basic conception of emergency management, and the organizational arrangements through which its mission should be accomplished continued to evolve through the end of the 20th Century.

The end of the 1980s saw passage of the Superfund Amendments and Reauthorization Act (SARA Title III) in 1986 (Lindell & Perry, 2001) and President Ronald Reagan's Presidential Policy Guidance (1987) that became the last gasp of nuclear attack related civil defense programs in the United States (Blanchard, 1986). Passage of the Robert Stafford Disaster Relief and Emergency Assistance Act of 1988 again boosted state and local emergency management efforts. The Stafford Act established federal cost sharing for planning and public assistance (family grants and housing).

The 1990s opened with controversy for FEMA. In 1989, FEMA response to Hurricane Hugo was criticized as inept—a charge repeated in 1992 when Hurricane Andrew struck Florida. In 1993, flooding in the mid-western US caused more than 15 billion dollars in damage and resulted in six states receiving federal disaster declarations. President Clinton appointed James Lee Witt Director of FEMA in 1993, marking the only time a professional emergency manager held the post. Witt (1995) aggressively increased the federal emergency management emphasis on hazard mitigation and began a reorganization effort. Prior to this time, the federal emphasis had been largely upon emergency response and, to a lesser extent, short-term disaster recovery. Witt began the first real change in federal strategy since emergency management efforts had begun. By the close of the 1990s, FEMA's organization reflected its critical functions. In 1997, there were seven directorates within FEMA: Mitigation, Preparedness, Response and Recovery, the Federal Insurance Administration, the United States Fire Administration, Information Technology Services, and Operations Support (Witt, 1997). As the 21st Century began, the overall emphasis of FEMA remained mitigation and both comprehensive emergency management and integrated emergency management systems remained concepts in force.

The most recent epoch in American emergency management began on September 11, 2001, when the attacks on the World Trade Center and the Pentagon shocked Americans and challenged government disaster response capabilities. The attack initiated a comprehensive rethinking of "security", "emergencies", and the appropriate role of the federal government. During October, 2001, President George W. Bush used Executive Orders to create the Office of Homeland Security (appointing Governor Tom Ridge as Director) and the Office of Combating Terrorism (General Wayne Downing as Director). On October 29th, President Bush issued Homeland Security Presidential Directive Number 1 (HSPD-1), establishing the Homeland Security Council, chaired by the President. In June of 2002, President Bush submitted his proposal to Congress to establish a cabinet level Department of Homeland Security (DHS), which was passed later that year.

Since the establishment of DHS, the department's mission has encompassed three goals: preventing terrorist attacks within the United States, reducing vulnerability to terrorism, and minimizing the damage and recovering rapidly from terrorist attacks (Bush, 2002, p. 8). Although not reflected in the mission statement, DHS would also retain the *all hazards* responsibilities assigned to FEMA. As was the case in the establishment of FEMA over two decades earlier, DHS incorporated a variety of agencies and programs from many cabinet-level departments, including Agriculture, Commerce, Defense, Energy, Health and Human Services, Interior, Justice, and Treasury. The US Secret Service reports directly to the Secretary of Homeland Security, as does the Coast Guard. The line agencies of DHS comprise four Directorates. The *Border and Transportation Security Directorate* incorporated the Customs Service from the Department of Treasury, Immigration and Naturalization Service from the Department of Justice, Federal Protective Service, the Transportation Security Agency from the Department of Transportation, Federal Law Enforcement Training Center from the Department of Treasury, Animal and Plant Health Inspection Service from the Department of Agriculture, and Office of Domestic Preparedness from the Department of Justice. The *Emergency Preparedness and Response Directorate* was built around FEMA and also included the Strategic National Stockpile and National Disaster Medical System of the Department of

Health and Human Services, Nuclear Incident Response Team from the Department of Energy, the Department of Justice's Domestic Emergency Support Teams, and the FBI National Domestic Preparedness Office. The *Science and Technology Directorate* incorporates the Chemical, Biological, Radiological and Nuclear Countermeasures Programs and the Environmental Measurements Laboratory from the Department of Energy, the National BW Defense Analysis Center from the Department of Defense, and the Plum Island Animal Disease Center from the Department of Agriculture. Finally, the *Information Analysis and Infrastructure Protection Directorate* absorbed the Federal Computer Incident Response Center from the General Services Administration, the National Communications System from the Department of Defense, the National Infrastructure Protection center from the FBI, and the Energy Security and Assurance Program from the Department of Energy.

Since 2001, the President has issued additional HSPDs defining the fundamental policies governing homeland security operations (www.dhs.gov/dhspublic). Thirteen HSPDs were issued through mid-2006. Recent documents have established the National Incident Management System (HSPD-5), the Homeland Security Advisory System (HSPD-3), the Terrorist Threat Integration Center (HSPD-6), and a common identification standard for all federal employees (HSPD-12). Other documents proposed strategies to combat weapons of mass destruction (HSPD-4), protect critical infrastructure (HSPD-7) and the agriculture and food system (HSPD-9), coordinate incident response (HSPD-8), and enhance protection from biohazards (HSPD-10). In addition, these documents have established policies for protecting international borders from illegal immigration (HSPD-2), promoting terrorist-related screening (HSPD-11), and securing maritime activities (HSPD-13).

These developments make it clear that the President and the Congress consider homeland security to be much broader than emergency management. Incorporation of FEMA into DHS's Emergency Preparedness and Response Directorate seems to imply FEMA is responsible only for preparedness and response (and perhaps disaster recovery if this is viewed as an extension of the emergency response phase). Consistent with this line of reasoning, one can interpret the mission of the Border and Transportation Security Directorate and the Information Analysis and Infrastructure Protection Directorate in terms of incident prevention. This gives these directorates responsibilities analogous to what emergency managers call hazard mitigation. Even so, the DHS organization chart seems to indicate a significant loss in the priority given to mitigation of natural and accidental technological hazards.

1.5: Characterizing Emergency Management Activities

Before discussing the tasks that constitute emergency management, it is important to briefly ground the discussion in the process of accomplishing emergency management. There have been years of dialogue regarding "who really does emergency management". Although the history just reviewed focuses largely on federal efforts, it is both accurate and appropriate to conceive of emergency management as a *local* endeavor to influence events with *local* consequences. This is in keeping with FEMA's practice of attempting to make US emergency management a "bottom up" proposition. Of course, the job can be done optimally only with intergovernmental communication and cooperation that links local, state, and federal efforts. In some cases—for example, biological threats—the full resources of the federal government are needed to even begin the management process. Certainly in a major incident, external support (particularly state and federal) of many forms is made available to local jurisdictions. There is an inevitable time lag, however; currently the *National Response Plan* alerts local communities they must plan to operate without external help for approximately 72 hours after disaster impact. In addition, when external support does arrive, the response proceeds most efficiently and effectively if there is a strong, locally devised structure in place into which external resources can be integrated (Perry, 1985). Taking these realities into account, the tasks of emergency management can be discussed more effectively if there is a structure into which to fit the discussion.

The Local Emergency Management System

Figure ??? describes the elements of a local emergency management system with some of its intergovernmental connections. By reviewing the figure, one can place in context some of the tasks and the tools available for emergency management. This chart is not intended to capture all actors and processes but, rather, to indicate the critical elements in the emergency management system. Ultimately, of course, the processes and tasks described here take place at every level of government.

The process of emergency management should be based on a careful hazard/vulnerability analysis (HVA) that identifies the hazards to which a community is exposed, estimates probabilities of event occurrence, and projects the likely consequences for different geographic areas, population segments, and economic sectors (Greenway, 1998; Ketchum & Whittaker, 1982). It is important to emphasize that HVA is not a static activity because hazards are not static. HVA is probably best conceptualized as a process that periodically reassesses the hazard environment so emergency managers can facilitate the challenging process of deciding which hazards are significant enough to require active management. This is a complex process that involves myriad considerations and input from a variety of actors; more detailed descriptions of this process are available in the work of Birkland (1997) and Prater and Lindell (2000).

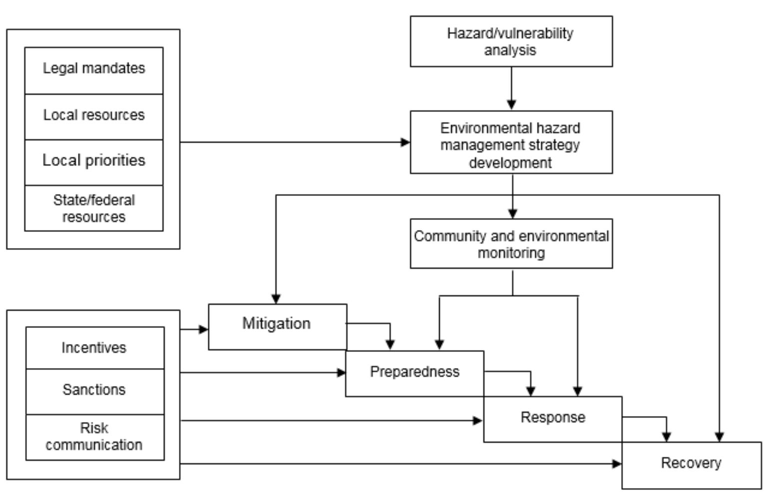


Figure 1.5.1: Local Emergency Management System.

Hazard management decisions are influenced by multiple considerations. There are statutory and administrative mandates to manage certain hazards. The available hazard data, derived from national sources such as FEMA's *Multi-Hazard Identification and Risk Assessment* (Federal Emergency Management Agency, 1997) and supplemented by local sources such as Local Emergency Planning Committees (LEPCs) and State Emergency Response Commissions (SERCs), are also critical components of the decision process. In addition, decisions to manage hazards are determined by state and federal resources, local resources (including the jurisdiction's budget), and the local resource allocation priorities.

Once a decision has been made to actively manage one or more hazards, three processes are initiated concurrently. The first is a hazard management planning process that examines mitigation and preparedness strategies. That is, the community must consider whether it is possible to eliminate a risk or reduce it through some emergency management strategy. At the local level, these deliberations involve not just emergency managers but also departments of land use planning, building construction, engineering, public works, public health, and elected officials because mitigation and preparedness actions require significant commitments of resources to reduce community hazard vulnerability. At the same time, the process of judging hazard impact begins, using much of the same technical hazard data to create strategies and acquire resources for response and recovery when a disaster strikes. The local response usually centers on preparations for the mobilization of local emergency services (fire department, EMS, hazardous materials teams, police, transportation and public works departments, and emergency managers) under an agreed upon incident management system (Brunacini, 2001; Kramer & Bahme, 1992). Both response and recovery activities are organized in conjunction with support from external sources, particularly the state and federal government. The purpose of this planning process is to institutionalize emergency response as much as possible while looking at disaster recovery as another path to sustainability or disaster resilience (in addition to mitigation). The third process to be initiated is environmental monitoring for the hazards to be managed. Typically, such monitoring is coupled with a warning system whose activation initiates response actions when disaster impact is imminent. The quality of the warning system depends upon the state of technology associated with the hazards to which the community is exposed and could provide days (in the case of hurricanes or riverine flooding) or minutes (in the case of tornadoes) of forewarning (Sorensen, 2000). The nature of the warning system is also affected by jurisdictional mitigation, preparedness, and response plans. In many cases, hazard monitoring is beyond the technical and financial capability of most communities and assumed by federal agencies and programs. In such cases—tsunamis, for example—the results of the monitoring program are relayed to local jurisdictions. Furthermore, information regarding the state of the warning system (its ability to accurately forecast and detect hazards) is shared with hazard planning systems as a means of informing longer term risk management plans.

The community planning process generates hazard management strategies that incorporate knowledge about hazards derived from many sources, including the scientific community and state and federal agencies. The resulting hazard management strategies can be categorized as hazard mitigation, disaster preparedness, emergency response, and disaster recovery. As will be discussed in greater detail below, mitigation seeks to control the hazard source, prevent the hazard agent from striking developed areas, limiting development in hazard prone areas, or strengthening structures against the hazard agent.

These community hazard management strategies must be individually implemented by households and businesses, or collectively implemented by government agencies acting on behalf of the entire community. The individual strategies only reduce the vulnerability of a single household or business. These generally involve simple measures to mitigate hazards by elevating structures above expected flood heights, developing household or business emergency response plans, and purchasing hazard insurance. The collective strategies are generally complex—and expensive—technological systems that protect entire communities. Thus, they mitigate hazards through community protection works such as dams and levees and prepare for hazard impacts through measures such as installing warning systems and expanding highways to facilitate rapid evacuation.

Collective hazard adjustments are relatively popular because they permit continued development of hazard prone areas, yet do not impose any constraints on individual households or businesses. In addition, their cost is spread over the entire community and often buried in the overall budget. Indeed, the cost is often unknowingly subsidized by taxpayers in other communities. For this reason, these collective hazard adjustments are often called "technological fixes". By contrast, individual hazard adjustments strategies require changes in households' and businesses' land use practices and building construction practices. Such changes require one of three types of motivational tactics—incentives, sanctions, or risk communication. Incentives provide *extrinsic rewards* for compliance with community policies. That is, they offer positive inducements that add to the inherent positive consequences of a hazard adjustment or offset the inherent negative consequences of that hazard adjustment. Incentives are used to provide immediate extrinsic rewards when the inherent rewards are delayed or when people must incur a short-term cost to obtain a long-term benefit. For example, incentives are used to encourage people to buy flood insurance by subsidizing the premiums. Sanctions provide *extrinsic punishments* for noncompliance with community policies. That is, they offer negative inducements that add to the inherent negative consequences of a hazard adjustment or offset the inherent positive consequences of that hazard adjustment. Sanctions are used to provide immediate extrinsic punishments when the inherent punishments are delayed or when people incur a short-term benefit that results in a long-term cost. For example, sanctions are used to prevent developers from building in hazard prone areas or using unsafe construction materials and methods. The establishment of incentives and sanctions involves using the political process to adopt a policy and the enforcement of incentives and sanctions requires an effective implementation program (Lindell & Perry, 2004).

By contrast, risk communication seeks to change households' and businesses' practices for land use, building construction, and contents protection by pointing out the *intrinsic* consequences of their behavior. That is, risk communication explains specifically what are the personal risks associated with risk area occupancy and also the hazard adjustments that can be taken to reduce hazard vulnerability.

With this overview, discussion can be turned to the four principal functions or phases of emergency management: hazard mitigation, emergency preparedness, emergency response, and disaster recovery. Much of the development and systematization of this four-fold typology may be traced to the efforts of the NGA's Emergency Management Project. As this group grappled with what it means to manage emergencies, it generated considerable discussion and some controversy within both the disaster research and emergency management communities. Since being adopted by FEMA, it is now widely accepted as an appropriate model for understanding the activities of emergency management. This scheme consolidates emergency activities into four discrete but interconnected categories distinguished by their time of occurrence in relation to disaster impact. Mitigation and preparedness activities are generally seen as taking place before the impact of any given disaster, whereas response and recovery activities are seen as post-impact measures.

Hazard mitigation

Hazard mitigation activities are directed toward eliminating the causes of a disaster, reducing the likelihood of its occurrence, or limiting the magnitude of its impacts if it does occur. Officially, FEMA defines mitigation as "any action of a long-term, permanent nature that reduces the actual or potential risk of loss of life or property from a hazardous event" (Federal Emergency Management Agency, 1998a, p. 9). This definition is somewhat ambiguous because it encompasses the development of forecast and warning systems, evacuation route systems, and other pre-impact actions that are designed to develop a capability for active response to an imminent threat. Thus, Lindell and Perry (2000) contended the defining characteristic of hazard mitigation was that it provides passive protection at the time of disaster impact, whereas emergency preparedness measures develop the capability to conduct an active response at the time of disaster impact. Since 1995, FEMA has emphasized mitigation as the most effective and cost-efficient strategy for dealing with hazards. Indeed, a recent study by the Multihazard Mitigation Council (2005) concluded investments in hazard mitigation return four dollars in losses averted for every dollar invested. The ways in which mitigation activities can reduce hazard losses can best be understood in terms of a model proposed by Burton, et al. (1993) that contends natural hazards arise from the interaction of natural event systems and human use systems. Thus, the potential human impact of an extreme natural event such as a flood, hurricane, or earthquake can be altered by modifying either the natural event system, or the human use system, or both. In the case of floods, for example, the natural event system can be modified by dams or levees that confine flood water. The human use system can be modified by land use practices that limit development of the flood plain or building construction practices that floodproof structures. Although the amount of control that can be exercised over natural event systems is often limited, technological hazards are inherently susceptible to such controls. Chemical, biological, radiological/nuclear, and explosive/flammable materials can all be produced, stored, and transported in ways that avoid adverse effects to plant workers, local residents and the public-at-large. However, this control can be lost, resulting in releases to the air, or to surface or ground water. It is possible to control the hazard agent by locating the system away from populated areas; designing it with diverse and redundant components or by operating it with smaller quantities of hazardous materials (known as *hazmat*), lower temperatures and pressures, safer operations and maintenance procedures, and more effective worker selection, training and supervision). Alternatively, one can control the human use system by preventing residential and commercial development—especially schools and hospitals—near hazardous facilities and major hazmat transportation routes. The choice of whether to mitigate technological hazards by controlling the hazard agent or the human use system depends upon political and economic decisions about the relative costs and benefits of these two types of control. Specific questions include who has control over the hazards, what degree of control is maintained, and what incentives there are for the maintenance of control.

Attempts to mitigate natural hazards, or events over which there is little human control, involve controlling human activities in ways that minimize hazard exposure. Thus, land use practices restricting residential construction in floodplains are important mitigation measures against riverine floods. The Hazard Mitigation and Relocation Act of 1993, for example, allows FEMA to purchase homes and businesses in floodplains and remove these structures from harm's way. Although moving entire communities involves considerable stress for all concerned, an intense and systematic management process—characterized especially by close coordination among federal, state, and local agencies—can produce successful protection of large numbers of citizens and break the repetitive cycle of "flood-rebuild-flood-rebuild" that is so costly to the nation's taxpayers (Perry & Lindell, 1997b). Likewise, building code requirements are used to restrict construction to those designs that can better withstand the stresses of hurricane force winds or earthquake shocks.

Disaster Preparedness

Disaster preparedness activities are undertaken to protect human lives and property in conjunction with threats that cannot be controlled by means of mitigation measures or from which only partial protection is achieved. Thus, preparedness activities are based upon the premise that disaster impact will occur and that plans, procedures, and response resources must be established in advance. These are designed not only to support a timely and effective emergency response to the threat of imminent impact, but also to guide the process of disaster recovery. A jurisdiction's disaster preparedness program needs to be defined in terms of

· What agencies will participate in preparedness and the process by which they will plan,

· What emergency response and disaster recovery actions are feasible for that community,

· How the emergency response and disaster recovery organizations will function and what resources they require, and

· How disaster preparedness will be established and maintained.

Emergency managers can address the first of these questions—what agencies and what will be the process for developing disaster preparedness—by defining an emergency management organization. This requires identifying the emergency management stakeholders in the community and developing a collaborative structure within which they can work effectively. It also requires ensuring an adequate statutory basis for disaster preparedness and administrative support from senior elected and appointed officials.

Emergency managers can address the second question—what are the feasible response and recovery actions—by means of analyses conducted to guide the development of major plan functions. These include, for example, evacuation analyses to assess the population of the risk areas, the number of vehicles that will be taken in evacuation, when people will leave, and what is the capacity of the evacuation route system.

Emergency managers can address the third question—how will the response and recovery organizations function—in the emergency operations plan (EOP), the recovery operations plan (ROP), and their implementing procedures. These documents define which agencies are responsible for each of the functions that must be performed in the emergency response and disaster recovery phases. Some of the generic emergency response functions include emergency assessment, hazard operations, population protection, and incident management (Lindell & Perry, 1992, 1996b). While developing the plans and procedures, emergency managers also need to identify the resources required to implement them. Such resources include facilities (e.g., mobile command posts and emergency operations centers—EOCs), trained personnel (e.g., police, fire, and EMS), equipment (e.g., detection systems such as river gages and chemical sensors, siren systems, pagers, emergency vehicles, and radios), materials and supplies (e.g., traffic barricades, chemical detection kits, and self-contained breathing apparatus), and information (e.g., chemical inventories in hazmat facilities, congregate care facility locations and capacities, and local equipment inventories).

Emergency managers can also address the fourth question—how disaster preparedness will be established and maintained—in EOP and ROP. Sections of these plans should define the methods and schedule for plan maintenance, training, drills, and exercises. Training should always be conducted for emergency responders in fire, police, and EMS. In addition, training is needed for personnel in special facilities such as hospitals, nursing homes, and schools.

Emergency Response

Emergency response activities are conducted during the time period that begins with the detection of the event and ends with the stabilization of the situation following impact. FEMA (1998b, p. 12) indicates the goal of emergency response is "to save lives and property by positioning emergency equipment and supplies; evacuating potential victims; providing food, water, shelter and medical care to those in need; and restoring critical public services". In many cases, hazard monitoring systems ensure authorities are promptly alerted to disaster onset either by means of systematic forecasts (e.g., hurricanes) or prompt detection (e.g., flash floods detected by stream gages), so there is considerable forewarning and consequently a long period of time to activate the emergency response organization. In other cases, such as earthquakes, pre-impact prediction is usually not available, but prompt assessment of the impact area is feasible within a matter of minutes to hours and can quickly direct emergency response resources to the most severely affected areas.

Some of the more visible response activities undertaken to limit the primary threat include securing the impact area, evacuating threatened areas, conducting search and rescue for the injured, providing emergency medical care, and sheltering evacuees and other victims. Operations mounted to counter secondary threats include fighting urban fires after earthquakes, identifying contaminated water supplies, or other public health threats following flooding, identifying contaminated wildlife or fish in connection with a toxic chemical spill, or preparing for flooding following glacier melt during a volcanic eruption. During the response stage, emergency managers must also continually assess damage and coordinate the arrival of converging equipment and supplies so they can be deployed promptly to those areas with the greatest need.

Emergency response activities are usually accomplished through the efforts of diverse groups—some formally constituted, others volunteer—coordinated through an EOC. Usually, local emergency responders dominate the response period. These almost always include police, firefighters, and EMS personnel, and often include public works and transportation employees. Uncertainty and urgency—less prevalent in mitigation, preparedness, and recovery—are important features of the response period. In the world of disaster response, minutes of delay can cost lives and property, so speed is typically essential. However, speed of response must be balanced with good planning and intelligent assessment to avoid actions that are impulsive and possibly counterproductive. Finally, emergency response actions need to be coordinated with disaster recovery. That is, life and property are priorities, but response actions foreshadow recovery actions. For example, damage assessments are later used to support requests for Presidential Disaster Declarations and debris removal might be concentrated on roadways that are essential for restoring infrastructure. The emergency response phase ends when the situation is stabilized, which means that the risk of loss of life and property has returned to precrisis levels.

Disaster Recovery

Disaster recovery activities begin after disaster impact has been stabilized and extends until the community has been returned to its normal activities. In some cases, the recovery period may extend for a long period of time. The Federal Emergency Management Agency (1995a, p. XX) states "[r]ecovery refers to those non-emergency measures following disaster whose purpose is to return all systems, both formal and informal, to as normal as possible." The immediate objective of recovery activities is to restore the physical infrastructure of the community—water, sewer, electric power, fuel (e.g., natural gas), telecommunication, and transportation—but the ultimate objective is to return the community's quality of life to at least the same level as it was before the disaster. Recovery has been defined in terms of short-range (relief and rehabilitation) measures versus long-range (reconstruction) measures. Relief and rehabilitation activities usually include clearance of debris and restoration of access to the impact area, reestablishment of economic (commercial and industrial) activities, restoration of essential government or community services, and provision of an interim system for caring for victims—especially housing, clothing, and food. Reconstruction activities tend to be dominated by the rebuilding of major structures—buildings, roads, bridges, dams, and such—and by efforts to revitalize the area's economic system. In some communities, leaders view the reconstruction phase as an opportunity to institute plans for change that existed before the disaster or to introduce mitigation measures into reconstruction that would constitute an improvement upon the community's pre-impact state. Such an approach to reconstruction has been documented after the great Alaska earthquake of 1964 (Anderson, 1969a). After the eruption of Mt. Usu on the northern island of Hokkaido, Japan, local leaders convinced the central government to invest in a wide range of civic improvements aimed at enhancing the local area's economic viability as a tourist center (Perry & Hirose, 1982).

Finally, it should be noted that the bulk of the resources used in the recovery phase (particularly on reconstruction) are derived from extracommunity sources. In the United States, these sources include private organizations and state governments, but for the most part they come from the federal government. Furthermore, even after James Lee Witt began FEMA's emphasis on hazard mitigation, most of the money and resources for emergency management continued to be consumed in the recovery phase.

Evaluation of the Emergency Management System

The preceding discussion has examined the four principal functions of the emergency management system—mitigation, preparedness, response, and recovery. In summary, two points should be reiterated here. First, although the distinctions among these four functions are fuzzy (i.e., the transition from one phase to the next is gradual rather than sharp), they are distinctly time phased. Mitigation and preparedness measures take place in advance of any specific disaster impact, whereas response takes place during and recovery occurs after disaster impact. Therefore, practical problems accompany the development of mitigation and preparedness strategies because they must usually be accomplished during periods of normal activity, when environmental threats are not imminent. Historical evidence indicates that it has been difficult to mount efforts to engage in these sorts of activities. Response and recovery take place within the context of a disaster impact—clearly unusual times—and benefit from the operation of an emergency social system as well as from the high level of community cohesiveness that usually emerges in the immediate aftermath (Lindell & Perry, 1992).

The second point is that, in the past, far more resources and emphasis have been allocated to response and recovery activities than to mitigation and preparedness. This is consistent with a cycle, well known to disaster researchers and emergency management professionals, of citizen and governmental interest in disasters. Immediately after impact, the attention of both the public and community officials is riveted upon the physical devastation and social disruption. Considerable resources are made available for shelter, food, clothing, and financial aid to victims, as well as debris clearance and the physical restoration of critical facilities within the community. However, public attention declines significantly as time passes. Because considerable time is required to translate such concern into budget allocations and coherent programs, many preparedness measures—and to an even greater extent mitigation measures—have simply failed to be implemented.

To a certain extent this differential emphasis has been a function of the difficulty citizens and political officials have in maintaining a high level of concern about disasters during times when they seem so remote. To do so requires that both citizens and leaders dwell upon negative events that may or may not occur sometime in the future—a task that is almost universally regarded as unpleasant and thus elicits procrastination. Perhaps equally important in the resource disparity, however, are the limitations posed by the technical state of knowledge regarding various hazards. The state of technology itself imposes limits on the types of mitigation and preparedness activities that can be undertaken. If the location of a potentially catastrophic event cannot be defined in advance, the feasible set of mitigation actions is severely limited. For example, tornado risk is essentially uniform within each local jurisdiction. so land use regulation would achieve little reduction in hazard vulnerability. Furthermore, in the absence of a technology of detection and highly accurate impact predictions, many preparedness measures are not feasible—such as evacuation from unreinforced masonry (e.g., brick) buildings immediately before an earthquake. Thus, in the past, it may have not been possible to devote resources anywhere other than to response and recovery. In the future, as more comprehensive forms of emergency management are implemented, the emphasis must shift toward the development of mitigation and preparedness measures within the limits of existing technology while pursuing research and development designed to advance the state of that technology.

1.6: Visions of Emergency Management

This overview of emergency management in the United States has included a discussion of the kinds of organizations that operate within the emergency management system, the different patterns of responsibility and interaction among the components of that system, and the general time phases of emergency management. The development of a perspective on emergency management requires consideration of at least two additional topics. The first of these deals with the evolution of prevailing federal conceptions of how hazards are managed—especially the underlying assumptions that define what goals are important and that determine the creation and structure of emergency organizations. The second topic concerns the way in which hazards are conceptualized—whether one focuses upon the event itself or upon the demands that events place upon social systems.

Alternative Conceptions of Managing Hazards

As one might infer from the history of emergency management organizations, there is a separation of emergency functions that has emerged and persisted over the years. With only a few exceptions, federal organizations charged with addressing wartime attacks have been different from those charged with concerns about natural disasters. This separation of functions has also been reflected in the research by social scientists on human performance in the face of disasters. Historically, this is one of the earliest and, in terms of research and theory, one of the most fundamental distinctions in emergency management and research. Hence civil defense issues have been isolated, particularly since the advent of nuclear weapons. Although nuclear (or other wartime) attack involved functions—warning, protective action, emergency medical care, search and rescue, communications, and sheltering—similar to those addressed in natural disasters, the two were treated separately and usually under the auspices of different agencies. Indeed, Drabek (1991b, p. 3) concluded "the two principal policy streams that have shaped emergency management in the United States [are] responses to natural disasters and civil defense programs".

This separation of emergency management systems appears to have spawned what has been called the philosophy of "dual use", a term that was first used officially when President Nixon created the Defense Civil Preparedness Agency in 1972 (Harris, 1975). At the federal level, this meant funding priority was given to research and planning that would be useful in coping with both natural disasters and nuclear attack. Perhaps the most persistent application of the dual use philosophy was found in the natural disaster research sponsored by the Defense Civil Preparedness Agency in the l970s. As part of contract fulfillment, researchers were required to include an appendix to reports describing how their results applied to the nuclear attack setting. Although the dual use philosophy implied basic comparability between natural and technological disasters, this had little impact on the way either emergency managers or researchers partitioned such events. Even under dual use, the comparability issue was addressed largely after the fact (in the case of research, after the data collection and analysis were completed). Conceptions of emergency management practice and disaster research continued to compartmentalize wartime threats and natural disasters. Of course, the compartmentalizing was not limited to this broad division; there was also a tendency to separate different types of natural disasters. Yoshpe (1881, p. 32) indicates that legislation sanctioned dual use by 1976: "[It was]…established as a matter of national policy that resources acquired and maintained under the Federal Civil Defense Act should be utilized to minimize the effects of natural disasters when they occurred."

Beginning with the classic study of the Halifax explosion (Prince, 1920), social scientists interested in disaster response sporadically studied events that were not products of the natural environment or wartime attacks. Although few in number, a 1961 catalog of disaster field studies compiled by the National Academy of Sciences listed 38 research studies on technological incidents (Disaster Research Group, 1961). By the mid-1960s, a third distinct body of research was developing with respect to technological threats. These studies generally reflected the body of research conducted in connection with natural disasters and wartime attack. At the federal level, President Nixon's creation of the Environmental Protection Agency in 1970 (with a major emphasis on chemicals and chemical processes) solidified the concept of technological hazards as distinctly different phenomena.

By the late 1960s, each type of hazard or disaster had begun to be treated differently by policymakers, federal agencies, emergency management practitioners, and researchers. The separations were not analytic but largely reflected differences in the threat agent. Thus, there were lines of research on hurricanes, tornadoes, floods, explosions, mine collapses, wartime attacks, and so on. These divisions were also reflected in public policy for dealing with disasters; different organizations focused on different threats. An important consequence of this approach was the concentration on the distinctiveness of disaster agents and events. The prevailing idea was that disaster agents differ qualitatively, rather than just quantitatively, and that each of these hazards required its own unique mode of understanding and management.

This orientation was supported by the loosely coupled collection of federal agencies and programs that addressed emergencies through the 1960s and most of the 1970s. As public policy, difficulties began to arise with "dual use" as a philosophy and an organizational strategy. The difficulties became the basis for the beginning of a radical change in the way disasters were conceptualized. In retrospect, at least three forces guided the change in thinking. First, the persistence of "dual use" as a principle for justifying the support of disaster research by civil defense agencies pressed scientists to make explicit comparisons among disaster events. Such justification was based upon two rationales—generalizability and cost-effectiveness. The generalizability principle held that, in the absence of real war, natural disasters provided the next best approximation to study human disaster response. The cost-effectiveness rationale assumed that, by funding studies of one class of events, inferences could be made to other types of events at relatively small incremental cost—loosely described as "getting more knowledge for the research dollar". The cost-effectiveness rationale was to ultimately play a significant role in subsequent changes in emergency management philosophy. It was clear, however, that "dual use" forced researchers to think about and conduct cross-disaster applications of various emergency functions—emergency assessment, hazard operations, population protection, and incident management. Without a conscious intention of doing so, these comparisons began to build an empirical body of evidence regarding dimensions along which events normally thought to be quite distinct could be compared.

The second force that promoted changes in basic conceptions of emergency management was the rise of social scientific subdisciplines or specializations in disaster behavior. An important factor in this development was the growth of the Disaster Research Center (DRC—which was located first at The Ohio State University and later at the University of Delaware) under Quarantelli and Dynes beginning in 1963. This institution trained social scientists to study events caused by a diverse set of natural and technological hazard agents and complying with the dual use demands for comparisons with nuclear attack. These researchers focused not on the differences among disaster agents, but upon the *social management* of the consequences of disasters. They linked these diverse studies using a theoretical framework that was marked by the designation of a focal social system and discussions of generic management issues, such as the problems of resource mobilization, interactions of system components, and the interrelationships of the focal system with external systems. An early and important contribution of the DRC studies was to focus research and management attention upon the demands a crisis imposes upon a social system. These were conceptualized as *agent-generated* demands (i.e., tasks generated by a disaster as a function of impact—warning, search and rescue, emergency medical care) and *response-generated* demands (i.e., those tasks necessary to meet agent-generated demands—communication, resource mobilization). By focusing upon a disaster's demands and not on the physical characteristics of the disaster agent itself, this line of research posed a significant challenge to both the theoretical and operational perspectives that differentiated events based on the agent involved. It is important to point out that DRC did not ignore the effects of different types of hazard agents; each agent was acknowledged to produce its own distinctive pattern of demands. Instead, DRC's contribution lay in establishing a concern with social management of events within a systems perspective. This practice emphasized the problem of identifying and responding to different demands growing out of the crisis and set the stage for subsequent identification of generic or "common" management functions across disasters.

The third force for change came well after DRC began its operation. This was the NGA's emergency preparedness project. Primarily concerned with public policy associated with emergency management, these analysts focused first upon what they saw as the ineffective allocation of emergency management responsibilities among the federal agencies assigned to help states and localities cope with disasters. It was their contention that the presence of a bureaucratized and compartmentalized collection of federal disaster agencies made it difficult for lower levels of government to obtain necessary aid for both planning and recovery. Moreover, they emphasized the lack of cost effectiveness of the diverse constellation of federal programs and agencies. Another contribution of the NGA project was its perspective on disasters. As members of state government who were sensitive to the problems experienced by local governments, their view of disasters was less compartmentalized than that of their federal counterparts. States and localities had long been forced to plan for and respond to disasters without the benefit of a bureaucracy that had as many specialized agencies as that of the federal government. Among other reasons, their revenues simply could not support much specialization. The same people who were called upon to deal with floods also dealt with explosions, hurricanes, hazmat incidents, and tornadoes. Over the years, state and local emergency response personnel developed an approach based upon managing all types of disasters without regard to the precipitating agent. From a practical standpoint, their orientation meant that they focused on each disaster's demands and sought to manage those, making specific procedures apply to as many types of events as feasible. In one sense, this produces an emphasis upon the idea of developing organizational systems to perform generic functions. For example, warning systems, emergency medical care systems, evacuation plans, damage assessment procedures, communication systems, and search and rescue plans may all be applicable to crises associated with floods, hurricanes, nuclear power plant accidents, volcanic eruptions, earthquakes, and others. Driven in part by economic need, the NGA project became strong advocates for an "all hazards" approach to emergency management—which they called comprehensive emergency management—and their efforts drew intellectual strength from the comparative research at the Disaster Research Center.

Comprehensive Emergency Management

Operating together, these forces gave rise to Comprehensive Emergency Management (CEM) as a basic conceptual approach to disasters and to managing emergencies. In 1979, NGA issued a *Governor's Guide to Comprehensive Emergency Management* (National Governors' Association, 1979) that provided an articulate statement of the philosophy and practice of CEM. The approach was further legitimated through its adoption and promotion by FEMA in 1981. In 1993, when the US Congress repealed the Federal Civil Defense Act of 1950, a provision (Title VI) was added to the Stafford Act requiring the federal government to adopt the all-hazards approach inherent in CEM. In summary, CEM refers to the development of a capacity for handling emergency tasks in all phases —mitigation, preparedness, response, and recovery—in connection with all types of disaster agents by coordinating the efforts and resources of a wide variety of nongovernmental organizations

(NGOs) and government agencies. CEM is distinguished from previous conceptualizations—particularly dual use—by two important characteristics. First, CEM emphasizes comprehensiveness with respect to the performance of *all disaster relevant activities* by dictating a concern for mitigation, preparedness, response, and recovery. The second distinguishing feature of CEM is its concern with the management of *all types of emergencies* whether technological, natural, or willful (including state sponsored and terrorist attacks). This characteristic is an outgrowth of the idea that an emergency may be seen as a disruption of the normal operation of a social system. To the extent possible, one would like to minimize the likelihood and magnitude of system disruptions in the first place and minimize their duration by creating the potential for quickly stabilizing the system and subsequently restoring it to its normal activities following an unpreventable disruption. In this context, the cause of the disruption is less important than the nature and magnitude of its effects upon the social system. The only reason to distinguish among disrupting agents rests on the extent to which different agents impose distinctive demands on the system. For example, hurricanes can be distinguished as events that provide long periods of forewarning when compared with earthquakes.

In developing a framework for managing all phases of all types of disasters, CEM can be seen as an attempt to integrate emergency management by developing a body of techniques effective for managing the responses to multiple disaster agents. CEM represents an extremely significant departure from historical views of emergency management that make sharp distinctions among hazard agents and claim (either explicitly or implicitly) that a unique strategy must be developed for managing each of them. Furthermore, aside from the intuitive appeal of a more parsimonious theoretical approach, cost conscious officials at all levels of government are attracted to the more efficient use of resources promised by a comprehensive approach to emergency management (Quarantelli, 1992).

Once state and local governments began to adopt some variant of CEM, FEMA introduced the concept of Integrated Emergency Management Systems (IEMS) in 1983. The initial goal of IEMS was to facilitate the development of disaster management functions and (at the time it was introduced) to increase congressional support for a larger civil defense budget (Perry, 1985, p. 130). When pressed to distinguish IEMS from CEM, the principal reply was: “CEM is the long term objective, IEMS is the current implementation strategy” (Drabek, 1985, p. 85). It appears that the meaning of IEMS on a practical level derives from the term “integrated”—identifying the goal of addressing all hazards and consolidating emergency actions into a single office or organization within a jurisdiction. However, CEM remains the primary vision of disaster management in the US.

Classifying Hazard Agents

An emergency management vision that addresses all hazards must by necessity focus upon the concept of generic functions while acknowledging that special functions will be needed in the case of hazard agents that present unique or singular challenges. CEM implies a basic comparability across all types of disasters. Moving from emergency management to the academic study of disasters, one implication of comparability is that one should be able to distinguish hazard agents in terms of a common set of characteristics. A typology of hazard agents is a system for classifying them into categories within which the social management demands are similar. On a practical level, implementing CEM involves identifying generic emergency response functions and then specifying circumstances (tied to the impact of different disaster agents) under which they will need to be employed. If one could use such functions as key characteristics of disasters, then one could begin to develop meaningful taxonomies.

There have been few attempts to make systematic comparisons of human response to different disaster agents. Indeed, there has been a tendency among researchers to avoid examining relationships among different disaster agents, partly on the assumption that each “type” of event was simply unique. For example, the matter of comparing natural with technological threats rarely appeared in the professional literature at all until the 1970s. In part, this condition reflects the state of disaster research. For many years disaster studies were very descriptive in nature (Gillespie & Perry, 1976). Hence, attention often focused upon the event itself—the hurricane or the earthquake—and upon descriptions of specific consequences for disaster victims. Therefore, the research literature provided illustrative accounts of earthquake victims crushed under rubble, fire victims plucked from rooftops, and hurricane victims drowned in the storm surge. In this context, researchers argued that different agents have different characteristics and impose different demands on the social system and as a result probably must be explained using different theories. A typology is actually a form of theory created through taxonomy or reasoning (Perry, 1989). Thus, human reactions to different disaster events were expected to be different.

In one sense, it is entirely correct to consider each disaster agent, as well as each impact of each agent, to be different. Floods present obvious differences from earthquakes and, indeed, the eruption of the Mt. St. Helens volcano on March 27, 1980, was very different from its eruption on May 18, 1980. Such comments reflect an essentially phenotypic classification system, focusing upon the surface or visible properties of an event. Emergency managers and disaster researchers are not so much interested in classifying disasters in these terms, however, because their goals are associated primarily with the behavior of the affected social system. It is human response to the natural environment, technology, or other humans that produces the disasters of hurricanes, tornadoes, hazmat releases, or wartime attacks. Thus, the goal is to distinguish among social causes, reactions, and consequences, not necessarily to distinguish hurricanes from chemical plants. There has been an increased concern with the development of conceptual schemes for explaining human behavior in disasters. This theoretical concern directs one to identify characteristics of disasters that determine the nature and types of agent-generated and response-generated demands imposed upon stricken communities. This leads to the creation of a classification system that characterizes disasters, not in phenotypic terms, but in terms of features that will have an impact on the kinds of assessment, preventive/corrective, protective, or management actions that might be used in disaster response. To pursue such a goal, one might begin by choosing a given function—population warning, for example—and examine the ways in which performance of that activity varies across disaster events as a function of differing *agent characteristics* such as the amount of forewarning provided by detection and forecast systems.

There has been much discussion and only limited consensus among academic disaster researchers regarding either definitions of disaster or classification schemes for distinguishing among different types of disasters. However, as Perry (1998) has pointed out, most definitions of disaster contain many common elements—disagreements among definers tend to lie in minor aspects of definition or in the logic that is used to develop a definition. From the standpoint of practicing emergency managers, such minor variations pose few operational difficulties. Most events that are characterized as disasters, whether they arise from natural forces, technology, or even deliberate attacks, fit most of the academic definitions of the term. As defined by Fritz (1961, p. 652), a disaster is any event:

> *concentrated in time and space, in which a society or a relatively self-sufficient subdivision of society, undergoes severe danger and incurs such losses to its members and physical appurtenances that the social structure is disrupted and the fulfillment of all or some of the essential functions of the society is prevented.*

From this classic definition (as well as from the definitions discussed previously in this chapter) one can surmise that disasters occur at a distinguishable time, are geographically circumscribed and that they disrupt social activity. Barton has proposed a similar definition, but chose to focus upon the social system itself, arguing that disasters exist “when many members of a social system fail to receive expected conditions of life from the system” (1969, p. 38). Both Fritz and Barton agree that any event that produces a significant change in the pattern of inputs and outputs for a given social system may be reasonably characterized as a disaster. The important point to be derived from these definitions is that events precipitated by a variety of hazard agents—floods, chemical spills, volcanoes, nuclear power plant accidents, terrorist attacks—all fit equally well into these definitions as disasters. At this level of abstraction, there is no compelling reason to differentiate among natural, technological, or other types of hazard agents. Given the breadth of most definitions of disasters, the *analytic problem* becomes one of determining the characteristics by which to distinguish among the events that do satisfy the definition. As noted earlier, such dimensions should not be restricted to physical characteristics of the hazard agent and its impact, but should also include attributes relevant to the effects of the event upon the social system and its consequences for management.

Distinguishing disasters, accidents, and attacks

There has been some discussion among researchers regarding the lines along which natural disasters, technological accidents, and willful attacks might be meaningfully distinguished. While there remains much disagreement in the research community about *which* dimensions are meaningful, it is possible to begin to identify dimensions from the research literature. Much of this work can be traced to the staff of the Disaster Research Center who attempted to draw parallels between natural disaster response and possible response to nuclear attack (particularly between 1963 and 1972; see Kreps, 1981). Barton (1969) developed a scheme for identifying distinguishing features of disasters that characterize the nature of social system stress. Barton’s system defined four basic dimensions—scope of impact, speed of onset, duration of impact, and social preparedness of the threatened community. These dimensions have been used by a number of researchers in developing classification schemes (Lindell & Perry, 1992) and can be briefly explained here. *Scope of impact* is usually defined as the absolute geographic area (e.g., in square miles) affected by a disaster but, as will be described in Chapter 5, it also can be defined in terms of the affected percentage of a jurisdiction’s area (geographic scope), population (demographic scope), or economic production (economic scope). Aside from sheer size, this dimension has implications for resource mobilization within the affected social system and for the availability of supporting resources that might be drawn from nearby communities or higher levels of government. *Speed of onset* refers to the interval of time between a physical event’s first manifestation of environmental cues until its impact on a social system. Speed of onset varies both by the inherent nature of the hazard agent and the level of technological sophistication of the detection system. For example, earthquakes have a very rapid onset (there are often no detectable environmental cues before the initial shock), whereas droughts have a very slow onset (some take years to develop). In other cases, the technology to forecast meteorological hazards such as hurricanes has developed considerably over the course of the past 50 years so events, such as hurricanes, that could at one time occur with little or no forewarning are now routinely monitored and forecast days in advance. *Duration of impact* refers to the time that elapses between initial onset and the point at which the threat to life and property has been stabilized. This can be a few minutes (short) in the case of a tornado, a few hours or days (moderate) in the case of riverine floods, persistent for years in the case of drought, or intermittent for years in the case of volcanoes. Finally, *social preparedness* is a dimension that attempts to capture the ability of the social system to anticipate the onset of an event, control its impact, or cope with its negative consequences. Obviously, this social preparedness dimension is precisely the objective of emergency management.

Anderson (1969b) contributed another comparative dimension from his research on the functioning of civil defense offices (now more commonly called emergency management departments) during natural disasters and attempted to extrapolate to the nuclear attack environment. In developing his analysis, Anderson (1969b, p. 55) concluded that in spite of obvious differences between nuclear threats and natural disasters:

> *[these differences] can be visualized as primarily ones of degree. With the exception of the specific form of secondary threat, i.e. radiation, and the probability that a wider geographic area will be involved, a nuclear [threat] would not create essentially different problems for community response.*

Anderson's analysis introduced the issue of secondary impacts of disaster agents as an important defining feature. It should be remembered that virtually all hazards, whether natural or technological, accidentally or deliberately caused, entail some secondary impacts. Indeed, the secondary threat can be more devastating than the initial threat. Riverine floods tend to deposit debris and silt that persists long after the water has receded. Earthquakes often produce urban fires, and volcanic eruptions can melt glaciers or ignite forest fires.

By assembling lists of distinguishing characteristics such as those discussed above, one can compare or classify an apparently widely differing (in terms of superficial features) range of disaster events. As an example of how such comparisons might work, Table 1-1 compares three disaster agents—riverine floods, volcanic eruptions, and nuclear power plant accidents—in terms of the five distinguishing characteristics.

Table 1-1. Classification of Selected Hazard Agents.

Hazard Agent Characteristic	Riverine Flood	Volcanic Eruption	Nuclear Power Plant Accident
Scope of impact	Highly variable long, and narrow	Highly variable broad area	Highly variable broad area
Speed of onset	Rapid: flash flood Slow: main stem flood	Rapid	Variable
Duration of impact	Short	Long	Long
Health threat	Water inhalation	Blast, burns ash inhalation	Ingestion, inhalation, direct radiation
Property threat	Destruction	Destruction	Contamination
Secondary threats	Public health danger from water/sewer inundation	Forest fires, glacial snowmelt	Secondary contamination
Predictability	High	Poor	Variable ability to predict releases after accident onset

It is interesting to note that, at this analytic level, volcanic eruptions and nuclear power plant accidents are similarly classified. Both threats involve variable scopes of impact that are potentially widespread. Usually, a volcanic eruption's threats to human safety are limited to within a few miles of the crater. Life threatening levels of radiation exposure from a nuclear power plant accident is likely to be confined to the plant site or a few miles downwind from it (US Nuclear Regulatory Commission, 1978). Under special conditions, however, either type of event might involve a considerably greater scope of impact. The May 18, 1980, eruption of Mt. St. Helens volcano spread a heavy layer of volcanic ash over a three state area and the Chernobyl nuclear power plant accident spread radioactive material over an entire region. The speed of onset for volcanic eruptions and nuclear power plant accidents is likely to be rapid, although each of them has the potential for a significant degree of forewarning prior to the onset of a major event. These two events are also similar with respect to the duration of impact of the primary threat to human safety. In both cases, a volcanic eruption and a release of radioactive materials, the event could last from hours to days. Persistence of secondary impacts could, in each case, last for years, although the long-term health effects of volcanic ash are less significant than radiation. To the extent that volcanic eruptions continue in an eruptive sequence that lasts for years, the duration of impact can be said to be long. A nuclear power plant accident would be expected to be of moderate length although so few actual accidents have occurred that the empirical data are extremely limited. The accident at the Three Mile Island nuclear power plant, which is more accurately labeled as an emergency than as a disaster, involved a danger period that lasted for about six days. However, the Chernobyl accident severely contaminated areas that are still uninhabitable two decades later.

Both volcanic eruptions and nuclear power plant accidents generate secondary threats. The sheer number of secondary threats associated with volcanoes is quite large; ultimately they involve long-term threats to public health, to the stability of man-made structures, and to plants and animals in land and water ecosystems. The most probable secondary threat of a nuclear power plant accident is associated with the effects of residual radiation exposure arising from ground deposition and water contamination by radioactive materials. In addition to the potential exposure by way of external gamma radiation and inhalation of radioactive materials, there is the threat of exposure by means of ingestion of contaminated vegetation or animal products (meat or milk).

Finally, the state of technology is such that neither volcanic eruptions nor nuclear power plant accidents can be forecast accurately far in advance. There is in both cases, however, a technology for detecting and monitoring events once they are in progress. In the case of some volcanoes, once an eruptive sequence has begun either seismic or geochemical cues can be used to make approximate forecasts of eruptive events. With nuclear power plants, monitoring instruments are designed to detect even minor aberrations early in order to facilitate the implementation of corrective action before more serious difficulties arise. Thus, although one might not be able to predict a power plant accident, instruments are designed to detect problems in their early stages before they can escalate to an atmospheric release of radioactive material.

Riverine floods differ from the other two hazard agents primarily in terms of two characteristics. First, floods are frequently predictable, often days in advance. Second, speed of onset typically is gradual (by definition requiring a minimum of six hours to reach a flood crest, although more rapid onset can occur during flash floods in mountainous areas). Another general point of distinction is the frequency with which floods occur; they are the most common geophysical hazard in the United States (Perry, Lindell & Greene, 1981). Thus, from the standpoint of both emergency managers and the public, riverine floods are a familiar threat. Moreover, the duration of the primary flood impact is much shorter than a volcanic eruptive sequence or a nuclear power plant accident. Secondary impacts of floods include both public health threats and dangers to man-made structures, but in general the extent and duration of the effects of their secondary threats are less than either of the other two disaster agents. Finally, like a volcanic eruptive sequence or a nuclear power plant accident, the scope of impact of riverine floods is highly variable. Usually the scope of flood impacts is narrower than either of the other hazards, but there is a potential for widespread scope.

The preceding discussion demonstrates that it is possible to classify diverse disaster agents in terms of an underlying set of dimensions and then to discuss the agents in terms of functional emergency management activities. Such dimensions could include the physical characteristics of the hazard agent and its impact, as well as attributes relevant to the effects of the event upon the social system and its consequences for management. The characteristics derived from the disaster research literature have provided a systematic set of attributes that could be used to examine and compare riverine floods, volcanic eruptions, and nuclear power plant accidents. As indicated above, the differences between classification schemes in the academic literature tend to rest on differences between researchers regarding exactly which dimensions and how many dimensions are optimal in creating the typology. The 21st Century has seen no more agreement than the 20th Century did, although there are two discernable trends in the literature. One trend, followed by only a few, involves attempts to elaborate on the analytic approach described here, adding or subtracting dimensions or otherwise changing the complexity of the approach (Kreps, 1989; Tobin & Montz, 1997). By far most disaster researchers have continued to ignore the issue of analytic typology and remained with some sort of phenotypic classification, most commonly with the classic categories of "natural disasters", "technological accidents" and "willful attacks" (Cutter, 2001; Drabek, 1986).

Without regard to the low level of consensus among researchers, analytic classification systems are more than an abstract intellectual exercise. They provide an opportunity to demonstrate how, by means of careful examination, one can begin to identify differences among disaster agents with respect to their demands upon the emergency response system. From the information listed in Table 1-1, an emergency manager might conclude that two protective measures might be used in all three events: population evacuation and the imposition of access controls to the threatened area. Because a volcanic eruption or a nuclear power plant accident could present a health threat resulting from inhalation of airborne materials (volcanic ash or radioactive gases and particulates, respectively), taking shelter indoors and using respiratory protection is feasible. Ad hoc measures for respiratory protection could be as simple as folding a wet towel and breathing through it.

The importance of developing a comparative perspective structured by disaster agent characteristics lies in the prospect of identifying a profile of disaster demands that, in turn, define the functions that the emergency response organization must perform. Thus, classifying hazard agents with respect to defining characteristics allows emergency managers to better define the ways in which generic functions (e.g., emergency assessment, hazard operations, population protection, and incident management) should be implemented to achieve comprehensive emergency management. That is, the reason for identifying distinctive aspects of hazard agents is not to define each of them as "unique", but rather to highlight the ways in which generic functions must be adapted to the needs of a particular type of emergency. By adopting this approach, emergency managers are better able to identify the range of hazard agents for which a particular emergency response action is appropriate or to identify the ways in which an emergency response action must be adapted to the constraints of a given hazard agent. For example, evacuation is an appropriate protective action in response to a wide range of hazards such as floods, hurricanes, and volcanic eruptions. However, authorities recommend sheltering in-place rather than evacuation during tornadoes because of the rapid onset and unpredictable track of the funnel cloud. In some cases, especially hazmat releases, the hazard agent's speed of onset is so variable from one incident to another that there is no general rule regarding evacuation versus sheltering in-place. Moreover, evacuation was listed as a protective measure in nuclear power plant accidents and it was noted that the primary health threat to citizens in such events was radiation exposure. Research indicates that radiation hazard is feared as much or more than other natural and technological hazards (Lindell & Earle, 1983; Slovic, 1987). Assuming the conditions were appropriate for an evacuation warning, the emergency manager would be well advised of the possibility for a high level of spontaneous evacuation (people evacuating from areas that emergency managers consider to be safe). In turn, this alerts the emergency manager to a need for timely dissemination of information to the public about the characteristics of the impact and the potential personal consequences of exposure, thereby reassuring those who are not at risk that they are indeed safe.

The Remaining Chapters

CHAPTER OVERVIEW

2: Emergency Management Stakeholders

This chapter will introduce the many actors in emergency management and examine some of the problems inherent in dealing with the complex emergency management policy process. The first section will address four basic issues. First, how is a “stakeholder” defined, especially in the context of emergency management? Second, who are the stakeholders emergency managers should be concerned about? Third, at what level in the system and by which different stakeholders are different types of emergency management decisions made? Fourth, how can emergency managers involve these stakeholders in the emergency management process? Last, what types and amounts of power do different stakeholder groups have and how do they influence the emergency management policy process?

2.1: Definition of a "Stakeholder"

2.2: Community Stakeholder Groups

2.3: Decision Levels

2.4: Stakeholders and Power

2.5: The Emergency Management Policy Process

2.6: Involving Stakeholders in Emergency Management

2.7: Case Study: The Politics of Hazard Mitigation

Appendix 2: Federal Agencies and Their Responsibilities Under the National Response Plan

---

2.1: Definition of a "Stakeholder"

Stakeholders are people who have, *or think they have*, a personal interest in the outcome of a policy. This interest motivates them to attempt to influence the development of that policy. In the early days of this country, only citizens with a sufficiently large "stake" in the nation's welfare (as measured by property holdings) were allowed to vote. Now, all citizens are recognized as stakeholders insofar as all are affected by the decisions made by elected and appointed officials and, therefore, have the right to vote. Consequently, an emergency management stakeholder is an individual who is affected by the decisions made (or not made) by emergency managers and policymakers in his or her community. Since all citizens are likely to be affected by emergency management policies, this definition implies all citizens are emergency management stakeholders. Although this is true, it is not very helpful because stakeholders differ in the ways they are affected by emergency management policies and, even more important, they differ in the times at which they are affected and the magnitude of the impacts policy has on them. It is not enough, however, to say that everyone is potentially affected by disasters. Thus, this chapter will examine the different types of people who have an interest in the emergency management process, beginning at the simplest level of social organization.

2.2: Community Stakeholder Groups

Community stakeholder groups can be divided into three different categories—social groups, economic groups, and political groups. In turn, each of these types of groups can be characterized by its horizontal and vertical linkages (Berke, Kartez & Wenger, 1993). Horizontal linkages are defined by the frequency and importance of contacts with other groups of the same type; vertical linkages consist of ties with larger groups. Each of the three types of groups will be discussed in the following sections.

Social Groups

It is sometimes said local government is the foundation for emergency management but, in fact, the basic organizational unit for emergency management is the household. Households adopt hazard adjustments (especially mitigation and preparedness measures), households evacuate, and households suffer economic losses. All households, no matter their size or level of resources, have an interest in the emergency management policies developed and implemented in their communities. The household is the primary living unit providing shelter from routine environmental conditions. Households' actions affect their vulnerability to environmental hazards through their choice to live in more or less hazard-prone locations; to rent or buy residences that are more or less resistant to environmental extremes of wind, water, and ground-shaking; and whether or not to engage in pre-impact adjustments to limit their disaster vulnerability. As a group, households control a substantial amount of the social assets (buildings and their contents) at risk from environmental hazards, but this control is spread among a very large number of households, which makes it difficult to affect their policy choices. Although households typically attach a low priority to natural hazards, there is substantial variation, with some substantially more aware than others of the hazards they face.

Households vary in their incentives to prepare for disasters and to adopt hazard mitigation. For example, property owners have more money at risk than tenants because they own the structures as well as the contents of these structures. Households also vary in their capacity to select and implement appropriate hazard adjustments because of differences in their financial resources, their knowledge of hazards and adjustments, and the decision processes they use to apply this knowledge. Other stakeholders such as the local and state governments have a modest degree of influence over households. Government agencies often provide hazard information and sometimes provide incentives for adopting hazard adjustments, but are rarely able to compel households to do anything about hazards.

Just as citizens organize to better develop their understanding of issues and increase their power to present these views to the rest of the public, householders can organize as groups to develop emergency management policy in their neighborhoods. One of the most obvious gaps in the picture of stakeholders is the lack of a broad-based support group for individual householders, analogous to the Neighborhood Watch programs that exist across the country. In some communities, Community Emergency Response Teams (CERTs) are beginning to fill this role. CERTs may also be known as Neighborhood Emergency Response Teams, Neighborhood Emergency Assistance Teams, or other similar designations, but they share a common origin and many other characteristics (Simpson, 2001). CERTs are designed to train first responders at the neighborhood level and organize them in groups capable of providing basic emergency response services such as triage, first aid, urban search and rescue, fire suppression, and damage and casualty estimates at the block or neighborhood level. These groups are usually supported and trained by local emergency service agencies. As they become institutionalized, they can serve as a support group and interest aggregator for householders (for more information, see the FEMA Web site at training.fema.gov/emiweb/CERT/index.asp).

As we move up the scale of social organization, there are private sector groups such as religious organizations and other nongovernmental organizations (NGOs), nonprofit organizations (NPOs), community based organizations (CBOs), and businesses. All of these groups vary widely in size, level of organizational complexity, and amount of resources available. They also vary based on the functions they perform in society and, thus, varying levels of interest in local emergency management activities. Nonetheless, all are potential partners in formulating emergency management practices and policies. NGOs, NPOs, and CBOs can be important resources for emergency managers. Some have traditionally played key roles in specific phases of emergency management. For example, churches are often used as shelters during evacuations and frequently help provide recovery funding. They should be integrated into the early stages of response and recovery planning processes in order to ensure their resources are fully utilized without unnecessary duplication of effort and competition for access to disaster victims.

Large scale NGOs organized at the national level also have historically played a role in emergency management. The Salvation Army is widely involved in response and recovery activities and organizations such as the United Way serve to channel local funds to those needing help during the recovery period. The American Red Cross, an affiliate of the International Federation of Red Cross and Red Crescent Societies, has an official role in this country as the provider of emergency shelter.

Environmental organizations such as the Sierra Club (www.sierraclub.org) and the Worldwatch Institute (www.worldwatch.org) have not been very involved with local emergency management agencies, in spite of the conceptual overlap between environmental protection and hazard mitigation. This commonality of interests presents an opportunity for local emergency managers to forge alliances with environmental groups at the local level to foster sound land use practices, especially for the mitigation of floods through comprehensive watershed management. Environmental organizations have also published many books that are useful to emergency managers (e.g., Abramowitz, 2001a; Bullard, 1996; Flavin, 1994; Sierra Club, 2000).

Economic Groups

As households are the basic units in the hierarchy of social stakeholders, so too are businesses the fundamental units in the hierarchy of economic stakeholders. Businesses are important stakeholders because they are part of the societal institution that organizes the flow of goods and services. Destruction, damage, or even interruption of business activities can have significant adverse effects on the local economy and, in smaller countries, even on the regional or even national economy. Business owners control their resources in the same way as householders and, thus, can make the same sort of choices about how to react to hazards. Unlike households—which rarely exceed more than a half dozen persons in number—businesses range in size from small "mom and pops" that are the same size as families to large multinational corporations employing tens or even hundreds of thousands of people. Such businesses have varying levels of needs and resources to offer the emergency manager. Small businesses are particularly vulnerable to disruption following disasters, but are likely to be deeply embedded within the community and so are likely to respond favorably to appeals for assistance. Large corporations may have a large amount of resources in terms of personnel and even money, but local managers may have little discretion over how those resources can be used in the local emergency management process.

An especially important type of business that is a stakeholder in emergency management is the public utility provider, whether privately or publicly owned. These include the providers of electricity, water, sewer services, solid waste management, and communications such as telephone, television, and Internet access. Such businesses have been active in emergency management because they are responsible for rapid restoration of basic services to all their customers. All other stakeholders depend on these important service providers to quickly restore all the vital services so business interruption is minimized, household functioning is restored, government functions during the critical period, and health care is not interrupted at a peak demand period.

Businesses rarely react favorably to outside restrictions on their decisionmaking discretion, so it can be difficult to influence managers to adopt mitigation measures. Instead, like the rest of American society, business organizations have preferred to focus on response and recovery and, to a lesser extent, preparedness. Nonetheless, some active supporters of emergency management are beginning to emerge from the business community as the costs of disasters continue to rise. The insurance industry, in particular, has fostered a new emphasis on mitigation through organizations such as the Institute for Business and Home Safety (www.ibhs.org). Some real estate developers, bankers, home improvement retailers, and other businesses have also become active stakeholders in local emergency management.

The most useful concept for increasing the business community's interest in local emergency management has been *business interruption*. Once businesses realize the enormous potential costs of a failure in infrastructure systems, many began to take emergency preparedness very seriously. The key is to encourage businesses at the local level to understand the importance of their linkages to suppliers, customers, and employees as well as their dependence on a functioning infrastructure system (Lindell & Prater, 2003). If any of these relationships is disrupted by a disaster, businesses can suffer serious economic losses, even if their own facilities are undamaged. For example, employees who lose their housing might move away, customers might need to spend discretionary income on home repair, and suppliers might have their own difficulties with their physical plants, infrastructure, or supply chains. As business managers begin to understand the importance of this web of connections to the health of their businesses, they are likely to become more supportive of emergency management goals. This linkage was fostered by the "partnership model" that was promoted by FEMA's Project Impact initiative that many cities began experimenting with during the 1990s. Project Impact's model of involving the business community more directly in hazard mitigation and disaster preparedness met with great success in Tulsa and Seattle, as well as in other cities around the country. The suspension of federal funding has slowed the spread of the Project Impact model, but the success of this program makes it a valuable method for emergency managers to develop a more cooperative relationship with their local business communities.

One particular set of businesses—the news media—is especially important to the success of emergency management programs because their coverage of all phases of emergency management can be an important way to educate the public about hazards that might strike the community, not just to inform them of an imminent disaster. The news media can provide vicarious experience for those who have not had direct experience with such events. One well documented problem is the news media's tendency to perpetuate disaster myths rather than provide accurate information (Perry & Lindell, 1990). The news media are both consumers and creators of news. They consume “hard news” about environmental incidents and the responses to those incidents by describing the course of events and reporting the views of different stakeholders. They can also help to create “soft news” by describing the results of hazard/vulnerability analyses and the activities of planning organizations. This “soft news” can help to build support for emergency management even when there is no “hard news” about disasters, so emergency managers should get to know their local news media outlets and cultivate positive relationships with key personnel such as reporters, news anchors, editors, and producers.

Political Groups

Finally, there are various types of governmental stakeholders. Beginning at the base, we have the lowest level of organization, the municipality (i.e., town or city) and, just above this, the county. These jurisdictions have varying levels of power from one state to another because states differ in the powers that they grant to their political subdivisions. Much emergency management policy is set at the state level, and the federal government has traditionally been seen as a supporter to local and state efforts. The US Conference of Mayors (www.usmayors.org) and the National Governors’ Association (www.nga.org) have both taken lead roles in lobbying for increased attention to and funding for hazard mitigation and emergency preparedness at the national level (National Governors’ Association, 2001, 2002).

In addition to the different levels of government, there are different agencies within each level of government. These agencies vary widely on the dimensions of size, organizational complexity, and amount of human, financial, and technical resources. Different governmental levels perform analogous and complementary roles, but agencies within each level of government differ in their functions. For example, at the local level of government, the agencies most involved with emergency management are the fire and police departments, which are the first agencies to respond to most emergencies. In many jurisdictions, the emergency management function is attached to one of these departments, but in larger communities it frequently is an independent agency. In some communities, there is a separate emergency medical services agency, but often this function is provided by the fire department working together with local hospitals and ambulance companies. Public works departments or engineering departments, transportation departments, and land use planning and community development departments are important stakeholders in the mitigation process, and also have responsibilities during response and recovery phases. Public health departments and housing departments also have important emergency management functions. Making matters even more complex, most members of these agencies belong to professional associations that lobby for disaster-relevant legislation.

Regional and state-level stakeholder agencies include metropolitan planning organizations/councils of government, flood control districts, and coastal zone agencies, geological services agencies, and soil conservation agencies. The most important stakeholders are the state emergency management agencies, which vary widely in their levels of expertise, staffing, budgets, and other organizational resources. Nonetheless, these are the agencies that provide the major direction for local emergency managers, interact with state legislatures to provide the legal framework within which local emergency managers work, and serve to link local governments with FEMA regional offices.

Academics specializing in specific hazards (e.g., seismologists, vulcanologists, meteorologists, toxicologists) and mitigation measures (land use planners, structural engineers, and architects) and hazard/disaster researchers (economists, geographers, political scientists, psychologists, and sociologists) form another important stakeholder group. They provide the basic scientific knowledge base on which sound emergency management policies and practices are built. There are several important research centers around the country, some of which are technically oriented and focus on one type of hazard (Multidisciplinary Center for Earthquake Engineering, Mid America Earthquake Center, Pacific Earthquake Engineering Center, Earthquake Engineering Research Institute), others of which study all hazards and are multidisciplinary or focus on the social impacts of disasters (Disaster Research Center at the University of Delaware, Natural Hazards Research and Applications Information Center at the University of Colorado, Hazard Reduction & Recovery Center at Texas A&M University, and International Hurricane Center at Florida International University). These academic institutions are supplemented by a growing group of consultants and providers of goods and services tailored to the needs of emergency management.

At the national level, FEMA was until recently the lead agency for emergency management. With the signing of the Homeland Security Act (HS Act) in November of 2002, the United States undertook a significant restructuring of emergency management that is in its early stages. According to the HS Act, FEMA has been absorbed into the Department of Homeland Security, and its responsibilities fall to an Under Secretary for Emergency Preparedness and Response. Other under secretaries cover Information Analysis and Infrastructure Protection; Chemical, Biological, Radiological, and Nuclear Countermeasures; Border and Transportation Security; and Management. The Under Secretary for Emergency Preparedness and Response concentrates on preparedness and response in general, with particular attention to the Nuclear Incident Response Team, coordination, and development of improved communications systems. The Under Secretary is also responsible for aiding in recovery from “terrorist attacks and major disasters”. Mitigation is not mentioned in the authorizing legislation, but the analysis provided by the Executive Branch states that “the specification of primary responsibilities in this section does not detract from other important functions that will be transferred to the Department of Homeland Security…In all areas, the bill fully preserves the authority to carry out the functions of the FEMA, including support for community initiatives that promote homeland security, such as the Citizen Corps” (HS Act, p.7).

As part of this restructuring mandated by Homeland Security Presidential Directive HSPD-5, the Federal Response Plan has been replaced by the National Response Plan (NRP). The foundation for the NRP is the National Incident Management System (NIMS). NIMS attempts to standardize terminology, standards, and procedures at the national level in order to maximize the effectiveness of response to the very largest disasters or Incidents of National Significance. The NRP and NIMS must be adopted by all federal departments and agencies and by state and local organizations by FY 2005. After this date, no federal preparedness assistance is to be provided to jurisdictions that have failed to adopt the NIMS. Private sector organizations are encouraged to develop emergency response plans that include information-sharing and incident-reporting protocols that fit in with local, state, and federal response plans.

The NRP includes Planning Assumptions, Roles and Responsibilities, Concept of Operations, and Incident Management Actions as well as a complete set of Emergency Support Function (ESF) Annexes, Support Annexes, and Incident Annexes. These annexes lay out the responsibilities of various federal agencies in the NRP and are organized both by function and by incident type.

The first of NIMS’s basic components is Command and Management—which includes the ICS for internal management during an incident, Multiagency Coordination Systems for defining operations of various agencies that respond through mutual aid agreements, and Public Information Systems for communicating critical information quickly and accurately to the public. The Preparedness component includes Planning, Training, Exercises; Personnel Qualification and Certification; Equipment Acquisition and Certification; Mutual Aid Agreements; and Publications Management. The third component is Resource Management, which defines standardized resource description, inventory, mobilization, dispatch, and tracking mechanisms. Finally, the Communications and Information Management component covers Incident Management Communications, Information Management, Supporting Technologies, and Ongoing Management and Maintenance.

2.3: Decision Levels

Emergency managers must familiarize themselves with the different types of stakeholders in their communities. The roles of stakeholders in the emergency management process can be understood by examining the levels at which different types of decisions are made. For example, decisions about the level of preparedness for each individual household are made at the household level, and emergency managers can support good mitigation and preparedness practices by undertaking public education efforts and enhancing local government support for organizations such as CERTs.

Decisions about the level of attention and resources devoted to local emergency management are made by local government. Each emergency strikes a specific locality and so, in the United States, all emergency management is based on local government institutions and agencies. Agencies from outside the community, such as state emergency management agencies and FEMA, have a great deal of influence on local emergency management policies and practices. However, the emergency management process is fundamentally a local issue. Cities control their own emergency responders (primarily fire, police, EMS) and these groups must compete for resources with other local needs such as schools and roads.

In the United States, land use practices such as zoning ordinances and building codes are also established at the local level, but state governments create the context within which local governments work. This legal authority means legislation covering the powers of the city and county governments originates at the state level. For example, some states require local jurisdictions to engage in land use planning whereas other states do not (Burby, 1998). Moreover, states vary in the degree to which they support local emergency managers with technical resources and monetary aid for specific needs. Notwithstanding the important contextual role played by the states, it is local governments that are empowered to control land use for the public good. Consequently, local governments make the decisions about specific land use controls as they undertake land use planning and zoning programs. In addition, local governments adopt building codes that establish requirements for hazard resistance, especially for wind and seismic hazards. Local government also makes decisions about levels of staffing and resources for local emergency responders (fire, police, EMS).

Public works departments or their equivalents, transportation departments, water conservation districts, and other local or regional bodies make and implement policies that affect emergency management. In some cases, such as Harris County Texas where the city of Houston is located, regional emergency management has merged with the transportation and police to form joint EOC operations that integrate many functions.

In addition to local governments, state governments have a number of important emergency management functions. For instance, in the case of a major disaster, a local government would request aid from its state emergency management agency (SEMA). In turn, the SEMA can call upon other state agencies, not least of which is the agency administering that state's National Guard units. The latter are invaluable in many disasters because of their communication and transportation equipment, as well as their trained personnel.

If a state believes it needs more resources than are available, it can request a Presidential Disaster Declaration in order to have access to federal assistance. Most, but not all, requests for Presidential Disaster Declaration are approved. Disapprovals occur when FEMA disagrees that local and state resources have been exceeded. Between the passage of the Stafford Act in 1988 and 1998, only about one-fourth of the requests for a Presidential Disaster Declaration were denied (Sylves, 1998). The federal government has attempted to implement an objective set of criteria for deciding whether to issue a Presidential Disaster Declaration, but the process still includes many subjective decision points, and political considerations have affected the declaration process.

2.4: Stakeholders and Power

The first section of this chapter noted that stakeholders vary in the types and amounts of resources they bring to the emergency management process. One of the greatest differences is in the power different stakeholders have to influence others' behavior and, thus, alter emergency management policy. More specifically, organizational theorists have described six types or bases of power—reward, coercive, legitimate, expert, referent, and information power (French & Raven, 1959, Raven, 1965). These different forms of power can be distinguished on the basis of social dependence and the need for surveillance to maintain the target's desired behavior. The most familiar bases of power (reward and coercive) rest on the power holder's ability to impose upon the target additional positive or negative consequences that are extrinsic to the action itself. These consequences may be tangible (money) or intangible (social acceptance). Both reward and coercive power are socially dependent because they require continuing surveillance to be effective. Such surveillance can make them very (sometimes prohibitively) costly to implement. Moreover, coercive power generally elicits hostility and often can be subverted by noncompliance and active deception. Indeed, it is the low likelihood of detection that causes people to violate the speed limit except when they see police cars. It also explains the failure of lower levels of government to implement mandates, such as NIMS compliance, imposed by higher levels of government.

Legitimate, expert, and referent power bases are somewhat more attractive because they involve little surveillance. However, they are socially dependent in that they are specific to a given source. Legitimate power arises from one's role relationship to another and can come from a formal social position (e.g., city mayor) or from an informal relationship derived from norms of reciprocity, equity, or helplessness. By contrast, expert power stems from an individual's breadth and depth of knowledge in a particular domain (e.g., a physician). Referent power is based upon the target's identification with (or desire to identify with) the power holder; the target uses the power holder as a reference point.

According to Burnstein and Vinokur (1977), information power involves valid, novel, and relevant facts or arguments. Information power can be wielded either by introducing or withholding information (Mechanic, 1963). Informational influence is, in many respects, the most effective basis of power because it is socially independent. That is, once comprehended, it is internalized and its source becomes inconsequential. As a result, no surveillance is required to maintain the target's desired behavior. However, information power does require acceptance of another's statements only after an independent examination of their underlying rationale. Thus, exercising information power can be quite time consuming.

The existence of these multiple bases of power should make it clear that power operates in the upward (i.e., households to local government to states to federal government) as well as in the downward direction. Thus, households and businesses can exert upward influence through lawsuits, boycotts, public ridicule, and voter pressure that allows them to actively resist other stakeholders' actions. This balance of power is the consequence of the federal political structure of the United States coupled with a market economy which produces a complex policy environment that is fragmented vertically (between different levels of government) and horizontally (between the private and public sectors and, within the latter, among agencies within a given community).

Figure ???, adapted from Lindell, et al. (1997), illustrates the relationships among stakeholders in emergency management. The core of the figure illustrates the conventional hierarchical relationships among federal, state, and local government, with solid arrows indicating the (downward) direction in which most power is exerted in the relationship. In addition, however, this figure shows the relationships of local government with neighborhoods/households and industries/businesses—who control most of the property at risk. It shows how information and influence flow from the bottom up as well as from the top down, and between groups of stakeholders. Relationships may be based on any of the six bases of power.

In addition to the influence government has over neighborhoods/households and industries/businesses, these stakeholders are also affected by social influentials (e.g., knowledgeable peers), who are in turn influenced by social associations (e.g., environmental organizations). They are also affected by economic influentials who, in turn, are influenced by industry associations (e.g., bankers, and insurers). Finally, local government and businesses are influenced by hazards practitioners who, in turn, are influenced by their professional associations. All of these stakeholders interact with the governmental system to promote their preferred definitions of, and solutions to, problems (Stallings, 1995). Thus, this figure indicates emergency management policy is a much more complex process than government mandates "trickling down" from the federal government. Rather, emergency management involves a complex web of interlinked bi-directional power relationships among stakeholders with widely differing characteristics. In addition to these vertical linkages, there are horizontal linkages among stakeholders within a jurisdiction and from one jurisdiction to another (e.g., from one municipality to another). As later chapters will indicate, these vertical and horizontal linkages provide communities with the resilience to respond to and recover from disasters (Berke, et al., 1993).

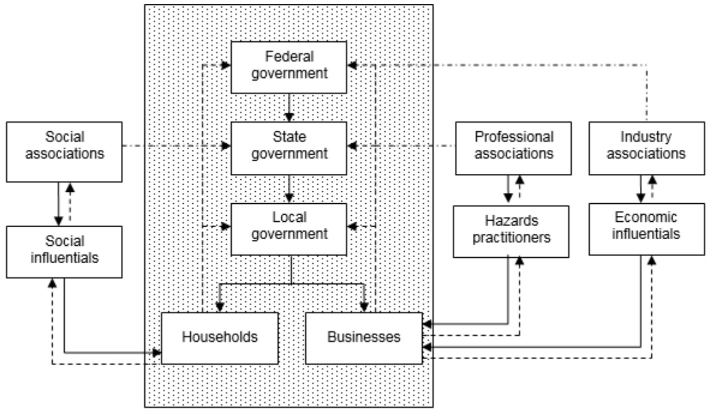


Figure 2.4.1: *Power Relationships Among Emergency Management Stakeholders.*

The predominant power base of a relationship might change over time, say from coercive power (e.g., mandates) to information power. The model also implies that stakeholders at the top of the diagram must mobilize the support of intermediate levels (especially local governmental agencies and elected officials) if anything is to be accomplished at the lower levels of the hierarchy. In the local government-households dyad, local government has more power. However, households do not lack power altogether. They can change local government through elections, subvert local policy through noncompliance, or appeal to higher authorities to change unpopular policies. Other policy dyads have similar dynamics, and other relationships, such as one between practitioners and state governments, can be hypothesized. The important point is that this is a complex, dynamic set of interlinked relationships that the emergency manager needs to understand.

2.5: The Emergency Management Policy Process

The basic *policy process model*, adapted from Anderson (1994), is presented in Table ???. This model, which presents five stages through which policies move, can be thought of as a systems model with a feedback loop that runs from policy evaluation back to agenda setting. Of course, the actual policy process is neither linear nor as neatly divided into discrete stages as the model. However, for purposes of analysis, it is useful to consider the various stages in turn, recognizing that they may run concurrently and the process is often cyclical in nature as feedback from policy evaluation is absorbed in the process.

Table $2.5.1$: The Policy Process Model.

Policy Terminology	Stage 1: Agenda Setting	Stage 2: Policy Formulation	Stage 3: Policy Adoption	Stage 4: Policy Implementation	Stage 5: Policy Evaluation
Definition of Policy Stage	Establishing which problems will be considered by public officials	Developing pertinent and acceptable proposed courses of action for dealing with a public problem	Developing support for a specific proposal so that a policy can be legitimized or authorized	Applying the policy by using government's administrative machinery	Determining whether the effective and what adju needed to achieve desired o
Typical objective	Getting the government to consider action on a problem	Generating alternative solutions to the problem	Getting the government to accept a particular solution to the problem	Applying the government's policy to the problem	Evaluating effectiveness an improvements

Agenda Setting

The model begins consideration of the policy process with setting the policy agenda. Many of the most difficult problems an emergency manager will face involve getting the public and public officials to pay attention to hazards. It is common to hear people say that emergency management is of no interest to politicians until a disaster happens. At that point it is too late to do much beyond the most basic reactive response to urgent needs. The time to think about disasters is well before they occur, so a skillful, adaptive response can be planned and tested through drills and exercises. Thus, the emergency manager's first task is to place hazards on the political agenda in his or her jurisdiction.

There are at least three types of political agendas: the systemic, the governmental, and the institutional. The systemic agenda is the broadest; it refers to the set of policy issues that at any one time receive attention in the news media and so become a topic of conversation among the voters. The governmental agenda is the set of issues with which legislative bodies and executives are actually engaged at a particular time. The institutional agenda is the set of issues that various institutions are working on, and varies widely across organizations such as government agencies, business groups, local environmental groups, and the like. Agendas are unstable over time because public attention shifts from one issue to another as events occur, and the governmental and institutional agendas change as policymakers both respond to these shifts and attempt to shape them (Baumgartner & Jones, 1993).

Although preparedness for emergency response and disaster recovery is usually less controversial than hazard mitigation, there are two reasons why local governments prefer to avoid any discussion of the potential for disasters in their communities. First, many local governments and business elites feel that calling attention to the potential for disasters in their community may discourage investment or tourism. Hazard mitigation is especially controversial because developers frequently believe land use and building construction restrictions will reduce or eliminate their profits. Second, there are many problems that arise on a daily basis, such as education and crime, that directly compete with emergency management for attention and resources. Every year a new class of kindergartners enters the public school system, but a disaster does not strike every year, and we cannot predict with certainty when it will strike. It is thus easy for local officials to push emergency management to the back burner and trust to luck rather than develop sound emergency management practices.

There are various ways to get around this initial reluctance to place emergency management on the policy agenda. First, emergency managers can use the occurrence of a natural or technological disaster in another jurisdiction as a *focusing event* to draw public attention to the need for local disaster planning and hazard mitigation (Birkland, 1997; Lavell, 1994). The focus of public and official attention on a particular hazard for some period of time provides a *window of opportunity* for policy change (Kingdon, 1984). The problem for local emergency managers is to make use of this policy window while it is open, for it will not stay open forever. In fact, it is unknown how long such a policy window will stay open, or specifically what conditions will make it close. Nonetheless, Kingdon suggests policy windows sometimes close because of successful action on a problem or, alternatively, persistent failure to take any action. Alternatively, a policy window might close when another event occurs, shifting the systemic agenda on to other matters. A policy window might also close when key advocates for that policy leave, or are pushed out of, their positions in a policymaking body. Finally, policy windows might close if no possible course of action seems available.

Given these constraints, we have hypothesized a distribution of stakeholder opinions on hazard mitigation over time, shown in Table ??? below (adapted from Prater & Lindell, 2000). Beginning before the disaster, most people are indifferent or opposed to any attempts at addressing hazards. About six months after the disaster, about half might be in favor of some sort of action, but about half are still either neutral or opposed.

Table $2.5.2$: Hypothetical Changes in Stakeholder Opinions.

Time (months)	Strong Proponents	Weak Proponents	Neutrals	Weak Opponents	Strong opponents
t - 6	5%	20%	50%	20%	5%
t + 6	10%	40%	35%	10%	5%
t + 18	5%	25%	50%	15%	5%

Source: Prater and Lindell (2001).

By 18 months after the disaster, opinion might have shifted back to nearly the same state as before, with only a slight erosion of the numbers opposed to action and a corresponding slight rise in the number in favor of hazard mitigation actions. This hypothesized distribution might or might not accurately reflect the situation regarding emergency management policy in any particular community, but the important point is that support for emergency management is likely to increase in the short run after a disaster, but will almost certainly decay before long.

Because of the short amount of time available to effect policy change, individual actors must work in an aggressive, pro-active manner to set issues on the agenda and to keep them there. Such individuals are called *policy entrepreneurs* who act as advocates or champions for an issue. Policy entrepreneurs might be elected or appointed officials, local media personalities, educators, business owners, or interested citizens. Whoever they are, however, they will need three qualities in order to be successful. First, they need technical expertise in hazards, which can either be acquired through the traditional educational process or by self-education as the need arises. Second, they need to have or acquire the political expertise necessary for any successful policy change effort. Finally, they need a great deal of personal commitment because it is very difficult to enact any policy change, and it can sometimes take years to overcome opposition to new policies. Policy change is possible even if no single individual has all of these qualities because a group of individuals can be effective if they collectively have these traits.

The resulting window of opportunity will not be open for long (Prater & Lindell, 2000), so local emergency managers can act as policy entrepreneurs if they are prepared with at least some data on the hazards to which the community is exposed and on the vulnerability of specific populations in the community. With these data in hand, the emergency manager can make a case that such an event could indeed "happen here." Second, the emergency manager should have clear ideas about sound emergency management policies that are relevant to the local situation and could be presented quickly for adoption by the local city council or other legislative body. The emergency manager should act in an entrepreneurial manner rather than passively producing plans according to a prescribed template and assuming that the community will follow his or her lead when an event occurs.

As in any policy debate, there are usually opposing interests that will be just as anxious to keep emergency management off the public agenda as emergency management professionals are to put it on (Bacharach & Baratz, 1962). This conflict of interests is especially true when it comes to emergency management policies. In some cases, there may be philosophical opposition to any governmental activity affecting private land use decisions. The property rights or "wise use" movement and the Supreme Court case of *Lucas vs. South Carolina Coastal Council* are examples of this attitude in action (Platt, 1998).

Emergency managers can play an important role in emergency management policy by supporting the hazard mitigation efforts of local planning and zoning commissions as they seek to expand the number of groups involved in the process. Since hazard mitigation, emergency response preparedness, and disaster recovery preparedness are meant to protect lives and property, it is possible to develop a strong coalition in favor of these practices when they are properly presented to the public. Such coalitions can be most effectively mobilized if issues are properly framed to maximize their appeal. The media have an important role in this process, particularly in the matter of *issue framing*—the words used to describe an issue. Issue framing can vary significantly depending on who is doing the talking. For many years, emergency management in the United States was framed in terms of the Cold War confrontation with the Soviet Union. In the 1980s and 1990s, a shift in framing from *civil defense* to *comprehensive emergency management* occurred, which promoted an increased emphasis on natural hazards and technological accidents. Currently, the federal government is reframing emergency management in terms of terrorism, coining the phrase *homeland security* to describe the new frame of reference.

Another frame, used for discussing natural disasters, has been the term *acts of God*. This phrase implies a view of humanity as powerless victims of impersonal external forces and, thus, absolved from responsibility for avoiding disasters. The mass media are particularly prone to use this frame, showing pictures of suffering victims that reinforce the message. The rise of the sustainable development paradigm has fostered an increased acceptance of the idea that disasters are at least partly a result of vulnerability created by human choices and actions. This recognition of human responsibility, in turn, has raised the prominence of hazard mitigation on the governmental agenda.

Scholars have noted that political issues might not be defined immediately as political problems. Rather, they can exist as conditions for some time before the existence of feasible coping strategies moves them into the realm of public discussion as problems that are amenable to solutions (Rochefort & Cobb, 1994). Thus, the first stakeholder to frame an issue can seize a significant political advantage, especially if he or she is successful in linking a proposed policy with widely shared public values. As an example, consider the "wise use" and "property rights" movements, which have mobilized opposition to the regulation of private property for the public good by framing the issue as one of "taking". Those who support land use regulation as a means of promoting hazard mitigation can offset the takings definition by reframing the issue in terms of the linkage to an alternative value. Thus, proponents of hazard mitigation could frame the issue of land use regulation as one of balancing property rights *and responsibilities*. Indeed, as will be discussed in Chapter 8, this is precisely what the Association of State Floodplain Managers has done with its *No Adverse Impacts Strategy*.

Policy Formulation

Emergency management policy entrepreneurs must have a set of policy proposals on hand before they attempt to shape the agenda. If not, they run the risk that policy makers will find the issue too overwhelming and ignore it on the assumption that "there is nothing we can do anyway". As the reframing of an issue from a condition into a problem becomes increasingly widespread, different stakeholders will propose solutions (Anderson, 1994; Kingdon, 1984). During this stage, many policy alternatives are likely to emerge. This makes policy formulation a critical stage in the process because it is a more technically demanding activity than agenda setting. Drafting legislation is crucial to the success of a policy because laws or regulations that are hastily drafted and poorly worded can have negative effects on the policy's implementation and eventual effectiveness.

The basis for any sound emergency management policy is a solid understanding of the community's hazard exposure, its physical and social vulnerabilities, and its emergency management capabilities. As will be discussed in Chapter 6, hazard/vulnerability analysis provides a *factual basis* for policy formulation. Next, proposed policies must be developed with the local political context in mind. It is crucial to define clearly who are the targets of a policy (i.e., what types of households and businesses), what activities are to be regulated (e.g., land use practices and building construction practices), and what influence mechanisms are to be used (i.e., risk information, economic incentives, legal penalties, or a combination of these). With regard to the activities to be regulated, government has many alternatives. Land use policies can be used to avoid the construction of residential, commercial, or industrial structures in frequently flooded wetlands. Such wetlands serve important hazard mitigation functions by absorbing wave energy during hurricanes and retaining excess water during riverine floods. Alternatively, building construction policies can be used to ensure houses within floodplains are elevated, those near the coast have adequate wind resistance, and those near fault lines have seismic safety features. Moreover, emergency preparedness policies might be used to control lot sizes (thus limiting the population at risk in hazard-prone areas) or mandate the width of streets in subdivisions to provide access for emergency vehicles and egress for evacuees.

To achieve the desired land use, building construction, and emergency preparedness objectives, governments can use hazard awareness campaigns to make households and businesses aware of the risks they face and of suitable hazard adjustments for reducing their vulnerability. *Hazard adjustments* include all pre-impact actions—hazard mitigation, emergency preparedness, and recovery preparedness (Burton, et al., 1993). Information campaigns relying on voluntary compliance tend to be politically acceptable, but few have been based upon contemporary scientific theories of social influence, and so these programs have had limited success to date (Lindell, et al., 1997). As will be discussed in Chapter 4, many hazard awareness programs provide very general information about physical hazards (e.g., what causes earthquakes) and sometimes describe what are the different hazard zones (in terms of either intensity, as is the case with hurricane risk areas, or frequency, as is the case with inland flood zones). However, few of them personalize the risk or describe appropriate hazard adjustments.

Alternatively, governments can motivate the adoption of hazard-resistant land use and building construction practices by providing economic incentives such as low interest loans or tax credits. Of course, the money for such incentives must come from somewhere and cash-strapped local jurisdictions may not be able to provide it. Finally, governments can require hazard-resistant land-use and construction practices as a condition for construction permits. Of course, verification of compliance requires on-site inspections, and the problems with such inspections are extremely well known (Lindell et al., 1997). Specifically, local jurisdictions experiencing budget difficulties frequently cut back funding for building inspectors, so those who remain on the job must process higher inspection workloads. In turn, this requires them to spend less time inspecting construction projects, which increases the likelihood of contractors successfully evading building code requirements and thereby cutting their construction costs.

More broadly, there is a significant degree of scholarly support for the idea that a combination of risk communication, land-use planning, building codes, and hazard insurance is an excellent way to address hazard vulnerability (Burby, 1998; Lindell & Perry, 2004) Whatever the combination selected, successful implementation requires the policy to be consistent with the community's *capacity* (e.g., tax base, agency capabilities) and *commitment* (especially the community values articulated in issue framing).

One important strategy in the policy formulation stage is to seek opportunities to work with other stakeholder groups to formulate policies that have a strong chance of being adopted and implemented. In most cases, this will involve working with weak proponents and neutrals to add features that will convert them into strong proponents. Sometimes, this will involve seeking out those who would normally be considered weak opponents—or even strong opponents—to craft a policy that they can accept. For example, this might mean working with developers and builders to formulate policies that allow them to develop less hazard prone areas, build on the less hazardous portions of their properties, or build structures that are more hazard resistant.

Policy Adoption

The policy adoption phase involves the mobilization of stakeholder groups to pressure the relevant level of government in order to ensure passage of the desired policy. An emergency manager should have a strategy for presenting the policy in the correct manner and at the right time so procedural issues do not derail policy adoption. It is important to have a policy officially adopted and on the books, for that is what gives it legal authority and allows for the institutionalization of a policy.

When developing any public policy, care should be taken to include members of relevant stakeholder groups to ensure their interests are considered. Moreover, emergency managers should give special attention to the priorities of their department heads and the jurisdiction's chief administrative officer. Inclusiveness is especially important in the case of hazard policies, because these policies often require a *certain present investment* (e.g., tax money allocated to first responder agency budgets) or a *certain opportunity cost* (e.g., a lucrative land development project foregone) in order to obtain an *uncertain future benefit* (reduced disaster losses). Moreover, these costs tend to be concentrated on a few stakeholders, whereas the benefits are widely distributed over the community as a whole. Consequently, those who expect an emergency management policy to affect them negatively have a more powerful incentive to mobilize than do those who expect to benefit.

The typical stakeholder groups that should be considered at the local level are those that have been mentioned already—business leaders (developers, builders, Chamber of Commerce), elected officials, government agency staff, civic groups, church leaders, and neighborhood associations. All these groups have roles to play in providing for community hazard management. For example, business leaders might need to enhance their business plans to include business continuity planning to be used in case of disaster (Federal Emergency Management Agency, no date, c). Their cooperation with the community's emergency management program can be facilitated by information about the losses they can avoid when disaster strikes.

Considerations other than economics should be addressed as well. Agencies such as the public works department might be accustomed to dealing with hazards but feel threatened when the decisionmaking process is expanded to include meetings with neighborhood groups. As anonymous bureaucrats, they might not be accustomed to being held personally accountable for technical decisions and might equate citizen participation with needlessly looking for trouble. Conversely, some neighborhoods that are especially vulnerable to hazard impact might have a large proportion of lower income or ethnic minority residents who lack knowledge about the political system or even actively mistrust it. All of these concerns need to be balanced because any perceived unfairness in the policy or the way it was adopted is likely to cause problems in the implementation phase. Even after a policy has been developed, there are many veto points at which interests can block the adoption or implementation of policies they consider undesirable.

Policy Implementation

Adoption is not the end of the story. All policies must be implemented in order to be effective. Implementation is the stage most fraught with difficulties because opponents who have failed to block policy adoption often seek to undermine it as it is put into practice. The implementation stage of policy making is defined as those events and activities that occur after a policy is adopted and include the policy's administration and its actual effects (Mazmanian & Sabatier, 1983). All policies are filtered through "street level bureaucrats", those individuals who actually interact with the public (e.g., land use planners and building inspectors), so their enthusiastic support for policy goals and implementation methods is especially important.

Implementation of emergency management policy depends substantially upon the nature of the governmental structure. In the United States, the government has a federal structure, so strong state and local governments can support or thwart the implementation of federal policy—whichever suits their purposes. Conversely, the federal government can either strengthen local emergency management processes by providing information or technical support or undermine local goals by failing to provide promised funding. If all stakeholders are included in the early stages of the policy process, it is more likely that the policy will be implemented in accordance with legislative intent.

Mazmanian and Sabatier (1989) have developed a widely used model of policy implementation, highlighting specific variables and their interactions that produce varying levels of success. Three types of independent variables are included in this model, the first of which is the *tractability of the problem*, or how easy it is to solve. Emergency management involves complex problems. Consequently, overly simplistic policies can have unintended consequences, yet comprehensive policies are difficult to develop. As a result, hazard mitigation policies rank low on the tractability dimension and are difficult to implement.

The second group of variables involves the *ability of the statute to structure implementation*. This is where statecraft and legislative skill are needed. One component of this concept is an adequate causal theory, which is a clear idea of how a particular emergency management policy will reduce casualties, damage, and losses. In the case of floods, dams are expected to protect people and property by confining excess river flow in reservoirs. The second component is a set of clear and internally consistent policy objectives. Using floods again as an example, conflicting objectives arise because dams are often intended to provide irrigation, electric power generation, and recreations functions (which favor full reservoirs) as well as flood control (which favors empty reservoirs). Moreover, policy clarity can be difficult to achieve because emergency management policy must be carefully crafted to achieve a balance between specificity and adaptability. Thus, on the one hand, clear directives are needed to produce results consistent with the intent of the policy. On the other hand, however, bureaucrats need the freedom to adapt the policy to the varied situations they encounter. The emergency management policy arena is especially prone to changes over time, so a significant amount of bureaucratic discretion probably will be necessary. Another important variable is the percentage of governmental resources allocated to emergency management, which is highly dependent on the fiscal resources available to the jurisdiction at the time of policy passage and on the importance of emergency management relative to other issues on the agenda.

The third set of variables affecting implementation consists of *nonstatutory factors*, the first of which is the jurisdiction's socioeconomic condition and the level of technology available to address the problem. These are constraints over which policymakers have little control in the short term. However, these constraints can be relaxed by means of investments in sustainable economic development (to enhance socioeconomic conditions) and technologies such as Geographic Information Systems (to enhance the level of technology), both of which are increasingly available to local governments. The second variable is one that carries over from previous stages of the policy process—the level of public support for emergency management policy. Public support tends to be cyclical, but it can be stabilized and even increased by persistent efforts to keep emergency management on the systemic agenda. Indeed, this affects the third and fourth factors—the attitudes and resources of constituency groups and support from the state or local government—both of which can be affected by coalition building activity. Finally implementing officials need to develop high levels of managerial and political skills to ensure successful implementation of emergency management policies.

Mazmanian and Sabatier's model provides an important basis for understanding policy implementation, but it neglects one factor that is critical to emergency management policy—the hierarchical relationships among federal, state, and local governments. This issue was the focus of May and Williams' (1986) book, *Disaster Policy Implementation*, which examined shared governance among multiple levels of government. The authors described four modes of shared governance: limited regulatory, general regulatory, mobilization, and collaborative. These four modes are distinguished by the form of partnership (general or limited) and the form of activity (regulatory or programmatic) in which federal and state governments are involved. May and Williams found seismic safety was an exemplar of the collaborative mode, which is characterized by general partnership and programmatic activity. They observed that, even though federal involvement in earthquake mitigation began with the passage of the 1977 Earthquake Hazards Reduction Act (Public Law 95-124), few collaborative efforts to improve the states' capacities for seismic risk reduction had been successful by the time of their study. According to May and Williams, problems in the shared governance of seismic safety arose at both ends of the partnership. At the federal level, technical expertise was in short supply and continuing personnel turnover hampered contacts with state agencies. Among the states, only California exercised initiative and showed a willingness to invest resources in the program. Problems arose between the federal government and the State of California mainly as a result of disputes over funding and control of projects.

Another important aspect of emergency management policy is the effect of state mandates on local adoption and implementation of these policies. Previous research has examined the effect of mandate design on policy implementation (Goggin, et al. 1990; Mazmanian & Sabatier, 1989; Van Meter & Van Horn, 1975). Accordingly, May (1993) compared data from five states (California, North Carolina, Florida, Texas, and Washington) to discover the links between the design of hazards relevant aspects of land use mandates and the implementation of hazards mitigation policy. May's analysis examined the effects of five independent variables: mandate facilitating features, mandate controls, mandate goal clarity, agency capacity, and agency commitment. Two of the state mandate variables had a significant positive impact on the level of state implementation. The first of these was mandate facilitating features, which is defined by characteristics meant to increase local government commitment and capacity to address mandate goals. The second state mandate variable was mandate controls, which are the tools state agencies can use to affect local government efforts.

Contrary to the predictions of Mazmanian and Sabatier's model, mandate goal clarity had no significant effect. It seemed to be sufficient for agency personnel to have a clear and consistent view of their duties, even if the statute was vague. The level of commitment by the state agency charged with implementing the mandate had a significant positive effect, whereas agency capacity did not, again failing to support Mazmanian and Sabatier's emphasis on agency capacity. This might be because, if an agency is strongly committed to a goal, sufficient capacity will be allocated to meet that goal even if other programs must suffer. May's research confirmed the importance of an adequate level of technical expertise, low turnover of personnel, agency commitment to hazards mitigation, and the existence of adequate facilitating features, and controls built into the mandate for the successful implementation of emergency management policy.

Further analyses addressed the factors affecting mandate strength (May, 1994). The most important factors affecting the strength and style of state mandates for hazard mitigation were the presence of a moralistic state political culture, as opposed to an individualistic or traditionalistic political culture (Elazar, 1994), lawmakers' perceptions of the seriousness of the hazard, and the political power of the target population. These results suggest it would be useful for local government officials to impress upon state legislators the importance of supporting their efforts at emergency management and for affected populations to organize in order to increase their political power.

The stronger the commitment of the implementing agency to the goals of the policy, the more likely it is to devote the necessary resources to implementing the policy. The agency needs to have enough tools available, in the form of incentives and sanctions, to adequately implement the policy. If lawmakers are convinced of the seriousness of the problem, they are more likely to provide adequate authority and capacity to the implementing agency so it can properly enforce the policy. This is especially true if the target population has the power to resist the policy.

Policy Evaluation

Finally, as in any system, the policy process model provides for a feedback loop in which the policy is periodically evaluated and either improved or terminated. The most effective programs include provisions for such feedback in the language of the statute and are carefully structured to allow for clear evaluation. One prominent illustration of the lack of policy evaluation is Project Impact, a program that will be discussed at greater length in Chapter 7. As successful as it might have been in mobilizing a constituency for community hazard mitigation, there was no systematic evaluation of its success in reducing disaster losses. Worse yet, one of the criteria for selection as a Project Impact community was a history of commitment to hazard mitigation. A demonstrated history of success in hazard mitigation would have made it very difficult to determine the success of a program intended to increase hazard mitigation efforts at the local level. This confusion of selection criteria and desired results made it difficult to disentangle how much of the improvement in hazard mitigation in Project Impact communities was due to the program, and how much would have occurred anyway, given the history of commitment to hazard mitigation in the community.

2.6: Involving Stakeholders in Emergency Management

Emergency management is a necessary function of local governments that is supported by state and federal governments. Although it provides much needed assistance after disasters, good emergency management practices can raise opposition during other phases of the disaster cycle. Although it would seem that emergency management is an obvious public good, there are always some forces that resist any policy or set of policies. Emergency managers must identify the sources of this resistance in order to be effective in changing their communities' priorities regarding emergency management.

What features of emergency management can arouse opposition, and why? Disaster relief seldom arouses opposition because it is a *distributive policy* that benefits a "deserving" population and has no identifiable losers. It is thus difficult to oppose disaster relief without appearing to be uncaring and unsympathetic. Not all emergency management policies are distributive, however. Mitigation practices such as land use controls and building codes are examples of *regulatory policy*, which imposes restrictions and limits on behavior and often imposes associated costs. Such policies frequently generate conflict because there are obvious losers. For example, a prohibition against construction on barrier islands produces benefits that are broadly distributed across the entire community when it is protected from hurricane damage. However, these benefits seem speculative at the time the policy is adopted and, in any event, would probably involve a relatively small amount of money for each household protected by the policy. Thus, few of those who benefit are likely to fight for adoption of the policy. By contrast, the "losses" (i.e., the potential profits that would have otherwise been reaped, known as *opportunity costs*) are concentrated among a few influential individuals who are, thus, highly motivated to fight against adoption of the policy. This situation leads to an increase in conflict that emergency managers must learn to manage in order to ensure the adoption and implementation of effective mitigation policies.

In order to develop an effective emergency management system, the local emergency manager must involve the relevant stakeholders in the process. Stakeholder involvement requires coordinating the various groups as emergency operations and recovery operations plans are drawn up and exercised, as well as during an event. Most of an emergency manager's work should be conducted between disasters and behind the scenes, as he or she seeks to facilitate relationships among the stakeholders that will strengthen horizontal linkages within the community and vertical linkages of the community with outside resources in higher levels of government (Berke, et al., 1993). These strong linkages will improve the flow of information, services, and supplies during a disaster. Nonetheless, emergency managers should not work in silence or in isolation. Such a mode of operation produces inadequate plans that are not used during disasters. The only way to produce usable emergency operations and recovery operations plans is through consultation and cooperation with all the relevant agencies—taking their needs, resources, and missions into account. Similarly, good emergency management policies are produced through consultation. How is this to be done?

One important way to involve stakeholders is to work with other government agencies. As will be discussed in the next chapter, Local Emergency Management Committees (LEMCs) can become valuable forums for input from other agencies on the emergency management process. Many of these were originally formed for the specific purpose of improving community right-to-know and preparedness for toxic chemical emergencies, but some have expanded their scope to address chemical emergency management and all of them can contribute to the management of other environmental hazards faced by their communities (Lindell & Perry, 2004). Such committees will be discussed in greater detail in the next chapter.

Another important way to involve stakeholders is to work with citizens' groups. Fostering citizen involvement requires emergency managers to initiate contacts throughout the community. Since it goes almost without saying that budget and staff constraints limit the extent to which such initiatives may be taken, the following paragraphs will sketch a few techniques that can be used with modest resource expenditures. To be successful, the process of community participation must be carefully organized and managed (Glass, 1979). Least likely to be effective would be to simply invite community residents to comment on local disaster plans in the absence of a structured program for presenting the plans and an orderly mechanism for evaluating and accommodating comments. When considering how to involve citizens in emergency planning, one must address four distinct tasks. First, affected residents must be notified that planning is underway and informed who is responsible for planning. In some cases, emergency managers can identify which residents will be affected by their functional relationship to a policy. For example, all homeowners in a watershed are relevant stakeholders for flood hazard management. Second, information must be provided to citizens that describes (as free from technical terminology as is reasonably achievable) the nature and severity of local hazards, the types of mitigation actions that are being taken to reduce these hazards, the assessment actions that are being taken to monitor the hazard, and the types of protective actions that can be implemented in an emergency. Educational contacts include hazard awareness programs intended to familiarize the public with the nature of the hazards to which the community is vulnerable and the basic provisions of the emergency plan. As a method of community involvement, educational contacts have the advantage of reaching large audiences at moderate cost, and the disadvantage of using essentially one-way communication. The emergency services officials get their message out but, except in rare circumstances, the audience cannot respond.

Third, techniques for information exchange involve seeking feedback from citizens, especially about specific planning efforts and emergency management policies that might be used in the operations phase. Fourth, citizen feedback must be incorporated into the preparedness process through support-building in which one seeks to enhance the credibility of the plan (and of the planners and response personnel) in the eyes of the public. Achievement of these information exchange and support-building objectives requires two-way communication, especially direct personal contact.

Specific Techniques for Community Involvement

One very simple technique for obtaining feedback and support requires nothing more than for emergency management staff to "talk up" their work to friends, relatives and neighbors—describing community hazard vulnerability and emergency plans in general terms—and seeking informal reactions. Such grassroots interaction can, of course, be extremely limited in its access to ethnic groups and socioeconomic classes if there are no emergency planners that are members of these groups. In light of their negligible cost, however, the long run value of such exchanges should not be underestimated.

A second technique for interacting with the public involves setting up a "hazard hotline" telephone number. This hotline need not be any more elaborate than advertising an office phone number and training existing staff to handle inquiries or using a recorded message. Citizens could be informed of the information line, perhaps via a mailed brochure, and staff could develop a procedure for promptly responding to questions. This type of phone-in arrangement is quite useful in that it serves to gather and disseminate information on a routine basis and has the potential to be expanded into a rumor control or warning confirmation line during times of disaster (Perry, 1982). Over the course of the year, one would not anticipate a large volume of inquiries. Such nonemergency calls probably would tax neither the ability of staff to respond nor the capability of telephone equipment to handle calls.

A third technique for communicating with the public is to establish direct contact with citizens in the community. Such contact is often achieved by speaking at meetings of school, neighborhood, and community organizations. Neighborhood meetings can deal with very specific and timely topics; they can reach otherwise difficult to contact groups; and they provide both face-to-face contact and an opportunity for dialogue. For example, a community or neighborhood club might welcome a speaker who describes how to prepare for a hurricane at the start of the most vulnerable season. Emergency managers could explain to residents how warnings will be disseminated, when and how to shelter in-place, what roads will serve as evacuation routes, and what procedures will be used to secure evacuated areas. Such meetings also afford an opportunity to ask citizens if they have a family emergency plan that provides for what to do if the family is separated when an evacuation is initiated, where the family plans to seek refuge, what they will pack to take with them, what vehicles will be taken and what route will be followed. Other questions that can be asked include their willingness to use services provided by authorities, such as warning confirmation numbers, public transportation, willingness to use a family message center, concerns about looting, and willingness to participate in emergency response support activities such as citizen patrols. Discussions at this level of specificity can not only provide emergency managers with an assessment of what the members of their community think about such issues, but also stimulate citizen thought, discussion, and preparedness for emergency response. Once again, it is important to remember that neighborhood groups and community organizations tend to have fairly homogeneous memberships. In order to communicate with all segments of the community, one must make contacts with many different types of groups.

Finally, sustained citizen involvement can be achieved by creating citizen advisory committees and citizen cadre opportunities. Advisory committees are usually small in size and attached to departments to provide general guidance, but they can be used for such specific topics as emergency planning. When an advisory committee is created, a significant commitment of time is usually required. At a minimum, officials must devise a schedule for periodic (monthly or bimonthly) meetings and an acceptable mechanism for soliciting information, evaluating it, and then either using it or explaining why it was not used. A properly administered citizen advisory committee can provide timely and accurate information on specific points of planning interest and can also mobilize strong support within the community.

While citizen advisory committees tend to involve people in the administrative aspects of emergency planning, citizen cadre opportunities tend to involve volunteers in selected operational duties. Citizen cadres require some degree of training and usually function as auxiliary personnel acting in support of regular emergency personnel. Citizen cadres have been used to fill sandbags on flood levees, direct traffic, serve on search and rescue teams, provide security in evacuated areas, and help administer family locator services. Citizen cadres incorporate volunteers into the emergency response process in ways that are commensurate with the skills they bring to the emergency response organization. Such auxiliaries can be used to ease the tremendous demands placed on regular personnel during the emergency response phase. Moreover, appropriately trained volunteers are familiar with emergency procedures and the logic behind them. Such persons can build support within the community by explaining emergency procedures to others.

In summary, the purposes of these techniques are to allow emergency authorities to better anticipate the reaction of their community in a disaster and to familiarize citizens with emergency response planning and operations. It might not be necessary or cost-effective to use all of these techniques in the same community. They are identified here as alternative programs from which to select the ones that best meet the emergency preparedness needs and budgetary constraints of a given community.

Forming coalitions with groups interested in related issues can be a valuable strategy for an emergency manager. Emergency managers can join other groups to ensure the adoption of policies that perform multiple functions and, thus, have a larger base on which to build support for emergency management. For example, environmental groups are interested in preserving wetlands or riverine corridors for their aesthetic value and other reasons. These same lands can perform valuable hazard mitigation functions by absorbing the effects of floods or avoiding an increase in community vulnerability by keeping housing out of a floodplain. Emergency managers can be more effective in an increasingly competitive political climate if they work collaboratively with other groups to promote policies meeting the objectives of multiple stakeholder groups.

Sources of State and Federal Assistance

State and federal emergency management agencies are extremely valuable sources of assistance to local emergency managers. These agencies can provide technical guidance on hazard/vulnerability analyses, hazard mitigation, emergency preparedness, emergency response, and disaster recovery. Of course, the types and quantities of state assistance vary from one state to another, so it is important for local emergency managers to contact their state emergency management agencies and to join their state emergency management associations to obtain information about the available resources.

Emergency managers can also take advantage of resources from other states. In a disaster, they rely on the *Emergency Management Assistance Compact* (EMAC, see www.emacweb.org), which was established in 1996 by an act of Congress. Since then, EMAC has been joined by all 50 states, the District of Columbia, Puerto Rico, and the US Virgin Islands. EMAC facilitates direct mutual aid from one state to another in response to any type of disaster. Because they are located closer to the impact area, these resources from neighboring states are likely to reach a stricken area faster than federal resources. Like other mutual aid agreements, EMAC provides for financial reimbursement, legal liability, and workers' compensation for any injuries incurred during the disaster response. In addition, EMAC recognizes the credentials of out-of-state emergency responders.

An EMAC operation begins when the governor a *requesting state* declares a state of emergency. An *authorized representative* who has the legal power to commit the requesting state's funds asks for assistance from the *EMAC National Coordination Group*. This unit is the nationwide point of contact for activating EMAC in response to a declared emergency.

An *A-team* deploys to the requesting state where it conducts a needs assessment, alerts EMAC members about these needs, and receives offers from *assisting states* that provide resources under the compact. The requesting state and the assisting state negotiate the availability and cost of requested resources and, after reaching agreement, dispatch the requested resources.

To facilitate this process, each EMAC member state has a *designated contact* who is an expert on EMAC procedures. There also is an *EMAC National Coordinating Team* that can be activated by DHS/FEMA to coordinate federal response and recovery operations. This team deploys to the National Response Coordinating Center, located in Washington, D.C., so it can help to coordinate with any EMAC teams responding to the incident scene. The EMAC National Coordinating Team can be complemented by an *EMAC Regional Coordinating Team*, which mobilizes at a Regional Coordination Center to coordinate regional response and recovery operations. From there, the EMAC Regional Coordinating Team coordinates with any EMAC field units providing assistance at the incident scene.

There is also an enormous amount of assistance available from federal agencies. Many types of technical and financial assistance are addressed throughout the remainder of this text, particularly the chapters on hazard/vulnerability analysis, hazard mitigation, emergency preparedness, emergency response, and disaster recovery. There is an almost bewildering variety of technical support that the federal government makes available during disasters. The appendix to this chapter lists the emergency support functions (ESFs) into which federal emergency response activities are organized and the assignments of federal agencies to ESFs.

2.7: Case Study: The Politics of Hazard Mitigation

St. Louis, Missouri lies in the New Madrid Fault Zone and most of its buildings are vulnerable unreinforced masonry structures. In 1976, the Department of Housing and Urban Development escalated the seismic standards for Federal Housing Authority and Veterans Administration loans in this region from the Building Officials and Code Administrators' (BOCA) Basic Building Code to the more stringent Uniform Building Code (UBC) Zone II requirements (Drabek, Mushkatel & Kilijanek, 1983). Concerned about the effect on new construction, local developers, contractors and officials sought technical assistance in challenging the policy. HUD officials viewed local opposition as a threat to their entire policy, which they felt was more than adequately justified by the safety threat to local residents. However, technical experts attacked the scientific basis for HUD's policy with the assertions that inclusion of St. Louis in Zone II was a cartographic error, the assumed 300-500 year return intervals were in error, and projected damage from a repeat of the 1811-1812 earthquakes was overestimated. The city lobbied the local HUD office to request that the HUD Secretary exempt St. Louis from the seismic requirements and asked its congressional delegation, the Home Builder's Association, and public interest groups to support this request. By 1981, the BOCA I Code was used for all structures except multifamily housing rehabilitation projects, where the UBC Zone II requirements were applied. Even the impact of this requirement was minimal because it was enforced by the HUD regional office in Kansas City and the local HUD office in St. Louis, not by the city or county of St. Louis. Consequently, most engineers and developers contacted by Drabek and his colleagues were uncertain about which standards should be applied.

Appendix 2: Federal Agencies and Their Responsibilities Under the National Response Plan

St. Louis, Missouri lies in the New Madrid Fault Zone and most of its buildings are vulnerable unreinforced masonry structures. In 1976, the Department of Housing and Urban Development escalated the seismic standards for Federal Housing Authority and Veterans Administration loans in this region from the Building Officials and Code Administrators' (BOCA) Basic Building Code to the more stringent Uniform Building Code (UBC) Zone II requirements (Drabek, Mushkatel & Kilijanek, 1983). Concerned about the effect on new construction, local developers, contractors and officials sought technical assistance in challenging the policy. HUD officials viewed local opposition as a threat to their entire policy, which they felt was more than adequately justified by the safety threat to local residents. However, technical experts attacked the scientific basis for HUD's policy with the assertions that inclusion of St. Louis in Zone II was a cartographic error, the assumed 300-500 year return intervals were in error, and projected damage from a repeat of the 1811-1812 earthquakes was overestimated. The city lobbied the local HUD office to request that the HUD Secretary exempt St. Louis from the seismic requirements and asked its congressional delegation, the Home Builder's Association, and public interest groups to support this request. By 1981, the BOCA I Code was used for all structures except multifamily housing rehabilitation projects, where the UBC Zone II requirements were applied. Even the impact of this requirement was minimal because it was enforced by the HUD regional office in Kansas City and the local HUD office in St. Louis, not by the city or county of St. Louis. Consequently, most engineers and developers contacted by Drabek and his colleagues were uncertain about which standards should be applied.

Appendix 2-A: Federal Agencies and

Their Responsibilities Under the National Response Plan

The NRP defines 15 emergency support functions (ESFs) that span the types of activities federal agencies can perform in response to an event that overwhelms the resources of local and state government. Table 9-5 lists the ESFs by number and name together with a brief description of the activities involved in each of them.

Table 9-5. Emergency Support Functions.

ESF #	Function name	Activities
ESF #1	Transportation	Provides transportation support including reporting damage, coordinating alternate transportation services, coordinating restoration, for air, w pipeline
ESF #2	Communications	Provides alternate telecommunications support and assists in the restoration of infrastructure for telecommunications and information technolog
ESF #3	Public Works and Engineering	Provides pre- and post-incident assessments of public works and infrastructure as well as engineering and construction management expertise
ESF #4	Firefighting	Provides for the detection and suppression of wildland, rural, and urban fires
ESF #5	Emergency Management	Provides for interagency planning and coordinated operations
ESF #6	Mass Care, Housing and Human Services	Provides sheltering and feeding of victims, short- and long-term housing, and support for victim counseling and benefits claims
ESF #7	Resource Support	Provides emergency facilities, equipment, materials and supplies, as well as contracting and transportation services
ESF #8	Public Health and Medical Services	Provides assessments of public health/medical needs, medical care personnel, and medical equipment and supplies
ESF #9	Urban Search and Rescue	Organizes, deploys, and supports teams to extricate trapped victims from collapsed buildings
ESF #10	Oil and Hazardous Materials Response	Detects, contains, and cleans up releases of oil and hazardous materials
ESF #11	Agriculture and Natural Resources	Provides nutritional assistance, controls animal and plant diseases, assures food safety and security, and protects natural and cultural reso properties
ESF #12	Energy	Assesses energy system damage and its likely effects
ESF #13	Public Safety and Security	Provides force and critical infrastructure protection and technical assistance to state and local government
ESF #14	Long-Term Community Recovery and Mitigation	Provides financial and technical assistance to support the recovery of state and local governments, including mitigation actions to prevent dis limit its magnitude
ESF #15	External Affairs	Provides coordinated dissemination of information from federal agencies to the general public, the Congress, state and local governments an and international governments

In addition, the NRP assigns federal agencies three types of responsibilities within each ESF. The first role is that of coordinator, which is responsible for planning and coordinating the federal response in that function. The second role is primary agency, which is responsible for staffing the emergency response. The third role is support agency, which is responsible for providing personnel technical assistance as requested by the primary agencies. The remainder of this appendix lists each agency's assigned ESF responsibilities.

***Department of Agriculture*.** USDA is the coordinator and shares the role of primary agency with the Department of the Interior (DOI) for ESF #11 (Agriculture and Natural Resources) and shares the role of primary agency for ESF #14 (Long-Term Community Recovery and Mitigation). USDA has secondary responsibility for ESF #3 (Public Works and Engineering), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #8 (Public Health and Medical Services), ESF #10 (Oil and Hazardous Materials Response), ESF #12 (Energy), and ESF #15 (External Affairs).

***Department of Agriculture/Forest Service*.** USDA/FS is the coordinator and primary agency for ESF #4 (Firefighting) and has secondary responsibility for ESF #1 (Transportation), ESF #2 (Communications), ESF #3 (Public Works and Engineering), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #7 (Resource Support), ESF #8 (Public Health and Medical Services), ESF #9 (Urban Search and Rescue), ESF #10 (Oil and Hazardous Materials Response), and ESF #13 (Public Safety and Security).

***Department of Commerce*.** DOC shares the role of primary agency for ESF #14 (Long-Term Community Recovery and Mitigation) and has secondary responsibility for ESF #1 (Transportation), ESF #2 (Communications), ESF #3 (Public Works and Engineering), ESF #4 (Firefighting), ESF #5 (Emergency Management), ESF #7 (Resource Support), ESF #9 (Urban Search and Rescue), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), ESF #12 (Energy), ESF #13 (Public Safety and Security), and ESF #15 (External Affairs).

***Department of Defense*.** DOD has secondary responsibility for ESF #1 (Transportation), ESF #2 (Communications), ESF #3 (Public Works and Engineering), ESF #4 (Firefighting), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #7 (Resource Support), ESF #8 (Public Health and Medical Services), ESF #9 (Urban Search and Rescue), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), ESF #12 (Energy), ESF #13 (Public Safety and Security), ESF #14 (Long-Term Community Recovery and Mitigation), and ESF #15 (External Affairs).

***Department of Defense/US Army Corps of Engineers*.** DOD/USACE is the coordinator and shares the role of primary agency for ESF #3 (Public Works and Engineering). DOD/USACE has secondary responsibility for ESF #4 (Firefighting), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #8 (Public Health and Medical Services), ESF #9 (Urban Search and Rescue), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), ESF #12 (Energy), ESF #13 (Public Safety and Security), and ESF #14 (Long-Term Community Recovery and Mitigation).

***Department of Education*.** ED has secondary responsibility for ESF #5 (Emergency Management), ESF #13 (Public Safety and Security), ESF #14 (Long-Term Community Recovery and Mitigation), and ESF #15 (External Affairs).

***Department of Energy*.** DOE is the coordinator and primary agency for ESF #12 (Energy). DOE has secondary responsibility for ESF #1 (Transportation), ESF #3 (Public Works and Engineering), ESF #5 (Emergency Management), ESF #7 (Resource Support), ESF #8 (Public Health and Medical Services), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), and ESF #15 (External Affairs).

Department of Health and Human Services**.** HHS is the coordinator and primary agency for ESF #8 (Public Health and Medical Services) and shares the role of primary agency on ESF #14 (Long-Term Community Recovery and Mitigation). HHS has secondary responsibility for ESF #3 (Public Works and Engineering), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #9 (Urban Search and Rescue), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), ESF #13 (Public Safety and Security), and ESF #15 (External Affairs).

Department of Homeland Security**.** DHS shares the roles as coordinator and primary agency for ESF #13 (Public Safety and Security) and coordinator for ESF #15 (External Affairs). DHS has secondary responsibility for ESF #1 (Transportation), ESF #2 (Communications), ESF #3 (Public Works and Engineering), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #7 (Resource Support), ESF #8 (Public Health and Medical Services), ESF #9 (Urban Search and Rescue), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), ESF #12 (Energy), and ESF #14 (Long-Term Community Recovery and Mitigation).

Department of Homeland Security/Emergency Preparedness and Response/Federal Emergency Management Agency**.** DHS/EPR/FEMA is the coordinator and primary agency for ESF #5 (Emergency Management). FEMA is the coordinator and shares the role of primary agency for ESF #6 (Mass Care, Housing and Human Services). FEMA is the coordinator and primary agency for ESF #9 (Urban Search and Rescue). FEMA is the coordinator and shares the role of primary agency for ESF #14 (Long-Term Community Recovery and Mitigation). FEMA is the coordinator and primary agency for ESF #15 (External Affairs). FEMA has secondary responsibility for ESF #2 (Communications), ESF #4 (Firefighting), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), and ESF #12 (Energy).

Department of Homeland Security/Information Analysis and Protection/National Communications System**.** DHS/IAIP/NCS is the coordinator and primary agency for ESF #2 (Communications). NCS has secondary responsibility for ESF #1 (Transportation), ESF #2 (Communications), ESF #3 (Public Works and Engineering), ESF #4 (Firefighting), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #7 (Resource Support), ESF #8 (Public Health and Medical Services), ESF #9 (Urban Search and Rescue), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), ESF #12 (Energy), ESF #13 (Public Safety and Security), ESF #14 (Long-Term Community Recovery and Mitigation), and ESF #15 (External Affairs).

Department of Homeland Security/US Coast Guard**.** DHS/USCG shares the role as primary agency for ESF #10 (Oil and Hazardous Materials Response). USCG has secondary responsibility for ESF #1 (Transportation), ESF #3 (Public Works and Engineering), ESF #4 (Firefighting), ESF #8 (Public Health and Medical Services), ESF #9 (Urban Search and Rescue), and ESF #13 (Public Safety and Security).

Department of Housing and Urban Development**.** HUD shares the role as primary agency for ESF #14 (Long-Term Community Recovery and Mitigation). HUD has secondary responsibility for ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), and ESF #15 (External Affairs).

Department of Interior**.** DOI has secondary responsibility for ESF #1 (Transportation), ESF #2 (Communications), ESF #3 (Public Works and Engineering), ESF #4 (Firefighting), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #10 (Oil and Hazardous Materials Response), ESF #12 (Energy), ESF #13 (Public Safety and Security), ESF #14 (Long-Term Community Recovery and Mitigation), and ESF #15 (External Affairs).

Department of Justice**.** DOJ shares a role as coordinator and primary agency for ESF #13 (Public Safety and Security). DOJ has secondary responsibility for ESF #1 (Transportation), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #8 (Public Health and Medical Services), ESF #9 (Urban Search and Rescue), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), and ESF #15 (External Affairs).

Department of Labor**.** DOL has secondary responsibility for ESF #3 (Public Works and Engineering), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #7 (Resource Support), ESF #8 (Public Health and Medical Services), ESF #9 (Urban Search and Rescue), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), ESF #12 (Energy), ESF #14 (Long-Term Community Recovery and Mitigation), and ESF #15 (External Affairs).

Department of State**.** DOS has secondary responsibility for ESF #1 (Transportation), ESF #5 (Emergency Management), ESF #8 (Public Health and Medical Services), ESF #9 (Urban Search and Rescue), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), ESF #12 (Energy), and ESF #15 (External Affairs).

Department of Transportation**.** DOT is the coordinator and primary agency for ESF #1 (Transportation). DOT has secondary responsibility for ESF #1 (Transportation), ESF #3 (Public Works and Engineering), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #7 (Resource Support), ESF #8 (Public Health and Medical Services), ESF #9 (Urban Search and Rescue), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), ESF #12 (Energy), ESF #14 (Long-Term Community Recovery and Mitigation), and ESF #15 (External Affairs).

Department of Treasury**.** TREAS shares a role as coordinator and primary agency for ESF # 14 (Long-Term Community Recovery and Mitigation). TREAS has secondary responsibility for ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), and ESF #15 (External Affairs).

Department of Veterans Affairs**.** VA has secondary responsibility for ESF #3 (Public Works and Engineering), ESF #6 (Mass Care, Housing and Human Services), ESF #7 (Resource Support), ESF #8 (Public Health and Medical Services), ESF #9 (Urban Search and Rescue), ESF #13 (Public Safety and Security), and ESF #15 (External Affairs).

Central Intelligence Agency**.** CIA is a member of the Interagency Incident Management Group but has no responsibilities for ESFs.

Environmental Protection Agency**.** EPA is the coordinator for ESF #10 (Oil and Hazardous Materials Response) and shares the role as primary agency. EPA has secondary responsibility for ESF #3 (Public Works and Engineering), ESF #4 (Firefighting), ESF #5 (Emergency Management), ESF #8 (Public Health and Medical Services), ESF #11 (Agriculture and Natural Resources), ESF #12 (Energy), ESF #13 (Public Safety and Security), ESF #14 (Long-Term Community Recovery and Mitigation), and ESF #15 (External Affairs).

Federal Communications Commission**.** FCC has secondary responsibility for ESF #2 (Communications), ESF #5 (Emergency Management), and ESF #15 (External Affairs).

General Services Administration**.** GSA is the coordinator and primary agency for ESF #7 (Resource Support). GSA has secondary responsibility for ESF #1 (Transportation), ESF #2 (Communications), ESF #3 (Public Works and Engineering), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #9 (Urban Search and Rescue), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), and ESF #15 (External Affairs).

National Aeronautics and Space Administration**.** NASA has secondary responsibility for ESF #5 (Emergency Management), ESF #7 (Resource Support), ESF #9 (Urban Search and Rescue), ESF #13 (Public Safety and Security), and ESF #15 (External Affairs).

Nuclear Regulatory Commission**.** NRC has secondary responsibility for ESF #5 (Emergency Management), ESF #7 (Resource Support), ESF #10 (Oil and Hazardous Materials Response), ESF #12 (Energy), ESF #13 (Public Safety and Security), and ESF #15 (External Affairs).

Office of Personnel Management**.** OPM has secondary responsibility for ESF #6 (Mass Care, Housing and Human Services), ESF #8 (Public Health and Medical Services), and ESF #15 (External Affairs).

Small Business Administration**.** SBA has secondary responsibility for ESF #1 (Transportation), ESF #2 (Communications), ESF #3 (Public Works and Engineering), ESF #4 (Firefighting), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #7 (Resource Support), ESF #8 (Public Health and Medical Services), ESF #9 (Urban Search and Rescue), ESF #10 (Oil and Hazardous Materials Response), ESF #11 (Agriculture and Natural Resources), ESF #12 (Energy), ESF #13 (Public Safety and Security), ESF #14 (Long-Term Community Recovery and Mitigation), and ESF #15 (External Affairs).

Social Security Administration**.** SSA has secondary responsibility for ESF #8 (Public Health and Medical Services), ESF #13 (Public Safety and Security), and ESF #15 (External Affairs).

Tennessee Valley Authority**.** TVA has secondary responsibility for ESF #3 (Public Works and Engineering), ESF #5 (Emergency Management), ESF #12 (Energy), ESF #14 (Long-Term Community Recovery and Mitigation), and ESF #15 (External Affairs).

US Agency for International Development**.** USAID has secondary responsibility for ESF #8 (Public Health and Medical Services), ESF #9 (Urban Search and Rescue), and ESF #15 (External Affairs).

US Postal Service**.** USPS has secondary responsibility for ESF #1 (Transportation), ESF #5 (Emergency Management), ESF #6 (Mass Care, Housing and Human Services), ESF #8 (Public Health and Medical Services), ESF #11 (Agriculture and Natural Resources), ESF #13 (Public Safety and Security), and ESF #15 (External Affairs).

White House Office of Science and Technology Policy**.** OSTP is a member of the Interagency Incident Management Group but has no responsibilities for ESFs.

American Red Cross. ARC has secondary responsibility for ESF #3 (Public Works and Engineering), ESF #5 (Emergency Management), ESF #8 (Public Health and Medical Services), ESF #11 (Agriculture and Natural Resources), ESF #14 (Long-Term Community Recovery and Mitigation), and ESF #15 (External Affairs).

CHAPTER OVERVIEW

3: Building and Effective Emergency Management Organization

This chapter describes the activities needed to build effective emergency management organizations, beginning with the fundamentals of running a local emergency management agency. The most important concept in this chapter is the development of a local emergency management committee (LEMC) that establishes horizontal linkages among a local jurisdiction's government agencies, NGOs, and private sector organizations relevant to emergency management. In addition, an LEMC can provide vertical linkages downward to households and businesses and upward to state and federal agencies.

3.1: Introduction

3.2: The Local Emergency Management Agency

3.3: Determinants of Emergency Management Effectiveness

3.4: LEMC Activities

3.5: Case Study: Emergency Management in Smith Hill

3.1: Introduction

To build an effective emergency management organization, it is necessary to understand the relationships among some of the stakeholders that are involved. As noted in Figure 2-1, local government has downward vertical linkages with households and businesses, upward vertical linkages with state and federal agencies, and horizontal linkages with social and economic influentials and hazards practitioners. However, it also is important to understand the horizontal and vertical linkages *within* local government. Specifically, local emergency management agencies (LEMAs) typically have horizontal linkages with personnel in police, fire, emergency medical services, public works, and emergency management/homeland security departments. At the municipal level, all of these departments report to (i.e., have a vertical linkage with) their jurisdiction's chief administrative officer (CAO), such as a mayor or city manager, who has direct supervisory authority over them. The CAO is responsible for ensuring these departments perform their assigned duties within the requirements of the law and accomplish these functions within the time and funds allocated to them. Accordingly, the CAO has the authority to hire, fire, allocate funds, and evaluate performance—a relationship represented in Figure 3-1 as a solid line. However, the CAO typically is not an expert in public safety, emergency medicine, or emergency management and, therefore, cannot provide these departments with guidance on how to perform their missions most effectively. Thus, city and county agencies frequently have vertical linkages with corresponding agencies at the state (and sometimes federal) level that provide technical, and sometimes financial, assistance. Because agencies at higher (state and federal) levels of government lack the legal authority to compel performance by the corresponding agencies at lower (county and city) levels, their relationship is sometimes represented as a "dotted line" relationship in organizational charts (see Figure 3-1). In turn, the agencies at the state level report to the governor in a line relationship just as the agencies at the local level report to their jurisdictions' CAOs.

The relationships among agencies at the county level are somewhat more complex for jurisdictions in which agency heads are directly elected by the voters rather than appointed by the local CAO. County sheriffs, in particular, can be quite protective of their autonomy, so they can be characterized as having just as much of a "dotted line" relationship with the Chair of the County Board of Supervisors as with the state police.

Although it is not shown in Figure 3-1, the hierarchical relationship between the local and state levels also extends to the federal level, with the corresponding agencies represented at each level. In addition, however, emergency management organizations have two other "dotted line" relationships that should be noted. First, local emergency managers often establish memoranda of agreement (MOA) with peer agencies in neighboring jurisdictions to provide personnel and material support during emergencies. Second, emergency management agencies have close relationships with Local Emergency Management Committees (LEMCs), which is a generic term for formalized disaster planning networks that are used to increase coordination among emergency-relevant agencies within a given community.

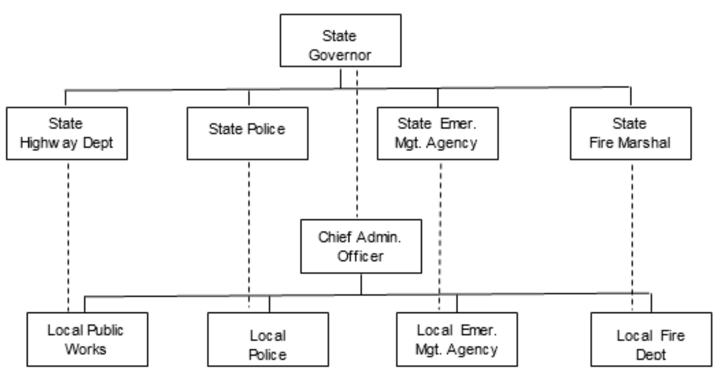


Figure 3.1.1: Relationships among local and state agencies

Some of these LEMCs are established by legal mandate, as is the case for those required by the Emergency Planning and Community Right to Know Act (also known as the Title III of the Superfund Amendments and Reauthorization Act of 1986—SARA Title III) to inform and prepare their communities for accidental releases of toxic chemicals. However, some emergency managers have established similar organizations without a specific legal mandate—calling them disaster preparedness committees, disaster planning committees, emergency management advisory committees, or some other similar name (Daines, 1991; Drabek, 1987, 1990). Some of these LEMCs have assumed responsibility for disaster recovery and hazard mitigation as well as preparedness and response, and some address all hazards to which their community is exposed, not just accidental releases of toxic chemicals. Although LEPCs established under SARA Title III are probably the most common of these emergency planning organizations and LEPCs have been the subject of more research than any other type of formalized planning network, the lessons learned from studies of LEPCs are likely to apply to all such organizations. Consequently, we will use the more generally applicable acronym LEMC throughout the remainder of this book.

3.2: The Local Emergency Management Agency

Similarly, the generic term we will use in this book to refer to the community agency that is responsible for emergency management is the Local Emergency Management Agency (LEMA). In practice, the LEMA might be known as the Office of Civil Defense, Emergency Management, Emergency Services, Homeland Security, some combination of these names, or yet some other name. Moreover, the LEMA might be a separate department, a section of another department, or an individual attached to the chief administrative officer's office. In many cities and counties, especially those with small populations or limited hazard vulnerability, the LEMA is staffed by a single individual, whose title, like the name of the LEMA, varies. Consequently, we will refer to this individual as the local emergency manager. In larger jurisdictions—especially those that are exposed to major hazards—the local emergency manager is likely to have multiperson staff. The emergency manager almost always reports directly to the jurisdiction's CAO during emergencies, but frequently reports to the head of a major agency such as police or fire during normal operations. Local emergency managers vary in their employment status—full-time paid, part-time paid, or volunteer—again depending upon jurisdiction size (and, thus, its financial resources) and hazard vulnerability. In the past, local emergency managers have varied significantly in their training and experience, which frequently is associated with their jurisdictions' resources and vulnerability; those jurisdictions that can afford to pay more tend to attract personnel with greater qualifications. Of course, this is not an invariant rule; there are many well-qualified and dedicated personnel in smaller jurisdictions.

The Job Description

A local emergency manager's first task should be to understand the duties of his or her own position as defined by a job description (Federal Emergency Management Agency, 1983). To whom does the incumbent (the person who serves as the local emergency manager) report, who reports to the incumbent, what is the specific function of the position, what duties for the position are specifically listed in the job description, and what are the specific qualifications (education, training, and experience) that are listed in the job description? If there currently is no job description or the one that exists is outdated, the emergency manager should draft a new job description and discuss it with her or his superior.

LEMA Staffing

Many LEMAs have administrative (clerk, secretary, or administrative assistant) or professional (emergency management analyst) staff that are paid part- or full-time. Such personnel need to have job descriptions specifying their titles, reporting lines, functions, duties, and qualifications. These personnel support the LEMA by receiving and tracking correspondence, drafting plans and procedures, maintaining databases, scheduling meetings, maintaining meeting minutes, and the like. In many cases, a LEMA's budget is too small to support enough paid staff to perform all of these activities. Consequently, volunteers are enlisted by contacting community service organizations, clubs, Boy and Girl Scout troops, and others. These volunteers can be a valuable source of assistance in achieving the LEMA's goals by performing tasks that are delegated by the local emergency manager. Indeed, some volunteers have valuable skills (e.g., computing, radio communications) the emergency manager lacks.

Each of the LEMA staff members should be given a clear description of his or her duties. In addition, most jurisdictions require paid staff to be provided with periodic (at least annual) performance appraisals. These appraisals allow employees to assess their performance over the previous year and to set training and performance objectives for the year to come. Although rarely mandatory, regularly scheduled performance reviews for volunteers are valuable in guiding their development and enhancing their performance effectiveness. A jurisdiction's human resources department can provide valuable guidance on its personnel policies.

LEMA Program Plan

Emergency managers need to develop program plans that systematically direct their efforts over the course of the year. FEMA (1983, 1993) has advised emergency managers to set annual goals in each of the major programmatic areas for which they are responsible—such as hazard and vulnerability analysis, hazard mitigation, emergency preparedness, recovery preparedness, and community hazard education. Once these goals have been set, the local emergency manager should assess the LEMA's ability to achieve these goals. This *capability assessment* is likely to identify satisfactory levels of capability in some areas but not in others. The emergency manager should document the *capability shortfall* and devise a *multiyear development plan* to reduce that shortfall. The limited funds available for emergency management make it a certainty that the shortfall cannot be eliminated within a single year, so this is the reason why a multiyear (typically five year) development plan is needed. Despite its long planning horizon, the multiyear development plan should identify specific annual milestones (measurable objective indicators) to determine if progress is being made at a satisfactory rate.

LEMA Budget Preparation

An organization's budget lists the categories of anticipated expenditures and the amount that has been allocated to each category. The budget usually covers the jurisdiction's *fiscal year*, which is a 12 month period that might or might not be the same as the *calendar year* (from January 1 to December 31). The budget is a financial plan that identifies the amount of money that has been allocated to each of its budget categories. Typical budget categories include routine continuing items such as staff salaries, office space, office equipment (e.g., copiers, computers, fax machines), telephone (local and long-distance), travel, and materials and supplies (e.g., paper, toner). The budget should anticipate the need to replace worn out or obsolete equipment or to purchase new equipment that will increase the LEMA's capabilities. The budget also should contain a *contingency fund* that addresses the costs of resources that will be expended in a foreseeable emergency.

The challenge for the emergency manager is to ensure the expenses do not exceed the budgeted amount. This is not difficult to do for the routine continuing items because, for example, staff salaries, office space, and local telephone service are fixed and materials and supplies are quite predictable from month to month. Repairs to office equipment can be unpredictable, but this can be managed by signing a service contract that establishes a fixed fee for routine preventive and corrective maintenance. Long-distance telephone and travel for training are somewhat less predictable but are discretionary, so these activities can be reduced if the expenses for other categories prove to be greater than expected.

The amount to set aside in the contingency fund for emergency response is more difficult to estimate because the scope of an emergency (or even whether one occurs) is unpredictable. Nonetheless, past agency records or discussions with emergency managers in neighboring jurisdictions can provide some insight into the appropriate amount to request. When preparing a budget, it is essential to justify each of the budget items. Once again, records of previous years' expenses are useful guides, but it is important to make adjustments for inflation (consult the jurisdiction's budget office for guidance on the amount they allow) as well as making adjustments for changes in the program plan. Has a new chemical facility been opened? Are there new subdivisions that have been built in flood prone areas? As new needs arise that cannot be addressed with the resources provided by previous budgets, the emergency manager needs to request funding increases that will meet the new program requirements. The nature of these needs is typically documented in a *budget narrative* that accompanies the budget request. The budget and the accompanying narrative are submitted in written form and, in many cases, are presented orally as well. In the latter case, the use of presentation graphics can be a valuable method of explaining how each of the budget items contributes to the achievement of the program plan.

Whatever the amounts turn out to be for the budget categories, it is essential that the emergency manager submit the new year's budget in the format that is being used by his or her jurisdiction. The local budget office will provide assistance in this area.

LEMA Funding Sources

The local emergency manager's most obvious source of funding is the head of the department in which the LEMA is administratively located or, if the LEMA is an independent agency, the jurisdiction's CAO. It is important to recognize that other funding sources can provide valuable supplements as well. The federal government has a range of programs that provide financial assistance to local government. For example, Emergency Management Performance Grants require LEMAs to submit a statement of work and budget that makes the local jurisdiction eligible for matching funds (i.e., a 50/50 cost sharing). This program is administered through each state's emergency management agency, which might impose its own requirements for funding. For example, Texas requires a LEMA to have an emergency management plan that meets a specified standard of quality and provides competitive awards based upon the quality of recent planning, training, and exercising activities. Continued financial support is contingent upon meeting performance and financial reporting requirements, as well as achieving the annual objectives specified in the initial proposal.

Another example is the Hazardous Materials Assistance Program, which provides technical and financial assistance through the states to support oil and hazardous materials emergency planning and exercising. Applications are required to list the program objective, describe the means by which the objective will be achieved (including a list of specific activities and their duration) and the expected achievements of the project. LEMAs submit applications through their state emergency management agencies for review by the corresponding FEMA regional offices.

There are also local sources that can be contacted for financial and in-kind assistance. Local industrial facilities such as nuclear power plants and chemical facilities might be contacted for financial contributions to defray the costs of emergency preparedness for their facilities. Truck and rail carriers might be contacted for training assistance. Commercial businesses such as large retail outlets might be able to provide in-kind contributions or make small financial contributions for community hazard awareness programs.

LEMA Budget Management

As the fiscal year progresses, expenses are automatically incurred for some items such as salaries, space, and local telephone use. Other expenses might require the emergency manager's authorization (and possibly countersignature by a higher authority). These include purchase orders for equipment and supplies or travel vouchers for attendance at training courses or professional conferences. These records are forwarded to the jurisdiction's accounting office where they are entered and charged against the appropriate accounts.

In many jurisdictions, local emergency managers receive monthly program accounting, which refers to the recording of actual expenses and a comparison of these expenses to the corresponding budget amounts. A budget statement lists budget categories in rows and indicates, in one column, how much money was allocated to each category and, in another column, how much money has been spent to date in that category. If the budget was based upon accurate projections, monthly variances (deviations of actual expenditures from anticipated expenditures) will be small. If the monthly variances are large, corrective action will need to be taken. Unforeseen expenditures attributable to a major emergency often are the basis for a supplemental request to the LEMA's parent department or directly to the CAO, but foreseeable items such as replacement of broken equipment are likely to receive an unfavorable review. Consequently, emergency managers must make mid-year adjustments in other categories. Unfortunately, training and travel are the categories that are commonly cut in such situations—which can produce a chronic training shortfall if budgeting problems are recurrent.

Senior elected and appointed officials typically require periodic (e.g., monthly or quarterly) reports of progress on the program plan and budget. As is the case with the presentation of each year's budget, presentation graphics can be a valuable method of explaining which milestones in the program plan have been achieved and how this compares to the level of progress expected to date. In addition, the emergency manager should explain what percentage of each budget line has been expended to date in comparison to the percentage of the year that has elapsed. For example, the emergency manager should find it easy to explain why 0% of the budget for computer replacement has been expended in the first three months (25%) of the year. However, it probably would be more difficult to say why 40% of the budget for salaries had been expended in that same period. In either case, the source of the variances and the anticipated method of adjustment must be explained.

3.3: Determinants of Emergency Management Effectiveness

There has been a significant amount of research conducted over the past 30 years that identifies many conditions influencing the effectiveness of LEMAs. This research will be described in greater detail in the following pages, but it can be summarized by the model depicted in Figure 3-2. This figure indicates that LEMA effectiveness—measured by such organizational outcomes as the quality, timeliness, and cost of hazard adjustments adopted and implemented by the community—is the most direct result of individual outcomes and the planning process. Outcomes for the individual members of the LEMA and LEMC include job satisfaction, organizational commitment, individual effort and attendance, and organizational citizenship behaviors. The planning process includes staffing/equipping, organizational structuring, team climate development, situational analysis, and strategic choice.

In turn, the planning process is determined by the level of community support from officials, news media, and the public. The planning process is also affected by hazard experience, as measured by direct experience with disasters and by vicarious experiences that reveal potential impact of future disasters. Hazard experience also appears to have an indirect effect on the planning process via its effects on community support. It is important to recognize that even though the model as depicted in Figure 3-2 is static—that is, the arrows begin on the left and end on the right hand side of the figure—the actual process is dynamic because success tends to be a self-amplifying process in which high levels of individual and organizational outcomes produce increased levels of *vicarious* experience with disaster demands (through emergency training, drills, and exercises), community support, better staffing and organization, and more emergency planning resources.

Hazard Exposure/Community Vulnerability

Many studies have found the level of community hazard adjustment is increased by experiencing disaster impact—especially catastrophic impacts. Frequent, recent, and severe impacts make the community's vulnerability to hazards easier to remember and more likely to stimulate action. In some cases, this leads to the development of a *disaster subculture* in which community residents adopt routinized patterns of disaster behavior (Wenger, 1978). When disasters are infrequent, long-removed in time, or have had minimally disruptive impacts, hazard vulnerability is likely to elicit little attention from households, organizations, or the community as a whole. However, the community's exposure to environmental hazards can be made salient by vicarious experience that is gained by reading or hearing about other communities' experiences with disasters. These can be gained through newspaper articles or television accounts or, most powerfully, through first-person accounts—especially if they come from peers (Lindell, 1994a). For example, a local fire chief is most likely to be influenced by other fire chiefs' accounts of their experiences, a city manager is most likely to be influenced by another city manager, and so on.

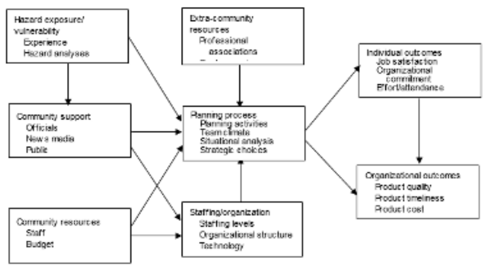


Figure 3.3.1: A model of local emergency management effectiveness

Hazard exposure can also be affected by salient cues such as the daily sight of the cooling towers of a nuclear power plant, the intricate maze of piping at a petrochemical plant, or the placards on railcars and trucks passing through town. Information from hazard and vulnerability analyses can also have an effect on the community, but this pallid statistical information is likely to have less of an effect than the vivid first-person accounts described above (Nisbett & Ross, 1980). As will be discussed in the next chapter, *Risk Perception and Communication*, the psychological impact of hazard/vulnerability analyses can be increased by linking data on hazard exposure to likely personal consequences.

The importance of hazard exposure and vulnerability for emergency management is well supported by research. For example, Caplow, Bahr, and Chadwick (1984) found emergency management network effectiveness to be greater in communities with recent disaster experience or, for those without recent experience, if there was consensus about the most salient hazard. Moreover, Adams, Burns, and Handwerk (1994) found that one-third of inactive LEMCs in a nationwide survey blamed lack of hazard vulnerability for their lack of progress. This accusation is likely to have some validity because Kartez and Lindell (1990) found that a greater degree of experience with disaster demands such as issuing evacuation orders, searching for mutual aid resources and responding to mass casualties is associated with organizational outcomes such as an increase in the number of good emergency preparedness practices (e.g., establishing citizen emergency information hotlines, establishing equipment rate and use agreements with contractors). Specifically, they found cities that were high in experience adopted 1.5 more preparedness practices than those that were low in experience. Similarly, Lindell and Meier (1994) and Lindell and Whitney (1995) found a previous history of evacuations was positively related to emergency planning effectiveness. Moreover, Lindell, et al. (1996) also found that a recent history of emergencies—as well as the number of hazardous facilities—both had modest but statistically significant positive correlations with LEMC effectiveness.

Community Support

Community support from senior elected and appointed officials, the news media, and the public is important because it affects the resources that are allocated to the LEMA and the LEMC. As noted earlier, many researchers have systematically documented what numerous emergency managers have personally experienced—emergency management is a low priority for the local elected and appointed officials who control budgets and staffing allocations (Labadie, 1984; Sutphen & Bott, 1990). As Kartez and Lindell (1990, p.13) quoted one police chief,

> *My number one priority is getting the uniforms out in response to calls. The public judges me on that performance, not whether I'm planning for an earthquake that may never happen. If left alone, disaster planning would get even less attention from my office. It requires that the executive clearly make this a priority.*

The importance of community support for emergency management is supported by research. Adams and his colleagues (1994) found that two-thirds of the inactive LEMCs blamed community indifference and more than one-third blamed lack of funding for their lack of achievement. Other studies found community support (official resolutions, media coverage, and community group actions) was positively related to emergency planning effectiveness (Lindell & Meier, 1994; Lindell & Whitney, 1995; Lindell, et al, 1996). For example, community information requests, media coverage, local support, and the backing of local officials all were strongly and significantly correlated with LEMC effectiveness.

Community Resources

Differences among jurisdictions in the effectiveness of their LEMAs and LEMCs can be attributed partially to variation in their communities' resources. Kartez (1992) found inconsistent evidence for effects of jurisdictional size, wealth, growth rate, employment, minority concentration, and industry concentration on compliance with SARA Title III mandates. However, Adams, et al. (1994) reported compliance was significantly correlated with jurisdiction size, median household income, and percent of urban population, The conflict between these two studies probably is attributable to the fact that Adams found the strongest effects in the smallest, poorest, and most rural jurisdictions, which were underrepresented in one of Kartez's (1992) samples, and altogether absent from his other sample. Nonetheless, the community support variables had stronger correlations with LEMC effectiveness than did any of the community resources variables. Lindell, et al. (1996) reported that jurisdictions' populations, budgets, police staffing, and fire staffing have statistically significant, but small, influences on LEMC effectiveness

Extra-community Resources

Lindell and Meier (1994) found that emergency planning resources obtained from outside the community (guidance manuals, training courses, and computer resources) were positively related to emergency planning effectiveness. Lindell and Whitney's (1995) study replicated many of these findings, but also found that emergency planning effectiveness was correlated most highly with membership in a statewide LEPC Association, and with state emergency planning resources. Later, Lindell, et al. (1996) reported access to such emergency planning materials as computer software, federal agency technical reports, state emergency planning agency technical support, and Chemical Manufacturers Association materials had a statistically significant and moderately large correlation with LEMC effectiveness. Also, frequency of external contact with federal regional offices, state agencies, and other LEMCs was strongly related to success. Technical materials provided through *vertical diffusion* by federal agencies (DOT, EPA, and FEMA) also have a positive impact on LEMC effectiveness, as does *horizontal diffusion* of emergency preparedness practices and resources obtained from private industry and neighboring jurisdictions. These resources can provide vicarious experience with disaster demands and demonstrate the effectiveness of specific innovations including plans, procedures and equipment (Kartez & Lindell, 1987).

Staffing and Organization

A number of studies have substantiated the impact of an LEMC's staffing and organization on its effectiveness. For example, the International City Management Association (1981) identified a number of characteristics of effective emergency management organizations. These included defined roles for elected officials, a clear internal hierarchy, good interpersonal relationships, commitment to planning as a continuing activity, member and citizen motivation for involvement, coordination among participating agencies, and public/private cooperation.

Caplow, et al. (1984) found emergency management network effectiveness was greater in communities with recent disaster experience or, for those without recent experience, if there was consensus about the most salient hazard. The more effective networks had members with more experience and a wider range of local contacts, had written plans and were familiar with them, had personal experience in managing routine natural hazards such as floods, and were more familiar with the policies and procedures of emergency-relevant state and federal agencies.

Similarly, Lindell and Meier (1994) found the number of members, number of hours worked by paid staff, number of agencies represented on the LEMC, and organization into subcommittees were all positively related to emergency planning effectiveness. Lindell and Whitney (1995) found LEMC staffing and structure lacked a significant correlation with LEMC effectiveness, but was correlated with organizational climate, which did have a very strong impact on LEMC effectiveness. Lindell, et al. (1996) also found the total number of members and—more importantly—the average number of members attending meetings were significant. There also was a significant correlation between effectiveness and the number of agencies and organizations represented on the LEMC. Representation by elected officials and by citizens' groups was the most important, whereas having representatives from the news media was least important for overall emergency planning effectiveness. Establishment of an organizational structure through subcommittees was significant, probably because this allows members to focus on specific tasks and thus avoid feeling overwhelmed by all the work that needs to be done.

Planning Process

The emergency planning process consists of five principal functions: planning activities, team climate development, situational analysis, resource acquisition, and strategic choice.

Planning activities.

Kartez and Lindell (1990) found superior planning practices involving key personnel from diverse departments in a participative and consensus-oriented process of horizontal integration—exemplified by such activities as interdepartmental task forces, interdepartmental training, and after-action critiques—had an even greater effect on the adoption of good emergency preparedness practices than did disaster experience. Specifically, cities that had a better planning process adopted 2.5 more preparedness practices than those that had a poorer planning process. Interestingly, as Table $ref2$ indicates, planning activities such as interdepartmental training, reviews with senior officials, and establishment of interdepartmental task forces had especially strong effects on the adoption of good emergency preparedness practices. By contrast, more routine activities such as procedure updates, plan updates, and reviews of mutual aid agreements had small effects.

Table $3.3.2$: Effects of Planning Activities on Good Emergency Preparedness Practices.

Largest difference	Smallest difference
Interdepartmental training Reviews with senior officials Interdepartmental task force Community disaster assistance council After action critiques Exercises Vulnerability analyses Meetings with TV/radio managers	Procedure updates Plan updates Review mutual aid agreements with neighboring cities

Source: Adapted from Kartez and Lindell (1990)

Characteristics of meetings are important influences on organizational effectiveness. These include meeting frequency, formalizing member orientation, formalizing meetings through regular scheduling, advance circulation of written agendas, keeping written minutes, and formalizing overall activities by setting and monitoring progress toward annual goals(Lindell & Meier, 1994; Lindell, et al., 1996). These results indicate the effectiveness of an LEMC and its subcommittees can be increased if they conduct frequent meetings that help them to maintain steady progress and this will work if these meetings are regularly scheduled far enough in advance for members to avoid conflicts with their own calendars. If possible, LEMC meetings should be scheduled monthly on the same day of the week and time of day. The agenda for each meeting should be distributed in advance and written minutes should be kept of each meeting.

These findings are consistent with more recent research, which shows effectiveness in disaster response is significantly determined by agencies breadth of prior coordination and the depth (both frequency and intensity) of prior contact (Drabek, 2003). In addition, these findings are consistent with research conducted by Gillespie and his colleagues (Gillespie & Colignon, 1993; Gillespie, Colignon, Banerjee, Murty, & Rogge, 1993; Gillespie & Streeter, 1987). Specifically, these researchers documented a need to facilitate effective relations between organizations with full-time staff members and organizations with part-time staff and volunteers by scheduling meetings at times convenient for all staff (full-time, part-time, and voluntary). Such meetings should concentrate on common interests and be guided by agendas. Failure to meet these suggestions usually results in termination by neglect, not by direct confrontation over disparate values.

Organizational climate development.

Lindell and Whitney (1995) found emergency planning effectiveness was greatest in LEMCs that had positive *organizational climates*, which can be defined as "distinctive patterns of collective beliefs that are communicated to new group members through the socialization process and are further developed through members' interaction with their physical and social environments" (Lindell & Brandt, 2000, p. 331). Organizational climate presumably affects LEMC effectiveness because it influences the degree to which members' motivation is aroused, maintained, and directed toward group goals (Lindell & Whitney, 1995).

Lindell and Brandt (2000) found that three dimensions of leadership climate (leader initiating structure, leader consideration, and leader communication), four dimensions of team climate (team coordination, team cohesion, team task orientation, and team pride), and one dimension of role climate (role clarity, but not role conflict or role overload) were strongly related to each other and can be defined as *climate quality*. Organizational climate is important because it is positively related to important individual outcomes such as job satisfaction, organizational commitment, attendance, effort, turnover intentions, and organizational citizenship behaviors (performance beyond minimal requirements), as well as organizational outcomes such as product quality, timeliness, and cost. These latter variables were measured in the research studies by LEMC chair ratings and State Emergency Response Commission staff ratings of the organization's performance.

Climate quality is consistently related to support from elected officials—especially external guidance and recognition. Climate quality is also positively related to the organization of LEMCs into subcommittees, meeting formalization, and meeting frequency. However, climate quality is unrelated to LEMC size, which suggests that increasing the number of members can increase the range of knowledge and skills on the LEMC without impairing group performance.

The research findings indicate that LEMC leaders can establish a positive *leadership climate* within the organization by being clear about what tasks are to be performed, as well as recognizing individual members' strengths and weaknesses and being supportive of their needs. These two aspects of leader behavior, which are known as leader initiating structure and leader consideration, respectively, have long been recognized by organizational researchers (Stogdill, 1963). The importance of these dimensions in facilitating organizational effectiveness has been recently confirmed in LEMCs (Lindell & Brandt, 2000; Lindell & Whitney, 1995; Whitney & Lindell, 2000).

In addition to a positive leadership climate, it also is important to foster a positive *team climate*. Specifically, team members must focus on the tasks to be performed rather than spending all of their time socializing (team task orientation). In addition, they must share information and coordinate individual efforts (team coordination). When these occur, members tend to trust each other and feel that they are included in all activities (cohesion), as well as believe their LEMC is one of the best (team pride).

Moreover, LEMC leaders need to promote a positive *role climate* within the organization. Team members must understand what tasks are to be performed and how to perform them, which avoids the stress caused by role ambiguity. Leaders and members must agree on what tasks are to be performed, which avoids the stress caused by role conflict. Finally, members must have enough time to perform the tasks for which they are responsible, which avoids the stress caused by role overload (James & Sells, 1981; Jones & James, 1979).

LEMC effectiveness is also enhanced when there is a positive *job climate*, which arises when members have enough independence to do their work however they choose as long as they deliver a quality product on time and within the resources available (personal autonomy). They also should be allowed to perform a "whole" piece of work that provides a meaningful contribution to the group product (task identity). Finally, members should be allowed to perform tasks that exercise a variety of significant skills (skill variety).

The LEMC will function more effectively when it has a positive *reward climate*, which is characterized by members having opportunities to perform new and challenging tasks (member challenge), opportunities to work with other people (social contacts), and are told that other people appreciate their work (social recognition). When the leadership, team, role, job, and reward components of organizational climate are positive, there are positive outcomes at the individual and organizational levels. Specifically, there is higher member job satisfaction, attendance, effort, and citizenship behavior (working beyond minimum standards) and lower turnover intentions and actual turnover. These positive outcomes at the individual level also produce positive consequences at the organizational level in terms of greater organizational stability (due to decreased turnover) and greater productivity (due to greater effort).

Situational analysis.

Although this is recognized as an important issue in the strategic management of organizations (Thompson & Strickland, 1996), there appears to have been little or no research on the degree to which situational analysis contributes to the effectiveness of LEMAs and LEMCs. Important components of situational analysis include hazard exposure analysis, physical vulnerability analysis, social vulnerability analysis, evaluation of hazard adjustments, and capability analysis. As Chapter 5 will describe more fully, *hazard exposure analysis* identifies the natural and technological hazards to which the community is exposed and assesses the specific locations that would be affected by different intensities of impact (e.g., 50- and 100-year flood plains, areas prone to liquefaction from earthquakes); such analyses are frequently documented by maps of geographical risk areas. *Physical vulnerability analysis* assesses the community's structures (residential, commercial, and industrial buildings) and infrastructure (fuel, electric power, water, sewer, telecommunications, and transportation) in terms of their ability to withstand the environmental forces predicted by the hazard exposure analyses. By contrast, *social vulnerability analysis* assesses the community's demographic segments and economic sectors to identify differences in hazard exposure, occupancy of physically vulnerable structures, utilization of physically vulnerable infrastructure, and limited resources (psychological, social, economic, and political) for recovering from disaster impact.

The systematic evaluation of hazard adjustments examines alternative hazard adjustments (hazard mitigation, disaster preparedness, emergency response, and disaster recovery) to assess their ability to avoid hazard impacts such as casualties and damage, to limit these impacts when disaster strikes, and to recovery rapidly after disaster. The evaluation of hazard adjustments also examines their resource requirements in terms of the time, effort, money, and organizational cooperation needed to adopt and implement them. The final component of situational analysis, capability assessment, determines whether households, businesses, government agencies, and non-governmental organizations (NGOs) have the capacity (i.e., resources) and commitment (i.e., motivation) needed to adopt the available hazard adjustments.

Resource acquisition.

Resource acquisition refers to obtaining emergency planning staff, equipment, and information of many different types from a variety of sources. The principal source of emergency planning staff is the LEMA but, as will be discussed below, there are other local government agencies, private sector organizations, and NGOs that can be drawn upon to staff the LEMC. Similarly, the major type of emergency planning equipment—the microcomputer—is usually available at the LEMA but the types of high speed/high storage capacity computers needed for conducting hazard and vulnerability analyses are more frequently located and used in the Land Use Planning Department where Geographical Information Systems (GISs) are routinely used (Lindell, Sanderson & Hwang, 2002). The types of information include data about hazards and population segments at risk, as well as procedures for hazard/vulnerability analysis. Communities can obtain hazard data by accessing Web sites maintained by federal agencies such as the FEMA, USGS, and National Weather Service, as well as state hazard analysis web sites (Hwang, Sanderson & Lindell, 2002) or, for technological hazards, local industry (for fixed-site hazards) and rail or truck carriers (for transportation hazards). In addition, these organizations provide computer software, planning guidance manuals, and training courses that explain how to assess community vulnerability (e.g., FEMA's HAZUS).

Strategic choice.

Organizational scientists generally agree there is no single best way to organize and this proposition has been supported by Drabek's (1987, 1990) findings of significant variation in the strategies and structures utilized by individual emergency managers. Some successful emergency managers enthusiastically endorse strategies that are explicitly rejected by other equally successful managers. Further support for the contingency principle of organization is provided by Mulford, Klonglan, and Kopachevsky's (1973) finding that strategy adoption was dependent upon contextual conditions in the community. Nonetheless, the available research indicates there are some structures and strategies that are likely to significantly improve the success of all LEMCs regardless of context—and especially without significant expense. Although this might seem surprising, it is consistent with previous studies showing that external constraints can be circumvented to some extent by a superior planning process that enhances horizontal linkages among agencies within a jurisdiction and with adjacent jurisdictions, downward vertical linkages to households and businesses, and upward vertical linkages to state and federal agencies (Kartez & Lindell, 1987, 1990). Indeed, it is precisely the purpose of an LEMC to establish this planning process.

As Drabek (1987, 1990, 2003) has observed, disaster researchers have long been interested in the intergovernmental structures and interpersonal strategies adopted by emergency managers. For example, a multiyear research project conducted at Iowa State University found that communities in which local Civil Defense Directors had developed systemic linkages among local groups tended to be the most effective in achieving community preparedness (Klonglan, Beal, Bohlen, & Schafer, 1967). These findings were elaborated by Mulford, Klonglan, and Tweed (1973), who noted the importance of local emergency managers' horizontal linkages with their colleagues in similar organizations throughout their states, and also their vertical linkages with local elected officials.

Mulford, et al. (1973) identified six strategies used by effective emergency managers. These include a *resource building strategy*, which emphasizes the acquisition of human, technical, and capital resources needed for effective agency performance, and an *emergency resource strategy*, defined by securing the participation of emergency-relevant organizations in emergency planning and response. The *elite representation strategy* involves the placement of members of the focal organization (in this case, the LEMA) in positions or situations where it is possible to interact with influential members of other emergency-relevant organizations, and the *constituency strategy* consists of the establishment of a symbiotic relationship between two organizations whereby both benefit from cooperation. The *cooptation strategy* consists of absorbing key personnel, especially those from other organizations, into the focal organization's formal structure as directors or advisors, while the *audience strategy* focuses upon educating community organizations and the public at large about the importance of community emergency preparedness. Mulford, Klonglan, and Kopachevsky (1973) noted strategy adoption was contingent upon environmental (jurisdictional size), organizational (funding level) and personal (Civil Defense Director training) characteristics. Some particularly important areas on which interorganizational coordination has focused include increased involvement of private organizations, local public services, elected officials and community leaders, and greater efforts to acquire external funding. (Klonglan, Mulford & Hay, 1973).

Research conducted at the Disaster Research Center during the same time period found disaster planning requires emergency response organizations to recognize the ways in which community-wide disasters differ from routine emergencies that can be handled by a single agency (Dynes, Quarantelli, & Kreps, 1972). In addition, they encouraged local disaster planners to foster significant predisaster relationships among organizations that must respond to a disaster (Anderson, 1969b). Dynes and Quarantelli (1975) described differences in interorganizational orientation in terms of nine models including the *maintenance* (acquiring and maintaining human, material, and financial resources), *disaster expert* (developing knowledge and skill about hazard agents such as hurricanes and hazardous materials), and *abstract planner* (construction of contingency plans derived from generic planning principles) models. Other models include the *military* (developing a well-defined hierarchical organization), *administrative staff* (developing managerial knowledge and skill), and *disaster simulation* (focusing on the rehearsal of disaster plans through drills and exercises) models. Finally, there are the *derived political power* (acting as the representative of the jurisdiction's CAO), *interpersonal broker* (establishing contacts among emergency-relevant organizations), and *community educator* (overcoming community indifference through hazard awareness programs) models.

Table summarizes the research on emergency managers' strategies in the following way. The first category of strategies is defined by LEMA organizational development, which involves the military and administrative staff models to address the development of clear roles and lines of authority, while the abstract planner model emphasizes the development of coordinated emergency response plans, and the disaster simulation model supports the importance of emergency exercises to test the organizational forms that have been developed. Another strategy involves the resource building strategy and the maintenance model to ensure the acquisition of resources—such as personnel, facilities (e.g., normal office space and emergency response facilities such as EOCs), equipment, materials and supplies, and especially money from local government funding— that will positively affect LEMA effectiveness. Moreover, analysis of the physical environment encompasses the disaster expert model, according to which success will be influenced by interagency coordination in the assessment hazard vulnerability and community resources. Finally, Table 3-2 makes it clear that most of the strategies emphasize management of the social environment. According to the researchers at Iowa State University and the Disaster Research Center, development of an LEMC is facilitated by securing the legitimacy from the CAO (derived political power model), establishing the collaboration among emergency-relevant organizations (emergency resource strategy and interpersonal broker model), and placing LEMA staff in positions to influence important others (the constituency, elite representation, and cooptation strategies). Finally, influence is magnified by engaging in outreach to community groups and news media (the audience strategy and community educator model).

Table Emergency Management Development Strategies.

Strategy Type	Iowa State University	Disaster Research Center

Organizational development		Administrative staff Military Abstract planner Disaster simulation
Resource acquisition	Resource building	Maintenance
Physical environment analysis and management		Disaster expert
Social environment analysis and management	Emergency resource Elite representation Constituency Cooptation Audience	Derived political power Interpersonal broker Community educator

More recent studies have examined these ideas in further detail by studying the ways in which local emergency managers implement these strategies. Drabek (1987, 1990) integrated the findings of previous disaster researchers with theoretical principles derived from the broader organizational literature (e.g., Pennings, 1981; Osborne & Plastrik, 1998) to identify strategies and structures used by successful managers. Similarly, Gillespie and his colleagues (Gillespie & Colignon, 1993; Gillespie, et al., 1993; Gillespie & Streeter, 1987) conducted an intensive study of a single disaster preparedness network that had not coalesced into a formally designated LEMC. In addition, Lindell and his colleagues (Lindell, 1994b; Lindell & Brandt, 2000; Lindell & Meier, 1994; Lindell & Whitney, 1995; Lindell, et al., 1996a, 1996b; Whitney & Lindell, 2000) reported a series of studies conducted on nearly 300 LEMCs in three Midwestern states.

Drabek (1987, 1990) found the most effective of the local emergency managers he interviewed emphasized the development of constituency support by actively trying to increase the resource base of all local agencies—not just their own. To do this, they relied on committees and joint ventures to involve other community organizations. Consistent with the organizational development strategy, some of them attempted to manage conflict over controversial issues before they got out of control. In particular, they achieved more consensus with other community agencies on the mission of the LEMA. In a variation on the disaster expert strategy, some of them brought in outside experts.

Drabek found that local emergency managers' reliance on these strategies varied with community size. Successful directors in small communities used them less frequently than successful directors in large communities but more frequently than unsuccessful directors in either small or large communities. Successful directors had more frequent contacts and more formalized interagency agreements such as MOAs. Although all successful emergency managers gave considerable emphasis to coordination with other emergency-relevant agencies, they tended to give less emphasis to local businesses and (except in the smallest communities) to elected officials.

In the studies conducted by Gillespie and his colleagues (Gillespie & Colignon, 1993; Gillespie, et al., 1993; Gillespie & Streeter, 1987), the researchers found a large proportion of the organizations relevant to disaster response were not linked to the preparedness network—which indicates some deficiencies in the local emergency managers' strategies for social environment analysis and management. Gillespie and his colleagues expanded the utility of the research on social management strategies by noting interorganizational linkages consist of informal contacts, verbal agreements, and written agreements. In addition, they emphasized that the existence (or even the frequency) of interorganizational contacts does not measure the importance of the relationship (i.e., that needed information, services, or resources have been established or transferred). This argument points to a logical connection between social environment analysis/management and resource acquisition. That is, the low priority given to local emergency management often makes it impossible for LEMAs to purchase needed resources outright. Consequently, local emergency managers must build capacity by collaborating with other organizations that do have those resources or that have the influence to obtain the funding that will allow them to make those purchases.

Of course, organizations are more likely to collaborate with the LEMA if there are compelling reasons for them to do so. Consistent with this notion, Gillespie and his colleagues found interorganizational linkages were initiated by awareness of potential disaster demands and by recognized needs for avoiding gaps in services or duplication of effort. Other reasons for collaboration included ensuring timely access to information, services, or resources; development of internal organizational response capability; and development of political influence to enhance organizational autonomy, security, and prestige.

Gillespie and his colleagues also found interorganizational linkages are developed through active and personable individuals, but pre-existing personal and professional contacts are important, as well as routine interagency and interjurisdictional meetings, drills, and exercises. However, these linkages are impeded by geographical distance, lack of funds, lack of staff, incompatible professional perspectives and terminology, lack of trust in an organization or its representative, overconfidence in one's own capability, and unequal rewards and costs of participation for those in different organizations.

Individual Outcomes

As noted earlier, individual outcomes include job satisfaction, organizational commitment, attachment behaviors (effort, attendance, and continued membership), and organizational citizenship behaviors. Some of these variables were studied by Whitney and Lindell (2000), who noted that research on motivational factors involved in staffing voluntary community organizations suggests people participate in these organizations when they perceive social and environmental problems within a community to which they are attached and find organizations they expect to be successful in mitigating these problems (Chavis & Wandersman, 1990; Florin & Wandersman, 1984). Such studies have found that participation in community groups is significantly related to three types of benefits (personal, social, and purposive) and their corresponding costs (Prestby, et al., 1990). Moreover, members' sense of individual and collective self-efficacy, and thus their motivation to participate, is enhanced when these organizations are empowered by successfully influencing actions taken by the community.

Other research has found that people often join and remain in a voluntary organization because they are attracted to its activities, and that volunteers are more likely than paid workers to have high intrinsic satisfaction (Pearce, 1983). These findings indicate volunteers' experiences may differ from those of their compensated counterparts and suggests it is important to examine members' *organizational commitment*. Porter, Steers, Mowday, and Boulian defined this construct as "the strength of an individual's identification with and involvement in a particular organization" (1974, p. 604) and characterized it as including: a) strong belief in, and acceptance of, the organization's goals and values, b) willingness to exert considerable effort on behalf of the organization, and c) strong desire to maintain organizational membership. Meyer and Allen (1984) noted research on organizational commitment has examined two different types of commitment: affective and continuance. Affective commitment, which is seen in terms of an emotional orientation to the organization, is likely to be expressed in high levels of employee performance (Meyer, et al., 1989). By contrast, continuance commitment is conceptualized as an accumulation of "side bets", which are anything of value individuals have invested in an organization that would be lost if they were to leave. Continuance commitment motivates employees to remain in the job but fails to elicit performance beyond minimum requirements. Organizational commitment is important in understanding LEMC effectiveness because it has been found to predict a variety of participation behaviors. In an analysis of over 200 articles pertaining to organizational commitment, Mathieu and Zajac (1990) concluded that organizational commitment has a weak but positive correlation with attendance, but it has very strong negative correlations with two turnover-related intentions: to search for job alternatives and to leave one's job.

Whitney and Lindell (2000) discovered LEMC members' attachment behaviors (attendance, effort, and continued membership in the organization) were positively related to their affective commitment but not their continuance commitment. In turn, affective commitment was significantly influenced by effective LEMC leadership (the ability to structure team tasks, communicate clearly, and show consideration for team members) and the LEMC members' job related self-efficacy (perceptions of their own competence) and role clarity (clear sense of direction in which to allocate one's efforts). Other factors affecting commitment included members' identification with an LEMC's goals (perceived hazard vulnerability and perceived effectiveness of emergency planning) and perceived opportunity for reward (public recognition and personal skill development). The negative findings regarding continuance commitment do not mean that this variable is altogether irrelevant because the study assessed members' commitment to the LEMC (which lacks the tangible rewards used to secure compliance commitment), not to their normal jobs (which can provide such rewards). Based on the research reviewed by Mathieu and Zajac (1990), one should expect compliance commitment to significantly predict performance on these other jobs.

Organizational Outcomes

Organizational outcomes such as the quality, timeliness, and cost of plans and procedures are the most direct results of individual outcomes and the planning process but there also are intermediate results that are indicative of organizational effectiveness. These include the production of hazard and vulnerability analyses, public information briefings, brochures, and Web sites.

Lindell and Whitney (1995) and Lindell and Meier (1994) examined different indexes of LEMC effectiveness—chair judgments of effectiveness on six planning activities and submission of completed plans to the State Emergency Response Commission—and found these were significantly correlated, but nonetheless distinct. Later, Lindell, et al. (1996) examined LEMC effectiveness in terms of four criteria: chairs' judgments of their LEMC's quality of performance on 13 emergency planning activities, the percentage of vulnerable zones computed, the number of talks given by the LEMC to community groups, and whether the LEMC had conducted an emergency exercise. This study also found the level of LEMC performance varied significantly from one activity to another.

Specifically, LEMCs were generally effective in collecting and filing hazard data, inventorying local emergency response resources, acquiring emergency communications equipment, and developing training for local emergency responders. By contrast, LEMCs were relatively ineffective in developing protective action guides, analyzing air infiltration rates for local structures, analyzing evacuation times for vulnerable areas, and promoting community toxic chemical hazard awareness.

There are significant correlations between organizational and individual outcomes (Lindell & Brandt, 2000). This suggests increasing members' job satisfaction, effort, attendance, and citizenship behaviors and reducing their turnover intentions will improve the organization's performance. In addition, organizational outcomes had significant correlations with external contextual variables (such as community resources, emergency experience, and elected official support) and internal structural variables (such as LEMC size, subcommittee structure, meeting formalization, meeting frequency, role formalization, and computer technology). Finally, the organizational outcomes had significant correlations with organizational climate variables (such as leader, team, role, job, and reward characteristics). All of these correlations identify ways in which emergency managers can work with LEMC members to improve organizational performance. In particular, emergency managers' knowledge of these relationships can serve as a basis for expert power in persuading other LEMC members to change the conditions within the organization.

3.4: LEMC Activities

The previous section has described the factors that influence emergency planning effectiveness and later chapters will provide recommendations for the *content* of Emergency Operations Plans, Recovery Operations Plans, and Hazard Mitigation Plans as described by sources such as the Federal Emergency Management Agency (1996b), Foster (1980), Daines (1991), Lindell and Perry (1992), and Schwab, et al. (1998). However, there is an important intermediate step that needs to be addressed—the *process* of plan development as it has been recommended by Daines (1991), Federal Emergency Management Agency (1996b), and Schwab, et al. (1998).

The development of an emergency plan is a multistage process that encompasses nine steps. First, the local emergency manager establishes a preliminary planning schedule. Second, the CAO publishes a planning directive. Third, the local emergency manager facilitates the organization of the LEMC. Fourth, the local emergency manager works with LEMC members to assess disaster demands and capabilities. This leads to a designation of the organizations responsible for each component of the Emergency Operations Plan, Recovery Operations Plan, and Hazard Mitigation Plan and finalization of the schedule for plan completion. Fifth, LEMC members write the components of these plans. Sixth, LEMC members evaluate and revise the draft plans. Seventh, the local emergency manager distributes the draft plans to collaborating organizations and other jurisdictions for community review. Last, after the collaborating organizations and other jurisdictions have commented on the draft plans, the LEMC revises them and publishes them in final form. Each of these steps is addressed in more detail below.

Establish a Preliminary Planning Schedule

Table 3-3 shows an example of how the emergency manager should identify the principal tasks to be performed and the expected amount of time required to perform them. An experienced emergency manager will be able to generate accurate time estimates, but the LEMC members will need to review and approve them at a later date to confirm that the deadline for publication of the final plans is feasible.

Table 3-3. Sample Preliminary Planning Schedule

Time (months) 0 2 4 6 8 10 12

Organize the LEMC [--]
Assign responsibility for plan components [-----]
Assess response requirements and capabilities [-----]
Finalize planning schedule [--]
Write plan components [-----------------------]
Evaluate/revise the draft plan [---------]
Obtain community review [--------]
Revise/publish the final plan [----------]

Disseminate a Planning Directive

Local emergency managers coordinate rather than direct the efforts of other agencies, so they need some power base other than rewards and punishments to elicit cooperation. As noted in Chapter 2, French and Raven (1958; Raven, 1965) contend there are four bases of power in addition to reward and coercive power that can be used in organizations. These other bases of power are information, expert, referent, and legitimate power. Quite obviously, reward and coercive power refer to the ability to provide incentives for compliance and punishments for lack of compliance. Information power refers to specialized knowledge of the state of the social or physical environment, whereas expert power refers to specialized knowledge about the dynamics of the social or physical environment (and, thus an ability to predict—and perhaps control—elements of those environments). Referent power refers to influence that is determined by another's liking or admiration for an individual and legitimate power is conferred when people believe that an individual has the right to expect compliance with his or her requests.

Publication of a planning directive signed by the CAO confers legitimate power upon a local emergency manager by indicating that specific areas of authority have been delegated. This planning directive should be a written document that formalizes the CAO's specific expectations about the emergency planning process. Thus, the planning directive should contain three sections, the first of which should state the purpose of the planning process, the legal authority under which it is being conducted, and the specific objectives that the planning process is expected to achieve. Second, the planning directive should describe the concept of the planning process, including a general description of the LEMC organization, the organizations that are expected to participate in plan development, and the local emergency manager's authority as the CAO's representative in this area. Last, the planning directive should address the procedure for plan approval and the anticipated deadline for publication of the final plan. Even though the planning directive is signed by the CAO, it is often drafted by the emergency manager.

Organize the LEMC

The emergency manager should request a representative from each of the governmental agencies, NGOs, and private sector organizations that have been designated in the planning directive as having significant emergency response capabilities or hazard vulnerabilities. The enumeration of all relevant organizations in the planning directive is especially important because public safety agencies such as police and fire are likely to participate in any event, but other local organizations are likely to participate only if directed by the CAO (Kartez & Lindell, 1990). A typical list of such organizations can be found in Table 3-4.

Table 3-4. Organizations Typically Participating in LEMCs.

Fire Local utilities (gas, electric power, telephone)
Police Red Cross
Emergency medical services Hospitals
Public works Nursing homes
Land use planning Schools
Building construction News media
Chief Administrative Officer's office Environmental groups
Public health Local industry
Local elected officials Labor unions

Members of these organizations should work part-time (a few hours a month) for the LEMC while continuing their jobs in their normal organizations. Once the LEMC has been established, the emergency manager should work with the members to select officers such as a Chair, Vice-Chair, Information Coordinator, and subcommittee chairs. As with other organizations, the Chair presides over meetings and represents the organization to senior elected and appointed government officials, the heads of private sector organizations within the jurisdiction, the news media, and the public. In addition, the LEMC Chair represents the LEMC to other jurisdictions and to state and federal agencies. The Vice-Chair performs these duties when the Chair is absent, but the Vice-Chair's primary role is to take a more active role in the management of the internal affairs of the LEMC. The Secretary serves in a role that is not a clerical position but is instead responsible for ensuring meetings are scheduled and written minutes of the meeting are recorded. In addition, the Secretary is the principal point of contact for information about hazards and vulnerability, the planning process, and planning products. The Information Coordinator might even be the person who is responsible for monitoring the LEMC's budget.

LEMCs tend to be more effective when members are assigned to specific activities rather than having everyone contribute to all tasks. Thus all LEMCs should have subcommittees, but each one should determine for itself what is the most appropriate division of labor for its own situation. Most communities are likely to find it useful to have a Hazard/Vulnerability Analysis committee; a Planning, Training, and Exercising committee; a Recovery and Mitigation committee; a Public Education and Outreach committee; and an Executive committee.

The Hazard/Vulnerability Analysis committee is responsible for identifying the hazards to which the community is exposed and the vulnerability of residential, commercial, and industrial structures and infrastructure (fuel, electric power, water, sewer, telecommunications, and transportation) to these hazards. In addition, the Hazard/Vulnerability Analysis committee should also identify any secondary hazards that could be caused by a primary disaster impact. These secondary hazards would include, for example, earthquake-initiated hazardous materials releases from chemical facilities and earthquake-initiated dam failures that cause flooding in low-lying areas. The Hazard/Vulnerability Analysis committee also should identify the locations of facilities such as schools, hospitals, nursing homes, and jails whose populations are vulnerable because of the limited mobility of their resident populations, as well as the locations of other facilities with vulnerable non-resident populations. A sample of such facilities is listed in Table 6-1.

The initial task of the Planning, Training, and Exercising committee is to write the Emergency Operations Plan (EOP). This committee should also coordinate the identification of facilities and equipment that are needed for disaster response. A major focus here will be on a jurisdictional emergency operations center (EOC). In addition, the Planning, Training, and Exercising committee should develop a training program to enhance emergency responders' capabilities. The Planning, Training, and Exercising committee only needs to develop training materials for disaster-related tasks that are not performed during normal operations or routine emergencies (both of which are addressed in departmental training). That is, they must develop training that provides an overview of disaster response and also enhances skills required for tasks that are infrequently performed, difficult, and critical to the success of the emergency response organization. They can either develop the necessary training materials for themselves or obtain them from other sources. Finally, the Planning, Training, and Exercising committee must test the implementability of the plan through drills and exercises. To accomplish these tasks, the Planning, Training, and Exercising committee should recruit representatives from the primary emergency response and public health agencies.

The Recovery and Mitigation committee has the responsibility for developing a preimpact recovery plan that will facilitate a rapid restoration of the community to normal functioning after disaster. Recovery planning is often erroneously thought of as an activity that can be postponed until after a disaster strikes, but practitioners have argued that there are many recovery tasks that can (and *should*) be addressed during preimpact planning (Schwab, et al., 1998) and this contention has been supported by recent research (Wu & Lindell, 2004). In addition, the Recovery and Mitigation committee is responsible for identifying mitigation projects that will reduce the community's vulnerability to environmental hazards. Some mitigation projects can probably be implemented before a disaster occurs, but others will need to be planned for implementation in conjunction with disaster recovery. To accomplish these functions, the Recovery and Mitigation committee should have representatives from public works, community development, land use planning, and building construction agencies.

The Public Education and Outreach committee is responsible for risk communication with the news media and the public. Thus, its members should summarize the findings of the Hazard/Vulnerability Analysis committee that identify the community's principal hazards and its most vulnerable locations and demographic groups. The Public Education and Outreach committee should also develop a description of the activities of the Planning, Training and Exercising committee and an explanation of how these will provide a capability for prompt and effective emergency response to the community's hazards. Finally, the Public Education and Outreach committee should describe the activities of the Recovery and Mitigation Committee and an explanation of how these will provide a capability for prompt and effective emergency recovery from a disaster. Public Education and Outreach committee members should use this information about the community's hazards and the hazard adjustments (preparedness, response, recovery, and mitigation) that will protect the community to construct nontechnical summaries that can be understood by households and businesses throughout the community. The Public Education and Outreach committee should develop slides or other graphic presentations to support talks to community groups, as well as brochures to be distributed to households and businesses.

The Executive committee is responsible for ensuring the LEMC sets specific, achievable objectives each year and accomplishes those objectives through an efficient expenditure of resources. Accordingly, the Executive committee will consist of the LEMC's principal officers—Chair, Vice-Chair, Secretary, and subcommittee chairs. In addition to planning, organizing, directing, and monitoring the internal activities of the LEMC, the Executive committee needs to obtain the resources—especially the funds—to support the LEMC's activities. Although most of the work of the LEMC is performed by personnel who are already being paid through their primary work organizations, there often are additional expenses for acquiring computer hardware and software, training materials, and travel for outside training. In addition, there are likely to be expenses for producing and printing public education brochures and other such materials. Sometimes government agencies or private organizations participating in the LEMC are willing to pay for some of these expenses from their budgets, but many times other sources of revenue such as filing fees from hazardous materials facilities are needed.

A critical step in the process of organizing the LEMC is to conduct a planning orientation so the members of the LEMC will develop a common understanding of the process. In preparation for the planning orientation, local emergency managers should anticipate two very important obstacles to emergency planning (Daines, 1991). First, they should recognize that planning agencies lack emergency response experience. Second, they should be aware that emergency response agencies often lack disaster planning experience because they tend to rely on standard operating procedures and improvisation for minor emergencies. In addition, few—if any—LEMC members are likely to be aware of the planning resources available from state and federal agencies, as well as from other sources. Thus, the local emergency manager should introduce LEMC members to the basic tenets of the state's Emergency Operations Plan, Disaster Recovery Plan, and Hazard Mitigation Plan, as well as provide copies of the state's planning guidance in each of these areas. Similarly, the emergency manager should introduce LEMC members to the basic tenets of the National Response Plan, as well FEMA response, recovery, and mitigation programs and planning guidance.

Assess Response Requirements and Capabilities

Before beginning to write the EOP, Recovery Operations Plan, or Hazard Mitigation Plan, LEMC members need to identify the functions that need to be performed in a community-wide emergency. Information about the likely impact locations as well as the impact scope (area affected) and intensity will be produced by the hazard/vulnerability analyses. These analyses will also identify the residential, commercial, and industrial activities in the exposed locations, as well as locations that could produce secondary hazards (e.g., dam failures or chemical releases) or that have especially vulnerable populations (e.g., schools, hospital, nursing homes, jails).

In addition, this assessment of response requirements needs to address the likely responses of households and businesses in disaster. As will be discussed in Chapter 8, there are widespread misconceptions—frequently labeled *disaster myths*—about the ways in which people respond to disasters. Though there is some small kernel of truth in these beliefs, the incidence of individually and socially maladaptive behavior is substantially exaggerated. According to Dynes (1972), households and businesses are the foundation of community emergency response and these organizations respond

- In their normal forms to perform their normal tasks (existing organizations),
- In their normal forms to perform new tasks (extending organizations),
- In new forms to perform their normal tasks (expanding organizations), or
- In new forms to perform new tasks (emerging organizations).

In addition, community organizations link to form emergent multiorganizational networks (EMONs, Drabek, et al., 1981). Thus, the mission of the LEMC can be conceived as one of developing a planned multiorganizational network that can be adapted as needed to the demands of each incident involving emergency response and disaster recovery.

In addition, representatives of the different agencies may have misconceptions about the capabilities of other agencies within their jurisdiction or of agencies at other levels (e.g., state and federal) of government. Consequently, the emergency manager needs to assist the LEMC in addressing these issues systematically so plans will be based upon realistic assumptions about what needs to be done and who will be able to do it (Dynes, et al., 1972).

Write Plan Components

As the previous discussion indicates, there will be three plans, the EOP, the Recovery Operations Plan, and the Hazard Mitigation Plan The emergency manager should work with the cognizant committees (especially the Planning, Training, and Exercising Committee and the Recovery and Mitigation Committee) to ensure they have the appropriate persons to draft the components (basic plan, annexes, and appendixes) of each plan. In addition, the emergency manager should provide guidance regarding the structure and content of the plans, as well as resources that committee members can use as they write the plan components. The Federal Emergency Management Agency's (1996b) *Guide for All-Hazard Emergency Operations Planning* is a useful source for the EOP (see also National Response Team, 1987, for hazardous materials planning and US Nuclear Regulatory Commission, 1980, for nuclear emergency planning) and Schwab, et al. (1998) provide guidance for the development of the Recovery Operations Plan, especially the integration of hazard mitigation into disaster recovery.

In most cases, the emergency manager will draft the basic plan and the representatives of each organization will draft the annexes that pertain to their agencies. For example, the police will draft the EOP annex on law enforcement, whereas the land use planning department should write the Recovery Operations Plan annex on temporary housing. Each of the relevant committees—especially the Planning, Training and Exercising Committee and the Recovery and Mitigation Committee, and the LEMC as a whole—should set performance goals collaboratively to ensure that all members are committed to them. These goals should be challenging enough to motivate high levels of performance and should be specific enough that people can determine whether they are making progress in achieving the goals. Goal achievement should be formally evaluated regularly to determine if the planning schedule is being met and achievements should be discussed annually with the jurisdiction's CAO.

Evaluate/Revise the Draft Plans

The emergency manager should ensure that all draft plans—the EOP, the Recovery Operations Plan, the Hazard Mitigation Plan, and relevant sections of the community's comprehensive plan that contain sections affecting hazard mitigation—are reviewed by other committees within the LEMC to identify potential conflicts between agency task allocations and their resource capabilities, or conflicts between the provisions of one plan and another.

Obtain Community Review

Once the draft plans have been reviewed within the LEMC, the local emergency manager should release them for wider review throughout the community. Working in coordination with the Public Education and Outreach committee, the emergency manager should make copies available at libraries and other public facilities throughout the community so households and businesses can examine them in detail. Of course, it is essential that people be notified that the draft plans are available for review and comment.

Thus, the Public Education and Outreach committee should make a major effort to meet with neighborhood groups (e.g., community councils, Parent-Teacher Associations) and service organizations (e.g., Rotary, Kiwanis, Chamber of Commerce) to summarize the hazard/vulnerability analysis process and its results, as well as the planning process and the general provisions of the draft plans for preparedness, response, recovery, and mitigation. People should be given an adequate amount of time to review the plans and provide comments. In addition, the emergency manager should ensure that at least one public meeting is held at which individuals and organizations from throughout the community can provide oral comments concerning the draft plans. Such comments should be transcribed and retained in the LEMC's archives.

Revise/Publish the Final Plans

The local emergency manager should ensure that all input from the community review is forwarded to the appropriate committees so they can address any identified problems in the final versions of the EOP, the Recovery Operations Plan, and the Hazard Mitigation Plan. Wherever possible, it is useful to provide a document to accompany each final plan that categorizes the comments received and explains how they were incorporated into the plan or, if that is not possible, explains why specific comments could not be addressed. Once all changes have been made in the plan, it should be submitted to the CAO or local governing body for their approval. At this point, final approval is usually indicated by a page containing the signatures of the jurisdiction's senior authorities. Copies of the final plans and accompanying documents should be forwarded to all government agencies and other participating organizations (e.g., American Red Cross) having designated roles in the plans. Additional copies of the final plans and accompanying documents should be deposited in the same locations as the draft plans so these documents will accessible to households and businesses throughout the jurisdiction.

3.5: Case Study: Emergency Management in Smith Hill

CHAPTER OVERVIEW

4: Risk Perception and Communication

This chapter explains how people perceive the risks of environmental hazards and the actions they can take to protect themselves from those hazards. Addressing such perceptions is the most common way for emergency managers to change the behavior of those at risk from long-term threats or imminent impacts of disasters. This chapter describes the *Protective Action Decision Model*, which summarizes findings from studies of household response to disasters, and concludes with recommendations for risk communication during the continuing hazard phase, escalating crises, and emergency response.

4.1: Introduction

4.2: The Classical Persuasion Model

4.3: The Protective Action Decision Model

4.4: Risk Communication During the Continuing Hazard Phase

4.5: Risk Communication During an Escalating Crisis or Emergency Response

4.6: Case Study: Risk Perception and Warning of the Mt. St. Helens Eruption

---

4.1: Introduction

Risk can be defined broadly as a condition in which there is a *possibility* that persons or property could experience adverse consequences. Some people, by virtue of their access to data or their specialized expertise in interpreting those data, have more information than others about the risk of a particular hazard and about ways in which that risk can be managed. These risk analysts have a responsibility to convey their assessments to decisionmakers who must determine what action to take in response to the risk that the analyst has characterized. These assessments typically define *risk* in terms of the *likelihood that an event of a given magnitude will occur at a given location within a given time period* and describe the *expected consequences that the event will inflict on persons, property, and social functioning*. The decisionmakers to whom the analysts communicate this information can be either the population at risk or emergency managers who are responsible for protecting the population at risk. In either case, the principal reason for risk communication is to initiate and direct protective action.

Risk communication has become a common concept in recent decades—appearing in many contexts (infectious diseases, food additives, natural hazards, routine effluents, and technological accidents) and referring to many target groups (employees, households, minority groups, and legislators, to name only a few). The principal concern of this chapter will be events that, because of their rapid onset and the large amounts of energy or materials released, have the potential to cause significant numbers of casualties and substantial amounts of property damage unless timely and effective action is taken.

Some of these extreme events *originate* in the natural environment and, thus, are known as natural hazards. Events involving the release of substantial amounts of energy (e.g., earthquakes) can cause immediate destruction of buildings and infrastructure, inflicting many casualties (deaths, injuries, and illnesses) and much disruption to social, economic, and political activities. In some cases, these effects are immediate, whereas in other cases they might take years to manifest themselves.

In addition to hazards originating in the natural environment, there are also hazards that are *transmitted through* the natural environment. These include some, but not all, of what are commonly referred to as technological hazards. Some technological hazards can have a very rapid onset and have the potential for killing many people very quickly unless there is a prompt and effective emergency response. Others involve the cumulative effect of routine air- or water-borne releases from technological facilities or contamination of food and drugs. Many exposures to these hazards unfold over an extended period of time and the adverse health effects even more delayed—frequently producing low incidence rates of disease in the affected population. Regardless of the speed of onset or the persistence of the hazard, the same principles of risk communication are likely to apply.

There is, however, a temporal distinction that is central to the organization of this chapter—the amount of time between the detection of the hazard and the onset of exposure. A risk communication effort addressing the imminent threat of an extreme event is referred to as a *warning*; it is intended to produce an appropriate *emergency response*. By contrast, a risk communication program addressing the long-term potential for such events to occur is often known as a *hazard awareness program*; such efforts are intended to produce *long-term hazard adjustments*. There are quite distinct research literatures on natural and technological hazards that have produced similar conclusions about warnings but have encountered an important difference in the case of hazard awareness programs. Natural hazards seem to arouse substantially less concern than technological hazards, so risk communication programs about the long-term threat of natural hazards generally have sought to *increase* public concern. By contrast, risk communication programs about the long-term threat of technological hazards have more frequently sought to *decrease* public concern. Research on technological risk perception has sought to explain why some hazards elicit more concern than others, and it appears the difference is due, at least in part, to such hazard characteristics as the voluntariness and controllability of hazard exposure and the degree of dread about its consequences (Slovic, 1987).

Risk communication attempts to promote appropriate protective behavior by those to whom the information is directed; such *hazard adjustments* to long-term threats include modifying the hazard, modifying the hazard's impact by preventing specific effects, moving to another location, changing the land use to reduce hazard vulnerability, sharing the loss, or bearing the loss (Burton, et al., 1993). Alternatively, one can think of such behavior changes as *disaster responses* to an imminent threat by such actions as evacuating, sheltering in-place, expedient respiratory protection, or food interdiction (Drabek, 1986; Mileti, Drabek & Haas, 1975).

In general, this chapter will emphasize the communication of information to those who are actually at risk of exposure to a hazard, but also will recognize the need for communicating to those who *think* they are at risk of exposure to the hazard even if authorities do not share this belief. In the latter case, messages are sometimes needed to convince people they do not need to take protective actions because they will not be exposed to the hazard or because the actions being taken by authorities will be sufficient to protect them. Alternatively, such messages might be designed to convince people that hazard managers do not need to implement protective actions because the costs of responding outweigh the risk. Moreover, authorities are occasionally knowledgeable enough about citizens' concerns that a one-way communication flow from them to citizens will produce results that are satisfactory to all concerned. In practice, however, authorities frequently need feedback from citizens and should expect such feedback whether or not they believe it is needed. For most environmental hazards, the risk communication process should be based upon a hazard analysis that identifies *risk areas*—the geographical locations in which the environmental extremes are expected to occur—and the mechanisms by which exposure can occur. The risk communication process also should be guided by a vulnerability analysis identifying the populations and property located in those risk areas. These analyses provide the basic data upon which messages can be formulated that describe the vulnerability of different population segments and the protective responses that are appropriate to reduce these risks.

It is important to recognize that one cannot focus exclusively on a risk analyst's definition of the situation to generate risk messages. Unfortunately, many well-intended attempts at risk communication are based on the assumption that risk area populations fail to implement analysts' protective action recommendations because they are unaware of or misperceive the risk. Thus, analysts assume that disseminating scientific information about the hazard agent will motivate people to adopt their protective action recommendations. This assumption is correct in some cases, but it substantially oversimplifies the risk communication process because it ignores the roles of the information source, the channel by which the information is transmitted, and the individual differences among message receivers. In addition, this naive approach to risk communication also ignores the effects of impediments to information processing such as competing demands for attention, the use of cognitive heuristics (simplified rules of thumb for processing complex information), and conflicts of the new information with people's existing beliefs (Yates, 1990). Finally, such an approach neglects the social structural (community) and cultural environments in which communication processes are immersed (Gudykunst, 1998).

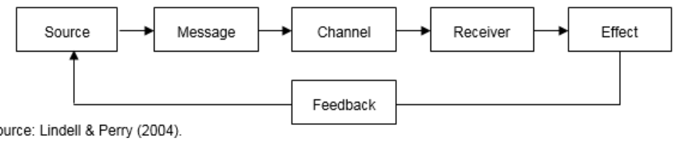
Instead, risk communication should be a process in which stakeholders share information about hazards affecting a community. The use of the term *sharing* is important because risk analysts and emergency managers must understand how different segments of the population at risk think about a hazard if they are to be effective in communicating with their audience. These population segments include businesses and households that are vulnerable to a specific hazard, as well as community and industry personnel who are responsible for managing a hazard in ways that reduce the risk to a level that is acceptable to the community.

People's attentiveness to risk communication varies across the four emergency management functions—hazard mitigation, emergency preparedness, emergency response, and disaster recovery. Decades ago, Fritz (1968) observed most of the money and resources for emergency management are expended in connection with response and recovery activities. This is consistent with the cycle, noted in previous chapters, of significant citizen and government interest in disasters only during imminent threats and in the immediate aftermath of disasters. However, public attention declines significantly as time passes. Because considerable time is required to translate public concern into government budget allocations and coherent programs, many mitigation and preparedness programs have simply failed to be implemented (Birkland, 1997; Prater & Lindell, 2000).

4.2: The Classical Persuasion Model

According to Lasswell (1948), all communication should be analyzed in terms of who (Source) says what (Message), via what medium (Channel), to whom (Receiver), and directed at what kind of change (Effect). This *classical persuasion model*, which is depicted in Figure 4-1, was further articulated by Hovland, Janis and Kelley (1953) and has remained the predominant conceptual approach in the field of communication, and especially research on persuasive communication (McGuire, 1969, 1985; O'Keefe, 1990).

Research guided by this model has found sources are perceived primarily in terms of expertise and trustworthiness, but also by other characteristics such as status, likeability, and attractiveness. Similar to French and Raven's (1959; Raven, 1964) definitions of expert and information power, a source's expertise is defined by its information about a situation and knowledge about cause-and-effect relationships in the environment. By contrast, trustworthiness refers to a source's willingness and ability to provide accurate information and take actions that protect the receiver without seeking hidden advantage for him- or herself.



Source: Lindell & Perry (2004).

Figure 4-1. The Classical Persuasion Model.

Messages vary in their content—especially their information about a hazard, its impact characteristics (e.g., magnitude, location, and time of impact), potential personal consequences (e.g., likelihood of casualties, property damage, and social disruption), alternative protective actions (e.g., evacuation, sheltering in-place), and the attributes of those protective actions (e.g., efficacy; safety; cost; and requirements for time and effort, knowledge and skill, tools and equipment, and cooperation from others). In addition, messages also vary in terms of their style (clarity, forcefulness, and speed of delivery, use of figurative or humorous language), inclusions and omissions (whether or not to include one's own weak arguments, address opponents' arguments, or to rely on implicit or explicit conclusions), ordering of message content, and amount of message material (McGuire, 1985).

The information channels available for use by emergency managers include print media such as newspapers, magazines, and brochures; electronic media such as television, radio, telephone, and the Internet; and face-to-face interaction through personal conversations and public meetings. The distinctions among these information channels are important because they differ in the ways they accommodate the information processing activities of receivers. For example, orally presented information is ephemeral and will be lost unless otherwise recorded, whereas written information inherently provides a record that can be examined at a later time. Moreover, many types of risk information can be presented in either verbal (words), numeric (numbers), or graphic (pictures) format. Sometimes one mode of presentation is more effective for a particular type of information; for example, charts generally are more effective than tables of numbers in conveying trends. However, there are individual differences among receivers, so some presentation modes are more effective for some people but not others. For example, some people can understand verbal descriptions much more readily than graphs of data, whereas the reverse is true for others.

Receivers differ in many respects, but the most important of these are psychological characteristics that have direct effects on the communication process. For example, receivers differ in their perceptions of source credibility, access to communication channels, prior beliefs about hazards and protective actions, ability to understand and remember message content, and access to resources needed to implement protective action (Lindell & Perry, 2004). The effects of a message on a receiver include attention, comprehension, acceptance, retention, and behavioral change. Indeed, researchers agree message effects should be characterized in terms of multiple stages, but the boundaries among these stages are not well defined, so differences exist among various researchers in their typologies (see McGuire, 1985 vs. Mileti & Peek, 2001) and some theorists have varied in their definitions of these stages over time (McGuire, 1969, 1985).

Finally, feedback is an important component of the communication model because some attempts are unidirectional, whereas others are interactive. Unidirectional communications are appealing to many risk communicators because they appear to be less time consuming and sometimes this actually is the case. Frequently, however, interactive communication is needed for receivers to indicate they have not comprehended the message that was sent or to explain that the message sent by the source did not satisfy their information needs.

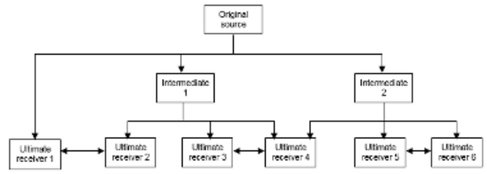
The classical persuasion model makes it clear that risk communication is an activity with relatively clearly defined parameters regarding source, message, channel, and intended effect. In most cases, the source is an authority, the message describes an environmental hazard, and the intended effect is a change in receivers' behavior. However, receiver characteristics have very important influences on each of the stages in the communication process. For example, the effect of a given information source is determined by receivers' perceptions of that source and the effect of a given message is determined by receivers' willingness to attend to and ability to comprehend and retain the information. Moreover the effect of a given channel is determined by receivers' access to and preference for that channel and the amount of feedback depends upon receivers' willingness and ability to provide it. Unfortunately, authorities often fail to recognize the importance of these factors and sometimes fail to design risk communication programs in accordance with the principles of effective communication even when these issues are recognized (Perry & Lindell, 1991).

Some scholars have criticized the classical persuasion model as providing an incomplete representation of the risk communication process (Kasperson & Stallen, 1990). They contend the feedback loop in the model implies a dyadic relationship that is limited to contact with the original information source. However, extensive research shows people engage in information seeking activities that are directed to other sources as well. More generally, risk communication should be represented by a network in which multiple sources are linked to intermediate sources who receive information and relay it to the ultimate receivers (Figure 4-2). The original sources could be linked to few or many intermediates or could even be linked directly with some of the ultimate receivers. Similarly, the intermediates could be linked to few or many of the ultimate receivers and the ultimate receivers could be linked to each other.

Another apparent limitation of the classical persuasion model is that receiver characteristics have pervasive effects on the other components of the model. For example, receivers' demographic characteristics are correlated with access to sources and channels, as well as with message comprehension. Thus, receiver characteristics are of critical importance in determining the success of risk communication programs, but many of them are psychological in nature and, thus, not readily observed. Nonetheless, receivers' demographic characteristics—such as sex, age, education, income, race, and ethnicity—are readily identifiable. Because some of these demographic characteristics are related to relevant psychological characteristics, they can provide some indication as to how receivers will respond.

4.3: The Protective Action Decision Model

A review of theories on social influence, persuasion, behavioral decisionmaking, attitude-behavior relationships, protective action, and innovation processes reveals a wide variety of perspectives providing useful accounts of the ways in which risk communication can influence disaster response and hazard adjustment (Lindell & Perry, 2004). Although these theories overlap to some extent with the findings of research on hazards and disasters, all of them provide valuable insights that can extend our understanding of ways in which people respond to the threat of environmental hazards. The relevant elements of these complementary approaches have been integrated with the findings of disaster research to produce a model of the factors that influence individual's adoption of protective actions against natural and technological hazards and disasters. This integrated model is the Protective Action Decision Model (PADM).

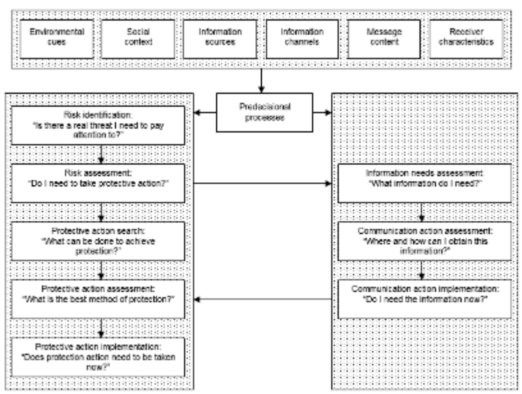


Source: Lindell & Perry (2004).

Figure 4-2. Communication Network Model.

According to Lindell and Perry (2004), the PADM is most directly based upon a long history of research on disasters that has been summarized by many authors (Barton, 1969; Drabek, 1986; Fritz 1961; Janis & Mann, 1977; Lindell & Perry, 1992; Mileti, et al., 1975; Mileti & Peek, 2001; Mileti & Sorensen, 1987; Perry,et al., 1981; Tierney, et al., 2001). This research has found sensory cues from the physical environment (especially sights and sounds, see Gruntfest, Downing & White, 1978) or socially transmitted information (e.g., disaster warnings) can each elicit a perception of threat that diverts the recipient's attention from normal activities. Depending upon the perceived characteristics of the threat, those at risk will either resume normal activities, seek additional information, pursue problem focused actions to protect persons and property, or engage in emotion focused actions to reduce their immediate psychological distress. Which way an individual chooses to respond to the threat depends upon evaluations of both the threat and the available protective actions.

The findings of previous disaster research can be combined with propositions drawn from the theories listed earlier in this chapter to express the PADM in terms of a flow chart that provides a graphic representation of the model (see Figure 4-3). The process of decisionmaking begins with environmental cues or risk communication messages that initiate a series of predecisional processes. In turn, these predecisional processes stimulate either a protective action decisionmaking process or an information seeking process. To proceed through the successive stages of either process, the individual must arrive at an affirmative answer to the questions posed. The dominant tendency is for environmental cues and risk communication messages to prompt protective action decisionmaking, but information seeking occurs when there is uncertainty about the answer to the critical question at a given stage in the protective action decisionmaking process. Once the question is resolved, processing proceeds to the next stage in the protective action decisionmaking process.



Source: Lindell & Perry (2004).

Figure 4-3. Information Flow in the PADM.

The model attempts to characterize the way people "typically" make decisions about adopting actions to protect against environmental hazards. The stages within the protective action decisionmaking process are sequential, as are those within the information seeking process. However, few people follow every step in the model in the exact sequence listed in Figure 4-3. For example, an extremely credible (or powerful) source might obtain immediate and unquestioning compliance with a directive to evacuate an area at risk—even if there were no explanation why evacuation was necessary or what alternative protective actions were feasible (Gladwin, Gladwin & Peacock, 2002). Such an order would, of course, be quite improbable in contemporary American society, but compliance with such an order would bypass all of the intermediate stages in the PADM. Other situations can be imagined in which some, but not all, decision stages would be bypassed. The important lesson is that—unless risk communicators have an extreme amount of credibility or power to compel compliance—the more stages in the PADM they neglect, the more ambiguity there is likely to be for message recipients. In turn, greater ambiguity is likely to lower compliance and cause warning recipients to spend more time in seeking and processing information rather than preparing for and implementing protective action. Indeed, ambiguity can initiate a repetitive cycle of decision processing and information seeking that postpones the initiation of protective action until it is too late to be completed before hazard onset.

Predecisional Processes

Both environmental cues and risk communication from other persons prompt three predecisional processes that are needed to bring information to conscious awareness. These are exposure to, attention to, and interpretation of environmental cues or—alternatively—reception of, attention to, and comprehension of socially transmitted information (Fiske & Taylor, 1991). Environmental cues and risk communications are somewhat independent of each other, so one household might only observe environmental cues, whereas another might receive only warnings. Still other households might have access to both environmental cues and warnings. Regardless of whether information comes from environmental cues or social warnings, all three pre-decisional processes are necessary. That is, information from the physical environment will not lead to the initiation of appropriate protective actions unless people are exposed to, heed, and accurately interpret the environmental cues. Similarly, information from the social environment will not lead to the initiation of appropriate protective actions unless people receive, heed, and comprehend the socially transmitted information.

These predecisional processes are critical because some of those at risk who are exposed to environmental cues will heed this information, but others will not. Whether or not people heed the available information is determined by their expectations, competing attention demands, and the intrusiveness of the information. Specifically, expectations of threat are established when people have advance information that leads them to believe the potential exists for a significant environmental impact. For example, many people in tornado-prone areas know the months of the year in which there is a peak level of activity. Consequently, they check weather forecasts frequently and attend to environmental cues such as cloud formations. Competing demands are important because attention is limited, so absorption in one task will tend to prevent the processing of information associated with other tasks. Continuing with the example of tornadoes, people who are engaged in tasks that require intense concentration are less likely to notice gathering storm clouds and might not notice a warning even if they have a radio turned on. Of course, the perceptual intrusiveness of hazard information affects attention because it disrupts cognitive processing of the primary task at hand. Those who did not notice the gathering storm clouds, or even an approaching funnel cloud, are certain to notice the roar of the wind or will notice a warning if it is preceded by a loud signal from a radio or a nearby siren. Finally, interpretation of environmental cues is critical because this requires an understanding of the hazard. For example, some coastal residents have lost their lives because they did not understand that a sudden recession of water is the trough phase of a tsunami. The naïve reaction to receding water has frequently been to confuse it with a sudden low tide and to take advantage of an unexpected opportunity to collect stranded fish. Of course, those who have been properly trained recognize this as a sign of danger and immediately evacuate to high ground.

The predecisional processes for warnings are similar to those of environmental cues. First, people must receive information from another person through a warning channel and attend to this information. Accordingly, the characteristics of the warning channel itself can have a significant impact on people's reception and attention to warning message content. Once a warning has been received and heeded, some people will comprehend the available information, whereas others will not (what Turner, Nigg & Heller-Paz, 1986, call "hearing and understanding"). The comprehension of warning messages will depend upon whether the message is conveyed in words they understand. Quite obviously, warnings disseminated in English are unlikely to be understood by those who understand only Spanish. In addition, however, comprehension also affected by more subtle factors. A warning source cannot achieve comprehension of a warning message if it uses technical terms that have no meaning for those at risk. For example, phrases such as "hypocenter", "Saffir-Simpson Category", "oxidizer", and "millirem" are specialized terms that will not be understood by all who hear them. Specialized terms cause confusion and distract people from processing the information in the rest of the message. If such terms must be used in warning messages, they should be explained —ideally before any emergencies arise.

Decision Stages

Once the three predecisional processes have been successfully completed, cognitive processing turns to the decision stages in the core of the model presented in Figure 4-3—risk identification, risk assessment, protective action search, protective action assessment, and protective action implementation. In addition, information seeking activities include information needs assessment, communication action assessment, and communication action implementation. Each of the decision stages in the PADM is discussed in detail below.

Risk identification.

According to the PADM, people's decisions about how to respond to a hazard or disaster begin with risk identification, which can be interpreted as the initial step in what Lazarus and Folkman (1984) call *primary appraisal*. As noted earlier, this process can be initiated by the detection of environmental cues, but the most important sources of risk identification usually are warning messages from authorities, the news media, and peers such as friends, relatives, neighbors, and coworkers. Conversely, the first step emergency managers must take when promoting the adoption of hazard adjustments is to disseminate their message widely to attract the attention of those at risk and inform them of the potential for environmental extremes that could threaten their health, safety, and property.

In both disaster response and hazard adjustment, those at risk must answer the basic question of risk identification, "Is there a real threat that I need to pay attention to?" (Anderson, 1969a; Janis & Mann, 1977; Mileti, 1975; Perry, 1979a). The importance of the resulting *threat belief* is supported by research showing individuals routinely try to maintain their definition of the environment as "normal" in the face of evidence that it is not (Drabek, 1986). Researchers have found a positive relationship between level of threat belief and disaster response across a wide range of disaster agents, including floods (Mileti, 1975; Perry, Lindell & Greene, 1981), volcanic eruptions (Perry & Greene, 1982; Perry & Hirose, 1991), hazardous materials emergencies (Lindell & Perry, 1992), hurricanes (Baker, 1991), earthquakes (Blanchard-Boehm, 1998), and nuclear power plant emergencies (Houts, Cleary & Hu, 1988; Perry, 1985).

Risk assessment.

The next step, *risk assessment*, refers to the process of determining the likely personal consequences that the disaster or hazard could cause (Otway, 1973; Perry, 1979a). Decades of research have shown the perception of personal risk—the individual's expectation of personal exposure to death, injury, illness, or property damage—is a critical variable in explaining disaster response (Mileti & Sorensen, 1987). This process of assessing personal relevance, which Mileti and Sorensen (1987) refer to as the "personalization of risk", has been recognized as an important factor by persuasion theorists as well as disaster researchers (Eagly & Chaiken, 1993). In the risk assessment stage, a positive response to the question, "Do I need to take protective action?" elicits *protection motivation* whether the risk involves a disaster response or long-term hazard adjustment (Fritz & Marks, 1954; Perry, 1983). Some of the factors associated with people's personalization of risk include "the probability of the impending event occurring [and] the severity, to the individual, of such a development" (Withey, 1962, p. 104; see also Neuwirth, Dunwoody & Griffin, 2000 and Lindell & Perry, 2000 for reviews of relevant research).

The immediacy of a threat is also important because warning recipients must understand that the message describes a threat whose likely consequences will occur in the very near future. Thus, immediacy is related to forewarning, which is the amount of time between the arrival of the warning (or personal detection of environmental cues) and disaster onset. For emergency managers, the amount of forewarning received from hazard detection agencies such as the National Weather Service and US Geological Survey affects their choice of message content, the channels feasible for delivery, and the number of times the warning can be repeated. For those at risk, the amount of forewarning received from emergency managers affects their sense of urgency to act. Other factors being equal, the likelihood of immediate disaster response increases as the amount of time until impact decreases. However, people tend to devote this additional time to other activities such as information seeking and expedient property protection when they believe there is more time before impact than the minimum necessary to implement protective action. Information seeking can ultimately increase compliance with recommended protective actions but does, inherently, delay it. Similarly, the amount of time risk area residents devote to expedient property protection also delays their initiation of personal protective action. In both cases, the delay in protective action might be dangerous because the time of disaster impact cannot be predicted with perfect accuracy. For many of the events studied by disaster researchers, warnings were issued when impact was imminent, thereby reducing the extent of these other activities. Ultimately, increasing the amount of forewarning changes the risk communication from a disaster warning to a hazard awareness message (Perry, et al., 1981; Nelson & Perry, 1991).

Previous research has addressed people's beliefs about other temporal dimensions of hazard impact, as well. The duration of impact, which refers to the length of time hazard impacts will persist, has been addressed principally in connection with studies of technological risk perception (Slovic, Fischoff & Lichtenstein, 1980; Lindell & Earle, 1983; Lindell & Barnes, 1986). For radiological and toxic chemical hazards, it appears many people are concerned that long-term contamination could prevent them from returning to their homes for a long period of time after a disaster (Lindell, 1994c).

In general, research has shown simple measures of risk perception are positively correlated with disaster response (Drabek, 1999), but it also is important to qualify this finding with one further consideration. Specifically, the hazards most frequently studied by disaster researchers are ones whose principal physical impacts are property damage and traumatic injuries. In such cases, the exposure paths from the hazard agent through the environment to those at risk are relatively simple and well understood by the general public. Physical proximity to the hazard increases risk, so safety increases with distance from the point of impact. Indeed, Kunreuther, et al. (1978) reported proximity, along with certainty and severity, was an important threat characteristic influencing the purchase of hazard insurance. The correlations between risk perception and behavioral responses to that object might not be so high in cases where the exposure paths are more complex than those involved in simple proximity. For example, food contamination and infectious diseases both involve complex exposure paths that might be difficult for most people to understand. For example, some have found it difficult to understand why AIDS can be transmitted by infected needles but not by mosquito bites because the two types of exposure seem to be similar (both involve injection through the skin surface).

Similar issues must be considered in examining hazards that have different types of impacts. For example, Perry and Montiel (1997) reported the magnitude of perceived risk was higher for threats affecting life safety and property than for those affecting property alone. Another issue concerns the definition and measurement of perceived risk. Some studies have used very global measures of risk, whereas others have used more specific measures. Early studies of evacuation compliance that defined risk in terms of three components—certainty, severity, and immediacy—of the threat have reported high positive correlations between risk perception and disaster response (Perry, et al., 1981). However, some researchers have applied these characteristics to the occurrence of a disaster, whereas others have applied them to personal hazard exposure, and still others have applied them to the consequences of that exposure. In some cases, there are essentially no differences among disaster impact, personal hazard exposure, and personal consequences. For example, people living close to a volcano might think the occurrence of a major eruption is highly likely to occur within the next year, their chance of severe exposure is high because they live so close to the volcano, and their chance of experiencing severe adverse health consequences within that time interval is high because the effects of blast and ash will be felt immediately. In other cases, the differences among disaster impact, personal hazard exposure, and personal consequences could be profound. For example, people living in the vicinity of a toxic chemical facility might think the occurrence of a major release to ground water is highly likely to occur within the next year, but also believe their chance of severe exposure within that time interval is low because they live *upstream* from the release point. Even if they thought the chances of personal exposure were high, they might believe their chance of experiencing severe adverse health consequences within that time interval is low because it would take many years to develop cancerous tumors.

The differences among disaster impact, personal exposure, and personal consequences are important because a number of investigators have found many people have an unrealistic sense of optimism about their ability to avoid danger—in extreme cases, this results in a sense of total invulnerability. For example, data from Lindell and Prater (2000) indicate people's perceptions that there is a significant probability of an earthquake in their community do not necessarily imply that they believe there is a high probability of being personally affected by that earthquake. Moreover, some studies have indicated perceptions of severity also can be quite complex. Research on earthquake hazard has revealed perceptions of severity to be multidimensional because people are concerned about death, injury, property damage, and disruption to work and daily activities (see Lindell & Perry, 2000, for a review). Other research on risk perceptions regarding radiological and toxic chemical hazards indicates people are also concerned about delayed health effects such as cancers and genetic effects (Lindell, 1994; Lindell & Barnes, 1986; Perry & Montiel, 1997).

Protective action search.

If a threat is judged to be real and some unacceptable level of personal risk exists, people turn to *protective action search*—which involves retrieving one or more feasible protective actions from memory or obtaining information about them from others. The relevant question in protective action search is "What can be done to achieve protection?" and its outcome is a *decision set* that identifies possible protective actions. The results of some studies (e.g., Jackson, 1977) suggest risk area residents' first attempt to answer this question often involves a search for what can be done *by someone else* to protect them against the hazard. When there is insufficient time to find someone else to provide protection—as is usually the case during disasters—or when such a search is unsuccessful, households must rely on their own resources to achieve protection. In many instances, an individual's own knowledge of the hazard will suggest what type of protection to seek (e.g., sheltering in the basement following a tornado warning). People are especially likely to recall actions they have taken on previous occasions if they have had personal experience with that hazard. Alternatively, they might consider actions they have taken in the course of their experience with similar hazards—recognizing, for example, the impact of a volcanic mudflow is similar to that of a flood and, thus, protective responses to flood are likely to be effective for a mudflow as well.

Information about protective actions also can be received from a variety of external sources. Specifically, those in the risk area are likely to become aware of alternative protective actions by observing the behavior of others. This occurs, for example, when neighbors are seen packing cars in preparation for hurricane evacuation or employing contractors to reinforce their homes against earthquake shaking. People also are likely to consider actions with which they have had vicarious experience by reading or hearing about others' actions in response to a hazard. Such vicarious experience is frequently transmitted by the news media and relayed by peers—friends, relatives, neighbors, and coworkers. Finally, people also are made aware of appropriate protective actions by means of disaster warnings and hazard awareness programs that carry protective action recommendations from authorities. Specifically, a well designed warning message will assist recipients in constructing a decision set by providing *guidance* in the form of one or more protective action recommendations (Mileti & Sorensen, 1988). Nonetheless, authorities should not assume warning recipients will implement the official protective action recommendation even if only one protective action is mentioned in the warning message. People will always be aware that continuing normal activities is an option and they might think of other alternatives by recalling such actions from memory or observing the actions of others.

Protective action assessment.

After people have established that at least one protective action is available, they pass from the protective action search stage to protective action assessment. This involves examining alternative actions, evaluating them in comparison to the consequences of continuing normal activities, and determining which of them is the most suitable response to the situation. At this point, the primary question is "What is the best method of protection?" and its outcome is an *adaptive plan*.

As noted earlier, choice is an inherent aspect of emergencies because those at risk generally have at least two options—taking protective action or continuing normal activities. Comparing alternatives with respect to their attributes leads, in turn, to a balancing or trade-off of these attributes with respect to their relative importance to the decision maker. Under some conditions, those at risk can only take one action and, therefore, must make a choice among the alternatives. Evacuation maximizes the protection of personal safety, but abandons property to the action of the hazard agent or, as some evacuees have erroneously feared, to looters (Perry, et al., 1981; Lindell & Perry, 1990). On the other hand, emergency measures to protect property (e.g., sandbagging during floods) require the property owner to remain in a hazardous location. This problem also exists in the context of long-term hazard adjustment but is significantly reduced because households have time before disaster onset to carefully consider trade-offs among alternative protective actions and to implement multiple actions. Even when there is only a moderate amount of forewarning, households might be able to engage in a combination of actions. For example, if a flood has been forecast to arrive within a few hours, people could perform emergency floodproofing and elevate contents to higher floors to provide as much property protection as possible, yet evacuate family members before the floodwater reaches a dangerous level.

When households assess the salient characteristics of alternative protective actions, they are likely to consider a set of characteristics that have been identified by previous research on disaster response and hazard adjustment. In reviews of disaster studies conducted since the 1940s, Fritz (1961), Sorensen and White (1980), Sims and Bauman, (1983), Drabek (1986), and Tierney, et al. (2001) have noted that a protective action is unlikely to be considered unless it is considered to be effective in reducing the negative consequences associated with disaster impact. Thus, *efficacy,* which is measured by the degree of reduction in vulnerability to the hazard, refers to success in protecting both persons and property (Cross, 1980; Kunreuther, et al., 1978). In some cases, such as sandbagging during floods, property protection is the specific objective of the protective action. In other cases, however, people consider the implications for property protection of actions whose principal goal is to protect persons. For example, many researchers have found that those who fail to comply with an evacuation recommendation do so because of concerns about protecting their property from looting.

Research also suggests people evaluate protective actions in terms of their *safety*—that is, the risks that might be created by taking that protective action. For example, some research has reported that those who have not complied with recommendations to evacuate did so because they were concerned about the traffic accident risks involved. As a general rule, the traffic accident risks of evacuation appear to be no greater than those of normal driving (Lindell & Perry, 1992). However, it is important to recognize warning recipients' behavior is determined by their *beliefs* about safety, not the historical evidence about safety. Thus, it is important for local authorities who want to increase compliance with evacuation recommendations to ensure people are aware that evacuation accident rates are low.

Alternative protective actions also can be assessed in terms of their perceived *time requirements* for implementation, which are a function of the number and duration of the steps required to complete a given action. Evacuation is typically time consuming, requiring unification of the family, preparation for departure, selection of a safe destination and route of travel, and transit out of the risk area (Lindell & Perry, 1987; Lindell, Prater, Perry & Wu, 2002). By contrast, time requirements for in-place protection are small—requiring only that occupants shut off sources of outside air, such as doors, windows, chimney dampers, and forced air circulation systems for heating and cooling (Lindell & Perry, 1992). A major problem in large scale evacuations such as those for hurricanes is people's underestimation of the amount of time needed to reach their destinations. Kang, Lindell and Prater (in press) found coastal residents have reasonably accurate expectations about the time requirements of familiar tasks under their control (e.g., packing bags and shuttering windows), but they substantially underestimate the amount of travel time needed to clear the risk area. The problem seems to be that they plan to take familiar routes to familiar destinations and assume it will take the usual amount of time to get there. Unfortunately, they fail to account for the fact that an evacuation might have ten times as much traffic on that route as they normally encounter, thus turning a two hour trip into a 20 hour trip.

Perceived implementation barriers

The *perceived implementation barriers* affecting protective action decisions arise from resource constraints precluding the selection of a preferred protective action, as well as obstacles that are expected to arise between the decision to take a protective action and the achievement of protection. In the former category, resource constraints include a lack of knowledge and skill, tools and equipment, or social cooperation required to achieve protection (Lindell & Prater, 2002). In the case of evacuation, this may include a lack of knowledge of a safe place to go and a safe route to travel. Related barriers include the lack of access to a personal vehicle (e.g., those who are routinely transit dependent or families in which one spouse has the only car during the workday) or lack of personal mobility due to physical handicaps. These were clearly factors affecting the alarming death toll in Hurricane Katrina. In some instances, the separation of family members will be considered to be an evacuation barrier. Until family members have been reunited or separated family members can establish communication contact and agree upon a place to meet, evacuation is unlikely to occur (Killian, 1952; Drabek & Boggs, 1968; Haas, Cochrane & Eddy, 1977). Of course, separation of family members is unlikely to be a significant problem during incidents, such as hurricanes, that have ample forewarning.

Finally, a variety of researchers (Cross, 1980; Fritz, 1961; Kunreuther, et al., 1978; Sorensen & White, 1980) have reported the *perceived cost* of actions to protect personal safety is a consideration in protective actions decisions. Such costs include out-of-pocket expenses (gasoline, food, and lodging), opportunity costs (e.g., lost pay from workdays missed during evacuation), effort, personal sacrifice, and aesthetic cost (e.g., the unattractive appearance of houses that are elevated out of the flood plain). The high cost of protective action can lead people to delay its implementation until they are certain it is necessary. For example, many households delay hurricane evacuation because they want to avoid incurring evacuation expenses if possible. These averaged $262 per household during the Hurricane Lili evacuation (Lindell, Prater, Lu, Arlikatti, Zhang & Kang, 2004).

A significant impediment to the assessment of protective actions arises when none of the available alternatives dominates the others (i.e., is superior to the others on all of the evaluation attributes). For example, Lindell and Perry (1992) reported evacuation was rated higher than sheltering in-place and expedient respiratory protection in efficacy for protecting persons (a positive consequence). However, evacuation also was judged to be higher in its resource requirements for time, effort, skill, cost, and barriers to implementation (all negative consequences). This suggests people must sometimes make a difficult choice between the higher effectiveness of evacuation and its higher resource demands against the lower effectiveness of the alternative protective actions (sheltering in-place and expedient respiratory protection) and their lower resource demands.

The importance of *perceived* attributes in the protective action assessment stage should alert risk communicators to the potential for differences between the judgments of experts and the public, especially in connection with protective actions that are not well known to those at risk. Sheltering in-place can substantially reduce toxic gas exposure to safe levels (Wilson, 1987, 1989), but its effectiveness does not seem to be recognized outside a relatively narrow circle of experts. Moreover, attempts to evacuate immediately prior to tornado impact, which are contrary to scientific recommendations (Glass, et al., 1980), are probably due to the recognition that sheltering in-place during the tornado does not guarantee survival. This observation also holds true for many victims of fires in high-rise buildings who have attempted unsuccessfully to evacuate when sheltering in their rooms would likely have saved their lives.

The end result of protective action assessment is an adaptive plan, but people's adaptive plans vary widely in their specificity, with some being only vague goals (e.g., "We'll stay with my sister's family") and others begin extremely detailed. At minimum, a specific evacuation plan includes a destination, a route of travel, and a means of transportation. More detailed plans include a procedure for reuniting families if members are separated, advance contact to confirm the destination is available, consideration of alternative routes if the primary route is unsafe or too crowded, and alternative methods of transportation is the primary one is not available.

Research has documented a tendency for those who lack a ready adaptive plan to experience more negative disaster outcomes (Quarantelli, 1960; Perry, 1979b; Drabek, 1986). A classic example in the literature on floods lies in the Hamilton, Taylor, and Rice (1955, p. 120) interview with the recipient of an evacuation warning that contained no information on safe evacuation routes or safe destinations: "We couldn't decide where to go... So we grabbed our children and were just starting to move outside...if it had just been ourselves, we might have taken out. But we didn't want to risk it with the children."

Protective action implementation.

The fifth step, *protective action implementation*, occurs when all the previous questions about risk reduction have been answered satisfactorily. Specifically, those at risk have determined action should be taken, at least one available option is likely to be effective in achieving protection, and that option is logistically feasible. In general, the implementation of protective actions consumes resources people would prefer to allocate to other activities, so those at risk frequently delay implementation until they have determined that the immediacy of the threat justifies the disruption of normal activities. Thus, people often ask the question, "Does protective action need to be taken now?" The answer to this question, whose outcome is the *threat response*, is crucial because people sometimes postpone the implementation of protective action even when there is imminent danger. As noted earlier, recipients of hurricane warnings have often been found to endanger their safety because too many of them wait until the last minute to begin their evacuations. Unfortunately, they fail to recognize that adverse weather conditions and a high volume of traffic can significantly reduce the average speed of evacuating vehicles, thus running the risk that their evacuation will not be completed before the arrival of storm conditions (Baker, 1979, 1990, 1993; Dow & Cutter, 1998, 2002; Prater, Wenger & Grady, 2000). The problem of procrastination is even more severe in connection with long-term hazard adjustment than it is in disasters with ample forewarning because hazard awareness programs cannot specify even an approximate deadline by which action must be taken. For example, an earthquake prediction might indicate a 75% chance of a damaging earthquake within the next 20 years.

Information needs assessment.

At all stages of the protective action decision process, people who are responding to the threat of disaster must act on the basis the available information, even if it is insufficient for a confident appraisal of the threat or the available protective actions. However, when people think time is available, they cope with the lack of information by implementing three additional stages involving information search. The process of information search begins with an *information needs assessment* arising from an individual's judgment that the available information is insufficient to justify proceeding further in the protective action decision process. The research literature indicates ambiguity at any point in the protective action decision process will tend to initiate information seeking, especially when the probability of disaster impact reaches a critical threshold. Thus, if any of the questions cannot be answered with an unequivocal yes or no, people will ask "What information do I need to answer my question?" so they can generate an *identified information need*. As is the case with a lack of information about a threat, information seeking can also resolve a lack of information about appropriate protective actions. In particular, additional information about alternative protective actions could make it clearer which action would be most appropriate for that situation. Such information seeking is frequently needed because, as noted earlier, those at risk are rarely aware of all of the alternatives available to them.

Communication action assessment.

Identification of a need for information does not necessarily suggest where the needed information can be obtained. Thus, the next question in the information seeking process is "Where and how can I obtain this information?" Addressing this question leads to information source selection and information channel selection, which constitute an *information search plan*. The sources from which information is sought are likely to differ depending upon stage of the protective action decision process that has generated the need for information. For example, uncertainty about risk identification and risk assessment can stimulate questions directed to officials and, more likely, the news media (see Lindell & Perry, 1992). The high level of reliance on the news media appears to be due to people's desire to confirm the information they initially received in a warning message from one source by contacting a different source (Drabek, 1969). By contrast, uncertainties about protective action search, protective action assessment, and—especially—about protective action implementation are likely to prompt questions directed to peers.

The sources sought are likely to be affected by the available channels, which in many disasters precludes the use of the telephone because circuits are so overloaded that it is impossible to obtain a dial tone for hours or even days. Further, attempts to reach authorities sometimes prove futile because emergency response agencies are busy handling other calls. Thus, people are often forced to rely on the mass media and peers even when they would prefer to contact authorities. This distinction between risk area residents' *preferred* channels of information receipt and their *actual* channels of information receipt also can be seen in connection with long-term hazard adjustment. For example, Lindell and Perry (1992) reported residents of communities downstream from the Mt. St. Helens volcano revealed some significant disparities between their preferred and actual channels of information receipt in the years after the 1980 eruptions. However, there also were significant differences between the two communities of Toutle and Lexington in both their preferred and actual channels of information receipt. Unfortunately, the available research does not reveal any general principles of source and channel preference that can be assumed to apply across a broad range of communities.

Communication action implementation.

The final step in the information search process is communication action implementation, which provides *decision information* by answering the question, "Do I need the information now?" If the answer to this question is positive, that is, they are threatened by an imminent disaster, people will actively seek the needed information from the most appropriate source through the most appropriate channel. Drabek's (1969; Drabek & Stephenson, 1971) research indicates people will go to great lengths, contacting many people over a period of minutes to hours, if the prospect of an imminent disaster needs to be confirmed. However, information seeking will be less frequent and less active if the location is specific but the time of impact is ambiguous. Perry, Lindell, and Greene (1982) reported many residents of the area around Mt. St. Helens monitored the radio four or more times a day after the initial ash and steam eruptions led authorities to believe increased activity might indicate an increased probability of a larger eruption. By contrast, the absence of locational specificity and time pressure inherent in a hazard awareness program provides little need for those at risk to obtain immediate answers, so they are likely to forego active information seeking in favor of passive monitoring of the situation. Unfortunately, the absence of a deadline for action means this passive monitoring is likely to continue until an imminent threat arises (as in the case of hurricanes and floods) or until a disaster strikes (as in the case of earthquakes).

Communication action implementation can have one of three outcomes. If the query elicits a message that meets the information needs that initiated the search, then information seeking has been successful and the decision maker can return to the point in the protective action decision process that generated the information search. However, if the source is unavailable, the query produces no additional information, or the query produces no useful information at all, then information seeking is unsuccessful. The response to this situation is likely to depend upon an individual's expectations for success in obtaining the desired information from another source or through another channel. Optimism regarding either of these is likely to motivate further information seeking. Pessimism regarding the success of obtaining the needed information is likely to force the decision maker to attempt a protective action decision on the basis of the information available.

In summary, The PADM provides a framework that identifies the critical stages of information processing relevant to household adoption of protective actions and—for each stage—the activities performed, the typical question asked, and the outcome (see Table 4-1). If an individual cannot determine a satisfactory answer to the question posed at one of the decision stages, then progress toward implementation of a protective action is likely to be delayed and possibly even terminated. If the process terminates due to a negative answer about risk identification, then the decision maker is likely to return to normal activities. If the process terminates due to a negative answer about risk assessment, then the decision maker is likely to monitor the situation. If the process terminates due to a negative answer about the availability or acceptability of protective actions, then the decision maker is likely to enter a state of either denial or panic (Janis & Mann, 1977). Which of these emotion-focused coping strategies is used depends upon a person's susceptibility to distraction, with the most distractible being inclined to denial and the least distractible being inclined to intense fear. Nonetheless, extensive research reveals a very low incidence of panic in disaster (Drabek, 1986).

Table 4-1. Warning Stages and Actions.

Stage	*Activity*	*Question*	*Outcome*
1	Risk identification	Is there a real threat that I need to pay attention to?	Threat belief
2	Risk assessment	Do I need to take protective action?	Protection motivation
3	Protective action search	What can be done to achieve protection?	Decision set (alternative actions)
4	Protective action assessment and selection	What is the best method of protection?	Adaptive plan
5	Protective action implementation	Does protective action need to be taken now?	Threat response

6	Information needs assessment	What information do I need to answer my question?	Identified information need
7	Communication action assessment and selection	Where and how can I obtain this information?	Information search plan
8	Communication action implementation	Do I need the information now?	Decision information

Source: Lindell & Perry (2004).

4.4: Risk Communication During the Continuing Hazard Phase

As noted at the beginning of this chapter, there are theoretical and practical reasons for distinguishing between risk communication activities undertaken during the continuing hazard phase (which are directed toward long-term hazard adjustment) and those taken during an escalating crisis or emergency response (which are directed toward disaster response to avoid personal exposure or minimize personal consequences). The continuing hazard phase involves a stable probability (usually low) that a catastrophic incident will threaten public safety, property, and the environment. This phase is characterized principally by hazard mitigation and emergency preparedness activities, although preparedness for disaster recovery also should be undertaken at this time (Schwab, et al., 1997; Wu & Lindell, 2004).

There are five basic functions that should be addressed in the continuing hazard phase. Table 4-2 identifies these as strategic analysis, operational analysis, resource mobilization, program development, and program implementation. These five functions and the tasks associated with them are listed in the table as if they form a simple linear sequence but, in fact, some tasks will be performed concurrently. In addition, the process will frequently be iterative. For example, some resource mobilization tasks might take place concurrently with the operational analysis, or tasks conducted during the operational analysis phase might be suspended temporarily in order to return to the strategic analysis and refine it.

Strategic Analysis

Task 1: Conduct a community hazard/vulnerability analysis.

As will be discussed in Chapter 6, emergency managers need to understand the hazards to which their communities are exposed and the geographic areas at risk. Knowing the characteristics of the most significant hazards makes it possible to identify the most appropriate hazard adjustments. Identifying the geographic areas at greatest risk makes it possible to identify the most vulnerable population segments and types of businesses. In turn, this knowledge about vulnerable population segments and types of businesses provides information about how to target the risk communication program and also suggests which incentives and sanctions might be best suited to increasing hazard adjustment adoption (see Lindell & Perry, 2004, for a further discussion of the roles of risk communication, incentives, and sanctions).

Table 4-2. Tasks for the Continuing Hazard Phase.

Strategic analysis
Conduct a community hazard/vulnerability analysis
Analyze the community context
Identify the community's prevailing perceptions of the hazards and hazard adjustments
Set appropriate goals for the risk communication program

Operational analysis
Identify and assess feasible hazard adjustments for the community and its households/businesses
Identify ways to provide incentives, sanctions, and technological innovations
Identify the available risk communication sources in the community
Identify the available risk communication channels in the community
Identify specific audience segments

Resource mobilization
Obtain the support of senior appointed and elected officials
Enlist the participation of other government agencies
Enlist the participation of nongovernmental (nonprofit) and private sector organizations
Work with the mass media
Work with neighborhood associations and service organizations

Program development for all phases
Staff, train, and exercise a crisis communications team
Establish procedures for maintaining an effective communication flow in an escalating crisis and in emergency response
Develop a comprehensive risk communication program
Plan to make use of informal communication networks
Establish procedures for obtaining feedback from the news media and the public

Program implementation for the continuing hazard phase
Build source credibility by increasing perceptions of expertise and trustworthiness
Use a variety of channels to disseminate hazard information
Describe community or facility hazard adjustments being planned or implemented
Describe feasible household hazard adjustments
Evaluate program effectiveness

Source: Lindell & Perry (2004).

Task 2: Analyze the community context.

As noted in Chapter 3, the most comprehensive research on the practice of local environmental hazard management is that undertaken by Drabek (1987, 1990), whose careful analysis of the problem has identified many effective managerial strategies. In particular, he has emphasized the need for emergency managers to continually study their communities' ethnic composition, communication channels, perceptions of authorities, levels of education, and income distribution.

If environmental hazards are not high on the community's priorities, as usually is the case (Rossi, Wright, Webber-Burdin, Peitras & Diggins, 1982), emergency managers need to begin with small programs, demonstrate their effectiveness, and build constituencies for environmental hazard management (Lindell, 1994b). In developing a risk communication program, emergency managers need to realistically assess the resources the community can afford to allocate to this activity, but should not limit their assessment to the resources of a single agency. Instead, they should explore the ways in which a variety of different organizations (e.g., LEMA, police department, fire department, watershed management authority, and public health department) might collaborate in developing a comprehensive program. As noted in Chapter 3, the LEMC provides an excellent framework within which to achieve this collaboration.

Task 3: Identify the community's prevailing perceptions of hazards and hazard adjustments.

Of the many hazards that are prevalent in modern society, the ones that seem to produce the greatest conflict are those having a potential for inflicting significant harm on bystanders such as the residents of areas near technological facilities. The general public perceives the risks of nuclear power plants and chemical facilities as being greater than those of other technologies and natural hazards (Lindell & Earle, 1983; Slovic, 1987). In addition, they differ from technologists by considering what Hance, Chess, and Sandman (1988) call "outrage" dimensions, including a risk's (un)naturalness, (un)familiarity, (lack of) understanding by science, (lack of) detectability, (un)trustworthiness of information sources, (lack of) controllability by those exposed, (lack of) voluntariness in exposure, (un)fairness in the distribution of risks and benefits, and dread. Thus, this line of research suggests residents of most communities are likely to consider the risks of technological facilities to be greater than those of natural hazards, even if the annual fatality rate is the same for the two types of hazards (Slovic, 1987).

As noted earlier, technological hazards generate a level of risk perception exceeding what experts consider to be warranted, whereas natural hazards seem to elicit the opposite pattern. Emergency managers can begin to address this problem by explaining the community hazard/vulnerability analysis and their resulting assessments of risk area residents' personal likelihood and consequences of disaster impact. A major impediment to effective risk communication is the difficulty in explaining small probabilities of occurrence and small numbers of expected casualties per year. This has led some experts to propose risk comparisons that list the annual death rate (Morrall, 1986), loss of life expectancy (Cohen & Lee, 1979), and the time to increase risk by one chance in a million (Crouch & Wilson, 1982). Unfortunately, these solutions seem to produce more problems than they solve (Covello, 1991). Specifically, such risk comparisons typically ignore the uncertainties in the estimates (which could differ significantly from one hazard to another). Moreover, by comparing hazards only in terms of casualties, these risk comparisons equate hazards having what many people consider to be very different types of consequences. The problem is compounded when the experts presume that if people “have voluntarily accepted” risks having higher fatality rates (often these are a lifestyle risks such as automobile driving), they also “should accept” another risk having a lower fatality rate (often this is the risk of a technological facility that someone is proposing to build and operate). Of course, this argument ignores the fact that the facility risk will be added to the lifestyle risk, not substituted for it, and that the facility risk often is estimated from analytical models whereas the lifestyle risk is computed actuarially from a very large database. Even local residents who cannot articulate these distinctions explicitly often seem to be aware of them implicitly and, thus, reject these arguments.

Task 4: Set appropriate goals for the risk communication program.

As indicated earlier, hazard awareness is an important first step in the process of hazard adjustment, so people need to be informed about the hazards to which their community is exposed. This could include information about physical science, engineering, public health, social science, and planning perspectives on environmental hazards. In addition, people need to be informed about the likelihood that events of different magnitudes will occur at their locations. In the case of hurricanes, emergency managers should ensure residents of coastal communities understand the basic atmospheric processes that cause hurricanes, the long-term probabilities of their community being struck by hurricanes in Saffir-Simpson Categories 1-5 over the next ten years, and the different types of threats caused by hurricanes (wind, tornadoes, storm surge, and inland flooding). However, it also is necessary to ensure local residents personalize the risk of casualties to themselves and their families, damage to their property, and disruption to daily activities such as work, school, and shopping. To help people personalize the risk, local emergency managers should provide detailed maps showing areas at risk from wind, storm surge, and inland flooding, as well as the vulnerability of different types of structures in the community to these threats. For example, hurricane vulnerability can be assessed by defining the areas that would be affected by hurricanes in Saffir-Simpson Categories 1-5 and displaying these risk areas on large-scale maps. Such maps should indicate streets, rivers, political boundaries, and other local landmarks that will help people to identify the risk areas in which their homes and workplaces are located. These maps could be supplemented by drawings of different types of structures (e.g., mobile homes, typical single family residences, and typical multifamily structures) showing the level of damage expected for each hurricane category. Such information needs to be developed and pretested thoroughly because recent studies have shown only one- to two-thirds of coastal residents can accurately identify their hurricane risk areas, even when shown a risk area map (Arlikatti, et al., in press; Zhang, Prater & Lindell, 2004).

In addition, emergency managers must foster people’s sense of personal responsibility for self-protection to achieve high levels of household hazard adjustment adoption. Thus, it is important to remind local residents of the limits to what local government and industry can do in mitigating environmental hazards. Moreover, as the PADM indicates, risk communication programs should ensure people are aware of the available hazard adjustments and have accurate beliefs about the efficacy and resource requirements of these hazard adjustments. Indeed, there is theoretical and empirical support for the proposition that the probability of hazard adjustment adoption is higher if messages address attitudes toward the hazard adjustments themselves as well as addressing the hazard (Lindell & Whitney, 2000). That is, emergency managers should provide information about the personal consequences of hazard impact to arouse protection motivation but also identify feasible protective actions, describe the effectiveness of those actions, and help people to meet the resource requirements needed for implementation.

Finally, the risk communication program should be structured as a progressive, long-term process but emergency managers should recognize that even the most scientifically sound and effectively implemented risk communication programs will not produce very high levels of household adoptions of hazard adjustments. A long-term perspective will not demonstrate immediate results, but it can put environmental hazards on the political agenda, which can reinforce the results achieved at the household level (Birkland, 1997; Prater & Lindell, 2000).

Operational Analysis

Task 1: Identify and assess feasible hazard adjustments for the community and its households/businesses.

The purpose of this task is to address the problem that many people who know about their exposure to environmental hazards often don’t know what to do to reduce their vulnerability (Lindell & Perry, 2000). To identify feasible hazard adjustments, local emergency managers could access resources such as the American Red Cross web site at www.redcross.org/services/disaster/beprepared, where they can find information about recommended household adjustments for a wide range of hazards. These can be evaluated in terms of resource requirements such as financial cost, time and effort, knowledge and skill, tools and equipment, and required cooperation with others.

Task 2: Identify ways to provide incentives, sanctions, and technological innovations.

Some hazard adjustments require a significant amount of household resources for implementation, so the level of adoption could be increased by supplementing risk communication with sanctions, incentives, or technological innovations. As noted in Chapter 1, sanctions are appealing because they avoid the obvious costs associated with incentives and have been shown to be effective in situations such as the use of seat belts in automobiles (Escobedo, Chorba & Remmington, 1992). However, sanctions are less useful than they might seem because they require constant monitoring for enforcement, even in the workplace (Lindell, 1994a). By contrast, the financial cost of a hazard adjustment can be reduced by providing incentives such as grants, loans at subsidized interest rates, or tax credits. An alternative incentive is for emergency managers to reduce resource requirements such as knowledge and skill by providing specific plans or checklists for hazard adjustment implementation. For example, providing plans for homeowners to bolt their houses to their foundations makes this hazard adjustment feasible for do-it-yourselfers with only a modest level of construction experience, but adding a community tool bank also makes this hazard adjustment feasible for those who lack the tools and equipment that are needed.

Task 3: Identify the available risk communication sources in the community.

As noted earlier, sources can be categorized as authorities (local, state, and federal government agencies, facility operators, and scientists), news media, (especially newspapers, television, and radio) and peers (friends, relatives, neighbors, and coworkers). These sources are judged in terms of their credibility, which primarily comprises perceived expertise and trustworthiness, but these credibility perceptions are likely to vary depending upon whether a source is speaking about hazards or hazard adjustments. Within the latter category, sources are likely to be differentiated with respect to their credibility regarding disaster responses and long-term hazard adjustments and, within each of these categories, with respect to hazard adjustment efficacy and hazard adjustment resource requirements (Lindell, 1994c).

The best risk information sources will be credible because of their expertise regarding multiple hazards and their trustworthiness to multiple community groups. Previous hazard research has documented that official sources are generally the most credible, and message recipients infer credibility from the source's credentials (e.g., job title and educational degrees), acceptance by other sources of known credibility, or previous history of job performance (Perry & Lindell, 1990b). Lindell and Perry (1992) found the degree of expertise attributed to different sources varies from one hazard to another and there is evidence that perceptions of source characteristics vary by gender, ethnicity, and other demographic characteristics (Nigg, 1982; Perry, 1987; Perry & Nelson, 1991).

Source credibility has special implications among ethnic minorities, but most research on ethnicity has focused on Mexican Americans, African Americans, and Whites. The results of these studies indicate authorities (particularly firefighters and police) tend to be regarded as credible by the majority of all three ethnic groups, except under special circumstances (Lindell & Perry, 1992). African Americans and Whites tended to be more skeptical of the mass media than Mexican Americans. In general, Mexican Americans are more likely than African Americans or Whites to consider peers (friends, relatives, neighbors, or coworkers) to be the most credible sources. There is evidence, however, that the results vary by community, which appears to reflect historical differences in relationships between ethnic groups and authorities in these specific communities.

The practical implication of these differences in source credibility is that each emergency manager must identify the patterns of credibility attribution in his or her own community. There is no substitute for knowing which minority groups live and work in the community, if they are geographically concentrated (and where), and how they view alternative sources of information about environmental hazards and hazard adjustments. Such information can be gained from census data, informants, and personal observation. Census data can be used to identify those census tracts having a greater than average percentage of ethnic minorities. These data can be supplemented by informants, who can describe the nature of credibility attributions among the ethnic groups located in those areas. It is particularly important to identify *opinion leaders*, who are individuals that are recognized as especially credible by particular ethnic groups, that might be recruited to participate as additional sources of risk information. In this regard, they play the role of social influentials, as was discussed in Chapter 2, and intermediate information sources, as represented in Figure 4-2. Finally, the best information comes from emergency managers’ active outreach programs employed over a long period of time—for example, speaking at meetings of neighborhood associations and civic organizations, and involving a diverse group of citizens in advisory committees. Not only does such community involvement provide emergency managers with information about citizens’ credibility attributions, but it also enhances authorities’ visibility, fosters dialogue, and facilitates citizens’ access to accurate risk information.

Task 4: Identify the available risk communication channels in the community.

The primary risk communication channels available in most communities are electronic media such as radio and television (and, increasingly, Web sites) and print media such as local newspapers and magazines. Other print media that have been used in hazard awareness programs include brochures, posters, newsletters, telephone book inserts, comic/coloring books, reports and scientific journal articles. Additional communication channels include informal face-to-face conversations (drop-in hours at local libraries and information booths at local events and shopping malls) and formal meetings with or without audiovisual presentations such as computer simulations, slide shows and films (Hance, et al., 1988; Mileti, Fitzpatrick & Farhar, 1990). Even though emergency managers have access to all of these channels in principle, access to some of them is limited in practice because their costs exceed agency budgets. To gain access to low-cost opportunities for publicity, emergency managers must establish contacts with local media personnel. In addition, collaboration with private sector organizations can sometimes yield financial contributions that can be used to pay for low cost items such as brochures and posters.

Task 5: Identify specific audience segments.

Emergency managers face a significant dilemma when designing their hazard awareness programs. On the one hand, most risk communication programs have assumed a very homogeneous "public" and have done little to tailor information materials to different groups. One obvious reason for this strategy is that it is easier and cheaper to provide a generic program; another reason is that existing research can barely provide a basis for what to say to the "typical" person, let alone guidance on how to tailor messages to specific demographic groups. On the other hand, individuals with different demographic characteristics are likely to have different interests and concerns, distinct motives for undertaking hazard adjustments, and varying media preferences, so different approaches must be used.

A variety of sources have emphasized the importance of tailoring information to the characteristics of each audience segment (Expert Review Committee, 1987; Hance, et al., 1988; Nelson & Perry, 1991; Olson, Lagono & Scott, 1990). Accordingly, the design of these *audience segmentation* strategies should be based upon local assessments of receiver characteristics, which we have defined broadly in terms of geographic (e.g., recency and frequency of hazard experience, and proximity to the impact area) and demographic (e.g., age, sex, education, income, and ethnicity) attributes. Emergency managers should assess each audience segment's channel access and channel preference to identify the types of media (e.g., radio) and, more specifically, the channels used (e.g., specific radio stations). Next, emergency managers need to ensure recipients heed and comprehend the messages, which can be facilitated by determining each population segment's and business sector's perceptions of different information sources to assess their credibility.

Message comprehension can be improved if emergency managers determine whether there are any audience segments for whom there are language barriers. These are less likely to arise among more acculturated ethnic groups (except perhaps among Native Americans) or among ethnic groups whose socioeconomic status is similar to that of the majority population. However, language tends to be a very important issue for recent immigrants and for minority groups who either have resisted acculturation (which is most likely when there is a high level of ethnic identity) or who have experienced sufficient prejudice and discrimination to preclude acculturation. Thus, information about environmental hazards and hazard adjustments often needs to be presented in multilingual format, preferably across multiple channels. In jurisdictions with small minority populations, the number of channels will be quite limited—perhaps not including mass media at all—but the emergency managers who know their communities should be able to identify some (even informal) mechanisms of native language communication.

Moreover, emergency managers should assess the information needs of each population segment to determine what message content should be transmitted to them. Specific questions include whether local residents have adequate information about the hazards to which they are vulnerable, appropriate hazard adjustments, and the efficacy and resource requirements of those hazard adjustments. Finally, emergency managers need to identify any audience segments that lack a sense of personal responsibility or self-efficacy for adopting hazard adjustments. Any groups that are low on these characteristics should be targeted for special attention during the implementation of the risk communication program.

Resource Mobilization

Task 1: Obtain the support of senior appointed and elected officials.

The research literature from a wide range of settings indicates successful implementation of a new program in any type of organization needs the support of higher level management (Lindell, 1994b). In the public sector, obtaining the support of senior appointed and elected officials is an important step toward obtaining the participation of other government agencies, as well. Organizational support can be increased when middle managers recognize they must effectively "sell" the issues that they believe should have a high priority. This means emergency managers must successfully identify community hazard vulnerability as an important issue and propose hazard mitigation, emergency preparedness, and recovery preparedness as effective solutions.

Task 2: Enlist the participation of other government agencies.

No matter how supportive senior appointed and elected officials would like to be, they are almost certain to have few additional resources to allocate to environmental hazard management, let alone to environmental risk communication. Consequently, emergency managers should adopt an interorganizational approach, the first stage of which is to be certain each agency is aware of the risk communication programs being planned and implemented by other governmental (city, county, state and federal) agencies, nongovernmental organizations, and hazardous technological facilities. The second stage of this interorganizational approach is to develop a coalition that pools the resources of multiple agencies within local government (Drabek, 1990; Gillespie, et al., 1993; Lindell, et al., 1996a). To elicit the active support of other government agencies, emergency managers should identify ways in which collaboration can achieve the goals of both organizations. For example, emergency managers could work with the police to ensure that Block Watch (also known as Neighborhood Watch) groups are provided with information about environmental hazards.

Task 3: Enlist the participation of nongovernmental and private sector organizations.

Nongovernmental organizations such as the American Red Cross and religious organizations such as the Salvation Army are active in household emergency preparedness and, especially, disaster recovery. Some of these organizations routinely work with needy families and can identify the geographic areas in which there is a high concentration of population segments that are most likely to be vulnerable to disaster impact. These organizations can also help to identify methods of assisting households to prepare for emergencies, reduce the vulnerability of the structures in which they live, or to find safer places to which they can move.

In addition, there are many disaster-relevant infrastructure organizations such as water, wastewater, fuel, and electric power utilities that can play a significant role in promoting the adoption of hazard adjustments. Most of these respond to more routine emergencies such as severe thunderstorms and winter storms, so they are aware of the demands that disasters can place on a community. In addition, these organizations routinely send bills to all of the residents of their service areas, a situation which provides emergency managers with an opportunity to disseminate notices about sources and channels for obtaining further information about hazards and hazard adjustments.

Task 4. Work with the mass media.

Collectively, the mass media comprise a variety of channels that routinely reach a large number of community residents. Consequently, a knowledge of media goals and operations, as well as familiarity with specific news media personnel, can set the stage for relationships in which information about environmental hazards adjustment can be disseminated. At the same time, the visibility and credibility of local environmental hazard management agencies can be enhanced. In particular, contact with reporters and editors can allow emergency managers access to channels with which citizens are familiar and routinely use for information. Cultivation of a cooperative relationship with the mass media through these mechanisms serves to diversify channels for the dissemination of risk information, as well as to increase the visibility of the environmental hazard management function in the community. Finally, reporters are often aware of their specialized audiences and tend to target them directly. This aspect of media coverage creates opportunities for emergency managers to target messages to specific audience segments defined by gender, age, ethnicity (and language groups), and socioeconomic status.

It is important for emergency managers to recognize that, even though they consider environmental hazards to be a topic of vital concern for the community, reporters and editors will not automatically consider this information to be "newsworthy" during the continuing hazard phase. In order to increase the priority of this topic for the news media, many federal agencies such as the National Weather Service urge government officials to "declare" weeks for hazards such as tornadoes and hurricanes. Local emergency managers can take advantage of the publicity generated by these agencies to contact their local media. In addition, emergency managers can collaborate with the news media by working with them to develop the background materials reporters will need in an escalating crisis, emergency response, or disaster recovery. Thus, emergency managers need to anticipate what types of information reporters are likely to seek during these events and to prepare fact sheets and other "boilerplate" that can be used no matter what specific conditions occur during an emergency.

Task 5: Work with neighborhood associations and civic organizations.

Most communities have many neighborhood associations and civic organizations whose members participate when they perceive social and environmental problems in their community that they expect the organization to be successful in mitigating (Chavis & Wandersman, 1990; Florin & Wandersman, 1984). Such studies have found group members' sense of individual and collective self-efficacy is enhanced when these organizations are empowered by successfully influencing actions taken by the community (Prestby, et al., 1990). As noted in Chapter 3, emergency managers can help the leaders of these groups to increase members' organizational commitment by increasing leader initiating structure (explaining what tasks to perform and how to perform them), leader consideration (recognizing the needs and limitations of each person), and perceived reward opportunities, and by reducing role conflict (differing expectations regarding members' duties). In addition, emergency managers can work with these organizations by providing them with opportunities to learn about environmental hazards and feasible adjustments to those hazards. Time is frequently available for this purpose during organizational meetings because most of these organizations meet regularly, but are not always able to fill their meeting agendas.

Program Development

Task 1. Staff and train a crisis communication team.

One important principle of risk communication is to establish a crisis communication team as part of a broader emergency preparedness program (Churchill, 1997; Fink, 1986). The crisis communication team forms a critical link between technical experts and the population at risk, so it must be able to communicate effectively with both groups. In addition, the crisis communication team should be represented by a spokesperson who is technically competent to explain the situation clearly. As noted earlier, spokespersons will be perceived as credible if they have relevant credentials (e.g., job title and educational degrees), are accepted by other sources of known credibility, or have a demonstrated history of job performance that has enhanced their credibility (Lindell & Perry, 1992; Perry & Lindell, 1990). It also will be helpful if they receive training from public relations experts (Hance, et al., 1988).

As is the case with any other emergency response organization, the crisis communication team should have written operating procedures to guide its activation and initial contacts with the news media. The crisis communication team's procedures should include documentation of all emergency response related activities, especially an event log recording the information that was available and the criteria that were used to guide critical decisions such as those involving protective actions for the public. The crisis communication team should also prepare to monitor information being disseminated by the news media and should designate a rumor control center that will be staffed by operators who are frequently updated on the status of the incident and the response to it.

The crisis communication team should recognize that reporters are taught to describe events in terms of stories that are framed by five questions—who, what, when, where, and why (Churchill, 1997). Specifically, they will want to know what happened and what were the specific causes of the event. Other questions include who was (or will be) affected—including casualties, property damage, and economic disruption—and what authorities have done (and will do) to respond to the situation. It frequently is difficult to answer one or more of these questions because information is lacking. In such cases, it is important for the spokesperson to avoid speculation (and especially premature blame), but rather to admit he or she does not know the answer and will find out as soon as possible. This should not be interpreted as a license to plead ignorance even when you are reasonably confident about your assessment of the situation. It is important to strike a balance between avoiding speculation and withholding information.

When providing information to the news media, it is important to remember few reporters have scientific backgrounds, so technical details might not only be unnecessary but potentially confusing and thus counterproductive. To distinguish material that is informative from that which is useless or confusing requires advance preparation—especially advance contact with local reporters. This will not solve all problems; major crises such as the 911 terrorist attacks and Hurricane Katrina draw reporters from around the country and even around the world. Reporters from national or international newspapers and television networks will not cover stories in exactly the same way as local reporters, but most of the important information needs will be common to all categories of reporters.

Despite their limited knowledge about scientific and technological processes, reporters should be treated with respect because they have a difficult job to do. Specifically, they must translate complex scientific concepts in terms that can be understood by any reasonably intelligent and literate citizen. Thus, emergency managers who prepare briefing materials that facilitate this process will have a far better chance of getting their message to the public than those who continue to speak in technical jargon (McCallum & Anderson, 1991). Just as officials should translate warnings from English to minority languages in order to ensure the warning messages are transmitted correctly, agency officials also should translate their assessment of a situation from technical jargon to ordinary English to ensure this message is also transmitted correctly. It is important to provide reporters with the best available information when they face a deadline, even if that information is less reliable or current than one might prefer.

Finally, the crisis communication plan and procedures should be evaluated using drills that test the crisis communication team alone and also by means of full scale exercises that test the integration of the crisis communication function into the overall emergency response organization. Each drill or exercise should be followed by a critique that evaluates the adequacy of the crisis communication plan and procedures, as well as the staffing, training, and materials used.

Task 2: Establish procedures for maintaining an effective communication flow during an escalating crisis or emergency response.

All organizations participating in the risk communication program should establish procedures for coordinating the information they disseminate during crises and emergencies. It is especially important to routinize the flow of information among these organizations to ensure each organization receives all the information it needs as promptly as possible. The types of information needed in an escalating crisis will depend upon the circumstances, but recommendations regarding the content of incident notifications can be found in guidance for chemical (National Response Team, 1987) and nuclear (US Nuclear Regulatory Commission, 1980) facilities, and are summarized in Table 4-3. It is *advisable* that this table be adopted as a template because it is based upon long experience with escalating crises and disaster responses. It is *essential* that facility operators and local emergency managers discuss their information capabilities and needs and agree in advance what information will be exchanged when the need arises.

Task 3: Develop a comprehensive risk communication program.

As noted earlier, McGuire's (1985) system for analyzing message content can be defined in terms of the amount of material, speed of presentation, number of arguments, repetition, style, clarity, ordering, forcefulness, and extremity of the position advocated. Some of these characteristics can be measured objectively; for example, the amount of material can be measured in terms of the number of words, the speed of presentation can be measured in words per minute, and the number of arguments can be counted. Other characteristics are more ambiguous—repetition can be measured either in terms of the number of verbatim duplications of the message or the number of times an idea or argument is presented. Finally, characteristics such as the clarity and extremity of the arguments must be measured subjectively. As one might expect, there often are significant individual differences in receivers' perceptions of the subjective message characteristics as well as in their reactions to all of these message characteristics.

Table 4-3. Essential incident data.

Date and time of report
Name, affiliation, and telephone number of information source
Location, type and current status of the incident

- Derailment, containment failure, fire, explosion, liquid spill, gaseous release
- Hazardous material name, physical properties (gas, liquid, solid), environmental cues (sights, sounds, smells), and potential health effects
- Hazardous material release duration and quantity released
- Casualties and damage already incurred

Incident prognosis

- Potential for fire or explosion at site
- Potential for fire or explosion affecting residential, commercial, or industrial areas
- Hazardous material quantity available for release and expected release duration
- Locations and populations requiring protective action
- Types of protective actions recommended: evacuation, sheltering in-place, expedient respiratory protection, interdiction of food/water

Weather conditions (current and forecast wind speed and direction)
Chronology of important events in the development of the incident
Current status of response

- Facility/shipper/carrier actions: assessment, preventive, corrective, population protective actions
- Local/state/federal agency actions: assessment, preventive, corrective, population protective actions

Source: Lindell & Perry (2004).

At a somewhat broader level, Mileti and his colleagues (Mileti, et al., 1992; Mileti & Peek, 2000; Mileti & Sorensen, 1987) have defined warning message content in terms of information about the information source, the nature of the hazard, the impact location and time, guidance about recommended protective action, and frequency of repetition. Messages can be further characterized in terms of stylistic characteristics, which include message specificity (the level of information detail), consistency (compatibility of information within and between messages), and certainty (the stated or implied probability of an event's occurrence, as well as sources' apparent confidence in what they are saying). The stylistic characteristics also include clarity (simplicity of the words used in the message), accuracy (the degree to which a source's statements are proven to be correct over time), sufficiency (adequacy of the amount of information provided—neither too much nor too little), and channel (electronic, print, face-to-face).

In evaluating the suitability of message content, the primary concern is that it should take into account the protective action decision process that determines the adoption of household hazard adjustments. Although adjustment adoption intentions and actual adoption depend upon many additional variables, the four key message content factors are *personal risk*, *personal responsibility for action* (when this is necessary during the continuing hazard phase), *guidance for protective action* (including information about an action's efficacy and resource requirements), and *sources of further information*. These factors should become important themes during risk communication and should be addressed in designing messages that are most likely to have an impact.

There are several implications of the PADM for the construction of risk communication messages. First, information about hazards and hazard adjustments should be presented in a form that attracts attention and is easily understood and retained but, even then, it will require periodic repetition over time.

Second, risk communication programs should address risk perception but should not over-emphasize it. Risk perception should be addressed because probabilities are difficult for most people to understand. In particular, the statement that "there is a 1% probability of a damaging earthquake within the next year" might have little impact on people's behavior, but cumulating probabilities over time by making the mathematically equivalent statement that there is a 20% chance of an earthquake in the next twenty years does seem to make more of a difference in risk perception (Kunreuther, 2001). However, even communication programs that succeed in increasing the accuracy of people's risk perceptions are of no consequence if risk area residents fail to act on these risk perceptions by adopting effective hazard adjustments. In the case of warnings, it is especially important to describe what the risk is, where it is going to happen, when it is going to happen, and what the effects will be (Mileti, 1993). Beyond this, however, detailed explanations of risk assessment processes and hazard agent dynamics might be unnecessary or even counterproductive if such information displaces a discussion of the other three issues—personal responsibility for action, guidance for protective action (including information about a hazard adjustment's efficacy and resource requirements), and sources of further information (Mileti, 1993).

Explicitly addressing personal responsibility for action is important because research suggests repeated officials statements regarding the need for households struck by earthquakes to be self sufficient for 72 hours have increased citizens' sense of personal responsibility for self protection (Lindell & Perry, 2004). Thus, a frank acknowledgement of the limits to governmental assistance might be useful in other contexts as well. Moreover, self sufficiency is likely to increase when emergency managers describe the ways in which households can protect themselves, together with specific descriptions of the resource requirements to implement these hazard adjustments. In addition, emergency managers should work with NGOs in their communities to ensure households with low incomes and other disadvantages are able, as well as willing, to take personal responsibility for self protection.

As noted earlier in this chapter, guidance for protective action during an emergency response often requires nothing more than stating what is the recommended protective action and when to implement it (e.g., evacuate now). In other cases, such as the continuing hazard phase, guidance would include information about a hazard adjustment's efficacy and resource requirements (e.g., bolting water heaters to the foundation).

Finally, sources for further information should be addressed because message recipients vary in so many ways that they might need individualized information. This might include information about their personal risk (for those who are on the edge of the risk area), alternative protective actions (e.g., sheltering in-place rather than evacuation for those whose health status is too fragile to be moved safely), or sources of assistance (e.g., for those who have no personal vehicle and have not been able to leave with friends, relatives, neighbors, or coworkers).

In addressing the four critical risk communication issues, emergency managers should pay attention to message style factors such as achieving clarity by choosing simple, nontechnical language. The essential information is simple and can be communicated quickly by the broadcast media or in a small space by the print media. For additional detail or elaboration, people can be referred to another specific channel or source. Messages should be short enough to avoid losing receivers' attention because of seemingly irrelevant details that induce boredom. Conversely, long messages presenting many details have the potential for overloading receivers with so much information they are unable to determine what is centrally important and what is peripheral. That is, the provision of too much information is probably as dysfunctional as the provision of insufficient information. Nonetheless, emergency managers should recognize what is "too long" will vary from one community to another and even from one situation to another. In regard to the latter, people's attention spans for emergency management information will be relatively short during the continuing hazard phase, but can be expected to increase significantly during an emerging crisis or emergency response. In the latter case, lengthy messages should be repeated frequently to ensure that people can obtain the information they need if they fail to attend to it or comprehend it the first time they receive it.

In all multiethnic communities, the production of brochures or other official written information should be multilingual. It is important to note, as Lindell and Perry (1992) indicate, that translations should be professionally executed to avoid complications arising from dialect variations within the same language group. Furthermore, when providing hazard information to non-English outlets, it is appropriate to provide it in both English and the target language to minimize information distortion that might be introduced if employees of a radio or television station, newspaper, or magazine provide a "freelance" translation of the English version.

Task 4: Plan to make effective use of informal communication networks.

It is important for emergency managers to recognize peer communication takes place during all phases—the continuing hazard phase, the escalating crisis phase, and the emergency response phase. They should plan to use these informal networks to increase the level of hazard adjustment adoption in their communities and to alert peers to dangerous situations. However, even the best intended friends, relatives, neighbors and coworkers might misunderstand a message in the first place or inadvertently distort it through selective recall. One strategy for reducing distortion is to disseminate information through a range of official sources and channels, creating what Mileti (1993, p. 148) calls a "supplemental barrage of information". The idea is to provide many opportunities for citizens to hear official messages via several channels in the expectation that people will retain the common elements of these messages.

Task 5: Establish procedures for obtaining feedback from the news media and the public.

As Figure 4-1 indicates, feedback is a critical part of any communication process because it provides receivers with an opportunity to confirm they have comprehended the message, to reconcile inconsistencies within or between messages, or to obtain information that is not available in the messages they have received. Feedback is an inherent part of some communication channels such as informal face-to-face discussions. It is somewhat more limited in public hearings where public comment might be limited to a few minutes at the end of a meeting (indeed, avoiding feedback is often a major objective of such "hearings") and, in any event, individual speakers are typically limited to 3-5 minutes apiece. This need for feedback is precisely the reason why many scholars recommend informal channels of communication (e.g., Committee on Risk Perception and Communication, 1989; Covello, 1987; Hance, et al, 1988). Thus, if community or agency procedures require public hearings, these should be supplemented by less formal procedures such as advisory panels and meetings with neighborhood associations and civic organizations.

During emerging crises, there often is pressure to disseminate information more rapidly via electronic and print media, so opportunities for monitoring the degree of message distortion are somewhat limited. One effective strategy for performing this function is to monitor the news media by obtaining copies of local newspapers, listening to radio, and viewing television broadcasts. In addition, emergency managers can obtain feedback from citizens via rumor control centers with a telephone number or a Web site that has been publicized in advance.

Program Implementation During the Continuing Hazard Phase

Task 1: Build source credibility by increasing perceptions of expertise and trustworthiness.

As noted previously, disaster researchers have found those who think they are at risk from environmental hazards seek information from the news media (print and broadcast) and peers (friends, relatives, neighbors, and coworkers), as well as from authorities (federal, state and local government). In order to ensure local authorities are considered to be the *most* credible source, they must take steps during the continuing hazard phase to enhance perceptions of their expertise and trustworthiness. Accordingly, the members of the crisis communication team should ensure its procedures are coordinated with all relevant agencies' emergency operations plans. This coordination can be verified by using joint training, drills, and full-scale exercises to produce joint messages, messages that reference each other or, at least, messages that are consistent with each other.

It also is important for personnel from each agency to develop a demonstrated history of effective job performance that enhances their credibility. In part, this experience can be gained during minor incidents such as severe storms and minor floods that cause localized damage and disruption of normal activities. However, credibility can also be enhanced by effective performance in public hearings or in meetings with advisory committees, neighborhood associations, and civic organizations. Of course, expertise is only one component of credibility; trustworthiness is also essential. According to Renn and Levine (1991), trust develops when messages are perceived to be accurate, objective, and complete. This can be expected when a source is fair, unbiased, complete, and accurate (Meyer, 1988; Trumbo & McComas, 2003). Similarly, Maeda and Miyahara (2003) contend that a trustworthy source is competent, open and honest, caring and concerned, and sympathetic. Accordingly, emergency managers are advised to earn a community's trust by being competent, caring, honorable, and considering outrage factors when working with the public (Covello, McCallum & Pavlova, 1988; Hance, et al., 1988). It also is important to promote meaningful public involvement by involving the community in the continuing hazard phase (or early in the decision process of a new facility), avoiding secret meetings, and explaining the agency's procedures (especially what constraints on public participation are imposed by law and agency policy). Emergency managers also should provide accurate information that is responsive to people's requests. In this regard, it is important to recognize the difference between the information people think they need and the information experts think is needed. Emergency managers must learn to respond to both sets of information needs.

Task 2: Use a variety of channels to disseminate hazard information.

Information channels differ significantly with respect to the types of information most suited to them, so messages tend to be "channel-bound". Radio, face-to-face conversations, and oral presentations are limited to verbal information, whereas television, print media, computer simulations, slide shows, and films can convey numeric and graphic information as well as verbal information. The fact that messages disseminated through different media inherently have different characteristics implies different channels could be selected to contribute to different stages of information processing. For example, radio or television "spots" might have their greatest impact in establishing initial hazard awareness (i.e., attracting attention to the problem) and maintaining its intrusiveness by means of frequent thought and discussion. By contrast, printed materials are most effective in providing the detailed information needed to establish a perception of threat and identifying suitable hazard adjustments. This function follows from their ability to be retained and re-read to enhance comprehension and memory for important information such as definitions and checklists.

Still other channels include public meetings and interactive (listener or viewer call-in) broadcast programs, which provide opportunities for two-way communication that are effective for answering unresolved questions but have the disadvantage that communication is oral and thus less readily retained. The advantage of such interactive channels is that their use is likely to enhance the receiver's personalization of the message, but large public meetings are especially likely to elicit theatrical demonstrations of outrage rather than sincere questions. Thus, when agency policies or particular circumstances require large public meetings, Hance, et al. (1988) advocate considering the use of neutral moderators such as the League of Women Voters, structuring agendas so that public comment can be made before the end of the meeting (by which time most people have left), and breaking the meeting up into smaller working groups with specific topics to address.

In addition to the channel boundedness of certain types of information (verbal, numeric, and graphic), environmental hazard mangers should recognize channel access is unevenly distributed in communities and can be compounded by variations in ethnicity and income. Typically, variation in resources and personal skills do not eliminate channel access altogether, but instead concentrate it on a narrower range of channels. Moreover, individual preferences also restrict the access each channel provides to different community groups, so cross-channel linkages might be required. If enough channels are used, emergency managers are likely to reach all members of a community that has even the most varied pattern of channel preferences.

Task 3: Describe community or facility hazard adjustments being planned or implemented.

In many communities, there are emergency management actions being planned or implemented by local government agencies or, in the case of some technological hazards, by hazardous facility operators. Local residents should be informed of any hazard mitigation actions being taken to reduce the probability of an incident so they will understand that their risk is being reduced. Of course, it is unlikely all of them will believe these measures will be wholly effective in protecting them and, indeed, emergency managers should acknowledge there is no mitigation action that can guarantee complete safety. That is, land use and building construction practices can reduce, but not eliminate, the threat of natural hazards. The same can be said about the use of land use practices and engineered safety features in connection with technological hazards. In addition, emergency managers should describe any emergency preparedness actions being taken to facilitate an active response to an incident and any recovery preparedness actions to support a rapid restoration of the community to normal patterns of social and economic functioning after an incident occurs.

Task 4: Describe feasible household hazard adjustments.

Even when hazard mitigation actions have been implemented to reduce the likelihood of incidents ranging from floods to accidental chemical releases, some local residents will not be satisfied that these actions will provide an adequate level of safety. In such cases, emergency managers should inform risk area residents of hazard adjustments they could take to protect themselves. For example, households can mitigate flood risk by adopting a variety of floodproofing measures (Federal Emergency Management Agency, 1986), prepare for airborne releases of toxic chemicals by reducing air infiltration in their homes (Lindell & Perry, 1992), or drink bottled or boiled water in the event of groundwater contamination of local wells.

In some cases, the most cost-effective (and, sometimes, the only available) hazard adjustments are those taken by households. For example, earthquakes cannot be prevented (as engineered safety features can prevent chemical releases) or controlled (as levees can control floods). Consequently, the most effective methods for reducing earthquake casualties and damage is by household hazard adjustments, such as bolting heavy items with a high center of gravity (e.g., refrigerators, water heaters) to the walls. In such cases, emergency managers should promote the adoption of the most feasible hazard adjustments by beginning with the ones that are most effective, most generally useful, and lowest in resource requirements.

Task 5: Evaluate program effectiveness.

It is important to evaluate the effectiveness of any risk communication program by measuring the degree to which it has achieved its objectives (Stallen, 1991). An evaluation of program effectiveness is the logical complement to the goal setting activity undertaken in the strategic analysis. Thus, emergency managers should determine how to measure the goals that they have set, how to collect the data needed, and how to decide if the data indicate the goals have been achieved. This comparison process can then serve as the basis for determining whether changes need to be made in the risk communication program.

As this chapter has indicated many times, a primary goal of environmental risk communication should be to promote household adoption of hazard adjustments. Thus, the first step in the program evaluation will usually be to identify the hazard adjustments whose adoption the program is seeking to increase. The remaining steps will depend upon the resources available.

4.5: Risk Communication During an Escalating Crisis or Emergency Response

There is an important difference between a state of chronic hazard and an escalating crisis, but the time at which the transition takes place is rarely well defined. It helps to consider the definition of an escalating crisis—a situation in which there is a significantly increased probability of an incident occurring that will threaten the public's health, safety, or property. Unfortunately, the problem is that the probability of occurrence is at least partially subjective. Thus, the determination of whether a crisis exists will also be subjective. As a practical matter, a crisis exists if authorities (including technological facility operators), *or* the news media, *or* a significant proportion of those in the community believe that there is an increased risk. Asserting that a crisis exists if any of these groups defines the situation as such follows from the basic principle that "perception is reality". If the news media or local residents believe there is a crisis, then there is a crisis unless authorities can convince them otherwise. This might make it seem as if any abnormal situation will inevitably become an escalating crisis, but such is not necessarily the case. The crucial point is that authorities must be prepared to explain specifically why a situation is or is not a crisis.

Classify the Situation

Authorities can exert some control over other people's definition of a situation by establishing specific criteria in advance of an incident that systematically define elevated conditions of threat. For example, the National Weather Service has established an emergency classification system that consists of watches and warnings, whereas the US Nuclear Regulatory Commission (1980) classifies an incident as an Unusual Event, an Alert, a Site Area Emergency, or a General Emergency. The number of categories in the emergency classification system should correspond to meaningful differences in the levels of response by local authorities (and facility personnel, in the case of technological facilities), but the number of categories is less important than that the fact that the emergency classification system has been established in advance, is defined as objectively as possible, and is agreed to by all responding organizations (Lindell & Perry, 1992). By establishing a set of objective indicators of environmental or plant conditions that are linked to specific response actions, authorities commit themselves in advance to take those actions under those conditions—a situation indicating decisions are being made on the basis of rational scientific considerations rather than the exigencies of the moment.

Program Implementation During an Escalating Crisis or Emergency Response

Once authorities have determined that environmental conditions have exceeded the criteria listed in the emergency classification system, they need to implement the predetermined response actions. Many of these actions will include further emergency assessment, property protection, population protection, and incident management. One of the most important incident management actions is risk communication, and this will consist of six tasks:

- Activate the crisis communication team promptly,
- Determine the appropriate time to release sensitive information ,
- Select the communication channels appropriate to the situation,
- Maintain source credibility with the news media and the public,
- Provide timely and accurate information to the news media and the public, and
- Evaluate performance through post-incident critiques.

Task 1: Activate the crisis communication team promptly.

When the criteria in the emergency classification system have been exceeded, the crisis communication team should activate promptly and prepare to disseminate information even if it does not need to release that information immediately. Members of the team should contact all appropriate authorities and open all necessary communication links to ensure all sources of information and expertise are brought to bear on the situation. It is essential that all organizations be aware of the information being disseminated by other organizations so they can identify any disagreement and prepare appropriate explanations before they are contacted by the news media to explain the discrepancies.

Emergency managers should review the information in press kits and any background materials they have prepared for briefing the news media in press conferences or community groups in public hearings. They should also contact personnel in their agencies who are peripherally related to the crisis (e.g., plant workers and clerical support staff) to brief them about the situation. Such personnel might otherwise have only incomplete or outdated information to provide about the situation if they are queried by the news media and peers.

During the initial stages of an escalating crisis or emergency response, emergency managers should take care to review their communication objectives (Churchill, 1997). These objectives should become the criteria according to which all later press releases, press conferences, and public meetings are evaluated. In most environmental emergencies, the principal objectives will be to promote appropriate protective action by those whom the authorities believe to be in the most immediate danger and also to promote active monitoring of the situation by those who might later be determined to be at risk. The objectives should not be to prevent panic, which disaster researchers have found to be extremely rare (Drabek, 1986; Lindell & Perry, 1992). Nor should authorities ridicule what they consider to be unnecessary protective action by those who *think* they are at risk, as long as such actions do not impede the protection of those whom the authorities believe *are* at risk. It is especially important for authorities to avoid attempting to promote one protective action by criticizing another. For example, some misguided attempts have been made to promote sheltering in-place by asserting that people are exposing themselves to major traffic accident risks if they evacuate. Not only is this incorrect (the accident risks in evacuation appear to be no greater than those of normal driving; Lindell & Perry, 1992), but it is likely to lead those at risk to believe that there is nothing they can do to protect themselves.

Task 2: Determine the appropriate time to release sensitive information.

When emergency managers, but not others, can detect the subtle environmental cues that indicate the onset of an emergency, they must determine when to alert others of the danger. Thus, the crisis communication team needs to be guided by procedures that define when information is to be released, but there are no universal rules for determining when to release information because even experts disagree (Kasperson, 1987). On the one hand, early releases of information often are characterized by a significant degree of uncertainty, so there is a possibility that crisis conditions might never materialize or will be less severe than initially expected. Consequently, authorities frequently withhold information in order to avoid unnecessary disruption. The disadvantage of delaying the release of information is that this can be misinterpreted as a cover-up if the data are leaked (Hance, et al., 1988) and there are many ways in which such leaks can occur. It also is important to respond appropriately to reporters' questions when they become aware that something important is happening. Statements of "no comment" are almost certain to be interpreted as meaning that authorities have important information that is being withheld.

By contrast, early release of information tends to enhance the credibility of the information source and to increase a source's control over the agenda. In particular, being the first to break bad news provides an opportunity to put the information into an appropriate context. In addition, controlling the timing of a press release can have a significant impact on the amount of attention it receives. A press release distributed on a slow news day might receive substantially more coverage in the news media than the same information released on a busy day or late on a Friday afternoon preceding a three day weekend.

Task 3: Select the communication channels that are appropriate to the situation.

One of the most significant differences between a continuing hazard and an escalating crisis is that the latter is "newsworthy", so emergency managers will generally have little difficulty in obtaining the news media coverage they sought, usually unsuccessfully, during the continuing hazard phase. As always, news media coverage needs to be monitored to ensure reporters are accurately disseminating the information released by emergency managers, yet this procedure alone cannot ensure those at risk are receiving, heeding, and comprehending the information they need. Thus, emergency managers need to promote dialogue through two-way communication, preferably in small groups rather than massive public hearings. This will help them to understand public risk perceptions and explain risks more effectively (Hance, et al., 1988).

Even though an escalating crisis or an emergency response will prompt the news media to seek information, emergency managers should not rely only on reporters' requests for interviews to determine when and what information to disseminate. Instead, they should initiate communication with reporters through press releases and press conferences. Typically, press releases afford the most control over the agenda, whereas interviews provide the least control.

Task 4: Maintain source credibility with the news media and the public.

During an escalating crisis or emergency response, emergency managers should obtain timely and accurate data from within their own and other agencies and make their recommended actions consistent with the analyses. If the available data are incomplete, they should be honest about what is and is not known. A candid confession of ignorance might be uncomfortable at the time, but it is less dangerous to one's credibility than making up an answer that is later found out to be incorrect.

A related principle is that emergency managers should recognize the news media have many sources of information in addition to authorities. Consequently, it is important to respond to reporters when they need information for an imminent deadline because they will obtain the best information they can from whatever sources are available at the time that they need to file their stories (Churchill, 1997). Accordingly, it is often better to explain that data have been or are being collected, describe how they are being or will be analyzed, and indicate the date on which the results of the analyses will be released. Hance, et al. (1988) note that agencies should present some management options when the data reveal environmental problems, but practitioners differ in their beliefs about the balance between analyzing these options thoroughly and presenting tentative options that provide a starting point for input from the community.

Trust is a major issue because there tends to be so little of it to begin with and what there is can be lost so easily. As Kasperson (1987) noted, trust in institutions has been decreasing for some time and television anchors tend to be among the few people other than independent scientists that are generally trusted. Television anchors are trusted because they are familiar, authoritative, and have developed a track record of accuracy over time. Frequently, those who must communicate information about environmental risks are stereotyped as representatives of their organizations and, unless the stereotype is positive at the outset, it can be difficult to build trust during a crisis. This is the reason why it is so important for emergency managers to forestall public stereotypes about their agencies, and thus themselves, by working with community groups on multiple environmental issues before crises arise and publicizing the accomplishments of their agencies in handling these problems.

Task 5: Provide timely and accurate information about the hazard to the news media and the public.

News releases should be no longer than two pages with simple short sentences in plain English (Churchill, 1997). They should contain a dateline (date and location of release), the organizational source (including point of contact) for the information, a summary lead that provides a one sentence abstract of the press release, the text of the press release, and a brief description of any attachments. These should be supplemented by fact sheets that contain basic background information appropriate to any incident. There should be attachments including information such as a biographical summary about the spokesperson and other pertinent details about the hazard and official responses.

In deciding how to present risk information, it is important to assess the audience's level of technical sophistication so the presentation can avoid being too technical for people to understand, yet not so simplistic the audience is insulted. In general, it is important to presume the average member of the audience is intelligent but uninformed about environmental risks. Thus, emergency managers should avoid acronyms and use ordinary English words rather than technical jargon to explain basic concepts. They also should anticipate the possibility of confrontational tactics by the news media or some members of the public. If confronted with differing interpretations from other experts, emergency managers should be prepared to calmly reiterate their own scientific qualifications, repeat the rationale for their own position on the dispute, and explain what they believe are the weaknesses in alternative positions.

Emergency managers should be prepared to describe the process by which risks were assessed (including ways in which cautious estimates were used in different steps of the analysis), and what the risks are (in terms of quantities released, ambient concentrations, individual exposures via different pathways, probabilities of adverse effects, and expected levels of impact over different time periods). They also should be prepared to acknowledge uncertainties in hazard data and even be ready to acknowledge they don't know the answer to a question when this is the case. However, they also should be prepared to state what will be done to obtain an answer to the question and when the answer will be forthcoming.

Task 6: Evaluate performance through post-incident critiques.

To improve their performance, organizations must learn from their experience. Thus, each incident in which emergency managers must disseminate risk information to the news media or the public should be followed by a thorough critique of performance (Lindell & Perry, 1992; National Response Team, 1987). All members of the crisis communication team should review the goals of the risk communication program, the event logs kept during the incident, and other available documentation to identify deficiencies in organizational performance. Experience in drills, exercises, and incidents has demonstrated the importance of focusing on the performance of the organization rather than the performance of individuals because this enhances a spirit of cooperation. Thus, each participant should be encouraged to follow up on any deficiencies by identifying the ways in which these can be corrected by improvements in plans, procedures, training, facilities, equipment, or materials and supplies.

4.6: Case Study: Risk Perception and Warning of the Mt. St. Helens Eruption

In late March, 1980, Mt. St. Helens began a series of ash and steam eruptions that culminated six weeks later in a blast that ejected one cubic mile of material from the top of the mountain. Prior to the March eruptions, most residents of nearby communities were aware that Mt. St. Helens was a volcano and could name a specific threat that could affect their safety (Perry & Greene, 1983). The majority of those within about 20 miles of the volcano expressed concern about ashfall, whereas most of those in communities 30-40 miles away were concerned about mudflows and floods. The severity and immediacy of the volcano threat led people to search for information frequently—most of them sought information four times a day or more. The unfamiliarity of the threat led them to rely on the news media more than peers. Reliance on authorities was very high in communities closest to the volcano, but very low farther away. Similarly, residents of areas closest to the volcano thought they were more likely to evacuate and had made more preparations to evacuate.

On the day of the May 18 eruption, most of those living close to the volcano (Toutle/Silverlake) were warned by authorities (48%) but almost as many were warned by peers (41%) and few were warned by the news media (11%). By contrast, most of those living farther away the volcano (Woodland) were warned by peers (59%) and equal proportions of the remainder were warned by authorities (21%) and the news media (20%). The initial response also differed by community. Toutle/Silverlake residents were most likely to prepare to evacuate (40%), but many took family oriented action (18%), sought to confirm the warning (19%), or continued normal routines (18%). Woodland residents were most likely to take family oriented action (41%), while others sought to confirm the warning (21%) or continued normal routines (29%) rather than prepare to evacuate (7%). Most residents of both communities sought warning confirmation, but those in Toutle/Silverlake were less likely to use the mass media (33% vs. 59% in Woodland) and more likely to contact peers and local authorities.

CHAPTER OVERVIEW

5: Principal Hazards in the United States

This chapter describes the principal environmental hazards that are of greatest concern to emergency managers in communities throughout the United States. Each of these hazards will be described in terms of the physical processes that generate them, the geographical areas that are most commonly at risk, the types of impacts and typical magnitude of hazard events, and hazard-specific issues of emergency response.

5.1: Introduction
5.2: Meteorological Hazards
test
5.3: Hydrological Hazards
5.4: Geophysical Hazards
5.5: Technological Hazards

5.1: Introduction

Most of the hazards that concern emergency managers are environmental hazards, which are commonly classified as natural or technological. Natural hazards are extreme events that originate in the natural environment, whereas the technological hazards of concern to emergency managers originate in human controlled processes (e.g., factories, warehouses) but are transmitted through the air and water. The natural hazards are commonly categorized as meteorological, hydrological, or geophysical. The most important technological hazards are toxic chemicals, radiological and nuclear materials, flammable materials, and explosives.

The list of natural and technological hazards that could occur in the United States is much larger than can be addressed here. Accordingly, this chapter focuses on the hazard agents that most commonly confront local emergency managers. The first section addresses four meteorological hazards—severe storms (including blizzards), severe summer weather, tornadoes, and hurricanes. It also includes wildfires because these are significantly influenced by lack of rainfall. The second section describes three hydrological hazards—floods, storm surges, and tsunamis. The third section addresses geophysical hazards—volcanic eruptions, earthquakes, and landslides. The material in these three sections is drawn primarily from Alexander (1993), Bryant (1997), Ebert (1988), Federal Emergency Management Agency (1997), Hyndman and Hyndman (2005), Meyer (1977), Noji (1997), Scientific Assessment and Strategy Team (1994), and Smith (2001). The fourth section covers technological hazards, primarily toxic, flammable, explosive, and radiological materials. The material in these three sections is drawn primarily from Edwards (1994), FEMA (no date, a), Goetsch (1996), Kramer and Porch (1990), and Meyer (1977). The last section summarizes information on biological hazards. The material in this section is drawn primarily from World Health Organization (2004), World Health Organization/Pan American Health Organization (2004), and Chin (2000).

The chapter does not address emergencies caused by large, unexpected resource shortages, energy shortages being a prime example. Nor does it address slow onset disasters such as ozone depletion, greenhouse gas accumulation, deforestation, desertification, drought, loss of biodiversity, and chronic environmental pollution. For information on these long term hazards, see sources such as Kontratyev, Grigoryev and Varotsos (2002).

5.2: Meteorological Hazards

The principal meteorological hazards of concern to emergency managers are severe storms (including blizzards), severe summer weather, tornadoes, hurricanes, and wildfires.

Severe Storms

The National Weather Service (NWS) defines a severe storm as one whose wind speed exceeds 58 mph, that produces a tornado, or that releases hail with a 3/4 inch diameter or greater. The principal threats from these storms are lightning strikes, downbursts and microbursts, hail, and flash floods. Lightning strikes can cause casualties, but these tend to be few in number and widely dispersed so they are easily handled by local emergency medical services units. However, lightning strikes also can initiate wildfires that threaten entire communities—especially during droughts (see the discussion of wildfires below). Downbursts (up to 125 mph) and microbursts (up to 150 mph) are threats to aircraft as they take off or land. This creates a potential for mass casualty incidents. Large hail generally causes few casualties and the associated damage rarely causes significant social or economic disruption. The areas with the greatest thunderstorm hazard are in the desert southwest (northwest Arizona), the plains states (centered on Kansas) and the southeast (Florida), but only the latter two areas have high population densities.

Severe winter storms pose a greater threat than those at other times of year because freezing temperatures produce substantial amounts of snow—whose volume exceeds that of an equivalent amount of rain by a factor of 7-10. A severe winter storm is classified as a blizzard if its wind speed exceeds 38 mph and its temperature is less than 21°F (degrees Fahrenheit). These conditions can produce significant wind chill effects on the human body. Table 5-1 shows increasing wind speed significantly accelerates the rate at which a low temperature causes frostbite. It is important to recognize that a temperature of 40°F and wind speed of 20 mph will not freeze water, even though the wind chill is 30°F.

These storms can immobilize travel, isolate residents of remote areas, and deposit enormous loads of snow on buildings—collapsing the long-span roofs of gymnasiums, theaters, and arenas. In addition, the weight of ice deposits can bring down telephone and electric power lines. The hazard of winter storms is most pronounced in the northern tier of states from Minnesota to northern New England, but also can be extremely disruptive farther south where cities have less snow removal equipment.

Table 5-1. Wind Chill Index.

		Wind Temperature (°F)																	
		40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
Wind speed (mph)	5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
	10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
	15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
	20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
	25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
	30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
	35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
	40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
	45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
	50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
	55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
	60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Source: National Weather Service <www.noaa.nws.gov>

Note: Wind Chill Temperature is defined only for temperatures less than or equal to 50°F and wind speeds greater than 3 mph. Bright sunshine may increase the wind chill temperature by 10-18°F.

Frostbite times | 30 minutes | 10 minutes | 5 minutes

Extreme Summer Weather

Emergency managers should be concerned about extreme heat because this can be a silent killer within the community. The body responds to high heat by using evaporating sweat to cool itself. However, high humidity decreases the efficiency with which perspiration can discharge heat, so the body's core (internal) temperature rises. When the heat gain exceeds the amount the body can remove, extreme core temperatures can cause a series of heat-related disorders. The least serious condition is *heat cramp*, which is characterized by mild fluid and electrolyte imbalances. Next in severity is *heat syncope*, which causes sudden loss of consciousness that disappears when the victim lies down. *Heat exhaustion* produces symptoms of weakness or dizziness and *heat stroke* is a condition in which the victim might be delirious or comatose. Unless treated effectively by rapid cooling, heat stroke can produce neurological damage and fatalities in about 15% of those affected.

Temperature and humidity are combined into a heat index of *apparent temperature* the National Weather Service uses for weather advisories (see Table 5-2). Apparent temperatures of 80-90°F warrant *caution* because prolonged exposure and physical activity can cause fatigue. *Extreme caution* should be taken when apparent temperatures reach 90-105°F because prolonged exposure and physical activity can cause heat cramp and heat exhaustion. *Danger* exists when apparent temperatures reach 105-130°F because prolonged exposure and physical activity can cause heat stroke. *Extreme danger* exists when apparent temperatures exceed 130°F because heat stroke is imminent.

Hazard maps show the most severely exposed areas are in the desert Southwest, Mississippi Valley, and Southeastern states. Demographic groups at greatest risk are outdoor laborers, the very old (particularly those over 75), the very young, and those who have chronic diseases. The problem can be especially severe in the inner cities where city buildings re-radiate sunlight (increasing the ambient temperature) and block the wind (decreasing evaporative cooling). Those who live in residences lacking air conditioning have the greatest exposure when they live in high crime areas where they might even be afraid to open the windows for fans.

Table 5-2. Heat Index.

		Temperature (° F)						
		80	85	90	95	100	105	110
Relative humidity (%)	40%	79	84	90	98	109	121	135
	50%	80	86	94	105	118	133	
	60%	81	90	99	113	129	148	
	70%	82	92	105	122	142		
	80%	84	96	113	133			
	90%	85	101	121				

Note: This chart is based upon shady, light wind conditions. Exposure to direct sunlight can increase the Heat Index as much as 15°F.)Source: National Weather Service < www.noaa.nws.gov>

Heat Index	Possible Heat Disorder
80°F - 90°F	Caution: Fatigue possible with prolonged exposure and physical activity.
90°F - 105°F	Extreme caution: Sunstroke, heat cramps and heat exhaustion possible.
105°F - 130°F	Danger: Sunstroke, heat cramps, heat exhaustion likely; heat stroke possible.

Greater than 130°F	Extreme danger: Heat stroke highly likely with continued exposure.

Tornadoes

Tornadoes form when cold air from the north overrides a warmer air mass and the cold air descends because of its greater weight. The descending cold air is replaced by rising warm air, a process that initiates rotational flow inside the air mass. As the tornado forms, pressure drops inside the vortex and the wind speed increases. The resulting high wind speed can destroy buildings, vehicles, and large trees. The resulting debris becomes entrained in the wind field, which adds to the tornado's destructive power.

There are approximately 900 tornadoes each year in the United States, most of which strike Texas, Oklahoma, Arkansas, Missouri, and Kansas. However, there is also significant vulnerability in the North Central states and the Southeast from Louisiana to Florida. Tornadoes are most common during the spring, with the months of April-June accounting for 50% of all tornadoes. There also is predictable diurnal variation, with the hours from 4:00-8:00 pm being the most frequent time of impact. Tornadoes have distinct directional tendencies as well, most frequently traveling toward the northeast (54%), east (22%), and southeast (11%). Only 8% travel north, 2% travel northwest, and 1% travel west, southwest, or south, respectively. There also is a tendency for tornadoes to follow low terrain (e.g., river valleys and to move in a steady path, although they sometimes times skip about—missing some structures and striking others. A tornado's forward movement speed (i.e., the speed at which the funnel moves forward over the ground) can range 0-60 mph but usually is about 30 mph. Tornadoes can vary substantially in physical intensity and this attribute is characterized by the *Fujita scale*, which has a low end of F0 (maximum wind speed of 40 mph) and a high end of F5 (maximum wind speed of 315 mph). The Fujita scale has been criticized for neglecting the effects of construction quality, thus overestimating windspeeds for tornadoes that are F3 and higher. Discussion is underway to replace the existing Fujita scale with an Enhanced Fujita scale (for further information, see meted.ucar.edu/resource/wcm/html/230.htm for a powerpoint presentation. For discussion of this change, see www.wind.ttu.edu/F_Scale/default.htm).

Only about one third of all tornadoes exceed F2 (111 mph). The impact area of a typical tornado is 4 miles (mi) in length but has been as much as 150 mi. The typical width is 300-400 yards (yd) but has been as much as 1 mi. It is important to recognize that 90% of the impact area is affected by a wind speed of less than 112 mph, so many structures in a stricken community will receive only moderate or minor damage. Only about 3% of tornadoes cause deaths and 50% of those deaths are residents of mobile homes—structures that are built substantially less sturdily than site-built homes.

There has been an increased number of tornadoes reported during recent years, but this is due in part to improved radar and spotter networks. However, tornadoes have been observed in locations where they have not previously been seen, suggesting some long-term changes in climate are also involved. Detection is usually achieved by trained meteorologists observing characteristic clues on Doppler radar. Over the years, warning speed has been improved by NOAA Weather Radio, which provides timely and specific warnings. Those who do not receive a warning can assess their danger from a tornado's distinct physical cues; dark, heavy cumulonimbus (thunderstorm squall line) clouds with intense lightning, hail and downpour of rain immediately to the left of the tornado path, and noise like a train or jet engine. The most appropriate protective action is to shelter in-place, which is universally recommended to be a specially constructed safe room (Federal Emergency Management Agency, no date, b). If a safe room is not available, building occupants should shelter in an interior room on the lowest floor. Mobile home residents should evacuate to community shelter and those who are outside should seek refuge in a low spot (e.g., a small ditch or depression) if in-place shelter is unavailable.

Hurricanes

A hurricane is the most severe type of tropical storm. The earliest stages of hurricane development are marked by thunderstorms that intensify through a series of stages (tropical wave, tropical disturbance, tropical depression, and tropical storm) that result in a sustained surface wind speed exceeding 74 mph. At this point, the storm becomes a hurricane that can intensify to any one of the five Saffir-Simpson categories (see Table 5-3).

The nature of atmospheric processes is such that few of the minor storms escalate to a major hurricane. In the average year there are 100 tropical disturbances, 10 tropical storms, 6 hurricanes, and only 2 of these hurricanes strike the US coast. Hurricanes in Categories 3–5 account for 20% of landfalls, but over 80% of damage. Category 5 hurricanes are rare in the Atlantic (three during the 20th Century), but are more common in the Pacific. Tropical storms draw their energy from warm sea water, so they form only when there is an increase in sea surface temperature that exceeds 80°F. For most Atlantic hurricanes, this takes place in tropical water off the West African coast. These storms are generated when the surface water absorbs heat and evaporates, and the resulting water vapor rises to higher altitudes. When it condenses there, it releases rain and latent heat of evaporation. An easterly steering wind (which is named for its direction of origin, so an easterly wind blows from east to west) pushes these storms westward across the Atlantic. The hurricane season begins the first of June, reaches its peak during the month September, and then decreases through the end of November.

Table 5-3. Saffir-Simpson Hurricane Categories.

Saffir/ Simpson Category	Wind Speed (mph)	Velocity Pressure (psf)	Wind Effects
1	74 - 95	19.0	• Vegetation: some damage to foliage. • Street signs: minimal damage. • Mobile homes: some damage to unanchored structures. • Other buildings: little or no damage.
2	96 - 110	30.6	• Vegetation: much damage to foliage; some trees blown down. • Street signs: extensive damage to poorly constructed signs. • Mobile homes: major damage to unanchored structures. • Other buildings: some damage to roof materials, doors, and windows.
3	111 - 130	41.0	• Vegetation: major damage to foliage; large trees blown down. • Street signs: almost all poorly constructed signs blown away. • Mobile homes: destroyed. • Other buildings: some structural damage to small buildings.
4	131 - 155	57.2	• Street signs: all down. • Other buildings: extensive damage to roof materials, doors, and windows; many residential roof failures.
5	>155	81.3	• Other buildings: some complete building failures.

Source: Adapted from National Hurricane Center < www.nhc.noaa.gov/aboutsshs.shtml>

Hurricanes have a definite structure that is very important to understanding their effects. The hurricane *eye* is an area of calm 10-20 miles in radius that is surrounded by bands of high wind and rain that spiral inward to a ring around the eye, called the *eyewall*. The entire hurricane, which can be as much as 600 miles in diameter, rotates counterclockwise in the Northern Hemisphere. This produces a storm surge that is located in the *right front quadrant* relative to the storm track. Hurricanes have a forward movement speed that averages about 12 mph, but any given hurricane can be faster or slower than this. Indeed, each hurricane's speed can vary over time and the storm can even stall at a given point for an extended period of time. Atlantic hurricanes tend to track toward the west and north, but can loop and change direction. Storm intensity weakens as it reaches the North Atlantic (because it derives less energy from the cooler water at high latitudes) or makes landfall (which cuts the storm off from its source of energy and adds the friction of interaction with the rough land surface).

Hurricanes produce four specific threats—high wind, tornadoes, inland flooding (from intense rainfall), and storm surge. The strength of the wind can be seen in the third column of Table 5-3, which shows that the pressure of the wind on vegetation and structures is proportional to the square of the wind speed. That is, as the wind speed *doubles* from 80 mph in a Category 1 hurricane to 160 mph in a Category 5 hurricane, the velocity pressure *quadruples* from less than 20 pounds per square foot (psf) to over 80 psf. Damage from high wind (and the debris that is entrained in the wind field) is a function of a structure's exposure. Wind exposure is highest in areas directly downwind from open water or fields. Upwind hills, woodlands, and tall buildings decrease exposure to the direct force of the wind but increase exposure to flying debris such as tree branches and building materials that have been torn from their sources.

Storm clouds in the outer bands of a hurricane can sometimes produce tornadoes that are mostly small and short-lived. Hurricanes can also produce torrential rain at rates up to four inches/hour for short periods of time and one US hurricane produced 23 inches over 24 hours. Such downpours cause severe local ponding (water that fell and did not move) and inland flooding (water that fell elsewhere and flowed in). Both inland flooding and storm surge are discussed below under hydrological hazards.

Hurricane disasters resulted in relatively few casualties in the US during the 20th Century. The worst hurricane disaster occurred in Galveston, Texas, in 1900 when over 6000 lives were lost in a community of about 18,000. However, coastal counties have experienced explosive population growth in recent decades, which creates the potential for another catastrophic loss of life—Hurricane Katrina being a notable example. Moreover, economic losses are increasing substantially over time. Inflation makes only a small contribution to the increase; most of the increase is due to increased population in vulnerable areas and increased wealth (per person) in those areas (Pielke & Landsea, 1998). There is extreme variation in losses by decade due to variability in the number of storms. For example, the two decades from 1950-1969 experienced 33 hurricanes whereas the equivalent period from 1970-1988 experienced only six hurricanes.

Hurricanes are rapidly detected by satellite and continually monitored by specially equipped aircraft. Storm forecast models have been developed that have provided increasing accuracy in the prediction of the storm track. Nonetheless, there are forecast uncertainties about the eventual location of landfall, as well as the storm's size, intensity, forward movement speed, and rainfall. One of the biggest problems is that the long time required to evacuate some urbanized areas (30 hours or more, see Lindell, Prater, Perry & Wu, 2002) requires warnings to be issued at a time when storm behavior remains uncertain. The strike probability data in Table 5-4 indicate many coastal jurisdictions must be warned to evacuate even though the storm will eventually miss them. Moreover, there is significant uncertainty about the wind speed and, thus, the inland distance that must be evacuated.

Appropriate protective actions for hurricanes are well understood; within the storm surge/high wind field risk areas, shelter in-place is recommended only for elevated portions (i.e., above the wave crests) of reinforced concrete buildings having foundations anchored well below the scour line (the depth to which wave action erodes the soil on which the building rests). Authorities generally recommend that evacuation be completed before evacuation routes are flooded or high wind can overturn motor homes and other high profile vehicles. Outside storm surge risk areas, shelter in-place is suitable for most permanent buildings with solid construction, but debris sources should be controlled and permanent shutters should be installed on windows (or temporary shutters stored for quick installation). Evacuation is advisable for residents of mobile homes in high wind zones.

Table 5-4. Uncertainties about Hurricane Conditions as a Function of Time before Landfall.

Forecast period (hours)	Absolute landfall error (nautical miles)	Maximum probability	Miss/Hit Ratio	Average wind speed error (mph)
72	>200	10%	9 to 1	23
48	150	13-18%	7 to 1	18
36	100	20-25%	4 to 1	15
24	75	35-50%	2 to 1	12
12	50	60-80%	2/3 to 1	9

Source: Adapted from Emergency Management Institute/National Hurricane Center (no date)

Wildfires

All fires require the three elements of the fire triangle: *fuel*, which is any substance that will burn; *oxygen* that will combine with the fuel; and enough *heat* to ignite fuel (and sustain combustion if an external source is absent). The resulting combustion yields heat (sustaining the reaction) and combustion products such as toxic gases and unburned particles of fuel that are visible as smoke. Wildfires are distinguished mostly by their fuel. *Wildland* fires burn areas with nothing but natural vegetation for fuel, whereas *interface* fires burn into areas containing a mixture of natural vegetation and built structures. *Firestorms* are distinguished from other wildfires because they burn so intensely that they warrant a special category—in this case, they create their own local weather and are virtually impossible to extinguish. Wildfires can occur almost anywhere in the United States but are most common in the arid West where there are extensive stands of conifer trees and brush that serve as ready fuels. Once a fire starts, the three principal variables determining its severity are fuel, weather, and topography. Fuels differ in a number of characteristics that collectively define fuel type. These include the fuel's ignition temperature (low is more dangerous), amount of moisture (dry is more dangerous), and the amount of energy (resinous wood is more dangerous). A given geographical area can be defined by its fuel loading, which is the quantity of vegetation in tons per acre, and fuel continuity, which refers to the proximity of individual elements of fuel. Horizontal proximity can be defined, for example, in terms of the distance between trees. Vertical proximity can be defined in terms of the distance between different levels of vegetation (e.g., grasses, brush, and tree branches). Weather affects fire behavior by wind speed and direction as well as temperature and humidity. Wind speed and direction have the most obvious effects on fire behavior, with strong wind pushing the fire front forward and carrying burning embers far in advance of the main front. High temperature and low humidity promote fires by decreasing fuel moisture, but these can vary during the day (cooling and humidifying at sunset) as well as over longer periods of time. Topography affects fire behavior by directing prevailing wind currents and the hot air produced by the fire. Canyons can accelerate the wind by funneling it through narrow openings. Steep slopes (greater than 10°) take advantage of a fuel's location in the fire's heated updraft, which allows the advancing fire front to dry nearby fuels through radiant heating and also provide a ready path for igniting these fuels. A fire's forward movement speed doubles on a 10° slope and quadruples on a 20° slope.

Wildland fires are a major problem in the US because an average of about 73,000 such fires per year burn over three million acres. Approximately 13% of these wildfires are caused by lightning, but people cause 24% of them accidentally and 26% of them deliberately. The greatest loss of life from a US wildfire occurred in the 1871 Peshtigo, Wisconsin wildfire that killed 2200 people (Gess & Lutz, 2002). More recently, the 1991 Oakland Hills California wildfire killed 25 people, injured 150, and damaged or destroyed over 3,000 homes. Major contributors to the severity of this wildland urban interface fire were the housing construction materials (predominantly wood siding and wood shingle roofs), vegetation planted immediately adjacent to the houses, and narrow winding roads that impeded access by fire fighting equipment.

The US Forest Service maintains a Fire Danger Rating System that monitors changing weather and fuel conditions (e.g., fuel moisture content) throughout the summer fire season. Some of the fuel data are derived from satellite observations and the weather data come from hundreds of weather stations. Appropriate protective actions include evacuation out of the risk area, evacuating to a safe location (e.g., an open space such as a park or baseball field having well-watered grass that will not burn), and sheltering in-place within a fire-resistant structure (e.g., a concrete building with no nearby vegetation).

test

		Temperature(F)						
		80	85	90	95	100	105	110
Relative Humidity %	40%	1	2	3	4	5	6	7
	50%	14	13	12	11	10	9	8
	60%	15	16	17	18	19	20	21
	70%	28	27	26	25	24	23	22
	80%	15	16	17	18	19	20	21
	90%	28	27	26	25	24	23	22

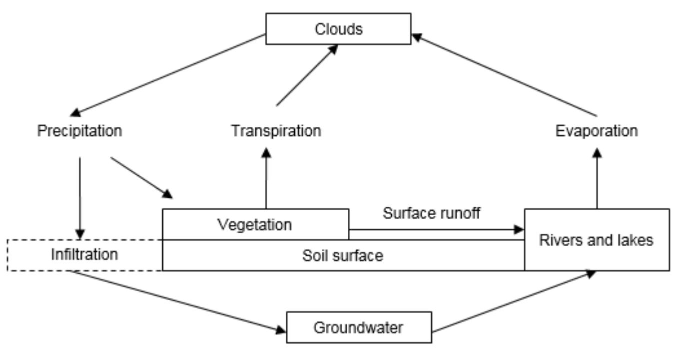
5.3: Hydrological Hazards

The principal hydrological hazards of concern to environmental hazard managers are floods, storm surges, and tsunamis.

Floods

Flooding is a widespread problem in the United States that accounts for three-quarters of all Presidential Disaster Declarations. A flood is an event in which an abnormally large amount of water accumulates in areas where it is usually not found. Flooding is determined by a hydrological cycle in which precipitation falls from clouds in the form of rain and snow (see Figure 5-1). When it reaches the ground, the precipitation either infiltrates the soil or travels downhill in the form of surface runoff. Some of the water that infiltrates the soil is taken up by plant roots and transported to the leaves where it is transpired into the atmosphere. Another portion of the ground water gradually moves down to the water table and flows underground until reaching water bodies such as wetlands, rivers, lakes, or oceans. Surface runoff moves directly to surface storage in these water bodies. At that point, water evaporates from surface storage, returning to clouds in the atmosphere.

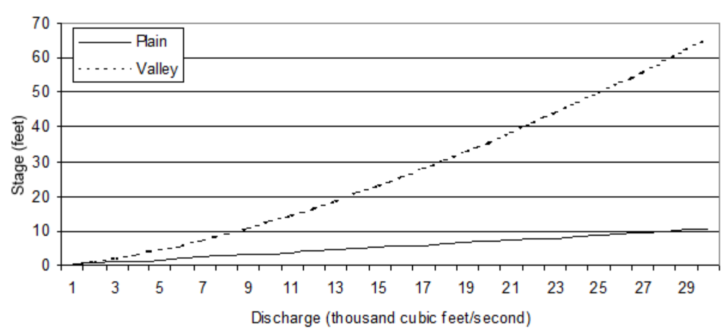
Figure 5.1: The Hydrological Cycle



There are seven different types of flooding that are widely recognized. *Riverine (main stem) flooding* occurs when surface runoff gradually rises to flood stage and overflows its banks. *Flash flooding* is defined by runoff reaching its peak in less than six hours. This usually occurs in hilly areas with steep slopes and sparse vegetation, but also occurs in urbanized areas with rapid runoff from impermeable surfaces such as streets, parking lots, and building roofs. *Alluvial fan flooding* occurs in deposits of soil and rock found at the foot of steep valley walls in arid Western regions. *Ice/debris dam failures* result when an accumulation of downstream material raises the water surface above the stream bank. *Surface ponding/local drainage* occurs when water accumulates in areas so flat that runoff cannot carry away the precipitation fast enough. *Fluctuating lake levels* can occur over short-term, seasonal, or multiyear periods, especially in lakes that have limited outlets or are entirely landlocked. *Control structure (dam or levee) failure* has many characteristics in common with flash flooding.

Floods are measured either by discharge or stage. Discharge, which is defined as the volume of water per unit of time, is the unit used by hydrologists. Stage, which is the height of water above a defined level, is the unit needed by emergency managers because flood stage determines the level of casualties and damage. Discharge is converted to stage by means of a rating curve (see Figure 5-2). The horizontal axis shows discharge in cubic feet per second and the vertical axis shows stage in feet above flood stage. Note that high rates of discharge produce much higher stages in a valley than on a plain because the valley walls confine the water.

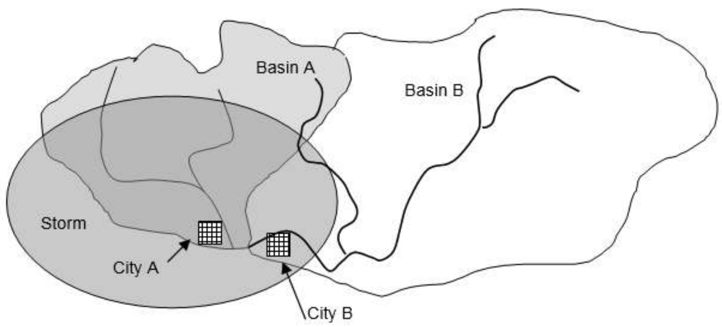
Figure 5.2: Stage Rating Curve



Flooding is affected by a number of factors. The first of these, precipitation, must be considered at a given point and also across the entire watershed (basin). The total precipitation at a point is equal to the duration of precipitation times its intensity (frequently measured in inches per hour). Total precipitation over a basin is equal to precipitation summed over all points in the surface area of the basin. The precipitation's contribution to flooding is a function of temperature because rain (a liquid) is immediately available whereas snow (a solid) must first be melted by warm air or rain. Moreover, as indicated by Figure 5-3, the precipitation from a single storm might be deposited over two or more basins and the amount of rainfall in one basin might be quite different from that in the other basin. Consequently, there might be severe flooding in a town on one river (City A) and none at all in a town on another river (City B) even if the two towns received the same amount of rainfall from a storm.

As the hydrological cycle makes clear, flooding is also affected by surface runoff, which is determined by terrain and soil cover. One important aspect of terrain is its slope, with runoff increasing as slope increases. In addition to slope steepness, slope length and orientation to prevailing wind (and, thus, the accumulation of rainfall and snowfall) and sun (and, thus, the accumulation of snow) are also important determinants of flooding.

Figure 5.3: Map of the Distribution of Precipitation from a Storm



Slope geometry is also an important consideration. Divergent slopes (e.g., hills and ridges) provide rapid runoff dispersion. By contrast, convergent slopes (e.g., valleys) provide runoff storage in puddles, potholes, and ponds. Mixed slopes have combinations of these, so slope mean (the average slope angle) and variance (the variability of slope angles) determine the amount of storage. A slope with a zero mean and high variance (a plain with many potholes) will provide a larger amount of storage than a slope with a zero mean and low variance (a featureless plain). Similarly, a slope with a positive mean and high variance (a slope with many potholes) will provide a larger amount of storage than a slope with a positive mean and low variance.

Soil cover also affects flooding because dense low plant growth slows runoff and promotes infiltration. In areas with limited vegetation, surface permeability is a major determinant of flooding. Surface permeability increases with the proportion of organic matter content because this material absorbs water like a sponge. Permeability also is affected by surface texture (particle size and shape). Clay, stone, and concrete are very impermeable because particles are small and smooth, whereas gravel and sand are very permeable—especially when the particles are large and have irregular shapes that prevent them from compacting. Finally, surface permeability is affected by soil saturation because even permeable surfaces resist infiltration when soil pores (the spaces between soil particles that ordinarily are filled with air) become filled with water. Groundwater flows via local transport to streams at the foot of hill slopes and via remote transport through aquifers. Rapid in- and outflow through valley fill increases peak flows whereas very slow in- and outflow through upland areas maintains flows between rains.

Evapotranspiration takes place via two mechanisms. First, there is direct evaporation to atmosphere from surface storage in rivers and lakes. Second, there is uptake from soil and subsequent transpiration by plants. Transpiration draws moisture from the soil into plants' roots, up through the stem, and out through the leaves' pores (similar to people sweating). The latter mechanism is generally much higher in summer than in winter due to increased heat and plant growth, but transpiration is negligible during periods of high precipitation.

Stream channel flow is affected by channel wetting which infiltrates the stream banks (horizontally) until they are saturated as the water rises. In addition, there is seepage because porous channel bottoms allow water to infiltrate (vertically) into groundwater. Channel geometry also influences flow because a greater channel cross-section distributes the water over a greater area, as does the length of a *reach* (distinct section of river) because longer reaches provide greater water storage. High levels of discharge to downstream reaches can also affect flooding on upstream reaches because flooded downstream reaches slow flood transit by decreasing the river's elevation drop.

Flooding increases when upstream areas experience deforestation and overgrazing, which increase surface runoff to a moderate degree on shallow slopes and to a major degree on steep slopes as the soil erodes. The sediment is washed downstream where it can silt the channel and raise the elevation of the river bottom. These problems of agricultural development are aggravated by flood plain urbanization. Like other cities throughout the world, US cities have been located in flood plains because water was the most efficient means of transportation until the mid-1800s. Consequently, many cities were located at the head of navigation or at transshipment points between rivers. In addition, cities have been located in flood plains because level alluvial soil is very easy to excavate for building foundations. Finally, urban development takes place in flood plains because of the aesthetic attraction of water. People enjoy seeing lakes and rivers, and pay a premium for real estate that is located there.

One consequence of urban development for flooding is that cities involve the replacement of vegetation with *hardscape*—impermeable surfaces such as building roofs, streets, and parking lots. This hardscape decreases soil infiltration, thus increasing the speed at which flood crests rise and fall. Another factor increasing flooding is intrusion into the flood plain by developers who fill intermittently flooded areas with soil to raise the elevation of the land. This decreases the channel cross-section, forcing the river to rise in other areas to compensate for the lost space.

Flood risk areas in the US are generally defined by the 100-year flood—an event that is expected to have a 100-year recurrence interval and, thus, a 1% chance of occurrence in any given year. It is important to understand that these extreme events are essentially independent, so it is possible for a community to experience two 100-year floods in the same century. Indeed, it is *possible* to have them in the same year even though that would be a very *improbable* event. This statistical principle is misunderstood by many people who believe there can be only one 100-year flood per century. The belief that a 100-year flood occurring this year cannot be repeated for another 100 years (or at least nearly 100 years) is a very dangerous fallacy. Moreover, a 100-year flood is an arbitrary standard of safety that reflects a compromise between the goals of providing long-term safety and developing economically valuable land. A 50-, 200-, or even a 500-year standard could be used instead. Community adoption of a 50-year flood standard would provide more area for residential, commercial, and industrial development. However, the resulting encroachment into the flood plain would lead to more frequent damaging floods than would a 100-year flood standard. Alternatively, a community might use different standards for different types of structures. For example, it might restrict the 100-year floodplain to low intensity uses (e.g., parks), allow residential housing to be constructed within the 500-year floodplain, and restrict nursing homes, hospitals, and schools to areas outside the 500-year floodplain.

Emergency response to floods is supported by prompt detection, which is local or regional in scope. This includes automated devices such as radar for assessing rainfall amounts at variable points in a watershed, rain gages for detecting rainfall amounts at predetermined points in a watershed, and stream gages for detecting water depth at predetermined points along a river. Detection also can be achieved by manual devices such as spotters for assessing rainfall amounts, water depth, or levee integrity at specific locations (planned before a flood or improvised during one). Once data on the quantity and distribution of precipitation have been collected, they are used to estimate discharge volumes over time from the runoff characteristics of a given watershed (e.g., soil permeability and surface steepness) at a given time (e.g., current soil saturation). Once discharge volume is estimated, it can be used together with downstream topography (e.g., mountain valley vs. plain) to predict downstream flood heights.

Timely and specific warnings of floods are provided by commercial news media as well as NOAA Weather Radio. The most appropriate protective action for persons is to evacuate in a direction perpendicular to the river channel. Because flash floods in mountain canyons can travel faster than a motor vehicle, it is safest to climb the canyon wall rather than try to drive out. It also is important to avoid crossing running water. Just two feet of fast moving water can float a car and push it downstream with 1000 pounds of force.

Storm Surge

Storm surge is an elevated water level that exceeds the height of normal astronomical tides. It is most commonly associated with hurricanes, but also can be caused by extratropical cyclones (nor'easters). The height of a storm surge increases as atmospheric pressure decreases and a storm's maximum wind speed increases. Storm surge is especially significant where coastal topography and bathymetry (submarine topography) have shallow slopes and the coast has a narrowing shoreline that funnels the rising water. These factors are magnified when the storm remains stationary through several tide cycles and the affected coast is defined by low-lying barrier islands whose beaches and dunes have been eroded either by human development or by recent storms. Storm surge—together with astronomical high tide, rainfall, river flow, and storm surf—floods and batters structures and scours areas beneath foundations as much as 4-6 feet below the normal grade level. At one time, storm surge was the primary source of casualties in all countries, but inland flooding is now the primary cause of hurricanes deaths in the US. However, surge is still is the primary source of casualties in developing countries such as Bangladesh. In these countries, population pressure pushes the poor to farm highly vulnerable areas and poverty limits the development of dikes and seawalls, warning systems, evacuation transportation systems, and vertical shelters (wind resistant structures that are elevated above flood level).

Tsunamis

Tsunamis are commonly referred to as "tidal" waves but they are, in fact, sea waves that are usually generated by earthquakes. In addition, tsunamis can be caused by volcanic eruptions or landslides that usually, but not always, occur undersea. Tsunamis are rare events because 15,000 earthquakes over the course of a century have generated only 124 tsunamis, a rate of less than 1% of all earthquakes and only 0.7 tsunamis per year. This low rate of tsunami generation is attributable to earthquake intensity; two-thirds of all Pacific tsunamis are generated by shallow earthquakes exceeding 7.5 in magnitude.

Tsunamis can travel across thousands of miles of open ocean (e.g., from the Aleutians to Hawaii or from Chile to Japan) at speeds up to 400 mph in the open ocean, but they slow to 25 mph as they begin to break in shallow water and run up onto the land. Tsunamis are largely invisible in the open ocean because they are only 1-2 feet high. However, they have wave lengths up to 60 miles and periods as great as one hour. This contrasts significantly with ordinary ocean waves having wave heights up to 30 feet, wave lengths of about 500 feet, and periods of about 10 seconds. Tsunamis can have devastating effects in some of the places where they make landfall because the waves encounter bottom friction when the water depth is less than 1/20 of their wavelength. At this point, the bottom of the wave front slows and is overtaken by the rest of the wave, which must rise over it. For example, when a wave reaches a depth of 330 feet, its speed is reduced from 400 mph to 60 mph. Later, reaching a depth of 154 feet reduces its speed to 44 mph. This causes the next 650 feet of the wave to overtake the wave front in a single second. As the wave continues shoreward, each succeeding segment of the wave must rise above the previous segment because it can't go down (water is not compressible) or back (the rest of the wave is pressing it forward). Because the wavelength is so long and wave speed is so fast, a large volume of water can pile up to a very great height—especially where the continental shelf is very narrow. It is important to note that the initial cue to tsunami arrival might be that the water level drops, rather than rises. Indeed, this was the case in the 2004 Indian Ocean tsunami. People's failure to understand the significance of the receding water contributed to a death toll exceeding 200,000. An initial *wave* is created only if the seafloor rises suddenly, whereas an initial *trough* is created if the seafloor drops. In either case, the initial phase will be followed by the alternate phase (i.e., a wave is followed by a trough or vice-versa).

Tsunamis threaten shorelines worldwide and have no known temporal (i.e., diurnal or seasonal) variation. If a tsunami is initiated locally (i.e., within a hundred miles), the potential for a tsunami can be detected by severe earthquake shaking. However, coastal residents' only physical cue to a remotely initiated tsunami is wave arrival at coast, although the arrival of a trough (making it appear that the tide went out unexpectedly) should be recognized as a danger sign. International tsunami warning systems base their detection of remote tsunamis on seismic monitoring to detect major earthquakes and tidal gauges located throughout the Pacific basin to verify tsunami generation. Once tsunami generation has been confirmed, alerts can be transmitted throughout the Pacific basin. The need for prompt action can be inferred from tsunami's forward movement speed; a tsunami generated 100 miles away from a coast can arrive in about 15 minutes.

The physical magnitude of a tsunami is extremely impressive. Wave crests can arrive at 10-45 minute intervals for up to six hours and the highest wave, as much as 100 ft at the shoreline, can be anywhere in the wave train. The area flooded by a tsunami is known as the inundation zone, which equivalent to a 100-year floodplain or hurricane storm surge risk area. Because of the complexities in accounting for wave behavior and the characteristics of the offshore bathymetry and onshore topography, tsunami inundation zones must be calculated by competent analysts using sophisticated computer programs. The physical impacts include casualties caused by deaths from drowning and traumatic injuries from wave impact. Property damage is caused by the same mechanisms.

Regarding protective measures, sheltering in-place in elevated structures can protect against surge. However, steel reinforced concrete structures on deep pilings are required to withstand wave battering and foundation scour. Consequently, evacuation to higher ground is the most effective method of population protection. Evacuation to a safe distance out of the runup zone is obviously difficult on low-lying coasts, but it also can be difficult where there are nearby hills if the primary evacuation route runs parallel to the coastline.

5.4: Geophysical Hazards

To properly understand geophysical hazards, it is important to recognize the earth's three distinct geological components. The *core* consists of molten rock at the center of the earth, the *crust* is solid rock and other materials at the earth's surface that vary in depth from four miles under the oceans to 40 miles in the Himalayas, and the *mantle* is an 1800 mile thick layer between the core and the crust. According to tectonic theory, the earth's crust is defined by large plates that float on the mantle and move gradually in different directions over time.

Tectonic plates can diverge, converge, or move laterally past each other. When they diverge, new material is generated from below the earth's mantle, usually at mid-ocean ridges, that flows very slowly (at a rate of a few inches per year) away from the source. This process produces a gradual expansion of the plate toward an adjoining plate. Thus, one plate converges with another plate and the heavier material (a seafloor) is *subducted* under lighter material (a continent). In the US, this process is taking place in the Cascadian Zone along the Pacific coast of Washington, Oregon, and Northern California. Tectonic activity produces intermittent movement, which causes earthquakes and sometimes tsunamis. In addition, the subducted material travels to great depth within the earth where it is liquefied under intense heat and pressure. The resulting magma causes volcanic activity.

Crustal plates also move laterally past each other as, for example, the North American plate is moving northward past the Pacific Plate along the San Andreas fault. Friction can lock the fault and increases strain until it is released suddenly in an earthquake; the longer the fault is locked, the more energy is stored until it is released. Finally, there is some intraplate activity such as the mid-ocean "hot spots" that have formed the Hawaiian Islands and mid-continental fault zones. One US example is the New Madrid Seismic Zone affecting Missouri, Illinois, Indiana, Kentucky, Tennessee, Mississippi, and Arkansas.

These tectonic processes give rise to the most important geophysical hazards in the US—volcanic eruptions and earthquakes. However, landslides are another geophysical hazard that will also be addressed in this section.

Volcanic Eruptions

Volcanoes are formed when a column of magma (molten rock) rises from the earth's mantle into a magma chamber and later erupts at the surface, where it is called lava. Successive eruptions, deposited in layers of lava or ash, build a mountain. Major eruptions create craters that are gradually replaced in dome-building eruptions. Cataclysmic eruptions create calderas that leave only a depression where the mountain once stood. US volcanoes (recently erupted) are located principally in Alaska (92) and Hawaii (21), as well as along the west coast of the 48 contiguous states (73): Oregon has 22, California has 20, and Washington has 8. Vulcanologists distinguish among 20 different types of volcanoes that vary in the type of ejected material, size, shape, and other characteristics, but the two most important types of volcanoes are shield volcanoes and stratovolcanoes. Shield volcanoes produce relatively gentle *effusive* eruptions of low-viscosity lava, resulting in shallow slopes and broad bases (e.g., Kilauea, Hawaii). Stratovolcanoes produce *explosive* eruptions of highly acidic lava, gas, and ash, resulting in steep slopes and narrow bases. One well known stratovolcano is Mt. St. Helens, Washington, which erupted spectacularly in 1980 (see Perry & Greene, 1983; Perry & Lindell, 1990).

The principal threats from volcanoes include gases and tephra that are blasted into the air, pyroclastic flows that blast laterally from volcano flanks, and the heavier lava and lahars that generally travel downslope. Many gases are dangerous because they are heavier than air, so they accumulate in low-lying areas. Other than harmless water vapor (H_2O), some gases are simple asphyxiants that are dangerous because they displace atmospheric oxygen (carbon dioxide, CO_2; methane, CH_4). There are also chemical asphyxiants (carbon monoxide, CO) that are dangerous because they prevent the oxygen that is breathed in from reaching the body's tissues. In addition, there are corrosives (sulfur dioxide, SO_2; hydrogen sulfide, H_2S; hydrogen chloride, HCl; hydrogen fluoride, HF; and sulfuric acid, H_2SO_4) and radioactive gases (such as radon, Ra). Tephra consists of solid particles of rock ranging in size from talcum powder ("ash") to boulders ("bombs"). Pyroclastic flows are hot gas and ash mixtures (up to 1600°F) discharged from the crater vent. Lahars are mudflows and floods, usually from glacier snowmelt, with varying concentrations of ash. The impacts of volcanic eruption tend to be strongly directional because ashfall and gases disperse downwind; pyroclastic flows follow blast direction and lava and lahars travel downslope through drainage basins. The forward movement speed of the hazard varies. Gas and tephra movements are determined by wind speed, usually less than 25 mph. Pyroclastic flows can move at over 100 mph. Lava typically moves at walking speed (5 mph) but can travel faster (35 mph) on steep slopes. Lahars move at the speed of water flow, usually less than 25 mph, but can exceed 50 mph in some instances.

The physical magnitude of the hazard also differs for each specific threat. Inundation depths for ashfall and lahars can range up to tens of meters in depth. Lava flows and pyroclastic flows are so hot that any impact is considered to be unsurvivable. Similarly, the impact area also varies by threat. Tephra deposition depends on eruption magnitude, wind speed, and particle size, with traces of ash circling the globe. Lava flows, lahars, and pyroclastic flows follow localized drainage patterns, so safe locations can be found only a short distance from areas that are totally devastated. These considerations indicate volcano risk areas can be defined as listed in Table 5-5.

Table 5-5. Volcano Risk Areas.

Category	Name	Distance*	Threats
1	Extreme	0-100 m	High risk of heat, ash, lava, gases, rock falls, and projectiles
2	High	100-300 m	High risk of projectiles
3	Medium	300-3000 m	Medium risk of projectiles
4	Low	3 km – 10 km	Low risk of projectiles
5	Safe	> 10 km	Minimal risk of projectiles

* (In meters and kilometers; these distances do not include mudflows and floods that can travel up to 100 km or tsunamis that can travel thousands of km.

Source: Adapted from < www.volcanodiscovery.com>

The physical impacts of a volcanic eruption vary with the type of threat. Gases can cause deaths and injuries from inhalation, but pyroclastic flows are more dangerous because they can cause deaths and injuries from blast, thermal exposure, and inhalation of gas and ash. In addition, they also can cause property damage from blast, heat, and coverage by ash (even after it has cooled). Tephra causes property damage from excess roof loading, shorting of electric circuits, clogged air filters in vehicles, and abrasion of machinery. Deaths and injuries can be caused by bomb impact trauma, and health effects can result from ash inhalation (including fluoride poisoning of grazing animals). Lava causes property damage from excess heat and coverage by rock (when cooled). Deaths and injuries from thermal exposure to lava can occur, but are rare because it moves so slowly. Lahars can cause property damage from flooding and coverage by ash (when water drains off) and deaths from drowning. Tsunamis cause property damage from wave impact and water saturation, as well as deaths from drowning and traumatic injuries. In addition, volcanic eruptions can cause tsunamis and wildfires as secondary hazards.

The threat of volcanic eruption can be detected by physical cues indicating rising magma. These include earthquake swarms, outgassing, ash and steam eruptions, and topological deformation (changes in slope, flank swelling). Appropriate protective measures include sweeping ash from building roofs and evacuating an area at least six miles in radius for a crater eruption and 12-18 miles in the direction of a flank/lateral eruption. People also should be evacuated from floodplains threatened by lahars. The principal problem in implementing evacuations is that there are substantial uncertainties in the timing (onset and duration) of eruptions, so people have sometimes been forced to stay away from their homes and businesses for months at a time. In some cases, the expected eruption never did materialize, causing severe conflict among physical scientists, local civil officials, and disrupted residents.

Earthquakes

When an earthquake occurs, energy is released at the *hypocenter*, which is a point deep within the earth. However, the location of an earthquake is usually identified by a point on the earth's surface directly above the hypocenter known as the *epicenter*. Earthquake energy is carried by three different types of waves, P-waves, S-waves, and surface waves. P-waves, typically called primary waves but are more properly known as pressure waves, travel rapidly. By contrast, S-waves, typically called secondary waves but technically known as shear waves, travel more slowly but cause more damage. The third type, surface waves, includes Love waves and Rayleigh waves. These have very low frequency and are especially damaging to tall buildings.

The physical magnitude of an earthquake is different from its intensity. *Magnitude* is measured on a logarithmic scale where a one-unit increase represents a 10-fold increase in seismic wave amplitude and a 30-fold increase in energy release from the source. Thus, a M8.0 earthquake releases 900 (30 x 30) times as much energy as a M6.0 earthquake. By contrast, *intensity* measures the impact at a given location and can be assessed either by behavioral effects or physical measurements. The behavioral effects of earthquakes are classified by the Modified Mercalli Intensity Scale, which defines each category (see Table 5-6, column 1) in terms of its behavioral effects of earthquake motion on people, buildings, and objects in the physical environment (column 3). Physical measurements can be assessed in terms of average peak acceleration (column 4), which describe seismic forces in horizontal and vertical directions. This acceleration is measured either as the number of millimeters per second squared (mm/sec^2) or as a multiple of the force of gravity (g = 9.8 $meters/sec^2$)

The impact of an earthquake at a given point is determined by a number of factors. First, intensity decreases with distance from the epicenter, with slow attenuation along the fault line and more rapid attenuation perpendicular to the fault line. In addition, soft soil transmits energy waves much more readily than bedrock, and basins (loose fill surrounded by rock) focus energy waves. Thus, isoseismal contours (lines of constant seismic energy) can be extremely irregular, depending on fault direction and soil characteristics. The complex interplay of these factors can be seen in Figure 5-4, which displays the isoseismal contours (lines of equal seismic intensity) for the 1994 Northridge earthquake.

Within the impact area, the primary earthquake threats (mostly associated with plate boundaries) are ground shaking, surface faulting, and ground failure. Ground shaking creates lateral and upward motion in structures designed only for (downward) gravity loads. In addition, unreinforced structures respond poorly to tensile (upward stretching) and shear (lateral) forces, as do "soft-story" (e.g., buildings with pillars rather than walls on the ground floor) and asymmetric (e.g., L-shaped) structures. Moreover, high-rise buildings can demonstrate resonance, which is a tendency to sway in synchrony with the seismic waves, thus amplifying their effects.

Surface faulting—cracks in the earth's surface—is a widespread fear about earthquakes that actually is far less of a problem than popularly imagined. The vulnerability of buildings to surface faulting is easily avoided by zoning regulations that prevent building construction within 50 feet of a fault line. Unfortunately, zoning restrictions are infeasible for utility networks (water, wastewater, and fuel pipelines, electric power and communications lines, roads and railroads) that must cross the fault lines.

Table 5-6. Modified Mercalli Intensity (MMI) Scale for Earthquakes.

Category	Intensity	Type of Damage	Max. acceleration (mm/sec^{-2})
I	Instrumental	Detected only on seismographs	< 10
II	Feeble	Some people feel it	< 25
III	Slight	Felt by people resting; like a large truck rumbling by	< 50
IV	Moderate	Felt by people walking; loose objects rattle on shelves	< 100
V	Slightly strong	Sleepers awake; church bells ring	< 250
VI	Strong	Trees sway; suspended objects swing; objects fall off shelves	< 500
VII	Very strong	Mild alarm; walls crack; plaster falls	< 1000
VIII	Destructive	Moving cars uncontrollable; chimneys fall and masonry fractures; poorly constructed buildings damaged	< 2500
IX	Ruinous	Some houses collapse; ground cracks; pipes break open	< 5000
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread	< 7500
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards	< 9800
XII	Catastrophic	Total destruction; trees driven from ground; ground rises and falls in waves	> 9800

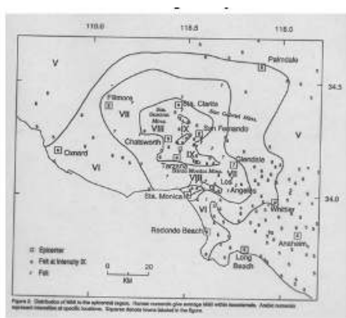
Source: Adapted from Bryant (1991).

Ground failure is defined by a loss of soil bearing strength and takes three different forms. Landsliding occurs when a marginally stable soil assumes a more natural angle of repose (a more detailed discussion is presented in the next section). Fissuring or differential settlement occurs when loose fill, which is very prone to compaction and consolidation, is located next to other soils that are less prone to this behavior. Finally, soil liquefaction is caused by loss of grain-to-grain support in saturated soils (e.g., where there is a high water table). Ground failure is a threat because building foundations need stable soil to support the rest of the structure. Even partial failure of the soil under the foundation can destroy a building by causing it to tilt at a dangerous angle.

Earthquakes also can cause major secondary threats such as tsunamis, dam failures, hazardous materials releases, and building fires. Tsunamis were addressed earlier, but dam failures can occur if ground shaking causes earth or rock dams to rupture or the valley walls abutting the dam to fail. Hazardous materials releases can occur if ground shaking causes containment tanks or pipes to break. Fires are caused by broken fuel and electric power lines that provide the necessary fuel and ignition sources. In addition, fire spread is promoted when broken water lines prevent fire departments from extinguishing the initial blazes.

As yet, there is no definitive evidence of physical cues that provide reliable forewarning of an imminent earthquake. Unusual animal behavior has been observed, but this has not proved to be a reliable indicator of an imminent earthquake. The Chinese successfully predicted an earthquake at Haicheng in 1975 and saved thousands of lives by evacuating the city. However, there was no forewarning of the 1976 earthquake at Tangchan. Currently, earth scientists are examining many potential predictors such as increased radon gas in wells, increased electrical conductivity and magnetic anomalies in soil, and topographic perturbations such as changes in ground elevation, slope, and location ("creep"). There were great expectations for short-term earthquake predictions 30 years ago, but seismologists currently give only probabilities of occurrence within long periods (5, 10, or 20 years).

Figure 5-4. Isoseismal Contours for the Northridge Earthquake.



Source: Adapted from Dewey, et al. (1994).

Very short term forewarning of earthquakes can sometimes be initiated by detection of the relatively harmless P-waves that arrive from distant earthquakes a few seconds before the arrival of the damaging S-waves and surface waves. Currently, however, there is no method of advance detection and warning for local earthquakes because these are so close to the impact area that P-waves and S-waves arrive almost simultaneously. Protective measures can be best understood by the common observation that "earthquakes don't kill people, falling buildings (especially unreinforced masonry buildings) kill people". Thus, building occupants are advised to shelter in-place under sturdy furniture while the ground is shaking. Those who survive the collapse of their buildings typically attempt to rescue those survivors who remain trapped, but the success of this improvised response depends upon the type of building. Unreinforced masonry buildings are much more likely to collapse, but search and rescue from these structures can be relatively easy. By contrast, steel-reinforced concrete buildings are much less likely to collapse, but search and rescue is extremely difficult unless sophisticated equipment is available to well-trained urban search and rescue teams. Unfortunately, almost all victims will die by the time remote urban search and rescue (USAR) teams arrive because crush injuries usually kill within 24 hours. However, USAR teams take longer than this to mobilize and travel to the incident site. Another problem with earthquakes is that destruction of infrastructure (electric power, fuel, water, wastewater, and telecommunications) impairs emergency response. Consequently, households, businesses, and local governments must be self-sufficient for at least 72 hours until outside assistance can arrive.

Landslides

The term *landslide* is often used to refer generically to a number of different physical phenomena involving the downward displacement of rock or soil that moves because of gravitational forces. *Slides* occur because a failure surface is created by two distinct soil strata and the upper stratum is displaced downslope. Some slides are triggered by earthquakes or volcanic eruptions. However, many are caused by heavy rainfall that saturates soil, increasing the weight of the upper surface and lubricating the failure surface. *Debris flows* have such a high water content distributed throughout the soil mass that they act like a viscous (thick) fluid. *Lateral spreads* involve the outward movement of material on the sides and downward movement of material on the top of a soil mass. *Topples* and *falls* involve rock masses that detach from steep slopes and either tilt or fall free to a lower surface.

Slopes remain stable when shear stress is less than shear strength. Shear stress increases with the steepness of the slope and the weight placed on that slope. Shear strength depends upon the internal cohesion (interlocking or sticking) of soil particles and the internal friction of particles within a soil mass, which is reduced by soil saturation. Thus, landslides are most common in areas having steep slopes composed of susceptible soils types (i.e., ones with low internal cohesion) that are stratified (creating failure surfaces) and saturated with water. Slide probability is commonly increased by four different conditions. The first occurs when slopes have been cleared of vegetation, whereas the second occurs when excavations for houses and roads use the “cut and fill” method on unstable steep slopes. (This technique is used to create a level surface on a slope by cutting soil out of a section of hillside and using it to fill the area below this cut.) The third condition creating landslides occurs when the construction of many buildings and roads significantly increases the weight placed on the slope and the fourth condition occurs when construction of access roads removes support from the foot of the slope.

Landslide risk areas can be mapped by conducting geological surveys to identify areas having slopes with distinct soil strata that are likely to separate when saturated or shaken. Visible cues of imminent slides can also be seen at the head and toe of a potential slide area, which can be monitored to determine whether to take protective actions. These include installing slope drainage systems or retaining walls, and temporarily evacuating or permanently relocating the population at risk.

5.5: Technological Hazards

Hazardous materials

Hazardous materials (also known as *hazmat*) are regulated by a number of federal agencies including the US Department of Transportation, US Environmental Protection Agency, US Nuclear Regulatory Commission, and the Occupational Safety and Health Administration of the US Department of Labor. In addition, the US Coast Guard and Federal Emergency Management Agency of the US Department of Homeland Security have responsibilities for emergency response to hazmat incidents. Because these agencies have different responsibilities, they have correspondingly different definitions of hazmat. According to the Department of Transportation, hazmat is defined as substances that are “capable of posing unreasonable risk to health, safety, and property” (49CFR 171.8).

Until the late 1980s, the location, identity, and quantity of hazmat throughout the United States was generally undocumented. However, Title III of the Superfund Amendments and Reauthorization Act—SARA Title III (also known as the Emergency Planning and Community Right to Know Act—EPCRA) of 1986 required those who produce, handle, or store amounts exceeding statutory threshold planning quantities of approximately 400 Extremely Hazardous Substances (EHSs) to notify local agencies, their State Emergency Response Commission (SERC), and the US EPA. Nonetheless, the Chemical Abstract Service (CAS) lists 1.5 million chemical formulations with 63,000 of them hazardous. There are over 600,000 shipments of hazmat per day (100,000 of which are shipments of petroleum products). Fortunately, only a small proportion of these chemicals account for most of the number of shipments and the volume of materials shipped (see Table 5-7, adapted from Lindell & Perry, 1997a). These hazmat shipments result in an average of 280 liquid spills or gaseous releases per year, the vast majority of which occur in transport. Of these spills and releases, 81% take place on the highway and 15% are in rail transportation. These incidents cause approximately 11 deaths and 311 injuries per year.

Table 5-7. Volume of production for top 12 EHSs, 1970–1994.

Rank in top 50	Chemical name	Year				% increase 1970-1994
		1970	1980	1990	1994	
1	Sulfuric acid	29,525	44,157	44,337	44,599	51
8	Ammonia	13,824	19,653	17,003	17,965	30
10	Chlorine	9,764	11,421	11,809	12,098	24
13	Nitric acid	7,603	9,232	7,931	8,824	16
23	Formaldehyde	2,214	2,778	3,360	4,277	93
25	Ethylene oxide	1,933	2,810	2,678	3,391	75
31	Phenol	854	1,284	1,769	2,026	137
33	Butadiene	1,551	1,400	1,544	1,713	10
34	Propylene oxide	590	884	1,483	1,888	220
36	Acrylonitrile	520	915	1,338	1,543	197
37	Vinyl acetate	402	961	1,330	1,509	275
47	Aniline	199	330	495	632	218

Source: Adapted from Lindell and Perry (1997a).

Emergency managers typically expect to find hazmat produced, stored, or used at fixed-site facilities such as petrochemical and manufacturing plants. However, such materials are also found in facilities as diverse as warehouses (e.g., agricultural fertilizers and pesticides), water treatment plants (chlorine is used to purify the water), and breweries (ammonia is used as a refrigerant). Hazmat is transported by a variety of modes—ship, barge, pipeline, rail, truck, and air. In general, the quantities of hazmat on ships, barges, and pipelines can be as large as those at many fixed site facilities, but quantities usually are smaller when transported by rail, smaller still when transported by truck, and smallest when transported by air. Small to moderate size releases of less hazardous materials at fixed site facilities are occupational hazards but often pose little risk to public health and safety because the risk area lies within the facility boundary lines. However, releases of this size during hazmat transportation are frequently a public hazard because passers-by can easily enter the risk area and become exposed. The amount that is actually released is often much smaller than the total quantity that is available in the container but prudence dictates that the planning process assume the plausible worst case of complete release within a short period of time (e.g., 10 minutes in the case of toxic gases, see US Environmental Protection Agency, 1987). In addition to the quantity of the hazmat released, the size of the risk area depends upon its chemical and physical properties.

The US DOT groups hazmat into nine different classes—explosives, gases, flammable liquids, flammable solids, oxidizers and organic peroxides, toxic (poisonous) materials and infectious substances, radioactive materials, corrosive materials, and miscellaneous dangerous goods. Each of these hazmat classes is described in the remainder of this section. It is important to be aware that classification of a substance into one of these categories does not mean it cannot be a member of another class. For example, hydrogen sulfide is transported as a compressed gas that is both toxic and flammable.

Explosives

Explosives are chemical compounds or mixtures that undergo a very rapid chemical transformation (faster than the speed of sound) generating a release of large quantities of heat and gas. For example, one volume of nitroglycerin expands to 10,000 volumes when it explodes; it is this rapid increase in volume that creates the surge in pressure characteristic of a blast wave. Explosives vary in their sensitivity to heat and impact. Class A consists of high explosives that *detonate* (up to 4 mi/sec), producing overpressure, fire, and missile hazards. Class B consists of low explosives that *deflagrate* (approximately .17 mi/sec—about 4% as fast as a detonation) and cause fires and flying debris (usually referred to as missile hazards). Class C consists of low explosives that are fire hazards only. Explosives can cause casualties and property damage due to overpressure from atmospheric blast waves or missile hazards. Destructive effects from the quantities of explosives found in transportation can be felt as much as a mile or more away from the incident site.

Compressed gases are divided into flammable and nonflammable gases. Nonflammable gases—such as carbon dioxide, helium, and nitrogen—are usually transported in small quantities. These are a significant hazard only if the cylinder valve is broken, causing the contents to escape rapidly through the opening and the container to become a missile hazard. Flammable gases (acetylene, hydrogen, methane) are missile and fire hazards. Rupture of gas containers can launch missiles up to a mile, so evacuation out to this distance is advised if there is a fire. Large quantities of flammable gases, such as railcars of liquefied petroleum gas (LPG), are of significant concern because the released gas will travel downwind after release until it reaches an ignition source such as the pilot light in a water heater or the ignition system in a car. At distances of one-half mile or more, the gas cloud can erupt in a fireball that flashes back toward the release point. Emergency managers need to understand the community-wide hazards associated with fires arising from flammable gases. Consequently, this topic is discussed in greater detail later in this chapter.

Flammable liquids

Flammable liquids, which evolve flammable vapors at 80°F or less, pose a threat similar to flammable gases. A volatile liquid such as gasoline rapidly produces large quantities of vapor that can travel toward an ignition source and erupt in flame when it is reached. When a flammable liquid is spilled on land, there should be a downwind evacuation of at least 300 yards. A flammable liquid that floats downstream on water could be dangerous at even greater distances and one that is toxic requires special consideration (see the section on toxic chemicals, below). A fire involving a flammable liquid should stimulate consideration of an evacuation of 800 yards in all directions.

Flammable solids

Flammable solids self-ignite through friction, absorption of moisture, or spontaneous chemical changes such as residual heat from manufacturing. Flammable solids are somewhat less dangerous than flammable gases or liquids, because they do not disperse over wide areas as gases and liquids do. A large spill requires a downwind evacuation of 100 yards, but a fire should stimulate consideration of an evacuation of 800 yards in all directions.

Oxidizers and organic peroxides

Oxidizers and organic peroxides include halogens (e.g., chlorine and fluorine), peroxides (e.g., hydrogen peroxide and benzoyl peroxide), and hypochlorites. These chemicals destroy metals and organic substances and also enhance the ignition of combustibles (a spill of liquid oxygen can cause the ignition of asphalt roads on a hot summer day). Oxidizers and organic peroxides do not burn, but are hazardous because they promote combustion and some are shock sensitive. A large spill should prompt a downwind evacuation of 500 yards and a fire should initiate an evacuation of 800 yards in all directions.

Toxic chemicals

Toxic chemicals, which can have large impact areas, are classified in a number of ways. DOT Class 2 consists of nonflammable gases and Class 6 is defined as poisons. Class A includes gases and vapors, a small amount of which is an inhalation hazard, whereas Class B consists of liquids or solids that are ingestion or absorption hazards. Many of these chemicals are defined by SARA Title III/EPCRA as EHSs. Toxic materials are a major hazard because of the effects they can produce when inhaled into the lungs, ingested into the stomach by means of contaminated water or food, or absorbed through the skin by direct contact. Of these exposure pathways, inhalation hazard is typically the greatest concern because high concentrations achieved during acute exposure can kill in a matter of seconds. Nonetheless, prolonged ingestion can cause cancers in those who are exposed and also can cause genetic defects in their offspring. Moreover, chemical contamination of victims poses problems for volunteers and professionals providing first aid and transporting victims to hospitals. These chemicals vary substantially in their volatility and toxicity, so evacuation distances following a spill or fire must be determined from the Table of Protective Action Distances in the *Emergency Response Guidebook* (US Department of Transportation, 2000, see www.dot.gov). Emergency managers need to understand the community-wide hazards that could result from a toxic chemical release. Consequently, this topic is discussed in greater detail later in this chapter.

Infectious substances

Infectious substances have rarely been a significant threat to date because there are relatively few shipments of these substances, they usually are transported in small quantities, and they have restrictive requirements for packaging and marking. However, infectious substances have the potential to be used in terrorist attacks, so emergency managers should knowledgeable about them. This topic is discussed in greater detail in the section on biological hazards.

Radioactive materials

Radioactive materials are substances that undergo spontaneous decay, emitting ionizing radiation in the process. The types and quantities of materials transported in the US generally have very small impact areas. With the exception of nuclear power plants, for which planning is supported by state and federal agencies and electric utilities, releases of radioactive materials are likely to involve small quantities. Nonetheless, even a few grams of a lost radiographic source for industrial or medical X-rays can generate a high level of public concern. Here also, the recently recognized threat of terrorist attack from a “dirty bomb” that uses a conventional explosive to scatter radioactive material over a wide area deserves emergency managers’ attention because of the potential for long-term contamination of central business districts. A large spill should prompt a downwind evacuation of 100 yards and a fire should initiate an evacuation of 300 yards in all directions. Emergency managers need to understand the community-wide hazards that could arise from a release of radioactive materials. Consequently, this topic is discussed in greater detail later in this chapter.

Corrosives

Corrosives, which are substances that destroy living tissue at the point of contact, can be either acidic or alkaline. Examples of acids include hydrochloric acid (HCl) and sulfuric acid (H_2SO_4), whereas examples of alkaline substances (caustics) include sodium hydroxide (NaOH), potassium hydroxide (KOH), and ammonia (NH_4). In addition to producing chemical burns of human and animal tissues, corrosives also degrade metals and plastics. The most frequently used and transported substances in this class are not highly volatile, so the geographical area affected by a spill is likely to be no greater than 100 yards unless the container is involved in a fire or the hazmat enters a waterway (e.g., via storm sewers). These chemicals vary substantially in volatility and toxicity, so evacuation distances following a spill or fire must be determined from the Table of Protective Action Distances in the *Emergency Response Guidebook.*

Miscellaneous dangerous goods

Miscellaneous dangerous goods, as the name of this category suggests, this class comprises a diverse set of materials such as air bags, certain vegetable oils, polychlorinated biphenyls (PCBs), and white asbestos. Materials in this category are low to moderate fire or health hazards to people within 10-25 yards.

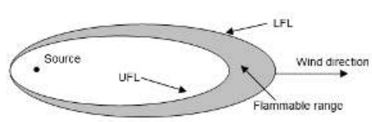
Fires

Flammable materials support rapid oxidization that produces heat and affects biological systems by thermal radiation (burns). As noted earlier in the section on wildfires, combustion requires the three elements of the fire triangle: *fuel*, which is any substance that will burn; *oxygen* that will combine with the fuel; and enough *heat* to ignite the fuel. Combustion usually yields enough heat to sustain the combustion reaction, but it also produces combustion products that might be more dangerous than the heat. Combustion of simple hydrocarbons or alcohols as fuels generally yields carbon dioxide, carbon monoxide, water vapor, and unburned vapors of the fuel as combustion products. More complex and heavier substances such as pesticides also yield carbon dioxide, carbon monoxide, water vapor, and unburned vapors of the fuel. However, they also produce highly toxic chemicals. It can be very difficult to predict what will be the combustion products from a building fire (e.g., an agricultural warehouse) because the temperature of the fire is variable over time and from one location to another in the fire, and the chemicals reacting with each other often are variable over time and from one location to another in the fire.

In understanding combustion, it is important to recognize an important distinction between gases and liquids. A gas is a substance that, at normal temperatures and pressures, will expand to fill the available volume in a space. By contrast, a liquid is a substance that, at normal temperatures and pressures, will spread to cover the available area on a surface. Any liquid contains some molecules that are in a gaseous state; this is called vapor. All liquids generate increasing amounts of vapor as the temperature increases and the pressure decreases. Conversely, at a given temperature and pressure, the amount of vapor in a liquid varies from one substance to another. There are three temperatures of each flammable liquid that are important because they determine the production of vapor. In turn, vapor generation is important because *it is the vapor that burns, not the liquid.* The three important temperatures of a liquid substance are its boiling point, flash point, and ignition temperature. The boiling point is the temperature of a liquid at which its vapor pressure is equal to atmospheric pressure. Vapor production is negligible when a fuel is below its boiling point but increases significantly once it exceeds this temperature. The flash point of a liquid is the temperature at which it gives off enough vapor to flash momentarily when ignited by a spark or flame. A liquid is defined as combustible if it has a flash point above 100°F. (e.g., kerosene) and flammable if it has a flash point below 100° F. (e.g., gasoline). The final temperature to understand is the ignition temperature, which is the minimum temperature at which a substance becomes so hot that its vapor will ignite even in the absence of an external spark or flame.

Gases and vapors have flammable limits that are defined by the concentration (percent by volume in air) at which ignition can occur in open air or an explosion can occur in a confined space. The lower flammable/explosive limit (LFL/LEL) is the minimum concentration at which ignition will occur. Below that limit the fuel/air mixture is “too lean” to burn. The upper flammable/explosive limit (UFL/UEL) is the maximum concentration at which ignition will occur. Above that limit the fuel/air mixture is “too rich” to burn. When released from a source, a flammable gas or vapor disperses in an approximately circular pattern if there is no wind but in an approximately elliptical pattern in the normal situation in which the wind is blowing (see Figure 5-5).

Figure 5.5: Flammable Plume



The most dangerous flammable substances have a low ignition temperature, low LEL, and wide flammable range. Indeed, gasoline is widely used precisely because of these characteristics. It has a low flash point (–45 to –36°F), a low LFL (1.4-1.5%), and a reasonably wide range (6%). By contrast, peanut oil is useful in cooking because it has the opposite characteristics—a high flash point (540°F) and an undefined LFL because it does not vaporize.

An important hazard of flammable liquids is a *Boiling Liquid Expanding Vapor Explosion* (BLEVE), which occurs when a container fails at the same time as the temperature of the contained liquid exceeds its boiling point at normal atmospheric pressure. BLEVEs involve flammable or combustible compressed gases that are not classified as “explosive substances”, but can produce fireballs as large as 1000 feet in diameter and launch shrapnel to distances up to one half mile from the source.

Toxic Industrial Chemical Releases

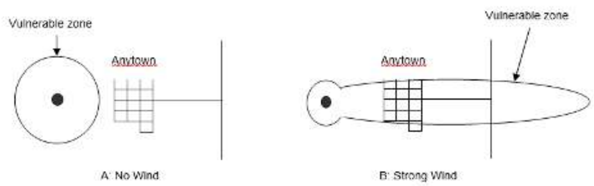
Toxic industrial chemical releases are of special concern to emergency managers because the airborne dispersion of these chemicals can produce lethal inhalation exposures at distances as great as 10 miles and sometimes even more. The spread of a toxic chemical release can be defined by a dispersion model that includes the hazmat's chemical and physical characteristics, its release characteristics, the topographic conditions in the release area, and the meteorological conditions at the time of the release. The chemical and physical characteristics of the hazmat include its quantity (measured by the total weight of the hazmat released), volatility (as noted earlier, higher volatility means more chemical becomes airborne per unit of time), buoyancy (whether it tends to flow into low spots because it is heavier than air), and toxicity (the biological effect due to cumulative dose or peak concentration). It also includes the chemical's physical state—whether it is a solid, liquid (remember, a substance above its boiling point is a vapor), or a gas at ambient temperature and pressure. In general, vapors and gases are major hazards because they are readily inhaled and this is the most rapid path into the body.

Release characteristics are defined by the chemical's temperature and pressure in relation to ambient conditions, its release rate (in pounds per minute), and the size (surface area) of the spilled pool if the substance is a liquid. Temperature and pressure are important because the rate at which the chemical disperses in the atmosphere increases when these parameters exceed ambient conditions. The release rate is important because it determines the concentration of the chemical in the atmosphere. Specifically, a higher release rate puts a larger volume of chemical into a given volume of air, thus increasing its concentration (where the latter is defined as the volume of chemical divided by the volume of air in which it is located).

Topographical conditions relevant to liquid spills include the slope of the ground and the presence of depressions. As is the case with flooding, steep slopes allow a liquid to rapidly move away from the location of the spill. Both flat slopes and depressions decrease the size of a liquid pool which, in turn, affects the size of the pool's surface area and reduces the rate at which vapor is generated from it. Thus, dikes are erected around chemical tanks to confine spills in case the tanks leak and hazmat responders build temporary dikes around spills for the same reason. Topographical characteristics also affect the dispersion of a chemical release in the atmosphere. Hills and valleys are land features that channel the wind direction and can increase wind speed at constriction points—for example, where a valley narrows and causes wind speed to increase due to a "funnel" effect. Forests and buildings are rough surfaces that increase turbulence in the wind field, causing greater vertical mixing. By contrast, large water bodies have very smooth surfaces that do not constrain wind direction and, because they provide no wind turbulence, allow a chemical release to maintain a high concentration at ground level where it is most dangerous to people nearby.

The immediate meteorological conditions of concern during a hazmat release are wind speed, wind direction, and atmospheric stability class. The effect of wind speed on atmospheric dispersion can be seen in Figure 5-6, which shows a release dispersing uniformly in all directions when there is no wind (Panel A). Thus, the plume isopleth (contour of constant chemical concentration) corresponding to the Level of Concern (LOC) for this chemical is a circle. The nearby town lies outside the vulnerable zone so its inhabitants would not need to take protective action. However, Panel B describes the situation in which there is a strong wind, so the plume isopleth corresponding to the LOC for this chemical takes the shape of an ellipse. In this case, the nearby town lies inside the vulnerable zone and would need to take protective action.

Figure 5-6. Effects of Wind Speed on Plume Dispersion.



As Table 5-8 indicates, the atmospheric stability class can vary from Class A through Class F. Class A, the most unstable condition, occurs during strong sunlight (e.g., midday) and light wind. This dilutes the released chemical by mixing it into a larger volume of air. Class F identifies the most stable atmospheric conditions, which take place during clear nighttime hours when there is a light wind. These conditions have very little vertical mixing, so the released chemical remains highly concentrated at ground level.

Table 5-8. Atmospheric Stability Classes.

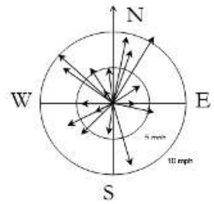
	Strength of sunlight			Nighttime conditions	
Surface Wind Speed (mph)	Strong	Moderate	Slight	Overcast ³ 50%	Overcast < 50%
< 4.5	A	A-B	B	-	-
4.5-6.7	A-B	B	C	E	F
6.7-11.2	B	B-C	C	D	E
11.2-13.4	C	C-D	D	D	D
>13.4	C	D	D	D	D

A: Extremely Unstable Conditions
B: Moderately Unstable Conditions
C: Slightly Unstable Conditions
D: Neutral Conditions (heavy overcast day or night)
E: Slightly Stable Conditions
F: Moderately Stable Conditions

Source: Adapted from FEMA, DOT, EPA (no date, a).

It is important to recognize that meteorological characteristics can sometimes remain stable for days at a time, but at other times can change from one hour to the next. Figure 5-7, adapted from McKenna (2000), displays the wind direction at each hour during the day of the accident at the Three Mile Island (TMI) nuclear power plant in terms of the orientation of an arrow. Wind speed is indicated by the length of the arrow. The figure shows wind speed and direction changed repeatedly during the course of the accident, so any recommendation to evacuate the area downwind from the plant would have referred to different geographic areas at different times during the day. This would have made evacuation recommendations extremely problematic because the time required to evacuate these areas would have taken many hours. Consequently, the evacuation of one area would have still been in progress when the order to initiate an evacuation in a very different direction was initiated.

Figure 5-7. Wind Rose from 3:00 a.m. to 6:00 p.m. on the First Day of the TMI Accident.



Source: Adapted from McKenna (2000).

The ultimate concern in emergency management is the protection of the population at risk. The risk to this target population varies inversely with distance from the source of the release. Specifically, the concentration (*C*) of a hazardous material decreases with distance (*d*) according to the inverse square law (i.e., $C = 1/d^2$). However, distance is not the only factor that should be of concern. In addition, the density of the population should be considered because a greater number of persons per unit area increases risk area population. Moreover, there might be differences in susceptibility within the risk area population because individuals differ in their dose-response relationships as a function of age (the youngest and oldest tend to be the most susceptible) and physical condition (those with compromised immune systems are the most susceptible).

Toxic chemicals differ in their exposure pathways—inhalation, ingestion, and absorption. Inhalation is the means by which entry into the lungs is achieved. This is generally a major concern because toxic materials can pass rapidly through lungs to bloodstream and on to specific organs within minutes of the time that exposure begins. Ingestion is of less immediate concern because entry through the mouth into the digestive system (stomach and intestines) is a slower route into the bloodstream and on to specific organs. Depending on the chemical's concentration and toxicity, ingestion exposures might be able to be tolerated for days or months. Authorities might choose to prevent ingestion exposures by withholding contaminated food from the market or recommending that those in the risk area drink boiled or bottled water. Absorption involves entry directly through the pores of the skin (or through the eyes), so it is more likely to be a concern for first responders than for local residents. Nonetheless, some chemicals can affect local populations in this way, as was the case with the release of methyl isocyanate during the accident in Bhopal, India, in 1984.

The harmful effects of toxic chemicals are caused by alteration of cellular functions (cell damage or death), which can be either acute or chronic in nature. Acute effects occur during the time period from 0–48 hours. Irritants cause chemical burns (dehydration and exothermic reactions with cell tissue). Asphyxiants are of two types; simple asphyxiants such as carbon dioxide (CO_2) displace oxygen (O_2) within a confined space or are heavier than oxygen so they displace it in low-lying areas such as ditches. By contrast, chemical asphyxiants prevent the body from using the oxygen even if it is available in the atmosphere. For example, carbon monoxide (CO) combines with the hemoglobin in red blood cells more readily than does O_2 so the CO prevents the body from obtaining the available O_2 in the air. Anesthetics/narcotics depress the central nervous system and, in extreme cases, suppress autonomic responses such as breathing and heart function.

Chronic, or long-term, effects can be general cell toxins, known as cytotoxins, or have organ specific toxic effects. In the latter case, the word *toxin* is preceded by a prefix referring to the specific system affected. Consequently, toxins affecting the circulatory system are called hemotoxins, those affecting the liver are hepatotoxins, those affecting the kidneys are nephrotoxins, and those affecting the nervous system referred to as neurotoxins. Other chronic effects of toxic chemicals are to cause cancers, so these chemicals are referred to as carcinogens. Mutagens cause mutations in those directly exposed, whereas teratogens cause mutations to the genetic material of those directly exposed and, thus, mutations in their offspring. The severity of any toxic effect is generally due to a chemical's rate and extent of absorption into the bloodstream, its rate and extent of transformation into breakdown products, and its rate and extent of excretion of the chemical and its breakdown products from the body (i.e., the substances into which the chemical decomposes).

Research on toxic chemicals has led to the development of dose limits. Some important concepts in defining dose limits are the LD-50, which is the dose (usually of a liquid or solid) that is lethal to half of those exposed, and the LC-50, which is the concentration (usually of a gas) that is lethal to half of those exposed. Based upon these dose levels, authoritative sources have devised dose limits that are administrative quantities that should not be exceeded. LOCs are values provided by EPA indicating the *Level of Concern* or "concentration of an EHS [Extremely Hazardous Substance] above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time" (US Environmental Protection Agency, 1987, p. XX). IDLHs are values provided by NIOSH/OSHA indicating the concentration of a gas that is *Immediately Dangerous to Life or Health* for those exposed more than 30 minutes. TLVs are *Threshold Limit Values*, which are the amounts that the American Conference of Government Industrial Hygienists has determined that a healthy person can be exposed to 8–10 hours/day, 5 days/week throughout the work life without adverse effects.

Weaponized Toxic Chemicals

Although it seems plausible that a deliberate attack might use explosives to cause release toxic chemicals from a domestic source such as a chemical plant, rail car, or tank truck, it also is possible that a weaponized toxic agent might be used. Such agents were originally used by the military in battles dating back to World War I. Over the years, attention turned to increasingly toxic chemicals that, by their very nature, require smaller doses to achieve a significant effect (e.g., disability or death). One consequence of the more advanced toxic agents is that they can affect victims through absorption in secondary *contamination*. That is, chemical residues on a victim's skin or clothing can affect those who handle that individual. Indeed, any object on which the chemical is deposited becomes an avenue of secondary contamination (World Health Organization, 2004). A list of the most likely weaponized toxic agents is presented in Table 5-9. Some of these agents are produced by biological processes (botulism, anthrax, and encephalitis) that affect victims through the production of toxins and, thus, are more properly considered to be chemical weapons (World Health Organization, 2004).

Table 5-9. Weaponized Toxic Agents.

Agent	Example
Tear gases/other sensory irritants	Oleoresin capsicum ("pepper spray")
Choking agents (lung irritants)	Phosgene
Blood gases	Hydrogen cyanide
Vesicants (blister gases)	Mustard gas
Nerve gases	O-Isopropyl Methylphosphonofluoridate (Sarin gas)
Toxins	Clostrinium botulinum ("botulism")
Bacteria and rickettsiae	Bacillus anthracis ("anthrax")
Viruses	Equine encephalitis

Source: Adapted from World Health Organization (2004)

A terrorist attack involving a toxic chemical agent might be detected initially by fire, police, or emergency medical services personnel responding to a report of a mass casualty incident. Likely symptoms include headache, nausea, breathing difficulty, convulsions, or sudden death—especially when these symptoms are displayed by a large number of people in the same place at the same time. In this case, the appropriate response will be the same as in any other hazardous materials incident. Specifically, there will be a need to control access to the incident site, decontaminate the victims as needed, and transport them for definitive medical care. In addition to the normal coordination with emergency medical services and hospital personnel, it is appropriate for emergency managers to be aware of the assistance that is available from local poison control centers. Other than that, the capabilities needed to respond effectively to an attack using toxic chemicals will be much the same as those needed for an industrial accident involving these materials (World Health Organization, 2004). Unfortunately, few communities—even those with a significant number of chemical facilities—have hospitals with the capability to handle mass casualties from toxic chemical exposure caused by either an industrial accident or a terrorist attack.

In the event of a terrorist attack, emergency managers will need to deal with a consideration that is not encountered in most other incidents to which they respond. Specifically, the incident site will be considered a crime scene by law enforcement authorities. Consequently, emergency mangers must learn about the basic procedures these personnel will follow, including collecting evidence, maintaining a chain of custody over that evidence, and controlling access to the incident scene. This latter issue should be carefully coordinated to avoid a conflict between emergency management procedures for victim rescue and law enforcement procedures for crime scene security.

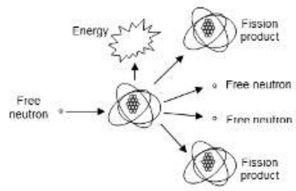
Radiological Material Releases

There are 123 nuclear power plants in the US, most of which are located in Northeast, Southeast, and Midwest. To understand the radiological hazards of these plants, it is necessary to understand the *atomic fission reaction*. The atoms of chemical elements consist of positively charged protons and neutrally charged neutrons in the atom's nucleus, together with negatively charged electrons orbiting around the nucleus. Some unstable chemical elements undergo a process of spontaneous decay in which a single atom divides into two less massive atoms (known as fission products) while emitting energy in the form of heat and ionizing radiation. The ionizing radiation can take the form of alpha, beta, or gamma radiation. Alpha radiation can travel only a very short distance and is easily blocked by a sheet of paper but is dangerous when inhaled (e.g., Pu-plutonium). Beta radiation can travel a moderate distance but be blocked by a sheet of aluminum foil. Gamma radiation can travel a long distance and can be blocked only by very dense substances such as stone, concrete, and lead.

Radioactive materials are used for a variety of purposes. Small quantities of some materials are used as sources of radiation for medical and industrial diagnostic purposes (e.g., imaging fractured bones and faulty welds). Large quantities of other radiological materials are used as sources of heat to produce the steam needed to drive electric generators at power plants. In these nuclear power plants, enriched uranium fuel fissions when struck by a free neutron (see Figure 5-8). The thermal energy released is used to heat water and, thus, produce steam. The free neutrons are used to continue a sustained chain reaction and the fission products are waste products that must eventually be disposed in a permanent repository.

The fuel temperature is controlled by cooling water and the reaction rate is controlled by neutron absorbing rods. The amount of fission products increases with age, so the reactor is refueled by moving the fuel in stages toward the center of the reactor vessel. Spent fuel, which contains a significant amount of radioactive fission products and some uranium, is stored onsite until transfer to a repository. The nuclear fuel is located in the plant's reactor coolant system (RCS), where it is contained in fuel pins that are welded shut and inserted into long rods that are integrated into assemblies. Cooling water is pumped into the reactor vessel where it circulates, picks up heat (and small amounts of radioactive fission products) from the fuel, and flows out of the reactor vessel.

Figure 5-8. The Atomic Fission Reaction.



There are two types of RCSs, Pressurized Water Reactors (PWRs) and Boiling Water Reactors (BWRs). In PWRs, the core coolant water is pressurized (the pressurizer is a device used to control the pressure in the reactor vessel) to prevent it from boiling. The hot water passes through a heat exchanger (called the steam generator), gives up its heat, and returns to the reactor vessel, completing the primary coolant system. The water in the secondary coolant system is allowed to boil, producing steam in the steam generator. In BWRs, the core coolant water is allowed to boil, generating steam directly. The steam is delivered to the turbine, spinning it to make electricity. The RCS is located in a containment building (the turbine is in an adjacent building), which is constructed with thick walls of steel-reinforced concrete to withstand high internal pressures or external missile impact. However, it has many penetrations for water pipes, steam pipes and instrumentation and control cables. These penetrations are sealed during normal operations, but the seals could be damaged during an accident that allows radioactive material to escape from the containment building into the environment.

During a severe accident involving irreversible loss of coolant, the fuel will first melt through the steel cladding, then melt through the RCS, and finally escape the containment building (probably through a basemat melt-through or steam explosion). This process could produce a release as soon as 45-90 minutes after core uncovery. If the core melts, the danger to offsite locations depends upon containment integrity. Early health effects are likely if there is early total containment failure and are possible if there is early major containment leakage. Otherwise, early health effects are unlikely. The problem is that containment failure might not be predictable (McKenna, 2001).

A radioactive release would involve a mix of radionuclides (i.e., a variety of radioactive substances that vary in their atomic weight) and this mix is called the *source term*. The source term is defined by three classes of radionuclides—particulates, radioiodine, and noble gases. Particulates include uranium (U) and strontium (Sr), the latter of which is dangerous because it is chemically similar to calcium (Ca) and therefore tends to be deposited in bone marrow. Radioiodine (I-131) is dangerous because it substitutes for nonradioactive iodine in the thyroid and, thus, can cause thyroid cancer. Noble gases such as krypton (Kr) do not react chemically with anything, but are easily inhaled to produce radiation exposures while they remain in the lungs.

The source term is also characterized by its volatility. As noted in connection with toxic chemicals, volatility is an important characteristic of a substance because higher volatility means more of the radionuclide becomes airborne per unit of time and stays airborne. The quantity of radioactivity released can be measured in terms of the number of pounds or kilograms, but this is not a very useful measure because two different source terms with the same mass might emit very different levels of radiation. Consequently, the amount of radioactivity (ionizing radiation) released is measured by the number of disintegrations per unit time (Curies). In fact, these disintegrations are what a Geiger counter measures. The amount of radioactivity is usually measured in curies of an individual radionuclide or class of radionuclides.

Exposure pathways for radiological materials are similar to those of toxic chemicals. Breathing air that is contaminated with radioactive materials can cause inhalation exposure and eating food (e.g., unwashed local produce) or drinking liquids (e.g., water or milk) that is contaminated can cause ingestion exposure. Contamination also can enter the body through an open wound such as a compound fracture, laceration, or abrasion, but radiological materials do not cause absorption exposures because they do not pass through the skin. However, because radiological materials release energy, they can produce exposures via direct radiation (also known as "shine") from a plume that is passing overhead. If the plume has a significant component of particulates, these might be deposited on the ground, vegetation, vehicles, or buildings and the direct radiation from the deposited particulates would produce a continuing exposure. In some cases, the small particles of deposited material could become resuspended and inhaled or ingested. In this connection, it is important to recognize the distinction between irradiation and contamination. Irradiation involves the transmission of energy to a target that absorbs it, whereas contamination occurs when radioactive particles are deposited in a location within the body where they provide continuing irradiation.

Measuring radiation dose is somewhat more complicated than measuring doses of toxic chemicals. As noted earlier, a Curie is a measure of the activity of a radioactive source in atomic disintegrations/second, whereas a Roentgen is a measure of exposure to ionizing radiation. A rad is a measure of absorbed dose, and a rem ("Roentgen equivalent man") is a measure of committed dose equivalent. The term *committed* refers to the fact that contamination by radioactive material on the skin or absorbed into the body will continue to administer a dose until it decays or is removed. The term *equivalent* refers to the fact that there are differences in the biological effects of alpha, beta, and gamma radiation. Weighting factors are used to make adjustments for the biological effects of the different types of radiation. However, for offsite emergency planning purposes, one rem is approximately equal to one rad.

The health effects of exposure to ionizing radiation are defined as early fatalities, prodromal effects, and delayed effects. Early fatalities occur within a period of days or weeks and are readily interpreted as effects of radiation exposure. Early fatalities begin to appear at whole body absorbed doses of 140 rad (which is equal to 1.4 Gray, the new international scientific unit) but less than 5% of the population would be expected to die from such exposures. Approximately 50% of an exposed population would be expected to die from a whole body dose of 300 rad and 95% would be expected to die from a dose of 460 rad.

Prodromal effects are early symptoms of more serious health effects (e.g., abnormal skin redness, loss of appetite, nausea, diarrhea, nonmalignant skin damage), whereas delayed effects are cancers that might take decades to manifest themselves and might only be associated with a particular exposure on a statistical basis. Genetic disorders do not reveal their effects until the next generation is born. Prodromal effects would be expected to manifest themselves in less than 2% of the population at a dose of 50 rad, whereas 50% would be expected to exhibit prodromal symptoms at 150 rad and 98% would be expected to show these symptoms at 250 rad.

The delayed effects of radiation exposure can be seen in Table 5-10, which lists the number of fatal cancers, nonfatal cancers, and genetic disorders that can be expected as a function of the number of person-rem (that is, the number of persons exposed times the number of rems of exposure per person). The small numbers involved are indicated by the fact that the coefficients are presented in scientific notation (i.e., 2.8 E-4 = .00028). That is, 2.8 fatal cancers, 2.4 nonfatal cancers, and 1 genetic effect are expected if 10,000 people are each exposed to 1 rem of radiation to the whole body.

Table 5-10. Average Risk of Delayed Effects (Per Person-Rem)

Effect	Whole Body	Thyroid	Skin
Fatal Cancers	2.8 E-4	3.6 E-5	3.0 E-6
Nonfatal Cancers	2.4 E-4	3.2 E-4	3.0 E-4
Genetic Disorders	1.0E-4		

It is important to be aware of the differential biological affinity of radionuclides for specific organs. Whole body radiation refers to the response of the "typical" cell to irradiation, reflecting the common components and structures all cells share. By contrast, the thyroid is sensitive to I-131 and bone marrow is sensitive to Sr-90. Organ differences in dose-response arise because rapidly dividing cells, found in the gut (damage causes diarrhea and vomiting) and hair follicles (damage causes hair loss), are especially susceptible. There also are individual differences in dose-response. For example, fetuses are extremely susceptible because all of their cells are dividing rapidly, and the same is generally true of preschool children. Unfortunately, recommendations for protective action by pregnant women are easily misinterpreted. The concern is for the health of the highly susceptible fetus, not that of the much less susceptible adult woman. Other population segments include those at risk of any environmental insult: the very old, the very young, and those with compromised immune systems.

Population protective actions for radiological emergencies are based upon three fundamental attenuation factors—*time*, *distance*, and *shielding*. Evacuation reduces the amount of time exposed and increases distance from the source, whereas sheltering in-place can provide shielding if this is done within dense materials that absorb energy and are airtight. To determine when protective action should be initiated, the EPA has developed Early Phase Protective Action Guides (PAGs), which are specific criteria for initiating population protective action in radiological emergencies (Conklin & Edwards, 2001). Note that the whole body dose listed in Table 5-11 for initiating evacuation (1 rem) is only a small fraction of the exposure level that would be expected to produce prodromal effects in the most susceptible 2% of the general population.

Table 5-11. EPA Protective Action Guides

Organ	EPA PAGs[a] (rem/Sv)	Protective Action[b]
Whole body	1-5 (.01-.05)	Evacuation
Thyroid	25 (.25)	Stable Iodine (KI)

[a] Dose inhalation from and external exposure from plume and ground deposition.

[b] Actions should be taken to avert PAG dose.

* Evacuation is considered to be the most effective protective action for nuclear power plant accidents at American sites.

Biological Hazards

According to the World Health Organization (2004, p. 5), biological weapons are “those that achieve their intended target effects through the infectivity of disease-causing micro-organisms and other such entities including viruses, infectious nucleic acids, and prions”. Some biological agents produce toxins and, thus, are actually chemical weapons whose “chemical action on life processes [is] capable of causing death, temporary incapacitation or permanent harm” (World Health Organization, 2004, p. 6).

Emergency managers should recognize that most biological agents likely to be used in deliberate attacks on their communities also exist as natural hazards. They also could be released accidentally from fixed-site facilities (e.g., commercial or academic laboratories) or in transportation among those facilities. These biological agents exist at low levels of prevalence in human populations or, alternatively, in animal populations from which they can spread to human populations. Indeed, one quarter of the world’s deaths in 1998 were caused by infectious diseases. The major consequence of most biological agents is the *magnification* of their effects by infection, unlike chemical agents that generally experience *dissipation* over time and distance. Biological agents magnify their effects by multiplying within the target organisms, but chemical agents cannot do this.

Biological agents can be dispersed by contaminating food or water to achieve exposure through ingestion. For example, a terrorist attack might attempt to introduce a plant or animal infection that would affect people through the food distribution system. However, this system is routinely monitored by the US Department of Agriculture and state departments of agriculture. In some cases, these agencies already receive support from state emergency management agencies when natural outbreaks occur. For example, collaborative relationships have been demonstrated in recent cases of Bovine Spongiform Encephalopathy (BSE—“mad cow” disease) and naturally occurring outbreaks of livestock anthrax.

Alternatively, a biological agent can be used to create an aerosol cloud of liquid droplets or solid particles to achieve an inhalation hazard. The aerosol can be dispersed either in the open environment or through a building’s heating, ventilation, and air conditioning (HVAC) system, but the latter is likely to produce more casualties because the concentration of the biological agent will be greater. The effectiveness of the dispersion will depend on the hazard agent’s physical (particle size and weight) characteristics. Micrometeorological variation can produce corresponding variation in the dispersion of the hazard agent and, under certain conditions, extreme dilution or loss of its viability. Nonetheless, epidemic spread could compensate for poor initial dispersion.

As is the case with some toxic chemical agents, biological agents can be very difficult to detect when symptoms do not appear until long after exposure occurs. The incubation period for biological agents is free of symptoms, so tourists or business travelers might travel a long way from the attack site before they become symptomatic. Consequently, infection with a contagious agent could cause secondary outbreaks that are caused by victims of the initial exposure transmitting the agent to people with whom they come into contact during their travels. Thus, infection can spread widely before local authorities are aware that an attack has even occurred.

The dispersal of the victims at the time the symptoms are manifested and the similarity of these symptoms to those of routinely encountered diseases such as influenza could impede prompt recognition of an attack. The major problem here is that the symptoms of biological agents are frequently indistinguishable from common maladies such as colds and influenza. Consequently, the occurrence of a covert biological agent release is most likely to be identified by noting a significant increase in the incidence of such symptoms. This would either be achieved by health care providers in emergency rooms and clinics supplemented by the health surveillance system operated by the public health department.

There is an emerging sensor technology for detecting many biological agents. These sensors can identify the presence of agents at a very early stage rather than awaiting the development of symptoms in human populations. However, they can only detect these agents at specific locations and, because of their expense, cannot currently be widely distributed. For the foreseeable future, their deployment is likely to be limited to the most critical facilities. Consequently, it is important for emergency managers to establish a working relationship with their local health departments. In turn, these will have established contacts with regional laboratories and state and federal public health agencies to provide assistance in identifying the agent, treating the victims, and decontaminating the incident site.

Countermeasures for biological agents include isolation and quarantine. *Isolation* is the action taken to prevent those who are known to be ill with a contagious disease from infecting others. It typically is associated with special treatment to remedy the disease. By contrast, *quarantine* is used to prevent those who might have been exposed to a biological agent but do not currently exhibit symptoms. Thus, they might not become ill and, indeed, they might not even have the disease. However, it is critical to prevent them from infecting others. Thus, quarantine is somewhat similar to sheltering in-place from toxic chemical hazards. The difference is that people being quarantined are asked (or legally required) to remain indoors in order to protect others from themselves (because *they* are the hazard) rather than to protect themselves from an external hazard. Although there is extensive research on household compliance with evacuation warnings, the same cannot be said for isolation and quarantine. Nonetheless, it seems safe to say the level of compliance will be less than perfect, so emergency managers should try to assess local residents’ perceptions of these protective actions if the need to implement them arises.

In addition, biological agents can be combated by vaccines that provide protection against specific agents and other therapeutic agents that seek to block the body’s reaction to the agent. Emergency managers will be particularly interested in the latter type of therapy because a generic therapeutic mechanism would be effective against a wide variety of biological agents, just as a wide-spectrum antibiotic is effective against a range of bacteria.

Index

D

dire

Glossary

Sample Word 1 | Sample Definition 1

Detailed Licensing

Overview

Title: Fundamentals of Emergency Management

Webpages: 46

All licenses found:

- Public Domain: 91.3% (42 pages)
- Undeclared: 8.7% (4 pages)

By Page

- Fundamentals of Emergency Management - *Public Domain*
  - Front Matter - *Public Domain*
    - TitlePage - *Public Domain*
    - InfoPage - *Public Domain*
    - Table of Contents - *Undeclared*
    - Licensing - *Undeclared*
  - 1: Introduction to Emergency Management - *Public Domain*
    - 1.1: Introduction - *Public Domain*
    - 1.2: Fundamental Theories of Disaster - *Public Domain*
    - 1.3: Hazards, Emergencies, Disasters, and Catastrophes - *Public Domain*
    - 1.4: The Development and Tasks of the Emergency Management System - *Public Domain*
    - 1.5: Characterizing Emergency Management Activities - *Public Domain*
    - 1.6: Visions of Emergency Management - *Public Domain*
  - 2: Emergency Management Stakeholders - *Public Domain*
    - 2.1: Definition of a "Stakeholder" - *Public Domain*
    - 2.2: Community Stakeholder Groups - *Public Domain*
    - 2.3: Decision Levels - *Public Domain*
    - 2.4: Stakeholders and Power - *Public Domain*
    - 2.5: The Emergency Management Policy Process - *Public Domain*
    - 2.6: Involving Stakeholders in Emergency Management - *Public Domain*
    - 2.7: Case Study: The Politics of Hazard Mitigation - *Public Domain*
    - Appendix 2: Federal Agencies and Their Responsibilities Under the National Response Plan - *Public Domain*
  - 3: Building and Effective Emergency Management Organization - *Public Domain*
    - 3.1: Introduction - *Public Domain*
    - 3.2: The Local Emergency Management Agency - *Public Domain*
    - 3.3: Determinants of Emergency Management Effectiveness - *Public Domain*
    - 3.4: LEMC Activities - *Public Domain*
    - 3.5: Case Study: Emergency Management in Smith Hill - *Public Domain*
  - 4: Risk Perception and Communication - *Public Domain*
    - 4.1: Introduction - *Public Domain*
    - 4.2: The Classical Persuasion Model - *Public Domain*
    - 4.3: The Protective Action Decision Model - *Public Domain*
    - 4.4: Risk Communication During the Continuing Hazard Phase - *Public Domain*
    - 4.5: Risk Communication During an Escalating Crisis or Emergency Response - *Public Domain*
    - 4.6: Case Study: Risk Perception and Warning of the Mt. St. Helens Eruption - *Public Domain*
  - 5: Principal Hazards in the United States - *Public Domain*
    - 5.1: Introduction - *Public Domain*
    - 5.2: Meteorological Hazards - *Public Domain*
      - test - *Public Domain*
    - 5.3: Hydrological Hazards - *Public Domain*
    - 5.4: Geophysical Hazards - *Public Domain*
    - 5.5: Technological Hazards - *Public Domain*
  - Back Matter - *Public Domain*
    - Index - *Public Domain*
    - Glossary - *Undeclared*
    - Detailed Licensing - *Undeclared*