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Principal Threats Facing Communities And Local Emergency Management Coordinators

Federal Emergency Management Agency
Office of Civil Defense

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PRINCIPAL THREATS FACING COMMUNITIES AND LOCAL EMERGENCY MANAGEMENT COORDINATORS

A Report to the United States Senate
Committee on Appropriations

March 6, 1991

Federal Emergency Management Agency
Office of Civil Defense

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SUMMARY

Under the language of Senate Report 101-128, Department of Veterans Affairs and Housing and Urban Development and Independent Agencies Appropriation Bill, 1990, which accompanied the 1990 Federal Emergency Management Agency (FEMA) appropriations bill, FEMA was directed to:

> *...prepare a study on the principal threats facing communities and local emergency management coordinators. ...The study should rank the principal threats to the population according to region and any other factors deemed appropriate.*

The Senate Report 101-900 on the FY 1991 appropriations includes directions for FEMA "to update the report annually." This revised version of the April 5, 1990, report to the United States Senate Committee on Appropriations is submitted in compliance with that mandate.

THE THREATS

The United States is vulnerable to a wide range of threats. Periodic and at times little publicized disasters resulting from floods, tornadoes, landslides and fires take scores of lives and cause hundreds of millions of dollars in property damage annually. The magnitude of major disasters such as Hurricane Hugo and the Loma Prieta earthquake in California serve to heighten the realization of the United States' vulnerability to such events when viewed in relationship to the loss of life, severity of property damage, disruption of services and long-term impact on the affected population.

These facts are further complicated by advancements in technology and the increased development and use over the past few decades of chemicals which have led to the rise of a new and wide range of technological threats virtually unknown 20 or 30 years ago.

Yet major disasters such as Hugo and Loma Prieta pale beside the damage that could be inflicted by a calculated, purposeful and sustained attack on the United States. Ongoing variables on the international scene pose continuing threats to the security of the United States. The Soviet Union still retains an undiminished nuclear arsenal capable of widespread devastation if directed towards this country. The advancing missile capability of Third World countries poses additional dangers to the United States in view of the ability some countries have to obtain chemical, biological or nuclear warheads for these missiles. According to the Congressional Research Service of the Library of Congress, in a 1988 report on missile proliferation, even the continental United States could be within the range of ballistic missiles from a few additional countries by the year 2000.

TYPES OF THREATS

The United States is faced with three primary types of threats: *natural, technological and national security*. Disasters caused by natural forces comprise the largest single category of repetitive threats to communities and emergency management coordinators. These *natural threats,* which pose problems in all areas of the country, can be localized or widespread, predictable or unpredictable. The damage resulting from natural disasters can range from minimal to major (depending on whether they strike major or minor population centers). The impact of extremely severe natural disasters can have a long-term effect on the infrastructure of any given location. Threats in this category include avalanche, dam failure, drought, earthquake, flood, hurricane/tropical storm, landslide, subsidence, tornado, tsunami, volcano, wildfire and winter storm.

Possessing much the same unpredictability as natural threats, *technological threats* represent a category of events that has expanded dramatically throughout this century with the advancement of modern technology. Technological threats include hazardous materials or radiological incidents that occur at fixed facilities or as the result of transportation accidents, power failure, structural fires and transportation accidents of all types.

The potential for damage from realized *national security threats* ranges from the relatively localized damage that could be expected to result from a low-intensity conflict (including terrorism, subversion, insurgency or drug trafficking) to the catastrophic devastation that could be expected from a chemical, biological or nuclear attack on the United States. Like the other categories of threats, national security threats can be either predictable or unpredictable (e.g., a preemptive strike *versus* an attack following a buildup of tensions). National security threats include nuclear attack, chemical and biological warfare, civil disorder and low-intensity conflict.

LOSSES CAUSED BY DISASTERS

The magnitude of the losses caused by natural and technological disasters in the United States are staggering.

In the five-year period from 1983-1988, an average of *2,300,000* fires per year were reported in the United States. Average annual losses for the years of 1983-1988 included *5,900 civilian fire deaths, 29,000 civilian injuries and $7.8 billion in property damage.*

During the period 1900-1989, approximately *13,046* people lost their lives in hurricanes from Texas to the northeast; property losses from hurricanes during the same period exceeded *$43 billion.*

From 1959 to 1988, *23,488* tornadoes struck the United States. In the southern States alone, from North Carolina due west to Texas, *11,343* tornadoes hit while *9,234* tornadoes struck the midwestern region (North Dakota, South Dakota, Nebraska, Iowa, Missouri, Kansas, Illinois, Indiana, Wisconsin, Minnesota, Michigan, Ohio and Kentucky). The Upper Northwestern States, including Alaska, Washington, Oregon, Idaho, Montana and Wyoming—an area generally not associated with tornado activity—were struck by *583* tornadoes during the same period.

Average annual losses from landslides total *$1-2 billion*; flood losses reach an estimated *$2.4 billion*. Tornadoes result in average annual losses in excess of *$500 million*. Highway hazardous materials incidents have average annual losses of *$19 million*.

In addition to the average annual fire deaths of *5,900* persons, the United States can expect the following average death rates from various threats: *(1) 72 from floods; (2) 83 from tornadoes; (3) 104 from winter storms; (4) 25-50 from landslides; (5) 33 from hurricanes and (6) 13 from transportation accidents involving hazardous materials.*

A number of specific disasters have caused extraordinary death rates. A hurricane in Galveston, Texas, in 1900 caused *6,000* deaths. Over *2,200* people died from a dam break and the resultant flooding in Johnstown, Pennsylvania, in 1889. A severe wildfire in Wisconsin in 1871 was responsible for the loss of *1,182* lives. Over *700* people died in the 1906 San Francisco earthquake.

These examples of life and property losses, whether taken in historical perspective or viewed in terms of annual or average annual losses, are indicative of not only the wide range of threats to the population but also the severity and magnitude of the impact such disasters can inflict on the population.

RANKINGS

An effort has been made to be responsive to the Committee's direction to "...rank the principal threats to the population according to region and any other factors deemed appropriate." However, it is important to note that any ranking of the threats to communities and emergency management coordinators is potentially misleading because of: (1) the wide variations that can occur with the application of different criteria to the same threat; (2) the significant differences the impact of a particular disaster may have on a region and the individual States within that region; (3) the fact that threats in one region are not necessarily applicable to another region; (4) variances in the types of data collected on each threat and (5) the lack of available data in some cases with which to develop a reasoned ranking. The variances in or lack of available data were critical factors which hampered attempts to make viable rankings of threats by region.

Relative rankings of threats by regions were also difficult because of the widely varied factors, such as the frequency of disaster occurrence; the level of community preparedness in areas vulnerable to various threats; the degree to which disasters strike urban or largely rural, sparsely populated areas; the way local emergency managers perceive and rank the potential severity or magnitude of particular threats in their reports to FEMA; the impact "worst case" disasters have on considerations for rankings them as significant threats and the potential critical danger of a particular threat which, in fact, may occur only infrequently.

State and local emergency coordinators have given equal ranking to floods, power failures and transportation accidents involving hazardous materials as the three most critical threats their communities face, regardless of region. The second most serious threats, again of equal ranking among all regions, were wildfires, winter storms, dam failures and hazardous materials accidents at fixed facilities. Transportation accidents (air, rail, etc., but not including hazardous material accidents) and structural fires ranked third in all regions. Nuclear attack is listed as the fourth ranked threat by local emergency managers in all 50 States and the District of Columbia. Fifth-ranked threats include drought and fixed facility hazardous materials incidents. Tornadoes ranked sixth based on these reports.

FEMA'S MISSION — PREPAREDNESS, MITIGATION, RESPONSE & RECOVERY

The Federal Emergency Management Agency is responsible for ensuring the establishment and development of policies and programs for emergency management at the Federal, State and local levels. This -responsibility includes the development of a national capability to mitigate against, prepare for, respond to and recover from the full range of emergencies, i.e., natural and technological disasters and national security emergencies.

In view of the broad range of threats to the population and industry of the United States, the Federal Emergency Management Agency is also responsible for ensuring that plans are in place as part of an integrated, all-hazard emergency management program. While the nature of some emergencies (e.g., earthquakes, hurricanes, tornadoes, radiological emergencies, etc.) does require certain hazard-specific procedures and activities, the goal of the Agency is to ensure that an integrated, all-hazards emergency management capability is established at all levels of government.

The Agency has a wide range of programs that provide financial and technical assistance to State and local governments. The benefits from these programs help State and local emergency managers meet their responsibilities for coordinating the government activities that their communities need to cope with the numerous disasters that threaten them.

INTRODUCTION

As part of the review process for the Fiscal Year (FY) 1991 budget of the Federal Emergency Management Agency (FEMA), the Senate Appropriations Committee (hereinafter referred to as the "Committee") has directed FEMA to update on an annual basis the study on the principal threats facing communities and local emergency management coordinators. The specific task (originally assigned in FY 1990) was as follows:

> *The Committee directs FEMA to prepare a study on the principal threats facing communities and local emergency management coordinators. The Committee understands that certain natural and man-made disasters threaten communities with a varying degree of severity and frequency. The study should rank the principal threats to the population according to region and any other factors deemed appropriate.*

Background

On a daily basis, the population of the United States is at risk from a broad spectrum of threats. The scope of these threats ranges from the impact of a house fire in an individual residence to a hazardous materials incident, perhaps on an Interstate highway, to the devastating affect a catastrophic natural disaster such as a major earthquake would have on many thousands of square miles. It also includes the single potentially most threatening event of all—nuclear attack.

And what is the potential impact of these disasters on the population and the government of this country? As a result of the rapid technological growth in the United States during this century, an infrastructure has been developed that is tightly interconnected by vast systems of sophisticated communications, transportation, industry, government and economic integration. This infrastructure is continually exposed to disruption—or destruction in a catastrophic event—by the full range of disasters that threaten this country. The concurrent urbanization of the United States, particularly since World War II, has substantially increased the numbers of people exposed to a particular threat in a given area.

These points were brought home vividly in the Fall of 1989 with the impact of Hurricane Hugo on the Virgin Islands, Puerto Rico, and North and South Carolina and the Loma Prieta earthquake in the San Francisco Bay area. Television brought the scenes of devastation into the homes of millions of people. In the case of Hurricane Hugo, people were able to watch the landfall of Hugo and witness the tremendous winds and destruction as they occurred. In succeeding days, they saw the scope of the damage inflicted by the hurricane, including the disruption of governmental services, communications, transportation and industry. Minutes after the Loma Prieta earthquake rocked the San Francisco Bay area, millions of viewers were able to see the destruction on bridges, the major fire in the City of San Francisco and the rescue efforts on a major road system that had collapsed. The magnitude of the destruction in these incidents provided significant evidence of the continuing dangers posed by the variety of threats to which this Nation is exposed.

Yet even major natural disasters such as Hugo and the Loma Prieta earthquake pale beside the damage that could be inflicted by a calculated, purposeful and sustained attack on the United States. This country has been fortunate enough to evade major warfare on its soil for over a century. As a result, many local emergency management coordinators may not fully comprehend the very different problems generated by war. The complexity of warfare, be it conventional, nuclear, chemical or biological, is well beyond the scope of simply scaling up our responses to natural or technological disasters. Civilian attack defense already includes nearly all aspects of other-hazard operations in addition to its own unique preparations and responses—an emphasis on natural and technological hazards alone does not automatically yield the necessary attack defense capabilities.

The Threats

For the purposes of this study, three major categories of threats will be discussed: natural, technological and national security.

Natural threats, the largest single category of repetitive threats to communities and emergency management coordinators, come from weather-, geological-, seismic- or oceanic-related events. They affect any area of the country. Their impact can be localized or widespread, predictable or unpredictable. The damage can range from minimal to major (depending on whether the disasters strike rural or urban population centers). If the damage from a disaster incident is severe enough, it can have long-term impact on the infrastructure of any given location. Natural threats include avalanche, dam failure, drought, earthquake, flood, hurricanes/tropical storm, landslide, subsidence, tornado, tsunami, volcano, wildfire and winter storm.

Technological/man-made threats represent a category of events that has expanded dramatically throughout this century with the advancements in modern technology. Like natural threats, they can affect localized or widespread areas, are frequently unpredictable, can cause substantial loss of life (in addition to the potential for damage to property), and can pose a significant threat to the infrastructure of a given area. Technological/man-made threats include hazardous materials incidents at fixed facilities or in transit accidents, power failures, radiological incidents at fixed facilities or in transit accidents, structural fires and other types of transportation accidents.

National security threats are those threats that primarily come from actions by external, hostile forces to the land, population or infrastructure of the United States. The potential for damage resulting from national security emergencies ranges from the relatively localized damage caused by a low-intensity conflict (including subversion, insurgency, terrorism and drug trafficking) to the catastrophic devastation that could be expected following a widespread chemical, biological, conventional or nuclear attack on the United States. Like natural or technological/man-made threats, national security threats can be either predictable or unpredictable (for example, a preemptive strike versus an attack following a buildup of tensions). National security threats include nuclear attack, chemical/biological warfare, low-intensity conflict and civil disorder.

The Nature of Threats

A single threat cannot be viewed as a constant, either in terms of the potential for damage to property, loss of lives or the preparedness measures that must be undertaken to protect the population and infrastructure. For example, the State of Texas experienced 4,110 tornadoes during the period from 1959 to 1989, a significantly higher number than registered for any other State. However, these tornadoes often touched down in rural or sparsely populated areas, causing very limited amounts of damage. Conversely, a single tornado or outbreak of tornadoes in a more urbanized area can cause tremendous losses of life and property, as can be seen in the following example.

Ohio sustained a significantly lower number of tornadoes than Texas during the same years of 1959 to 1989—a total of 467. Yet, in April 1974 during an unusually severe outbreak of 144 tornadoes in a two day period, the city of Xenia, Ohio, suffered 33 deaths; had 1,200 structures demolished; 1,500 structures damaged and total damage reaching an estimated $70 to $90 million (according to American Insurance Association estimates). If the same outbreak of tornadoes had occurred in a relatively isolated area, the losses would have been considered negligible at best.

A disaster also cannot be viewed as an isolated event with a predictable kind of damage, i.e., each one can trigger a series of other related incidents that can substantially increase the impact of the original disaster event. Such secondary events could, in fact, result in significantly higher death rates or substantially increased damage. The following are some classic examples of the "secondary effects" of a variety of disasters:

- In 1964, the Prince William Sound earthquake in Alaska generated a marine landslide which undermined the Valdez Delta. A total of 122 persons in Alaska, Washington, Oregon, California and Hawaii were drowned in the tsunami resulting from the marine landslide.
- The Mount St. Helens eruption in 1980 generated the largest landslide in recorded history—2.8 million cubic feet of rock. This event has created three "natural" dams which, in the opinion of the U.S. Geological Survey, are extremely unstable and likely to collapse and release millions of gallons of water from the lakes which have formed behind the dams.
- The extensive and widespread blow-down of timber by the impact of Hurricane Hugo in 1989 has become a potentially critical fire hazard in South Carolina.
- The Loma Prieta earthquake in 1989 caused or reactivated large-scale landslides, including the collapse of a sea cliff where one death was recorded. The U.S. Geological Survey has estimated that literally thousands of possible landslides have been formed to the south. The potential hazard of these landslides could be revealed if a severe coastal storm should occur.

Thus, communities and emergency management coordinators are faced with not only the threats themselves, but also with a wide variety of other factors which make the process of mitigating against, preparing for and responding to them far more complex.

The predictability of a hazardous event or the magnitude of its impact depends on the nature of the particular hazard itself. There is a seasonal association for certain types of natural threats such as tornadoes and hurricanes. Other threats such as earthquakes have no seasonal relationship and predictability is nearly impossible. Technology has simply not progressed to the point where the timing of an earthquake can be predicted with any degree of reliability.

There is also a significant variance in the potential impact of a disaster on a "prepared" jurisdiction *versus* an "unprepared" jurisdiction. For example, the earthquake preparedness and mitigation measures taken in San Francisco and Los Angeles have proven to be significantly effective in reducing the magnitude of losses from large earthquakes—high-rise structures in San Francisco built according to stringent earthquake building codes showed little to no damage during the Loma Prieta earthquake. Even though the seismic risk in Charleston, South Carolina, and the New Madrid Seismic Zone (including Missouri, Arkansas, Tennessee, Kentucky and Illinois) is great, the lack of major seismic activity in these areas during this century has lessened the fear of the threat. Consequently, many of the jurisdictions in these areas have not implemented strong earthquake building codes like those in San Francisco and Los Angeles. Thus, the impact of a major earthquake in the New Madrid Seismic Zone or around Charleston, South Carolina, could result in tremendous losses of life and property that could possibly be avoided with more stringent measures for preparedness and mitigation.

The same is also true for other types of threats. The infrequent occurrence of severe storms or the erratic paths they sometimes take over areas not normally prepared to cope with such storms can result in reduced warning times and/or preparedness measures. For example, inland cities such as Charlotte, North Carolina, do not normally expect to sustain major hurricane damage. Based on the original path of Hurricane Hugo, it was predicted to pass far to the east of the city, primarily along coastal areas. Hugo, however, followed an extremely erratic course and shifted, causing significant damage in Charlotte. In another example, a major winter storm in the midwestern States could be disruptive but may not cause major damage since residents and communities in these areas are better prepared for such a storm. Conversely, a similar storm in the Deep South could result in higher death rates and major damage to roads, communications, transportation and utilities because of inadequate preparedness due to the infrequency of major winter storms in that area.

There is also no unanimity among experts about how potential atmospheric and other environmental changes caused by the long-term effects of elements, such as *acid rain* and the *greenhouse effect*, may impact upon the United States. There is, however, a growing consensus that weather trends on the African Continent, where most hurricanes that affect the continental United States form, will result in an increase in the frequency and severity of hurricanes hitting the United States mainland during the next decade. Fortunately, this expectation was not borne out during the 1990 hurricane season.

Ongoing variables in the international scene pose continuing threats to the security of the United States. The Persian Gulf War could have far-ranging ramifications that could impact adversely upon this country. The Soviet Union still retains an undiminished nuclear arsenal capable of widespread devastation if directed towards this country. The control of that arsenal may be in question if the unrest in the Soviet Republics escalates and disrupts the political structure of the Soviet Union. An estimated 17 or more nations may be nearing nuclear capability, inspection or verification of which is, in most cases, virtually impossible in hostile or unwilling countries. Some 20 countries may be producing chemical weapons today. An estimated 15 Third World nations now have the ability to produce or acquire mid-range missiles which could easily be fitted with nuclear, chemical or biological warheads. According to the Congressional Research Service of the Library of Congress, even the continental United States could be within the range of ballistic missiles from a few additional countries by the year 2000.

The capability of a foreign nation to deliver weapons upon targets in the United States is not necessarily a threat. The threat comes from the intent to use that capability. Threat assessment must take into account the ever-changing climate of world politics.

Preparedness Measures/ Hazard Mitigation Activities

Federal, State and local emergency managers must prepare their communities against the wide range of threats that they face on a daily basis, in spite of the numerous variables involved. Regardless of whether the emergency manager is preparing for the threat of a severe storm, a tornado or the ultimate threat —conventional or nuclear attack—there is one common denominator: *emergency management is like insurance—it may never have to be used, but if it is not available when needed the losses can be staggering.*

The civil defense program provides the primary means by which State and local governments can develop the infrastructure of emergency management personnel, facilities, communications, hardware and systems to prepare for and respond to the full range of disasters that may threaten the population of the United States. State and local emergency management personnel who are funded by the civil defense program develop Emergency Operations Plans and procedures to prepare for, respond to and recover from natural and technological/man-made disasters and all forms of attack. The implementation in 1988 by FEMA's civil defense program of a survivable crisis management program has initiated the means by which each State and local jurisdiction will have the ability to direct, control, manage and coordinate emergency operations, both within the jurisdictions and in cooperation with other State and local governments and the Federal government.

Modern technology has significantly enhanced our ability not only to forecast the impact of some disasters, regardless of whether they result from natural, technological/man-made or national security threats, but also to take measures to reduce the potential loss of life and damage to the infrastructure. Our predictive ability to forecast severe storm conditions or the possibility of tornadoes has substantially enhanced the preventive and/or safety measures that can be taken by the population. The ability to project the path of hurricanes usually allows adequate time to undertake protective measures on structures and evacuations, thereby reducing the loss of life. Spring flooding can frequently be predicted based on the snowfall levels at higher elevations and forecast temperature levels.

However, the degree to which forecasting can contribute to predicting disasters varies. The flash flood in Shadyside, Ohio, that swept 26 people to their deaths on June 14, 1990, came without warning. Technology has not progressed to the point where the timing or severity of an earthquake can be predicted with any degree of reliability. In spite of the mitigation measures that can be taken, such as applying strict standards in the construction of buildings, highways and other structures, millions of residents in earthquake-prone areas throughout the country are still vulnerable to a sudden, unexpected occurrence.

Mitigation programs undertaken in response to a wide range of threats do, however, result in measurable numbers of lives saved and property protected, regardless of whether the event can be predicted or not. Mitigation efforts such as earthquake resistant engineering were critical in reducing the loss of life in the Loma Prieta earthquake. Bridges, roads and buildings that were built according to stringent earthquake standards stood up well during the earthquake. Other structures that had not been built according to strict standards did not fare so well, as was evident from the destruction of the Oakland freeway. Hurricane preparedness activities, including media announcements, the dissemination of printed information for residents in threatened areas prior to impact and floodplain management initiatives have gone far in reducing the impact of water/wind-related disasters in coastal and inland areas.

THREATS AFFECTING THE UNITED STATES

This section describes the primary threats which the United States faces and provides general information concerning the dangers posed by them.

There are numerous threats facing the nation's population and infrastructure. Threats can be widespread or localized, affecting one or more States. Periodic and at times little publicized disasters resulting from floods, tornadoes, landslides and fires take scores of lives and cause hundreds of millions of dollars in property damage annually. The magnitude of the losses of major disasters, such as Hurricane Hugo and the Loma Prieta earthquake in California, when viewed in relationship to the loss of life, severity of property damage, disruption of services and long-term impact on the affected population, serve to heighten the realization of the vulnerability of the United States to such events.

The vulnerability to threats is further magnified by the fact that analyses of future trends in disaster prevention and preparedness are complicated by the identification of newer threats, some of which were virtually unknown 20 or 30 years ago. Advancements in technology and the increased development and use of chemicals over the past decades have resulted in the rise of a new and wide range of threats. Estimates of the impact of some of these threats are often difficult because of a lack of experience with them or a thorough knowledge of the full range of their impact. However, the extent of their effects have been demonstrated in recent tragedies in Bhopal, India, and Chernobyl in the Soviet Union.

For the purposes of this study, three major categories of threats will be discussed: natural, technological and national security. Each class of threats is further broken down into specific incident types. For each type of incident, information is provided to define the hazard, its national frequency, regions at risk, season(s) in which it may occur, its effects, the worst recorded event and relevant statistical information and discussion.

NATURAL THREATS

Natural threats, the largest single category of repetitive threats to communities and emergency management coordinators, come from weather-, geological-, seismic- or oceanic-related events. They pose a threat to any area of the country; their impact can be localized or widespread, predictable or unpredictable. The damage resulting from natural disasters can range from minimal to major (depending on whether they strike major or minor population centers). The impact of extremely severe natural disasters can have a long-term effect on the infrastructure of any given location. Natural threats include avalanche, dam failure, drought, earthquake, flood, hurricane/tropical storm, landslide, subsidence, tornado, tsunami, volcano, wildfire and winter storm.

Avalanche

Definition

A mass of sliding snow in mountainous terrain with large snow deposits on slopes of 20 degrees or more

National Frequency

Approximately 10,000 avalanches are reported each year. There may be as many as 100 times more that are not observed or recorded. From 1980 to 1985, Alaska recorded 441 avalanches that affected people.

Regions at Risk

The mountain ranges in New Hampshire, Vermont and the Far West have avalanches where the primary risk to people exists in recreational areas that feature climbing and skiing. Transportation corridors along numerous year-round highways and railroads in the western risk areas experience frequent avalanche activity. In Alaska alone, from 1975 to 1985, 205 avalanche events blocked highways, hitting or disabling 30 vehicles; 274 events blocked railroads, derailing 21 cars. Avalanches closed Colorado highways on 60 days during the winter of 1983-1984. The map in *Figure 1* illustrates the risk severity for snow avalanches by State.

Season(s)

Fall, Winter, Spring.

Effects

Annually, an average of 140 Americans are caught in avalanches; 65 are buried and 17 are killed. While there are no national cost figures available, the economic impact of avalanches that damage and destroy public, commercial and private property and forest lands includes the costs for restoration, maintenance and post de facto litigation. The following examples of some of the costs incurred in specific areas have been taken from the *National Research Council 1990 Report entitled, **Snow Avalanche Hazards and Mitigation in the United States**, pp. 17-19.*

- Avalanches cost the Washington State Department of Transportation an estimated $330,000 each year. That figure does not include State salaries and expenses for avalanche control or plowing and snow removal.

- Costs from damages caused by avalanches in Alaska were estimated to be at least $11.4 million during the years of 1977 through 1986.

- Rescue operations cost $74,250 for an avalanche on U.S. Forest Service land in Colorado that killed four people near a ski area on February 18, 1987. Additional undisclosed expenses related to preparation for anticipated litigation were also incurred.
- A March 31, 1981, avalanche in Californian's Alpine Meadows ski area resulted in seven deaths and caused approximately $1.5 million in property damages. The ensuing law suits (not including appeals) cost in excess of $1,500,000. The cost of the undisclosed out-of-court settlements potentially could have been $14 million.

Worst Event

Definitive data unavailable. The worst period in American history for avalanche-related deaths was during the Colorado gold and silver mining fields from 1880 to 1920 when about 400 people were killed.

Discussion

Avalanches, which are the most frequent form of lethal mass movement, can be triggered by various means including earthquakes. They generally occur in the Rockies and other mountains of the western States. There is no centralized reporting of occurrences because most incidents happen in remote, sparsely populated locations and seldom inflict permanent damage. The avalanche threat is becoming more significant because of increasing development and recreation in mountainous regions.

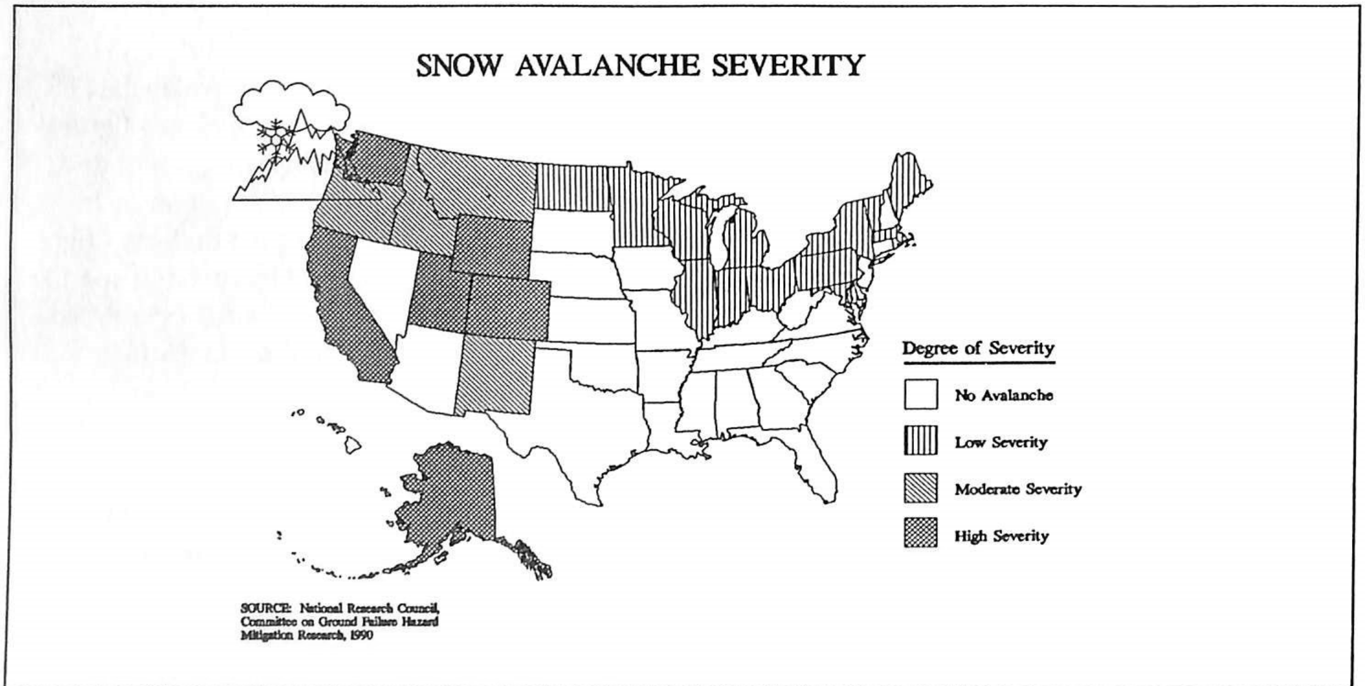


Figure 1

Dam Failure

Definition *Collapse or failure of an impoundment that causes downstream flooding*

National Frequency Dam failures occur several times annually, however, no national average is available.

Regions at Risk There are over 80,000 dams throughout the States. Over 20,000 of them are classified as posing "high" or "significant" hazards. These designations mean that, if such a dam failed, lives would be lost and extensive property damage would be suffered. *Figure* 2 lists some of the dam and levee failures from 1874-1982 in which lives were lost.

DAM & LEVEE FAILURES IN THE U.S.
1874 - 1982

YEAR	LOCATION	STRUCTURE	DEATHS
1874	Williamsburg, MA	Earth Dam	144
1889	Johnstown, PA	Earth Dam	2,209
1890	Walnut Grove/Prescott, AZ	Dam	150
1894	Mill River, MA	Dam	143
1900	Austin/Austin, PA	Dam	8
1928	St. Francis, CA	Dam	(est.) 400-700
1955	Yuba City, CA	Levee	38
1963	Baldwin Hill, CA	Earth Dam	5
1972	Buffalo Creek, WV	Slagheap Dam	125
1972	Rapid City, SD	Dam	200
1976	Newfound, NC	Earth Dam	4
1976	Teton, ID	Earth Dam	14
1977	Toccoa, GA	Earth Dam	35
1982	Estes Park, CO	Earth Dams (2)	3
	TOTAL		3,528-3,778

Source: Adapted from U.S. Nuclear Regulatory Commission/ A Risk Comparison.

Figure 2

Season(s) Dam failures usually occur as a secondary effect of storms or earthquakes.

Effects

The primary consequence of the dam failure hazard is loss of life and property damage downstream of the failure. Of the estimated 80,000 dams in the United States, about 95 percent are owned by State and local authorities and private organizations as opposed to the 5 percent owned by the Federal government.

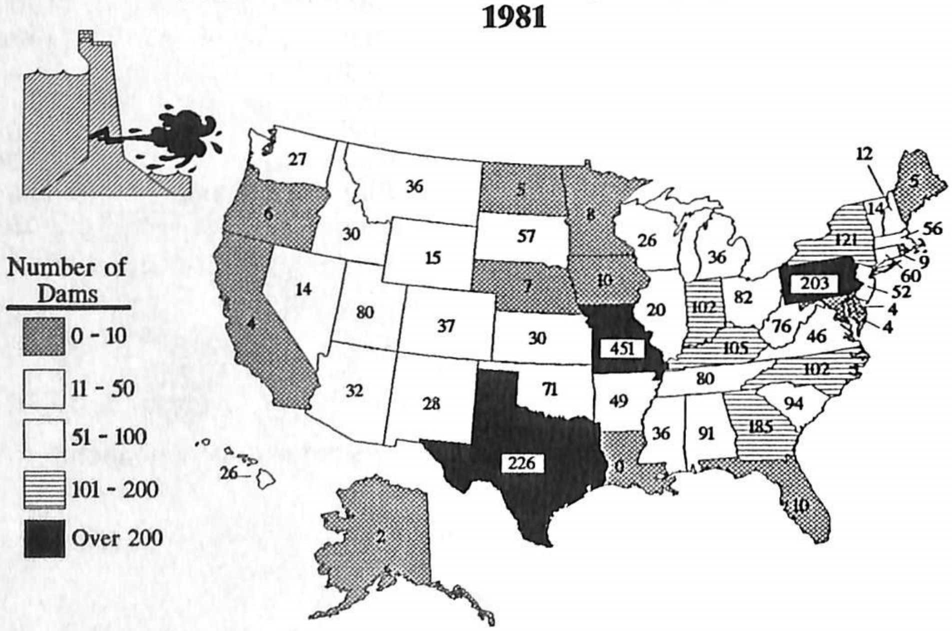
Worst Event

The Johnstown flood on May 31, 1889, resulted in the deaths of more than 2,200 persons.

Discussion

Between 1972 and 1981, the U.S. Army Corps of Engineers had the responsibility for the inspection of all non-Federal dams. The responsibility has since been returned to the States. Inspection of Federal dams continues to be the responsibility of the owner agency. The number of unsafe dams in 1981 is shown in *Figure 3*. It is important to note in the Figure, however, that the age of the data does not necessarily mean that the number of dams considered "unsafe" at the time of inspection remains at that level today—some deficiencies may have been corrected while other dams have become unsafe due to poor maintenance.

UNSAFE DAMS IN THE UNITED STATES
1981



SOURCE: U.S. Corps of Engineers

Figure 3

Drought

Definition *A prolonged period without rain*

National Frequency The frequency is difficult to measure. Droughts can happen at any time of the year.

Regions at Risk The entire country is at risk.

Season(s) Year round

Effects Drought in the farm belt devastates crops, resulting in low yields and economic losses. Winds blow away top soil and create dust storms further eroding the fertility of the land. Water tables are lowered. Parched forest lands are more susceptible to wildfires during periods of drought.

Worst Event "Dust Bowl" of the 1930's in the Southwest

Discussion Drought has been a major problem for the Southwest and sections of the Midwest since 1987. In 1989, California had drought emergencies in effect for five counties at the end of the fiscal year. The east and south San Francisco Bay region and several San Joaquin Valley communities had the most severe water shortages in the State. Streamflow in Nevada, Utah and Arizona was considerably less than normal, consequently, water storage was seriously low in many populated areas. Extremely dry weather conditions prevailed in southern Texas where water tables were quite low. The amount of precipitation in the Missouri River Basin during 1989 was not high enough to alleviate the long-term drought conditions in the area. The southern part of Florida was the only area east of the Mississippi River affected by severely dry conditions. (Source: ***Seventh Annual Flood Damage Report to Congress for Fiscal Year 1989****, by the U.S. Army Corps of Engineers in cooperation with the Office of Hydrology, National Weather Service.*)

As the severity map for the 1990 drought season in *Figure 4* shows, the previous years' drought trend continued throughout most of the country except in the Southeast. Sections of Alabama and Georgia as well as additional land areas in Florida experienced serious water shortages during 1990.

The economic effects of a drought are both direct and indirect. For example, crop losses affect farming income which, in turn, may mean foreclosure of farms because of unserviced debt. Estimating the economic losses attributed solely to drought-related damage is difficult to do and can be misleading when compared from year to year because of constantly fluctuating commodity markets. Also, some areas of the country may suffer drought-related losses while other areas that produce the same crops have record yields, as was the case during the 1989 and 1990 growing seasons.

Misuse of the land and lack of appropriate cultivation practices contributed to the severity of drought effects up until the last 50 years. Research, education and governmental financial aid has done much to restore the land and mitigate the impact of droughts since then. The trend for droughts may worsen in the long term because of the greenhouse effect and cause water shortages for irrigation in the west and for human consumption throughout the country (especially in overdeveloped areas).

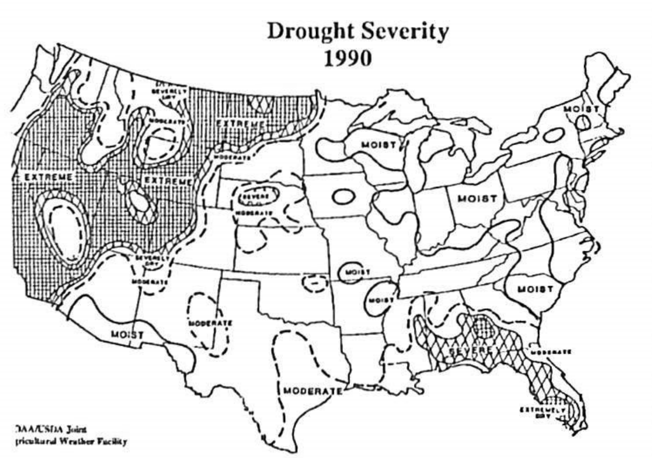


Figure 4

Earthquake

Definition *A sudden motion of the ground which may cause surface faulting (ground rupture), ground shaking and ground failure*

National Frequency Each year, there are literally thousands of earthquakes in the United States, most of which are of such small magnitude that they are not felt by the population.

Regions at Risk Earthquakes have occurred in most areas of the United States *(see Figure 5)*. The most frequent earthquake events occur in States west of the Rocky Mountains, although historically the most violent earthquakes have occurred in the central United States. California is especially vulnerable because of its high seismic activity. Other highly vulnerable areas are those of Charleston, South Carolina, and the central United States (the New Madrid Seismic Zone), both of which were devastated by earthquakes in the last century.

EARTHQUAKES (INTENSITY V AND ABOVE)
IN THE UNITED STATES THROUGH 1970

Figure 5

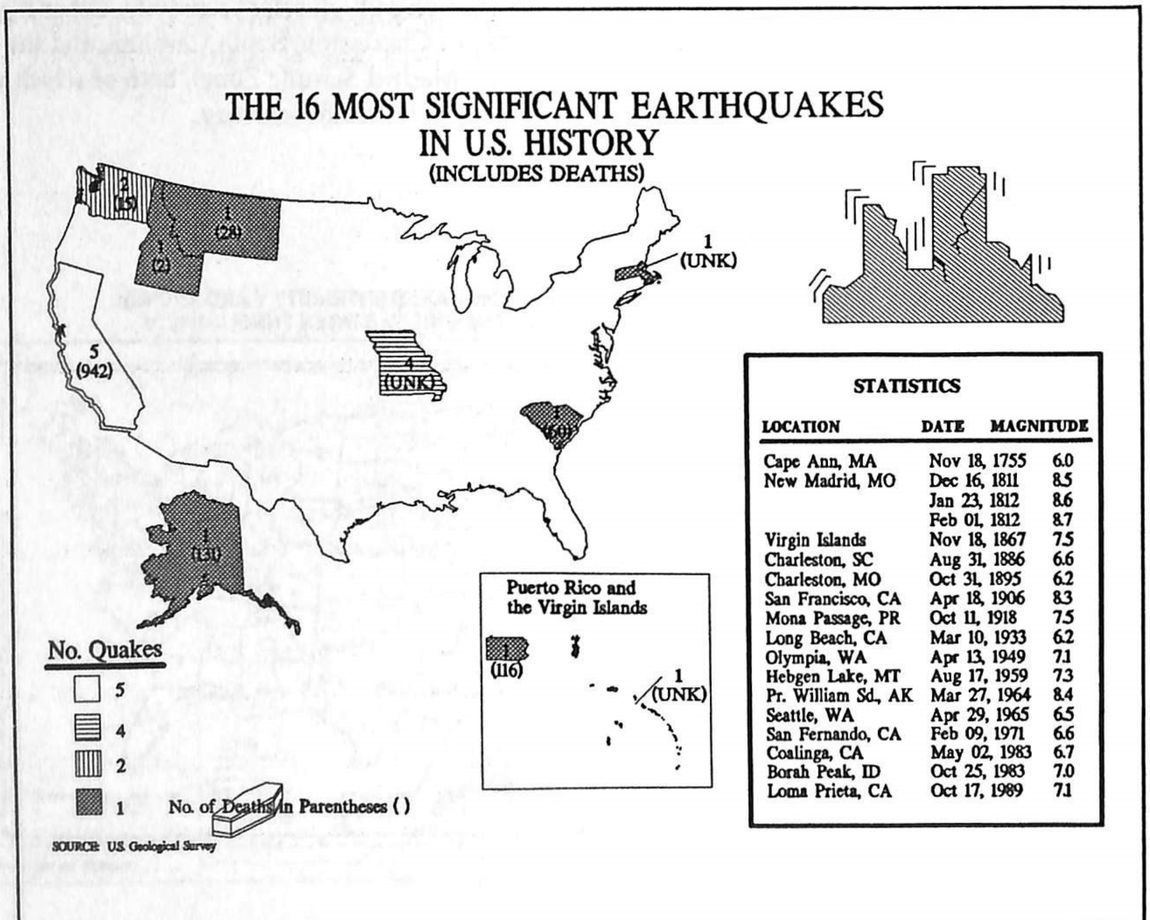
Season(s) Year round

Effects

The greatest danger to life in significant earthquakes comes from falling objects, broken glass and structural failures. Severe earthquakes destroy power and telephone lines and gas, sewer or water mains which, in turn, may set off fires and/or hinder fire-fighting or rescue efforts. They may also trigger landslides, rupture dams and generate seismic sea waves (tsunamis).

Worst Event

The worst event for deaths occurred in the 1906 San Francisco quake when 700 lives were lost. The worst event for economic damage was the more than $10 billion loss caused by the 1989 Loma Prieta earthquake. *Figure 6* displays the 16 most significant earthquakes in the history of the United States and the number of deaths from each event.



STATISTICS

LOCATION	DATE	MAGNITUDE
Cape Ann, MA	Nov 18, 1755	6.0
New Madrid, MO	Dec 16, 1811	8.5
	Jan 23, 1812	8.6
	Feb 01, 1812	8.7
Virgin Islands	Nov 18, 1867	7.5
Charleston, SC	Aug 31, 1886	6.6
Charleston, MO	Oct 31, 1895	6.2
San Francisco, CA	Apr 18, 1906	8.3
Mona Passage, PR	Oct 11, 1918	7.5
Long Beach, CA	Mar 10, 1933	6.2
Olympia, WA	Apr 13, 1949	7.1
Hebgen Lake, MT	Aug 17, 1959	7.3
Pr. William Sd., AK	Mar 27, 1964	8.4
Seattle, WA	Apr 29, 1965	6.5
San Fernando, CA	Feb 09, 1971	6.6
Coalinga, CA	May 02, 1983	6.7
Borah Peak, ID	Oct 25, 1983	7.0
Loma Prieta, CA	Oct 17, 1989	7.1

Figure 6

Discussion

Tens of potentially damaging earthquakes of a magnitude equal to 5 or greater on the Richter Scale occur annually in the United States. For example, in a typical year such as 1982, 70 earthquakes of a magnitude equal to 5 or greater on the Richter scale occurred throughout the country. Of these, there were 45 in Alaska, 22 in the contiguous 48 States and 3 in Hawaii. Great magnitude earthquakes (equal to 8 or greater on the Richter Scale), which are more infrequent, occur in the United States on an average about once every 12 years.

Earthquakes occur in virtually all 50 States, Puerto Rico and the Virgin Islands. They happen most frequently in California, Alaska and the Caribbean in the grid of faults, chains of volcanoes and mountains and deep oceanic trenches which are the boundaries between the great crustal plates that form the Earth's outer shell. Intraplate earthquakes—shocks within the interior of the giant crustal plates—are less common occurrences, but they can be equally destructive. Intraplate earthquakes are more typical of the types of earthquakes that occur in the eastern United States.

While earthquakes are relatively infrequent in the eastern States, an earthquake the magnitude of Loma Prieta could cause significantly more damage in the eastern States than it did in California. Because of unique factors relating to the length of time seismic waves take to diminish in the East, the ground shaking in eastern earthquakes extends over much larger areas than it does in western earthquakes of comparable magnitude. For example, the distributions of intensities of the 1811 New Madrid, Missouri, earthquake and the 1886 Charleston, South Carolina, earthquake each were substantially greater than those of the 1906 San Francisco, California, earthquake and the 1971 San Fernando, California, earthquake.

Landslides, lateral spreads, differential settlements and ground cracks induced by earthquake ground shaking are a principal cause of damage and casualties. In the 1906 San Francisco, California, earthquake, lateral spreads and ground settlement were responsible for considerable damage in the city. This damage included the breaking of several water pipelines that, in turn, left the city largely defenseless against the conflagration that followed.

Earthquake magnitude is a measure of the strength of an earthquake, or the strain energy released by it, as calculated from the instrumental record made by the event on a calibrated *seismograph.* Seismographs record a zig-zag trace that shows the varying amplitude of ground oscillations beneath the instrument. Sensitive seismographs, which greatly magnify these ground motions, can detect strong earthquakes from sources anywhere in the world. The time, location and magnitude of an earthquake can be determined from the data recorded by seismograph stations.

The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of waves caused by seismographs. Adjustments are included in the magnitude formula to compensate for the variation in the distance between the various seismographs and the epicenter of the earthquakes.

On the Richter Scale, magnitude is expressed in whole numbers and decimal fractions. For example, a magnitude of 5.3 might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Earthquakes with magnitudes of about 2.0 or less are usually called microearthquakes; they are not commonly felt by people and are generally recorded only on local seismographs. Events with magnitudes of about 4.5 or more—there are several thousand such shocks annually—are strong enough to be recorded by sensitive seismographs all over the world.

Floods

Definition

Four types of floods are included in this discussion.

- *Riverine—periodic overflow of rivers and streams*
- *Flash—quickly rising small streams after heavy rain or rapid snowmelt*
- *Urban—overflow of storm sewer systems, usually due to poor drainage, following heavy rain or rapid snowmelt*
- *Coastal—flooding along coastal areas associated with severe storms, hurricanes or other events*

National Frequency

The frequency is undetermined, but there are numerous floods each year.

Regions at Risk

Floods occur in every State and territory.

Season(s)

Flooding can happen any time of the year, but predominates in the Spring.

Effects

The long-term (1925-1988) average annual death toll from flooding stands at 72. The average annual figure for economic damage, derived from losses during the years of 1979 through 1988, is $2.4 billion. Property damage and agricultural losses for the 1989 fiscal year were estimated to be $1.1 billion. The map in *Figure 7* shows the FY 1989 per capita flood damages. Other effects from floods include crop damage and soil erosion. Flooding can also trigger secondary events such as power failure and landslide. In spite of risk reduction mitigation efforts for floodplain management, increasing numbers of households are at risk and increased damage is projected for the future.

Worst Event

The worst recorded event (loss of lives) was the 1889 flood in Johnstown, Pennsylvania, in which more than 2,200 lives were lost. (The flood itself was actually caused by the failure of a dam upstream from Johnstown. This flood is a classic example of the "secondary effects" that can occur from another event.) The worst economic losses were incurred in the 1972 floods that resulted from Hurricane Agnes ($4 billion) and the 1973 spring flood of the Mississippi River system ($1.2 billion).

AVERAGE FLOOD DAMAGE SUFFERED

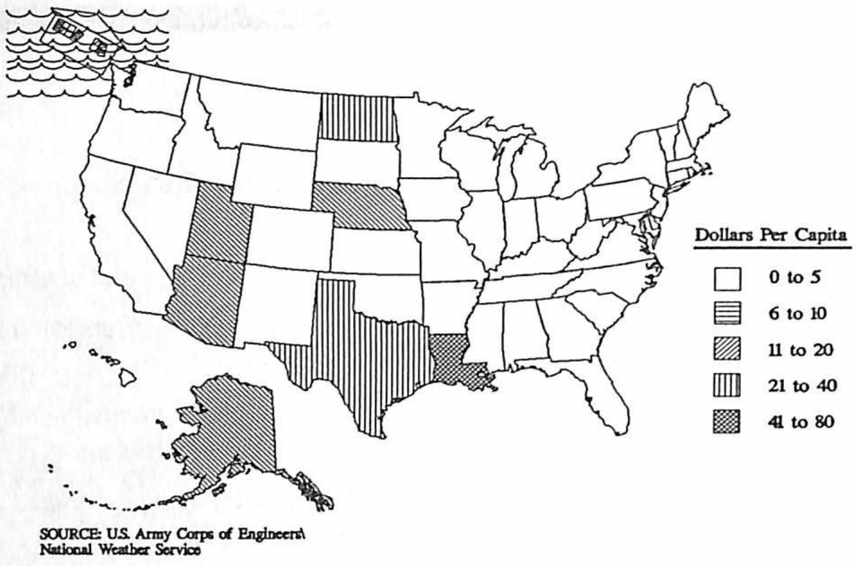


Figure 7

Discussion

Flooding, perhaps the most pervasive natural hazard in the United States, occurs from a variety of causes. Floods often accompany hurricanes and tornadoes. While some floods develop over a period of days, "flash floods" can result in raging waters in a matter of minutes.

In an attempt to alleviate flood losses, Congress established the National Flood Insurance Program with the passage of the National Flood Insurance Act of 1968. The intent was to mitigate future damage and provide protection for property owners against potential losses through an insurance mechanism that was not formerly available. Over 2.5 million insurance policies have been issued under this program, and claimants have received $2.5 billion for 350,000 insurance losses since 1978. Claim payments of $365 million covered flood damage caused by Hurricane Hugo in South Carolina. Communities participating in the National Flood Insurance Program are required to adopt and implement measures to reduce future flood losses in Special Flood Hazard Areas.

Hurricanes/Tropical Storms

Definition

A large cyclonic storm accompanied by high winds, extreme rainfall and storm surge

National Frequency

The national average for hurricane incidents within the continental United States, based on figures from 1871 to 1989, is 1.9. During the same period, Florida experienced the largest number of hurricanes of any State, 57— Texas was second with 37. In 1989, three hurricanes and two tropical storms reached the shores of the United States. During the last 10 years, the Western Pacific Insular Areas have experienced 14 hurricanes. An average of 29 tropical storms or hurricanes occur each year in the West Pacific Ocean.

Regions at Risk

Vulnerable areas in the United States include the territories in the Caribbean, the coast from Texas to Maine and tropical areas of the western Pacific Ocean, including Hawaii. (Typhoons are the Pacific Ocean version of hurricanes.) *Figure 8* depicts the number of hurricanes by State during the period 1871-1989.

Season(s)

Summer and Fall. Hurricanes and tropical storms occur seasonally (June through November) with August and September being the peak months.

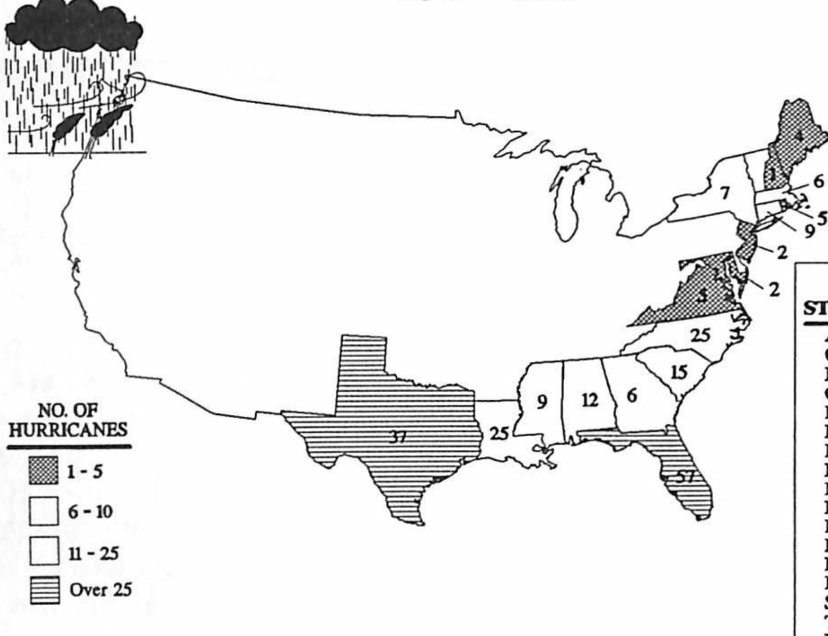
Effects

The consequences of hurricane winds and storm surge, which are often accompanied by other devastating events such as tornadoes, include loss of life, coastal erosion, coastal and inland flooding, structural failures, felled trees which cause other damage, power failures and significant economic disruption. The annual rate of hurricane-related deaths is 33. A total of 61 hurricane/tropical storm-related deaths were recorded for 1989 by the National Hurricane Center—26 deaths were attributed directly to Hurricane Hugo.

Worst Event

The worst event happened in Galveston, Texas, in 1900 when 6,000 lives were lost. The greatest economic damage resulted from Hurricane Hugo in 1989 with an estimated ***direct*** loss of $9.2 billion. (See *Figure 9* for a list of the 20 costliest U.S. hurricanes during the period 1900-1989; note that hurricanes were not assigned names prior to 1951).

NUMBER OF HURRICANES BY STATE
1871 - 1989



STATE	NUMBER HURRICANES
Alabama	12
Connecticut	7
Florida	57
Georgia	6
Louisiana	25
Maine	4
Maryland	2
Massachusetts	6
Mississippi	9
New Hampshire	1
New Jersey	2
New York	9
North Carolina	25
Rhode Island	5
South Carolina	15
Texas	37
Virginia	5

SOURCE: NOAA, National Hurricane Center

Figure 8

THE 20 COSTLIEST U.S. HURRICANES, 1900 - 1989
(Adjusted to 1980 Dollars, in Billions)

HURRICANE	YEAR	DAMAGE
Hugo (VI, PR, SC, NC)	1989	$10.000
Agnes (Northeast U.S.)	1972	4.700
Betsy (FL, LA)	1965	4.670
Camille (MS, LA)	1969	3.810
Diane (Northeast U.S.)	1955	3.086
New England	1938	2.632
Frederic (AL, MS)	1979	2.550
Carol (Northeast U.S.)	1954	1.733
Carla (TX)	1961	1.412
Donna (FL, East Coast)	1960	1.335
Celia (South TX)	1970	1.142
Hazel (SC, NC)	1954	1.057
Florida (Miami)	1926	.936
Eloise (Northwest FL)	1975	.880
Dora (Northeast FL)	1964	.850
Northeast U.S.	1944	.677
Beulah (South TX)	1967	.608
Southeast FL, LA, MS	1947	.516
Audrey (LA, TX)	1957	.510
Claudette (TX)	1979	.444

Figure 9

Discussion

Hurricanes are cyclonic storms with counterclockwise winds of 74 miles per hour or higher. The coastal areas that receive the full brunt of hurricane winds and storm surge sustain the most damage. Since hurricanes dissipate quite rapidly to less than hurricane strength after they make landfall, inland areas receive less severe damage, usually from flooding associated with the exceptionally heavy rains commonly associated with the remaining storm system.

Figure 10 contains data on the deadliest hurricanes, those causing 25 deaths or more (1900 to 1989).

DEADLIEST U.S. HURRICANES
(1900 - 1989)

HURRICANE	YEAR	CATEGORY	NUMBER OF DEATHS
Texas, Galveston	1900	4	6,000
Florida (Lake Okeechobee)	1928	4	1,836
Florida (Keys/S. Texas)	1919	4	600-900
New England	1938	3	600
Florida (Keys)	1935	5	408
Audrey (LA & TX)	1957	4	390
Northeast U.S.	1944	3	390
Louisiana (Grand Isle)	1909	4	350
Louisiana (New Orleans)	1015	4	275
Texas (Galveston)	1915	4	275
Camille (MS & LA)	1969	5	256
Florida (Miami)	1926	4	243
Diane (Northeast U.S.)	1955	1	184
Florida (Southeast)	1906	2	164
Mississippi/Alabama/ Pensacola, Florida	1906	3	134
Agnes (Northeast U.S.)	1972	1	122
Hazel (SC & NC)	1954	4	95
Betsy (FL & LA)	1965	3	75
Carol (Northeast U.S.)	1954	3	60
Southeast Florida, Louisiana, Mississippi	1947	4	51
Hugo (SC, NC, PR & VI)	1989	5	26

Figure 10

Landslides

Definition

Downward and outward movement of slope-forming materials composed of natural rock, soils, artificial fills or combinations of these materials. The moving mass may be proceeded by any of three principal types of movement: falling, sliding or flowing, or by their combinations.

National Frequency

Precise data is not available, however, a 1985 report on "Reducing Losses from Landsliding in the United States," by the Committee on Ground Failure Hazards of the National Research Council, cited statistics which are representative of the magnitude of some of the major landsliding problems in recent years:

- In eastern West Virginia in 1969, a single storm associated with Hurricane Camille resulted in *1,534* landslides in one small drainage basin, the Spring Creek watershed.
- Between 1966 and 1981, Orange County, California, experienced *40* major bedrock landslides that resulted in a total economic loss of over *$40 million*.
- Storm-triggered landslides in the Los Angeles area during the winters of 1951-52, 1957-58, 1961-62, 1964-65, 1968-69, 1977-78 and 1978-79 produced an average loss of *$500 million* in each season of heavy storm activity.

An additional incident cited in ***Landslide Loss Reduction: A Guide for State and Local Government Planning****, FEMA 182, August 1989*, happened in 1982 when 24.3 inches of rain, falling within a 34-hour period, triggered *thousands* of landslides in the San Francisco Bay Region that killed *25 people* and caused more than *$66 million* in damages.

Regions at Risk

According to the report of the Committee on Ground Failure Hazards of the National Research Council, "Landsliding is widely distributed in the United States and is not restricted to a few localized areas. Many different physiographic and climatic regions are subject to landslides, and in much of the United States landsliding is a dominant process of landscape alteration." The same report stated that, "Landslides are indigenous to much of the Appalachian Highlands, particularly southwestern Pennsylvania, southeastern Ohio and northern West Virginia. More than two million mappable landslides are estimated to have occurred in the Appalachian Highlands from New England to the Gulf coastal plain. These include landslides in the portions of the highlands that extend into New England, New York, Maryland, Kentucky, Virginia, Tennessee, North Carolina, South Carolina, Georgia and Alabama."

See *Figure 11* for a map of the regions at risk from landslides in the United States.

Season(s)

Year round.

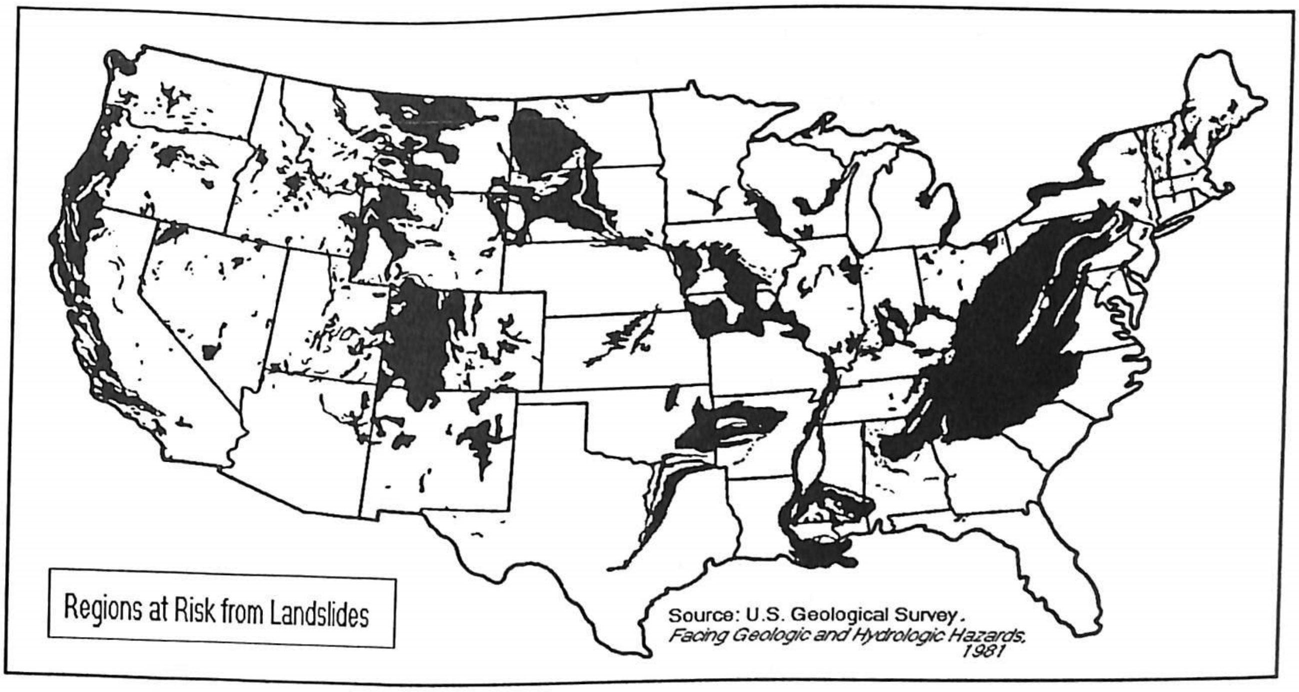


Figure 11

Effects

The annual death rate from landslides is 25 to 50, with annual economic losses estimated at $1 to $2 billion. According to the National Research Council report mentioned above, "The loss of life from landsliding is comparable to the total loss of life from floods, earthquakes and hurricanes (Krohn and Slosson, 1976)." Economic losses are extensive, including not only the replacement and repair of damaged facilities but associated costs relating to lost productivity, disruptions to utility and transportation systems and losses of revenue for affected communities.

Worst Event

In terms of sheer volume (2.8 billion cubic meters), the collapse of the northern part of the cone of the Mt. St. Helens volcano immediately before the May 18, 1980, eruption is the world's largest landslide in historical terms (because of evacuation and other preparedness measures taken beforehand, only 5-10 people were killed by the landslide).

Discussion

Landslides can occur either very suddenly or slowly. They can be triggered during earthquakes, heavy rainstorms or rapid snowmelt, volcanic eruptions, storm generated ocean waves or by other landslides. Landslides can also be triggered by freeze-thaw and shrink-swell cycles, root wedging, animal burrows, natural erosion or deposition or the thaw of ice-bearing soils such as permafrost. While most landslides are single events, more than one-third of the cases are associated with heavy rains or the melting of winter snows.

Although the term *landslide* is generally assumed to mean any slide of rock or soil down a mountainous or hilly location, the term actually encompasses a number of different types of earth movements. For example, lateral shifts, even in soil that appears to be nearly flat to the naked eye are, in reality, landslides. Such movement is often caused by heavy saturation or liquefication of the soil following heavy rains or snowmelt, but it can also be the result of an earthquake. Classic examples of lateral shifts occurred in Sylmar, California, during the 1971 San Fernando earthquake. Another type of landslide can come from the "rotational" movement of land. During the earthquake in Alaska in 1964, for example, acreage in some areas moved as much as 11 feet, yet the buildings standing on the land were undamaged. (It is believed that liquefied soil beneath the earth supported the buildings and absorbed much of the shaking from the earthquake.)

Earthquake shaking can dislodge rock and debris on steep slopes, triggering rock falls, avalanches and slides. Ground shaking can initiate shallow debris slides on steep slopes and, less commonly, rock slumps and block slides on moderate to steep slopes. Though rare, shaking can reactivate dormant slumps or blockslides. Earthquake shaking can also trigger soil avalanches in some weakly cemented fine-grained materials, such as loess, that form steep stable slopes under non-seismic conditions. (Source: ***Earthquakes, Volcanoes, and Tsunamis — An Anatomy of Hazards***, *by Karl V. Steinbrugge. Skandia America Group, 1982. pp. 69-72.)*

The effects of landslides can be both dramatic and devastating. Large landslides in 1958, thought to be triggered by earthquakes, generated wave heights of as much as 1,720 feet in Lituya Bay in southeastern Alaska. Most of the 150 people killed in Virginia in the 1969 flooding associated with the remnants of Hurricane Camille did not drown. They actually died from blunt-force injuries when struck by debris in the numerous debris flow avalanches caused by the heavy rain (Williams and Guy, 1973). In 1972, three coal-refuse impoundments at Buffalo Creek, West Virginia, collapsed during heavy rains. The flow of mud and debris from this event traveled almost 15 miles downstream, killing 125 people and leaving 4,000 homeless (Davies and others, 1973).

In the past two decades, the expansion of the population into seismic risk areas (including relatively flat terrain) and/or steeply sloping terrain has contributed to the increase of damaging landslides. Building residential and other structures and developing irrigated landscape areas in such terrain alter soil or hillside configurations and aggravate the instability of many slopes. Such development can also reactivate older landslides or create conditions for new landslides.

Subsidence

Definition

Any vertical displacement or downward movement of a generally level ground surface resulting from either natural or man-induced surface or subsurface conditions

National Frequency

As is the case with landslides, definitive data on the annual frequency of subsidence is unknown. However, subsidence results in millions of dollars of damage each year, with additional millions being spent in mitigation efforts.

Regions at Risk

Subterranean limestone regions; active or abandoned underground mining sites; areas subject to other hazards such as earthquakes or areas of extensive oil, gas or groundwater withdrawal are highly vulnerable to subsidence. States with the highest rates of subsidence activity include Alabama, California, Florida, Kansas, Louisiana, Missouri, Montana, New Jersey, Oklahoma, Pennsylvania, Tennessee, Texas and Washington.

Season(s)

Year round

Effects

While few deaths are recorded, the annual damage from subsidence nationwide exceeds $125 million—the annual rate in Florida alone is $10 million. The cities of Long Beach, California; Houston, Texas, and New Orleans, Louisiana, each have *cumulative* damage costs from subsidence of more than $100 million. (Source: ***Mitigating Losses from Land Subsidence in the United States***, National Research Council Committee on Ground Failure Hazards Mitigation Research, National Academy of Sciences, 1991.) The degree of damage depends on whether the subsidence occurs in an urban area or a rural, sparsely populated area. In the case of urban areas, extensive damage and disruption can occur to utility lines, residential or business areas, transportation systems, water canals and dams.

Worst Event

Because there are four major subsidence conditions found in the United States, a "worst event" is somewhat difficult to characterize. However, some of the most serious subsidence damages have been the result of ground sinking around abandoned metal or coal mines in Montana, New Jersey, Pennsylvania, Washington and a tri-State area formed at the junctions of Missouri, Oklahoma and Kansas.

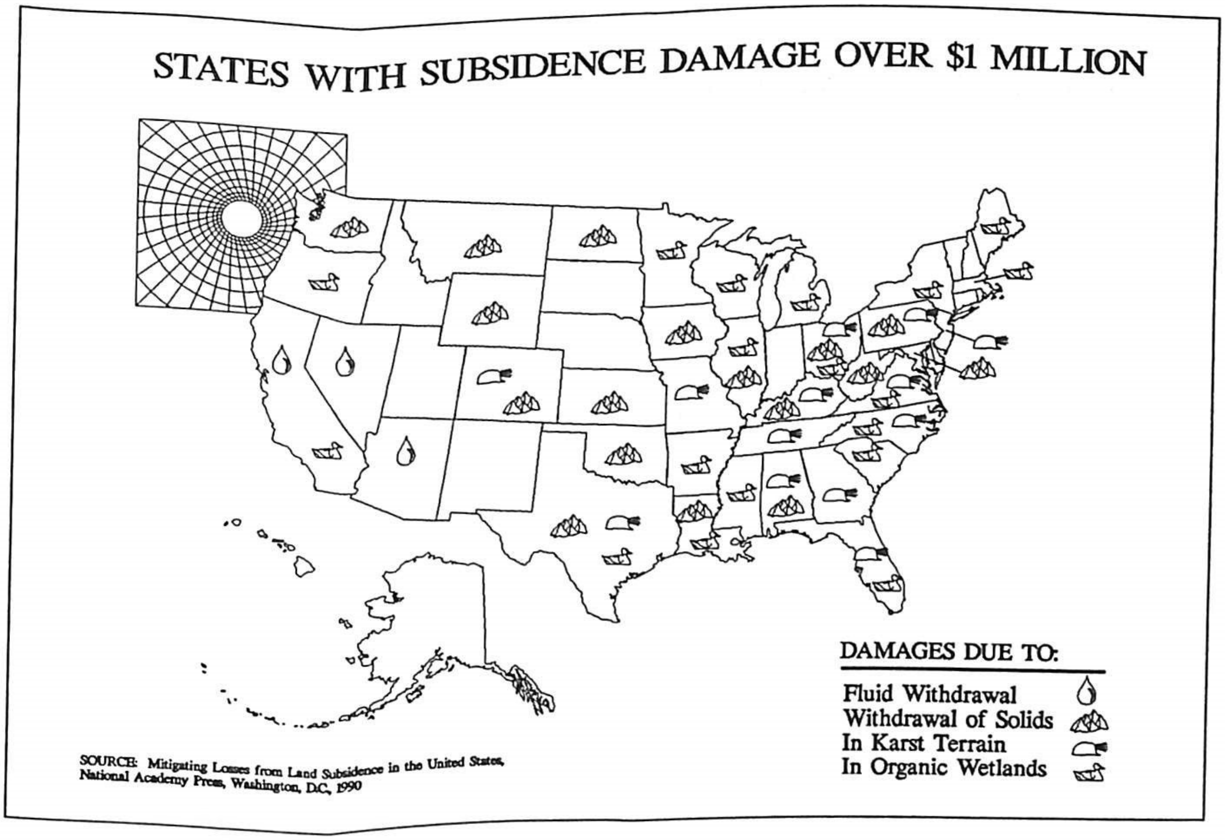


Figure 12

Discussion

Subsidence has affected at least 45 States in the United States (see *Figure 12*) and has lowered more than 17,000 square miles of land—an area equal to half the size of Maine. An additional 3,900 square miles are at risk. The principal causes of subsidence in this country are underground mining of coal, groundwater withdrawal and drainage of organic soil. Approximately 92 percent of the subsided surface is identified as either forest, idle or agricultural land. The remaining 8 percent (about 246 square miles) is generally urban.

Subsidence can be caused by either natural or man-induced processes. Natural processes include the changes relating to alterations in the earth's crust, the dissolution of underground minerals, thawing of ground ice in permafrost or alterations in the vegetative cover. Man-induced subsidence results from such activities as subsurface mining, excessive pumping or removal of groundwater, extraction of gas or oil from underground reservoirs, drainage of wetlands or the application of surface loads (such as buildings) on compressible soils.

Four primary types of subsidence conditions are found in the United States.

- subsidence resulting from the removal of underground fluid such as groundwater, oil or gas
- subsidence in organic wetlands
- subsidence due to mining, particularly coal mining
- subsidence (or "sinkholes") in *karst* terrain (subterranean limestone areas)

Subsidence rates can be either sudden or extremely slow, such as those resulting from long-term geological changes. Subsidence that comes from the removal of underground fluids often can be nearly imperceptible in the early stages and usually continues to be relatively slow as the condition worsens. Such subsidence conditions, which generally cover areas of tens of miles in diameter, are often gradual enough that damage to buildings or other structures is relatively light. These areas are, however, generally more susceptible to secondary damages such as flooding or inundation, particularly when they lie in floodplains or in low coastal areas. Underground fluid withdrawal has caused more than 31 areas in 7 States to subside The highest risk areas for this type of subsidence are located in Texas (Houston-Galveston, Baytown and Texas City-Seabrook), Louisiana (coastal areas) and California (San Joaquin Valley).

The reclamation of organic wetlands has allowed many metropolitan areas with limited available land to extend their boundaries by building on lands that would normally be considered unsuitable for construction. This drainage of water from organic soil has caused the subsidence of about 3,629 square miles within the United States. The worst subsidence of this nature has occurred in the greater New Orleans, Louisiana, area; the Sacramento-San Joaquin River Delta, California, and parts of the Florida Everglades. For some urban areas, however, the threat of subsidence is deemed an acceptable risk and subsidence management is factored into their considerations.

An estimated 220 counties in 42 States have underground mining activities that create the potential for subsidence. Some 617 square miles of undermined land in urban areas is at risk—71 percent of the threatened area is in Illinois, Pennsylvania and West Virginia. The removal of the solid materials within the mines creates a void that is frequently unstable. Once the solid material, such as coal, is removed, the weight of the materials above the mine are redistributed. Subsequently, the land area above the abandoned mine subsides with the collapse of the timbers, support columns or other such structures that were developed during the mining phase but are no longer maintained.

In the lower 48 States, 18 percent of the land is susceptible to catastrophic collapse into sinkholes because of underlying cavernous limestone, gypsum, salt or marble. Subsidence in subterranean limestone caverns can happen when underground water weakens the natural support structure by percolating through the limestone walls and causing cavities or dissolving the materials. Land overlying these caverns can collapse suddenly, forming sinkholes as much as 100 feet deep and 300 feet across. More than 11,583 square miles of land threatened by sinkholes are located in urban areas of the United States that are inhabited by *33 million people.*

As noted earlier, subsidence damage on an annual basis totals in the millions of dollars. Added to this total are the millions of dollars spent annually for mitigation and preparedness measures, particularly in urban areas with large areas of reclaimed wetlands. While modern technology is assisting in the mitigation effort, much remains to be done.

Tornado

Definition *A small radius cyclonic windstorm*

National Frequency The yearly national average of incidents (taken from 1959-1988 data) is 783. The average annual frequency per State is 16 with a high for Texas of 132 and less than 3 in 14 States.

Regions at Risk Tornadoes are a risk in all States but are more frequent in the Midwest, Southeast and Southwest. The States of Mississippi, Kansas, Arkansas, Oklahoma, Illinois, Indiana, Iowa, Missouri, Nebraska, Texas, Louisiana, Florida, Georgia, Alabama and South Dakota are at greatest risk. (See *Figure 13* for a national summary of the 1959-1988 tornado occurrences and *Figure 14* for the 1989 tornado activity.)

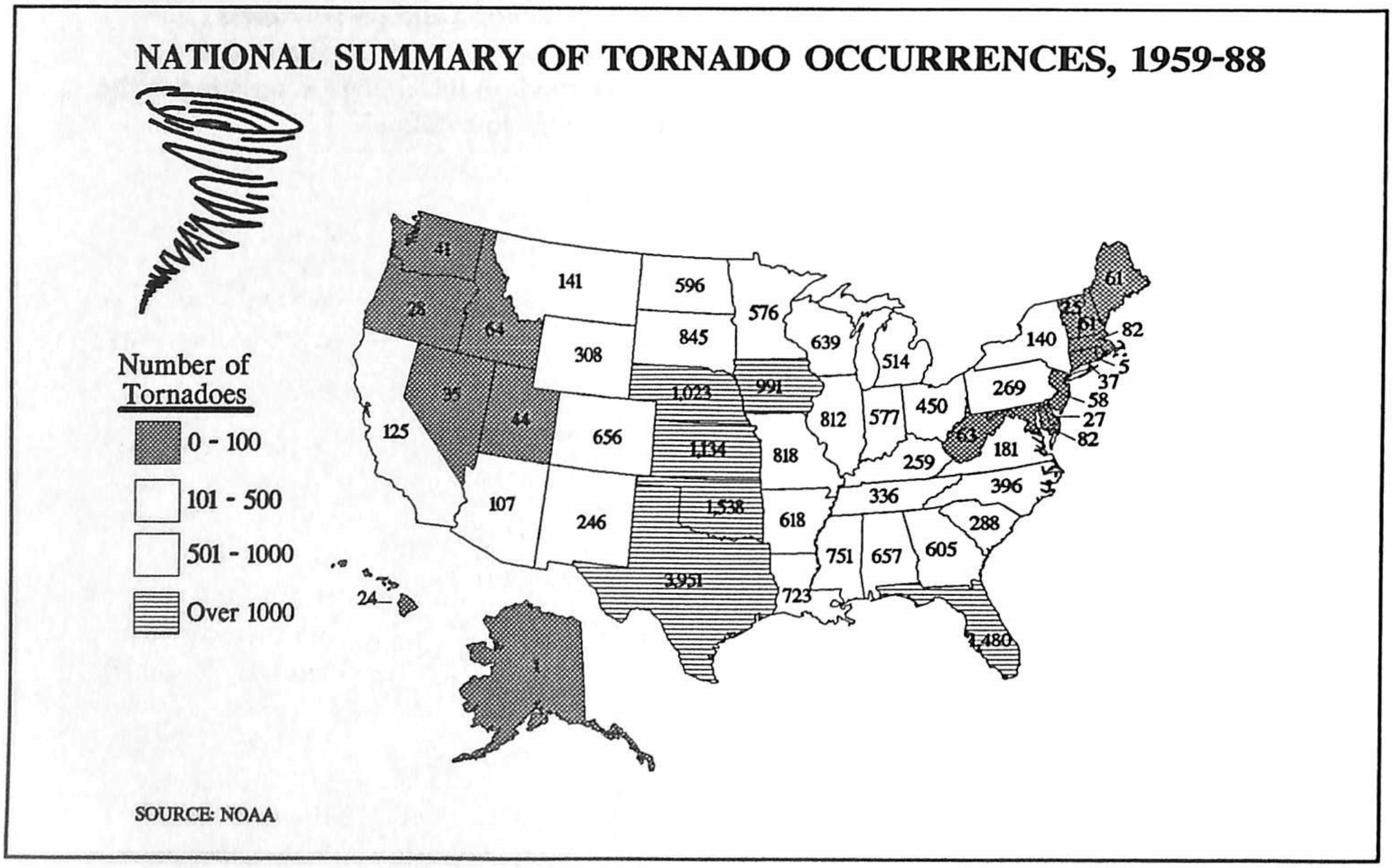


Figure 13

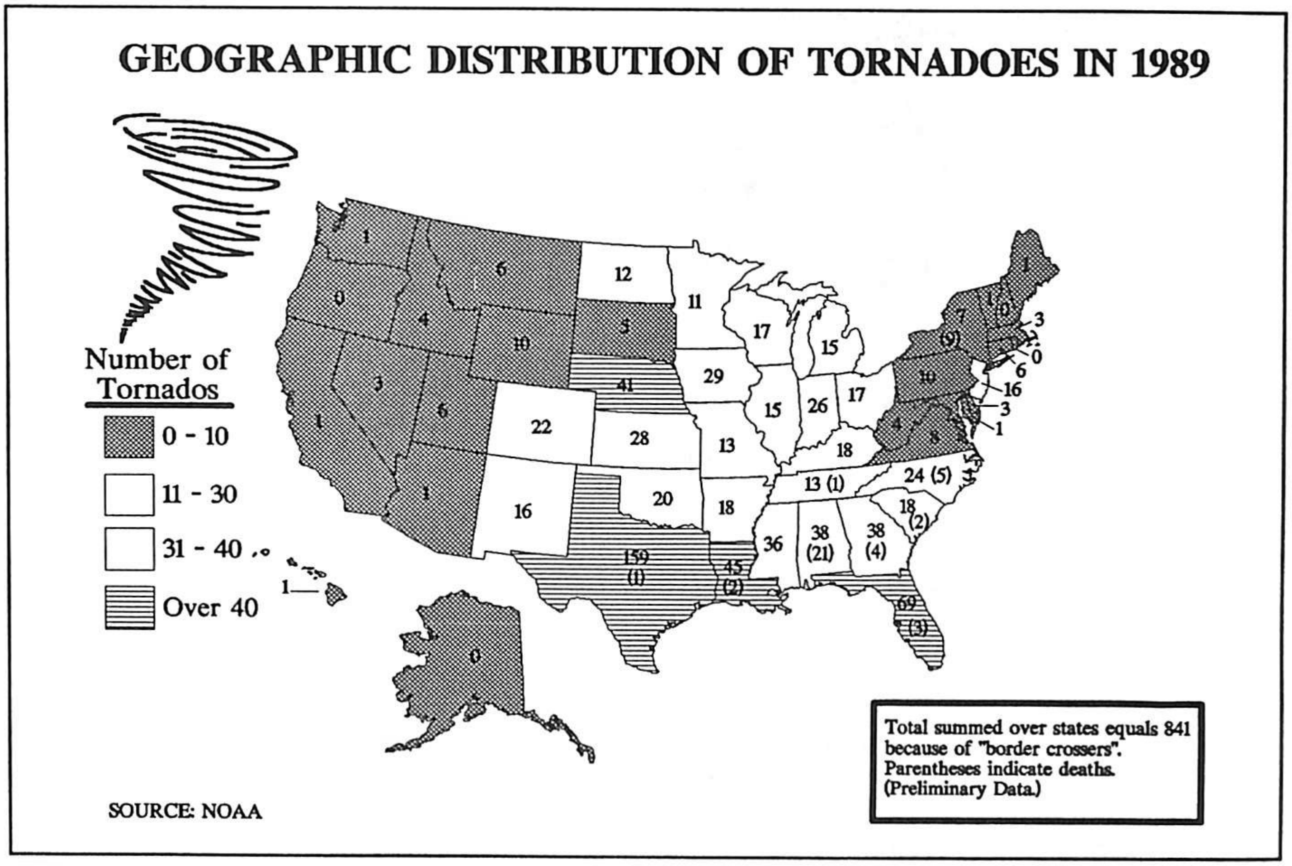


Figure 14

Season(s)

Tornadoes can occur year-around. While the normal tornado season extends from March to August, the peak months are from April through June.

Effects

The annual rate of deaths (averaged over the years 1959 to 1988) stands at 83. The annual rate of economic damage for the years 1965-1972 ranged from $50 to $500 million and over $500 million for 1973 to 1975. According to a U.S. Army Corps of Engineers/National Weather Service report, the fiscal year damage costs for 1989 exceeded $570 million. Tornadoes cause secondary events such as power failure and fires. (See *Figure 15* for a summary of tornado deaths during the period 1959-1988.)

Worst Event

The worst event in this century occurred on March 18, 1925, when eight tornadoes in Missouri, Illinois, Indiana, Kentucky, Tennessee and Alabama caused 689 deaths. The worst November on record was in 1988 when 121 tornadoes, mainly concentrated

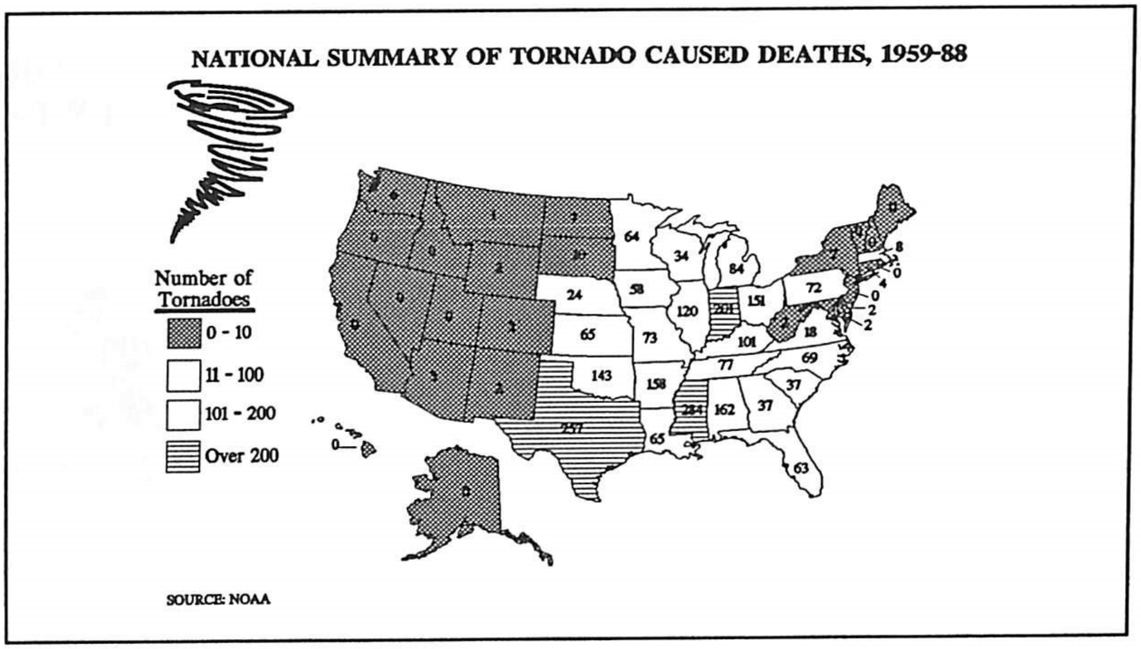


Figure 15

in four major outbreaks, struck 15 south-central States. (The annual tornado average for November is 23.) A total of 14 lives were lost and damages were in excess of $108 million.

Discussion

While they are relatively short-lived in duration, tornadoes are intensely focused, making them one of the most destructive natural hazards. With winds of 150 miles per hour or more at their centers, tornadoes can destroy almost everything in paths that can range from 200 yards to one mile wide. Although tornadoes normally travel for up to 10 miles, tornado tracks of 200 miles have been reported.

More tornadoes occur in the United States than anywhere else in the world. They generally develop from thunderstorms and sometimes as the result of hurricanes. The weather conditions which tend to generate this phenomenon are unseasonably warm and humid earth surface air, cold air at middle atmospheric levels and strong upper-level jet stream winds. The instability of weather patterns during the "transitional" Spring and Fall seasons, when warm- and cold-air systems often converge violently, make these times of the year particularly dangerous for tornado activity.

In the first half of this century, the number of tornadoes recorded per year was less than 200. Since 1953, the numbers have ranged from 421 to 1,102 per year. The increase results from a number of factors not necessarily related to weather changes. Increased population density means that there are more people to detect and report tornadoes which touch down in areas that were formerly isolated. In addition, significant improvements in technology, communications and military and weather service tracking have improved both the detection and reporting of tornadoes.

Tsunami

Definition *A water wave or a series of waves generated by an impulsive vertical displacement of the ocean or other body of water usually due to earthquakes, volcanoes or landslides*

National Frequency Between 1900 and 1990, coasts in the United States have been struck by 151 confirmed tsunamis, for an average frequency of 1.67 per year. During this time, a damaging tsunami occurred every 3.6 years on the average.

Regions at Risk Hawaii, the highest risk area, averages one tsunami every year with a damaging occurrence every 7 years. Alaska, also at high risk, averages a tsunami every 1.75 years and a damaging event every 7 years. The West Coast and American Samoa experience a damaging tsunami every 18 years on the average. Although Guam, the Commonwealth of the Northern Marianas (Saipan) and the other Western Pacific Insular entities record a tsunami every 3 years, they are at low risk because the waves cause almost no damage. Also at low risk are Puerto Rico, the Virgin Islands and the East Coast where tsunamis are recorded every 13 to 18 years. Historically, however, at least one tsunami has caused damage and deaths in Puerto Rico and the Virgin Islands. The tsunami risk table (developed by the National Geophysical Data Center) in *Figure 16* lists the 1900-1990 frequency rate.

Season(s) Year round

TSUNAMI RISK AREAS

Frequency Per Year 1900 - 1990

AREA	TOTAL	DAMAGING	RISK
Hawaii	1.00	0.14	High
Alaska	0.57	0.14	High
West Coast	0.5	0.06	Moderate
American Samoa	0.67	0.06	Moderate
Pacific Islands	0.33	0.01	Low
Puerto Rico/ Virgin Islands	0.06	0.01	Low
East Coast	0.08	0.01	Low

Figure 16

Effects

History records at least 470 fatalities and several hundred million dollars in property damage in the United States and its territories. Tsunamis can trigger the secondary effects of flooding and landslides.

Worst Event(s)

On April 1, 1946, a tsunami with wave heights of 55 feet above sea level struck Hawaii, killing 159 people and causing property damage estimated at $26 million. Generated by an earthquake near the Aleutian Islands in Alaska, the tsunami had a wave length of about 100 miles and traveled at about 490 miles per hour. Deaths from this tsunami were also recorded in Alaska and the West Coast.

A tsunami following the Prince Rupert Sound (Alaska) earthquake in 1964 directly impacted the three West Coast States and Alaska, resulting in 123 deaths and damage totaling $98 million. (Hawaii was also affected, but damages were significantly lower.) Tsunami-generated waves of 20 feet crashed ashore at Crescent City, California, and waves ranging from 10-16 feet swept along parts of other coastal areas of California, Oregon and Washington.

Figure 17 summarizes the damage from the five major tsunamis that have occurred within the past 50 years.

DAMAGE FROM MAJOR TSUNAMIS
(1940 - 1990)

Date/Source	Hawaii	Alaska	West Coast	Samoa
April 1, 1946 Aleutian Islands	$26,000,000 159 deaths	Some 5 deaths	Moderate 1 death	
November 4, 1952 Kamchatka, USSR	$1,000,000	Slight		Minor
March 9, 1957 Aleutian Islands	$5,000,000	Severe	Minor	Minor
May 22, 1960 S. Chile	$24,000,000	Minor	$1,000,000	Minor
March 28, 1964 Gulf of Alaska	$15,000	$86,000,000 107 deaths	$12,000,000 16 deaths	

Figure 17

Discussion

The term "tsunami," a Japanese word meaning "harbor wave," has become the accepted name for this phenomenon. Although tsunamis are often called tidal waves, the latter term is incorrect because tsunamis are not caused by the tidal action of the moon and the sun.

The waves triggered by an earthquake or volcano travel outward in all directions from the generating area, traveling at speeds of 300 to 600 miles per hour in the deep and open ocean. The distance between successive crests can be as much as 300 to 400 miles. In deep water, the height of the waves may be no more than 1-2 feet and may pass a surface vessel unnoticed. However, upon reaching shallower waters around islands or on a continental shelf, the speed of the advancing wave diminishes, its length decreases and its height increases greatly (possibly to more than 60 feet) as the water piles up along the shoreline. The advancing turbulent wave front of a tsunami may crash inland, sweeping all before it, sometimes beaching boats and ships thousands of feet inland. *(A tsunami triggered by the Krakatoa volcano in the Sunda Strait between Java and Sumatra on August 26, 1883, generated a tsunami estimated at 100 feet in height that caused tremendous loss of life on the islands.)*

A tsunami wave may break on the beach, appear as flooding or form a "bore" tide (a violent rush of water with an abrupt front) as it moves up a river or stream. When the trough of the wave arrives first, the water level drops rapidly, draining the harbor or offshore area and exposing sea life and ocean bottom. This phenomenon may be the only warning to residents that a large tsunami is approaching. Fatalities have occurred when people tried to gather fish or explore the strange landscape. The wave returns to cover the exposed coastline faster than the people can run. Although there may be an interval of minutes—or perhaps an hour—between waves, the second, third or later waves can be more destructive than the first. Residents returning to the waterfront after the first wave have been drowned in later waves. Successive wave crests may continue to pound the coast for several hours. Several days may pass before the sea returns to its normal state.

Most tsunamis are generated in the Pacific. Hawaii and the west coast of the United States have been struck repeatedly by tsunamis generated by earthquakes in South America and the Aleutian-Alaska region. Tsunamis of significant destructive force are relatively infrequent. During the last 60 years, 165 incidents have been recorded in the United States and the Western Pacific Islands.

While tsunamis are generally associated with the Pacific Ocean, they are rare, but not unknown, along the Atlantic coastline. A severe earthquake on November 18, 1929, in the Grand Banks of Newfoundland generated a tsunami that caused considerable damage and loss of life at Placentia Bay, Newfoundland. Small sea waves were recorded along the east coast of the United States as far south as Charleston, South Carolina. In the Caribbean, a large earthquake on November 18, 1867, centered between St. Thomas and St. Croix, caused sea waves more than 20 feet high that swept inland in the Virgin Islands and Puerto Rico. A local tsunami accompanying an offshore earthquake with a magnitude of 7.5 drowned many persons and destroyed numerous dwellings in northwestern Puerto Rico on October 11, 1918.

Although research into the history of tsunami experience is an important step for assessing risk, accurate assessment of future tsunami risk is complicated by changing demographics and modern developments. Population growth in coastal areas will increase the risk. Modifications to harbors and other mitigation efforts may have substantially reduced the risk in other areas. While modeling and study of historical data have contributed to the understanding of the effects of these waves, they remain an enigma and a threat to the United States coastal areas. (Sources: ***United States Tsunamis 1690-1988,*** *by Lander, J.F., and Lockridge, P.A., National Oceanic and Atmospheric Administration, National Geophysical Data Center, 1989;* ***Earthquakes, Volcanoes, and Tsunamis—An Anatomy of Hazards,*** *by Steinbrugge, Karl V., Skandia America Group, 1982. pp. 234-246;* ***Earthquakes: A National Problem,*** *[FEMA], including sources of information from Schnell, M.L., and Herd, D.G. [eds.];* ***National Earthquake Hazards Reduction Program: Report to the United States Congress,*** *U.S. Geological Survey Circular 918, 1984; and* ***The Severity of an Earthquake,*** *U.S. Geological Survey Popular Publication, 1979.)*

Volcano

Definition

An eruption from the earth's interior producing lava flows or violent explosions issuing rock, gases and debris

National Frequency

Among the known risk areas, volcanic eruptions occur more frequently in Hawaii.

Regions at Risk

The primary areas affected include the Pacific Rim States of Hawaii, Alaska, Washington, Oregon and California and the Commonwealth of Northern Marianas in the Western Pacific. Montana and Wyoming are also at risk, but to a much lesser extent.

Season(s)

Year round

Effects

Violent volcanic outbursts are characterized by clouds of poisonous gasses, rivers of lava and volcanic ash that can spread over wide areas. Major eruptions can result in heavy layers of ash covering widespread land areas, as witnessed following the eruption of Mt. St. Helens. Volcanic activity can also trigger tsunamis, landslides, floods (from the damming effects of slides or lava) and fires.

Worst Event

The eruption of Mount St. Helens in southwestern Washington on May 18, 1980, caused 60 deaths and approximately $1.5 billion in damage.

Discussion

All of the areas in the United States where volcanic action has occurred in the last 10,000 years are located west of the Rocky Mountains and, as a result, could pose potential future hazard areas (*see Figure 18*).

In addition to the Mount St. Helens event, other recent eruptions have occurred in Alaska's Mount Augustine in 1976 and 1986 and Mount Redoubt in 1989 and 1990. Hawaii's Kilauea and Mauna Loa have been relatively active in recent years. For the past seven years, Kilauea has posed a continuous threat to the surrounding population. Mauna Loa, on the same island, has been less active with a major eruption in 1950 and ones of smaller magnitude in 1975 and 1984. The Commonwealth of Northern Marianas has three active volcanos; Mt. Pagan erupted in 1981.

Areas of Potential Volcanic Activity

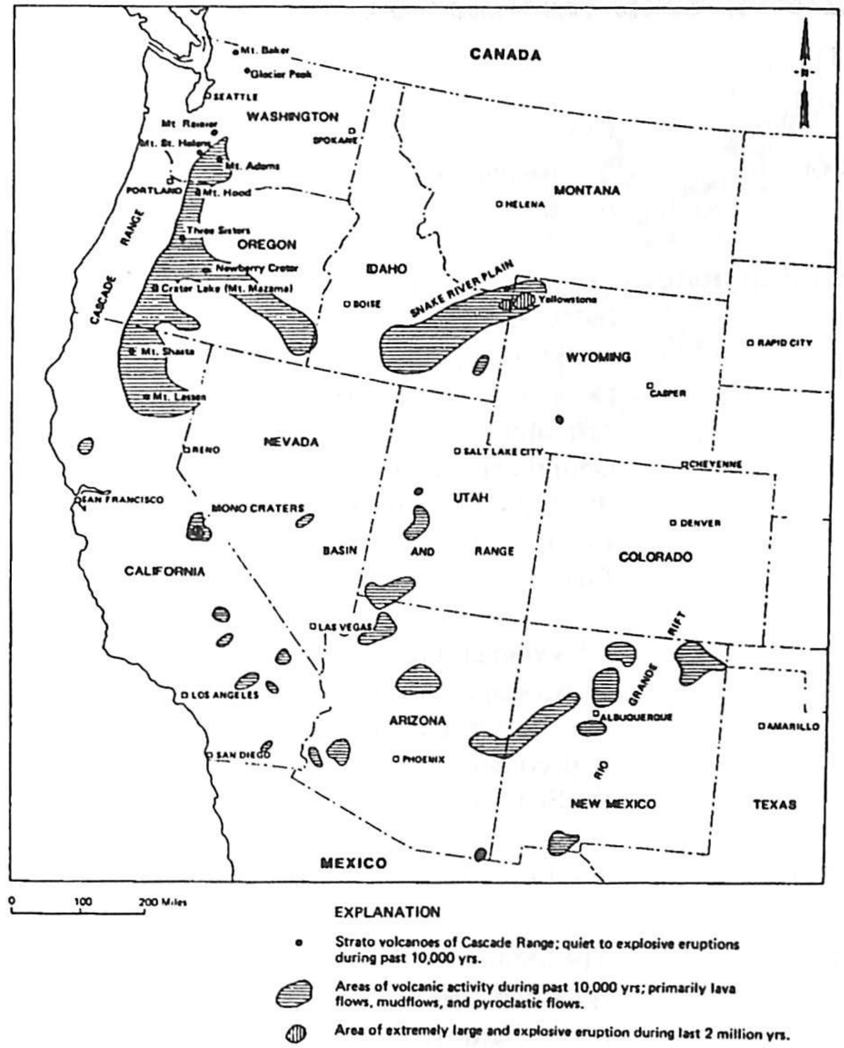


Figure 18

About 500 volcanoes have had recorded eruptions within historical times. Most volcanoes occur at the boundaries of the earth's crustal plates, such as the famous "Ring of Fire" that surrounds the Pacific Ocean Plate. Of the world's active volcanoes, about 60 percent are along the perimeter of the Pacific. (Source: ***Earthquakes, Volcanoes, and Tsunamis—An Anatomy of Hazards****, by Karl V. Steinbrugge. Skandia America Group, 1982. pp. 259-274.)*

Wildfire

Definition

Any instance of uncontrolled burning in grasslands, brush or woodlands

National Frequency

According to U.S. Forest Service figures for the years 1986-1988, the national average was 140,341. The State average was 2,794 with Georgia having the highest average of 12,478. In 1989, a total of 94,369 fires burned 2,039,363 acres. The State averages for fires and involved acreage was 1,887 and 40,787, respectively. Georgia again had the highest number of fires—7,325; however, the 37,783 acres burned was below average. Florida had the highest amount of land involved with 645,331 acres burned by 7,291 fires.

Regions at Risk

All wooded, brush and grassy areas—especially those in Kansas, Mississippi, Louisiana, Georgia, Florida, the Carolinas, Tennessee, California, Massachusetts and the National forests in the western states. *Figure 19* shows the distribution of wildfires in the States in 1989.

Season(s)

Wildfires occur most often in the Spring, Summer and Fall.

Effects

The annual death and economic damage rates have not been determined. Secondary events of wildfires would be soil erosion and subsequent landslides following heavy rains.

Worst Event

The worst single event in terms of deaths was the 1871 wildfire in Wisconsin where 1,182 people died. The worst single wildfire season in six decades occurred in 1988 with Federal expenditures of $538 million for combating fires in widespread areas of the West where 6,000 soldiers and marines and nearly 4,000 temporary workers assisted the 20,000 professional firefighters on the line.

Discussion

The 1988 wildfire season resulted in the burning of 2.2 million acres of tundra and spruce forest in Alaska, nearly twice the normal yearly average. In California, 9,832 fires burned 175,714 acres of State land and 400 private homes, barns and other structures were destroyed. The majority of these damages occurred as the result of a 35,000-acre fire near Sacramento in September 1988 that caused an estimated $22 million in damage.

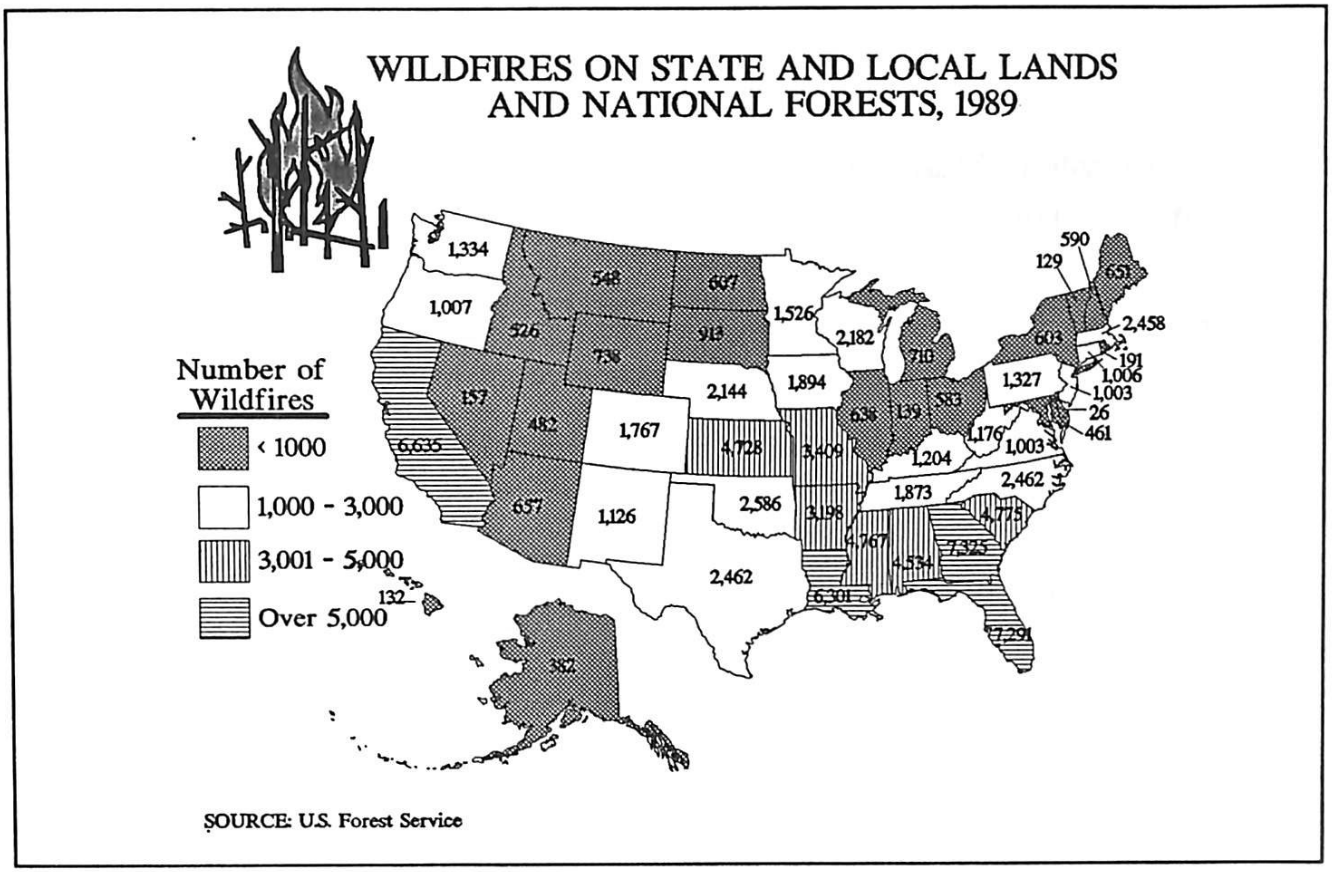

WILDFIRES ON STATE AND LOCAL LANDS
AND NATIONAL FORESTS, 1989
Number of Wildfires
‹ 1000
1,000 - 3,000
3,001 - 5,000
Over 5,000
1,334
1,007
6,635
1,767
1,126
2,144
1,894
1,526
2,182
2,586
2,462
1,873
1,204
1,327
1,003
2,462
2,458
590
129
191
1,006
1,003
26
461
132
382
SOURCE: U.S. Forest Service

Figure 19

Winter Storm (Severe)

Definition

Ice storm, blizzard and extreme cold. Vulnerable areas would be subject to heavy snowfall, combined snow and high winds or ice storms.

National Frequency

None has been determined. The winter storm season varies widely depending upon the area's latitude, altitude and proximity to moderating influences.

Regions at Risk

Almost the entire United States except Hawaii and the Territories are at risk. The level of risk depends on the normal severity of local winter weather. Winter storms known as "northeasters" cause extensive coastal flooding, erosion and property loss in the northeastern and middle Atlantic States.

Season(s)

Winter, although some may occur in the late Fall and early Spring.

Effects

The annual average of snow-related deaths for 1936-1969 was greater than 88. More recently, the National Weather Service data show that winter weather conditions during the years 1986 through 1989 were responsible for a total of 415 deaths—an average of 104. (Data for the intervening years was not available.) Economic damage has not been determined. The severe winter weather during the last two weeks of 1990 was blamed for more than 100 deaths and as much as $1 billion damage to California's citrus and vegetable crops.

In the aftermath of winter storms, the weight of snow can cause structural failures; for example, in 1978 the roof of the Hartford Civic Center in Connecticut collapsed following back-to-back blizzards. The spring thaw of heavy winter snowfalls and river ice jams can cause floods. The estimated damage from melting ice jams that lead to flooding is in excess of $199 million a year.

Worst Event

The worst event was an 1888 East Coast blizzard when 400 deaths were recorded.

Discussion

Some areas of the country tend to be more susceptible than others to severe winter storms. Generally, the regions where harsh winters are common are more prepared for severe winter weather. Those areas where such weather is rare are more likely to experience disruptions when winter storms impact.

TECHNOLOGICAL/MAN-MADE THREATS

Technological/man-made threats represent a category of events that has expanded dramatically throughout this century with the advancements in modern technology. Like natural threats, they can affect localized or widespread areas, are frequently unpredictable, can cause substantial loss of life (in addition to the potential for damage to property) and can pose a significant threat to the infrastructure of a given area. Technological/man-made threats include hazardous materials incidents at fixed facilities or in transit accidents, power failures, radiological incidents at fixed facilities or in transit accidents, structural fires and other types of transportation accidents.

Hazardous Materials Incident - Fixed Facility

Definition

Uncontrolled release of hazardous materials from a fixed site

National Frequency

In 1988, the second year of reporting for the Toxics Release Inventory, 6.2 billion pounds of environmental releases and offsite transfers of chemical wastes were reported by 19,762 manufacturing facilities which submitted 79,343 individual chemical release reports. While more facilities (5 percent) submitted more forms (7 percent), total releases and transfers decreased 11 percent from 1987 to 1988. Facilities in the Gulf Coast, Great Lakes and mid-Atlantic States and California had the largest number of releases. The Rocky Mountain and Great Plains States generated smaller amounts. Ten states accounted for over half of the total releases and transfers. Facilities in Louisiana reported the largest amount of releases (12 percent of the national total) with those in Texas coming in a close second.

Regions at Risk

All areas of the U.S. where hazardous materials facilities exist are at risk to this hazard. Jurisdictions with hazardous materials fabrication, processing, storage sites, hazardous waste treatment storage or disposal sites are at risk.

Season(s)

Year round

Effects

The designated chemicals cover a wide range of toxicity and many have minimal or no effects on humans in small doses. Further, release does not necessarily mean there was exposure to humans. In accordance with data maintained by the U.S. Coast Guard's National Response Center, there were 279 reports of hazardous material releases at fixed facilities which injured 537 people and killed 15 in 1990 (as of December 13). The 4-year annual averages are 280 for incidents, 637 for injuries and 24 for deaths.

Worst Event

An incident, which included a release of radioactive material, occurred at the Kerr-McGee plant in Oklahoma in 1986, resulting in one death and the hospitalization of 100 people. In addition, 1,000 people were contaminated in Erwin, Tennessee, at a nuclear fuel plant in 1979.

Discussion

The principal reporting of these incidents falls under the terms of the Emergency Planning and Right to Know Act of 1986 which requires reporting to the Environmental Protection Agency (EPA) releases of

308 specific chemicals in 20 chemical categories. This input serves as the basis for the Toxics Release Inventory maintained by the EPA. The different types of releases include:

- emissions of gases or particles to the air;
- wastewater discharges into rivers and other bodies of water;
- solid waste disposal in on-site landfills;
- injection of wastes into underground wells;
- transfers of wastewaters to public sewage plants; and
- transfers of wastes to off-site facilities for treatment or storage.

Hazardous Materials Incident - Transportation

Definition

Uncontrolled release of hazardous materials during transport

National Frequency

There are an average of 6,646 hazardous materials transportation incidents reported each year in the United States. This has varied from a high of 10,025 in 1981 to a low of 5,758 in 1986. The number of incidents has risen each year since the 1986 low to 7,503 in 1989, the last year of record.

Regions at Risk

Areas at risk would be along highways, rail lines, pipe lines, rivers and port areas. Because major highways run through virtually all local jurisdictions, every section of the country is at risk.

Season(s)

There is no season for these incidents but, since highway-related incidents account for 83 percent of the total, factors such as weather conditions do influence the patterns of occurrence.

Effects

An average of 13 deaths annually are attributed to hazardous materials transportation incidents. Annual economic damage is estimated at $19 million (1981-1989).

Worst Event

Definitive data unavailable

Discussion

There are a variety of Federal and State mechanisms for reporting incidents involving the transportation of hazardous materials. The major source of data related to interstate transportation incidents is the U.S. Department of Transportation (DOT). Data from this source for the years 1981 through 1989, shown in *Figure 20*, clearly indicate that the great majority of incidents occurred in highway transportation and that such incidents were responsible for the preponderance of resultant deaths and injuries.

(NOTE: DOT maintains hazardous materials transport incident data for 10-year periods; however, incident reporting requirements were changed in 1981 to exclude certain criteria that had been included in prior years. To avoid skewing the annual average rates by mixing reporting data criteria, the numbers cited above were calculated from the totals reported for the years of 1981 through 1989. These averages, based on only 9 years, provide more accurate, consistent risk assessment measurements than could be obtained by using a 10-year data base that includes figures on differing criteria for 1980.)

HAZARDOUS MATERIAL INCIDENTS BY TRANSPORTATION MODE (TOTALS, 1981 THRU 1989)

MODE OF TRANSPORTATION	NUMBER OF INCIDENTS	ASSOCIATED DEATHS	ASSOCIATED INJURIES
Air	1,177	0	127
Highway	48,907	113	1,762
Railway	8,620	0	611
Water	92	1	37
Freight Forwarder	926	0	36
Other	90	0	18
Totals	59,812	114	2,611

Figure 20

Power Failure

Definition

Interruption or loss of electrical service for an extended period of time. An extended period of time would be long enough to require emergency management organization response to needs for food, water, heating, etc., caused by loss of power.

National Frequency

Definitive data not available

Effects

A summary of potential effects includes loss of power to hospital and medical care facilities which could cause life-threatening situations for patients because necessary medical care equipment would be inoperable (in the absence of working backup generators); massive traffic stoppages due to failures of traffic lights; spoilage of food; lack of heating/air conditioning for many residences/businesses; work interruptions since equipment cannot be used; loss of major databases for business, educational and other institutions and polluted water because of inoperable sewage treatment facilities. The cost for repair to power systems and restoration of electricity as well as the economic and societal damage caused by a long-term blackout would be enormous. As an example, the 25-hour black out in New York City in 1977 cost approximately $345 million.

Worst Event

On November 9, 1965, a power failure in an Ontario plant blacked out parts of eight northeastern States and two provinces of Canada. More recently, recovery efforts in South Carolina were seriously hampered by widespread loss of electric power following Hurricane Hugo in September 1989.

Discussion

There are two classes of power failures: failures internal to the power distribution system such as occurred in New England in 1965 and failures from external causes such as severe storms.

The devastating effect on power systems by major natural disasters can cause widespread outages over a long period of restoration and recovery. Hurricanes affect **distribution systems** more than generation and transmission equipment with damage to the relatively low power lines from falling trees, flooding and flying debris. Earthquakes can destroy **distribution systems** and **generation and transmission equipment**. Damage to key pieces of equipment would be light in earthquake-resistant facilities, such as those in California. However, those areas vulnerable to earthquakes where facilities have been designed without earthquake-resistant features could experience considerable damage from a major earthquake. These high-risk facilities are located in the central Mississippi Valley, the southern Appalachians and an area centered around Indiana.

More ominous than natural hazards are threats from terrorists. Acts of terrorism could destroy critical components and incapacitate large segments of a transmission network for months. If terrorists targeted several key facilities with simultaneous attacks, major metropolitan areas or multi-State regions could lose all power. Most of these plant sites are unstaffed and many are located in isolated areas with little resistance to attack. Terrorist attacks on power systems in this country, which have been small-scale and unsophisticated, have not been a major problem in the past decade. The situation may worsen, however. If terrorists wish to cause a large amount of economic disruption, they can do so with relative ease by selecting power systems as targets. (Source: *Office of Technology Assessment, Congressional Board of the 101st Congress, report entitled,* ***Physical Vulnerability of Electric Systems to Natural Disasters and Sabotage****, prepared for Senate Committee on Governmental Affairs Hearing on Vulnerability of the Nation's Electric Systems to Multi-Site Terrorist Attack, S.Hrg. 101-959, June 28, 1990. pp.93-95.)*

There is no centralized data source for information on electric power loss events, especially none for those instances where an emergency response was required.

Radiological Incident - Fixed Facility

Definition

Uncontrolled release of radioactive material at a commercial nuclear power plant or other reactor facility

Regions at Risk

Areas at risk are normally designated as: (1) within the ***plume emergency planning zone*** of such facilities (jurisdictions located within a 10-mile radius of a nuclear power plant) or (2) within the ***ingestion emergency planning zone*** (jurisdictions within a 50-mile radius of a nuclear power plant). About 38 states are affected, in particular the eastern half of the contiguous 48 States and the West Coast States.

Season(s)

Year round

Effects

An incident could cause the release of radioactive materials into the atmosphere. Three dominant exposure modes to people have been identified: (a) whole body (bone marrow) exposure from external gamma radiation, (b) thyroid exposure from inhalation or ingestion of radioiodines and (c) exposure from ingestion of radioactive materials.

Worst Event

The nuclear power plant accident that occurred at the Three Mile Island Nuclear Power Plant in Pennsylvania on March 28, 1979, was the worst to date in the United States. While this incident caused no deaths, officials considered the possibility of evacuating 650,000 citizens within a 20-mile radius of the plant which is near Harrisburg.

Discussion

As a result of the incident at Three Mile Island, major changes were instituted in the regulation of the nuclear power industry. FEMA was given the responsibility for review and approval of State and local radiological emergency plans and preparedness for jurisdictions located near commercial nuclear power plants. *Figure 21* shows the location of commercial nuclear reactor sites in the United States as of December 1989. *Figure 22* depicts events that occurred at nuclear reactor facilities during the period 1985-1989.

COMMERCIAL NUCLEAR REACTOR SITES
IN THE UNITED STATES - DECEMBER 1989

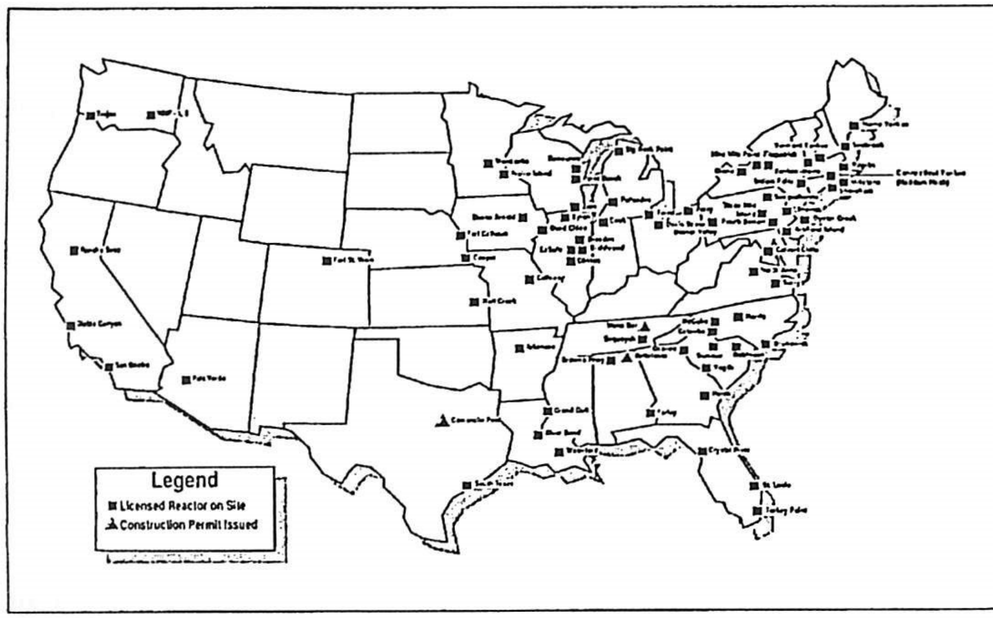


Figure 21

NUCLEAR REACTOR FACILITY EVENTS 1985-1989

Class of Event	Year 1985	1986	1987	1988	1989
Unusual Event	312	209	231	212	197
Alert	11	9	9	6	13
Site Area Emergency	0	0	0	1	0
General Emergency	0	0	0	0	0

Figure 22

Radiological Incident - Transportation

Definition

Any incident involving the shipment of radiological materials

These incidents were subsumed under the general Hazardous Materials —Transportation category previously discussed and are included in the same data base.

Structural Fires

Definition *Uncontrolled burning in residential, commercial, industrial or other properties in rural or developed areas*

National Frequency During the period 1983-1988, there were 2,300,000 fires reported in the United States annually.

Regions at Risk All areas are at risk to personal injury or property damage due to fire.

Season(s) Year round, with the residential fire rate in January being twice that of the summer months

Effects During 1983-1988, there was an average of 5,900 civilian fire deaths, 29,000 civilian injuries, and $7.8 billion (1988 dollars) in losses from fire reported each year. In 1988, there were 6,215 deaths—an upward trend of 5 percent.

Worst Event The largest number of lives lost in an urban structural fire occurred at the Iroquois Theater in Chicago in 1903 where 602 persons died. The "Chicago Fire" of 1871, which killed 230 people, burned 17,450 buildings and caused damages of $196 million, ranks as one of the worst urban fires in the country's history.

Discussion According to the FEMA United States Fire Administration (USFA), the fire problem in the United States is of major proportions and, comparatively, is one of the worst in the world in terms of relative populations. As reported by the United Nations World Health Organization in 1983, the United States, with 27 fire deaths per million persons per year, had the third highest ranking of the countries for which statistics were available. Only Scotland (32 deaths per million) and Canada (31 deaths per million) ranked higher. Nations reporting the lowest number of deaths included Germany/Spain (each with nine deaths per million), Italy (with seven deaths per million) and Switzerland (with five deaths per million).

Fire fatalities tend to be distributed according to population density, i.e., those States with the largest populations tend also to have the greatest number of fire fatalities. For example, ten States, which accounted for ***52 percent*** of the 5,514 recorded fires for 1987, reported the following fire-fatalities: New York (465), Texas (358), Illinois (335), California (307), Pennsylvania (284), Ohio (265), Michigan (249), Florida (211) North Carolina (210) and Georgia (190). The complete listing of States is included in *Figure 23*. (Note that Colorado is not listed because the inclusion of the 6 fire-related deaths in Denver, the only jurisdiction in the State that provides fire statistics, would distort the national picture.)

STATE FIRE DEATHS RECORDED IN 1987

Using Absolute Measures [1]

The following States account for close to 52% (2,874) of all recorded fire deaths nationally:

New York (465)	**Ohio (265)**
Texas (358)	**Michigan (249)**
Illinois (335)	**Florida (211)**
California (307)	**North Carolina (210)**
Pennsylvania (284)	**Georgia (190)**

The next 10 States account for an additional 26% (1,437) of all national fire deaths:

Alabama (175)	Louisiana (137)
New Jersey (173)	Mississippi (134)
South Carolina (168)	Indiana (130)
Virginia (143)	Maryland (126)
Tennessee (140)	Wisconsin (111)

The remaining 30 States account for the remaining 22% (1,203) of the national fire deaths [2]:

Missouri (110)	Washington (50)	New Hampshire (26)	North Dakota (12)
Massachusetts (99)	Oregon (48)	Rhode Island (23)	Nevada (10)
Oklahoma (92)	Connecticut (47)	Delaware (22)	Washington, DC (10)
Arkansas (83)	Minnesota (42)	Alaska (22)	Vermont (9)
Kentucky (82)	Arizona (41)	Montana (21)	Hawaii (8)
West Virginia (77)	Maine (37)	Nebraska (19)	Idaho (7)
Kansas (72)	Utah (29)	South Dakota (16)	Wyoming (7)
Iowa (54)	New Mexico (28)		

Source:* *State Fire Marshall Offices and USIA

[1] 95% (5,514) of the estimated 5,800 fire deaths.
[2] Colorado omitted - incomplete data

Figure 23

While it is useful to know by State where the greatest number of fire deaths occur, it is perhaps even more useful to know in which States people face the greatest *personal risk* of death by fire. As the map in *Figure 24* illustrates in the checkered pattern, the areas with the worst fire death rates per million population during 1987 were the Southeast and the States of Alaska, Maine, West Virginia and Delaware. The five States with the highest death rates per million were Mississippi (51.0), South Carolina (49.1), Alabama (42.9), Alaska (42.9) and West Virginia (40.6). For the past 15 years, the Southeast and Alaska have ranked consistently in the highest fire death category. While the States in the vertical and diagonal striped areas of the map have lower death rates than those in the checkered areas, they have fire death rates higher than most of the developed nations in Europe and the Far

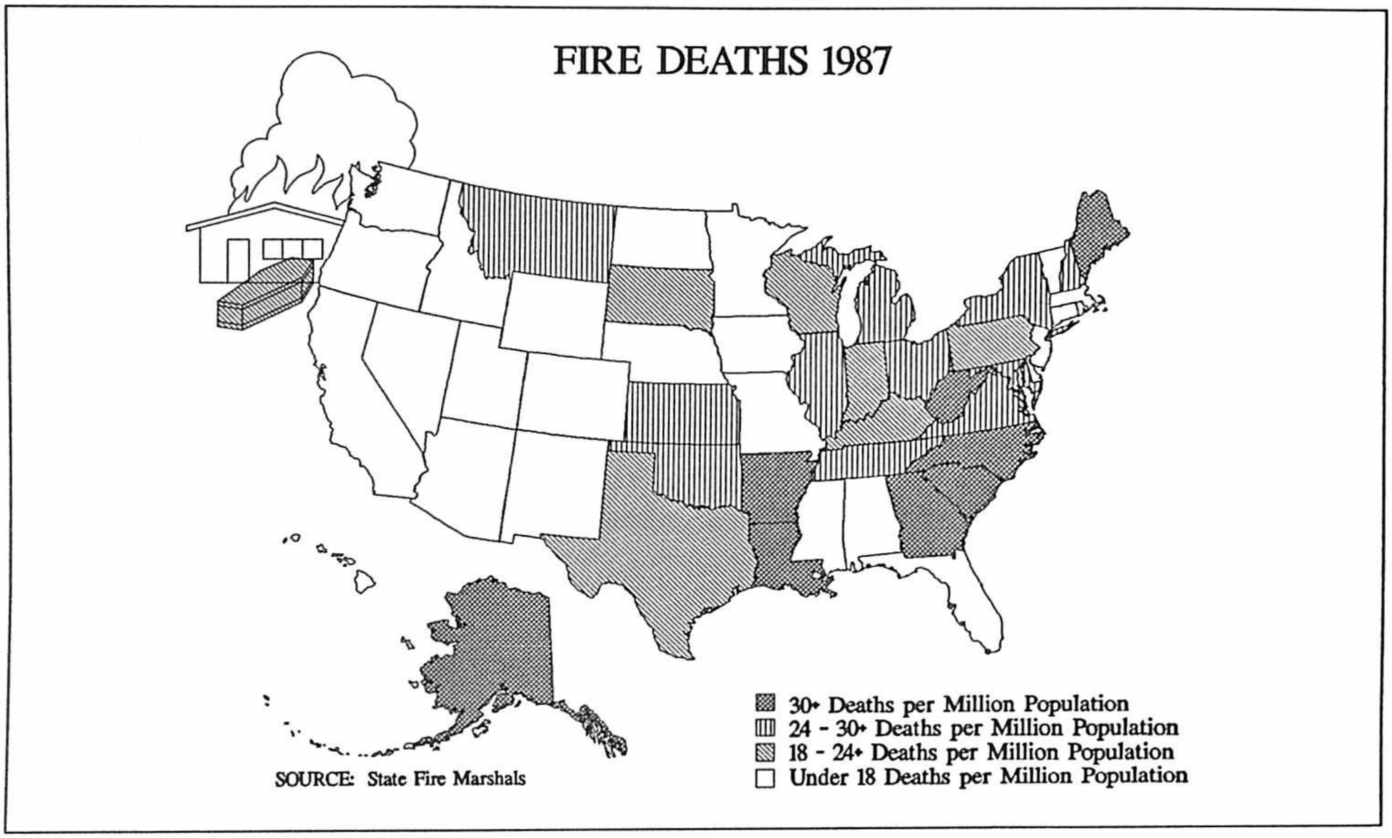


Figure 24

East. *Any one of these States would have the highest or the second highest death rate in the world if it were a separate country.*

The unshaded "best" States, generally in the Southwest, West and Mountain States, have fire death rates that compare with European and Far East nations. The four States with the lowest deaths per million for 1987 were Nevada and Minnesota (9.9 each), Hawaii (7.4) and Idaho (7.0). (Colorado, which was excluded because of incomplete data, probably ranks among the low death rate States also.) California's death rate was the lowest of the highly populated States. (Source: ***Fire in the United States: 1983—1987, and Highlights for 1988.*** *pp. 37-41. Federal Emergency Management Agency, United States Fire Administration.*)

Transportation Accidents

Definition

An incident involving air or rail travel resulting in death or injury

National Frequency

According to the National Transportation Safety Board, the scheduled airline accident rate per 100,000 departures in 1990 was 0.331, slightly higher than the 0.328 rate in 1989. The fatal accident rate, however, fell from 0.109 to 0.083. There were a total of 2,282 accidents and 819 deaths for all categories of aviation—a decline from the previous year. The 1990 accident rates for both commuter air carriers and general aviation were the lowest ever recorded by the Safety Board.

Accident reports maintained by the Federal Railroad Administration reveal that, during the years of 1984-1989, there were 18,869 train accidents. The annual average for that 6-year period was 3,145 or 5.33 accidents per million train-miles. The number of fatalities totaled 391, for an annual average of 65. In 1989, the 3,080 recorded accidents were below the annual average, but the 87 deaths were above the average and the highest in the last 6 years. Damage estimates from the train accidents in 1989 were over $212 million. The greatest number of accidents (328) occurred in Illinois—see *Figure 25*.

Regions at Risk

All areas of the country are at risk to transportation incidents. Risk areas would be around airports with Federal Aviation Administration control towers or with traffic flow heavy enough to pose a hazard and passenger rail lines. The greatest risk involves those local jurisdictions with airports, rail lines and major highway systems.

Season(s)

Year round

Effects

Effects can include loss of life, associated property losses and fire.

Worst Event

This accident occurred on May 25, 1979, at Chicago's O'Hare Airport when an American Airlines DC-10 lost its left engine upon take-off and crashed seconds later, killing all 272 people aboard and 3 on the ground.

Discussion

There are two circumstances in air transport which trigger a disaster response: an airliner crashing in a populated area, such as happened over Cerritos, California, in 1986 as the result of a collision with a private aircraft and a takeoff or landing accident such as occurred in Washington, D.C., in 1982 and Sioux City, Iowa, in 1989.

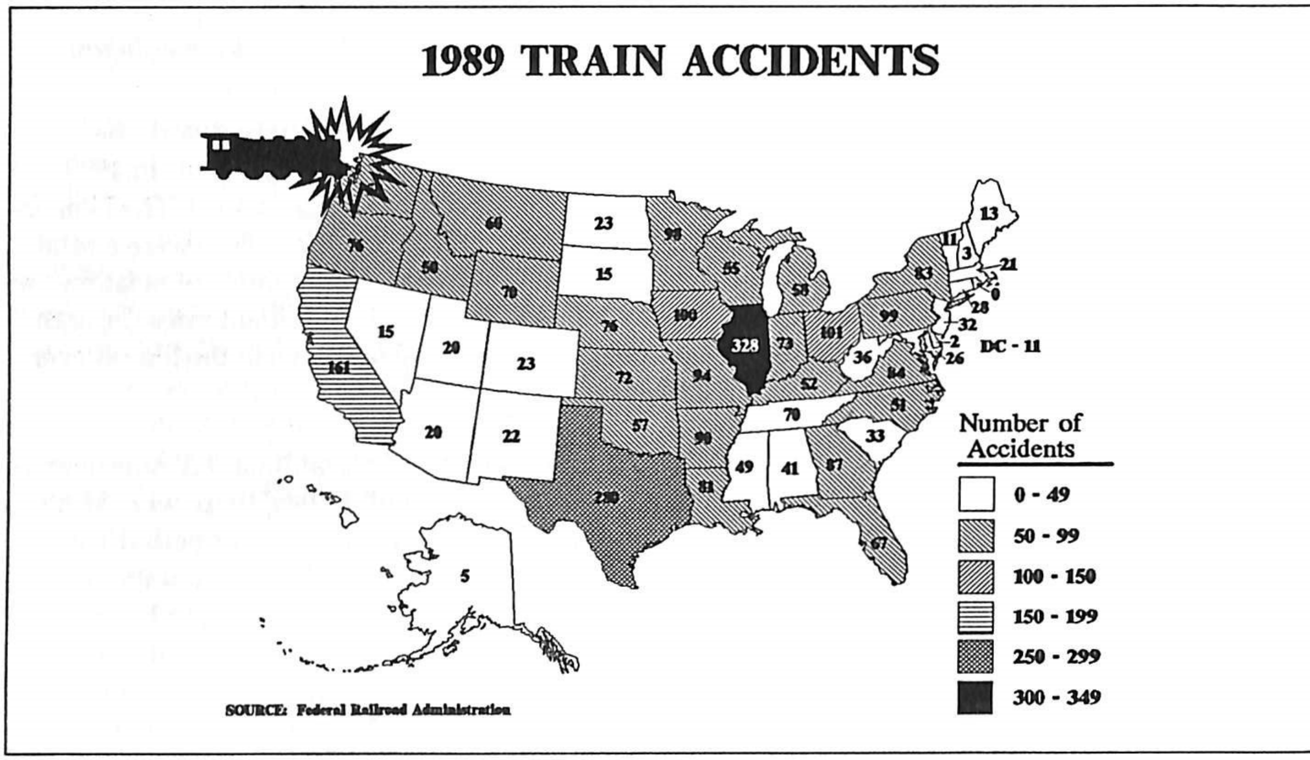


Figure 25

Apart from the actual rescue operations, the Washington, D.C., crash highlighted two problems. First, there was a multi-jurisdictional response and a lack of coordination capability, even to the extent there were no common radio frequencies for communications. Second, while this rescue operation was underway, there was another fatal accident involving a subway train which placed an added severe strain on the District of Columbia's disaster response resources.

In terms of loss of life, there have been two serious railroad accidents in the past 20 years. The first was in Chicago in 1972 when one commuter train plowed into the back of another, causing 45 deaths and over 200 injuries. (A saving factor can be attributed to the location of the accident—in the backyard of a major hospital which had participated in a disaster drill the preceding day.) The second occurred in Chase, Maryland, in 1987 when a train derailment resulted in the death of 16 people.

NATIONAL SECURITY THREATS

National security threats are those threats that primarily come from actions by external, hostile forces on the land, population or infrastructure of the United States. The potential for damage resulting from national security emergencies ranges from the relatively localized damage caused by a terrorist attack to the catastrophic devastation that could be expected following a chemical, biological or nuclear attack on the United States. Like natural or technological/manmade threats, national security threats can be either predictable or unpredictable (for example, a preemptive strike versus an attack following a buildup of tensions). National security threats include nuclear attack, chemical/biological warfare, civil disorder and low-intensity conflict (including terrorism, subversion, insurgency and drug trafficking).

Nuclear Attack

Definition

Any hostile action taken against the United States by foreign forces which results in destruction of military and/or civilian targets through use of nuclear weapons. (Blast, fallout and electromagnetic pulse effects are assumed from a large-scale nuclear attack.)

National Frequency

No U.S. occurrence

Regions at Risk

All areas of the U.S. are at risk for direct blast effects or secondary effects.

Season(s)

An attack could occur at any time of the year.

Effects

The effects of a nuclear attack, if one should occur, would be devastating and far reaching. Many millions of lives would be at risk to the effects of blast overpressure, fire and radioactive fallout. The loss of property and infrastructure would be catastrophic with an almost incalculable associated dollar value.

Discussion

As President Bush has stated in ***The National Security Strategy of the United States***, issued in March 1990:

> *Deterrence of a nuclear attack remains the cornerstone of U.S. national security. Regardless of improved U.S. — Soviet relations and potential arms control agreements, the Soviets' physical ability to initiate strategic nuclear warfare against the United States will persist and a crisis or political change in the Soviet Union could occur faster than we could rebuild neglected strategic forces. A START agreement will allow us to adjust how we respond to the requirements of deterrence, but tending to those requirements remains the first priority of our defense strategy.*
>
> *The United States must continue to maintain modern defenses that strengthen deterrence and enhance security. We cannot ignore continuing Soviet efforts to modernize qualitatively even as they cut back quantitatively. As Chairman Gorbachev declared last September 21st, "While reducing expenditure for [defense] purposes, we are paying attention to the qualitative rearmament of the Army, and in this way we are not permitting the overall level of our defense capability to be weakened in any*

degree." Our response thus represents prudent caution, but the Soviet leadership and people should realize that it is a caution based on uncertainty, not on hostility.

The areas in the U.S. at high risk from the large-scale nuclear attack threat can be illustrated by the blast overpressure map *(Figure 26)* and the fallout maps *(Figures 27 and 28)*. These maps were based on the Nuclear Attack Planning Base (NAPB) National Aimpoint List, a data base of projected Soviet targeting of the U.S. in a preemptive nuclear strike. *Figure 26* illustrates those areas in the U.S. which could be at risk from blast overpressure resulting from a large-scale nuclear

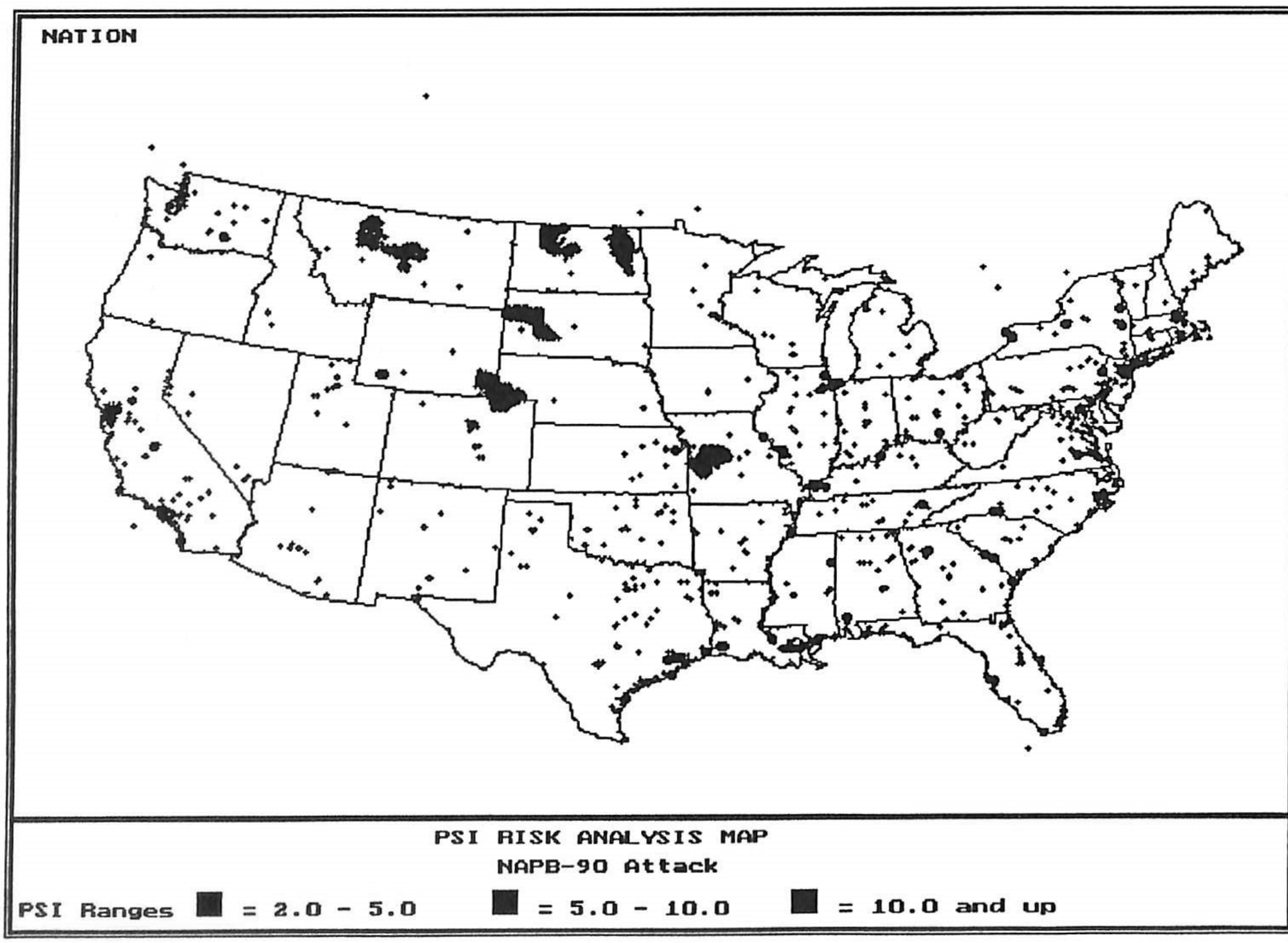


Figure 26

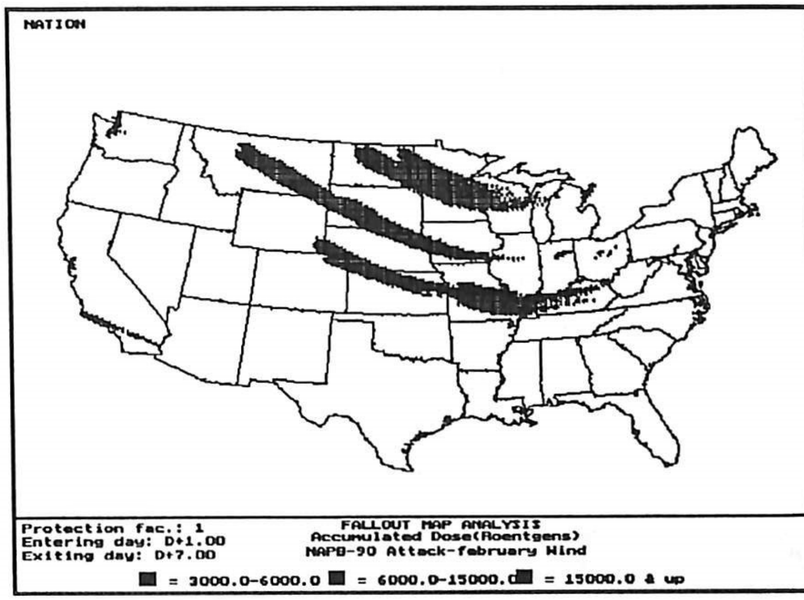


Figure 27

attack. In addition to the effects of blast overpressure, many areas could experience serious communications/electronic interruptions due to the effects of electromagnetic pulse.

The fallout maps shown in *Figures 27 and 28* illustrate radiation high risk areas, based upon a typical wind pattern from the months of February and May. If the fallout levels that are depicted on these two charts should actually occur, death or debilitating illness from

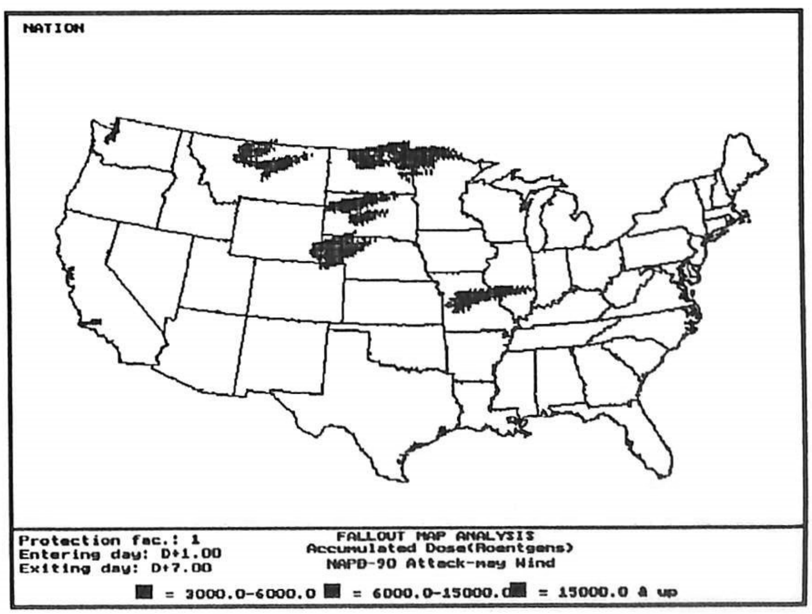


Figure 28

radiation is certain for resident populations without adequate shelter. In addition, these charts show that **exact** radiation levels can never be determined in advance of fallout arrival. Hence, a minimum fallout protection level for an entire area cannot (and should not) be defined. It should also be noted that other areas are also at risk at lower, but still harmful levels. Other wind patterns throughout a year would, of course, result in some variation of the fallout threat, but the fallout high risk areas are predominately east of the missile fields.

Of additional concern to the United States is the increasing proliferation of missile capability worldwide, a capability that could be made more lethal by the addition of chemical, biological or nuclear warheads. Apart from the *United States, the United Kingdom, France, the USSR and China,* there are thought to be at least 17 additional countries that are either nearing nuclear capability on their own or are considered capable of obtaining nuclear warheads or missiles from illegal sources. These include: Argentina, Brazil, Egypt, India, Iran, Iraq, Israel, Libya, Pakistan, North Korea, North Yemen, Saudi Arabia, South

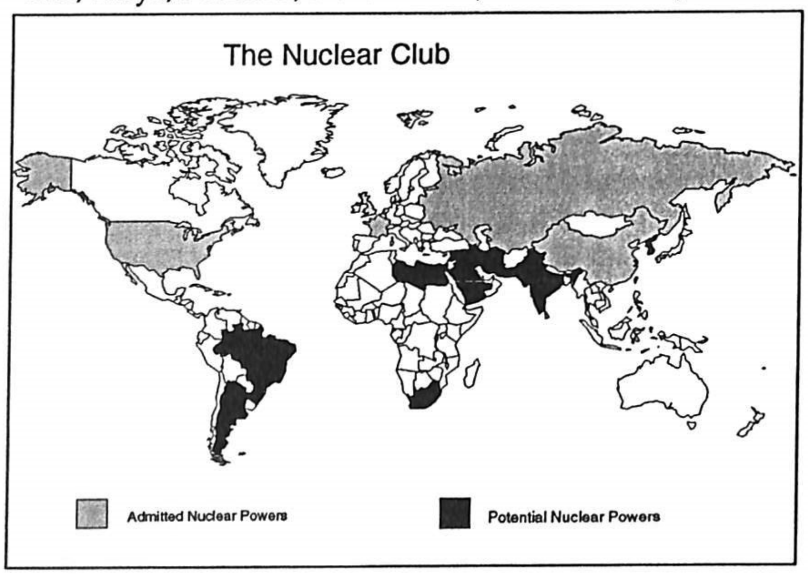


Figure 29

Africa, South Korea, South Yemen, Syria and Taiwan *(see Figure 29).* The recent Allied attacks have severely damaged Iraq's nuclear facilities and "have put [that country] out of the nuclear bomb-building business for a long time to come." (Source: *President George Bush in a speech to the Reserve Officers Association on January 23, 1991, as sited in* ***The Washington Post****, January 24, 1991,pp.A24 and A27.)*

As noted by the President in the March 1990 ***National Security Strategy of the United States:***

The spread of evermore sophisticated weaponry— including chemical, biological, and nuclear weapons—and of the missiles capable of carrying them represents a growing danger to international security. This proliferation exacerbates and fuels regional tensions and complicates U.S. defense planning. It poses ever greater dangers to U.S. forces and facilities abroad, and possibly even to the United States itself.

Chemical and Biological Warfare

Definition

The introduction of toxic or infective agents to harm an enemy's population and animal or plant food resources

National Frequency

No U.S. occurrence, however, with the continued development of chemical/biological weapons and improved delivery systems by Third World nations, the threat is increasing.

Regions at Risk

Nationwide

Season(s)

An incident could occur at any time of the year.

Effects

The effects of chemical warfare would be devastating to human and animal life or, depending on the agent used, plant life as well. Chemical weapons, including warheads on missiles, contain liquid or gaseous chemical agents that cause toxic damage to living tissue rather than the usual injuries that result from other physical effects such as blast, heat or shrapnel. Although chemical agents do little damage to buildings or vehicles, long-lasting chemical agents placed in structures or whole areas can render these locations useless for humans or animals.

There are four general types of chemical agents available for use as weapons that cause serious injury or death through inhalation and/or body surface contact: (1) blister agents—general tissue irritants such as mustard gas that can burn or blister the skin or the lung tissue if inhaled; (2) blood gases—agents such as hydrogen cyanide that interfere with cell respiration after entering the blood circulation through the lungs; (3) lung irritants—choking agents such as phosgene that irritate and damage lung tissue and (4) nerve agents—chemicals such as tabun, sarin and soman that interfere with the transmission of nerve impulses and disrupt vital bodily functions such as breathing. (Source: ***The Problem of Chemical and Biological Warfare. Vol. II, CB Weapons Today,*** *Stockholm International Peace Research Institute (SIPRI), 1973. p. 36 [as used in a Congressional Research Service report entitled,* ***Missile Proliferation: Survey of Emerging Missile Forces,*** *October 3, 1988]).*

Biological weapons contain living organisms that can cause disease or death; however, the success or effectiveness of a biological agent is directly related to its ability to reproduce in the organism attacked. The introduction of a biological agent into a city's water supply has the potential, for example, to kill the entire population of the city.

The lethal potential of these weapons has been increased recently by advances made in genetic engineering and biotechnology. Normally harmless, non-disease producing microorganisms can now be modified to become highly toxic or to produce diseases for which an opponent has no known treatment or vaccine. In other cases, disease agents which had been considered too unstable for storage or warfare applications can now be modified by genetic engineering and used as biological agents for warfare. (Source: ***Soviet Biological Warfare Threat.*** *Defense Intelligence Agency, DST-1610F-057-86, 1986. p.12, [Unclassified]. [As used in a Congressional Research Service report entitled,* ***Missile Proliferation: Survey of Emerging Missile Forces,*** *October 3, 1988]).*

Discussion

There is renewed concern regarding the proliferation and use of chemical and biological agents in warfare—in spite of the 1924 Geneva Accord banning their use. In 1970 when the United States halted the production of chemical agents, its estimated stockpile was 36,000 tons, compared with a stockpile of more than 360,000 tons maintained by the Soviets alone. Concern regarding biological and chemical warfare has been heightened by their use in Afghanistan and Southeast Asia and during the prolonged hostilities between Iraq and Iran and their threatened use in the current Persian Gulf conflict.

These threats could be a major problem because the agents require little sophistication and are much cheaper to manufacture than nuclear weapons. The technology and expertise required to produce chemical warfare agents are very similar to those common in the petrochemical, pharmaceutical, fertilizer and insecticide industries. The chemicals would likely be made in newly dedicated production units since new construction is easier than conversion of existing factories. These facilities can be built and operated to produce large quantities of the agents from widely available chemical compounds using relatively simple processing techniques. Any country with a modest amount of technical expertise that produces and refines petroleum could make mustard gas, for example, without importing any chemicals. Conversely, the production of nerve gas would require a greater challenge because of the requirement for large quantities of raw materials. (Source: *Congressional Research Service report entitled,* ***Missile Proliferation: Survey of Emerging Missile Forces,*** *October 3, 1988. p. CRS-33.)*

Before the Allied air strikes of the current conflict, the largest chemical weapons producing country in the Third World was Iraq where more than a thousand tons of agents, including mustard-type blister agents and sarin and tabun nerve agents, have been produced each year. Iranian officials claim that the chemical agents Iraq used against Iranian troops in several battles during the 1980-1988 war caused approximately 50,000 casualties, including about 5,000 fatalities. Kurdish insurgents and civilians in Iraq were also attacked by Iraqi chemical agents in 1988.

In the February 9, 1989, Senate Hearing on Global Spread of Chemical and Biological Weapons, Director William H. Webster of the Central Intelligence Agency told the Committee members that biological agents are more potent than chemical agents and can deliver the broadest area of coverage per payload pound of all weapon systems. A variety of means such as missiles, tube and rocket artillery, bombs, vectors (insects) or human agents can deliver and disseminate biological agents.

Iraq was believed to be producing and stockpiling significant quantities of botulin toxin and has done anthrax, typhoid and cholera research. According to unverified press reports, Iraq has used biological weapons and may have contaminated the water supply that caused an outbreak of typhoid fever in a Kurdish town in northern Iraq. (Source for above three paragraphs: *Eisenstadt, Mike, **"The Sword of the Arabs:" Iraq's Strategic Weapons**, The Washington Institute Policy Papers, Number Twenty One, The Washington Institute for Near East Policy, 1990. pp. 1, 6, and 8.)*

The intensive missile and bombing attacks by the Allied Forces should have eliminated or greatly reduced Iraq's capability to produce chemical and biological weapons for some time.

The potential for terrorist use is high. For example, a 1971 raid on a German terrorist group at a Paris laboratory uncovered numerous documents for manufacturing bacterial cultures. Libya is known to be developing toxins and Syria is producing nerve gas. Syria's missile delivery capability puts a new dimension on the Arab-Israeli conflict. With continuing advancements in missile capability, these weapons could easily be turned against the U.S. If any of the Third World powers should achieve intercontinental missile capability, the threat of chemical or biological weapons being targeted on population centers in the United States could increase considerably. There is also the possibility that devices for these types of weapons could be brought into this country virtually undetected.

Use of chemical or biological agents under conditions of war does not necessarily imply all-out use. Rather, limited use could be made in order to disrupt or undermine political order while preserving the industrial base of a country being attacked.

Civil Disorder

Definition	*Any incident, the intent of which is to disrupt a community to the degree that police intervention is required to maintain public safety. Terrorist attacks, riots, strikes that lead to violence and demonstrations resulting in police intervention and arrests are included in this category.*
National Frequency	Undetermined
Regions at Risk	Nationwide
Season(s)	Civil disorders may occur at any time but are more frequent during the summer months.
Effects	The effects of this threat can be varied based upon the type of event and its severity and range. Loss of life and property as well as disruptions in services such as electricity, water supply, public transportation, communications, etc., could result from civil disorder. Certain types of facilities are more vulnerable than others during civil disorders. These include Federal, State and local government buildings, universities, military bases, nuclear power facilities and correctional facilities.
Discussion	Prior to the Persian Gulf War, we had been in a period of quiescence with respect to riots and violent demonstrations. However, the resurgent antiwar movement can cause problems for local police forces. The need for increased security for sites vulnerable to attack by pro-Iraqi terrorist groups places additional demands on local law enforcement organizations. Also in relation to the issue discussed under nuclear attack, there are hostile governments bent on violent actions against the United States.

Low-Intensity Conflict

Definition

Low-intensity conflict involves the struggle of competing principles and ideologies below the level of conventional war, e.g., terrorism, subversion, insurgency and drug trafficking (as defined in the President's ***National Security Strategy of the United States [March 1990]****).*

National Frequency

From the years 1980 through November 1990, the Federal Bureau of Investigation (FBI) identified a total of 225 *terrorist* incidents (approximately 20.5 events annually). This does not include, however, figures on either *subversion, insurgency or drug trafficking* since only incomplete data was available.

Regions at Risk

Nationwide. Over the past 11 years the largest number of terrorist strikes occurred in the northeastern and southern States and Puerto Rico. However, during the years of 1985-1989, Puerto Rico was at greatest risk with 61 percent of the incidents. The major American targets are (1) military personnel and facilities, (2) commercial establishments and (3) Federal government buildings and property.

Season(s)

Low-intensity conflict can occur at any time of the year.

Effects

The effects of the threats posed by low-intensity conflict can vary significantly in relationship to the size and scale of the event and its associated severity. At a minimum, disruptions resulting from low-intensity conflict can include property damage, disruptions in services such as electricity, water supply, public transportation, communications, etc., and loss of life. Most terrorist activities (44 out of the 53 incidents in 1985-1989) were bombing attacks which included detonated and undetonated explosive devices, tear gas, pipe and fire bombs and a rocket attack. Three deaths and 29 injuries were attributed to terrorism in 1985-1986. No deaths or injuries have been recorded since then.

Discussion

To date, terrorism has been targeted primarily against American interests abroad. However, according to U.S. Army reports from the years of 1981 through 1990, there were 171 terrorist incidents in the Continental United States and Puerto Rico. (During this same period, the FBI recorded 196 incidents.) Of these Army-recorded incidents, 60 were in the Northeast, 54 in Puerto Rico, 31 in the South, 21 in the Western States and 5 in the Northern States. Terrorist attacks have been less prevalent since 1986 when there were 25 incidents. During the last four years, there have been a total of 27 strikes recorded, 18 of which happened in Puerto Rico. Since 1968, there have been 32 attacks directed against Department of Defense facilities. In view of the present situation in the Persian Gulf, threats of terrorism within the United States will likely increase.

As noted by President Bush in his ***National Security Strategy of the United States (March 1990)***:

> *It is not possible to prevent or deter conflict at the lower end of the conflict spectrum in the same way or to the same degree as at the higher. American forces therefore must be capable of dealing effectively with the full range of threats, including insurgency and terrorism.*

With regard to drug trafficking, President Bush also noted in the same report that:

> *The Department of Defense...has an important role to play in our National Drug Control Strategy in coordination with the Department of State and law enforcement agencies. The first line of defense against the illegal flow of drugs is at the source—in those countries where illicit drugs are produced and processed before being sent to the United States and other countries....Security assistance also provides host countries with the resources needed to confront the insurgency threats that often are endemic to narcotics-producing regions.*

RANKING OF THE THREATS

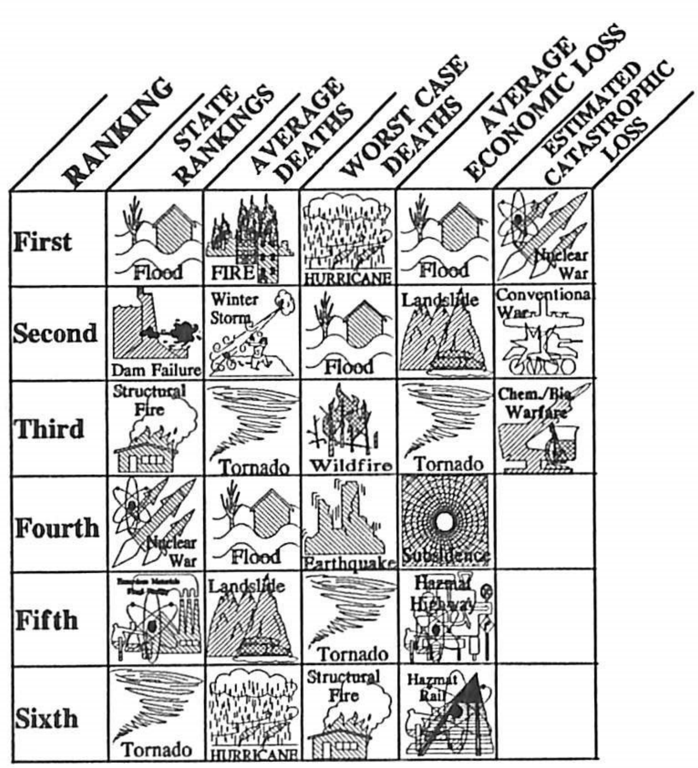
In its direction to FEMA, the Committee stated that it "...understands that certain natural and manmade disasters threaten communities with a varying degree of severity and frequency..." and specifically requested that the study, "...rank the principal threats to the population according to region and any other factors deemed appropriate." However, it is important to note that any ranking of the threats to communities and emergency management coordinators is potentially misleading because of: (1) the wide variations that can occur with the application of different criteria to the same threat, (2) the significant differences that can occur from the impact of a particular threat on a region and the individual States within that region, (3) the fact that threats in one region are not necessarily applicable to another region, (4) variances in the types of data collected on each threat and (5) the lack of available data in some cases with which to develop a reasoned ranking.

This is perhaps best typified in the application of criteria which must be used in order to develop the rankings. Threats can be ranked by some or all of the following criteria:

- the potential critical danger of a particular threat which may occur only infrequently;
- average annual frequency of occurrences;
- average annual economic loss;
- average annual loss of life;
- average annual number of incidents requiring Presidential declarations of major disasters/emergencies;
- average annual number of local jurisdictions reporting threats and ranking them;
- the seasonal occurrence of disaster incidents;
- differences in the potential impact of threats on urbanized *vs.* remote, sparsely populated areas and
- worst-case deaths by disaster type.

Figure 30 depicts the difficulties in obtaining a clear ranking of threats just in relationship to the various criteria used.

EXAMPLES OF THREAT RANKINGS BY VARIOUS CRITERIA



NOTE: This figure is a partial representation of the variations in threat rankings that can occur from the application of different ranking criteria or perceptions to threats.

Figure 30

During cyclical data collection conducted by FEMA, local emergency managers themselves identify threats with which they are concerned. The information is based on (1) the fact that the jurisdiction has been previously affected by the impact of the particular threat or (2) the possibility that the jurisdiction **could** be impacted by the threat.

As is shown in *Figure 31*, the top ranked threats reported by **all** States and Territories are *floods, power failures and transportation accidents involving hazardous materials*. The second ranked threats include *wildfires, winter storms, dam failures and hazardous materials accidents at fixed facilities* (with the District of Columbia and all States but Hawaii and most of the Territories reporting). The third ranking includes *transportation accidents* (air, rail, etc., but not transportation accidents involving

HAZARDS EXPECTED BY ONE OR MORE JURISDICTIONS IN A STATE/TERRITORY

STATE or TERRITORY	HAZARDS																							
	Nuclear Attack	Chem./Biol. Attack	Civil Disorder	Terrorism	Avalanche	Drought	Earthquake	Floods	Hurricane/T.S.	Landslides	Subsidence	Tornado	Tsunami	Volcano	Wild Fire	Winter Storm	Dam Failure	Haz. Mat. - FF	Haz. Mat. - Trans.	Power Failure	Radiological - FF	Radiological - Trans.	Transportation	Urban Fire
Alabama	●		●			●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
Alaska	●		●		●	●	●	●	●	●	●		●	●	●	●	●	●	●	●		●	●	●
Arizona	●		●			●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
Arkansas	●		●			●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●
California	●		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Colorado	●		●		●	●	●	●		●	●	●	●		●	●	●	●	●	●	●	●	●	●
Connecticut	●		●			●	●	●	●		●	●			●	●	●	●	●	●	●	●	●	●
Delaware	●		●			●	●	●	●		●	●			●	●	●	●	●	●	●	●	●	●
District of Columbia	●		●					●	●							●			●	●	●	●	●	●
Florida	●		●			●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Georgia	●		●		●	●	●	●	●		●	●			●	●	●	●	●	●	●	●	●	●
Hawaii	●					●	●	●	●	●		●	●	●	●		●	●	●	●			●	●
Idaho	●		●		●	●	●	●		●		●		●	●	●	●	●	●	●	●	●	●	●
Illinois	●		●			●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
Indiana	●		●			●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●
Iowa	●		●			●	●	●	●		●	●			●	●	●	●	●	●	●	●	●	●
Kansas	●		●			●	●	●			●	●			●	●	●	●	●	●	●	●	●	●
Kentucky	●		●			●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●
Louisiana	●		●			●		●	●		●	●	●		●	●	●	●	●	●	●	●	●	●
Maine	●		●			●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●
Maryland	●		●			●		●	●			●			●	●	●	●	●	●	●	●	●	●
Massachusetts	●		●			●	●	●	●		●	●	●		●	●	●	●	●	●	●	●	●	●
Michigan	●		●		●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●
Minnesota	●		●			●	●	●		●	●	●	●		●	●	●	●	●	●	●	●	●	●
Mississippi	●		●			●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
Missouri	●		●			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Montana	●		●		●	●	●	●		●	●	●		●	●	●	●	●	●	●	●	●	●	●
Nebraska	●		●			●	●	●				●			●	●	●	●	●	●	●	●	●	●
Nevada	●		●		●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●
New Hampshire	●		●			●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
New Jersey	●		●			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
New Mexico	●		●		●	●	●	●		●	●	●		●	●	●	●	●	●	●	●	●	●	●
New York	●		●			●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●
North Carolina	●		●		●	●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
North Dakota	●		●			●		●				●			●	●	●	●	●	●	●	●	●	●
Ohio	●		●			●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●
Oklahoma	●		●			●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
Oregan	●		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Pennsylvania	●		●			●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
Rhode Island	●		●			●	●	●	●		●	●			●	●	●	●	●	●	●	●	●	●
South Carolina	●		●			●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
South Dakota	●		●			●	●	●		●		●			●	●	●	●	●	●		●	●	●
Tennessee	●		●			●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
Texas	●		●			●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●
Utah	●		●		●	●	●	●		●	●				●	●	●	●	●	●		●	●	●
Vermont	●		●					●	●	●					●	●	●	●	●	●			●	●
Virginia	●		●			●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
Washington	●		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
West Virginia	●		●			●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
Wisconsin	●		●			●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
Wyoming	●		●		●	●	●	●		●	●	●		●	●	●	●	●	●	●		●	●	●
American Samoa							●	●	●	●			●					●	●	●				
Guam			●			●	●	●	●	●					●			●	●	●		●	●	●
Northern Mariana Islands								●	●					●	●				●	●				
Puerto Rico			●			●	●	●	●	●	●	●	●		●		●	●	●	●		●	●	●

Figure 31

hazardous materials) and *urban fires* (this includes structural fires). *Nuclear attack* is listed as the fourth ranked threat by all 50 States and the District of Columbia; however, none of the four Territories reporting listed nuclear attack as a threat. Fifth ranked threats include *drought and fixed facility hazardous materials incidents*. *Tornadoes* rank sixth based on these reports.

If, on the other hand, the ranking was to be based on the average annual number of deaths alone, the rankings would change dramatically. Even though the data on deaths is relatively incomplete (data is only available on one-third of the hazards on an annual basis and one-half on a worst case basis), the top six threats based on the average annual number of deaths would be: *(1) urban fires, 5,900 deaths; (2) winter storms, 88 deaths; (3) tornadoes, 83 deaths; (4) floods, 72 deaths; (5) landslides, 25-50 deaths, and (6) hurricanes, 33 deaths*. The revised data on death rates placed fire (which was inadvertently omitted in the 1990 report) in the first ranking and rearranged last year's rankings for floods (to fourth place) and winter storms (to second place). The jurisdictions ranked floods first and winter storms and fires second and third, respectively. Tornadoes were fifth in the jurisdictions' threat ranking but third in the death ranking. Landslides and hurricanes, ranked fifth and sixth for annual deaths, are not even ranked in the local emergency managers' listings. Wildfire, ranked second for community threats, is not listed because the number of deaths has not been determined.

The difference is even more dramatic when compared to a ranking based on the **worst-case deaths**. Based on this data, the rankings would be as follows: *(1) hurricanes—6,000 deaths from the Galveston, Texas, hurricane in 1900; (2) floods—2,209 deaths from the Johnstown, Pennsylvania, flood in 1889; (3) wildfires—1,182 deaths from a wildfire in Wisconsin in 1871; (4) earthquakes—700 deaths from the San Francisco, California, earthquake in 1906; (5) tornadoes—with 689 deaths in 1925 and (6) urban fire—602 deaths from the Iroquois Theater fire in Chicago, Illinois, in 1903* . Winter storms, landslides and highway hazardous material incidents, which rank first, fourth and sixth in relationship to the annual average number of deaths are not even ranked in relationship to the worst-case death data.

Based on a ranking of Presidential disaster declarations from January 1967 through December 1990, *severe storms and flooding (404 declarations)*, would rank first; *tornadoes and storms and flooding (104 declarations)* would rank second; *hurricanes and typhoons (71 declarations)* would rank third; *tornadoes (26 declarations)* would rank fourth; *snow and ice (20 declarations)* would rank fifth and *fires (14 declarations)* would rank sixth. *(See Figure 32).*

PRESIDENTIAL DISASTER DECLARATIONS

January 1967 Through December 1990

Hazard	No. of Occurrences
Severe Storms & Flooding	404
Tornadoes & Storms & Flooding	104
Hurricanes & Typhoons	71
Tornadoes	26
Snow & Ice	20
Fires	14
Levee or Dam Failure	8
Earthquake Volcano	8
Other	3
Total	664

Figure 32

And finally, if rankings are prepared on the basis of economic loss alone, the list changes yet again. Based on available figures on the average annual losses from various incidents, the rankings are as follows: *(1) floods—$2.4 billion, (2) landslide—$1-2 billion, (3) tornadoes—$50-$500 million, (4) subsidence—in excess of $125 million, (5) highway hazardous materials incidents—$14 million and (6) railway hazardous materials incidents—$5.6 million.*

While local emergency managers who reported actual or potential threats to FEMA listed nuclear attack as the fourth highest of the threats, none of them listed either of the potential threats posed by chemical or biological warfare or low intensity conflict. Part of this is attributable to the fact that this nation has fortunately been spared the effects of such events so that there is no relevant data on which to base a ranking. These facts do not, however, lessen the very real threat posed by such events and the fact that, by any standard, they could be ranked at the top of any list of threats because of the tremendous devastation, loss of life and economic impact that could be expected from a chemical or biological attack on this country or, depending on its severity and magnitude, a low intensity conflict.

Based on an analysis of frequency of occurrence, *fire* ranks as the number one threat facing the American population today, a fact applicable to all regions of the country. As noted earlier, the annual average of reported fires in the United States during the years 1983-1987 were *2,300,000*, which resulted in an average of *5,900 civilian fire deaths, 29,000 civilian injuries and $7.8 billion in losses from fire **each** year.*

Earthquakes are a particularly serious threat. While mitigation measures such as building codes can be implemented to reduce the potential damage from an earthquake, preparedness measures in general are particularly difficult because of the lack of warning prior to an occurrence. In terms of the potential for significant loss of life and damages totaling in the billions of dollars (particularly in urbanized areas), major earthquakes pose a serious threat to the population in risk areas—especially to those populations in the high-risk areas of California and associated risk areas in the western United States.

While all regions of the country are vulnerable to tornadoes, southern and midwestern States are particularly susceptible. During the period 1959-1988, a staggering *11,343* tornadoes struck the southern region, including the States of North Carolina, South Carolina, Georgia, Alabama, Florida, Tennessee, Arkansas, Louisiana, Mississippi, Oklahoma and Texas. During the same period, *9,234* tornadoes struck the Midwestern region, comprised of the States of North Dakota, South Dakota, Nebraska, Iowa, Missouri, Kansas, Illinois, Indiana, Wisconsin, Minnesota, Michigan, Ohio and Kentucky. In the remaining areas of the country, 513 tornadoes struck the southwestern States, including California; 1,091 affected the northeastern and mid-Atlantic States and 583 occurred in the upper northwestern States. Although many tornadoes hit sparsely populated, rural areas, they are a serious threat to many States and cause scores of deaths and millions of dollars in property damage on an annual basis.

Hurricanes and tropical storms are also of particular concern to all southern and eastern coastal States from Texas to Maine. During the period 1871-1989, *185* hurricanes and tropical storms hit the coastal areas from North Carolina to Texas; 33 hurricanes and tropical storms affected the coastal region stretching from Virginia to Maine. More than *13,000* people have lost their lives in hurricanes from Texas to the northeast in the years of 1900-1989. Property losses from major hurricanes during that time exceeded *$43 billion*.

The long-term effects of major hurricanes, like those from earthquakes, are particularly serious. The high winds that hurricanes trigger can cause enormous timber losses. Massive storm surges that result from the forces of cyclonic winds on the ocean below can substantially change the geography of a severely hit coastal area. In addition, hurricanes are classic examples of the types of disasters that can trigger "secondary effects" such as tornadoes and flooding which, together with storm surges, can trigger extensive damage. Because of the frequently erratic paths of hurricanes, inland States from Oklahoma on a northeastward path to Ohio, Pennsylvania, New York and the New England States can sustain significant damage from the downgraded remnants of hurricanes.

The average annual figure for economic damage from floods, derived from losses during the years 1979-1988, is *2.4 billion*. Perhaps the most pervasive of the natural hazards, floods represent another primary threat affecting all regions of the country to varying degrees. The Upper Northwest, including Washington, Oregon, Alaska, Idaho, Montana and Wyoming, has the lowest percentage of flood-prone areas, totaling 0-5 percent of the total land area of these States. The midwestern region, comprised of the States of North Dakota, South Dakota, Nebraska, Iowa, Missouri, Kansas, Illinois, Indiana, Wisconsin, Minnesota, Michigan, Ohio and Kentucky, has 0-20 percent of its total land area prone to flooding. The same ratio, 0-20 percent, applies to the western region, which includes the States of California, Nevada, Arizona, Utah, Colorado, New Mexico and Hawaii.

As is the case with hurricanes/tropical storms and tornadoes, the States in the southern region (North Carolina, South Carolina, Georgia, Alabama, Florida, Tennessee, Arkansas, Louisiana, Mississippi, Oklahoma and Texas) have the highest percentage of flood-prone land areas, a total of 0-30 percent.

Fires, earthquakes, tornadoes, hurricanes and floods represent the primary threats facing communities and emergency management coordinators. This by no means diminishes the magnitude of the many other threats discussed in this report but reflects, instead, the five most significant annual events threatening the U.S. population and infrastructure. To varying degrees, these events are often disasters of major proportions, disasters which can result in great losses of life and property covering hundreds of thousands of square miles of the United States. Their impact, both on the geography of the country and the affected population, is frequently long-term and response and recovery from these disasters can take many years.

THE RELATIONSHIP OF FEMA PROGRAMS TO THREATS

Emergency management consists of organized analysis, planning, decision making, assignment and coordination of available resources for mitigation, preparedness, response and recovery to save lives and protect property from the effects of any emergency, whether from natural, technological or attack sources. In order to fulfill their responsibilities to manage and conduct essential functions, State and local governments must have operational capabilities that will survive any kind of catastrophic emergency. Survivable crisis management capability ensures the ability to direct, control, manage and coordinate emergency operations within and among jurisdictions in cooperation with all government entities—Federal, State and local. To achieve this goal, all jurisdictions need integrated, in-place capabilities built on people, communications and hardware, systems and plans that will enable them to prepare for and respond to all emergencies, including catastrophic disaster from any source.

Agency Mission

FEMA is responsible for ensuring the establishment and development of policies and programs for emergency management at the Federal, State and local levels. This includes developing a national capability to mitigate against, prepare for, respond to and recover from the full range of emergencies that include natural and technological disasters and **all** national security emergencies.

In view of the broad range of threats the population and industry of the United States face, FEMA is also responsible for ensuring that plans are in place as part of an integrated, all-hazard emergency management program. While the nature of some emergencies (e.g., earthquakes, hurricanes, tornadoes, radiological emergencies, etc.) does require certain hazard-specific procedures and activities, the goal of the Agency is to ensure the establishment of an integrated, all-hazards emergency management capability.

The Agency has a wide range of programs available to provide financial and technical assistance to State and local governments. The purpose of these programs is to help State and local emergency managers coordinate their governments' mitigation, preparedness, response and recovery activities for protecting the population from the numerous hazards that threaten their communities.

The State and Local Programs and Support Directorate

The State and Local Programs and Support Directorate is responsible for developing and maintaining an effective emergency management and response capability designed to mitigate against and reduce the effects of civil emergencies upon life and property. The Directorate develops and oversees programs that enhance State and local government capabilities to prepare for, respond to and recover from emergencies. This responsibility includes preparedness planning and mitigation activities for earthquakes, dam safety, hurricanes, floods (except for those programs authorized by the National Flood Insurance Act of 1968, as amended, which are the responsibility of the FEMA Federal Insurance Administration), tornadoes, radiological and hazardous material accidents and all national security emergencies.

The Civil Defense Program

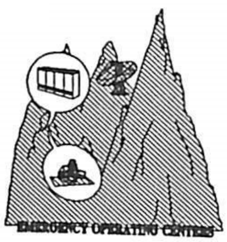
In accordance with the Federal Civil Defense Act of 1950, as amended, the civil defense program provides the basic elements to build an emergency management capability at the State and local levels—an infrastructure of personnel, hardware, facilities, communications and systems that will provide State and local governments with survivable integrated, all-hazard emergency management capability. As stated in Section 2 of the Civil Defense Act:

> *It is the policy and intent of Congress to provide a system of civil defense for the protection of life and property in the United States from attack and natural disasters.*

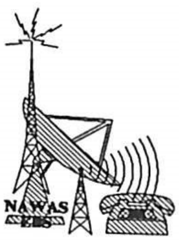
Congress has been clear in its support for attack-related preparedness but has authorized the "dual-use" of civil defense funds for preparing for and providing response to natural disasters. The authority to do so is limited only to the extent that such use "...is consistent with, contributes to, and does not detract from attack-related civil defense preparedness."

The civil defense program provides funding for up to 50 percent of the salaries of State and local emergency managers and fully funds population protection planners, radiological defense officers and facility surveyors in each State. The preparedness planning undertaken by these individuals has application to natural, technological and attack-related disasters.

Although the radiological defense program is primarily geared to providing equipment for determining radiation levels following a nuclear attack, the same equipment is available for use in peacetime radiological emergencies.



State Emergency Operating Centers, for which up to 50 percent of the funding is provided through the civil defense program, are focal points for coordinated State-level disaster response activities throughout the Nation and are the foundation of the developing survivable crisis management system. In addition, the lessons learned from their use in natural disasters allows State and local governments to be better prepared in the event of attack from conventional, nuclear, chemical or biological weapons.



Listed below are some examples of how the civil defense program is used for specific disasters:

- Through the National Warning System, over 7,000 warnings and tests were issued in 1990 alone.
- The Emergency Broadcast System (EBS) was developed in the civil defense program as a means for the President to talk to the general population during times of national emergency; yet, the EBS stations report that Governors and mayors use it nearly 1,000 times a year in response to natural and technological emergencies.
- Evacuations undertaken in natural disasters serve as excellent models for attack planners in determining methods to protect the population.
- Emergency Operating Centers (EOC's) usually are activated on a daily basis by State and local governments during natural disaster response operations to provide effective population protection and crisis management.
- The protection provided to counter the affects of electromagnetic pulse on State and local EOC's, civil defense emergency communications systems and equipment and EBS stations ensures their survivability because it also protects against the affects of lightning and power transients that occur during natural disasters.
- Plans developed by Emergency Management Assistance planners funded under the civil defense program at the State and local levels are frequently implemented during disasters.

Lessons learned by implementing these plans are of great importance in developing subsequent planning guidance and evaluations.

- Civil defense-sponsored testing/exercising proved invaluable to Sioux City, Iowa, by making possible that city's rapid response to the tragic plane crash that occurred in 1989. As Bev Costello, the Iowa State Training Manager noted in an October 1989 letter to the Superintendent of the FEMA Emergency Management Institute, "The direct impact of the FEMA exercise requirements is that we were very well prepared to respond [to the airline crash] and, in fact, responded accordingly because most of the responders had experience working together...*I found it interesting that the considerations not rehearsed were precisely the areas where problems arose*" (emphasis added).

The civil defense program reduces the vulnerability of the American people, not just to attack, but to the full range of hazards they face. Combined with the other emergency management programs of the Agency, it is an integral component of and provides the basic infrastructure for a State and local emergency management capability.

Natural and Technological Hazards Programs

FEMA's natural and technological hazards programs include the following elements: (1) National Earthquake Hazards Reduction, (2) Hurricane Preparedness, (3) Dam Safety, (4) Radiological Emergency Preparedness, (5) Hazardous Materials and (5) Chemical Stockpile Emergency Preparedness Program.

The purpose of the *National Earthquake Hazards Reduction Program* is to reduce the risk to lives and property. This is accomplished through a comprehensive, multi-agency program of scientific research, mitigation, preparedness and response planning and public education. FEMA, as the lead agency, has the statutory responsibility to plan, coordinate and recommend goals, priorities and budgets for earthquake activities among the principal agencies authorized under the Earthquake Hazards Reduction Act of 1977, as amended. The agencies include the United States Geological Service, the National Science Foundation and the National Institute for Standards and Testing.

The primary activities of the program are to:

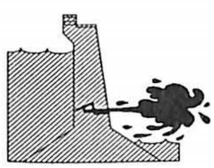
- develop improved seismic design and construction practices for adoption by Federal agencies, State and local governments and the private sector;

- provide financial and technical assistance to State and local governments to implement comprehensive earthquake hazard reduction programs;
- develop public education and awareness programs and
- plan for and coordinate an adequate Federal capability to respond to a catastrophic earthquake.


HURRICANE

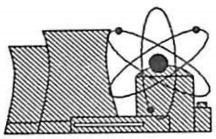
The goal of the *Hurricane Preparedness Program* is to reduce the loss of life and property damage from hurricanes in high-risk populations. FEMA, as the chair of the Interagency Coordinating Committee on Hurricanes, coordinates ongoing hurricane-related planning and mitigation activities of the U.S. Army Corps of Engineers, the National Weather Service, the National Hurricane Center and the Office of Ocean and Coastal Resource Management.

The primary functions performed include: (1) conducting population preparedness projects which assist State and local governments in developing and implementing evacuation plans for coastal areas and (2) and property protection projects, which assist State and local governments in developing and implementing hazard mitigation plans for coastal areas.


DAM SAFETY

The objective of the *Dam Safety Program* is to enhance the safety of the Nation's dams, thereby protecting lives and property. FEMA exercises dual responsibilities through its Dam Safety Program to (1) coordinate Federal dam safety activities and (2) coordinate and implement activities designed to encourage States to implement strong dam safety programs.

FEMA chairs the Interagency Committee on Dam Safety (ICODS) and coordinates non-Federal dam safety with the Association of State Dam Safety Officials. Training for dam safety officials has been enhanced by the development of "Training Aids for Dam Safety (TAD)." TAD was created, funded, developed and disseminated under FEMA's leadership. Technical assistance is provided through the publication, revision and distribution of technical assistance materials developed by ICODS and others. In addition, FEMA activities help to bring the dam safety message to State and local officials and the private sector by sponsoring State public awareness workshops, informational videos, brochures and other materials.



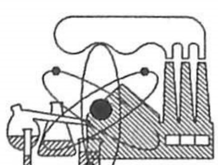
RADIOLOGICAL EMERGENCY

As a result of a Presidential Directive in 1979, FEMA was assigned the lead Federal role for radiological emergency planning and response. Under FEMA's *Radiological Emergency Preparedness Program,* the goal is to enhance integrated emergency planning and response for all types of peacetime radiological emergencies by the State, local and Federal governments. The primary emphasis is directed to planning and preparedness for commercial nuclear power plants, nuclear fuel cycle and material license holders, Department of Defense and Department of Energy facilities and transportation accidents.

Much of the program's effort is directed towards protecting the health and safety of citizens living in the Emergency Planning Zones that are established around each commercial nuclear power plant in the United States. There are 75 commercial nuclear power plant sites nationwide involving planning and preparedness activities of 460 State, local and tribal governments. Approximately 3 million people live within the Emergency Planning Zones around these sites.

Key activities pertaining to offsite radiological emergency planning and preparedness include evaluation of emergency response and utility plans, review of public emergency information materials, review and testing of utility alert and notification systems, periodic exercises to test emergency response plans and periodic program activities such as drills, plan updates and public meetings.

FEMA's primary regulatory responsibilities includes the provision of FEMA findings on the adequacy of offsite planning and preparedness to the Nuclear Regulatory Commission. FEMA findings are used by the Nuclear Regulatory Commission in making licensing determinations.



HAZARDOUS MATERIALS

The mission of the *Hazardous Materials Program* is to provide technical and financial assistance to State and local governments. In addition, FEMA coordinates and cooperates with the private sector in developing, implementing and evaluating hazardous materials emergency preparedness programs for State and local governments. The mission is accomplished through five separate functional elements—planning, training, exercising, information exchange and intergovernmental coordination/cooperation.

FEMA develops and distributes planning and preparedness guidance to State and local governments in cooperation with the 13 member agencies of the National Response Team. Hazardous materials training courses and course materials are developed and financial assistance is provided to State and local governments in support of State derived course development and delivery. FEMA supports State and local governments in the design implementation and evaluation of hazardous materials exercises used for assessing the adequacy and effectiveness of existing planning and training programs. FEMA also cooperates with the Department of Transportation in the maintenance of electronic bulletin boards to provide the latest information on hazardous materials planning, training, exercises and conferences to State and local governments and the private sector.

The Department of Defense Authorization Act of 1986 (PL 99-145) mandated the destruction of the Army's stockpile of unitary chemical weapons, which was stored at eight sites in the continental United States. The law directed the Secretary of Defense to provide for the "maximum protection of the environment, the general public, and the personnel who will be involved in the destruction of the chemical agents and munitions."

Based on a Memorandum of Understanding between FEMA and the United States Army, FEMA assists State and local jurisdictions surrounding these eight sites in preparing for incidents related to the storage and destruction of the Army's unitary chemical weapons stockpile through its *Chemical Stockpile Emergency Preparedness Program (CSEPP)*. The program provides technical assistance to these jurisdictions with comprehensive planning, exercises, training and emergency public information. In addition, FEMA serves as the conduit for Army funds to these jurisdictions through its Comprehensive Cooperative Agreement process.

The Disaster Relief Program

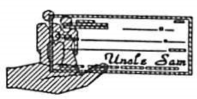
The Disaster Relief Program is designed to supplement the efforts and available resources of State and local governments and voluntary relief organizations. The President's declaration of a "major disaster" or an "emergency" authorizes Federal assistance under the Robert T. Stafford Disaster Relief and Emergency Assistance Act and triggers other Federal disaster relief programs.

As defined in "The Stafford Act":

> *An "emergency" means any occasion or instance for which, in the determination of the President, Federal assistance is needed to supplement State and local efforts and capabilities to save lives and to protect property and public health and safety, or to lessen or avert the threat of a catastrophe in any part of the United States.*

"Major disaster" means any natural catastrophe (including any hurricane, tornado, storm, high water, winddriven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm or drought), or, regardless of cause, any fire, flood, or explosion, in any part of the United States, which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance under this Act to supplement the efforts and available resources of State, local governments, and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby.

Two primary forms of Federal disaster assistance can be made available under a Presidential declaration of a major disaster: (1) assistance to individuals and (2) assistance to State and local governments.



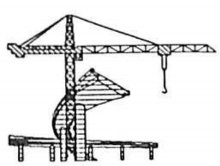
Individual Assistance

One of the most important objectives after any disaster is to inform individuals of the assistance available and to assist them in the application and delivery process. Information outlining available aid programs is disseminated by FEMA through radio, television, newspapers and the mass distribution of pamphlets, as well as "outreach" teams and toll-free telephone "hotlines." This *"Individual Assistance"* may include:

- temporary housing until alternative housing is available for disaster victims whose homes are uninhabitable;
- minimum essential repairs to owner-occupied residences in lieu of other forms of temporary housing so that families can return quickly to their damaged homes;
- disaster unemployment assistance and job placement assistance for those unemployed as a result of a major disaster;
- individual and family grants of up to $10,400 to meet disaster-related necessary expenses or serious needs when those affected are unable to meet such expenses or needs through other programs or other means;
- legal services to low-income families and individuals;
- crisis counseling and referrals to appropriate mental health agencies to relieve disaster-caused mental health problems and
- assistance through the Cora Brown Fund to victims of natural disasters for those disaster-related needs that have not been or will not be met by government agencies or other organizations that have programs to address such needs.

Although the following forms of assistance are *not FEMA programs*, FEMA, as the lead agency for Federal disaster assistance, coordinates the aid provided by other Federal agencies under Presidential declarations of major disasters or emergencies:

- loans to individuals, businesses and farmers for repair, rehabilitation or replacement of damaged real and personal property and some production losses not fully covered by insurance;
- agricultural assistance, including technical assistance; payments covering a major portion of the cost to eligible farmers who perform emergency conservation actions on farmland damaged by a disaster and provision of federally owned grain for livestock and herd preservation;
- veteran's assistance, such as death benefits, pensions, insurance settlements and adjustments to home mortgages held by the Veterans Administration if a VA-insured home has been damaged;
- tax relief, including help from the Internal Revenue Service in claiming casualty losses resulting from the disaster and State tax assistance and
- waiver of penalty for early withdrawal of funds from certain time deposits.



Public Assistance

Assistance to State and local governments is provided as soon as practicable following the President's declaration of a major disaster. Project applications submitted by States and eligible political subdivisions of States for *"Public Assistance"* may be approved to fund a variety of projects, including:

- clearance of debris, when in the public interest or on public or private lands or waters;
- emergency protective measures for the preservation of life and property;
- repair or replacement of streets, roads and bridges;
- repair or replacement of water control facilities (dikes, levees, irrigation works and drainage facilities);
- repair or replacement of public buildings and related equipment;
- repair or replacement of public utilities;
- repair or restoration of public facilities damaged while under construction;

- repair or replacement or recreational facilities and parks and
- repair or replacement of eligible private nonprofit educational, utility, emergency, medical and custodial care facilities, including those for the aged or disabled, and facilities on Indian reservations.

Other forms of assistance that may be made available under a Presidential declaration of a major disaster include:

- community disaster loans from FEMA to communities that may suffer a substantial loss of tax and other revenues and can demonstrate a need for financial assistance in order to perform their governmental functions;
- certain forms of hazard mitigation assistance from FEMA under its own authorities and with other Federal agencies through the interagency hazard mitigation team process;
- funding of mitigation projects through the Hazard Mitigation Grant Program, which can fund up to 50 percent of the project;
- repairs and operating assistance to public elementary and secondary schools by the Department of Education;
- use of Federal equipment, supplies, facilities, personnel and other resources (other than the extension of credit) from various Federal agencies and
- repairs to Federal-aid system roads when authorized by the Department of Transportation.

In many instances, disaster assistance may be obtained from the Federal government and voluntary agencies without a Presidential declaration of a major disaster or an emergency. The following are examples of the kinds of assistance from various Federal and voluntary agencies:

- *Search and Rescue Assistance* may be provided by the U.S. Coast Guard or U.S. Armed Forces in search and rescue operations to evacuate disaster victims and transport supplies and equipment.
- *Flood Protection Assistance* can be provided by the U.S. Army Corps of Engineers, which has the authority to assist in flood-fighting and rescue operations and to protect, repair and restore federally constructed flood-control works threatened, damaged or destroyed by a flood.

- *Fire Suppression Assistance* may be authorized by the President to provide aid, including grants, equipment, supplies and personnel to a State for the suppression of a forest or grassland fire on public or private lands that threatens to become a major disaster.
- *Emergency Loans for Agriculture* may be made to eligible farmers, ranchers and aquaculturists in areas designated as eligible by the Secretary of Agriculture or the Administrator of the Farmers Home Administration.
- *Disaster Loans for Homeowners and Businesses* can be provided by the Small Business Administration (SBA) to qualified homeowners and businesses to repair or replace damaged or destroyed private property when the Administrator declares a "disaster loan area" under SBA's statutory authorities. Economic injury loans can help small firms suffering economic losses as a result of a disaster.
- *Voluntary Agencies* provide an essential element of almost any disaster relief effort through the assistance they provide in the distribution of food, medicine and supplies, emergency shelter and the restoration of community services. The American National Red Cross provides grants and other types of assistance to individuals and families affected by disasters to meet their emergency needs. The Salvation Army, the Mennonite Disaster Service and other charitable organizations and church groups also provide significant assistance to those in need of help.

The National Urban Search and Rescue System

In addition to the aforementioned programs, a new era of Federal disaster response has been initiated with FEMA's development of the National Urban Search and Rescue (US&R) System. This program combines the benefits of the National Earthquake Hazards Reduction Program with the responsiveness of the Stafford Act. Under this program, grants will be made available to State and local jurisdictions that display a certain level of US&R response capability. These grants will be used to enhance their existing capabilities through equipment acquisition and additional training programs, while simultaneously providing the Federal government with an immediately deployable response capability to respond to disasters that require US&R support within the United States.

To ensure standardization of the Federal US&R response, FEMA has developed a 56-person task force structure by which all applicants must configure their resources. These task forces will be multi-functional, configured into four specialized teams of search, rescue, medical and technical. Criteria for task force personnel and equipment is currently being developed.

The Federal Insurance Administration

The FEMA Federal Insurance Administration directs Federal programs dealing with flood insurance and the Unified National Program for Floodplain Management.

FLOOD INSURANCE

Congress established the National Flood Insurance Program (NFIP) with the passage of the National Flood Insurance Act of 1968. The program was broadened and modified in the Flood Disaster Protection Act of 1973.

Before the passage of the National Flood Insurance Act of 1968, national response to flood disasters consisted of constructing flood control works and providing disaster relief to flood victims. Flood losses were not reduced nor was unwise development discouraged. No insurance companies provided flood coverage for the public, and building techniques to reduce flood damage were overlooked. In creating the National Flood Insurance Program, Congress provided a program for mitigating future damage from floods and an insurance mechanism for the public to obtain protection from flood losses.

The National Flood Insurance Program, which is administered by FEMA's Federal Insurance Administration, enables property owners to purchase flood insurance. It is designed to provide an insurance alternative to disaster assistance as a means of meeting escalating costs for repairing flood damage.

Local communities participate in the NFIP through an agreement with the Federal government. Under this agreement, the Federal government makes flood insurance available as a financial protection against actual flood losses if the community implements and enforces measures to reduce future flood risks to new construction in special flood hazard areas. To date, there are nearly 18,000 communities participating in this program.

When a community joins the NFIP, it adopts and enforces minimum floodplain management standards. FEMA works closely with States and local communities to identify flood hazard areas and flooding risks. The floodplain requirements are designed to prevent new development from increasing the flood threat and to protect new and existing buildings from anticipated floods.

In 1981, FEMA developed the "Write Your Own" program to reinvolve the private-sector insurance companies in the NFIP. The goals of the "Write Your Own" program are:

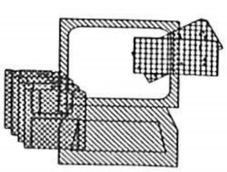
- to increase the NFIP policy base and the geographic distribution of policies,
- to improve service to NFIP policy holders through the infusion of insurance industry knowledge and
- to provide the insurance industry with direct operating experience with flood insurance.

The Community Rating System (CRS), created by FEMA in 1990, provides a new incentive for activities that reduce flood losses and support the sale of flood insurance. Any community that participates in the NFIP may apply for CRS classification to receive flood insurance premium rate credits for its residents. To qualify for these credits, the community must demonstrate that its implementation activities for floodplain management and public information exceed the minimum NFIP requirements.

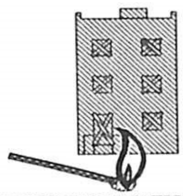
United States Fire Administration

The mission of the FEMA United States Fire Administration (USFA) is (1) to enhance the Nation's fire prevention and control activities, (2) to reduce significantly the Nation's loss of life from fire and (3) to achieve a reduction in property loss and non-fatal injury due to fire. The FEMA National Fire Academy provides educational programs at the FEMA training facility located in Emmitsburg, Maryland, and through off-campus outreach courses.

The United States Fire Administration offers a wide range of programs to both fire service professionals, emergency managers and the public. These include:


FIRE DATA

The National Fire Incident Reporting System, which operates in conjunction with the National Fire Information Council. The USFA coordinates this fire data collection and analysis program on a voluntary basis with most States and a number of metropolitan areas. This system allows USFA to track fire safety trends and measures any change in the numbers of fire casualties.



ARSON INFORMATION

The Management Application Project and the *Arson Information Management Systems Project* expand the data capabilities of the National Fire Incident Reporting System with computer software packages that manage fire data.

Community Volunteer Fire Prevention grants to 21 States and the District of Columbia fund local fire prevention and education projects.

TECHNICAL SUPPORT

The Firefighters Integrated Response Equipment System improves the design and performance of structural firefighters' clothing and equipment. Firefighter suits are being developed and tested to withstand hazardous chemicals and toxic gases. Field tests and studies to determine the effects of smoke and other environmental and behavioral characteristics on firefighters are being conducted.

Fire Education

The USFA works with the Children's Television Workshop to develop fire safety materials for use by educators, focusing on fire safety for pre-school children by using Sesame Street materials. The USFA also runs a series of educational teleconferences yearly for fire service and emergency management audiences throughout the country on subjects ranging from flammable gases and liquids to residential sprinklers, stress management and public affairs. In addition, the USFA maintains an Arson Resource Center as an information clearinghouse on arson data for use by students of the National Fire Academy, emergency management personnel and the public.

Summary

Regardless of whether the programs listed above are provided in the form of financial assistance, technical assistance or guidance, they provide the primary system within the Federal government to assist State and local governments in developing a readiness capability against threats. They cover the full range of emergency management activities—mitigation, preparedness, response and recovery—required against the full range of natural, technological and national security emergencies, including nuclear attack.

The following is a representative list of the types of assistance that FEMA is providing under the civil defense program in 1991:

- funding of up to 50 percent of the salaries of over 6,700 full and part-time State and local emergency managers in over 2,600 jurisdictions nationwide;
- updating and evaluating 320 State and local Emergency Operations Plans (EOP's);
- funding tours for up to 600 military reservist Individual Mobilization Augmentees to assist State and local emergency managers in emergency planning and preparedness activities for both national security and natural and technological hazards;
- assisting approximately 500 local jurisdictions review/update their radiological defense annexes for a cumulative total of approximately 3,600 developed/updated radiological defense annexes and assisting approximately 400 State and local radiological defense exercises;
- funding 160 State planners to develop/update State and local EOP's and
- supporting 3,950 State and local exercises and training 382,000 participants.

These activities are in addition to the on-going support provided by civil defense-supported programs such as Emergency Operating Centers, the Emergency Broadcast System, the National Warning System and other communications, planning, hardware and training functions.

In addition, other agency program activities include:

- site specific final determinations and offsite emergency preparedness planning, joint exercises and remedial exercises under the Radiological Emergency Preparedness program;
- the conduct of studies and analyses, the development of policy guidance, the conduct of exercises and assessments of training courses under the hazardous materials program;
- a wide variety of earthquake preparedness activities, including FEMA's role as lead coordinating agency, seismic design, State and local hazards reduction, Federal response planning, earthquake education and information transfer and multi-hazard planning;
- disaster preparedness, response and recovery activities under the Robert T. Stafford Disaster Relief and Emergency Assistance Act;

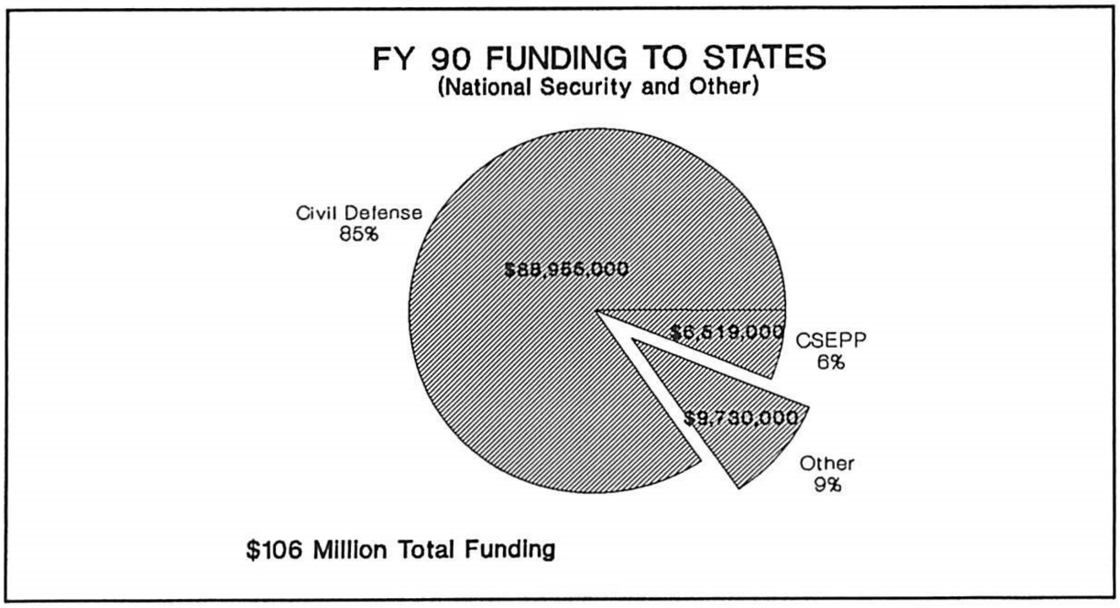


Figure 33

- the initiation of flood studies and the completion of restudies, limited flood-plain map updates, flood map revisions, erosion studies initiated and digital maps produced under the Federal Insurance Administration and
- a wide range of programs under the U.S. Fire Administration to enhance public awareness of the hazards of fire, fire protection and prevention measures; research codes and standards and undertake projects of anti-arson strategies; continue support for fire service leadership development through educational efforts, conferences and special publications; encourage broader involvement of the fire service in public/private partnerships in the areas of new technology and approaches to addressing fire problems; undertake research to develop superior protective clothing, tools and equipment to allow firefighters to operate more safely and effectively in emergencies and other measures to lower the rate of death, injury and illness among the nation's firefighters.

Figure 33 illustrates the financial assistance provided by FEMA programs through the FEMA Comprehensive Cooperative Agreement (CCA) process, which distributed in excess of $106 million to State and local governments in 1990. *Figure 34* displays the support these programs provided to State and local governments across the full range of threats.

FUNDING PROVIDED TO STATES THROUGH FEMA'S COMPREHENSIVE COOPERATIVE AGREEMENT PROCESS

NATURAL — **TECHNOLOGICAL** — **NATIONAL SECURITY**

Program	Avalanche	Dam Failure	Drought	Earthquake	Flood	Hurricane/Tropical Storm	Landslide	Subsidence	Tornado	Tsunami	Volcano	Wildfire	Winter Storm (Severe)	Hazardous Material Incident	Power Failure	Radiological Incident	Transportation Accident	Structural Fire	Nuclear Attack	Chemical Warfare	Civil Disorder	Low Intensity Conflict
CIVIL DEFENSE PROGRAMS																						
DCW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
EMA														✓	✓	✓	✓	✓	✓	✓	✓	✓
EMT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
FS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
IMA																						
PPP	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
RADEF														✓		✓	✓		✓	✓	✓	
SLE																						
NATURAL AND TECHNOLOGICAL HAZARD PROGRAMS																						
CAP																						
CSD																	✓	✓		✓		
DPIG		✓	✓	✓	✓	✓	✓		✓		✓		✓	✓								
DS																						
EP																						
HAZMAT																						
HMA																						
HP																						
REP																						
CSKPP														✓								

Figure 34

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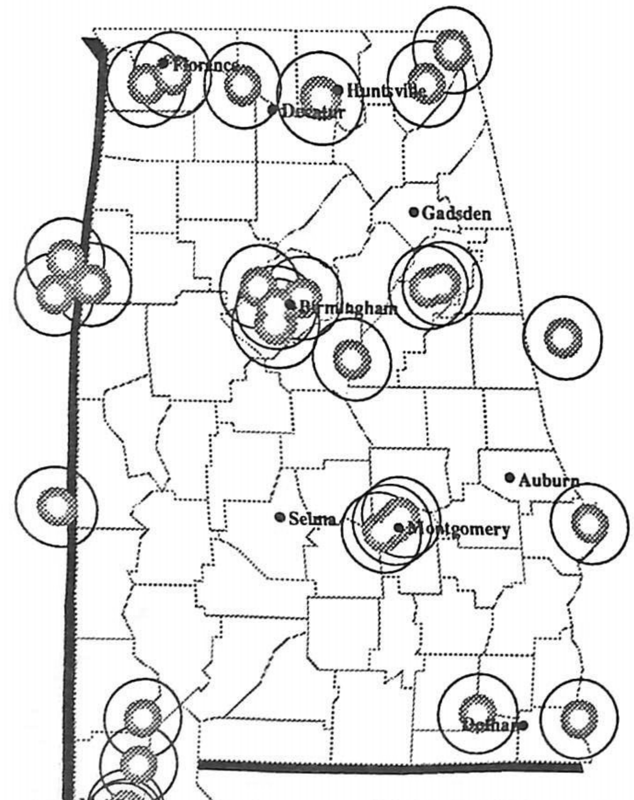
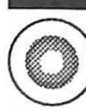
APPENDIX — STATE HAZARD MAPS

ALABAMA



Nuclear Attack

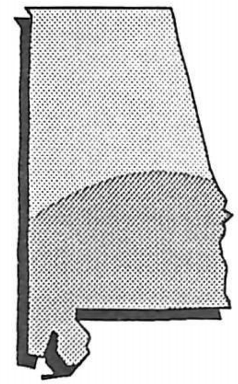


Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

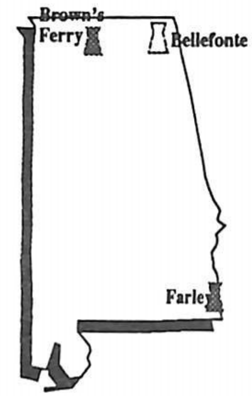
White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

Fallout Fallout radiation is a potential hazard for all localities.



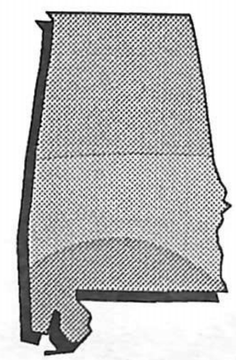
Earthquakes

- Low hazard
- Moderate hazard
- High hazard



Nuclear Power Plants

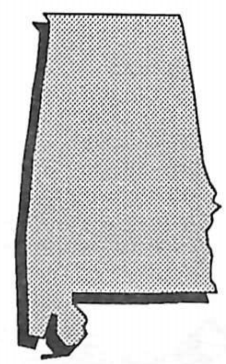
- Commercial nuclear power plants
- Plants without a full power license



Hurricanes

- 5-15 times*
- 15-30 times
- Over 30 times

*Occurrences of destruction over a 50-year period



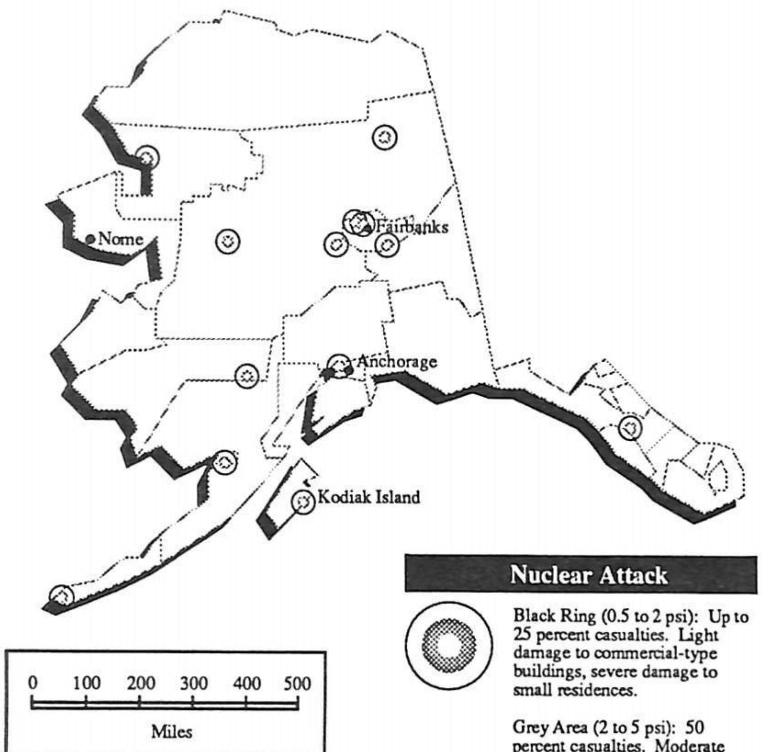
Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

ALASKA



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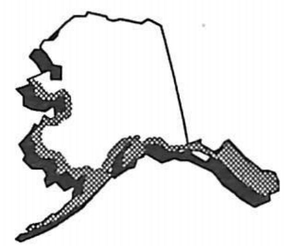
White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

Earthquakes

- Low hazard
- Moderate hazard
- High hazard

Snow and Extreme Cold

The entire state is subject to heavy snow, extreme cold and high winds. For more information, contact local authorities.



Tsunamis

Coastal areas historically subject to Tsunami

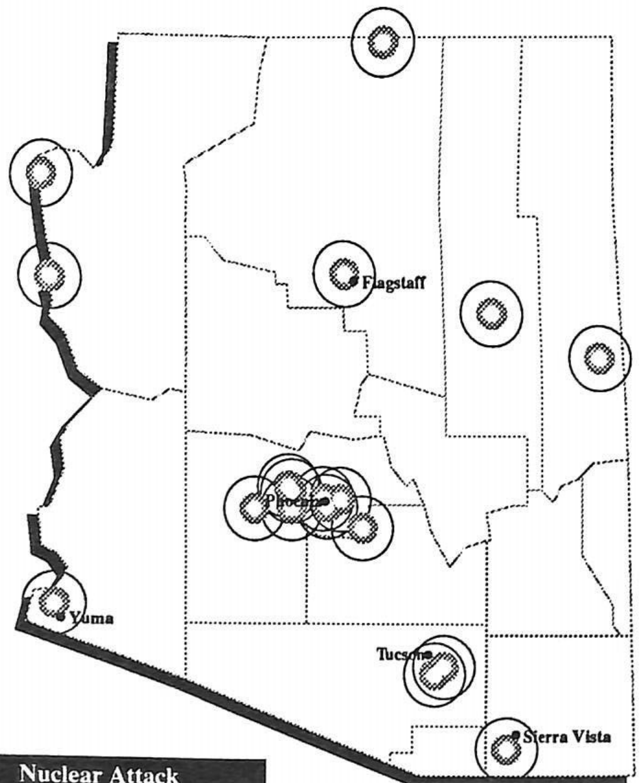
Volcanoes

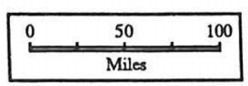
- 1 eruption per 10,000 yrs.
- 1 eruption per 1000 yrs.
- 1 eruption per 200 yrs.
- Volcanoes that have erupted since 1950

Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.

ARIZONA





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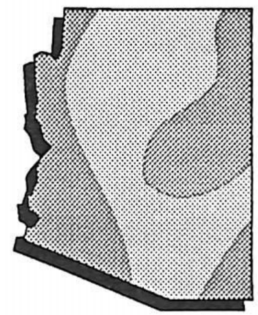
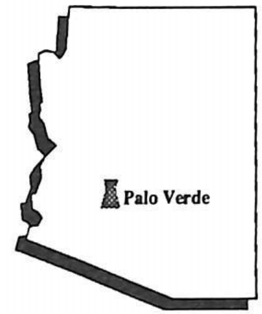


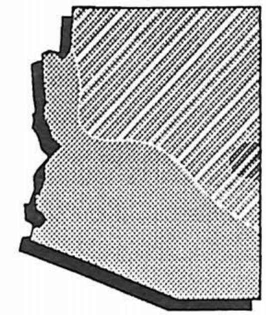
Earthquakes

- Low hazard
- Moderate hazard
- High hazard



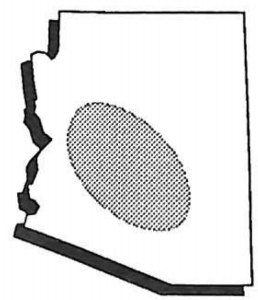
Nuclear Power Plants

- Commercial nuclear power plants



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

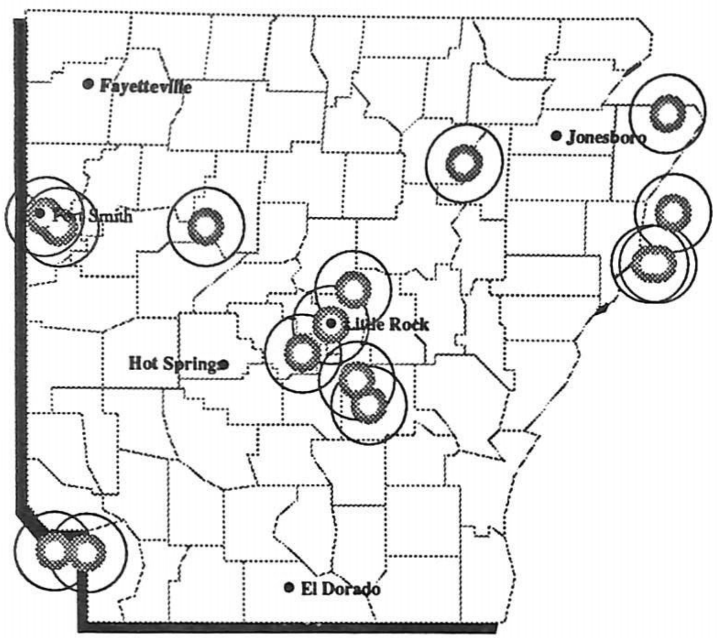
*per 10,000 square miles over a 28-year period

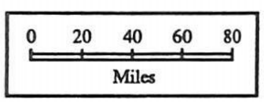
Volcanoes

- 1 eruption per 10,000 yrs.
- 1 eruption per 1000 yrs.
- 1 eruption per 200 yrs.

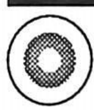
Floods Flooding is a potential hazard in areas throughout the state.

ARKANSAS





Nuclear Attack



Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

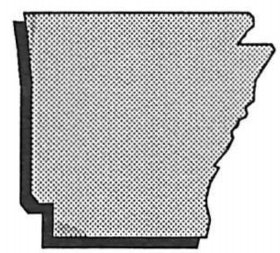
Fallout Fallout radiation is a potential hazard for all localities.

Earthquakes

- Low hazard
- Moderate hazard
- High hazard

Nuclear Power Plants

- Commercial nuclear power plants



Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

CALIFORNIA

Nuclear Attack

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Fallout Fallout radiation is a potential hazard for all localities.

Earthquakes

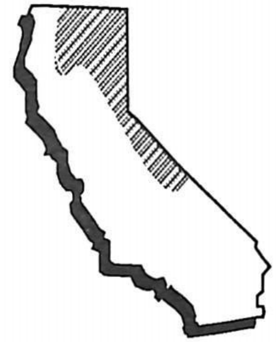
Low hazard

Moderate hazard

High hazard

Nuclear Power Plants

Commercial nuclear power plants



Snow and Extreme Cold

Moderate snowfall

Heavy snowfall

Extreme cold and freezing

Tornadoes

1-3 per year*

4-6 per year

7-9 per year

*per 10,000 square miles over a 28-year period

Tsunamis

Coastal areas historically subject to Tsunami

Volcanoes

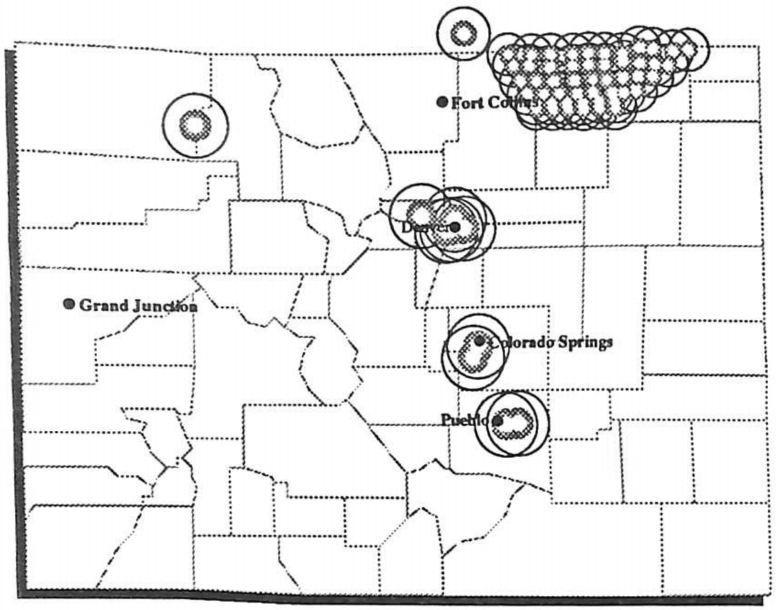
1 eruption per 10,000 yrs.

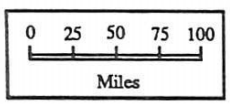
1 eruption per 1000 yrs.

1 eruption per 200 yrs.

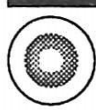
Floods Flooding is a potential hazard in areas throughout the state.

COLORADO





Nuclear Attack



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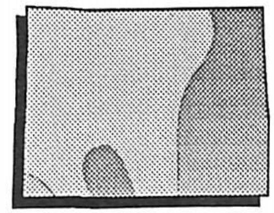
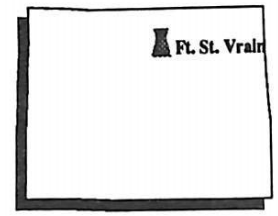


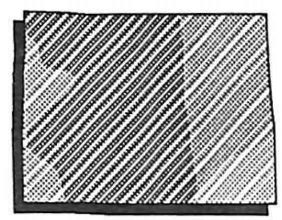
Earthquakes

- Low hazard
- Moderate hazard
- High hazard



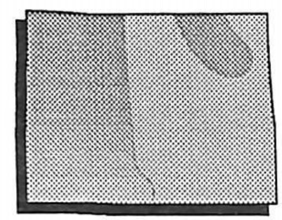
Nuclear Power Plants

- Commercial nuclear power plants



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



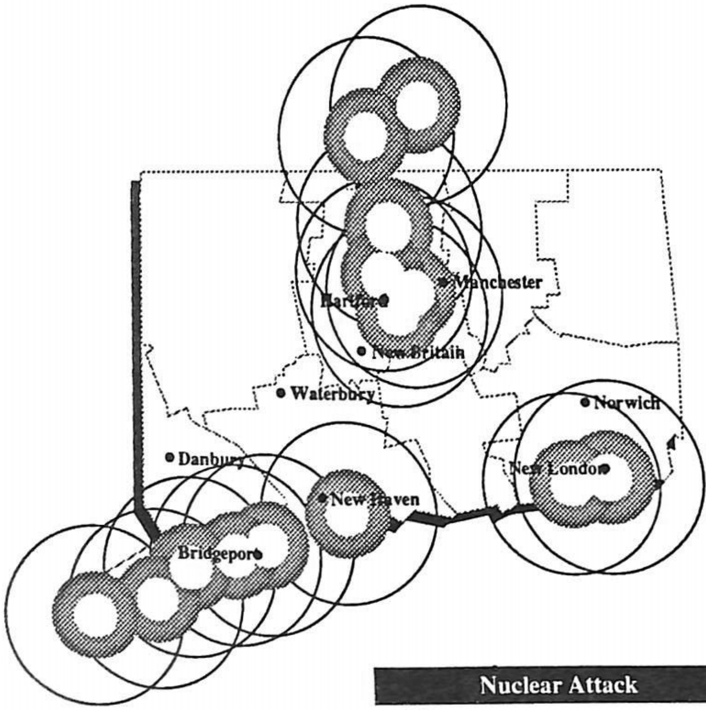
Tornadoes

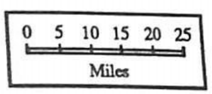
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

CONNECTICUT





Nuclear Attack

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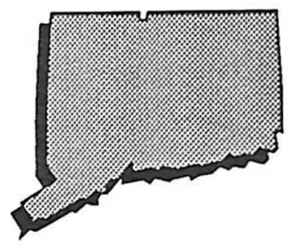
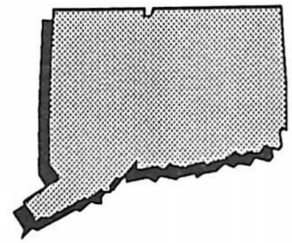


Earthquakes

- Low hazard
- Moderate hazard
- High hazard



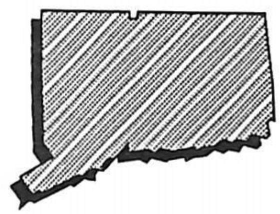
Hurricanes

- 5-15 times*
- 15-30 times
- Over 30 times

*Occurrences of destruction over a 50-year period

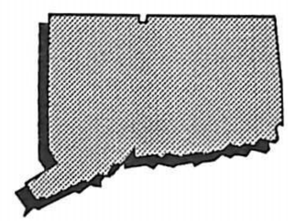
Nuclear Power Plants

- Commercial nuclear power plants



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



Tornadoes

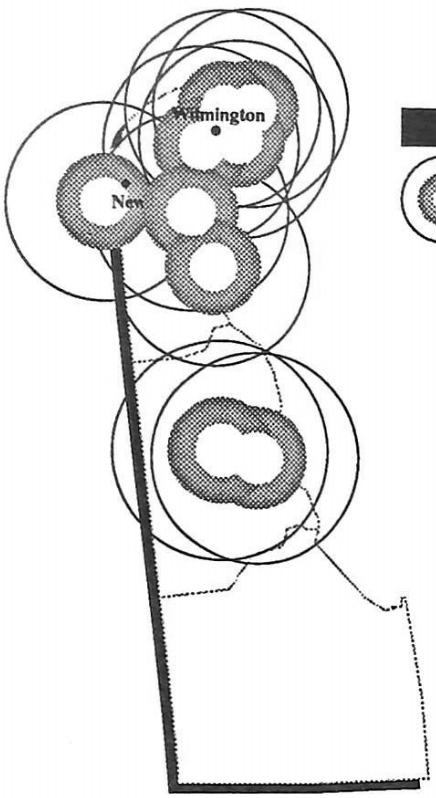
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

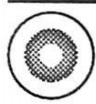
Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.

DELAWARE



Nuclear Attack



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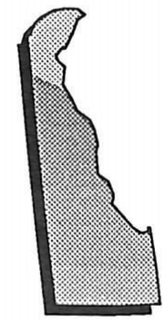
Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

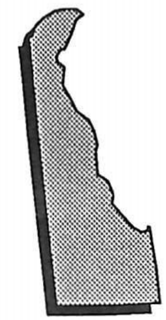
White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

0 5 10 15 20
Miles



Earthquakes

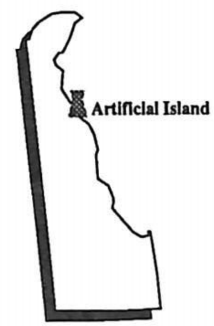
- Low hazard
- Moderate hazard
- High hazard



Hurricanes

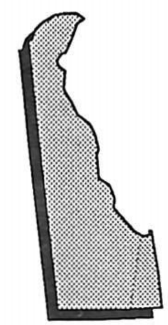
- 5-15 times*
- 15-30 times
- Over 30 times

*Occurrences of destruction over a 50-year period



Nuclear Power Plants

Commercial nuclear power plants



Tornadoes

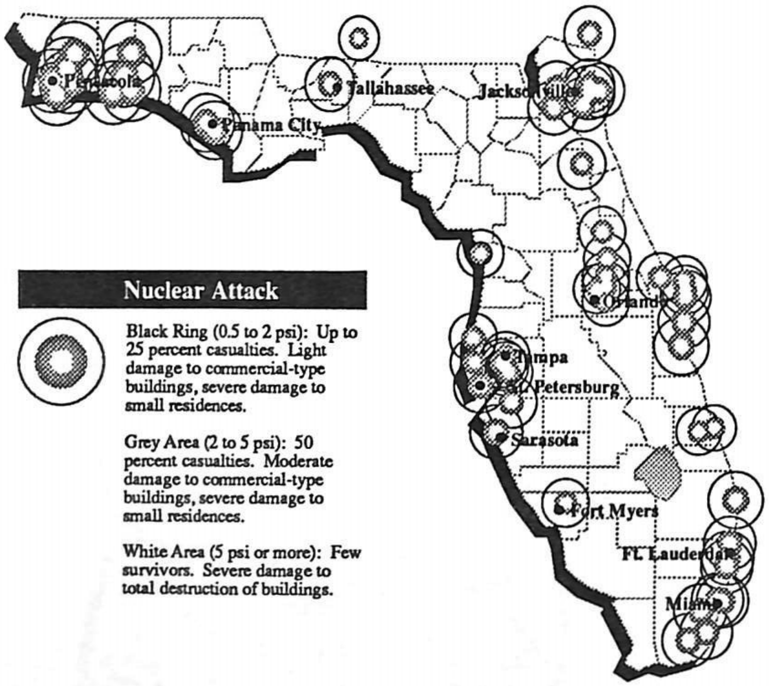
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.

FLORIDA



Nuclear Attack

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Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

0 30 60 90 120 150
Miles

Hurricanes

5-15 times*
15-30 times
Over 30 times

*Occurrences of destruction over a 50-year period

Tornadoes

1-3 per year*
4-6 per year
7-9 per year

*per 10,000 square miles over a 28-year period

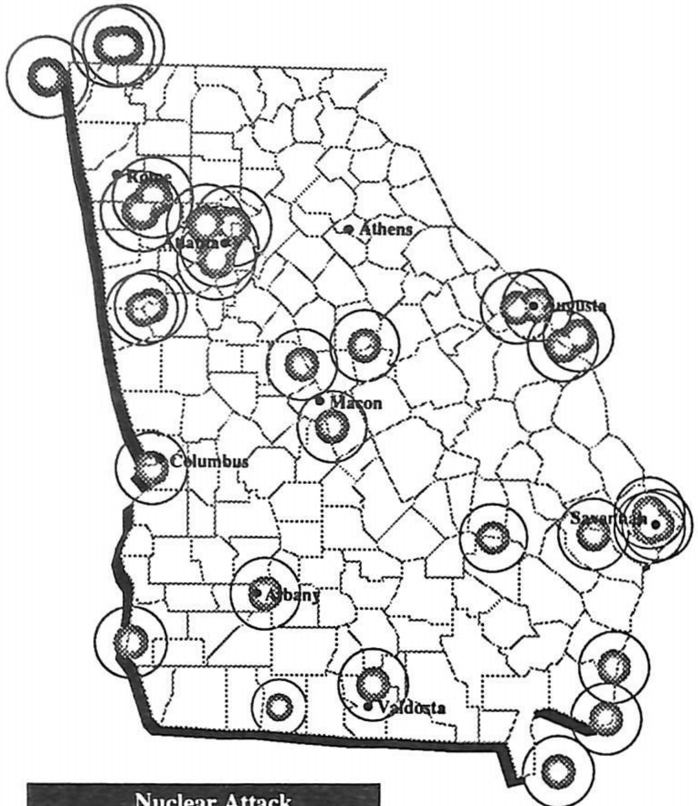
Nuclear Power Plants

Commercial nuclear power plants

Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.

GEORGIA



0 20 40 60 80
Miles

Nuclear Attack

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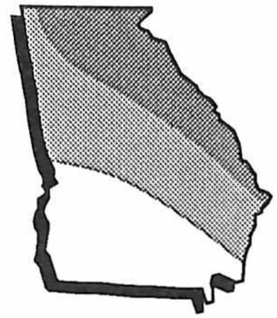
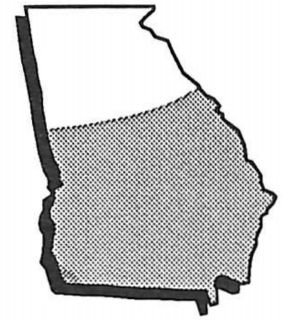
Fallout Fallout radiation is a potential hazard for all localities.



Earthquakes

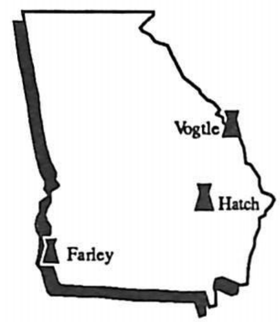
- Low hazard
- Moderate hazard
- High hazard



Hurricanes

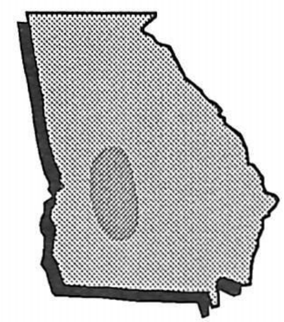
- 5-15 times*
- 15-30 times
- Over 30 times

*Occurrences of destruction over a 50-year period



Nuclear Power Plants

Commercial nuclear power plants



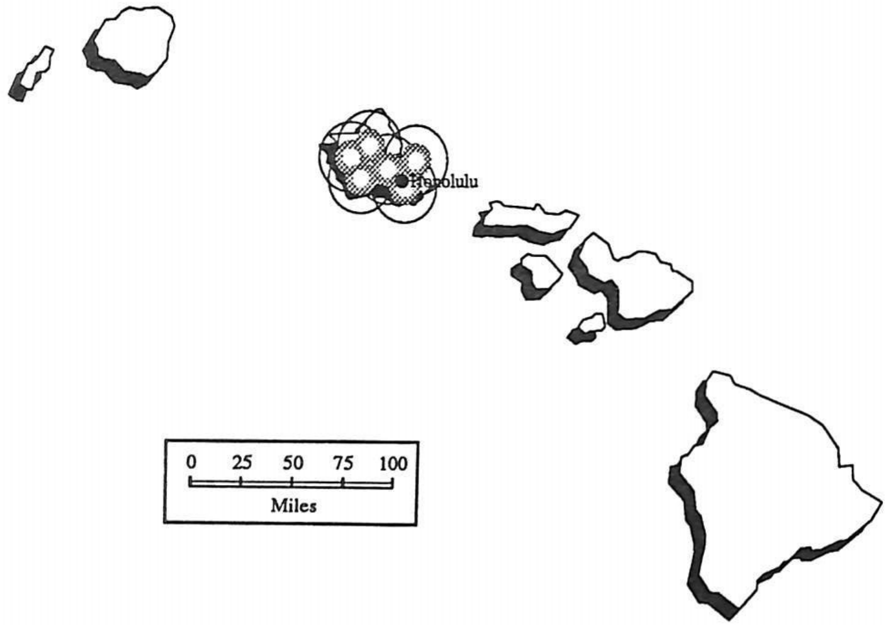
Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

HAWAII



0	25	50	75	100

Miles

Nuclear Attack

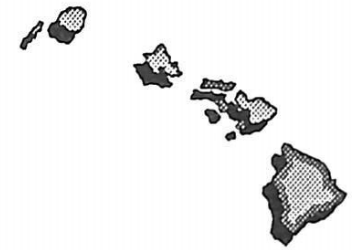
Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

Earthquakes

- Low hazard
- Moderate hazard
- High hazard



Tsunamis

- Coastal areas historically subject to Tsunami

Volcanoes

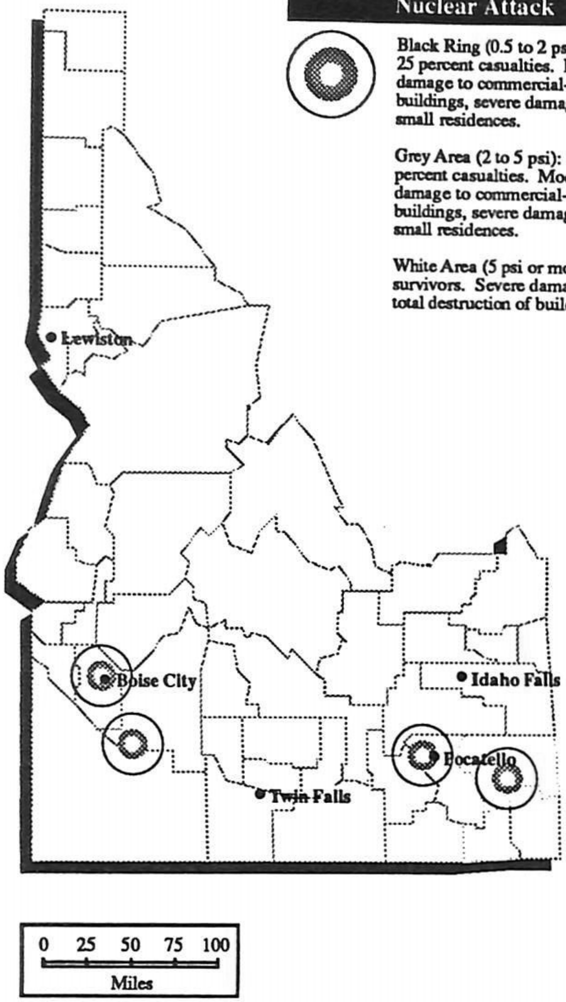
- 1 eruption per 10,000 yrs.
- 1 eruption per 1000 yrs.
- 1 eruption per 200 yrs.
- Volcanoes that have erupted since 1950

Fallout Fallout radiation is a potential hazard for all localities.

Typhoons and Floods Typhoons and floods are a potential hazards in areas throughout the state.

IDAHO

Nuclear Attack



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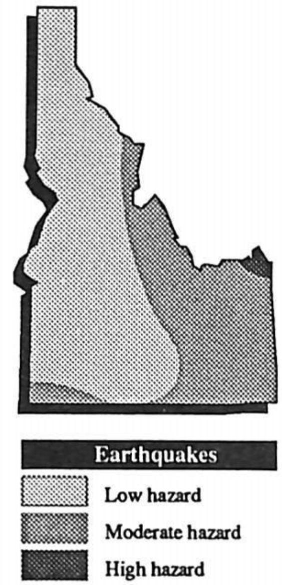
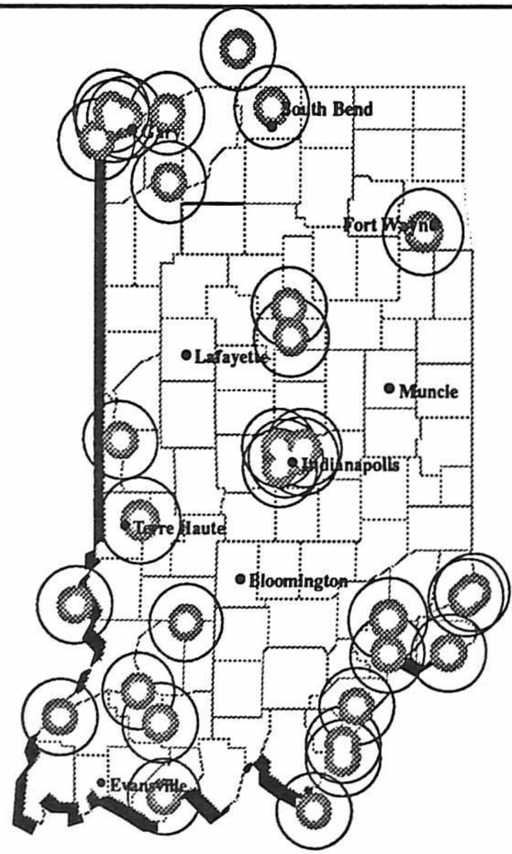


Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.

INDIANA



Nuclear Attack

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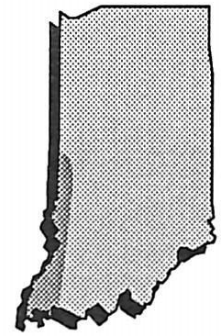
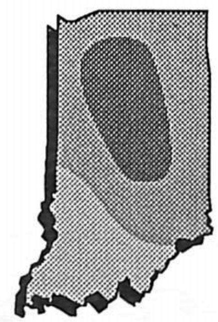


Earthquakes

- Low hazard
- Moderate hazard
- High hazard

Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



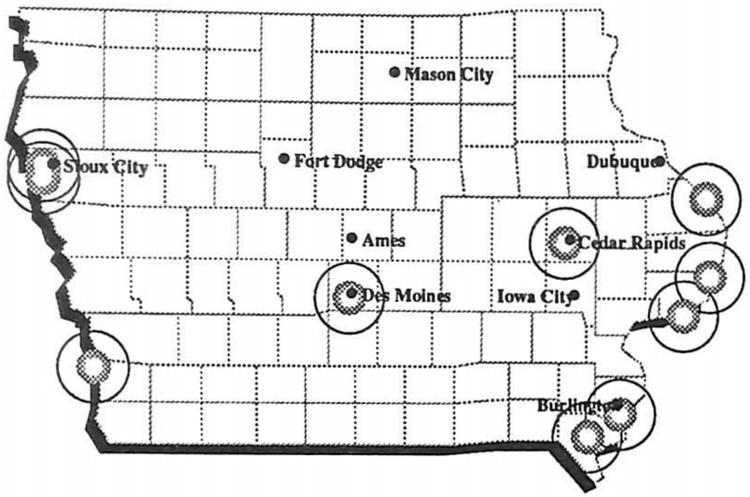
Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

IOWA



0 25 50 75 100
Miles

Nuclear Attack

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Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

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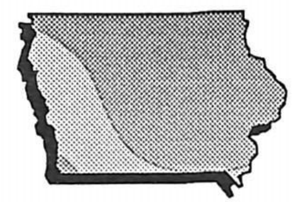

Earthquakes

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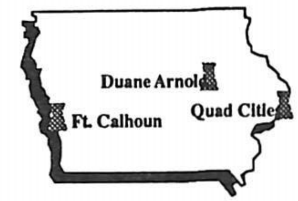
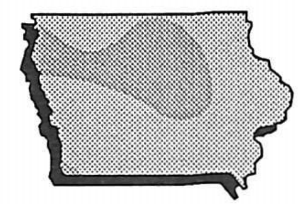


Nuclear Power Plants

- Commercial nuclear power plants

Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



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- 4-6 per year
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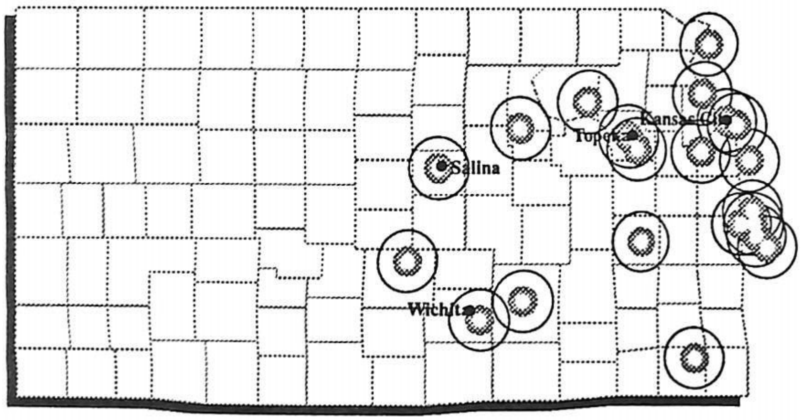
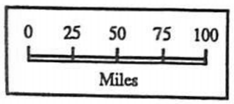
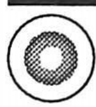
*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.





Nuclear Attack



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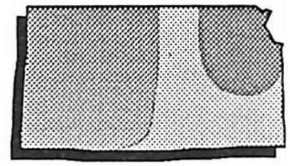

Earthquakes

- Low hazard
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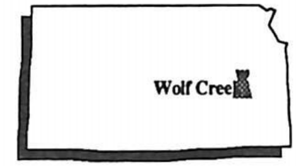
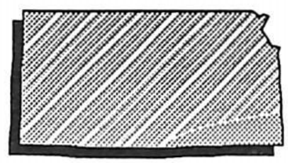


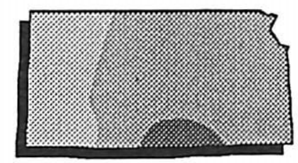
Nuclear Power Plants

- Commercial nuclear power plants



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



Tornadoes

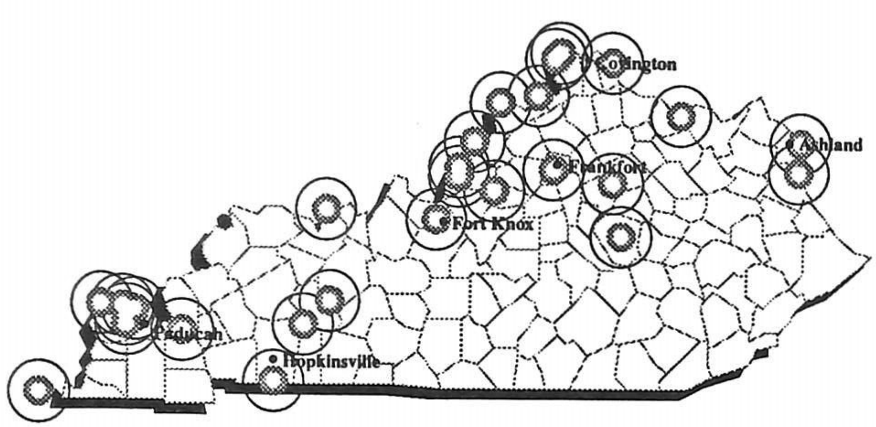
- 1-3 per year*
- 4-6 per year
- 7-9 per year

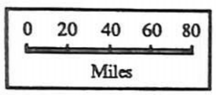
*per 10,000 square miles over a 28-year period

Fallout Fallout radiation is a potential hazard for all localities.

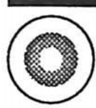
Floods Flooding is a potential hazard in areas throughout the state.

KENTUCKY





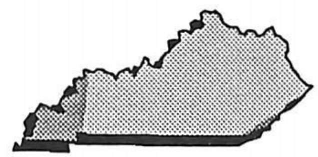
Nuclear Attack



Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

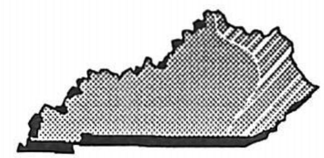
Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.



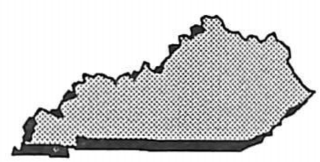
Earthquakes

- Low hazard
- Moderate hazard
- High hazard



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



Tornadoes

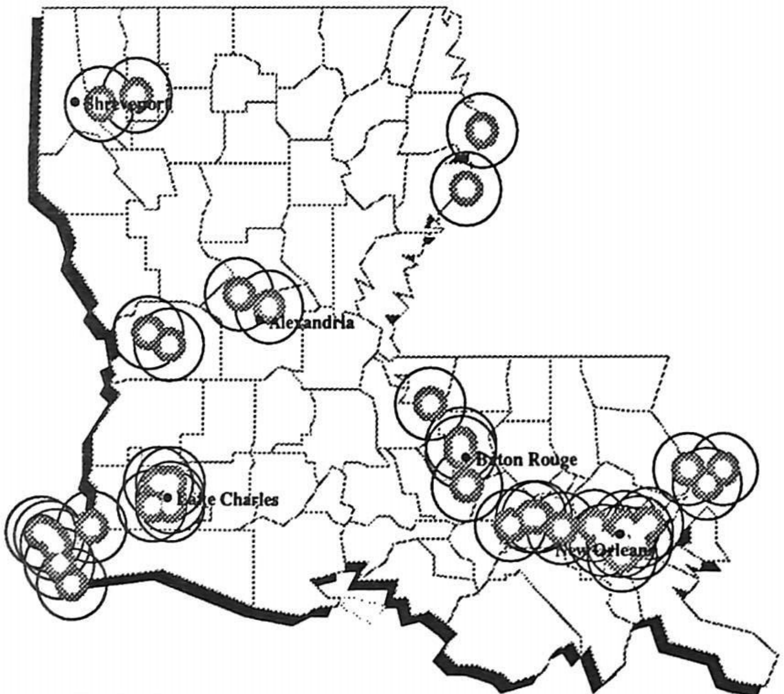
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.

LOUISIANA



Nuclear Attack

Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

0 20 40 60 80 100

Miles

Fallout Fallout radiation is a potential hazard for all localities.

Earthquakes

- Low hazard
- Moderate hazard
- High hazard

Hurricanes

- 5-15 times*
- 15-30 times
- Over 30 times

*Occurrences of destruction over a 50-year period

Nuclear Power Plants

Commercial nuclear power plants

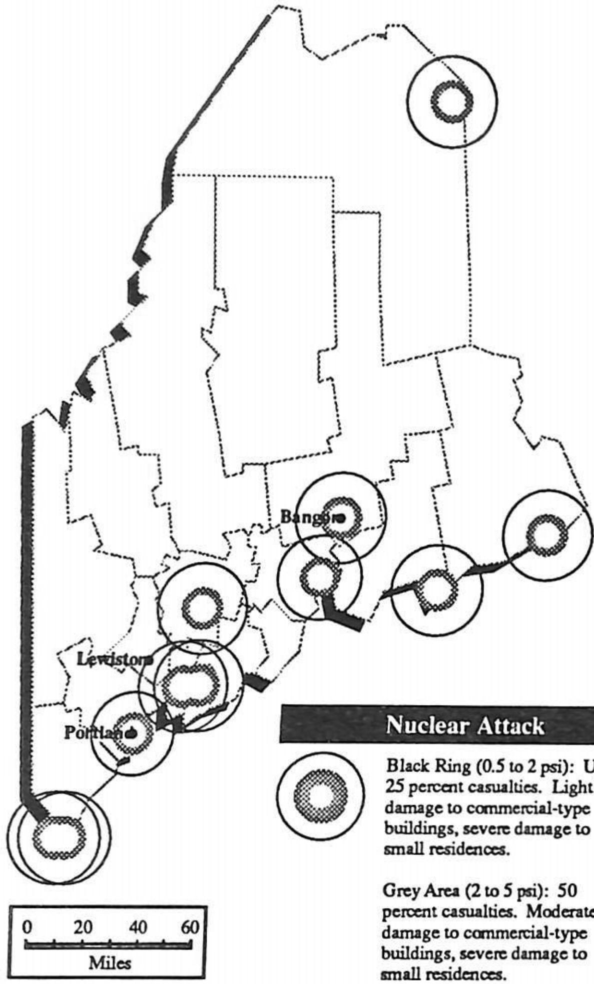
Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

MAINE



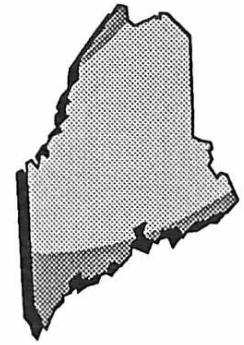
Nuclear Attack

Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

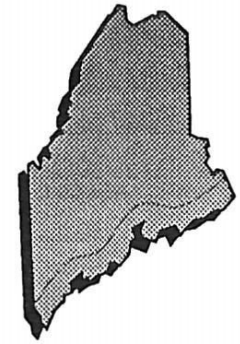
White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

Fallout Fallout radiation is a potential hazard for all localities.



Earthquakes

- Low hazard
- Moderate hazard
- High hazard



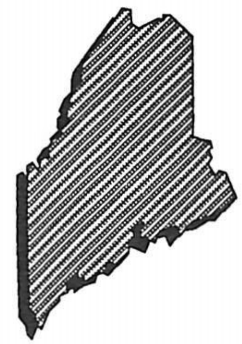
Hurricanes

- 5-15 times*
- 15-30 times
- Over 30 times

*Occurrences of destruction over a 50-year period

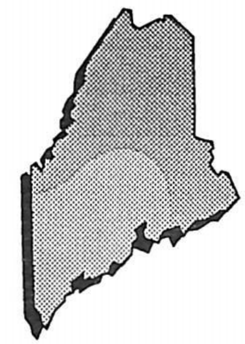
Nuclear Power Plants

- Commercial nuclear power plants



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



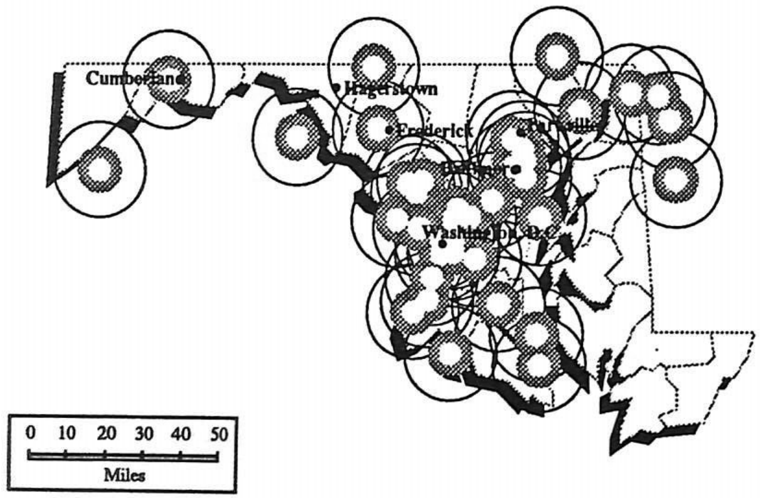
Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

MARYLAND



Nuclear Attack

Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

Earthquakes

- Low hazard
- Moderate hazard
- High hazard

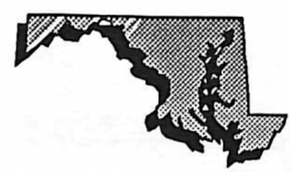
Hurricanes

- 5-15 times*
- 15-30 times
- Over 30 times

*Occurrences of destruction over a 50-year period

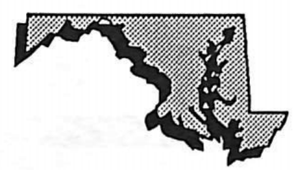
Nuclear Power Plants

- Commercial nuclear power plants



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



Tornadoes

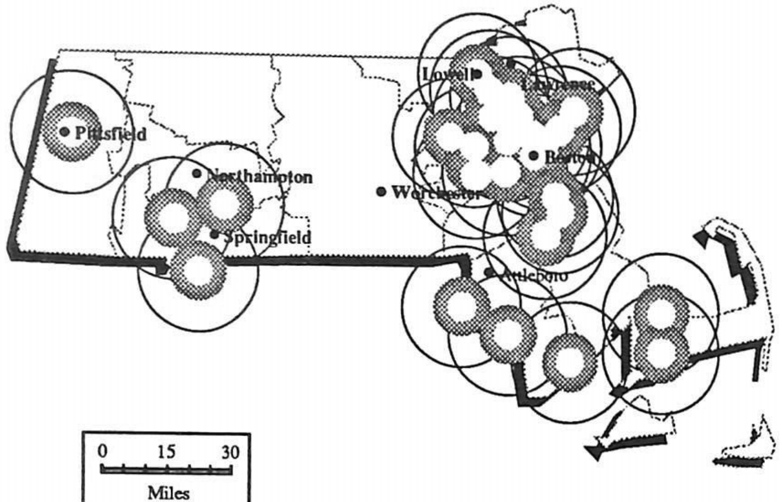
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

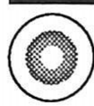
Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.

MASSACHUSETTS



Nuclear Attack

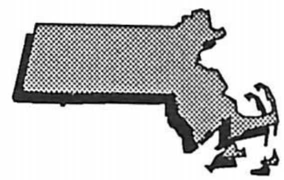


Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

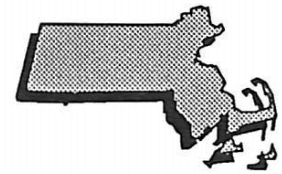
White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

Fallout Fallout radiation is a potential hazard for all localities.



Earthquakes

- Low hazard
- Moderate hazard
- High hazard



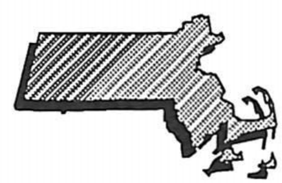
Hurricanes

- 5-15 times*
- 15-30 times
- Over 30 times

*Occurrences of destruction over a 50-year period

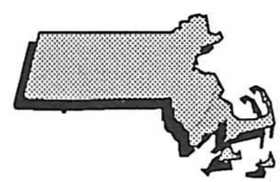
Nuclear Power Plants

- Commercial nuclear power plants
- Plants without a full power license



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



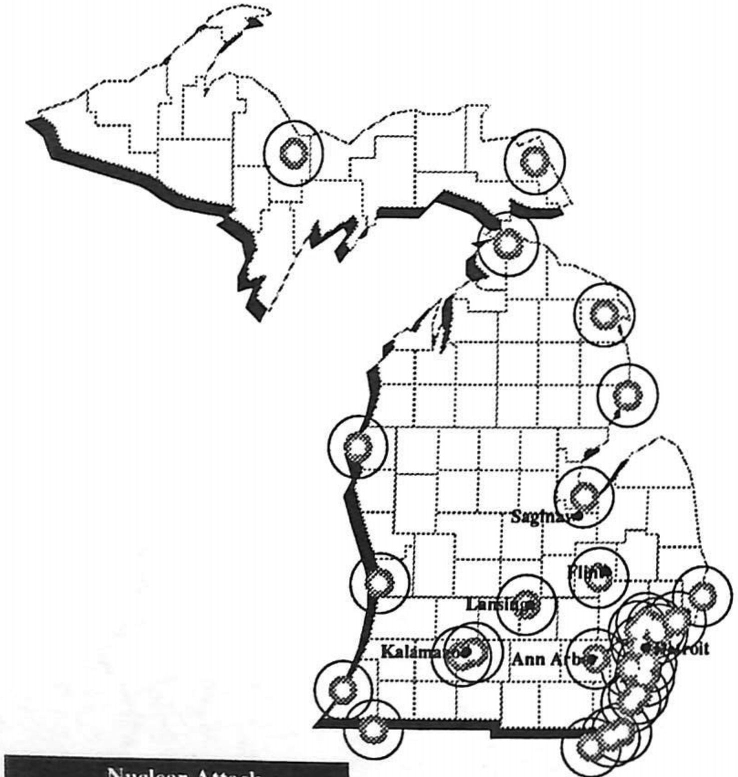
Tornadoes

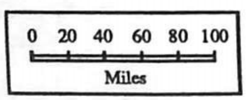
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

MICHIGAN





Nuclear Attack

Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

Fallout Fallout radiation is a potential hazard for all localities.

Earthquakes

- Low hazard
- Moderate hazard
- High hazard

Nuclear Power Plants

- Commercial nuclear power plants

Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing

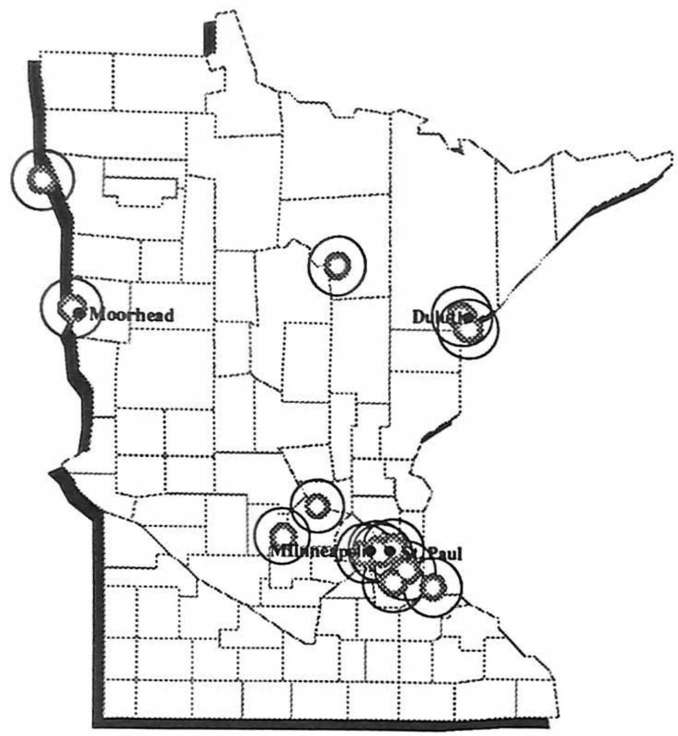
Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

MINNESOTA



0 30 60
Miles

Nuclear Attack

Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

Fallout Fallout radiation is a potential hazard for all localities.

Nuclear Power Plants

Commercial nuclear power plants

Snow and Extreme Cold

Moderate snowfall

Heavy snowfall

Extreme cold and freezing

Tornadoes

1-3 per year*

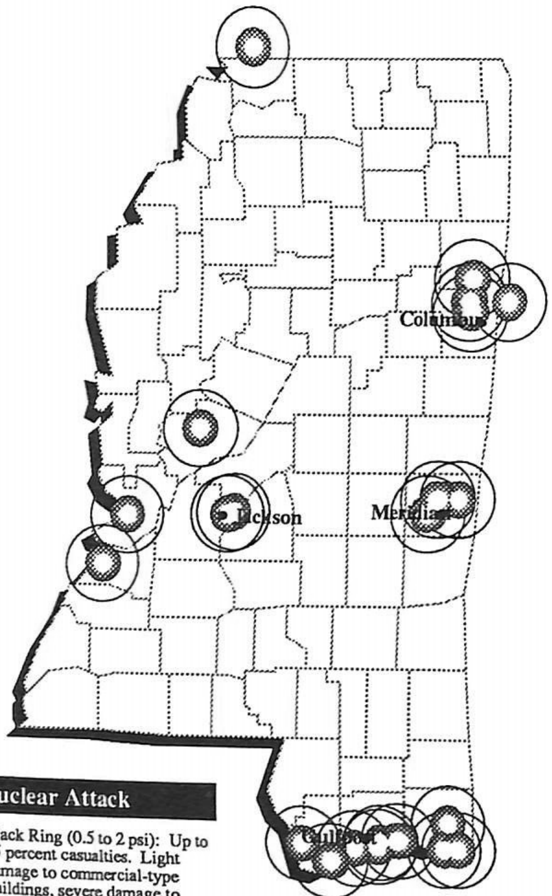
4-6 per year

7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

MISSISSIPPI



Nuclear Attack

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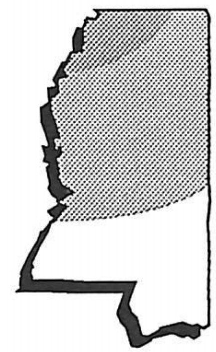
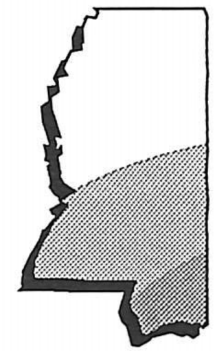
White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

Fallout Fallout radiation is a potential hazard for all localities.



Earthquakes

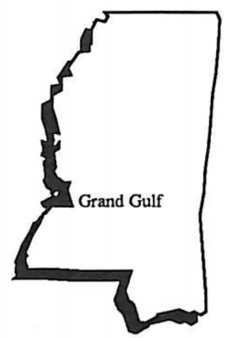
- Low hazard
- Moderate hazard
- High hazard



Hurricanes

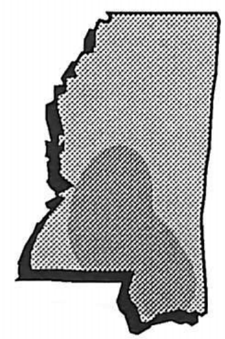
- 5-15 times*
- 15-30 times
- Over 30 times

*Occurrences of destruction over a 50-year period



Nuclear Power Plants

Commercial nuclear power plants



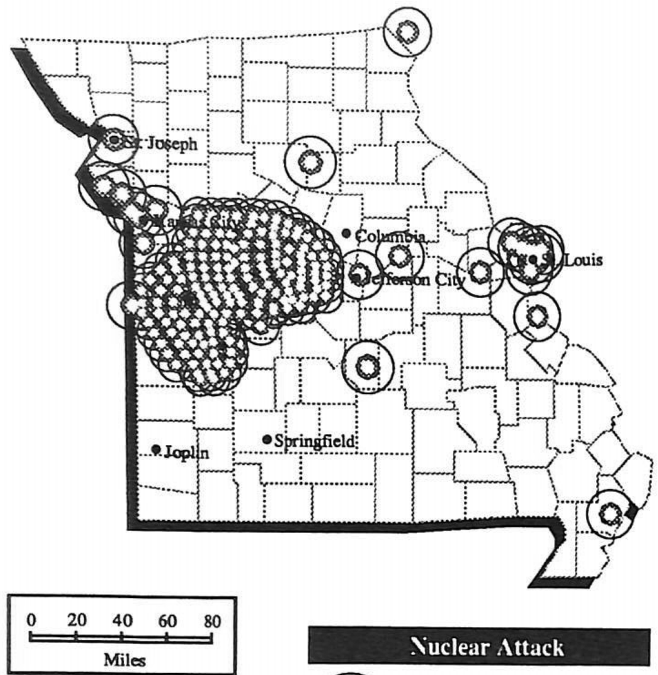
Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

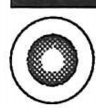
*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

MISSOURI



Nuclear Attack



Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

Earthquakes

- Low hazard
- Moderate hazard
- High hazard

Nuclear Power Plants

- Commercial nuclear power plants

Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing

Tornadoes

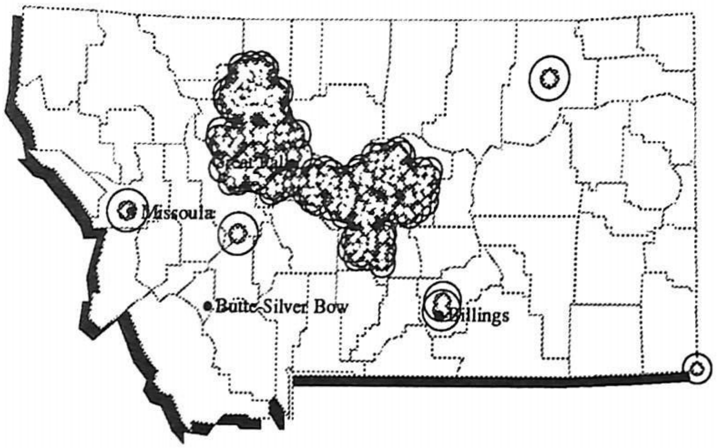
- 1-3 per year*
- 4-6 per year
- 7-9 per year

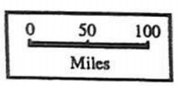
*per 10,000 square miles over a 28-year period

Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.

MONTANA





Nuclear Attack

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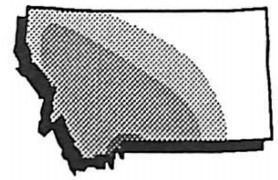
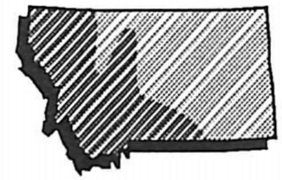
White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.



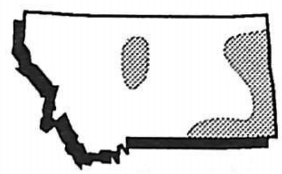
Earthquakes

- Low hazard
- Moderate hazard
- High hazard



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



Tornadoes

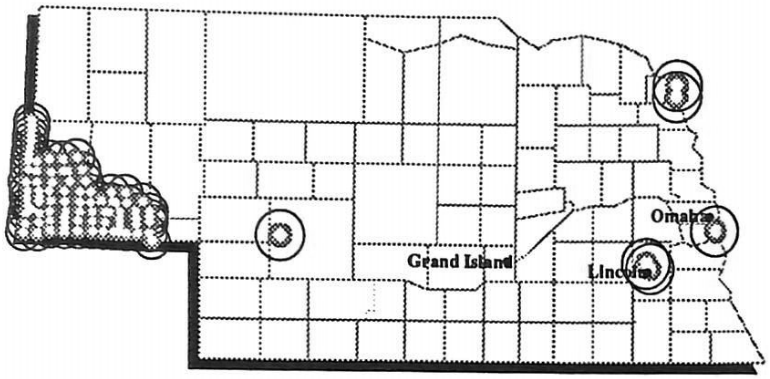
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Fallout Fallout radiation is a potential hazard for all localities.

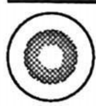
Floods Flooding is a potential hazard in areas throughout the state.

NEBRASKA



0 50 100
Miles

Nuclear Attack



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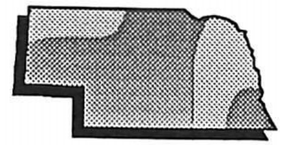
Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

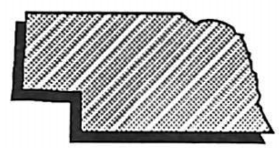


Earthquakes

- Low hazard
- Moderate hazard
- High hazard

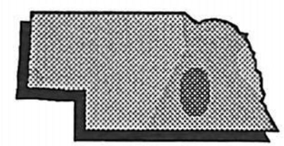
Nuclear Power Plants

- Commercial nuclear power plants



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



Tornadoes

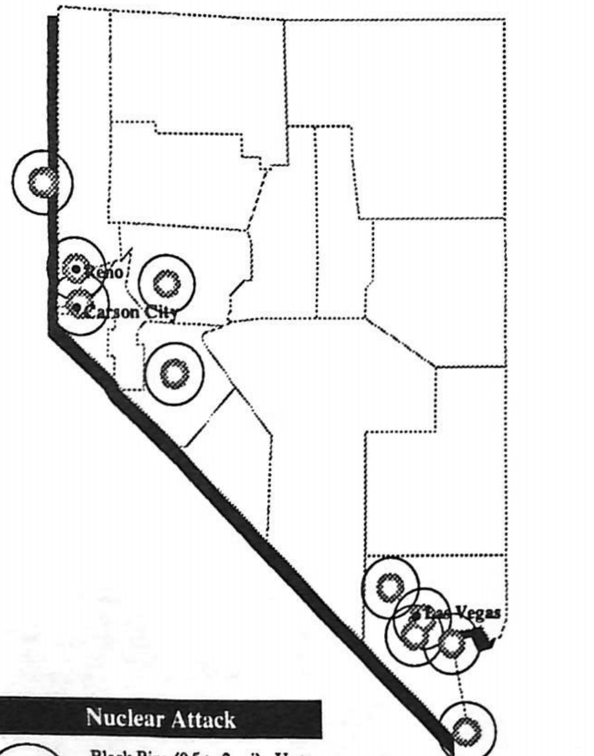
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.

NEVADA



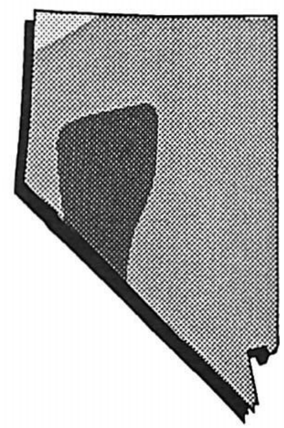
Nuclear Attack

Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

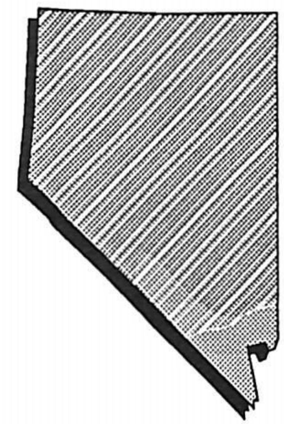
White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

Fallout Fallout radiation is a potential hazard for all localities.



Earthquakes

- Low hazard
- Moderate hazard
- High hazard



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing

Floods Flooding is a potential hazard in areas throughout the state.

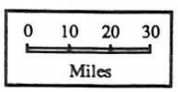
NEW HAMPSHIRE

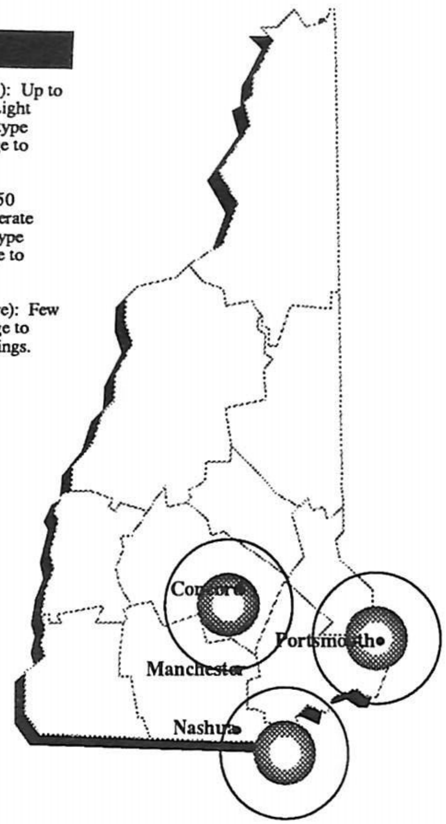
Nuclear Attack

Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

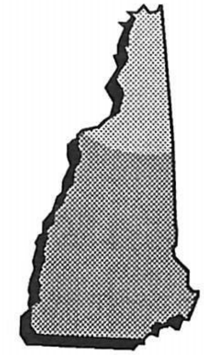
Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.



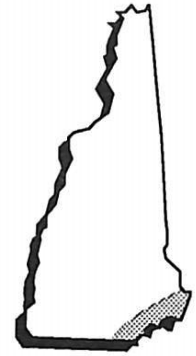


Fallout Fallout radiation is a potential hazard for all localities.



Earthquakes

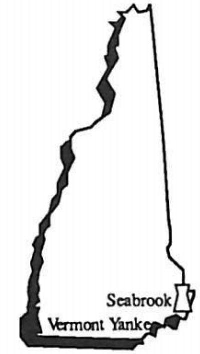
- Low hazard
- Moderate hazard
- High hazard



Hurricanes

- 5-15 times*
- 15-30 times
- Over 30 times

*Occurrences of destruction over a 50-year period

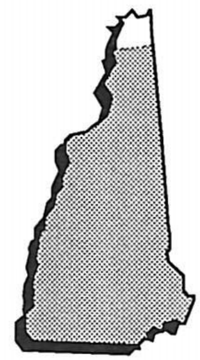


Nuclear Power Plants

- Commercial nuclear power plants
- Plants without a full power license

Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



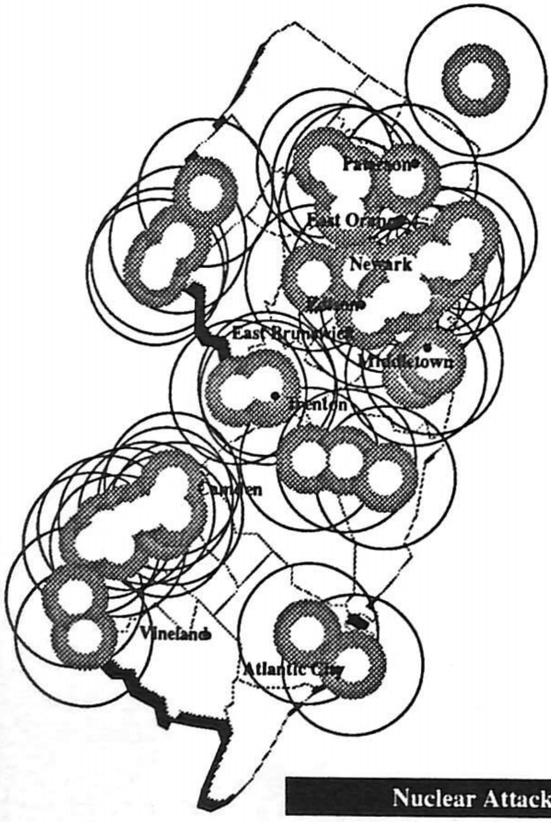
Tornadoes

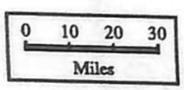
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

NEW JERSEY





Nuclear Attack

Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

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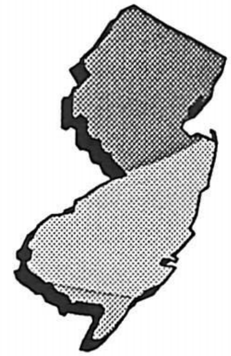

Earthquakes

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- Moderate hazard
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Hurricanes

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*Occurrences of destruction over a 50-year period

Nuclear Power Plants

Commercial nuclear power plants

Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
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Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

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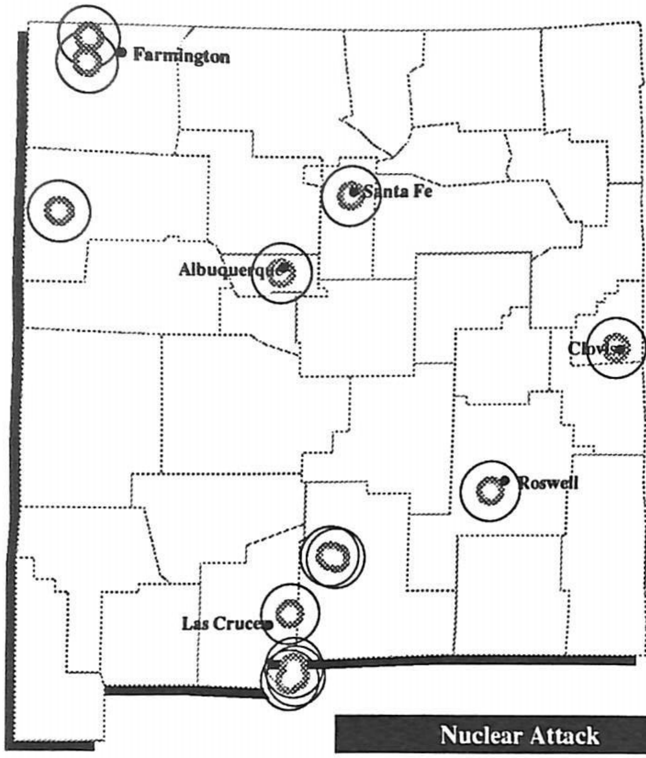
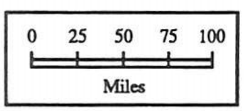
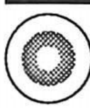
NEW MEXICO





Nuclear Attack



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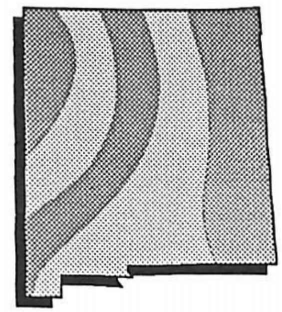

Earthquakes

- Low hazard
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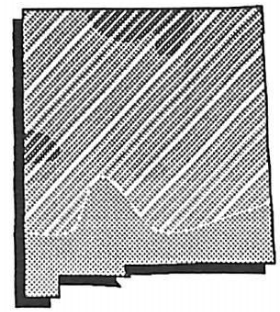
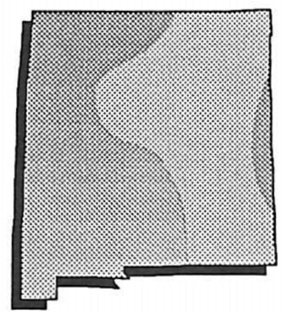


Snow and Extreme Cold

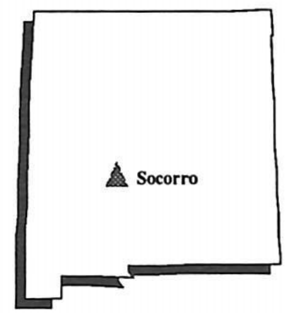
- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

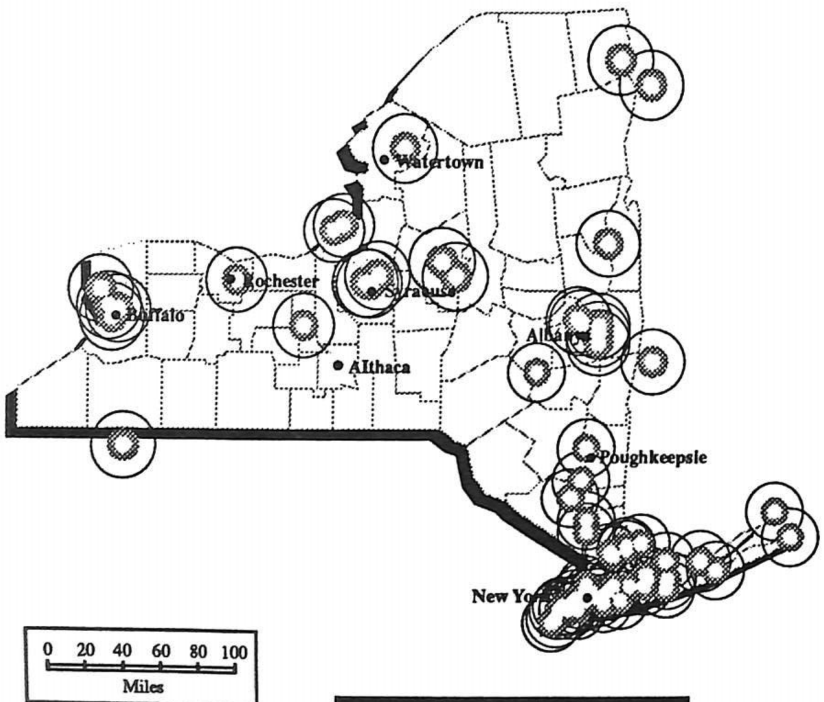


Volcanoes

- 1 eruption per 10,000 yrs.
- 1 eruption per 1000 yrs.
- 1 eruption per 200 yrs.

Floods Flooding is a potential hazard in areas throughout the state.

NEW YORK



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Earthquakes

- Low hazard
- Moderate hazard
- High hazard

Hurricanes

- 5-15 times*
- 15-30 times
- Over 30 times

*Occurrences of destruction over a 50-year period

Nuclear Power Plants

- Commercial nuclear power plants
- Plants without a full power license

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Tornadoes

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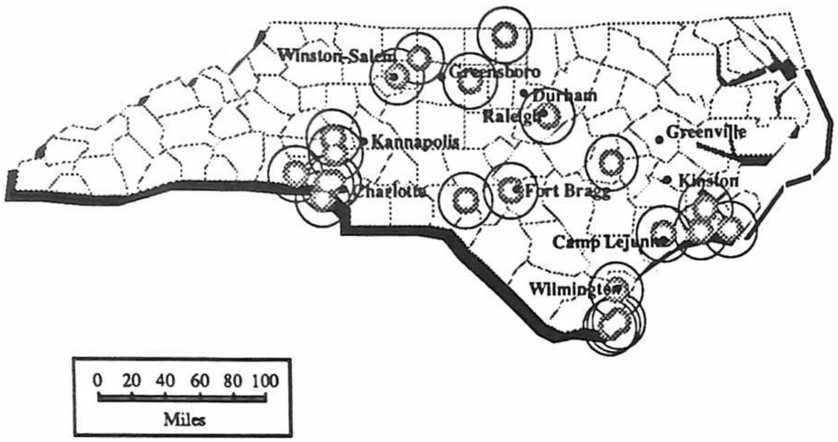
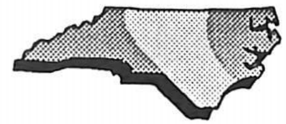
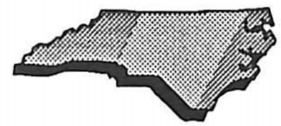
NORTH CAROLINA





Earthquakes

- Low hazard
- Moderate hazard
- High hazard



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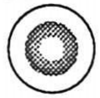
Nuclear Attack



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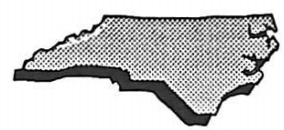
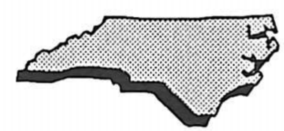


Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



Tornadoes

- 1-3 per year*
- 4-6 per year
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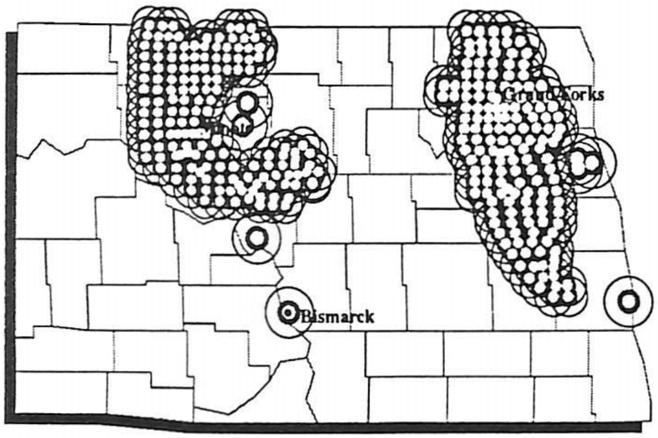
NORTH DAKOTA



0 50 100
Miles

Nuclear Attack

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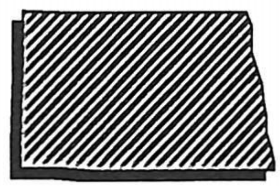
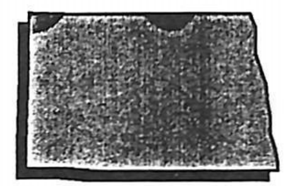


Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



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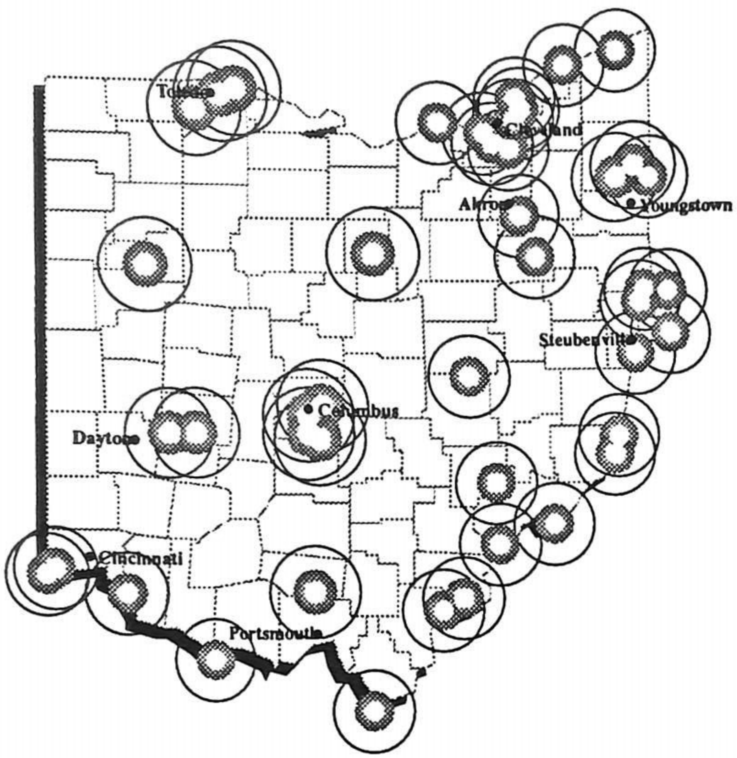

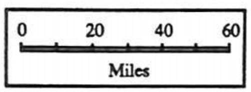

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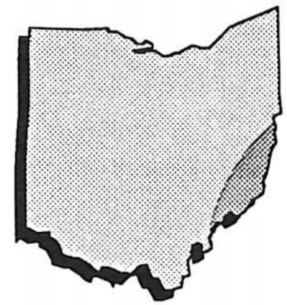

Earthquakes

- Low hazard
- Moderate hazard
- High hazard

Nuclear Power Plants

- Commercial nuclear power plants

Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing

Tornadoes

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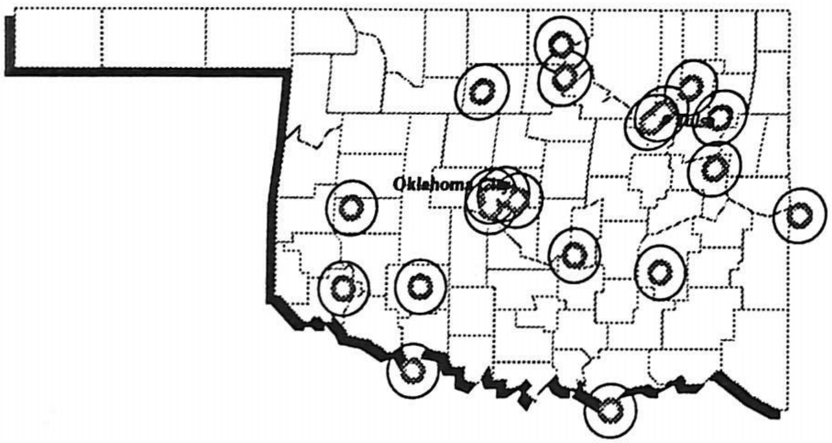
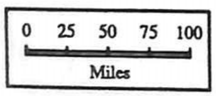
OKLAHOMA





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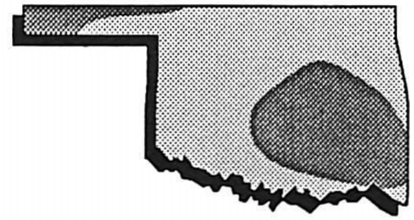

Earthquakes

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Snow and Extreme Cold

- Moderate snowfall
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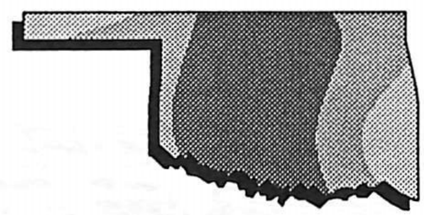


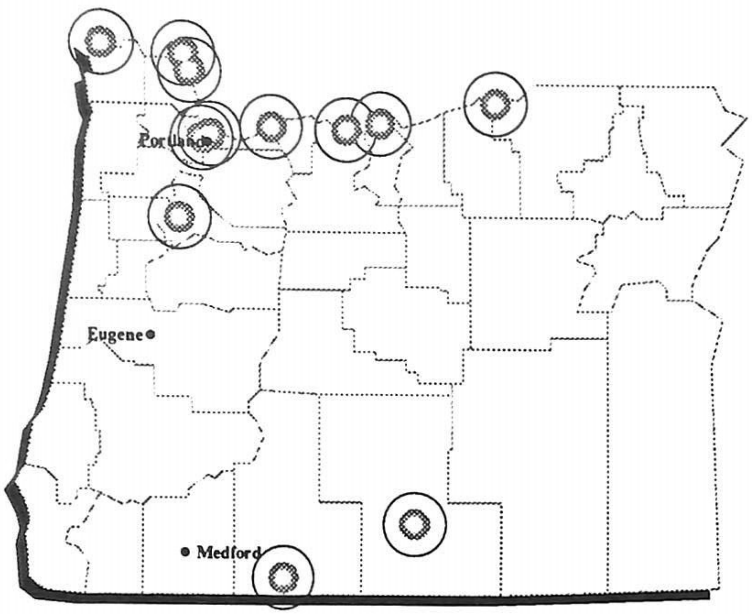
Tornadoes

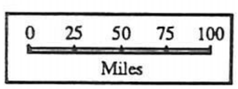
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

OREGON





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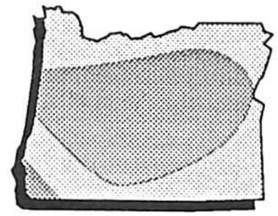
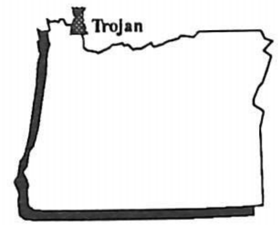


Earthquakes

Low hazard

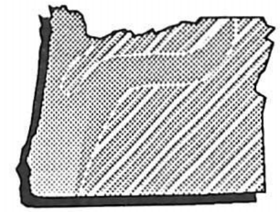
Moderate hazard

High hazard



Nuclear Power Plants

Commercial nuclear power plants

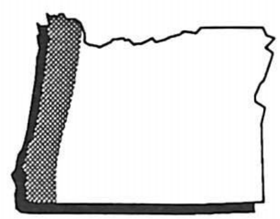


Snow and Extreme Cold

Moderate snowfall

Heavy snowfall

Extreme cold and freezing



Tsunamis

Coastal areas historically subject to Tsunami

Volcanoes

1 eruption per 10,000 yrs.

1 eruption per 1000 yrs.

1 eruption per 200 yrs.

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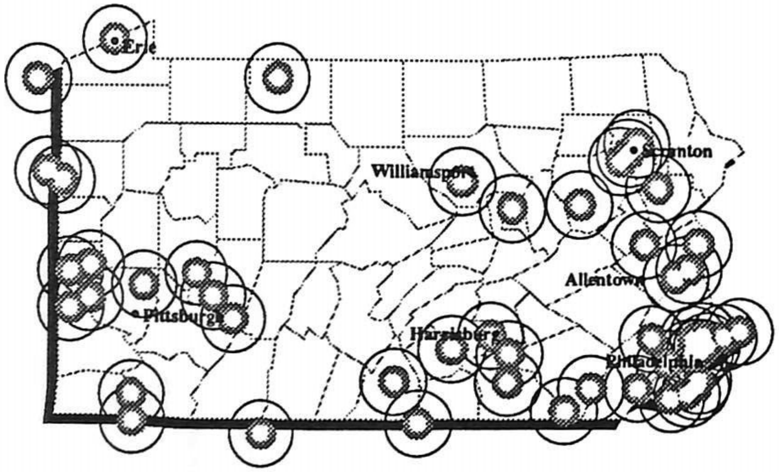
PENNSYLVANIA



0 50
Miles

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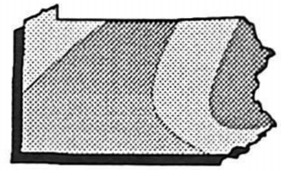

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Low hazard

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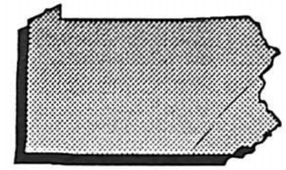


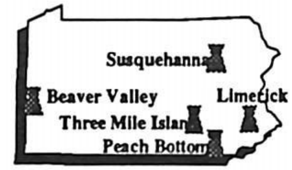
Hurricanes

5-15 times*

15-30 times

Over 30 times

*Occurrences of destruction over a 50-year period



Nuclear Power Plants

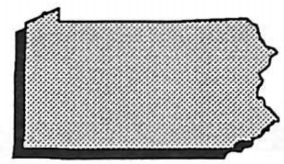
Commercial nuclear power plants

Snow and Extreme Cold

Moderate snowfall

Heavy snowfall

Extreme cold and freezing



Tornadoes

1-3 per year*

4-6 per year

7-9 per year

*per 10,000 square miles over a 28-year period

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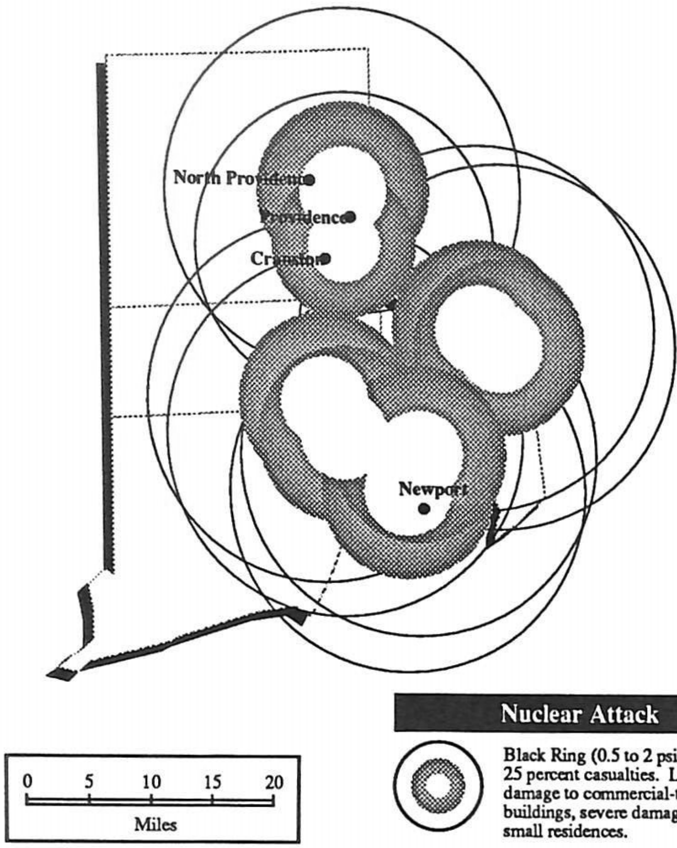
RHODE ISLAND



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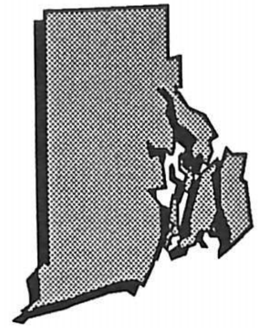

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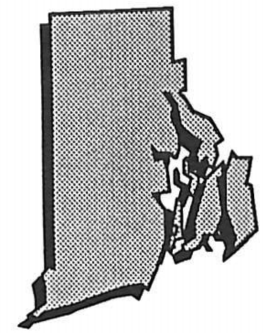

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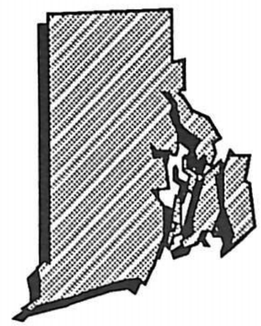

Snow and Extreme Cold

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- Heavy snowfall
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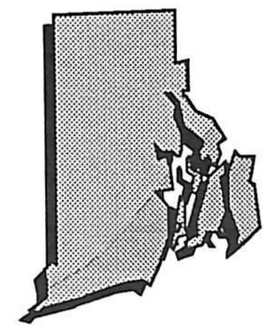

Tornadoes

- 1-3 per year*
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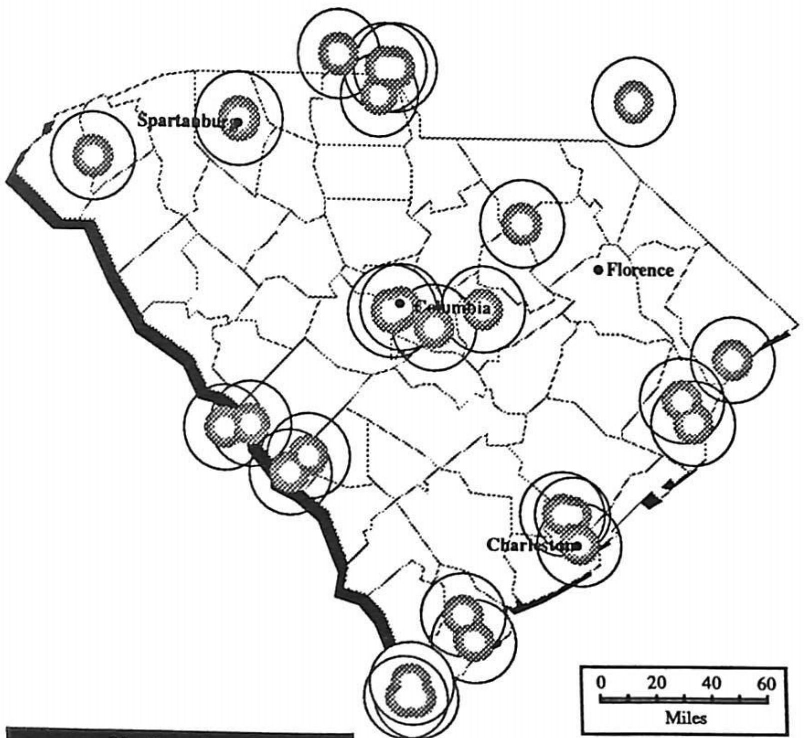
Floods Flooding is a potential hazard in areas throughout the state.

SOUTH CAROLINA



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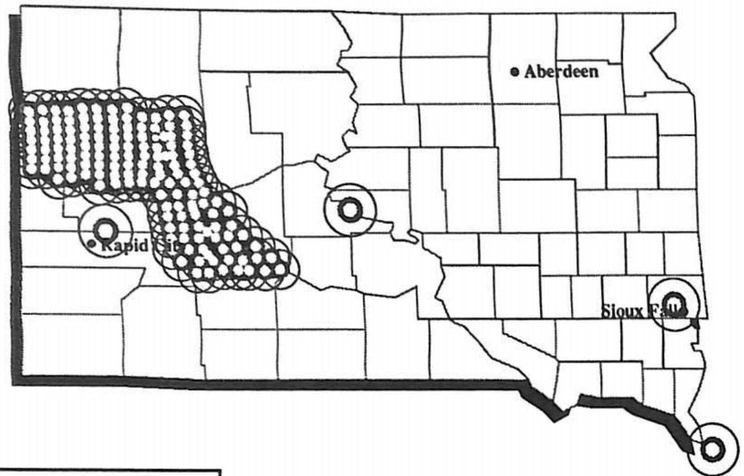
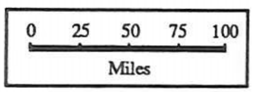
Floods Flooding is a potential hazard in areas throughout the state.

SOUTH DAKOT A



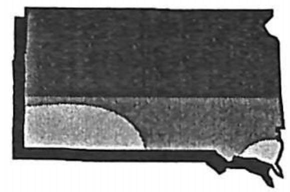


Nuclear Attack

Black Ring (0.5 to 2 psi): Up to 25 percent casualties. Light damage to commercial-type buildings, severe damage to small residences.

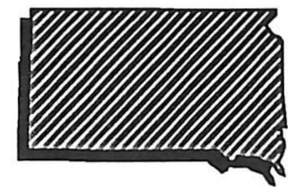
Grey Area (2 to 5 psi): 50 percent casualties. Moderate damage to commercial-type buildings, severe damage to small residences.

White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.



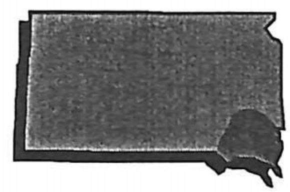
Earthquakes

- Low hazard
- Moderate hazard
- High hazard



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



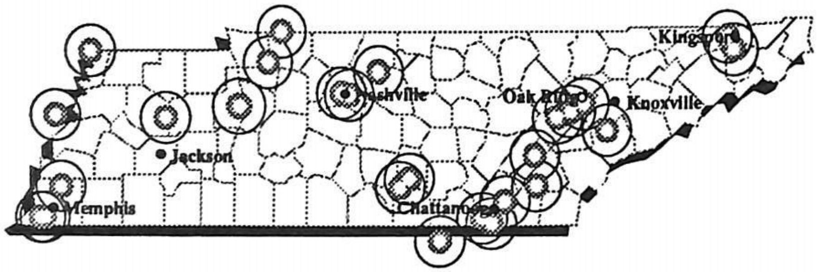
Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.



0 20 40 60 80 100
Miles

Nuclear Attack

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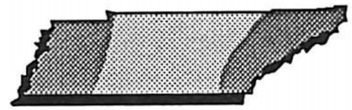
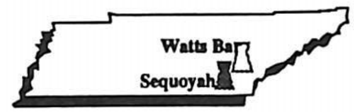


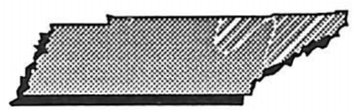
Earthquakes

- Low hazard
- Moderate hazard
- High hazard



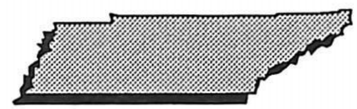
Nuclear Power Plants

- Commercial nuclear power plants
- Plants without a full power license



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



Tornadoes

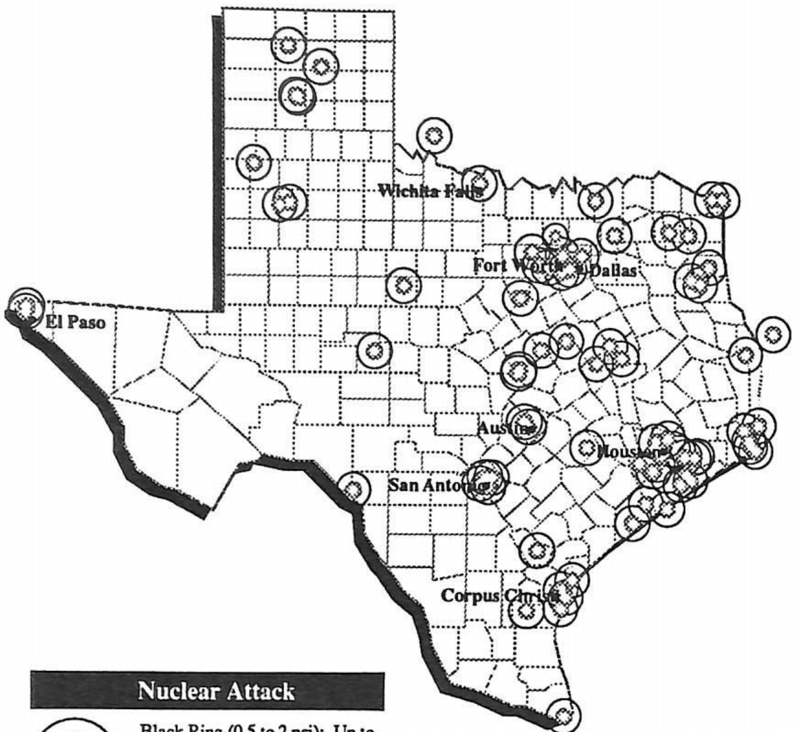
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.

TEXAS



Nuclear Attack

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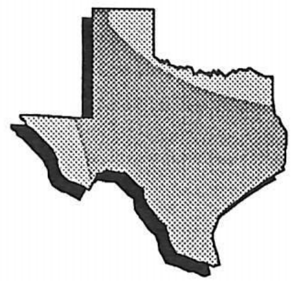
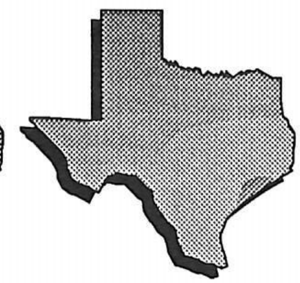
0 50 100 150 200
Miles

Fallout Fallout radiation is a potential hazard for all localities.



Earthquakes

- Low hazard
- Moderate hazard
- High hazard



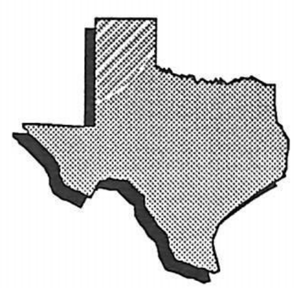
Hurricanes

- 5-15 times*
- 15-30 times
- Over 30 times

*Occurrences of destruction over a 50-year period

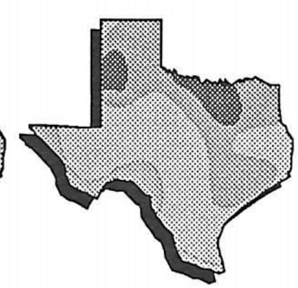
Nuclear Power Plants

- Commercial nuclear power plants
- Plants without a full power license



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



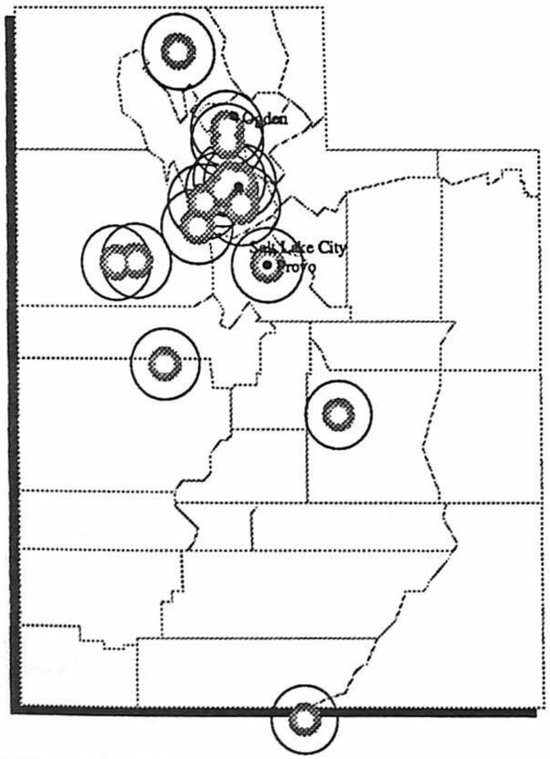
Tornadoes

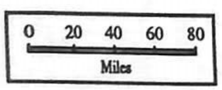
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

UTAH





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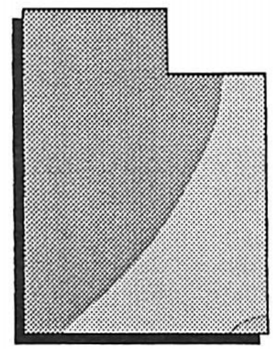
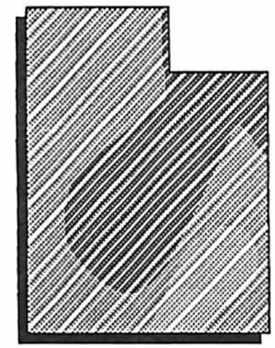


Earthquakes

- Low hazard
- Moderate hazard
- High hazard

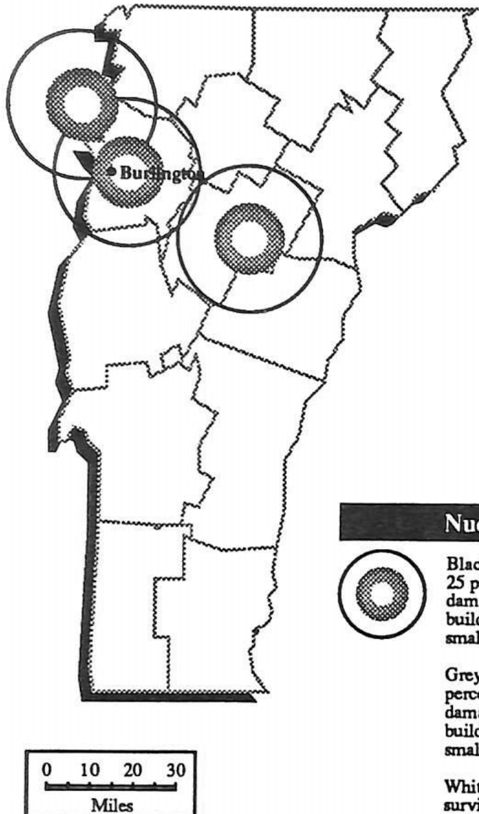


Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing

Floods Flooding is a potential hazard in areas throughout the state.

VERMONT



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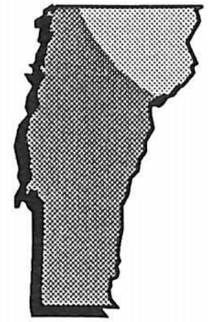
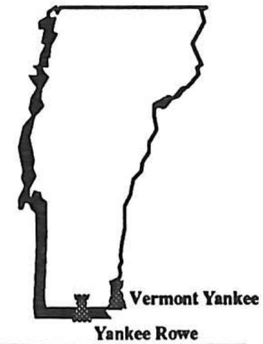


Earthquakes

- Low hazard
- Moderate hazard
- High hazard

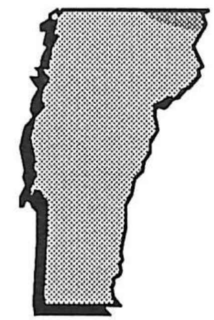


Nuclear Power Plants

- Commercial nuclear power plants

Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



Tornadoes

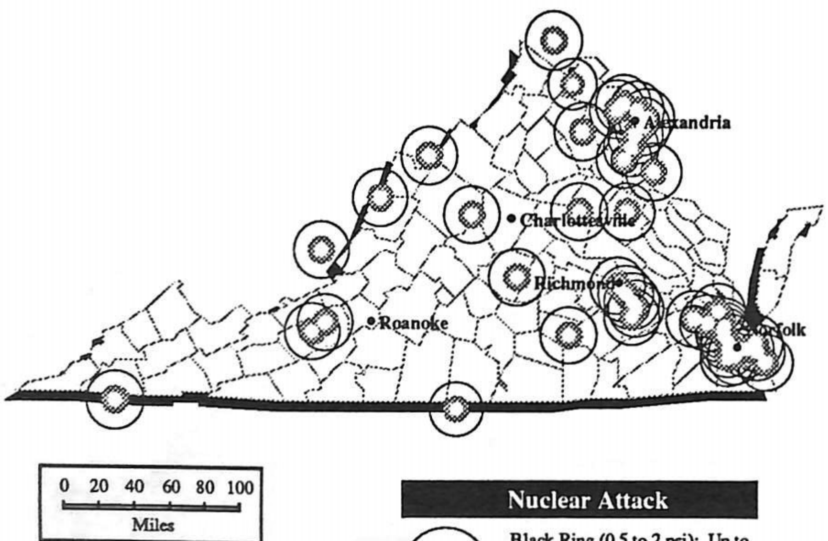
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.

VIRGINIA



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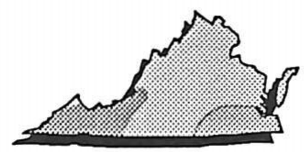
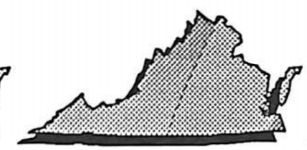


Earthquakes

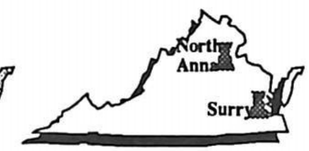
- Low hazard
- Moderate hazard
- High hazard



Hurricanes

- 5-15 times*
- 15-30 times
- Over 30 times

*Occurrences of destruction over a 50-year period

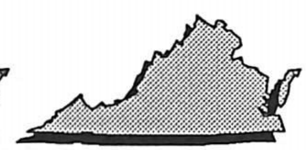


Nuclear Power Plants

- Commercial nuclear power plants

Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



Tornadoes

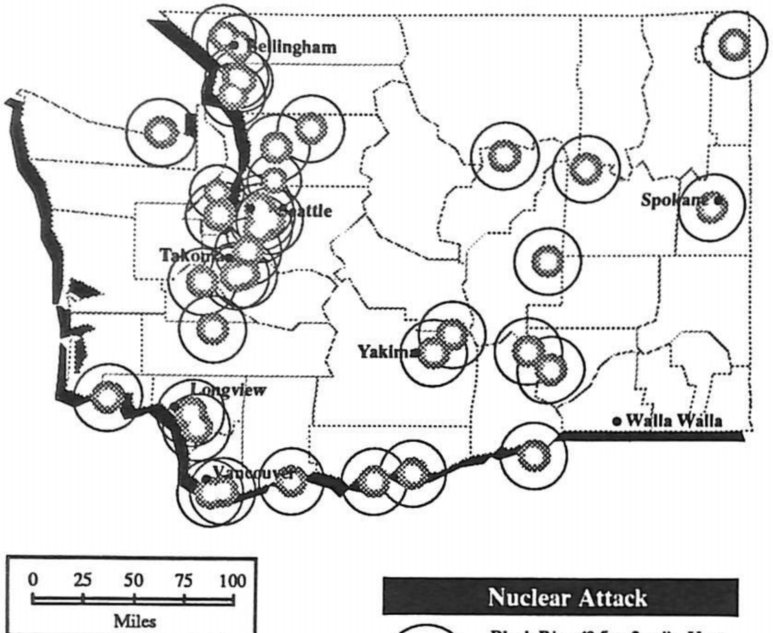
- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

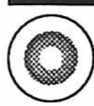
Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.

WASHINGT ON



Nuclear Attack



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White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

Earthquakes

- Low hazard
- Moderate hazard
- High hazard

Nuclear Power Plants

- Commercial nuclear power plants

Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing

Tsunamis

- Coastal areas historically subject to Tsunami

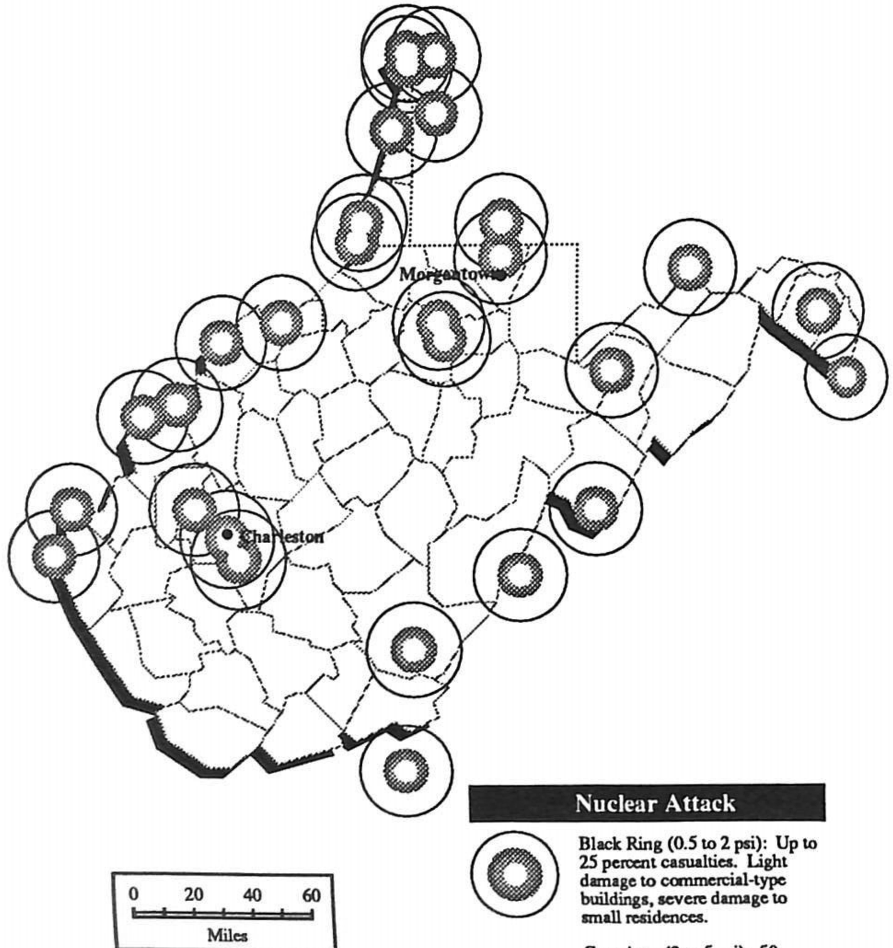
Volcanoes

- 1 eruption per 10,000 yrs.
- 1 eruption per 1000 yrs.
- 1 eruption per 200 yrs.
- Volcanoes that have erupted since 1950

Fallout Fallout radiation is a potential hazard for all localities.

Floods Flooding is a potential hazard in areas throughout the state.

WEST VIRGINIA



Nuclear Attack

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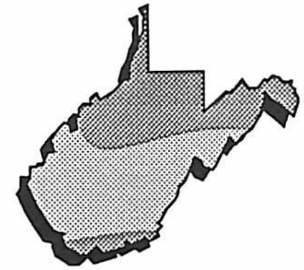
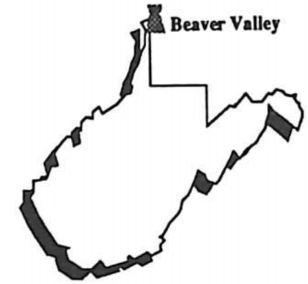
Fallout Fallout radiation is a potential hazard for all localities.



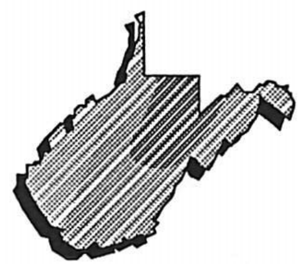
Earthquakes

- Low hazard
- Moderate hazard
- High hazard



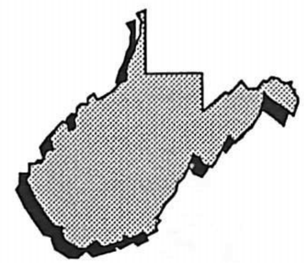
Nuclear Power Plants

Commercial nuclear power plants



Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



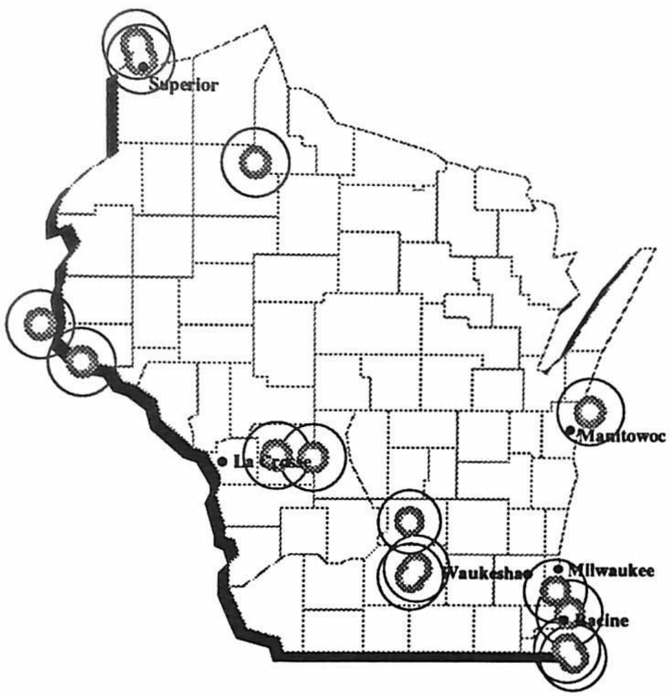
Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

WISCONSIN



0 25 50 75 100
Miles

Nuclear Attack

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White Area (5 psi or more): Few survivors. Severe damage to total destruction of buildings.

Fallout Fallout radiation is a potential hazard for all localities.

Nuclear Power Plants

Commercial nuclear power plants

Snow and Extreme Cold

- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing

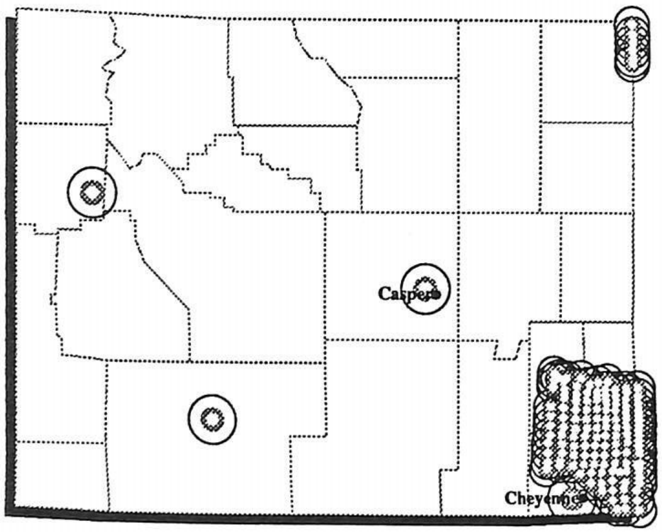
Tornadoes

- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period

Floods Flooding is a potential hazard in areas throughout the state.

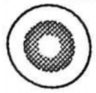
WYOMING



0	25	50	75	100

Miles

Nuclear Attack



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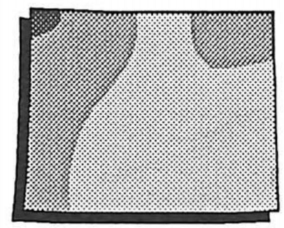
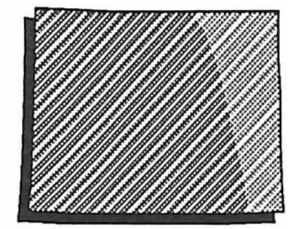


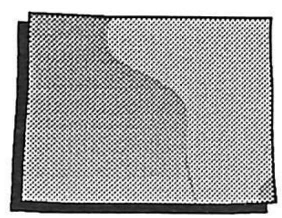
Earthquakes

- Low hazard
- Moderate hazard
- High hazard



Snow and Extreme Cold

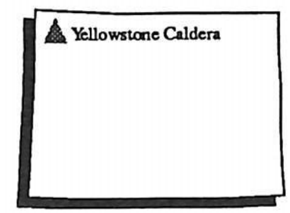
- Moderate snowfall
- Heavy snowfall
- Extreme cold and freezing



Tornadoes,

- 1-3 per year*
- 4-6 per year
- 7-9 per year

*per 10,000 square miles over a 28-year period



Volcanoes

- 1 eruption per 10,000 yrs.
- 1 eruption per 1000 yrs.
- 1 eruption per 200 yrs.

Floods Flooding is a potential hazard in areas throughout the state.

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