Effective Disaster Warnings

Report by the Working Group on
Natural Disaster Information Systems
Subcommittee on Natural Disaster Reduction
March 2000

TABLE OF CONTENTS (click on area to move to link)

General Information

About the National Science and Technology Council

President Clinton established the National Science and Technology Council (NSTC) by Executive Order on November 23, 1993. This cabinet-level council is the principal means for the President to coordinate science, space, and technology policies across the Federal Government. The NSTC acts as a virtual agency for science and technology to coordinate the diverse parts of the Federal research and development enterprise. The NSTC is chaired by the President. Membership consists of the Vice President, the Assistant to the President for Science and Technology, Cabinet Secretaries and Agency Heads with significant science and technology responsibilities, and other senior White House officials.

An important objective of the NSTC is the establishment of clear national goals for Federal science and technology investments in areas ranging from information technology and health research to improving transportation systems and strengthening fundamental research. The Council prepares research and development strategies that are coordinated across Federal agencies to form an investment package to accomplish multiple national goals.

To obtain additional information regarding the NSTC, contact the NSTC Executive Secretariat at (202) 456-6102.

About the Office of Science and Technology Policy

The Office of Science and Technology Policy (OSTP) was established by the National Science and Technology Policy, Organization, and Priorities Act of 1976. OSTP's responsibilities include advising the President on policy formulation and budget development on all questions in which science and technology are important elements; articulating the President's science and technology policies and programs; and fostering strong partnerships among Federal, State, and local governments and the scientific communities in industry and academia.

To obtain additional information regarding the OSTP, contact the OSTP Administrative Office at (202) 395-7347.

About the Committee on Environment and Natural Resources

The Committee on Environment and Natural Resources (CENR), one of five committees under the NSTC, is charged with improving coordination among Federal agencies involved in environmental and natural resources research and development; establishing a strong link between science and policy; and developing a Federal environment and natural resources research and development strategy that responds to national and international issues.

To obtain additional information about the CENR, contact the CENR Executive Secretary at (202) 482-5916.

Transmittal Letter

April 2000

Dear Colleague:

I am pleased to transmit the NSTC Report, Effective Disaster Warnings, which has been prepared by the Working Group on Natural Disaster Information Systems under the Committee on Environment and Natural Resources (CENR) Subcommittee on Natural Disaster Reduction. This document compiles into a single reference a wealth of information on public and private sector R&D capability to provide early warning of natural or technological hazards that threaten the safety and well-being of our citizens. It is designed to assist scientists, engineers, and emergency managers in developing more accurate and more numerous warnings as they deploy better sensors to measure key variables, employ better dynamic models, and expand their understanding of the causes of disasters. Warnings are becoming much more useful to society as lead-time and reliability are improved and as society devises ways to respond effectively.

The goal of this Report is to provide a broad overview of major issues related to warning the right people at the right time so that they can take appropriate action with respect to the disaster. It addresses the problems of delivering warnings reliably to only those people at risk and to systems that have been preprogrammed to respond to early warnings. Although the technology presently exists to build smart receivers to customize warnings to the users' local situation whether at home, at work, outdoors, or in their cars, substantial improvement can be made with better utilization of emerging opportunities provided by existing and new technologies. Current warnings can target those at risk at the county and sub-county levels and it should also be possible to customize the information for trucks, trains, boats, and airplanes. One high priority that needs to be addressed concerns agreeing on data/information standards and dissemination systems to be used.

This Report focuses on needs for improving delivery and effectiveness of warnings over the next 5 to 10 years. It recommends close collaboration between Federal, State, local, and private sector organizations to leverage government and industry capabilities and needs to deliver effective disaster warnings.

We hope that scientists, engineers, and emergency managers will find this Report to be a valuable reference on the policy issues of implementing advanced technologies for delivering warnings to people at risk.

Sincerely,

Neal Lane
Assistant to the President
for
Science and Technology

Home
Next Section
Previous Section

Working Group on Natural Disaster Information Systems

Peter Ward	**Chairman**, Seismologist and Volcanologist, U.S. Geological Survey
Rodney Becker	Dissemination Services Manager, National Weather Service
Don Bennett	Deputy Director for Emergency Planning, Office of the Secretary of Defense
Andrew Bruzewich	CRREL, U.S. Army Corps of Engineers
Bob Everett	Office of Engineering, Voice of America, International Broadcasting Bureau, U.S. Information Agency
Michael Freitas	Department of Transportation/Federal Highway Administration
Karl Kensinger	Federal Communications Commission, Satellite and Radio Communications Division
Frank Lucia	Director, Emergency Communications, Compliance and Information Bureau, Federal Communications Commission
Josephine Malilay	National Center for Environmental Health, Centers for Disease Control and Prevention
John O'Connor	National Communications System
Elaine Padovani	National Science and Technology Council, Office of Science and Technology Policy, Executive Office of the President
John Porco	Office of Emergency Transportation, Department of Transportation
Ken Putkovich	Chief, Dissemination Systems, National Weather Service
Tim Putprush	Federal Emergency Management Agency
Carl P. Staton	National Oceanic and Atmospheric Administration, NESDIS
David Sturdivant	Federal Communications Commission
Jay Thietten	Bureau of Land Management
Bill Turnbull	National Oceanic and Atmospheric Administration
John Winston	Federal Communications Commission

Home
Next Section
Previous Section

Executive Summary and Recommendations

People at risk from disasters, whether natural or human in origin, can take actions that save lives, reduce losses, speed response, and reduce human suffering when they receive accurate warnings in a timely manner. Scientists are developing more accurate and more numerous warnings as they deploy better sensors to measure key variables, employ better dynamic models, and expand their understanding of the causes of disasters. Warnings can now be made months in advance, in the case of El Niño, to seconds in advance of the arrival of earthquake waves at some distance from the earthquake. Computers are being programmed to respond to warnings automatically, shutting down or appropriately modifying transportation systems, lifelines, manufacturing processes, and such. Warnings are becoming much more useful to society as lead-time and reliability are improved and as society devises ways to respond effectively. Effective dissemination of warnings provides a way to reduce disaster losses that have been increasing in the United States as people move into areas at risk and as our infrastructure becomes more complex and more valuable.

This report addresses the problems of delivering warnings reliably to only those people at risk and to systems that have been preprogrammed to respond to early warnings. Further, the report makes recommendations on how substantial improvement can be made if the providers of warnings can become better coordinated and if they can better utilize the opportunities provided by existing and new technologies. Current warnings can target those at risk at the county and sub-county level. The technology presently exists to build smart receivers to customize warnings to the users' local situation, whether at home, at work, outdoors, or in their cars. It should also be possible to customize the information for trucks, trains, boats, and airplanes. The problem is to agree on standards and dissemination systems.

Disaster Warnings: Technologies and Systems

Disaster warning is a public/private partnership. Most warnings, including all official warnings, are issued by government agencies. Most dissemination and distribution systems are owned and operated by private companies. Liability issues make it problematic for private entities to originate warnings. Public entities typically cannot afford to duplicate private dissemination and distribution systems.

Effective warnings should reach, in a timely fashion, every person at risk who needs and wants to be warned, no matter what they are doing or where they are located. Such broad distribution means utilizing not only government-owned systems such as NOAA Weather Radio and local sirens, but all privately owned systems such as radio, television, pagers, telephones, the Internet, and printed media. If warnings can be provided efficiently and reliably as input to private dissemination systems, and if the public perceives a value and desire to receive these warnings, then private enterprise has a clear mandate to justify the development of new distribution systems or modification of existing systems. What if a warning-receiving capability were simply an added feature available on all radios, televisions, pagers, telephones, and such? The technology exists not only to add such a

Home
Next Section
Previous Section

feature, but to have the local receiver personalize the warnings to say, for example, "Tornado two miles southwest of you. Take cover." What does not exist is a public/private partnership that can work out the details to deliver such disaster warnings effectively.

The Emergency Alert System (EAS) is the national warning system designed primarily to allow the President to address the nation reliably during major national disasters. All radio and television stations (and soon all cable systems) are mandated by the Federal Communications Commission (FCC) to have EAS equipment and to issue national alerts. The stations and cable systems may choose whether they wish to transmit local warnings and they may also delay transmission for many minutes. The warnings consist of a digital packet of information and a verbal warning of up to two minutes in length. The EAS interrupts normal programming or at least adds a "crawl" to the margin of the television screen. Program producers and advertisers want to minimize unnecessary interruptions. As a result, only a modest percent of severe weather warnings issued by the National Weather Service are relayed to citizens by available stations. The warnings that are relayed may only apply to a small part of the total listening area but are received by all listeners. When people receive many warnings that are not followed by the anticipated events, they tend to ignore such warnings in the future.

The information and technology revolutions now underway provide a multitude of ways to deliver effective disaster warnings. Digital television, digital AM radio, and FM radio offer the capability to relay warnings without interrupting programming for those not at risk. Techniques exist to broadcast warnings to all wireless or wired telephones or pagers within small regions. Existing and planned satellites can broadcast throughout the country and the world. The Global Positioning Satellite (GPS) systems are providing inexpensive ways to know the location of receivers. The technology exists. The problem is to implement standards and procedures that private industry can rely on to justify development and widespread distribution of a wide variety of receivers.

Recommendations

This report provides the background information to justify the following recommendations:

1. **A public/private partnership is needed that can leverage government and industry needs, capabilities, and resources in order to deliver effective disaster warnings.** The Disaster Information Task Force (1997) that examined the feasibility of a global disaster information network has also recommended such a partnership. The partnership might be in the form of a not-for-profit corporation that brings all stakeholders together, perhaps through a series of working groups, to build consensus on specific issues for implementation and to provide clear recommendations to government and industry.

Home
Next Section
Previous Section

2. **One or more working groups,** with representatives from providers of different types of warnings in many different agencies, people who study the effectiveness of warnings, users of warnings, equipment manufacturers, network operators, and broadcasters, **should develop and review on an ongoing basis:**
   - A single, consistent, easily-understood terminology that can be used as a standard across all hazards and situations. Consistency with systems used in other countries should be explored.
   - A single, consistent suite of variables to be included in a general digital message. Consistency with systems used in other countries should be explored.
   - The mutual needs for precise area-specific locating systems for Intelligent Transportation Systems and Emergency Alert Systems to determine where resources can be leveraged to mutual benefit.
   - The potential for widespread use of the Radio Broadcast Data System (RBDS) and other technologies that do not interrupt commercial programs for transmitting emergency alerts.
   - Cost effective ways to augment existing broadcast and communication systems to monitor warning information continuously and to report appropriate warnings to the people near the receiver.

3. **A standard method should be developed to collect and relay instantaneously and automatically all types of hazard warnings and reports locally, regionally, and nationally for input into a wide variety of dissemination systems.** The National Weather Service (NWS) has the most advanced system of this type that could be expanded to fill the need. Proper attribution of the warning to the agency that issues it needs to be assured.

4. **Warnings should be delivered through as many communication channels as practicable so that those users who are at risk can receive them whether inside or outside, in transportation systems, or at home, work, school, or shopping, and such.** Delivery of the warning should have minimal effect on the normal use of such communication channels, especially for users who will not be affected.

The greatest potential for new consumer items in the near future is development of a wide variety of smart receivers as well as the inclusion of such circuits within standard receivers. A smart receiver would be able to turn itself on or interrupt current programming and issue a warning only when the potential hazard will occur near the particular receiver. Some communication channels where immediate expansion of coverage and systems would be most effective include NOAA Weather Radio, pagers, telephone broadcast systems, systems being developed to broadcast high-definition digital television (HDTV), and the current and Next Generation Internet.

Scope of This Report

This report focuses on the needs for and the policy issues of implementing advanced technologies for delivering warnings to people at risk. The report does not address the many research and development needs for such issues as developing more accurate and reliable warnings, for evaluating the most effective ways to get people to take action, and for implementing new technologies such as the Next Generation Internet.

The intended audience for this report includes:

- Legislators and other policymakers in Federal, State, and local government
- Emergency managers in public and private organizations and in the military
- Manufacturers of dissemination equipment and consumer receivers
- Government and private standards groups
- Citizens concerned with the need for more adequately warning people
- Economic and financial communities
- Insurance companies
- Broadcasters, cable operators, media, telecommunication companies, and related trade organizations
- Researchers working on ways to improve the provision and utilization of warnings

Home
Next Section
Previous Section

1. Introduction

Effective warnings allow people to take actions that save lives, reduce damage, reduce human suffering and speed recovery. Rapid reporting of what is happening during a disaster can be very effective in helping people reduce damage and improve response. Scientists and emergency managers are developing the capabilities to warn for more hazards and to increase warning accuracy, but our ways of delivering these warnings in a timely manner and to only those people at risk needs significant improvement. This report summarizes the major issues involved and the opportunities that technological advances make possible. There is a major need for better coordination among the warning providers, more effective delivery mechanisms, better education of those at risk, and new ways for building partnerships among the many public and private groups involved. In this report, we take the broad view over the next decade, to show where better coordination, standards, and regulations can lead to significant improvements and to encourage partnerships that can take the necessary actions. There are many new technologies that provide the chance not only to reach just the people at risk, but also to personalize the message to their particular situation. Industry is poised to design and market those systems that prove to be cost effective. Industry needs to know how the warnings can be provided to their systems and what standards or regulations they can depend on. The opportunities are available right now to reduce significantly the loss of life and economic hardship if we simply become better coordinated.

The major components of the warning process are shown in Figure 1. Signals from tens of thousands of sensors on the ground, sensors flown in the atmosphere, and sensors on numerous satellites are monitored at hundreds of centers throughout the country. At these sites specialists and their computers process the data, apply scientific techniques, compare it with models and the historic record, and issue warnings about anticipated hazardous events. These sensors are operated by Federal, State, and local government entities, universities, research laboratories, and volunteer organizations. The primary responsibility for providing warnings for natural disasters lies within the Federal Government, primarily with the National Weather Service (NWS) and the U.S. Geological Survey (USGS). Warnings of accidents, chemical spills, terrorism, computer viruses, and such may come from the Federal or local governments, industry, or emergency managers. These warnings then need to be communicated to the people at risk. Many informal channels exist to communicate warnings to local groups. Widespread communication depends on funneling the information from many or all centers into communications systems that can reach thousands to millions of people rapidly. When the information gets to the right people in a timely way, they can take actions to reduce disaster losses, speed response, and improve recovery.

There are numerous examples where warnings have been issued in a timely manner but were not received by the people at risk for a variety of reasons. For example:

- March 27, 1994, a tornado killed 20 worshipers at a Palm Sunday service at the UMC Goshen Church in northern Alabama. A warning had been issued 12 minutes before

Home
Next Section
Previous Section

the tornado struck the church. Though it was broadcast over the electronic media, the warning was not received by anyone in or near the church. The region also was not covered by NOAA Weather Radio.

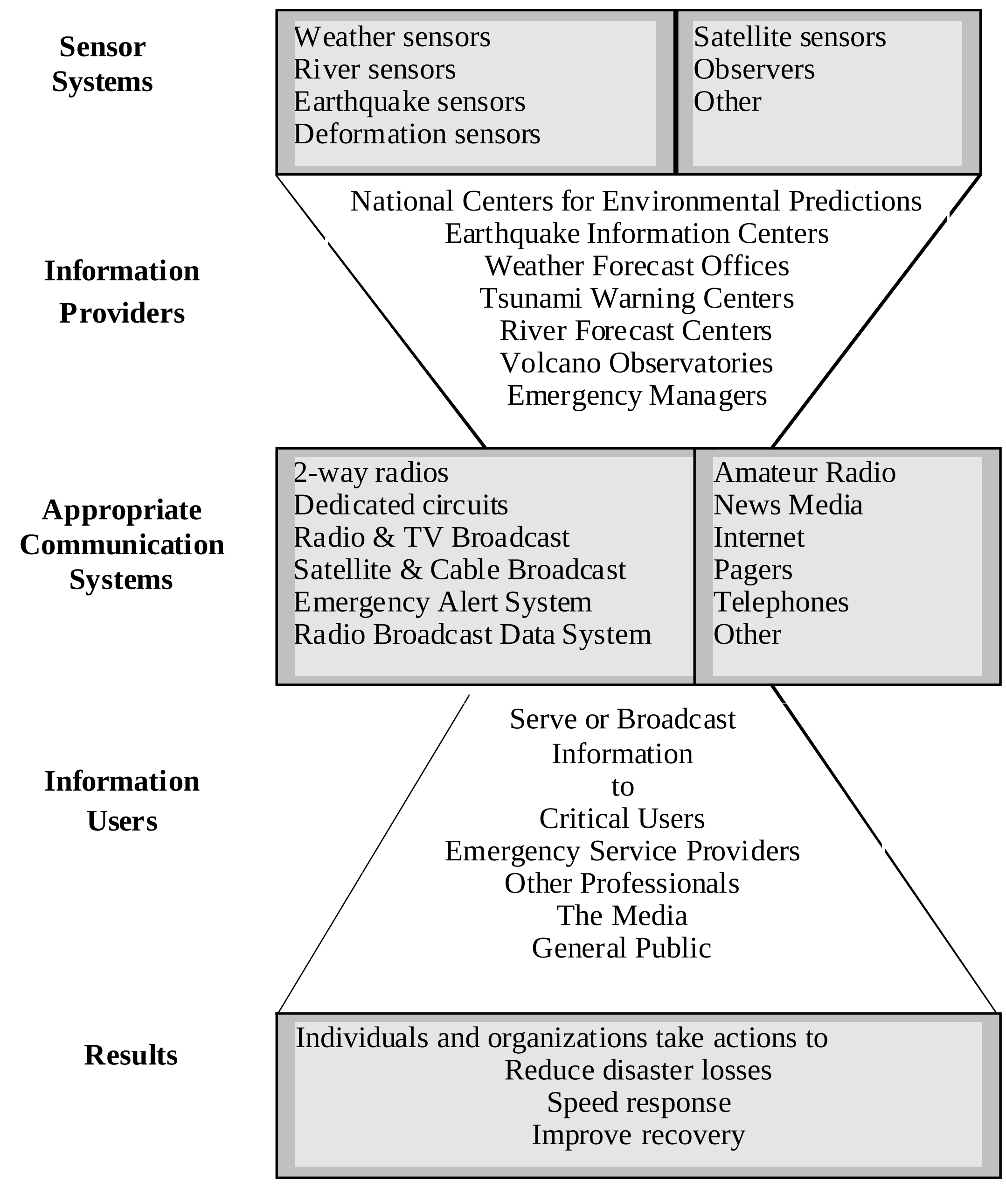

Figure 1: Major components of the warning process

Home
Next Section
Previous Section

- February 22-23, 1998, unusually strong tornadoes occurred in east central Florida during the late night and early morning, killing 42. The NWS issued 14 tornado warnings, which received wide distribution by the electronic media and NOAA Weather Radio. The warnings were not widely received as people were asleep and did not own tone-alert NOAA Weather Radios.

- May 31, 1998, a tornado killed six in Spencer, South Dakota. A warning was issued, but the sirens failed to sound because the storm had knocked out the power. Again, the area was outside reception of NOAA Weather Radio.

  Issuing warnings is primarily a government responsibility. Liability laws, in fact, make it problematic for private entities to issue warnings. Disseminating warnings, on the other hand, is primarily the domain of private industry, which owns and manufactures the infrastructure. Thus effective warning relies on close cooperation between public and private entities. In the past, some cooperation has been mandated by the Federal Communications Commission (FCC), and other cooperation has been volunteered. The challenge is to develop a partnership where all parties gain and where major developments are market-driven.

In this report, we provide the background for these issues by reviewing the problem, the potential for solutions, the kinds of systems available, and how the information can best be utilized.

Home
Next Section
Previous Section

2. The Escalating Costs and Changing Nature of Disasters

We have a major national problem: disaster costs are high and rising. Recently, OSTP has estimated that between 1992 and 1996, natural disasters cost the United States approximately $1 billion each week (Padovani, 1997). The Northridge earthquake of 1994 was the most expensive single disaster in the United States with total costs in excess of $40 billion. Future disasters are expected to increase these costs dramatically. For example, an anticipated earthquake in the eastern San Francisco Bay region is likely to cause more than $150 billion in losses (EQE International, 1995), similar to the 1996 Kobe earthquake in Japan. A repeat of the 1906 earthquake near San Francisco or the 1857 earthquake north of Los Angeles is likely to cost more than $200 billion (Risk Management Solutions, Inc., 1995). A repeat of the 1811-1812 earthquakes in southeast Missouri is likely to cost more than $200 billion (Risk Management Solutions, Inc., 1999).

Worst-case hurricane scenarios (e.g., direct hits of category 5 hurricanes on either New York City or New Orleans) would result in comparable losses. In 1992, Hurricane Andrew struck South Florida and Louisiana. Though a category 4 storm, it caused $15.5 billion in insured losses to South Florida alone. If Andrew had struck downtown Miami, twenty miles to the north of its actual landfall, losses would have approached $50 Billion (IRC, 1995). The Insurance Research Council (IRC) in 1995 noted that insured exposures for coastal counties adjacent to the Atlantic and Gulf Coasts exceeds $3 trillion. Concerning the potential for catastrophic loss of life, 36 million people live along the nation's hurricane-prone coasts. This figure is expected to swell to 73 million by 2010 (IRC, 1995).

Additionally, development along inland flood-prone areas is creating escalating disasters as well. Each year, on average, 139 people die in inland flooding while damage exceeds $3.5 billion. In the first nine months of 1997, floods claimed more than 80 lives, with damages of $6 billion (Department of Commerce, 1998).

Home
Next Section
Previous Section

	Dead	Affected	Homeless	Injured	Damage $1,000
Accident	112,045	54,130	449,892	24,401	$102,971,682
Avalanche	3,096	590	504,880	0	$458,389
Tech accident	16,414	152,130	1,363,992	217,937	$10,406,006
Cold wave	6,611	178	720,860	16,000	$14,037,494
Cyclone	312,869	42,502	78,346,169	13,444,592	$74,322,243
Drought	1,232,399	0	1,481,170,298	548,000	$28,344,147
Epidemic	131,456	3,179	14,867,306	0	$2,427,642
Earthquake	470,821	711,386	41,680,297	6,356,876	$230,897,897
Famine	608,675	0	5,205,000	0	$0
Urban fire	84,509	10,168	635,398	162,466	$8,998,078
Flood	324,403	576,313	1,662,354,415	84,903,618	$294,314,496
Forest fire	768	12,444	664,110	82,111	$29,834,150
Food shortage	380	0	47,341,857	0	$22,999
Hurricane	15,359	16,532	8,169,699	2,146,831	$53,562,775
Heat wave	10,339	1,064	53,603,130	0	$2,957,887
Insect infestation	0	0	446,000	2,000	$107,500
Landslide	20,509	6,671	3,450,963	2,694,920	$1,661,600
Power shortage	0	0	1,825,000	0	$4,000
Storm	39,332	162,294	88,649,523	3,638,488	$151,479,835
Tsunami	7,714	49	16,918	60,000	$2,270
Typhoon	33,537	116,355	128,858,136	8,715,747	$33,980,653
Volcano	25,477	7,124	2,359,973	378,192	$3,100,578
1972-1997 Totals	3,456,713	1,873,109	3,622,683,816	123,392,179	$1,043,892,321
Yearly average	132,951	72,043	139,333,993	4,745,853	40,149,705

Table 1: Global losses from natural and manmade disasters from 1972 through 1997 summarized from the EMDAT database. Costs are primarily based on insured losses that significantly underestimate losses in developing countries and are often assumed in the United States to represent approximately one-third of the total costs. Accident does not include automobile accidents.

While consistent statistics on disaster losses are difficult to develop, global losses also appear to be high and rising. The numbers shown in Table 1 for the world and Table 2 for the United States are based on the Emergency Events Database (EMDAT) developed by the Centre for Research on the Epidemiology of Disasters at the University of Louvain in Brussels, Belgium **(http://www.cred.be/). This database includes only disasters that killed at least 10 persons or affected more than 100 persons or, in the United States, if a disaster was officially declared and a request was made for assistance. Damage is based primarily on insured losses that significantly underestimate losses in developing countries and are often assumed in the United States to represent approximately one-third of the total costs. No adjustment has been made for inflation. On average, according to this source, during the period from 1972 through 1997, insured damage caused by natural and technological hazards was more than $40 billion per year, with 16.6 percent of the damage occurring within the United States.**

Home
Next Section
Previous Section

	Dead	Affected	Homeless	Injured	Damage $1,000
Accident	3,178	3,136	185	0	$12,733,950
Avalanche	0	0	0	0	$0
Tech accident	148	6,812	356,530	300	$1,588,055
Cold wave	919	0	0	0	$4,595,500
Cyclone	177	170	0	400	$250,000
Drought	48	0	0	0	$2,835,000
Epidemic	103	0	403,050	0	$0
Earthquake	151	11,838	2,200	31,494	$27,900,550
Famine	0	0	0	0	$0
Urban fire	919	1,027	1,400	0	$1,761,200
Flood	1,013	94	640,980	44,600	$25,633,000
Forest fire	38	332	2,200	2,361	$2,679,500
Food shortage	0	0	0	0	$0
Hurricane	483	115	729,200	275,500	$44,015,000
Heat wave	2,704	0	0	0	$2,015,000
Insect infestation	0	0	0	0	$0
Landslide	400	0	0	0	$0
Power shortage	0	0	0	0	$0
Storm	4,810	2,532	457,077	43,000	$45,691,750
Tsunami	0	0	0	0	$0
Typhoon	65	862	22,000	11,000	$212,000
Volcano	60	0	0	2,500	$860,000
1972-1997 Totals	15,216	26,918	2,614,822	411,155	$172,770,505
Yearly average	585	1,035	100,570	15,814	$6,645,019
USA*100/WORLD	0.4%	1.4%	0.1%	0.3%	16.6%

Table 2: United States losses from natural and manmade disasters during 1972 through 1997, summarized from the EMDAT database. Costs are primarily based on insured losses that significantly underestimate losses in developing countries and are often assumed in the United States to represent approximately one-third of the total costs. Avalanche statistics show no deaths since no single incident killed at least 10 people. Accident does not include automobile accidents.

Life loss in the United States, however, is only 0.4 percent of the global life loss. Lives lost during disasters averaged 585 per year in the United States and 132,951 per year globally. Improved warnings and building codes have significantly reduced the numbers of lives lost in the technologically advanced nations so that the global average of lives lost has been relatively flat since 1976. An earthquake near Tangshan, China, killed at least 240,000 people in 1976 (U.N. Global Programme, 1996), and a major tropical cyclone in the densely populated delta region of Bangladesh killed 300,000 people in 1970 (Tobin and Montz, 1997). The potential for saving lives through more effective warnings is especially great in the developing nations.

In terms of insured damage, the greatest hazards in the United States since 1972 are storms, hurricanes, earthquakes, floods, accidents, cold waves, droughts, forest fires, heat

Home
Next Section
Previous Section

waves, and urban fire. In terms of life loss, the greatest U.S. hazards are storms, accidents, heat waves, floods, cold waves, urban fire, hurricanes, landslides, cyclones, and earthquakes. Effective warnings can provide a significant reduction in the loss of both life and property.

All disaster statistics have their own inconsistencies based on the selection and reporting criteria. EMDAT underreports disasters that effect small numbers of people in single instances. For example, lightning, which strikes the earth 100 times per second, rarely kills 10 people, so that it would not be included in the EMDAT database. But lightning has killed 1,444 people in the United States from 1975 to 1994 (National Climatic Data Center, 1996). A more detailed discussion of U.S. disaster losses is presented in the second national assessment of hazards (Mileti et al., 1999).

Manmade or technological disasters are of increasing concern, whether acts of terrorism or accidental. Time is of the essence in limiting the effects of such disasters, especially biological or chemical spills, and even computer viruses. The needs for rapid notification are similar and just as great as for natural disasters.

3. Increasing Capabilities to Provide Accurate Warnings

Scientists are providing more and more warnings with increasing accuracy as they:

- Deploy improved monitoring instrumentation in more areas.
- Develop better understanding of the physical processes that cause disasters.
- Improve modeling capabilities that predict expected time of occurrence, impact area(s), and severity.

Some warnings are months in advance; others are seconds in advance. Even rapid notification during emergencies helps people understand what is happening and what they should do to minimize their risk. Some examples:

- In 1997, early warning of a likely peak in El Niño activity provided many communities several months to prepare in advance for likely damage.
- With gage information from the U.S. Geological Survey and forecast information from the National Weather Service, agencies that operate dams (such as the U.S. Army Corps of Engineers, National Resources Conservation Service, and the Bureau of Reclamation) are increasingly able to lower water levels behind dams prior to floods and to hold more water than usual back during the flood, to reduce flooding levels.
- The NWS Advanced Hydrologic Prediction System (AHPS) being prototyped in DesMoines, Iowa, has the capability to predict river elevations and inundation areas up to weeks and months in advance through the combined use of meteorologic, hydrologic, and climatologic forecasts.
- In 1900, this nation suffered its worst natural disaster as 6,000 people were killed in a hurricane in Galveston, Texas. In the past decade, the average annual toll is just 23.
- Volcanologists predicted the eruption of Pinatubo in the Philippines in 1991, saving many lives and allowing considerable equipment to be moved out of harm’s way. Volcanologists have been quite successful providing warnings prior to each eruption on well-studied volcanoes in the United States.
- The new NWS Doppler Radar systems are providing the capability to diagnose the potential for severe thunderstorms, tornadoes, and flood-producing rainfall. As a result, warnings are becoming predictive in nature rather than reactive.
- Prediction of lead-time for tornado warnings (in minutes) and accuracy (in percent) is increasing significantly with the advent of Doppler Radars. The average lead-time for the years 1993-1999 was about nine minutes, with accuracy averaging about 58

percent. Before Doppler Radar, lead-times were typically only a couple of minutes, with less accuracy. The projected lead-times and accuracy for the years 2000-2005, based on expected further improvements in science and technology, is near 14 minutes and 73 percent, respectively. Tornadoes also are being tracked more precisely through reports from thousands of volunteer observers with wireless telephones and video cameras.

- Prediction of hurricane landfalls is improving. Historically, hurricane track forecasts have improved 1 percent per year. From 1995 through 1998, there was a 10 to 20 percent improvement in all tropical cyclone forecasts. For the next four-year period, forecasts for land-falling storms should improve an additional 20 percent due to the use of better models and data from the Gulfstream aircraft.

- The National Atmospheric Release Advisory Capability (http://www.llnl.gov/ees/NARAC) (Sullivan and others, 1993) can provide detailed three-dimensional modeling of the release of any chemical, nuclide, or other substance into the atmosphere based on current weather conditions anywhere in the world within tens of minutes. ARAC is adding biological substances and has proposed inclusion of wildfires.

- Warnings prior to major landslides are possible when the specific landslide-prone regions are properly instrumented. More general statements of the imminence of landslides are possible where the water content of the soil and the rainfall are adequately monitored.

- It is now possible to detect major solar weather disturbances before they have grown large enough to cause significant damage to satellites, communication systems, and pipelines.

- Table 3 shows measures of performance for warnings issued by the National Weather Service since 1993 and estimated until 2004. This table shows the continued and anticipated further increase in lead-time and accuracy.

Warnings may be available months in advance for events such as El Niño. Warnings of volcanic eruptions may be possible weeks to days in advance. The tracks of hurricanes are forecast days in advance of landfall. The potential for severe thunderstorms and tornadoes can be anticipated a day or two in advance. Specific severe thunderstorms and tornadoes can be predicted with a lead-time in the tens of minutes. Advanced warnings of major destructive waves from large earthquakes are only likely to be available with seconds of lead-time in the United States (National Research Council, 1991).

With increased concern for manmade disasters from terrorism or accidents, new monitoring systems and response teams are being deployed. Minimizing the effects of such disasters depends on being able to warn people at risk quickly and reliably.

Home
Next Section
Previous Section

Warnings	1993	1994	1995	1996	1997	1998	1999 Est.	2000 Est.	2001 Est.	2002 Est.	2003 Est.	2004 Est.
Tornado												
Lead-Time (Minutes)	6	7	10	10	10	11	12	12	13	13	14	15
Accuracy (Percent)	43	46	60	59	59	66	70	70	70	70	72	74
Severe Thunderstorms												
Lead-Time (Minutes)	16	17	17	18	18	18	19	20	21	22	23	24
Accuracy (Percent)	70	72	75	82	82	84	84	85	86	87	88	89
Flash Flood												
Lead Time (Minutes)	22	18	26	39	45	52	41	46	48	50	55	58
Accuracy (Percent)	71	47	60	79	82	85	82	86	86	87	88	89
No Lead Time (Percent)	70	64	64	41	37	35	27	26	24	23	22	20
Temperature												
Correct Forecast (Percent)	82	82	84	85	86	86	87	87	88	88	89	89
Accuracy of Forecasting Onset of Freezing Temp	65	68	72	74	76	77	78	80	82	82	83	84
Snow Amount												
Forecasting Heavy Snow (Percent)	37	39	42	44	45	50	55	60	65	70	70	72
Precipitation Forecasts												
Lead time for 1” Forecast with Same Accuracy as 1-day in 1971 (Days in Advance)	2.1	2.2	2.3	2.3	2.3	2.3	2.3	2.4	2.4	2.5	2.5	2.6
Hurricanes												
Accuracy of Landfall (miles) w/24 hr Lead Time	111	191	81	90	44	*	84	81	81	78	78	75

1) It should be noted that there are limitations of scientific verification in assessment of program performance. The fundamental purpose of scientific verification is to objectively assess program performance through the use of standard statistical analysis. However, a number of factors unique to the atmospheric sciences must be considered to ensure proper interpretation of objectively derived statistics. The primary factor to consider is the natural variation in performance measures related to annual fluctuations in the meteorological conditions associated with severe weather.
2) Quality control procedures continue to be applied to performance measures in accordance with OIG audit of 1997.
3) Outyear measures are dependent on stable funding profile and take into account improved use of the WSR-88D, new satellites, improved forecast models, new and continued research activities of the USWRP, investments in critical observing systems, and the implementation of AWIPS.
4) 1998 Prelim statistics through August 1998. There is large variability in the hurricane warning program due to sample sizes and types of storms each year.

* Preliminary 1998 hurricane statistics will be provided at the end of this active hurricane season.

Table 3: Measures of performance of the Natinal Weather Service when issuing warnings.

Warnings days to months in advance can be disseminated through normal news channels. Warnings seconds to minutes in advance need to be broadcast instantly and in ways that attract peoples' attention. Responses to short-term warnings can be particularly effective when computers are preprogrammed to make transportation systems, pipelines, utilities, and manufacturing processes respond appropriately.

In many cases, the action that needs to be taken may require considerable time, so that the warning must be broadcast even hours in advance. For example, it takes from 52 to over 72 hours to evacuate such highly vulnerable areas as the Florida Keys, Miami, and New Orleans.

Home
Next Section
Previous Section

4. Issuing Effective Warnings

Warnings are effective only if they are accurate and result in appropriate action. The human components of effective warning systems have been described at length in the social and behavioral sciences literature since the 1950's and more recently in the public health and epidemiology literature (e.g., Mileti and Sorensen, 1990). Although both disciplines have used empirical research, the approaches are different in that the former addresses the conceptualization of the social-psychological process from the time of first warning to the time of response. The latter addresses health-related outcomes-such as deaths, injuries, or illnesses-in the population exposed to the hazardous event and identifies and quantifies the predictors of the risks for those outcomes.

The warning response process is categorized into the following components:
1. Perceiving the warning (hear, see, feel)
2. Understanding the warning
3. Believing that the warning is real and that the contents are accurate
4. Confirming the warning from other sources or people
5. Personalizing the warning
6. Deciding on a course of action
7. Acting on that decision

Further, a distinction is made between sender and receiver characteristics for each of the components (Nigg, 1995). Sender characteristics focus on:
1. The nature of the warning messages (content and style)
2. The channels through which the messages are given (type and number)
3. The frequency by which the messages are broadcast (number and pattern)
4. The persons or organizations receiving the message (officialness, credibility, and familiarity)

Receiver characteristics are primarily:
1. Environmental (cues, proximity)
2. Social (network, resources, role, culture, activity)
3. Psychological (knowledge, cognition, experience)
4. Physiological (disabilities)

Principal conclusions from the literature that influence the effectiveness of warnings are:
1. Warnings are most effective when delivered to just the people at risk. If people not at risk are warned, they will tend to ignore future warnings. Thus, if tornado or flash-flood warnings, for example, are issued for a county or larger region, but only a small percentage of the people who receive the warning are ultimately affected, most people conclude that such warnings are not likely to affect them.

2. If warnings that are not followed by the anticipated event are inconvenient, people are likely to disable the warning device. For example, if you are awakened in the middle

Home
Next Section
Previous Section

of the night to be warned of several events that do not ultimately affect you, you are likely to disable the warning device.

3. Appropriate response to warning is most likely to occur when people have been educated about the hazard and have developed a plan of action well before the warning (Liu et al., 1996).

4. There is a window of opportunity to capture peoples' attention and encourage appropriate action. Studies of responses to tornado warnings, for example, found that those who sought shelter did so within five minutes of first becoming aware of the tornado warnings (Balluz et al., 1997).

5. A variety of warning devices needs to be used in order to reach people according to what activity they are engaged in.

6. Warnings must be issued in ways that are understood by the many different people within our diverse society.

7. The probabilistic nature of warnings, particularly for natural disasters, needs to be made clear.

The content and style of a warning message are important. An effective message should:

- Be brief (typically less than two minutes and preferably less than one minute)
- Present discrete ideas in a bulletized fashion
- Use nontechnical language
- Use appropriate text/graphics geared for the affected hazard community and general population
- Provide official basis for the hazardous event message (e.g., NWS Doppler Radar indicates tornado, police report of chemical accident, etc.)
- Provide most important information first, including any standardized headlines
- Describe the areas affected and time (e.g., "pathcasting" for moving events such as weather systems, volcanic debris or element dispersal, etc.)
- Provide level of uncertainty or probability of occurrence
- Provide a brief call-to-action statement for appropriate public response (e.g., safety instructions for protection of life and property, any evacuation instructions, shelter or other care facilities, etc.)
- Describe where more detailed follow-up information can be found

Home
Next Section
Previous Section

5. Warning Terminology

Effective warnings should use standard terminology that clearly communicates the immediacy, reliability, severity, and scope of the hazard and of the appropriate basic response. There are many different types of hazardous events, with different time scales, that are studied by different organizations. The result is a variety of warning terminologies. The principal agencies issuing warnings of natural hazards in the United States are the National Weather Service (NWS) and the U.S. Geological Survey (USGS).

The NWS, through many decades of experience, has developed the following terminology for tornadoes, hurricanes, severe thunderstorms, other high wind events, snowstorms and blizzards, freezing rain, other precipitation events, extreme cold and heat, floods and flash floods, coastal and Great Lake events, high seas events, severe restrictions to visibility (fog, dust, ash), ice formation and breakup leading to damming and flooding, and fire danger conditions:

1. **Warning:** The hazardous event is occurring or is imminent. The public should take immediate protective action.
2. **Advisory:** An event, which is occurring or is imminent, is less severe than for a warning. It may cause inconvenience, but is not expected to be life- or property-threatening, if normal precautions are taken.
3. **Watch:** Conditions are favorable for occurrence (development or movement) of the hazard. The public should stay alert.
4. **Outlook:** The potential for a hazard exists, though the exact timing and severity is uncertain.
5. **Statement:** Detailed follow-up information to warnings, advisories, watches, and outlooks is provided.
6. **Forecast:** This is a prediction of what events are expected to occur. The range of predictability for hydrometeorological hazards extends from the short-term forecasts for one to two hours out to climatological forecasts for trends up to a year in advance.

   The terms “Watch” and “Warning” in particular have gained wide acceptance within the hazards community, including emergency managers and the media, and are used to set specific response actions in motion. Nevertheless, some of the public are still confused about the distinctions. The NWS, in partnership with FEMA, the American Red Cross, the United States Geological Survey, and the media, has provided outreach and education on weather hazards and terminology that is improving public response. Nevertheless, advances in science and technology are blurring the distinctions between watches, warnings, and forecasts. Increasing lead-times for warnings are making it necessary to provide additional information when warnings are in effect to ensure that people who receive the information can adequately evaluate their risk.

The United States Geologic Survey (USGS) provides similar public notices on escalating risk for volcanic eruptions, earthquakes, landslides, and other events. Terms used to describe level of risk include:

1. **Factual statement:** Report on current conditions of the volcano; does not anticipate future events. Such statements are revised when warranted by new developments.
2. **Forecast:** Comparatively nonspecific statement about volcanic activity to occur, weeks to decades in advance. A forecast is based on projections of past eruptive activity or is used when monitoring data are not well understood. This kind of statement is particularly useful for land use planning and development of emergency response plans.
3. **Prediction:** Comparatively specific statement giving place, time, nature, and, ideally, size of an impending eruption.

The level of risk of volcanic activity is specified by building on the common colors of traffic lights that everyone understands, but adds a fourth color, orange, as shown in Table 4. This color-coding scheme is especially useful to the airline industry during volcanic unrest and eruption along the very busy flight corridor from Alaska to Asia.

Color	Intensity of Unrest at Volcano	Forecast
Green	Volcano is in quiet, “dormant” state.	No eruption is anticipated.
Yellow	Small earthquakes are detected locally and/or increased levels of volcanic gas emissions.	An eruption is possible within a few days and may occur with little or no warning.
Orange	Number of local earthquakes is increasing. Extrusion of a lava dome or lava flows (nonexplosive eruption) may be occurring.	Explosive eruption is possible within a few days and may occur with little or no warning. Ash plume(s) are not expected to reach 25,000 feet above sea level.
Red	Strong earthquake activity is detected even at distant monitoring stations. Explosive eruption may be in progress.	Major explosive eruption expected within 24 hours. Large ash plume(s) are expected to reach at least 25,000 feet above sea level.

Table 4: Levels of risk of volcanic activity

Another warning scheme the USGS uses to indicate volcanic activity is a series of “Information Statements” and staged “Advisory Alert Levels.” The Alert levels (ONE, TWO, THREE) “indicate the level of volcanic unrest and degree of imminence of eruptive activity with attendant volcanic and hydrologic hazards.” Alert level notifications are accompanied by brief explanatory text to clarify hazard implications as fully as possible. In eastern California’s Long Valley, a response plan has been developed that specifies the appropriate actions that should be taken by officials and individuals when the alert level changes (Hill et al., 1991).

Probabilities are being given more and more frequently to specify the likelihood of an event occurring or the certainty of the forecast. The public is learning how to use this information. Increasingly, probabilities can be determined by specific computer models. For example, the NWS issues probabilities of where an approaching hurricane will strike the coast. The NWS expects to incorporate probability data in other information as the state of the science allows, including other warning events and varying amounts of liquid or frozen precipitation. A particular winter storm forecast could provide probability values for varying amounts of snowfall well in advance of the event. Already probabilities of forecast precipitation amounts are provided to local decision-makers and are input into hydrologic computer models to provide valuable flooding potential information for officials. Other government agencies also could be expected to provide such levels of service, as appropriate to their unique hazards.

A complete watch, warning, advisory, or forecast needs to include the following components:
1. Where the event is or will be
2. How imminent the event is
3. Anticipated severity of the event
4. Probability that the event will occur

An effective warning also needs to imply appropriate action based on prior education, or specify appropriate action.

It may be more effective to use several adjectives with a noun to address these differing components rather than relying on a single noun such as a watch or warning.

RECOMMENDATION: A working group with representatives from providers of different types of warnings in many different agencies, people who study the effectiveness of warnings, and users of warnings should develop a single, consistent, easily understood terminology that can be used as a standard across all hazards and situations. This terminology should be reviewed on an ongoing basis. Consistency with systems used in other countries should be explored.

6. The Universal Digitally Coded Warning

A variety of systems are being developed to deliver digitally coded warnings. Now is the time to agree on what variables should or could be included to describe the wide variety of possible events so that these systems can be compatible in the future. The emphasis in this chapter is on content, not precise format.

We think the following items may need to be included in a universal digital warning:

1. **Originator:** The agency and location that originates the message
2. **Transmitter:** Call sign of system relaying this message
3. **Time of origination:** Accurate to the second in a standard time such as UTC
4. **Error correction:** Data for an error checking and correction scheme
5. **Intended audience:** Who the message is intended for
6. **Valid lifetime:** When the message will expire in elapsed time, accurate to the minute
7. **Nature of the event:** What is the general nature of the event: weather, earthquake, flood, technological hazard, and so forth
8. **Type of event:** More specific information on the type of event. For example, if the "Nature of the Event" were weather, the type of event might be Tornado, or Thunderstorm.
9. **Severity of the event:** The expected or estimated magnitude of the event. This will give the recipient some idea of how severe it is likely to be.
10. **Probability of event occurring:** The predicted chance that the event will occur
11. **Primary area of impact:** The geographical location of the expected or predicted center of the event, and the area of greatest expected damage. Might use county and 1/9th county codes or geographic coordinates of a polygon.
12. **Secondary impact areas:** Geographical areas that can expect to sustain damage from the event or will be impacted by victims of the event
13. **Event specific parameters:** Depth, elevation, azimuth, velocity, etc.
14. **Expected or projected impact on emergency resources:** A reasonable estimate of the kinds of resources that will be needed or consumed in the immediate recovery period. Tents, blankets, earth-moving equipment, and fuel are good examples.
15. **Proposed protective action:** The best course of action recommended for the general public to take to protect themselves from danger and injury
16. **Text of message:** The actual text of the message in English and possibly other languages
17. **Audio (or digital data for audio) message:** Audio of the message in English
18. **Alternate Language(s) Message(s) Text:** The first part of this field will contain a language identifier. The text of the message will be in the indicated language.
19. **Audio (or digital data for audio) for alternate language(s):** The audio message in the alternate language. There may be several different languages used, depending on the ethnic makeup of the given area.
20. **Point of contact for additional information/advice:** Who to contact for further advice and assistance, and how to make contact

Home
Next Section
Previous Section

21. **Graphics:** Provision for transmitting graphics as part of the message. New systems are likely to be able to display simple graphics.
22. **End of message delimiter:** This field indicates the end of the message.

There may be a need for a range of digital warning contents, from a basic warning to a complete warning. Once standards are set and agreed to, manufacturers can develop the appropriate hardware and software.

RECOMMENDATION: A working group should develop a single, consistent suite of variables to be included in a general digital message. Consistency with systems used in other countries should be explored.

Home
Next Section
Previous Section

7. Alternatives for Funneling Warnings into Broadcast Systems

There are several hundred offices throughout the United States from which scientists are likely to issue warnings, and thousands of locations from which emergency managers or others could issue warnings. In most cases these warnings will apply within the nearby region, but some warnings may be for events at considerable distance. Many distribution systems are ideally suited to relay warnings from a local center to people nearby. Others based on satellite data-relays may need to combine warnings from throughout the country. There needs to be standard ways to collect warnings both locally and nationally and to introduce them into dissemination systems. The standard ways must also prevent fraudulent uses.

The most numerous warnings now issued relate to storms and floods. The National Weather Service, therefore, has developed the most complete warning system. All of their forecast offices are interconnected by two-way satellite communications. Warnings can be centralized, combined, and relayed immediately through NOAA Weather Wire Service (NWWSe, the Family of Services, Emergency Managers Weather Information Network (EMWIN), and the Internet. Local forecast offices can broadcast the warnings over local transmitters of the NOAA Weather Radio and thence through the Emergency Alert System (EAS).

The EAS, which will be described in more detail below, utilizes commercial radio and television stations and cable systems to provide another way to collect and disseminate warnings. This system was designed to provide the President of the United States the capability to address the nation, but it can also transmit signals within a local region only. The primary source of these messages is from the NWS and local emergency managers. Each broadcast station and cable system monitors a minimum of two key EAS sources and rebroadcasts appropriate messages. All EAS equipment has the capability to monitor additional sources. Messages can be introduced through the broadcast station, through the cable system, through an appropriately monitored radio frequency, or through the NWS.

The Internet also provides a way to collect and issue warnings and is being utilized more and more. Earthquake information is now posted within tens of seconds of detection to help guide response and recovery (e.g. http://quake.usgs.gov). The current Internet might not be sufficiently reliable during major disasters if it is overloaded or if local connections were lost. The time delay is also a potential problem in cases where timing within seconds is critical. An Intranet, especially with satellite links, could provide a powerful way to collect and broadcast warnings. The Next Generation Internet is expected to allow high-priority routing of the most important messages.

Information about critical events is collected by the National Response Center (NRC) operated by the Coast Guard through the telephone number 1-800-424-8802 (http://www.nrc.uscg.mil). The NRC was established to ensure that appropriate

Home
Next Section
Previous Section

government authorities are informed when a serious event happens or is likely, especially technological accidents.

Most other warning systems are more ad hoc, with specific people being advised by telephone, fax, e-mail, pager, and such. Several commercial systems have been developed to call rapidly and automatically all people within a specific region or to broadcast signals to specific groups of users. In some cases these systems have been installed around potentially hazardous sites such as nuclear power stations or major chemical facilities. Such systems may perform well, but could be improved if more standard systems were developed that could reach more people reliably.

We believe that the most logical nucleus for a national system for collecting warnings for dissemination should be built around the NWS systems. NOAA/NWS already calls their systems All-Hazards and currently receives earthquake information directly from the USGS National Earthquake Information Center in Golden, Colorado, and space weather information from the Space Environment Center in Boulder, Colorado. NOAA/NWS has had agreements with nuclear power plants in place for many years and more recently with the Chemical Stockpile Emergency Preparedness Program (CSEPP) for utilizing NOAA Weather Radio in the event of an incident at one of their facilities. NWS has reciprocal agreements with each state for data exchange for state-level incidents. Warnings issued by local emergency managers in most states go directly onto EAS without going through the NWS. Integrating such warnings into a national system that is broadcast, for example, by satellite, will take considerable care.

An important requirement for NWS to be accepted as the national collector and expediter of all-hazard warnings is for clear policies and procedures to be established to ensure that proper attribution is given to any agency or organization providing such warnings.

RECOMMENDATION: A standard method should be developed to collect and relay instantaneously and automatically all types of hazard warnings and reports locally, regionally, and nationally for input into a wide variety of dissemination systems. The National Weather Service (NWS) has the most advanced system of this type that could be expanded to fill the need. Proper attribution of the warning to the agency that issues it needs to be ensured.

Home
Next Section
Previous Section

8. Alternatives for Focusing Warnings on the People at Risk

As described in chapter 4 on issuing effective warnings, warnings will be most effective when they can be targeted directly to the people at risk There are several options:

a) **FIPS Codes**: EAS/NWRSAME (Emergency Alert System/NWR Specific Area Message Encoding) uses code numbers for counties specified in the Federal Information Processing Standard (FIPS). It is also possible to specify one-ninth parts of a county. Up to 31 different counties or 1/9th sections of counties can be specified in a given transmission. The 1/9th sections are not currently implemented in most areas, but use is increasing. Buyers of certain NWR receivers and EAS decoders can enter their county codes determined, for example, from a website (http://www.nws.noaa.gov/nwr or http://support.tandy.com/support_audio/doc40/40482.htm) or by telephone (1-888-NWR-SAME). Some counties are very large and flash floods or tornadoes may only affect a small part of a county. Also, some unused FIPS codes are being assigned for specific sites or needs such as for a nuclear power plant, offshore areas, and CSEPP sites. The NWS also uses a form of the FIPS codes in their Universal Generic Code, which is included in many NWS products to identify the affected area by county. This code enables users to specify the locations they want information on.

b) **Zip Codes**: These codes revised for the U.S. Postal Service could be used, but their applicability to rural land is less useful than in urban areas.

c) **Area Codes**: These codes are statewide in some states and cover only small areas within cities.

d) **Transmitter Range**: A natural selection spatially is done by the restricted transmission range of radio or television stations or by the restricted areas serviced by cable television. Some vendors market transmitters for use with the RBDS system with ranges of only a fraction of a mile or a few miles. These could be set up, for example, in emergency vehicles at a chemical spill or traffic accident.

e) **Wired Systems**: Signals can be sent to small regions over television cable, wired telephones, and even electric utility cables.

f) **Wireless Systems**: Wireless communications equipment has a range of typically 10 miles for analog signals and 3 miles for digital signals called cells. The technology exists to broadcast to all wireless telephones within a cell so that, for example, it is possible to track a tornado through a region, alerting only those within specific cells (See http://ceasa.net/).

g) **Latitude/Longitude Polygons**: If receivers could know their location in terms of latitude and longitude, then vertices of very specific polygons — for example, around a basin prone to flash floods or along a projected tornado track — could be transmitted. Vendors are already supplying receivers that can be programmed with latitude and longitude based on street address entered through a 1-800 telephone number. The numbers are either entered over the telephone line or by transmission to the unit through a paging service or other means. Location systems utilizing signals from Global Positioning Satellites (GPS) are becoming widespread in truck fleets and rental cars.

We believe that the most general locating system allowing arbitrary specification of a region at risk would be based on polygons with vertices specified with latitude and longitude coordinates. There are needs for area-specific locating related to the new Intelligent Transportation Systems (ITS) that are being developed (See http://www.its.dot.gov/) and the relationship of these systems to emergency alert systems needs to be explored in some detail. The costs of GPS receivers are decreasing. Looking five to ten years into the future, such systems might be readily available if we can agree on basic standards and integrate emergency needs with other needs.

Intelligent Transportation Systems needs for spatial location can be quite demanding, as for example, locating a vehicle within a traffic lane. Emergency alert needs are less demanding, perhaps within hundreds or even thousands of feet. Both uses, however, will demand significant infrastructure and/or widespread use of specialized receivers. The cause of both uses will be advanced by leveraging resources.

RECOMMENDATION: The mutual needs for precise area-specific locating systems for Intelligent Transportation Systems and Emergency Alert Systems should be explored in detail to determine where resources can be leveraged to mutual benefit.

Home
Next Section
Previous Section

9. The Emergency Alert System (EAS)

The Emergency Alert System (EAS) is a joint government-industry response to a Presidential requirement to have the capability to address the entire nation on very short notice in case of a grave threat or national emergency. In 1994, EAS replaced the Emergency Broadcast System (EBS), which was in use since 1963. Prior to EBS, CONELRAD (Control of Electromagnetic Radiation) was used. CONELRAD was implemented under President Truman in 1951.

At the national level, EAS can only be activated by the President or his constitutional successor. White House Communications Agency Trip Officers accompany the President at all times. At the direction of the President or his successor, they contact the Federal Emergency Management Agency (FEMA) to activate the national-level EAS. After the President has used the system, it may be used by Federal agencies to provide official information such as from FEMA, regarding disaster assistance, food availability, and other vital information. Appendix 2 contains a description of national-level EAS operations.

In addition to national-level emergencies, EAS is used at the state and local levels to provide emergency messages. Reports received by the Federal Communications Commission (FCC) reveal that the EAS is activated more than 100 times a month at state and local levels. EAS messages are originated by the National Weather Service (NWS) and State and local authorities such as governors, emergency managers, police, and others, for natural or technological disasters posing an immediate threat to life and property. Appendix 2 contains a description of State and local EAS operations and a report about State and local EAS plans and activations, the sources of EAS activations, and a description of the Broadcast Station Protection Program (BSPP). Broadcast stations and cable systems are not required to rebroadcast State and local activations. While EAS/EBS activations reported to the FCC average approximately 1,400 per year, the NWS typically issues significantly more NWR/SAME coded messages for short-term warnings per year.

The FCC coordinates all EAS activities relating to industry including:

- Inspection of radio and TV stations and cable systems for compliance with the Commission's EAS rules
- Review of all National, State and local EAS plans
- Appointment of volunteer personnel to the National, State, and local EAS advisory committees

FEMA coordinates all EAS activities relating to government entities including:

- Integration of EAS into emergency telecommunications policies, plans, and programs
- Coordination of the participation of State and local emergency management personnel in EAS

Home
Next Section
Previous Section

NWS:
- Coordinates the participation of its field office personnel in the State and local EAS
- Prepares and issues warnings for weather events that may be life-threatening
- Distributes the warnings using the Specific Area Message Encoding (SAME) on NOAA Weather Radio (NWR), NOAA Weather Wire, telephone, or any other means available
- Disseminates USGS earthquake warnings via NW

The SAME digital signal is identical to the EAS digital signal. Therefore, a consumer receiver monitoring NWR and radio and TV transmissions can use the same decoding circuitry.

State and local officials such as Governors, emergency management directors, and police and fire officials can request activation of the EAS for emergencies.

Industry participants in EAS include over 14,000 radio and television stations that were required to have EAS equipment on January 1, 1997. Currently all radio and television stations and cable systems with 10,000 or more subscribers (and in 2002, all cable and wireless cable systems) are mandated by the Federal Communications Commission (FCC) to have EAS equipment and to issue national alerts and conduct tests. Broadcast stations and cable systems may elect to participate in national-level activations (stay on the air) or not participate (go off the air). Over 99 percent have elected to participate. All broadcast station and cable system participation in EAS at the State and local levels is at the discretion of management. Therefore, they are not required to transmit State and local emergency messages.

Future objectives of the EAS include:
- Continuing studies of alternate ways (including new technologies) to disseminate Presidential messages to the public
- Completing development of all State and local EAS plans
- Developing EAS educational and training packages such as video training tapes for government and industry personnel
- Encouraging development of new consumer devices using the EAS/SAME technology to alert the public of emergency situations

The EAS is the principal system that allows the President to address the nation during or immediately after a disaster. All stations are required to retransmit Federal messages with appropriate priority. For most messages, including all warnings generated at the State or local levels, individual stations can choose to delay or omit retransmission. The EAS interrupts local audio programming or introduces a crawl (a moving line of text) along the edge of television pictures. The use of EAS varies from station to station, often depending on individual interest, since commercial stations are not anxious to broadcast unnecessary interruptions during programming or commercials. This means that EAS is not likely to function well as a vehicle for disseminating warnings as the number of warnings increases.

Home
Next Section
Previous Section

10. Radio Broadcast Data System (RBDS)

The Radio Data System (RDS) for FM broadcasting was first specified by the European Broadcasting Union in 1984. It has been used in most European countries since 1987, with some modifications in 1990 (See http://www.rds.org.uk/). Digital codes are transmitted at 1187.5 bits per second on a subcarrier that is added to the stereo multiplex signal (or monophonic signal as appropriate) at the input to the FM transmitter. On appropriate receivers, the codes can be displayed showing station name, program information, precise time, advertisements, paging messages, traffic conditions, and emergency alerts. Furthermore, the codes can be used to turn on the receiver, set the volume, stop any tape cassette or CD and issue a warning. RDS is transmitted by most FM radio stations in Western Europe, and car radios with RDS functionality are available from 50 different manufacturers.

In the United States, the RDS standard has been slightly modified by the National Radio Systems Committee (NRSC) and is called RBDS. The main objectives of RBDS are to enable improved functionality for FM receivers and to make them more user-friendly by incorporating features such as Program Identification, Program Service, Name Display, Open Data Application, and where applicable, automatic tuning for portable and car radios. The Open Data Application allows for the retransmission of emergency information sent by the EAS. Unlike EAS, RBDS does not interrupt programming for all listeners, only for those with appropriate receivers with the warning function enabled. There are many commercial uses for the RBDS signal that might compete for bandwidth with emergency messages but would also provide payback for the small costs of implementing RBDS at the transmitter. RBDS is being used by several hundred U.S. FM stations. Cadillac was the first U.S. automaker to offer RBDS receivers built in to some 1998 models.

Part 11 of the FCC rules permits broadcast stations to transmit Emergency Alert System (EAS) State and local level emergency messages through communications means other than the main audio channel. FM stations may use subcarriers, including the subcarrier used for RBDS, and TV stations may use subsidiary communications services. The RBDS standard contains criteria for processing EAS messages. The Tennessee State EAS plan contains provisions for using RBDS to distribute EAS messages. Tennessee FM stations with RBDS equipment can process EAS messages without interrupting their main channel programming and RBDS pagers, signs and device controls can access EAS messages.

RBDS was considered carefully in the early 1990’s when the FCC investigated new technologies to replace the Emergency Broadcast System (EBS). In December 1992, the FCC invited equipment manufacturers to demonstrate their alerting equipment. Eleven manufacturers participated, some showing the RBDS technology. Field tests of the new technologies were held in Denver in June 1993, and in Baltimore in September 1993. Expansion of RBDS involved creating new standards for AM, TV, and cable. Tests also showed that the effective throughput was lower for RBDS than for EAS. Therefore, on

Home
Next Section
Previous Section

November 10, 1994, the FCC adopted a common EAS message protocol to be used by all EAS participants. The EAS protocol must be transmitted on the main audio channel of AM, FM, and TV broadcast stations and cable system signals. The EAS protocol is identical to the Specific Area Message Encoding (SAME) protocol used by the National Weather Service (NWS). But EAS needed additional code elements not contained in the original SAME code structure. NWS agreed to expand the SAME code structure and the code structures are now identical. With EAS and SAME messages having identical protocols, receivers tuned to broadcast stations or NOAA Weather Radio can use the same decoding circuitry.

The RDS and RBDS technologies are well developed. They have been adopted most widely in Europe where most radio stations are publicly owned. They offer an excellent alternative to the EAS that is less invasive of standard programming. Agreement on clear standards for emergency messages would empower industry to implement these technologies in a cost-effective manner.

RECOMMENDATION: The potential for widespread use of the Radio Broadcast Data System (RBDS) for transmitting emergency alerts needs to be evaluated in close cooperation with broadcast industry groups and equipment manufacturers.

Home
Next Section
Previous Section

11. Other Alternatives for Delivering Warnings

Warning delivery systems can be viewed as primary and secondary. Primary delivery systems provide information directly from the source to the user in the most timely and reliable manner possible, using a minimum of telecommunications links. Secondary delivery systems have additional telecommunications links, information processing systems, or value-added interpretive systems inserted between the authoritative source and the user that affect their timeliness and reliability but allow them to reach mass audiences. Federal warning systems are summarized in Appendix 3 and primary Federal World Wide Web sites for disaster information are summarized in Appendix 4.

The EAS is the primary warning delivery system for the President, but is a secondary system for other types of warnings. The only primary systems currently available for widespread, reliable local and national delivery of disaster information are National Weather Service's NOAA Weather Wire Service (NWWS) and NOAA Weather Radio (NWR). Each system can deliver a warning for a specific condition and location, with digitally embedded alarm information directly from the forecaster at a local Weather Forecast Office (WFO) to those in the area specifically at risk within seconds of formulating the forecast. This information can then be used to automatically trigger the FCC Emergency Alert System and can be further disseminated through most of the secondary delivery systems discussed below.

NOAA Weather Wire Service (NWWS) transmits text and graphics via a geostationary satellite channel. Over 7,000 alphanumeric and graphic products are delivered through proprietary VSAT receivers within an average time of 3-5 seconds. Currently 1,500 receivers are located primarily at media and emergency management offices throughout the United States. NWS is moving to broadcast this information on higher-speed, nonproprietary open broadcast channels by the year 2000.

NOAA Weather Radio (NWR) transmits local weather forecasts currently from more than 520 transmitters located in all states and territories (USDA, FEMA, USDOC, 1999). Each Weather Forecast Office (WFO) generates for each transmitter a program that is typically four to six minutes in length. The program is updated every time there is a significant change in the applicable forecast. This program is replayed continuously. Emergency warnings can be broadcast at any time. The NWR signal is available currently to approximately 90 percent of the U.S. population with a goal to expand to 95 percent over the next few years. The signal must be received on a special radio set available at modest cost from several suppliers. Advanced receivers are available that will turn themselves on and set the volume in order to broadcast a warning when it is received. These receivers can also be set to the Specific Area Message Encoder code so that only identified events for a specific location will set off an alarm. Access to NWR would be substantially increased if the signal could be detected by most standard radios.

Emergency Managers Weather Information Network (EMWIN) is operated by the NWS and transmits text and images via the NOAA GOES satellites. It can be received on a personal computer with the addition of a pizza-sized antenna and electronics board costing less than $1,000. Software on the computer allows you to browse through weather information and emergency warnings for the whole country. In some areas the signal is rebroadcast on a VHF channel that can be received and input to a serial port for less than $50-worth of equipment. This system demonstrates how detailed and timely hazard information can be broadcast and received independent of terrestrial phone lines and power systems that might be compromised during an emergency.

Internet Weather Information Network (IWIN) provides information similar to EMWIN but over the Internet. While IWIN serves information, warnings can also be broadcast or pushed over the Internet. Delay times are unpredictable and could amount to seconds. The Internet will be more reliable and useful for warnings when:

1. Emergency messages can be given high priority with transmission assured even when the Internet is overloaded by heavy use during emergencies.
2. Warnings can be multicast (the one-to-many Internet equivalent of broadcasting).
3. Recipients have connections, which are always available to receive data.

It will also be necessary to couple these tools with an emergency managers' database showing the geographic location of each IP address. Once this foundation is available, the Internet will provide the ability for each user to receive warnings, to tailor those warnings to their own needs (farmers may need frost warnings, which would only annoy apartment dwellers), to receive those warnings in a mode appropriate to their needs (visually for the hearing impaired, by audio for the visually impaired, graphically to define spatial extent). Finally, the Internet provides the ability to couple detailed response information with the warning. For example, if an evacuation were required, directions could be tailored to the recipient's own location.

The Next Generation Internet (NGI) Implementation Plan identifies a prototype distribution system as one of the most important applications to be demonstrated (http://www.ngi.gov). Now is the time to start to develop the tools to take advantage of the advances in Internet technology being developed by the NGI program (National Research Council, 1996). This would also be an appropriate focus for one of the "Enabling Technology Centers" recommended by the President's Information Technology Advisory Committee (PITAC) (1999). Research in support of mobile users using geolocation systems such as GPS, coupled with wireless systems, should seek to develop warning and information capabilities similar to that becoming available to stationary Internet users.

Advanced Weather Information Processing System/Local Data Acquisition and Dissemination (AWIPS/LDAD) is a communications interface at each Weather Forecast Office (WFO) that will provide for a two-way exchange of information between local customers and the AWIPS at the NWS office through dial-up telecommunications lines. It will include access via an Intranet server. System-wide implementation is expected in FY2000.

Sirens and other audio devices are used especially in tornado country to sound alarms. They are more effective than most other alternatives for notifying people who are outside and who do not have special receivers. Large numbers of sirens are needed to cover populated areas and to be loud enough to be heard indoors by most people. Sirens are expensive to install and maintain and can only provide limited information. Their signals can reach people speaking different languages, but to understand the signal and to know what action is appropriate depends on prior education or experience.

Pagers were used by 40 million people in the United States in 1996 and are anticipated to be used by more than 100 million in the year 2000. Modern pagers can be used to transmit limited warning information. There is an unpredictable delay of seconds to tens of seconds while individual pagers are queued for transmission or while signals are relayed through satellites for transmission in other parts of the country. Several systems exist that take signals received by pagers and pass them to computers for automatic processing. Most pagers could or do receive signals on more than one channel. Standard pagers could be made into important warning devices if there were agreement on transmission of a standard warning channel and there were agreement on what types of processing of this warning signal the pagers should do. Some new systems integrate a pager and a small computer into a box the size of a smoke detector and provide warnings if the box is located in the region at risk or if the owner of the system belongs to a volunteer fire department or other affinity group.

Cable Television: More than 70 million households receive traditional cable service. By FCC mandate, EAS signals are now delivered to 90 percent of these homes with the balance to receive signals by October 1, 2002. Many cable operators will be adding EAS codes to all television channels, and vendors are providing small separate boxes that can be attached to the cable and produce audible or other warnings without involving the television sets. Some of these boxes can also be used to listen to NOAA Weather Radio. Television sets could also be equipped to turn on, set their volume, and broadcast warnings. Similar features could be standard on all radios and televisions at minimal additional cost if standards were agreed to. Cable systems also provide ways to focus emergency information on groups connected in a small region to the same cable.

Digital AM/FM Radio: New standards are being written worldwide for digital AM radio by Digital Radio Mondiale (DRM) (http://www.drm.org). Digital radio will offer multiple logical channels of information within a single transmission. Warnings can be inserted into the data stream with little or no impact on the quality of the entertainment channel. The time has come to integrate warning capability into a global standard before many systems are built.

Digital television also offers the chance to transmit warning information without impact on the quality of the entertainment channel. Unfortunately HDTV standards are in place and equipment is being manufactured, although initial sales are expected to be limited. The President's Advisory Committee on Public Interest Obligations of Digital Television Broadcasters (1998) recommended:

> Broadcasters should work with appropriate emergency communication specialists and manufacturers to determine the most effective means to transmit disaster warning information. The means chosen should be minimally intrusive on bandwidth and not result in undue additional burdens or costs on broadcasters. Appropriate regulatory authorities should also work with manufacturers of digital television sets to make sure that they are modified to handle these kinds of transmissions.

Vice President Al Gore underscored this recommendation and suggested that the FCC, perhaps in conjunction with the National Partnership on Reinventing Government, "could spearhead this collaborative effort to identify ways to redefine our hazard warning network." (Letter filed in response to the FCC Notice of Inquiry 99-360, (https://gullfoss.fcc.gov/cgi-bin/ws.exe/prod /ecfs/comsrch.hts).

Telephones can be dialed by computers to warn people within a specific area (Reverse 911 or Call Warning). Available commercial systems allow emergency managers to quickly specify the small region of interest and to have as many as hundreds of computers dialing simultaneously with a specific message. New systems are under development to dial from central telephone switches as many as 180,000 telephones per minute to give a 10-second message.

Wireless telephones are available in 40 percent of American households and usage is currently expanding by 45 percent each year. By early 2000, there were more than 86 million wireless telephone subscribers in the United States. Wireless telephones provide the capability to call a person rather than simply a location, but they also allow broadcast to all telephones within a cell or specific location without knowing which specific telephones are currently there. This broadcast ability has been developed and implemented for some systems in Europe. Individual cells are typically 10 miles in radius for analog systems and only 3 miles in radius for digital systems. This unique ability to reach any mobile receivers within a specific cell at a given time makes wireless telephones an excellent existing method to deliver warnings to only those people at risk. This means, for example, that as a tornado sweeps through a given community, people within the telephone cells at highest risk could be alerted.

Hardware and software exist for Cell-Broadcast/Short Message Service (C-B/SMS) for networks employing data compression technology using Frequency Division Multiple Access (FDMA), also known as the GSM (the Global System for Mobile Communications) carriers. In the United States, TDMA (Time Division Multiple Access) and CDMA (Code Division Multiple Access) compression technologies are also in use.

Industry standards are in place to provide C-B/SMS for TDMA and standards should be in place by 2002 for CDMA. The Telecommunications Industry Association (TIA) has issued a standard entitled Wireless Network Recommendation for Emergency Message Broadcast (TSB114).

The Cellular Emergency Alert Systems Association (CEASa, http://ceasa.net/) has identified numerous vendors and associations offering hardware, software, and operational standards required for C-B/SMS deployment and its integration into the existing National, State, and local EAS data sources.

The wireless telephone industry is extremely competitive. The commercial benefits of emergency cell-broadcast have yet to be quantified. There are many other potential commercial uses of wireless broadcast that might provide commercial benefits to implementing cell broadcast. There is a clear need for industry and government to use public and private resources to evaluate all aspects implementing emergency wireless broadcast of emergency information in the near future. This technology would be especially useful in tornado country so that prototype systems might be implemented in such regions first.

Electric utility networks could host warning signals using communications systems currently in place to monitor and control power usage in homes and businesses. Special receivers would be necessary.

Longwave radio is used in Europe to transmit time signals and some warning information. In the 1970's FEMA experimented with such a system at 530 kHz, the lowest end of the AM band (Westinghouse, 1976). While longwave transmitter antennas are large and expensive, the signal can cover a large area.

Satellites offer new opportunities for transmission of warnings to very large areas and even to specific areas. A national warning channel could be transmitted from one or more high, medium, or low earth-orbit satellites. Warnings could be added to commercial radio or television channels. The value of such systems would depend on the receivers knowing where they are located so that only warnings that apply to the specific location would be announced by the receiver. The possibility of using Direct Broadcast Satellites (DBS) and Digital Audio Radio (DAR) for broadcasting NWR Watches and Warnings is currently being explored by the NWS. Two new, fully capitalized ventures are planning to broadcast hundreds of channels of near-CD quality music by DAR on DBS. One is launching three satellites to cover Africa, India, and South and Central America, and is producing millions of hand-held receivers. The other will use satellites and terrestrial broadcasts to cover the United States, and is also developing receivers. Using a small portion of a single channel would allow all NWR SAME broadcasts to be delivered to any U.S. location. DAR receivers, equipped with NWR SAME decoding capability and programmed to select only those watches and warnings that applied to the location of the listener—as is currently done with NWR SAME broadcasts—could turn the receiver on, sound an alarm, and provide the audio watch or warning.

Local and State Warning Systems: In many parts of the country, local systems exist to provide warning information, most commonly flood warning information, to local emergency management officials. In a number of states, statewide emergency management networks also tie together emergency managers and provide a means to disseminate warnings to action officials.

Handicapped Issues: Once a receiver registers an emergency warning, it can turn on alarms, lights, vibrators, and other such devices to alert people with special needs. The possibilities are limited only by our imagination and our ability to build commercially viable systems. The NWS has worked with a number of organizations to improve service for the handicapped, particularly the deaf, since those with vision impairments can be readily warned with the existing NWR. The NWS is committed to providing service to the deaf. It is pursuing new technology that would allow subaudible digital signals to be incorporated in the standard broadcast that could be received by slightly modified NWR receivers. These receivers could activate any of the standard alarm systems used by the deaf and more importantly, provide a text output that could be displayed or recorded on inexpensive devices currently available in most deaf households.

Technology offers a broad range of possibilities for receiving warnings of potentially hazardous events. Each alternative has advantages and disadvantages, but it is only through a blend of systems that it will be possible to reach most people at risk wherever they are located and whatever they are doing. Emergency managers know that during an emergency, the best systems to use are those used every day. These are the systems we are familiar with and the ones we can use without having to read the manual during a crisis. Warning systems should similarly be systems used every day for other purposes so that they are valued and kept operational.

It is now technically feasible to have radios, televisions, telephones, pagers, and other commonly used equipment contain a small amount of circuitry that monitors continuously for emergency signals and when appropriate, turns the equipment on and emits a message or alarm. The EAS system contains the digital codes to activate such systems and more sophisticated codes may be available in the future. It is also technically feasible to make these receivers “smart” so that they can understand what warnings the owner wishes to receive, and can even know their location relative to the hazardous event. One issue will be to keep the cost down. Another problem is that appropriate standards to facilitate market deployment of such systems do not exist. Since warnings are primarily issued by governments and these receivers are built and owned by private entities, there is a significant need for all stakeholders to work together to develop appropriate standards and approaches, perhaps with government seed money.

RECOMMENDATION: One or more working groups need to evaluate cost-effective ways of augmenting existing broadcast and communication systems to monitor warning information continuously and to report appropriate warnings to the people near the receiver.

Home
Next Section
Previous Section

RECOMMENDATION: Warnings should be delivered through as many communication channels as practicable so that those users who are at risk can get the message whether inside or outside, at home, work, or school, while shopping or in transportation systems. Delivery of the warning should have minimal effect on the normal use of such communication channels, especially for users who will not be affected.

RECOMMENDATION: The greatest potential for new consumer items in the near future is development of a wide variety of smart receivers and the inclusion of such circuits within standard receivers. A smart receiver would be able to turn itself on or interrupt current programming and issue a warning only when the potential hazard will occur near the particular receiver. Some communication channels where immediate expansion of coverage and systems would be most effective include NOAA Weather Radio, pagers, telephone broadcast systems, systems being developed to broadcast high-definition digital television (HDTV), and the current and Next Generation Internet.

Home
Next Section
Previous Section

12. Preparedness and Response Plans

Warnings will only be effective if people understand what to do when a warning is received. Considerable effort has been made by the National Weather Service, the U.S. Geological Survey, the American Red Cross, the media, and many other groups to provide disaster response information. In many areas, the front pages of the telephone book explain how to respond to medical emergencies, earthquakes, severe weather, and such as appropriate for the particular region. Any effort to improve warning delivery systems nationally needs to be accompanied by public education programs and efforts to do contingency planning. Some examples of current plans are:

- The Federal Response Plan (FRP) (FEMA, 1996) is a written document that sets out the specific roles of key Federal agencies in response to warnings and disasters.
- Most States and local communities have similar types of plans.
- Many States likely to be affected by the same event have developed plans for mutual aid and response. One example is the Central U.S. Earthquake Consortium (CUSEC) (http://www.cusec.org).
- The U.S. Army Corps of Engineers develops Catastrophic Disaster Response Plans (CDRPs) in anticipation of the most devastating events projected for a region. Currently, plans are being developed for earthquakes in New Madrid, Missouri; the Cascadia Subduction Zone from northern California to Washington; Puerto Rico; Boston; and Los Angeles; and for hurricanes making landfall on Oahu and in the Houston/Galveston area.

Home
Next Section
Previous Section

13. Alternatives for In-depth Information

Warnings also need to be followed with more in-depth information. The news media play a critical role in re-dissemination and explanation of warnings. The Internet is rapidly become a source of real-time information and background information and should become even more utilized when videos are routinely transmitted. FEMA often operates a Disaster Recovery TV Channel during the recovery phase in a region severely damaged by a disaster. There may be widespread interest in a television channel dedicated to disaster-related education, preparedness, and response information. Ongoing education and contingency planning are important parts of the warning process.

14. A Plan for Action

This report shows that

- Disasters are an expensive and growing problem.
- Timely and accurate warnings can empower people to take actions that will reduce disaster losses, speed response, and make recovery more effective.
- Scientists are providing more frequent and more accurate warnings.
- Current warning delivery systems have inherent limitations.
- Technology exists to deliver warnings that are much more accurately targeted to the people at risk.
- Warnings are primarily issued by government entities, but warning distribution systems are primarily owned and operated by private entities.
- Improvement of the current system depends either on all stakeholders developing standards and systems that are mutually beneficial or the government mandating some type of system.

We believe that development of some type of public/private partnership is the most effective way to proceed. One example of such a partnership is the Intelligent Transportation Society of America (ITS America). ITS America was founded in 1991 to bring automobile manufacturers and highway infrastructure engineers and managers together to determine ways to bring the information age into the automobile and our highway systems. This not-for-profit corporation in the District of Columbia also acts as a Federal advisory committee so that it can provide official advice not only to industry but also to the government. The organization currently has approximately 45 technical committees that bring appropriate stakeholders together to build consensus on the best ways to solve specific technical problems. The organization also has many state chapters and foreign affiliates.

Any partnership needs to be based on an understanding of shared needs and the needs of each of the partners. Broadcasters have contributed considerably to the development of EAS. They have also expressed concerns about unnecessary interference with programming, possible illicit use of warning dissemination systems, and liability issues related to broadcasting or not broadcasting warnings.

There is also a need for seed money or funds for developing prototypes.

Disasters cut across every boundary that exists: political, geographic, professional, disciplinary, cultural, and such. At one time or another, nearly every citizen is faced with preparing for or responding to a disaster. Issuing warnings of potential disasters also involves many different types of people and organizations from scientists and engineers to manufacturers and sales people. The challenge is to find the most effective ways for these different people and different organizations to work together. Throughout this report we have identified specific needs for consensus building and standards. In the fast-moving fields of computers, communications, and information,

Home
Next Section
Previous Section

we need to seek more effective ways to meet these needs. We need to involve resources of private enterprise in meeting public needs for safety in ways that are commercially viable and that will endure.

RECOMMENDATION: A public/private partnership is needed that can leverage government and industry needs, capabilities, and resources to deliver effective disaster warnings. The Disaster Information Task Force (1997) that examined the feasibility of a global disaster information network has also recommended such a partnership. The partnership might be in the form of a not-for-profit corporation that brings all stakeholders together, perhaps through a series of working groups, to build consensus on specific issues for implementation and to provide clear recommendations to government and industry.

This report has focused on the problems of delivering warnings reliably to only those people at risk and to systems that have been preprogrammed to respond to early warnings. There are many other aspects of the warning process, such as improving the quality of warnings and improving the ways communities can respond to warnings that need to be addressed. A well-designed public/private partnership might play some important roles with these other aspects.

References

Advisory Committee on Public Interest Obligations of Digital Television Broadcasters, 1998. *Charting the Digital Broadcasting Future: Final Report*. Washington, D.C., 159 p. See http://www.ntia.doc.gov/pubintadvcom/piacreport.pdf

Balluz L, Schieve L, Holmes T, Kiezak S and Malilay J. 1997. *Predictors for people's response to a tornado warning: Arkansas*, 1 March 1997. *Disasters* 24(1): 71-77, 2000.

Disaster Information Task Force, 1997. *Harnessing Information and Technology for Disaster Management.* Washington, D.C. 253 p.

Department of Commerce, 1998. *Out of Harm's Way-2000.* 20 p.

EQE International, 1995. *The January 17, 1995, Kobe Earthquake, An EQE Summary Report.* See World Wide Website at http://www.eqe.com/publications/kobe/kobe.htm

FEMA, 1996. *The Federal Response Plan*. 306 p.

Hill, D. P., M. J. S. Johnston, et al., 1991. *Response Plans for Volcanic Hazards in the Long Valley Caldera and Mono Craters Area, California*. U.S. Geological Survey Open File Report 91-270, 94 p.

IRC, 1995. *Coastal Exposure and Community Protection, Hurricane Andrew's Legacy.* 48 p.

Liu, S., L. E. Quenemoen, J. Malilay, et al., 1996. *Assessment of a severe-weather warning system and disaster preparedness, Calhoun County, Alabama, 1994*. American Journal of Public Health, Vol 86, p. 87-89.

Mileti D. S. and J. H. Sorensen, 1990. *Communication of emergency public warnings: a social science perspective and state-of-the-art assessment.* Oak Ridge, Tennessee: Oak Ridge National Laboratory, 190 p.

Mileti, D. S., 1999. *Disasters by Design: A Reassessment of Natural Hazards in the United States*. National Academy Press, Washington, D.C. 350 p.

National Climatic Data Center, 1996. http://www.ncdc.noaa.gov/

National Research Council, 1991. *Real-time Earthquake Monitoring: Early Warning and Rapid Response*. National Academy Press, Washington, D.C. 52 p.

National Research Council, 1996. *Computing and Communications in the Extreme: Research for Crisis Management and Other Applications*. National Academy Press, Washington, D.C.176 p.

Home
Next Section
Previous Section

Nigg, J. M., 1995. *Risk communication and warning systems*. In: Horlick-Jones, T., A. Amendola, and R. Casale, editors, *Natural Risk and Civil Protection*. London, E & FN Spon, pp. 269-382.

Padovani, Elaine, 1997. Office of Science and Technology Policy, personal communication.

President's Information Technology Advisory Committee, 1999. *Information Technology Research: Investing in Our Future*. National Coordination Office for Computing, Information, and Communications, Arlington, VA, 80 pages. See http://www.ccic.gov/ac/report/

Risk Management Solutions, Inc., 1995. *What if a major earthquake strikes Los Angeles area?*

Risk Management Solutions, Inc., 1995. *What if the 1923 earthquake strikes again? A five prefecture Tokyo region scenario.*

Risk Management Solutions, Inc., 1995. *The Great Hanshin Earthquake.*

Risk Management Solutions, Inc., 1999, personal communication from Don Windeler.

Sullivan, T. J., T. S. Ellis, C. S. Foster, K. T. Foster, R. L. Baskett, J. S. Nasstrom, and W. W. Schalk, 1993. *Atmospheric Release Advisory Capability: Real-time Modeling of Airborne Hazardous Materials*. Bull. American Meteorological Society, Vol. 74, No. 12, pp. 2343-2361.

Tobin, G. A. and B. E. Montz, 1997. *Natural Hazards: Explanation and Integration*. The Guilford Press, New York. 380 pp.

United Nations Global Programme, 1996. *The Qinglong County Story*. See World Wide Website at http://www.globalwatch.org/ungp/qinglong.htm.

United States Department of Agriculture, Federal Emergency Management Agency, and United States Department of Commerce, 1999. *Saving Lives with an All-Hazard Warning Network*. 39 p.

Westinghouse, 1976. *Final Report, Low Cost Home Receiver Development, Decision Information Distribution System (DIDS)*, Contract: DAHC 20-73-C-0182, Westinghouse Defense and Electronics Systems Center, Baltimore, MD

Home
Next Section
Previous Section

Appendix 1: List of Acronyms

AM	Amplitude Modulation
ARAC	Atmospheric Release Advisory Capability
AWIPS	Advanced Weather Information Processing System
BSPP	Broadcast Station Protection Program
CARS	Cover America Response System
C-B/SMS	Cell-Broadcast/Short Message Service
CDMA	Code Division Multiple Access
CDRP	Catastrophic Disaster Response Plans
CEASa	Cellular Emergency Alert Service Association
CENR	Committee on Environment and Natural Resources
CONELRAD	Control of Electromagnetic Radiation
CRREL	Cold Regions Research Engineering Laboratory
CSEPP	Chemical Stockpile Emergency Preparedness Program
CTIA	Cellular Telephone Industry Association
CUSEC	Central US Earthquake Consortium
DAR	Digital Audio Radio
DBS	Direct Broadcast Satellites
DITF	Disaster Information Task Force
DRM	Digital Radio Mondiale
EAS	Emergency Alert System
EBS	Emergency Broadcast System
EMDAT	Emergency Events Database
EMWIN	Emergency Managers Weather Information Network
FCC	Federal Communications Commission
FDMA	Frequency Division Multiple Access
FEMA	Federal Emergency Management Agency
FIA	Flood Insurance Administration
FIPS	Federal Information Processing Standard
FM	Frequency Modulation
FRP	Federal Response Plan
GDIN	Global Disaster Information Network
GPS	Global Positioning Satellite
GSM	The Global System for Mobile communications
HDTV	High Definition Television
ITS	Intelligent Transportation Systems
IWIN	Internet Weather Information Network
LDAD	Local Data Acquisition and Dissemination
LP	Local Primary Source for EAS messages

Home
Next Section
Previous Section

NAWS	National Warning System
NCDC	National Climatic Data Center
NDIS	Working Group on Natural Disaster Information Systems
NEMIS	National Emergency Management Information System
NESDIS	National Environmental Satellite Data and Information Service
NOAA	National Oceanic and Atmospheric Administration, Department of Commerce
NRC	National Response Center
NRSC	National Radio Systems Committee
NSTC	National Science and Technology Council
NWR	NOAA Weather Radio
NWRSAME	NOAA Weather Radio Specific Area Message Encoding
NWS	National Weather Service of NOAA
NWWS	NOAA Weather Wire Service
OIG	Office of the Inspector General
OSTP	Office of Science and Technology Policy
PEP	Primary Entry Point for EAS messages
RDBS	Radio Broadcast Data System
RDS	Radio Data System
SAME	Specific Area Message Encoding
SNDR	Subcommittee on Natural Disaster Reduction
SP	State Primary source for EASl messages
SRD	Standards Requirements Document
TDMA	Time Division Multiple Access
TIA	Telecommunications Industry Association
UMC	United Methodist Church
UN	United Nations
US	United States
USGS	United States Geological Survey
USWRP	U.S. Weather Research Program
UTC	Universal Time Coordinated
VSAT	Very Small Aperture Terminal
WHCA	White House Communications Agency

Appendix 2: EAS Operations and Plans

National Level Activation and Messages. The White House Communications Agency (WHCA) Trip Officer, at the President's direction, activates the national EAS by contacting FEMA. FEMA controls activation of EAS equipment at 33 Primary Entry Point (PEP) broadcast stations. These broadcast stations are located in low-risk areas and they distribute the EAS Presidential messages. The PEP stations are designated as National Primary (NP) sources in the EAS. All of the other participating broadcast stations and cable systems activate EAS immediately upon receipt of the EAN event code from the NP stations. They activate EAS by transmitting the EAS digital codes, the two-tone Attention Signal, the audio messages alerting the public (including the Presidential message), and the End of Message (EOM) code.

United States Government official information is transmitted over the PEP system in the same manner as the Presidential audio message. If necessary, WHCA can directly access the PEP system and insert a Presidential message. PEP Stations have an emergency generator, fuel, and other equipment. The coverage area of the 33 PEP stations is 95 percent of the continental U. S. population, plus the territories of Guam, Puerto Rico, and the Virgin Islands. EAS State Primary (SP) sources monitor the PEP stations with their EAS equipment. They then activate their EAS equipment to trigger their State-level EAS network.

National Level Testing. Tests of the EAS equipment are required under FCC rules. However, EAS may be activated at the State or local level for emergency situations by a broadcast station or cable system in lieu of the following tests.

Required monthly tests of the EAS header codes, Attention Signal, Test Script, and EOM code are conducted by all broadcast stations and cable systems at least once a month. The tests originate from Local Primary (LP) or State Primary (SP) sources. Test time and script content are developed by State and local EAS advisory committees in cooperation with affected broadcast stations, cable systems, and other participants. These coordinated tests are transmitted within 15 minutes of receipt by all stations and cable systems in a State or an EAS Local Area.

Required weekly tests of the EAS codes are originated by all broadcast stations and cable systems at least once a week at random days and times. These tests require transmission of only the EAS header and EOM codes, not the Attention Signal and audio/video test scripts as required in the monthly tests.

Periodic national tests involving the National Primary (NP) sources are conducted as appropriate.

Home
Next Section
Previous Section

State and Local Level Operations. An Agreement signed in 1976 (later reaffirmed in 1982 as a Memorandum of Understanding) by the FCC, NWS, FEMA and the National Advisory Committee (NAC), details each organization's responsibilities to expand use of EAS for State and local emergencies. This is a unified effort to use EAS at the State and local levels to save lives and property. EAS is a complement to existing systems such as the National Warning System (NAWAS) and NOAA Weather Radio and Wire. The goal is a current plan for each State and territory and the 554 EAS Local Areas. All EAS plans are developed by industry and government volunteers and reviewed by the FCC for compliance with the FCC EAS rules and for enhancement of the national level EAS.

State and Local Area Activation. At the State level, EAS can be activated by the Governor, State Emergency Management Director, or the National Weather Service by contacting the State Primary (SP) source. The SP is a broadcast or other communications facility. This source activates the State EAS by transmitting the EAS signals that are relayed through the State EAS Relay Network. The Network is monitored in EAS Local Areas by Local Primary (LP) sources. LP sources then alert all remaining broadcast stations and cable systems in their EAS Local Areas. Some States use satellites, microwave, or dedicated telephone circuits as their State Relay Network.

At the EAS Local Area level, EAS can be activated by a Mayor, local Emergency Management, or the National Weather Service by contacting the Local Primary (LP) sources. LP sources are broadcast or other communications facilities that activate the EAS Local Area by transmitting the EAS signals to all stations and cable systems in their area.

Authentication and Testing. Authentication at the State and local level is left to the discretion of emergency officials, broadcasters, and cable operators. Some methods include: agreement on EAS codes to be used for certain emergencies; code words; call back telephone numbers; hotline circuits; two-way radio systems; and so forth. Authentication is required only between officials requesting activation and key EAS sources.

Coordinated State and EAS Local Area testing is encouraged by the FCC and specified in the State EAS plan. Coordinated tests involve government officials, broadcast stations, and cable systems, and are in lieu of the required FCC tests.

EAS Plans. Of the 50 States and 6 Territories, 38 have final plans and 11 have drafts. Of the 554 EAS Local Areas, 100 have final plans and 17 have drafts.

EAS Activations. EAS is activated for almost every major emergency. One method the FCC uses to evaluate EAS effectiveness is the use of a voluntary reporting system of EAS activations. Broadcasters and cable operators report activations by letter, FCC postcard, e-mail (eas@fcc.gov), and phone. Since 1976, the FCC has received 23,194 reports.

Home
Next Section
Previous Section

1999 - 356	1993 - 1,887	1987 - 831	1981 - 729
1998 - 693	1992 - 2,038	1986 - 1,167	1980 - 252
1997 - 387*	1991 - 1,425	1985 - 1,146	1979 - 252
1996 - 1,280	1990 - 1,522	1984 - 1,007	1978 - 944
1995 - 1,722	1989 - 1,274	1983 - 1,140	1977 - 55
1994 - 1,357	1988 - 524	1982 - 1,206	

* First year of EAS operation

Several hundred stations have voluntarily participated in EAS statewide and special tests. Statewide tests usually occur in conjunction with severe weather education events, and special tests are often scheduled for areas near nuclear plants. EAS has been approved by FEMA and the Nuclear Regulatory Commission as a method for alerting the public near nuclear plants.

Sources of EAS/EBS Activation Requests. In order to determine the sources of EBS/EAS activation requests at the State and local levels, the FCC evaluated the voluntary reports for two different time periods when the system was still EBS. The reports specify the source of the requests for EBS activation such as NWS, EBS decoder/receiver, broadcast station staff, wire service, or local official. Many stations rely on their EAS/EBS equipment because they cannot afford news staff, wire service, or NOAA Weather Radio or Wire to obtain emergency information. According to the reports, the percent of stations receiving alerts on their EBS equipment increased 100 percent from the 1983-1986 time period to the 1990-1992 time period (7 percent to 14 percent). This may be explained by stations cutting their costs by dropping other information sources and by increased EBS training and awareness.

1. Reports for 1990, 1991 and 1992.

Organization requesting EBS Activation	1990	1991	1992	Total	Percent of Total
National Weather Service	911	992	950	2853	68 percent
Emergency Services	131	72	129	332	8 percent
Broadcast station staff	113	35	48	196	5 percent
EBS receiver alert	194	130	241	565	14 percent
Other (wire service, etc.)	99	80	44	223	5 percent
	1448	1309	1412	4169	

2. Reports for January, 1983, through April, 1986.

Organization requesting EBS Activation	1983	1984	1985	1986	Total	Percent of Total
National Weather Service	1088	917	868	118	2991	76 percent
Emergency Services	78	95	176	52	401	10 percent
Broadcast station staff	68	75	112	10	265	7 percent
EBS receiver alert	85	92	66	15	258	7 percent
	1319	1179	1222	195	3915	

Home
Next Section
Previous Section

Of the 1,887 EBS activations reported in 1993, 895 (47 percent) were by key local EBS stations. These stations not only alert their own audience, but they also alert many other stations that monitor their signal for EBS alerts and tests.

From 1977 until August, 1994, the 18,396 reports received by the FCC were distributed by State and territory as follows:

Alabama	152	Kentucky	673	Oklahoma	134
Alaska	29	Louisiana	229	Oregon	45
American Samoa	1	Maine	11	Pennsylvania	1,901
Arizona	35	Maryland	199	Puerto Rico	24
Arkansas	137	Massachusetts	468	Rhode Island	29
California	174	Michigan	295	South Carolina	96
Colorado	27	Minnesota	252	South Dakota	104
Connecticut	38	Mississippi	122	Tennessee	127
Delaware	19	Missouri	1,580	Texas	3,107
Dist. of Columbia	14	Montana	9	Utah	8
Florida	191	Nebraska	259	Vermont	38
Georgia	73	Nevada	15	Virginia	231
Guam	0	New Hampshire	41	Virgin Islands	6
Hawaii	25	New Jersey	97	Washington	122
Idaho	49	New Mexico	528	West Virginia	87
Illinois	486	New York	437	Wisconsin	317
Indiana	1,832	North Carolina	996	Wyoming	25
Iowa	88	North Dakota	46		
Kansas	43	Ohio	2,270		

Broadcast Station Protection Program (BSPP). BSPP is jointly administered by the FCC and FEMA. FEMA funds BSPP, but there have been no funds in recent years. BSPP provides emergency equipment to key EAS sources. The sources purchase equipment (emergency generators, two-way radios, etc.); are reimbursed by FEMA; and sign an Equipment Loan Agreement with the FCC. The BSPP also funded the equipment for broadcast stations in the PEP system. Much of the original equipment was installed in the 1960's and is obsolete. The FCC inspects the equipment, which can also be used for day-to-day operation. In 1997, FEMA recommended that the FCC begin terminating many of the agreements. The equipment is being turned over to many of the stations, including the underground fuel tanks. Presently there are 373 agreements with an equipment inventory of $6,801,257

Appendix 3: Existing Federal Warning Systems

NAME OF THE SYSTEM:	**AWIPS/NOAAPORT**
Operated by:	National Weather Service
Locations where available:	Nationwide
Technical means:	C-Band Satellite Broadcast
Robustness of transmitters:	Redundant telecommunications and systems
Receiving equipment required:	Satellite earth station with 3-4 meter antenna
Robustness of receivers:	NA
Cost of receiving equipment:	Over $50,000
Cost of subscription:	None
Intended users:	High-end weather information users-weather industry, researchers, and such
Types/volumes information sent:	Multiple T-1 transmission of GOES imagery and most of NWS product set
Frequency of use:	Continuous
Benefits:	Most NWS products available on a single datastream
Problems:	Cost and size of receiver/earth station required
Contact address:	National Weather Service, Wx22/RM 11216/ SSMC#2 1325 East West Highway Silver Spring, MD 20910
Contact telephone:	(301) 713-1975

NAME OF THE SYSTEM:	CARS: COVER AMERICA RESPONSE SYSTEM
Operated by:	Contractor for FIA, FEMA
Locations where available:	Hyattsville, MD
Technical means:	Computer monitoring of telephone system
Robustness of transmitters:	Redundant Servers
Receiving equipment required:	None
Robustness of receivers:	NA
Cost of receiving equipment:	None
Cost of subscription:	NA
Intended users:	Information used by Flood Insurance Administration (FIA)
Types/volumes information sent:	Data on the general location of 3,500-4,000 callers per week and the type of media (TV, Radio, Print) used to inform them of FIA programs
Frequency of use:	Daily
Benefits:	Tracks and helps manage Cover America marketing program
Problems:	Normal problems associated with a new system starting up
Contact address:	FEMA Headquarters 500 C St. SW, Washington, DC 20472

Home
Next Section
Previous Section

NAME OF THE SYSTEM:	**EAS: EMERGENCY ALERT SYSTEM**
Operated by:	FCC in cooperation with FEMA and NOAA
Locations where available:	14,000+ AM, FM, TV stations and 33,000+ cable systems
Technical means:	Main audio (radio) and video (TV) channels
Robustness of transmitters:	Redundant activation centers. Many stations have backup generators and fuel tanks
Receiving equipment required:	Users receive signals over ordinary AM, FM radios or TV
Robustness of receivers:	Receivers at each station monitor up to 4 other stations.
Cost of receiving equipment:	Consumer devices less than $100. Decoding equipment is being built into new radios and TVs.
Cost of subscription:	No cost
Intended users:	Broadcasters, cable operators, and the public
Types/volumes information sent:	Digital package and up to 2 minutes of voice message. Emergency information and instructions. State and local activation for emergency weather information is common. Volume is variable.
Frequency of use:	Weekly tests. Activation on a state or local basis is more frequent.
Benefits:	Provides a national system for the broadcast of official emergency information
Problems:	Training of industry personnel to use equipment properly.
Contact address:	Room 7-C723, 445 12th Street, Washington, DC 20554
Contact telephone:	(202) 418-1160, fax (202) 418-2817, e-mail EAS@fcc.gov
Contact address:	FEMA, 500 C St. SW Washington, DC 20472

Home
Next Section
Previous Section

Contact telephone: (202) 646-3363

NAME OF THE SYSTEM: EMWIN: EMERGENCY MANAGER'S WEATHER INFORMATION NETWORK

Operated by: National Weather Service (NWS)

Locations where available: Anywhere GOES satellite transmission can be received

Technical means: Communications (WEFAX) channel on GOES series of satellites with redistribution on a number of radio transmissions

Robustness of transmitters: Delivery of products to GOES uplink via NWWS

Receiving equipment required: Receiver capable of receiving 1610 MHZ signal, demodulating and depacketizing received signal

Robustness of receivers: Up to user

Cost of receiving equipment: Less than $1,000

Cost of subscription: None

Intended users: Emergency managers and public

Types/volumes information sent: Defined set of alphanumeric products, graphics, and limited satellite imagery

Frequency of use: Continuous broadcast

Benefits: Low cost to user, good graphical user interface software

Problems: Timeliness limited by other information collection, telecommunications, and processing systems used to collect, assemble, and transmit EMWIN data stream

Contact address: National Weather Service, OSO12/RM 16324/ SSMC#2
1325 East West Highway
Silver Spring, MD 20910

Contact telephone: (301) 713-0191

Home
Next Section
Previous Section

NAME OF THE SYSTEM:	**FEMIS: FEDERAL EMERGENCY MANAGEMENT INFORMATION SYSTEM USED ON THE CHEMICAL STOCKPILE EMERGENCY PREPAREDNESS PROGRAM (CSEPP)**
Operated by:	U.S. Army, State, and local counties
Locations where available:	At present 3 of the 8 sites are on line. This will expand to all 8 sites with 10 states participating.
Technical means:	Complex network using several media (Microwave, Fiber Optic, and Landline) routers, hubs, and other equipment
Robustness of transmitters:	Networks have been designed to eliminate single points of failure. Redundant paths.
Receiving equipment required:	Routers, hubs, and servers
Robustness of receivers:	Extensive protection of network and equipment Redundant equipment and paths
Cost of receiving equipment:	U.S. Army pays for all equipment.
Cost of subscription:	U.S. Army pays all recurring costs.
Intended users:	Local and State emergency management officials
Types/volumes information sent:	GIF files of the area impacted by an incident, the daily work plan for the depot, text, meteorological data, control for alert and notification systems (two way radios, signals, etc.) status information. Volume is variable.
Frequency of use:	Several times daily under normal operating conditions. In the exercise mode and during a real incident, use will be constant.
Benefits:	Provides the emergency managers in the communities surrounding CSEPP sites with the vital information required to manage an incident and mitigate damages and loss of life. It also has a planning tool to develop and test plans and responses to different types of situations.
Problems:	The system is in the process of being deployed. Some peculiarities and bugs have been found and corrected to date.
Contact address:	FEMA, 5321 Riggs Rd., Gaithersburg, MD 20882-1817
Contact telephone:	(301) 926-5372

Home
Next Section
Previous Section

NAME OF THE SYSTEM:	**FAMILY OF SERVICES (FOS)**
Operated by:	National Weather Service (NWS)
Locations where available:	Anywhere a leased telephone line can be installed
Technical means:	Transmission of various information product sets from NWS Telecommunications Gateway in Silver Spring, Maryland, to end users over commercial telephone lines
Robustness of transmitters:	Dedicated servers in NWS Gateway
Receiving equipment required:	Telephone line and modem compatible with characteristics of transmitted data set
Robustness of receivers:	NA
Cost of receiving equipment:	0 - $5,000
Cost of subscription:	$10,500 - $60,000 (dependent on service selected)
Intended users:	Users that require direct access to large sets of data and information collected and processed at NWS Telecommunications Gateway
Types/volumes information sent:	Selection of many NWS products, including weather maps previously supplied by DIFAX
Frequency of use:	Continuous
Benefits:	Simple access to many NWS products at single location
Problems:	Timeliness of delivery is limited by the architecture of the telecommunications and processing network used in the collection of information from NWS offices and centers, and in the packaging and delivery of the resultant products to end users.
Contact address:	National Weather Service, OSO151/RM 5320/ SSMC#2 1325 East West Highway Silver Spring, MD 20910
Contact telephone:	(301) 713-1741

Home
Next Section
Previous Section

NAME OF THE SYSTEM:	**NAWAS: NATIONAL WARNING SYSTEM**
Operated by:	FEMA R&R NECC
Locations where available:	2,200 POINTS, 1,800 in offices manned 24 hours a day
Technical means:	Dedicated telephone network
Robustness of transmitters:	Multiple paths, automatic "failover" equipment. Four-wire system/2-wire can be used as fallback.
Receiving equipment required:	Telephone Type Sets (Comlabs)
Robustness of receivers:	Four wire/2-wire cutover, random daily tests
Cost of receiving equipment:	NA
Cost of subscription:	Recurring cost of $3.1 million per year paid by FEMA
Intended users:	National, regional, State, local: county/ city, sheriff, fire, and rescue services
Types/volume information sent:	Emergency information, emergency weather information, tests, missing aircraft, forest fire information, etc. Volume is variable.
Frequency of use:	Minimum of daily tests
Benefits:	National/Regional/State/Local notifications of emergency events and conditions
Problems:	Occasional circuit outage. Accidental telephone company testing on NAWAS circuits can cause operators to "tune out" or mute NAWAS monitor.
Contact address:	FEMA NECC, 19844 Blue Ridge Mountain Rd., Bluemont, VA 22012
Contact telephone:	(202) 631-6182

Home
Next Section
Previous Section

NAME OF THE SYSTEM: NEMIS: NATIONAL EMERGENCY MANAGEMENT INFORMATION SYSTEM.

Operated by:	Anteon, under contract to FEMA
Locations where available:	Prototype system
Technical means:	Independent Network, 4 prototype servers
Robustness of transmitters:	NA
Receiving equipment required:	NA
Robustness of receivers:	NA
Cost of receiving equipment:	NA
Cost of subscription:	NA
Intended users:	FEMA
Types/volumes information sent:	Access by computer to management data
Frequency of use:	Continuous
Benefits:	System for managing disaster assistance and administrative actions
Problems:	Under development
Contact address:	FEMA 500 C St. SW Washington, DC 20472
Contact telephone:	(202) 646-2888

Home
Next Section
Previous Section

NAME OF THE SYSTEM:	**NWR: NOAA WEATHER RADIO**
Operated by:	National Weather Service (NWS)
Locations where available:	All 50 States, Guam, Saipan, Puerto Rico, Virgin Islands
Technical means:	Over 520 VHF FM Radio Transmitters (162.400 - 162.550 MHZ @ 10 - 1000 watts) as of March 2000
Robustness of transmitters:	Programming done directly by forecasters at local NWS offices
Receiving equipment required:	Radio receiver that tunes VHF
Robustness of receivers:	NA
Cost of receiving equipment:	$15 and up
Cost of subscription:	None
Intended users:	Public, emergency managers, mariners, farmers, and others.
Types/volumes information sent:	Warnings, watches, forecasts, advisories, etc. that apply to local transmitter coverage area (approximately 5000 square miles)
Frequency of use:	Continuous 5-10 minute program segment continuously repeated and updated as necessary during severe weather and every 3 - 4 hours during benign weather
Benefits:	Timely delivery of critical information directly to public
Problems:	Only 75 percent to 85 percent of public currently has coverage. Due to VHF radio frequency, reception limited to line-of-sight
Contact address:	National Weather Service 1325 East West Highway Silver Spring, MD 20910
Contact telephone:	(301) 713-1738

NAME OF THE SYSTEM: NOAA WEATHER WIRE SERVICE (NWWS)

Operated by:	GTE for National Weather Service (NWS)
Locations where available:	All 50 states and Puerto Rico - Information uplinked from 20 NWS offices
Technical means:	C-Band, spread spectrum VSAT
Robustness of transmitters:	Every message redundantly uplinked
Receiving equipment required:	C-band satellite antenna and receiver
Robustness of receivers:	NA
Cost of receiving equipment:	$125 per month lease
Cost of subscription:	Included in lease cost
Intended users:	Mass news disseminators and emergency managers
Types/volumes information sent:	Over 7,000 alphanumeric and graphic products related to weather, earthquakes, space weather, and other hazards produced at local NWS offices and centers and delivered to end users in an average of 3-5 seconds.
Frequency of use:	Continuous
Benefits:	Timely, reliable, direct delivery of products to end users
Problems:	Cost to end user and proprietary nature of current satellite transmission and receiver design
Contact address:	National Weather Service, OSO153/RM 5307/ SSMC#2 1325 East West Highway, Silver Spring, MD 20910
Contact telephone:	(301) 713-0499
Contact address:	GTE, Information Systems Division 15000 Conference Drive Chantilly, VA 20151-3808

Home
Next Section
Previous Section

NAME OF THE SYSTEM:	**NOAA WEATHER WIRE SERVICE (NWWS) RECOMPETITION PREVIOUSLY IDENTIFIED AS NOAA WEATHER INFORMATION SERVICE (NWIS)**
Operated by:	Under contract to the National Weather Service
Locations where available:	Throughout the United States
Technical means:	To be determined (probably satellite)
Robustness of transmitters:	Uplinks at over 125 NWS Offices and Centers with operational backup capability provide redundant transmission of all information and tertiary redundancy for any critical information.
Receiving equipment required:	To be determined (Since the intention of NWWS is the universal, low cost delivery of NWS products to the public, it is anticipated that portions of the NWWS data stream will be made available on a number of delivery systems such as pagers, cable TV, Internet, and satellite TV.
Robustness of receivers:	NA
Cost of receiving equipment:	Determined by market
Cost of subscription:	None
Intended users:	Everyone requiring weather information
Types/volumes information sent:	Alphanumeric, graphics, and imagery. May include NEXRAD Doppler Radar products as option.
Frequency of use:	Continuous
Benefits:	Most timely access to locally prepared forecasts, advisories, watches, and warnings
Problems:	Implementation scheduled for 2000
Contact address:	National Weather Service, OSO153/RM 5306/ SSMC#2 1325 East West Highway Silver Spring, MD 20910
Contact telephone:	(301) 713-0026

Home
Next Section
Previous Section

Appendix 4: Primary Federal World-Wide-Web Sites for Disaster Information

General

Federal Emergency Management Agency (FEMA)
http://www.fema.gov

National Communications System (NCS) Emergency Response Link (ERLink) requires a password
http://www.ncs.gov/erlink.html

The Natural Disaster Reference Database (NDRD)
http://ltpwww.gsfc.nasa.gov/ndrd/disaster/

Communication

Federal Communications Commission, EAS
http://www.fcc.gov/eb/eas

Disease

Centers for Disease Control and Prevention
http://www.cdc.gov/

USGS National Wildlife Health Center
http://www.emtc.nbs.gov/nwhchome.html

Earth Science Hazards: Earthquakes, coastal storms, floods, geomagnetic storms, landslides, tsunamis, volcanoes, wildfire, wildlife diseases

U.S. Geological Survey
http://www.usgs.gov/themes/hazard.html

U.S. Army Corps of Engineers
http://www.usace.army.mil/inet/locations/bdry-pages/

NOAA National Tsunami Hazard Mitigation Center
http://www.pmel.noaa.gov/tsunami-hazard/

National Interagency Fire Center
http://www.nifc.gov/

Weather

National Weather Service
http://www.nws.noaa.gov

National Weather Service Interactive Weather Information Service
http://iwin.nws.noaa.gov/iwin/graphicsversion/main.html