Hazard Warnings and Warning Systems

<u>**Lecture Objectives:**</u>

-Know the main features and limitations of our national warning system

-learn the key features of an effective warning system

Sorensen, J.H. (2000) Hazard warning systems: Review of 20 years of progress. Natural Hazards Review, May, 119-125.

1. How has prediction and forecasting improved?
   (technology; major improvements: hurricanes, nuclear accidents; minor improvements: volcanoes, flood, earthquake)

2. How has warning integration (merging of monitoring/detection, social factors, to issue alerts/information) improved?
   (conversion to EAS; planning; study of “myths”; effectiveness)

3. How has warning dissemination improved?
   (clearer chain of command, technological advances, public awareness)

4. What do we know about responses to warnings?
   (hazard organizations need a clear role; physical public response known but not psychological)

Recommendations:
- create a national warning strategy;
- improve existing warning systems;
- improve and equalize understanding for range of hazards

What should a warning system do?

What information should a warning message include?

Effective Disaster Warnings

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

National Science and Technology Council
Committee on Environment and Natural Resources

November, 2000

http://www.fema.gov/ - currently unavailable

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. InformationAgency
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

Working group composed from major agencies involved in U.S. hazard mitigation (previous efforts were ad-hoc):

-communication
-meteorology
-transportation
-engineering
-science
-health
-land use

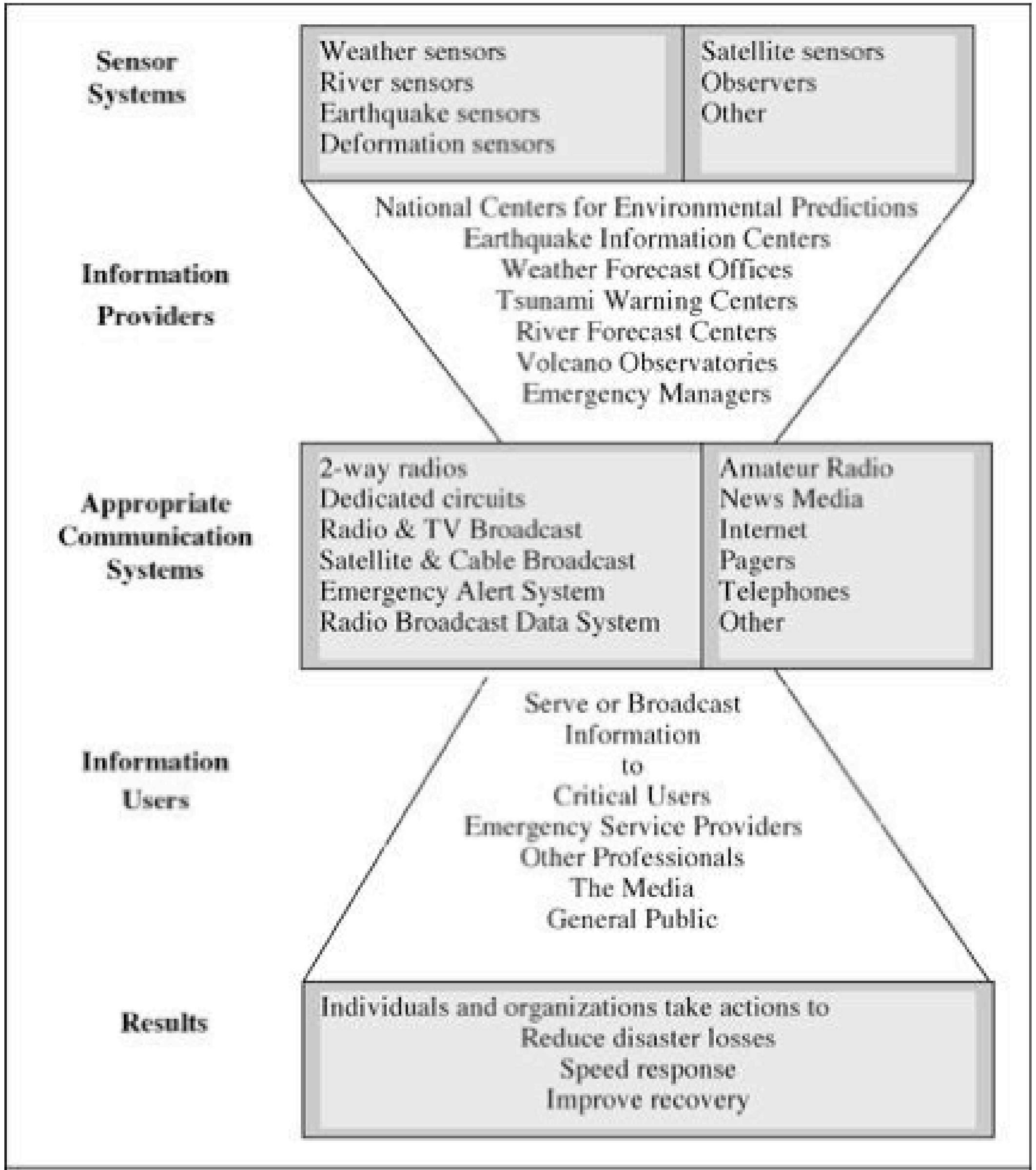

Figure 1: Major components of the warning process

Examples of warning failures:

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 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 was also not covered by NOAA Weather Radio.

February 22-23, 1998: Unusually strong tornadoes occurred in east and 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.

Emergency Alert System (EAS)

- Digital, replaced Emergency Broadcast System in 1994. Activated (local, state, national) hundreds of times each year

- At national level, only the president can issue an EAS. A special officer accompanies the president at all times, to contact FEMA, which then activates the EAS. Once the president uses it, FEMA can use it to distribute information.

- State and local officials can request EAS activation for emergencies

-FCC: coordinates all EAS activities related to industry

-station inspection

-review of all national, state and local EAS plans

-FEMA: coordinates all EAS activities related to government

-NWS: prepares and issues warnings for extreme weather events

Global Disaster Losses, 1972-1997

	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.

Why are floods and earthquakes so damaging?

EMDAT = Emergency Events Database (http://www.cred.be/)

Glossary

Affected people: People requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance (included in **total affected**); Appearance of a significant number of cases of an infectious disease introduced in a region or a population that is usually free from that disease.

Dead: Persons confirmed as dead and persons missing and presumed dead.

Estimated Damage: The economic impact of a disaster usually consists of direct (e.g. damage to infrastructure, crops, housing) and indirect (e.g. loss of revenues, unemployment, market destabilization) consequences on the local economy. For each disaster, the registered figure corresponds to the damage value at the moment of the event, i.e. the figures are shown true to the year of the event.

Homeless: People needing immediate assistance in the form of shelter (included in **total affected**).

Injured: People suffering from physical injuries, trauma or an illness requiring medical treatment as a direct result of a disaster (included **total affected**).

Miscellaneous accident: Disaster type term used to describe technological accidents of a non-industrial or transport nature (e.g. houses). It comprises of a number of disaster subsets: **Explosions**; **Collapses**; **Fires**; and other miscellaneous accidents involving domestic/non-industrial sites.

Total affected: People that have been **injured**, **affected** and left **homeless** after a disaster are included in this category.

U.S. disaster losses, 1972-1997

	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.

Measures of performance of the National Weather Service warnings

Warnings	1993	1994	1995	1996	1997	1998	1999 Est.	2000 Est.	2001 Est.	2002 Est.	2003 Est.	2004 Est.
Tornado												
Lead Time (mins)	6	7	10	10	10	11	12	12	13	13	14	15
Accuracy (%)	43	45	60	59	59	66	70	70	70	70	72	74
Severe Thunderstorms												
Lead Time (mins)	16	17	17	18	18	18	19	20	21	22	23	24
Accuracy (%)	70	72	75	82	82	84	84	85	86	87	88	89
Flash Flood												
Lead Time (mins)	22	18	26	39	45	52	41	46	48	50	55	58
Accuracy (%)	71	47	60	79	82	85	82	86	86	87	88	89
No Lead Time (%)	70	64	64	41	37	35	27	26	24	23	22	20
Temperature												
Correct forecast (%)	82	82	84	85	86	86	87	87	88	88	89	89
Accuracy of Forecast Onset of Freezing Temp (%)	65	65	72	74	76	77	78	80	82	82	83	84
Snow Amount												
Forecasting Heavy Snow (%)	37	39	42	44	45	50	55	60	65	70	70	72
Precipitation												
Lead time (days) for 1" forecast vs 1-day accuracy in 1971	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

Effective warning messages 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

USGS - Level of Concern Color Code for Volcanoes

Green Volcano is in its normal "dormant" state (normal seismicity and fumarolic activity is occurring).

Yellow Volcano is restless. Seismic activity is elevated. Potential for eruptive activity is increased. A plume of gas and steam may rise several thousand feet above the volcano which may contain minor amounts of ash.

Orange Small ash eruption expected or confirmed. Plume(s) not likely to rise above 25,000 feet above sea level. Seismic disturbance recorded on local seismic stations, but not recorded at more distant locations.

Red Large ash eruptions expected or confirmed. Plume likely to rise above 25,000 feet above sea level. Strong seismic signal recorded on all local and commonly on more distant stations.

Magnitude 9.0 - OFF THE WEST COAST OF NORTHERN SUMATRA
2004 December 26 00:58:53 UTC

Preliminary Earthquake Report

U.S. Geological Survey, National Earthquake Information Center

World Data Center for Seismology, Denver

A great earthquake occurred at 00:58:53 (UTC) on Sunday, December 26, 2004. The magnitude 9.0 event has been located OFF THE WEST COAST OF NORTHERN SUMATRA. (This event has been reviewed by a seismologist.)

Magnitude	9.0
Date-Time	**Sunday, December 26, 2004 at 00:58:53 (UTC)** = Coordinated Universal Time **Sunday, December 26, 2004 at 7:58:53 AM** = local time at epicenter Time of Earthquake in other Time Zones
Location	3.316°N, 95.854°E
Depth	30 km (18.6 miles) set by location program
Region	**OFF THE WEST COAST OF NORTHERN SUMATRA**

HURRICANE GORDON ADVISORY NUMBER 28
NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL AL072006
500 PM AST SUN SEP 17 2006

...GORDON FINALLY MOVING NORTH-NORTHEASTWARD...

AT 500 PM AST...2100Z...THE CENTER OF HURRICANE GORDON WAS LOCATED NEAR LATITUDE 34.6 NORTH...LONGITUDE 52.4 WEST OR ABOUT 1430 MILES ...2300 KM...WEST OF THE AZORES.

GORDON IS MOVING TOWARD THE NORTH-NORTHEAST NEAR 14 MPH...22 KM/HR ...AND A NORTH-NORTHEAST TO NORTHEAST MOTION WITH AN INCREASE IN FORWARD SPEED IS EXPECTED DURING THE NEXT 24 HOURS.

MAXIMUM SUSTAINED WINDS ARE NEAR 80 MPH...130 KM/HR...WITH HIGHER GUSTS. GORDON REMAINS A CATEGORY ONE HURRICANE ON THE SAFFIR-SIMPSON HURRICANE SCALE. LITTLE CHANGE IN STRENGTH IS FORECAST DURING THE NEXT 24 HOURS.

HURRICANE FORCE WINDS EXTEND OUTWARD UP TO 25 MILES...35 KM…FROM THE CENTER...AND TROPICAL STORM FORCE WINDS EXTEND OUTWARD UP TO 115 MILES...185 KM.

ESTIMATED MINIMUM CENTRAL PRESSURE IS 983 MB...29.03 INCHES.

REPEATING THE 500 PM AST POSITION...34.6 N...52.4 W. MOVEMENT TOWARD...NORTH-NORTHEAST NEAR 14 MPH. MAXIMUM SUSTAINED WINDS…80 MPH. MINIMUM CENTRAL PRESSURE...983 MB.

THE NEXT ADVISORY WILL BE ISSUED BY THE NATIONAL HURRICANE CENTER AT 1100 PM AST.

FORECASTER MAINELLI/AVILA