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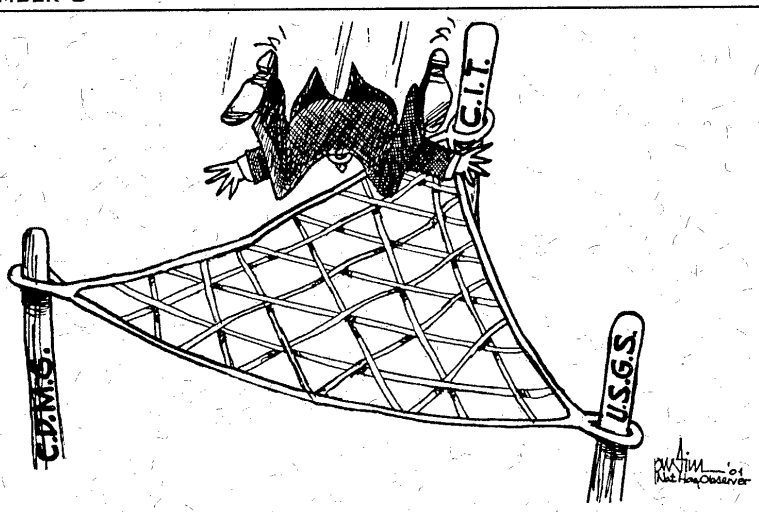

TriNet

New Tools for Rapid Earthquake Response Through Interdisciplinary Research

—an invited comment

Immediately following a damaging earthquake, emergency managers must quickly assess the situation and make response decisions. Where are the major incidents? What resources must be mobilized and in what quantities? What areas have sustained damage and what areas are relatively free of damage? Will mutual aid be needed?

Typically, first response organizations learn the answers to these questions through reconnaissance, police and fire services reports from the stricken areas, and information gathered from other agencies. Reconnaissance requires hours and sometimes days to complete; however, decisions regarding search and rescue, medical emergency response, mass care and shelter, and other critical response needs must be made quickly on the basis of available information. Often, this information is inadequate.

Historically, California's seismic networks have contributed to reconnaissance efforts after major earthquakes and provided, within the limits of available technology, rapid information on seismic activity. The information generated by the networks has, since the 1980s, included the magnitude, location, and identification of the ruptured fault, and, more recently, the probability of damaging aftershocks. While useful, this information was not sufficient to support critical postearthquake emergency management decisions. With the implementation of TriNet in 1997, this situation has changed in southern California.

In an assessment of seismic network performance conducted following the 1994 Northridge earthquake, scientists concluded that use of new digital equipment, modern data communications methods, and advanced computing could greatly improve the accuracy and timeliness of seismic information and provide useful decision support tools for emergency responders. In the months that followed Northridge, seismologists responsible for network operations assembled a proposal for a state-of-the-art seismic and strong motion network that would serve the needs of emergency management while also supporting scientific investigation and building code development. In 1997, the Federal Emergency Management Agency (FEMA), the California Governor's Office of Emergency Services (OES), the U.S. Geological Survey (USGS), and other partners agreed to provide funding for the network.

The TriNet project is named for the three organizations that have collaborated to build this network: the California Institute of Technology, the State of California Division of Mines and Geology (CDMG), and the USGS. This five-year

project will be completed at the end of 2001. The TriNet budget of approximately $21 million, including matching funds, has been invested in hardware, software development, data communications, and an outreach program that seeks to move technology from the laboratory to the emergency operations center. The real-time information products from TriNet are direct results of the new digital seismic and strong motion networks and include the rapid broadcast and web posting of accurate and reliable information on magnitude, location, fault configuration, and ground shaking for all earthquakes in the region; maps showing the distribution of ground motion expressed as intensity, peak acceleration, and velocity; and a prototype earthquake early warning system.

TriNet also provides ground shaking data for regional loss estimation software, including FEMA's HAZUS program and the Early Post-Earthquake Damage Assessment Tool (EPEDAT) developed by EQE International, Inc. EPEDAT and HAZUS employ similar methodologies and provide similar outputs. However, they differ in that HAZUS is nationally applicable while EPEDAT is customized with detailed building inventories for five southern California counties. EPEDAT was developed for, and is used by, California OES and shared with Los Angeles, Orange, Riverside, San Bernardino, and Ventura counties.

In addition, TriNet fulfills the other goals outlined above, providing data to support seismological and earthquake engineering research and improvements in building codes—efforts led by CDMG.

The maps, which display ground motion, are particularly important for emergency management. Known as ShakeMap and available on the web at *www.trinet.org/shake*, these maps offer important information beyond magnitude and location of an earthquake's epicenter. Because they can see the geographic distribution of ground shaking within five minutes of an earthquake, emergency responders can rapidly determine what areas have been severely impacted and begin responding based on an accurate overall assessment of the scope of the disaster. In Northridge, as in the 1989 Loma Prieta earthquake, some areas of heavy damage were quickly identified through ground and aerial reconnaissance, but there were also relatively hidden pockets of severe damage that were belatedly discovered. These areas included Santa Cruz and Watsonville in 1989 and Santa Monica in 1994. In future quakes, ShakeMap will identify these areas quickly and help minimize delays in response. Since March 1997, these maps have been generated automatically within five minutes for earthquakes as small as magnitude 3.5 and as large as the magnitude 7.1 Hector Mine earthquake that occurred on October 16, 1999.

The rapid loss estimation software programs used by local, state, and federal agencies to calculate damage and population impacts in an earthquake now utilize ground motion data from TriNet. HAZUS and EPEDAT calculate estimates of economic loss as both total dollar loss and losses to structures and contents; damage in terms of the number of red- (unsafe to reoccupy) and yellow- (restricted access) tagged buildings (both residential and commercial); damage to water, power, and natural gas infrastructure; and population impacts, including the number of casualties and persons displaced from their homes. Prior to the advent of TriNet, these loss estimation systems attempted to estimate ground motion based on quake magnitude and location. Using actual ground motion data will reduce the number of assumptions necessary for modeling damage and should improve the accuracy of loss estimates.

Perhaps the most intriguing of the new technologies being developed through the TriNet project is a prototype earthquake early warning capability that will, for some earthquakes, provide a few seconds warning prior to the arrival of strong ground motion. Early warnings may provide the opportunity to take life safety measures and mitigate hazards, albeit in a very short period of time. The earthquake early warning component of the TriNet project was approached as a multidisciplinary effort that involved the Disaster Research Center (DRC) at the University of Delaware (see p. 23 of this ***Observer***), the Center for Public Health and Disaster Relief at the University of California–Los Angeles (UCLA), EQE International, Inc., and several TriNet working groups.

The DRC first conducted a comprehensive assessment of the social science literature regarding both warning systems for other hazards and behavioral response to warnings. Building on these insights, the UCLA center conducted a survey of 200 organizations to assess the acceptability and feasibility of introducing earthquake early warning among four sectors of the community: education, health care, emergency management, and utilities and transportation lifelines. With both of these studies in hand, EQE International addressed the salient public policy issues raised by the introduction of earthquake early warning in California, including potential legal liabilities, costs and benefits, and the organization and management of a warning system. These studies will set the stage for the selection of early warning pilot project partners with whom TriNet will test this emerging technology.

The TriNet products hold great promise for improving emergency response after the next major earthquake in southern California. As it has proceeded, the project has benefited from the reservoir of experience held by the emergency services community, and it is through the cooperative efforts of many disciplines that earthquakes will be better understood and response will be more rapid and efficient. Based on the success of TriNet, a committee of scientists and emergency managers from northern and southern California is seeking state funding to implement the California Integrated Seismic Network. On an even larger scale, Congress has authorized and provided initial seed funding for the Advanced National Seismic System (ANSS), a USGS project that would develop a TriNet-like system for the entire nation.

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For additional information about TriNet, see the project web site: *www.trinet.org*; or contact the authors at the *Seismological Laboratory, Office of Earthquake Programs, MC 252-21, California Institute of Technology, Pasadena, CA 91125, e-mail: jgoltz@gps.caltech.edu or hauksson@gps.caltech.edu.*

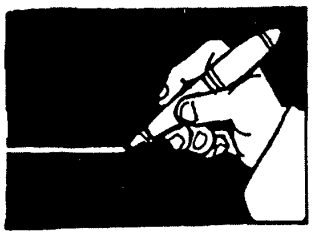
The Gilbert F. White Natural Hazards Mitigation Chair

The University of Colorado and the Natural Hazards Research and Applications Information Center have launched a major fundraising effort to establish an endowed faculty position dedicated to understanding and reducing loss caused by disasters.

Named after the center's founder and long-time mentor, the Gilbert F. White Natural Hazards Mitigation Chair will honor White by reflecting his life-long dedication to furthering knowledge and research regarding ways to alleviate human suffering caused by natural hazards. The post will ensure that hazards mitigation remains at the forefront of scholarship in social science. The chair will be open to any relevant discipline and will reside at the Natural Hazards Center, which is part of the university's Institute of Behavioral Science.

On May 2 of this year, in a ceremony at the Natural Hazards Center, Becky Turner, a representative of the State Farm Fire and Casualty Insurance Company and State Farm General Insurance Company, presented a check for $100,000 toward the position. The donation represents the initial step in a University of Colorado Foundation campaign to raise $3 million to endow the chair by White's 90th birthday on November 26.

Persons interested in learning more about or donating toward the Gilbert F. White endowed chair should contact *Linda Bachrach, C.U. Foundation, P.O. Box 1140, Boulder, CO 80306-1140; (303) 492-5689; e-mail: Linda.Bachrach@cufund.colorado.edu.*



On the Line

Effective Disaster Warnings
A National Tragedy

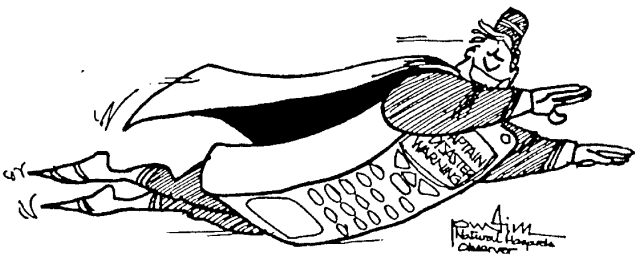
How many Americans know what to do when a tornado touches down in their county? How should they respond when the main highway is closed because of a chemical spill or terrorists have poisoned the local water system? How can local officials warn them that a flash flood has been spotted near where they live or work?

Accurate information delivered in a timely way can determine whether individuals take appropriate actions that protect themselves and their families, or dither about what to do, or even take steps that increase their risk.

Current news broadcast systems work well for long-term warnings such as those for hurricanes. Many days before a storm reaches the coast, network and local news channels can provide reasonable estimates of landfall and intensity. On a shorter scale, although the exact track of a tornado is difficult to predict, if an effective communication system is available, the tornado's progress can be monitored and communities in its path can be alerted minutes before it arrives. Warnings for chemical spills, terrorist acts, flash floods, or earthquakes, however, are rarely available before they occur, but accurate information immediately following the incident can often be used very effectively to reduce losses.

Scientists are improving the accuracy of and increasing the lead time for warnings. At the same time, emergency responders are improving their information gathering and

response systems. Yet, there is still a problem delivering critical information over the last mile—that is, to the people at risk no matter where they are and what they are doing. Experience shows that when people are showered with warnings that do not apply directly to them, they tend to tune out all subsequent advisories. To overcome this problem and improve individual response, warnings need to focus only on those at risk. In this technological age, numerous systems can accomplish this task, yet none have been implemented in the United States.



The underlying issues in this country are widespread confusion over the appropriate roles of government and industry, a substantial lack of coordination among government agencies and private sector groups, and a lack of resources devoted to the problem. The poor state of warning systems in the U.S. is indeed a national tragedy.

A recent report, ***Effective Disaster Warnings***, released by the National Science and Technology Council (NSTC), describes existing warning systems, the basic issues involved in providing effective warnings, and the many technologies that could be used to issue timely warnings. The report's primary conclusion is that a public-private partnership is needed to bring the appropriate groups together to implement effective warning systems. The council points out that most warnings are currently issued by federal, state, and local government authorities, but most current or potential warning delivery systems are owned and operated by private industry. The inadequate coordination among them is the result of historical approaches to warnings, unclear signals from several different branches of government, fears of government mandate, and the difficulties of finding private investors for "government-related" ventures.

Our current national warning system is the Emergency Alert System (EAS), managed by the Federal Communications Commission and implemented by private broadcasters under government mandate. This system, originally designed to allow the president to address the nation in times of national crisis, interrupts local programming. Most broadcasters and advertisers are not excited about increasing the number of regional and local warnings their stations already provide, and, as stated before, the EAS reaches many more people than those at risk from most hazards. Although digital coding technology can focus a warning on a small area and transmit it to that location, few individuals have receivers that can decode these messages.

The National Oceanic and Atmospheric Administration's NOAA Weather Radio (NWR), another national system, can be transmitted to over 95% of the population. It provides regular weather forecasts for the region surrounding each transmitter and issues warnings in both audio and digital formats. Unfortunately, this system uses a federal radio frequency far away from the AM/FM bands assigned to commercial broadcasters and thus requires a special receiver. Imagine how much more effective NWR would be if it could transmit to built-in circuitry in every radio and television in the U.S. This circuitry would be able to detect local warnings and interrupt programming or even turn on a receiver, increase the volume, and issue a warning only to those to whom it applies. The Radio Data System (RDS) does this in the FM band and is in widespread use in Europe, but is not available in the U.S.

Cellular telephones are becoming an American fixture; 111 million are currently in use, and rapid growth is anticipated in this market. The technology is available to broadcast to or dial up all telephones within a cell. Imagine how many lives could be saved issuing warnings to cell phone users as a tornado weaves across the countryside! Despite the determined effort of several citizens to promote such a system, providers have been slow to respond because they fear a government mandate similar to the requirements for the EAS. Furthermore, the confused roles of public and private groups make it difficult for industry to evaluate the business consequences of adopting this system.

Many entrepreneurs are developing systems to broadcast warnings only to people at risk. Some have found limited application around nuclear reactors and oil refineries, but market potential is limited by government programs and officials who favor outdated existing systems, by liabilities associated with issuing warnings, by the unclear delineations between public and private roles, by the reticence of investors to be associated with disasters or to be involved with government programs, and generally by the fog that obscures who is responsible for what and where the business opportunities lie.

It is time to bring the people on all sides of these issues together to set some clear goals, agree on roles, and deliver to the American people the effective warnings they deserve. We do not need more government. We need an effective public-private partnership.

Peter L. Ward
Chair
Working Group on Natural Disaster
Information Systems

The report ***Effective Disaster Warnings*** (2001, 56 pp.) is available on the World Wide Web at *www.nnic.noaa.gov/CENR/NDIS_rev_Oct27.pdf*. This report was the result of a year-long study by 19 federal employees from a dozen federal agencies who specialize in disaster warnings. This Working Group on Natural Disaster Information Systems (NDIS) was appointed by the Subcommittee on Natural Disaster Reduction under the NSTC's Committee on Environment and Natural Resources. For additional information about the working group, e-mail the author at *peward@wyoming.com*.

A New Special Publication from NHRAIC

On Hurricanes and Politics in Central America and the Caribbean

A year ago, researchers Richard Olson, Juan Pablo Sarmiento Prieto, Robert Olson, Vincent Gawronski, and Amelia Estrada published ***The Marginalization of Disaster Response Institutions: The 1997-1998 El Niño Experience in Peru, Bolivia, and Ecuador*** (Natural Hazards Center Special Publication #36—see the ***Observer***, Vol. XXIV, No. 5, p. 4, and *www.colorado.edu/hazards/sp/sp.html*). In their critical analysis of the organized response to El Niño, they show that most lessons from the earlier 1982-83 El Niño were lost—primarily because of a lack of prior planning and the political exigencies that emerged when the 1997-98 event became a major "catastrophe" that received national and global attention. Their principal finding is that, while at the outset the civil defense organizations in the respective countries were the nominal "national emergency organizations," each was rapidly pushed aside and replaced by one or more ad hoc governmental organizations, with resulting confusion, duplication of effort, weakened morale, and loss of credibility in each country's civil defense organization.

Would the same debilitating political process unfold following a high impact disaster such as a hurricane?

Well, in at least three cases, it did.

The Storms of '98: Hurricanes Georges and Mitch — Impacts, Institutional Response, and Disaster Politics in Three Countries, by Richard Olson, Ricardo Alvarez, Bruce Baird, Amelia Estrada, Vincent Gawronski, and Juan Pablo Sarmiento Prieto (Natural Hazards Center Special Publication #38, 2001, 68 pp.) examines the response and "disaster politics" (including media attention) associated with Hurricane Georges in the Dominican Republic and Hurricane Mitch in Honduras and Nicaragua. Again, a particular focus is the marginalization of agencies that were supposed to be the official response organizations. The authors conclude that

> despite some successes during the United Nations International Decade for Natural Disaster Reduction, it was sadly ironic that even as this much-publicized event was coming to a close, Hurricane Georges and especially Hurricane Mitch would devastate three countries. . . With this in mind, we need to step back and look at the entire situation for the Dominican Republic, Honduras, and Nicaragua (and many other countries, for that matter). A relatively simple equation can outline why disaster losses are going up, not down:
>
> > Population Growth + Urbanization + Mass Poverty-High Inequality + Deforestation and Other Environmental Degradation + Lack of Mitigation (Land Use and Building Standards) + Institutional (National Emergency Organization/Civil Defense) Weakness = Increasing Vulnerability and Eventual Catastrophe

As a list, this is hardly novel, but the combination of the first three variables sets the stage for Mitch-type catastrophes.

The authors go on to state that "disasters must be understood as innately political events . . . creating a variety of opportunities and constraints," and that institutional readiness is the direct result of political and policy decision making. Being political, such institution building is extremely difficult—particularly in countries with very limited resources and particularly when disasters are not salient problems.

To deal with the difficulty of establishing a strong, permanent emergency response institution, Olson and his colleagues offer their "accordion option." Under this approach, a national emergency organization recognizes its probable marginalization in a major disaster and therefore prepares a plan to be presented to the head of state if such an event should ensue. In that plan, the organization outlines how national-level disaster response can be expanded to include other ministries and organizations, while the emergency management office itself retains an organizing and coordinating role. The authors conclude by outlining the advantages of this approach.[1]

The Storms of '98: Hurricanes Georges and Mitch — Impacts, Institutional Response, and Disaster Politics in Three Countries can be purchased for $20.00, plus shipping ($5.00 for the U.S., Canada, and Mexico; $8.00 for international mail beyond North America). Orders should be directed to the *Publications Administrator, Natural Hazards Research and Applications Information Center, University of Colorado, 482 UCB, Boulder, CO 80309-0482; (303) 492-6819; fax: (303) 492-2151; e-mail: janet.kroeckel@colorado.edu.*

1. At least one of the authors (Olson) intends to continue his research into the apparently universal problem of the marginalization of disaster response institutions in large catastrophes (an issue not just in poorer countries)—see the *Grants* section of this ***Observer***.

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