Management of Catastrophic Events

By Ellis M. Stanley, Sr., CEM

What would happen to you and your family if you suddenly found yourself living in 1802 instead of 2002? Have you ever given this any thought? Are you prepared? What are your skills? What resources do you and your family have? How are your relationships with neighbors, friends or members of your church or civic organization?

On a day-to-day basis, we hear of stories in the news of wars, famine and pestilence. In the United States today, we constantly hear of carjackings, bombings, lost children, racial hate crimes, shootings, and more. Have you ever considered that the clock may be ticking and that these bad times, on a catastrophic scale, may someday be coming to you?

Are we that far away from Nuclear Devices being hijacked by terrorists and "A" bombs being smuggled into American cities - ready to be detonated remotely by a simple phone call? Many are preparing for troubled times. These enlightened individuals have much they can share with the rest of us; that is, until the storm is upon us. At that point, the time for preparation will be gone - lost to all who dismissed the possibility of catastrophic events.

The bigger question, then, is are we prepared to respond and recover from the 'BIG ONE'? Are we prepared from a local government perspective as well as from a grass roots community perspective? If not, why not, and what do we need to do to get to that state of readiness?

1.0 Catastrophic Events

When we think of catastrophic events we usually focus on those things that happen to someone else or someplace else. We usually focus on the "CNN" events. Those that bring about the most press but we seldom take into account things like the asteroid that nearly missed us the first week of January 2002 or the ongoing atmospheric phenomena that are responsible for, or are a result of, thunderstorms, tornadoes, and hurricanes.

How many of us are aware of the tools that this country has that could be utilized in our daily effort to mitigate, monitor or track our hazards. The use of satellites as a way of predicting and tracking hurricanes (and monitoring volcanic eruptions) is only one example that represent great potential for the emergency manager of the 21st century. Investigations of earthquakes involve a study of wave motion, seismic waves, plotting earthquake data, and the factors that cause earthquakes—including plate tectonics; Building model structures with features that can help reduce the damage caused by earthquakes; Simulate the movement and constructive effects of magma and lava on land formation, examine igneous rocks and volcanic ash, and investigate viscosity, crystallization, and the effects of ash fall on the atmosphere and surrounding landscape.

We are all aware that these tools (technology) are and have been available for some time and that the challenge is one of establishing relationships with the many partners in preparedness that might be required to assure our communities that we truly have the capability to manage emergencies and catastrophic events.

Have we as emergency managers created academic/scientific strategic plan that is linked to institutions such as the National Weather Service so that when we can understand the global issues? Do we understand why catastrophic weather and climatic change impacts the violent meteorological events that seem to be occurring with greater frequency. For example, why do hurricanes always move from east to west? Is there a correlation between the number of hurricanes that develop each year and average sea surface temperatures? Why are tornadoes so common in the middle part of the country during the early part of spring? What is a Nor'easter and why do they move to the north along the east coast of the United States? Perhaps the greatest question regarding fierce weather events concerns what they might tell us regarding changes in our climate. How do these occurrences and such global phenomena as El Nino and the attendant "strange weather" fit into present models of climatic change?

All one has to do is scan any daily newspaper to see evidence of the influence of weather and climate on our lives. Most people have had some experience with any number of catastrophic weather events. For example, hurricanes pound the east coast of the United States each summer and early fall, sometimes causing billions of dollars of property loss, coastal damage and flooding, and in some cases resulting in the deaths of tens or even hundreds of people. Tornadoes are perhaps even more feared by people living in the central section of the country, the so-called "tornado alley." Still, twisters have occurred in areas that are generally free of such phenomena, including Miami, Florida and Long Beach, California. Then there are the frontal storms, heavy thunder, hail and electrical events produced by the collision of cold air masses with warmer, moist air, and lake effect storms. Though these phenomena are local in extent, they can be dangerous and costly. One increasingly popular view holds that the incidence of catastrophic weather events is related in some way to the warming of Earth's climate, presumably as a consequence of the introduction of green house gases into the atmosphere. Indeed, many atmospheric scientists point to the seemingly more frequent weakening of the trade winds and the warming of the eastern Pacific Ocean, popularly known as El Nino, as a signal of this warming trend.

El Nino, as we all may recall was a global catastrophic event in the late 90's and since we were closing out the International Decade for Natural Disaster Reduction we 'responded' as such and came through it without too much damage and even less learned from our experience.

What could we have learned? As Christian E. Stalberg wrote in 1994, "The emergence of the intelligent city in the 21st century will radically transform emergency management as we know it today." Computing and telecommunications technologies, once separate and well defined, will merge and their distinctiveness will blur. Mobile wireless and Metropolitan Area Networks (MANs) will serve as the telecommunications backbone over which municipal management information systems will synchronize and orchestrate the various functions of government agencies and departments. Traditional organization and separation of municipal departments and agencies will undergo significant change as the intelligent city makes interdependent relationships more concrete and dynamic. Resource allocation will become more efficient as a separate and distinct function that is called upon during times of crisis as it is today, emergency management will become integrated into every facet of municipal planning and operations. The intelligent city will incorporate each of the elements of emergency management (preparedness, response, recovery and mitigation) into its overall planning and operational matrix.

I believe this; in fact I see this happening having been in the emergency management business for over 27 years. It is happening at the local levels, but there is much opportunity to get the other levels of partners to the table to have not only intelligent cities but intelligent governments and communities at all levels.

The emergency management professional as well as the marketplace has the responsibility to be prepared to meet these changes that are upon us. Local communities cannot continue to stick their heads in the sand and believe that this can't happen to us. The intelligent city will, in many respects, operate very much like an organism, monitoring its various component systems and responding accordingly to potential or actual changes of state in order to maintain equilibrium. This sensitivity to potential or actual changes affecting the equilibrium of the city will have important ramifications on emergency management. As conditions favoring disaster are detected, the intelligent city will respond accordingly, heightening readiness as appropriate. The intelligent city will assimilate knowledge of hazards and implement hazard mitigation as an integral component of its overall functionality.

Who will be responsible for this 'intelligent city'? Well, everyone of course, but it will be the primary responsibility of the Emergency Manager to manage this effort. It also depends on the assumption that everyone (local government, the community, the private sector, et al) is involved in the process. When a city is threatened by a pending or actual hazard that puts lives and/or property at risk, emergency managers interact with different departments and agencies in anticipation of changes that must be made to reduce losses or avoid them altogether. Emergency management is basically all about managing and coordinating a complex system.

As stated in *Emergency Service Multi-System Disruption and Recovery During Catastrophic Events* by Denney, Vanstralen and Denney, the probability of a catastrophic occurrence, expressed as numerical risk, does not help in planning. However, the possibility of an event, or the degree or ease that it will occur, allows incorporation of uncertainty into decision-making. Possibility is whether an event can happen; probability is frequency, or whether an event will happen.

This appears to be random and probabilistic. Cooperative emergency planning prepares system components and their assets to respond in an organized, coordinated manner to a-historic uncontrolled catastrophic events when they occur.

In the modern emergency management system the sharing of information and the interdependence of operational assets has resulted in a form of symbiosis that also directly impacts the extended system and its' processes. Theoretically, independent actions or the failure of a single component may result in negative consequences to other components and system effectiveness may be significantly impaired, particularly following an event of magnitude.

As a result system fragmentation may occur, and inexperienced emergency managers may perceive system fragmentation as system failure. The sense of urgency associated with disaster and the concern that problems will become worse in the absence of appropriate action creates an air of uncertainty concerning what has happened or is likely to happen, coupled with a strong urge to take some action "before it is too late."

It is apparent then that as the 21st century brings us intelligent cities it must also provide the opportunity to bring us intelligent emergency managers. That is to say emergency managers that recognize the great changes that are taking place and recognize the opportunities for change.

Catastrophes are non-linear systems. Social, physical and medical threats may be placed into an equation but the equations are not additive. Signals from a catastrophe have time duration. Each signal has an uncertainty. Increasing time duration will decrease uncertainty. However, the catastrophe will have changed during that time. Thus, decisions must be made during a catastrophe with uncertain data. Large time signals to produce information leave out information because of averaging the time signal. Thus, decisions must be made with short time signals, adapting to rapid changes of this open system. The problem, however, may be deciding which action to take.

Actions are shaped by contingent, unpredictable circumstances. Leaders are active participants and their actions shape the catastrophe, just as the external events that started the catastrophe do. The cascade that started with the initiating event will not stop, but can be directed. The goal may be to increase chances of success while decreasing chances of failure.

The 1994 Northridge Earthquake was an excellent example of the unpredictable nature of response by all elements of the community. As a result of that unpredictability positive things occurred which lead to the formation of groups such as Emergency Network Los Angeles (volunteer organizations active in disasters) and as a result of the September 11th WTC the business and industry became more proactive in its relationship with government.

The average emergency management system is actually composed of multiple micro systems that include hospitals, ambulances, fire departments, law enforcement and relief agencies that may or may not have a shared means of communication. Experience has demonstrated that if these micro systems have common capabilities and regularly train and interact with each other they will continue to do so whether or not the emergency management system is in tact. This is a direct result of the imbedding of purpose within individual system components.

As stated, localized micro systems will evolve within a fragmented system and perform flawlessly during an emergency. These localized micro systems will link to other micro systems and, at some point during the event, a new emergency management system will evolve that is composed of elements of the original.

It is important that emergency managers understand these concepts and incorporate them into their planning efforts.

Catastrophic events can often have a long-term impact on how business is done. What changes should we make to our personal technology policies to anticipate these changes? Most of the focus on the cause of the disaster has so far been on the inability of the intelligence organizations to identify and respond to this kind of threat. Funding for a more traditional war was focused on war machines and as this war emerges, the focus appears to be on surveillance methods and technologies. As we have seen in the past, defense technologies and the people trained in them have a habit of creating both opportunities and risks for the private sector. Opportunities will emerge in their development and sale of the domestic versions of these products and related risks will increase as they are misapplied to gain inappropriate access to company resources or information. We expect the rules restricting the legitimate use of this technology to be reduced as the US government adjusts to this new threat with obvious implications to internal policies surrounding the use, protection and retention of electronic communications and documents.

We are at War and natural disasters are common all over the country. We have always had floods, hurricanes, tornadoes, etc. For many of these (mostly local) phenomenon, we can partially prepare in traditional ways with insurance, or we can hope that the Governor or President will intervene with state or national assistance. But what happens when the state or national government itself is crippled by WAR or PESTILENCE or a catastrophic event we can't even foresee? What happens when an insurance company is driven to bankruptcy because they had to pay out to the relatives of tens or hundreds of thousands of deceased policyholders - former residents of a destroyed city? How will YOUR claim be paid?

On Tuesday September 11th all Americans were exposed to the increasing lengths that radical extremists will go to bring about terror and disrupt the way of life that most of us have taken for granted for our entire lives. While this is not the first incident of terrorism in our country, it certainly has been the most devastating and psychologically unsettling episode to date. News programs repeatedly displayed an airplane flying into the World Trade Center with the resultant explosion and subsequent collapse of both buildings. The catastrophic loss of human life was unbelievable.

Individual psychological responses to such a tragedy will vary from individual to individual. Perhaps the only atypical response to such an event would be to feel nothing at all. The closer one felt connected to the event, both physically and emotionally, the greater the likelihood of a more pronounced emotional reaction. People that had relatives or knew persons in the WTC, will experience the most immediate and traumatizing impact. Rescue workers, policemen, and fireman will pay an enormous emotional price for their prolonged exposure and frustration in dealing with the trauma that they have witnessed.

Now we must regroup and not lose the opportunities before us to make sure that the tools that we all use are all used in an integrated fashion to mitigate when possible, plan and prepare for and respond and recover from catastrophic events.

2.0 Dimensions of the Earthquake Problem

Earthquakes are hazards primarily because strong ground shaking destroys things that people have constructed—buildings, transportation lifelines, and communication systems. Earthquakes are also responsible for secondary, though often very damaging, effects such as soil liquefaction, landslides, tsunamis, and fires. Over the last century, earthquakes worldwide have caused an average of 10,000 deaths per year and hundreds of billions of dollars in economic losses. The United States has seen less seismic devastation than many other countries, primarily owing to its lower population density and superior building construction. Nevertheless, the average cost of U.S. earthquakes is currently estimated at $4.4 billion per year, and this figure appears to be rising rapidly, despite continuing improvements in building codes and structural design. California leads with the highest risk; indeed, 25% of the national risk is concentrated in Los Angeles County alone. However, the problem is truly national: 38 other states face substantial earthquake hazards, including 46 million people in metropolitan areas at moderate to high risk outside of California.

Scenarios constructed using loss-estimation tools have begun to quantify the magnitude of the risk that now faces large population centers in earthquake-prone regions. A repeat of the 1906 San Francisco earthquake would likely result in a total loss of $170 billion to $225 billion. The comparable loss for the 1994 Northridge earthquake, the costliest U.S. disaster on record, was about five times smaller. The direct losses in a repeat of the 1923 Kanto earthquake, near Tokyo, would be truly staggering—$2 trillion to $3 trillion—and the indirect economic costs could be much higher. The Kanto scenario is particularly dire, but much of the Pacific Rim and other regions with high earthquake hazards are urbanizing rapidly, and similar risks are faced by other megacities, such as Los Angeles, Istanbul, and Singapore. One expert has speculated that the urbanization in earthquake-prone areas of the developing world may result in a 4- to 10-fold increase in the annual fatality rate over the next 30 years, reversing a long-standing trend.

3.0 Seismic Information and Emergency Response

Science and technology can do nothing to prevent or control large earthquakes, and no known method can reliably predict when, where, and how big future tremors will be. However, once an earthquake happens, advanced seismic information systems can transmit signals from dense networks of seismometers to central processing facilities and, in a fraction of a minute, pinpoint the initial fault rupture (hypocenter) and determine other diagnostic features (e.g., fault orientation). If equipped with strong-motion sensors that accurately record the most violent shaking (when velocity reaches a meter per second and acceleration sometimes exceeds gravity), these automated systems can also deliver accurate maps in nearly real time of where the ground shaking was strong enough to cause significant damage. Such information can be crucial in helping emergency managers and other officials deploy equipment and personnel as quickly as possible to save people trapped in rubble and to reduce further property losses from fires and other secondary effects. Bulletins about the magnitude and boundaries of the shaking can also be channeled through the mass media, reducing public confusion during disasters, as well as allaying fears aroused by minor tremors.

Seismic information systems with the capabilities described above are now operational or under development in high-risk areas such as California, the Pacific Northwest, and the intermountain west, but the delivery of rapid information following earthquakes poses many technological and scientific challenges. The experience with recording large earthquakes is still fairly thin; with rare exceptions, areas of more moderate risk are currently serviced only by sparse seismographic networks with antiquated instrumentation and uneven capabilities for digital recording and processing. Research is needed in many aspects of post-event analysis; e.g., assimilating data into strong-motion predictions, increasing the reliability of aftershock predictions, and identifying areas of enhanced short-term risk through development of models of how earthquakes transfer stresses from one fault to another.

With appropriate technology, seismic information systems can be used as earthquake warning systems. Because electronic signals travel much faster than seismic disturbances, it is possible to notify regions away from the epicenter that an earthquake is in progress before any damaging waves arrive. Sub-oceanic earthquakes sometimes generate tsunamis (sea waves) that can inundate shorelines thousands of kilometers from the source. For example, the great 1964 Alaska earthquake generated tsunamis that killed 17 people along the Oregon-California coast, and tsunamis generated by the 1960 Chile earthquake killed 61 people in Hawaii and 122 people in Japan. These waves travel relatively slowly (500 to 700 kilometers per hour), so post-event predictions of tsunami arrival times and amplitudes can be used to warn coastal communities soon enough to allow for preparations and orderly evacuations. Agencies such as the National Oceanographic and Atmospheric Administration operate tsunami-warning networks that depend on precise seismic information to function properly. However, how tsunamis are generated by sub oceanic earthquakes and how they run up along coastlines are still poorly understood.

Advance warnings of strong motions caused by the fast-moving (2 to 8 kilometers per second) ground waves are more problematic than for tsunamis, because there is so little time for an event to be evaluated and an advisory broadcast through civil-defense or other warning systems. The damage zones of large earthquakes usually have radii of 200 kilometers or less, and it takes only 60 to 100 seconds for the most damaging waves (shear and surface waves) to propagate to this distance. Nevertheless, the time is adequate to issue electronic warnings that can initiate emergency shutdowns and other protective actions within power-generation, transportation, and computer systems, provided decisions can be reliably automated. The implementation of this capability will require seismic information systems that are robust with respect to regional disruptions in power and communications and methods for making (and aborting) decisions under stressful conditions, in addition to research on the basic problems of rupture dynamics, wave propagation, and site response.

4.0 Education

Educating people about earthquakes can effectively reduce human and economic losses during seismic disasters. The issues encompass delivery of earthquake information to the public, earthquake-oriented curricula in schools at all levels, the career focus of young researchers, and the transfer of knowledge to engineers, emergency managers, and government officials.

The Internet has greatly enhanced the capability for delivering a wide variety of earthquake information. Many public and private organizations maintain websites that host a variety of earthquake information services. These sites display up-to-the-minute maps of earthquake epicenters and strong motions, describe seismic hazards and damage, offer tips to homeowners about retrofitting and insurance, and make available curricular material. Regional seismic networks and earthquake-response organizations update their web sites regularly. The Hector Mine (California) earthquake of October 16, 1999, and the Nisqually (Washington) earthquake of February 28, 2001, were among the first U.S. “cyber-quakes” in the sense that the Internet became the dominant medium for exchanging data and posting results in the minutes and hours following the ruptures.

Information and communication technologies have irrevocably altered how scientists interact with the public in several subtle ways. New tools for digital representation and visualization are available to animate scientific descriptions of earthquakes and present research results in more attractive and intelligible formats. Renderings of numerical simulations now allow people to visualize more readily the complex physical processes on space-time scales too large or small, or places too remote, to be directly observed. Worldwide improvement in communication systems is feeding the public's interest in global problems. When devastating earthquakes occurred in El Salvador and the Indian province of Gujarat in January 2001, U.S. broadcast and print media, as well as Internet, coverage was quicker and more comprehensive than it had been for most previous, remote earthquakes.

The goal is to teach people enough about earthquake science to become smart users of information and to know how to prepare for and react to seismic events. Earthquakes furnish compelling examples of physics and mathematics in real-world action, and research on earthquakes illustrates the process of empirical inquiry and the scientific method in many interesting ways. The silver lining of seismic disruption is perhaps the "teachable moment" when a major earthquake captures public attention and the media are filled with technical explanations. Properly prepared students can learn a lot about natural science from these intense periods of reporting. National science education standards recommend that Earth science be taught at all grade levels. For example, students should learn about fossils and rock and soil properties in kindergarten through 4th grade; geologic history and the structure of the Earth in grades 5 through 8; and the origin and evolution of the Earth system in grades 9 through 12. A number of states have adopted these standards, which should give students a better understanding about how the Earth works and how its internal forces are acting to shape their environment. However, the content and methods for teaching earthquake science in primary and secondary schools remain pressing subjects that demand more attention, especially in areas of high seismic risk, such as Los Angeles.

Ellis Stanley is the General Manager or the City of Los Angeles Emergency Preparedness Department. Prior to that he was the Director of the Atlanta-Fulton County Emergency Management Agency since 1987.

Ellis is past President of the International Association of Emergency Managers (IAEM), the American Society of Professional Emergency Planners, and the National Defense Transportation Association. He also chaired the Certified Emergency Managers Certification Commission. He is Vice-President for Public Sector of BICEPP (Business & Industry Council on Emergency Preparedness and Planning) and is on the Emergency Services Committee of the Los Angeles Red Cross Chapter. He is an Emergency Preparedness Commissioner for Los Angeles County as well as a board member of the National Institute of Urban Search and Rescue.

National committees include the National Research Council's Board on Natural Disaster and the National Weather Services Modernization Transition Committee. He is an adjunct instructor at the National Emergency Training Center in Emmitsburg, MD and served as a member of the Board of Visitors of FEMA's Emergency Management Institute and an adjunct at St. Petersburg College Terrorism School.