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THE EVOLVING ROLE OF THE PUBLIC SECTOR IN MANAGING CATASTROPHIC DISASTERS
Lessons Learned

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This article focuses on the emerging role of the public sector in dealing with catastrophic disasters. An empirical analysis of the 9/11 response operations provides a detailed case study with an eye to its implications for not only emergency management practice but public policy as well. The "horde of hurricanes" inundating Florida in 2004 provides a brief example of a "routine" disaster for comparative purposes. The argument is made that the response to the extreme event of 9/11 provides clear evidence of (a) the different standards expected of the public sector in the 21st century and (b) the fundamental difference in kind between routine disasters and catastrophic disasters. The article states that the public increasingly expects better public sector leadership before, during, and after catastrophic disasters than has been seen in the past. High standards of responsiveness and the ubiquitous media compel public leaders to coordinate resources effectively.

Keywords: *catastrophic disasters; disaster management; September 11; 2004 hurricanes; Hurricane Katrina; crisis leadership; decision making*

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Catastrophic disasters (aka extreme events) are characterized by unexpected or unusual size, disruptions to the communication and decision-making capabilities of the emergency response system itself, and an initial breakdown in coordination and communication. Therefore, high performance in catastrophic disasters requires an ability to assess and adapt capacity rapidly, restore or enhance disrupted or inadequate communications, utilize uncharacteristically flexible decision making, and expand coordination and trust of emergency response agencies despite the hurlyburly of the response and recovery efforts. These requirements are superimposed on conventional bureaucratic systems that rely on relatively rigid plans, exact decision protocols, and formal relationships that assume uninterrupted communications. Building on the argument that crisis management is different in kind than traditional bureaucratic management because of sharply competing demands (Boin & 't Hart, 2003), this article asserts that public sector management in catastrophic disasters is fundamentally different from managing in routine emergencies.

It is easy to be lulled into a belief that catastrophic disasters are so rare that they are more a part of archeology, history, or even science fiction. It was millions of years ago that a meteor struck the Yucatan and killed off the dinosaurs. Santorini, most likely Atlantis, blew up 3,600 years ago, killing all the inhabitants of the most advanced Greek island of its day and probably ending the Minoan civilization.[1] It was more than 600 years ago that three successive waves of the bubonic plague swept across Europe, killing one third of the population of the continent.[2] Yet catastrophes are very much with us in the past century. In 1916 a polio epidemic killed more than 7,000 in the United States, and 2 years later an influenza strain killed more than 800,000 in the United States and 25 million people around the world. The AIDS epidemic today is even as fierce, despite our medical prowess. Adding to the odds of great loss of life and property is the increased density of population and the addition of man-made events to the pantheon of catastrophes. Consider the difference between the enormous and powerful 1811 earthquake in southern Missouri and Tennessee that rattled windows 1,000 miles away but injured few people[3] and the relatively smaller and more localized earthquake that occurred under San Francisco less than 100 years later that killed thousands. Fortunately, the United States has not had a major nuclear disaster such as the little-known Russian calamity in 1957 that killed tens of thousands of people (including most of the 1,500 cleanup workers) in the Yekaterinburg area and caused the relocation of 30 towns (McDonald, 2004).[4] The bursting of dams is another unlikely but plausible catastrophic event; the last great dam in the United States to burst was the St. Francis in Ventura County,

California, in 1928, killing 500 people in the effort to bring more water to Los Angeles (Rogers, 1995).[5] As if we needed any reminders of the devastation that natural disasters can cause, the Boxing Day (December 26) Tsumani of 2004 emanating from just offshore in Banda Aceh, Indonesia, caused more than 150,000 deaths around the entire periphery of the Indian Ocean, including 300 in Africa, more than 4,000 miles away.

Just as the 21st century started off with the enormous calamity of 9/11 for the United States, the most devastating event of the 20th century occurred in early September 1900 in Galveston, Texas, when the beachfront community was flooded by a hurricane, killing more than 6,000. Other great 20th-century American catastrophes (excluding shipwrecks) include the San Francisco earthquake (more than 2,500 dead), Pearl Harbor (2,403 dead), and the Lake Okeechobee flood caused by a hurricane in 1928, killing 2,000.[6] Also deadly were the Great New England Hurricane of 1938, killing 600, the tornado storm cluster of March 1925, killing 695, and the worst industrial accident in U.S. history that occurred in 1947 when a ship carrying fertilizer blew up while moored in Texas City, killing 581. Of course many catastrophic disasters may not leave an enormous wake of dead but may nonetheless leave a path of destruction that is staggering. The death toll of Hurricane Andrew was only 76 across its several landfalls, but it caused between $25 billion and $46 billion in damage in southern Florida alone (for some comparative statistics, see Kaplan, 1996; Schneid & Collins, 2001).

The magnitude of the catastrophic disaster that occurred at the World Trade Center (WTC) on September 11, 2001, provides a particularly useful case study to examine the evolving role of the public sector in managing extreme events in the 21st century. Cohen, Eimicke, and Horan (2002) provided a good rough analysis of the event soon after in *Public Administration Review*'s special issue. They emphasized lessons learned that applied to both routine and nonroutine emergencies: Emergency response planning is essential; emergency response institutions, procedures, and resources must be retained, even when the threats seem distant; communications systems must be made more redundant; emergency response procedures must assume communication breakdowns and allow for decentralized decision making; and there is no substitute for leadership during a crisis. Building on their analysis, this study includes a comparison with the four rapid-succession hurricanes that hit Florida in 2004 (Charley, Frances, Ivan, and Jeanne). This historically unprecedented sequence of storms traumatized the state and gripped the nation's attention because of its immense scope. However, we will argue that the "horde of hurricanes," despite many similarities, is a useful comparative example because it was not a catastrophic disaster but rather a "routine disaster."[7]

In this context it is important to remember that disasters, even catastrophic disasters, were generally not considered the province of government until the past century, and then primarily at the local level. "Prior to World War II, government programs to reduce environmental hazards were very limited" (Waugh, 2000, p. 11). Consider the disaster that was emblematic of 19th-century American catastrophes: Johnstown, Pennsylvania. In 1889 an earthen dam collapsed, and 2,200 people died in an event largely because of human negligence. The local government was completely overwhelmed, and the federal government's contribution was limited to rebuilding a few bridges. However, donations flowed into charities such as the American Red Cross, which ably administered assistance to the survivors. Clara Barton,[8] not the government, was responsible for the bulk of the response.

As with many other social service areas, the public sector's involvement expanded enormously in the 20th century. Increasingly, people expect the public sector to do a better and better job in management (Van Wart & Berman, 1999) and risk reduction of all types, with emergency management being key among them (Mileti, 1999). Indeed, the larger the emergency or potential for crisis, the more the expectation has grown for public sector involvement.

In some cases, the public sector has done a good job of meeting these increasingly demanding expectations. Perhaps representing the best success story, great fires swept through most American cities in the late 19th century. Boston experienced such a fire in 1872, and Chicago's famous 1871 blaze leveled one third of the city. As late as 1904, a fire in Baltimore destroyed 2,500 buildings in a single conflagration. Today's fire codes and fire response are so sophisticated that these events are now unheard of. Of course the ongoing expense of this fine record is substantial but palatable because of the ever-present threat of fires. Yet few areas of emergency are as well funded because they are cyclical (Waugh, 2000). Particularly problematic is when the catastrophic cycle is decades or hundreds of years but nonetheless nearly inevitable. Great quakes are probably "due" in Los Angeles and Tennessee, great tornado cluster storms only occur every 25 years or so, great Mississippi floods only occur every half century, "super" hurricanes do not occur every decade, and so on. Certainly the rarity of tsunami in the Indian Ocean contributed greatly to the death toll, as curious beach dwellers and visitors rushed to view the outgoing sea, a sure sign of a tsunami for the experienced.[9]

Very recently, Hurricane Katrina developed into a Category 1 hurricane before making landfall on the line between Miami-Dade and Broward Counties in Florida on August 25.[10] Katrina moved southwest across

Florida and west into the Gulf of Mexico, where it intensified rapidly to Category 5. In the early morning of August 29, Katrina made its second landfall near Buras, Lousiana, as a Category 4 storm featuring 140 mph winds, and its eye passed over the eastern edge of the city of New Orleans as the hurricane made its way to water once again. A few hours later, it made landfall for a third time near the Louisiana-Missisippi border, with 125 mph, Category 3 winds. The hurricane left an estimated 5 million people without power. Early in the morning of August 30, 2005, breaches in three places of the levees system on the Lake Pontchartian side of New Orlieans caused a second and even greater disaster. Heavy flooding covered almost the entire city during a sustained period, forcing the total evacuation of more than 1 million people. The city was uninhabitable, with 80% of its area flooded. Hurricane Katrina may well be the worst catastrophic disaster in the country's history.

Catastrophic disasters have become extreme tests, too, in which cameras record the performance of emergency operations in minute detail from the moment the disaster occurs. Administrative and political heads can roll if performance is not exemplary (Wamsley & Schroeder, 1996). For example, the recent frustration with the manner in which local, state, and federal agencies interacted in the framework of the National Response Plan was resoundingly critical. There is, of course, the political issue of whether or not the Federal Emergency Management Agency (FEMA) should be buried in the Department of Homeland Security, where it may receive short shrift until after disasters have occurred. It is the more basic management issue to which we turn here. Are catastrophic disasters similar to routine disasters? If different, what are the management ramifications?

Thus, the article focuses on the evolving role of the public sector in dealing with catastrophic disasters and the lessons learned using two primary cases. The devastating hurricanes hitting Florida in 2004 provide a brief example of the emergency management model working at an enormous scale but nonetheless in a routine modality. An empirical analysis of the 9/11 WTC provides a detailed case study of a catastrophic disaster. The argument is made that the response to the extreme event of 9/11, in particular the WTC, provides clear evidence of the different standards expected of the public sector in the 21st century, no matter whether those standards were actually achieved in that event or not. Just as Hurricane Andrew closed a chapter and the century in the history of extreme events in the United States with the public's demand for radically better public sector performance (Sylves & Waugh, 1996), the 9/11 WTC disaster inaugurated expectations of new, substantially higher standards while simultaneously exemplifying the incredible complexity of successfully managing

the panoply of extreme events in the future. The Department of Homeland Security was created in response to 9/11 and has inherited these challenging expectations that include the facilitation of a partnership of government, private, and nonprofit organizations and citizens (Waugh & Sylves, 2002). The article also argues that extreme events, although they share many characteristics with smaller hazards and routine disasters, have additional unique characteristics.

Although two cases are compared, it is the catastrophic disaster that is the focus. The routine disaster is primarily presented for illustrative purposes because of space limitations and is discussed more briefly. The routine disaster is the 2004 horde of hurricanes inundating Florida. For the analysis of the Florida hurricanes, 33 county emergency managers involved in hurricane responses were interviewed. The state situation reports were reviewed, and we also participated in several county-city debriefings about the successes and failures of the local emergency responses.

Because of the complexity of the catastrophic disaster occurring at the WTC, any single source of data would provide a shallow understanding. Three sources of empirical analysis were used to discover the relationships among agencies and provide a sense of how the overall system functioned on 9/11. First, the study uses data from a content analysis of *The New York Times* WTC stories from September 12, 2001, to October 4, 2001. Second, it uses situation reports from FEMA from September 13, 2001, to October 14, 2001. In addition, it uses semistructured interviews with 43 public and nonprofit directors, managers, and senior staff of the participant organizations (Kapucu, 2003). Network data collected from the content analyses were analyzed using the UCINET 6 social network analysis program (Borgatti, Everett, & Freeman, 2002).[11]

2004 HORDE OF HURRICANES IN FLORIDA: ROUTINE PREDICTABLE DISASTERS

The state of Florida was hit by four hurricanes during the 2004 hurricane season: Hurricane Charley (made landfall on August 13 near Cayo Costa in southwest Florida with 145 mph winds, went through the heart of the state over Orlando and to the Atlantic), Hurricane Frances (made landfall on September 5 at Sewall's Point north of West Palm Beach with 105 mph winds, went through central Florida and north through the Panhandle), Hurricane Ivan (made landfall on September 16 in Gulf Shores, Alabama, with 130 mph winds and went up to the Gulf of Mexico, caused major damage in Pensacola and flooding in central Florida), and

Hurricane Jeanne (made landfall on September 25 on Hutchinson Island, close to the Frances landfall, with 120 mph winds, went through central Florida northward and into Georgia; Bell & Smith, 2004; Florida State Emergency Operations Center, 2004). "Residents from every Florida county filed claims for at least one of the four storms, making this the most costly hurricane season ever" (Newman, 2004, p. A1). A total of 1.8 million people lost power after Hurricane Charley, 3.4 million lost power after Hurricane Frances, 2.8 million lost power after Hurricane Ivan, and 443,000 people lost power after Hurricane Jeanne (Newman, 2004). Hurricane Andrew—which we would classify as a good example of an extreme event—caused $26.5 billion in damage,[12] whereas the combined damage of the four hurricanes caused in excess of $40 billion. According to the National Hurricane Center (2005), the four hurricanes killed 117 people in the state of Florida and several thousands in the islands—4 dead in Cuba (Charley), 2 dead in the Bahamas (Frances), 2 dead in the Cayman Islands (Frances), 39 dead in Grenada (Ivan), 17 dead in Jamaica (Ivan), 5 dead in Venezuela (Ivan), 24 dead in Dominican Republic (Jeanne), 3,006 dead in Haiti (Jeanne), and 7 dead in Puerto Rico (Jeanne).

BASIC DESCRIPTION OF THE WTC EVENT:
A CATASTROPHIC DISASTER

SIZE OF THE EVENT

The event was caused by the crash of two commercial airliners into the tallest towers at the WTC, causing their collapse. A third smaller tower was partially destroyed. Four other buildings at the site were heavily damaged. Approximately 2,824 people were killed, and more than 6,000 were injured. At the time of the attack, 20,000 people were in the buildings. The cleanup alone cost between $5 billion and $6 billion. The overall direct and indirect cost of the event is estimated at $83 billion (Dawes, Birkland, Tayi, & Schneider, 2004; FEMA, 2001).

SHEER SIZE OF THE RESPONSE EFFORT

Because of the size of the event, the network responding was extremely large. One goal of the study was to identify exactly how large the network was and to analyze the components of it. Through the content analysis of the FEMA situation reports, news stories, interviews, and other sources (e.g., situation reports from the Health and Human Services, the New York

State Office of the Attorney General's Charitable Organization Report), it was found that the response system to the WTC was composed of 1,607 organizations. At 1,176, nonprofit organizations were by far the most numerous. Next most numerous were private, domestic organizations: 149. A surprising number of public and private international organizations, 77, were also involved. Although the number of federal agencies involved (73) is the smallest numerically, this obscures the fact that the universe of federal agencies is relatively small and that these agencies represent the vast bulk of the federal bureaucracy (Kapucu, 2003). Indeed, only 26 agencies were officially federal emergency response agencies identified by the Federal Response Plan (FEMA, 1999) at the time. Some of the nonprofit and private organizations were created specifically to deal with the crisis, such as the September 11th Fund, the Twin Towers Fund, the 9/11 Disaster Relief Fund, and the 9/11 United Services Group (Seessel, 2002).

COMPLEXITY OF THE INTERACTIONS

Because of the sheer size of the response effort, no single snapshot provides a comprehensive picture. Comparative views from FEMA situation reports and *The New York Times* news reports do provide different perspectives. The FEMA situation reports (see Figure 1) demonstrate the emphasis placed on interactions with emergency agencies, city and state agencies, the military and security agencies, and other federal agencies and relatively little interaction with nonprofits including FEMA's formal partner, the American Red Cross.

Contrasted with this image is the interaction map drawn from *The New York Times* analysis (see Figure 2). It visualizes a much more mixed picture, emphasizing the centrality of political institutions, private organizations that raised and disbursed unusual amounts of money for the cause, foreign condolences, and security agencies. Although still important, neither of the lead boundary-spanning agencies for the federal government or the nonprofit sector, FEMA and the American Red Cross, are portrayed as central to the major interaction streams as would be expected (Kapucu, 2005, 2006).

INCREASED COMMUNICATION AMONG RESPONDING AGENCIES

An analysis of the interviews discovered that interagency communication increased significantly as one would expect in an extreme event requiring more collaboration and cooperation. A total of 69.8% responded that the
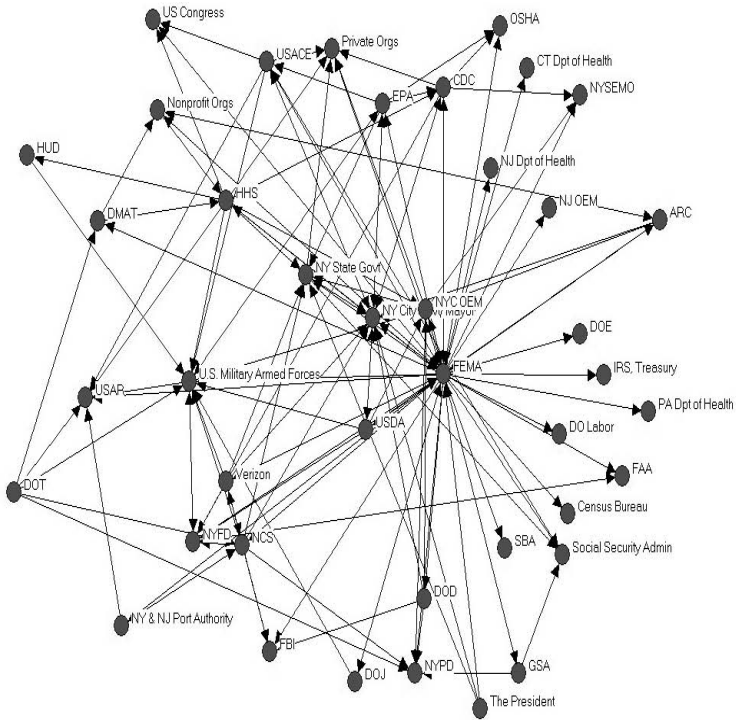
Figure 1:   Interorganizational Network, *The New York Times* News Reports Content Analysis

NOTE: SBA = U.S. Small Business Administration; NY & NJ Port Authority = New York and New Jersey Port Authority; CDC = Centers for Disease Control and Prevention; Homeland Security Office = The White House Department of Homeland Security; HHS = U.S. Department of Health and Human Services; Other state govts = other state government agencies participated to the response operations; FEMA = Federal Emergency Management Agency; Interior Dept = U.S. Department of the Interior; NYPD = New York City Police Department; NYFD = New York City Fire Department; NYCity Govt = New York City Government; NY S Govt = New York State Government; White House = The White House; U.S. Dept. State = U.S. Department of State; U.S. Treasury = U.S. Department of the Treasury; NYCEMO = New York City Emergency Management Office; ARC = American Red Cross; Private orgs = private sector organizations participated to the response operation; The President = U.S. President; Foreign Govts = foreign governments participated to the response operations; DOT = U.S. Department of Transportation; International orgs = international organizations participated to response operations; CIA = Central Intelligence Agency; DOJ = U.S. Department of Justice; Ntnl Trans. Safety Board = National Transportation Safety Board; Nonprofit orgs = nonprofit organizations; F. Reserve Bank = Federal Reserve Bank; Security & Exchange Com = U.S. Securities and Exchange Commission; Verizon = Verizon Communications; NYSOEM = New York State Office of Emergency Management; U.S. Congress = U.S. Congress; USPS = The United States Postal Service; U.S. Military Armed Forces = The U.S. Army; FBI = Federal Bureau of Investigation; FAA = Federal Aviation Administration; DOD = Department of Defense

Figure 2: Interorganizational Network, The Federal Emergency Management Agency Situation Reports

NOTE: See note to Figure 1. GSA = General Services Administration; DOE = U.S. Department of Energy; DO labor = U.S. Department of Labor; IRS, Treasury = U.S. Department of the Treasury; OSHA = Occupational Safety and Health Administration; DMAT = Disaster Medical Assistance Team; NCS = National Communication Service; USDA = U.S. Department of Agriculture; HUD = U.S. Department of Housing and Urban Development; USAR = Urban Search and Rescue; Social Security Admin = U.S. Social Security Administration; CT Dpt of Health = Connecticut Department of Health; NY Dpt of Health = New Jersey Department of Health; Census Bureau = U.S. Census Bureau; NJ OEM = New Jersey Office of Emergency management; PA Dpt Health = Pennsylvania Department of Health; EPA = U.S. Environmental Protection Agency; USACE = U.S. Army Corps of Engineers.

interactions increased significantly, and 20.9% of the agencies indicated that they increased somewhat. Only 9.3% indicated no change, and no interviewees indicated a decrease in interorganizational interactions. More than 95% indicated that such cooperation and information exchange was essential to

provide the highest quality service to the community. However, all the analyses indicated that the increase in interactions tended to be sector specific and that intersector communication did not increase significantly. This could be largely explained by the fact that 51% reported that the most important reason for cooperation was a common mission, and the second most important reason was service duplication (23%).

TYPES OF COMMUNICATIONS USED

Reliance on various types of interagency communication media during and after the event was varied and remarkably well distributed. The top four types were almost even: e-mail (23.4%), in person (22.3%), telephone (21.7%), and meetings (21.2%). These data demonstrate the failure of the historically preferred method of interagency communication in emergency situations: landline and cell phone systems. They also suggest the need for flexibility and redundancy of communication systems.

THE BENEFITS OF INTERAGENCY COORDINATION

Despite the frustrations of working with other organizations under duress, the interview respondents clearly identified major benefits. Of the interviewees, 95% indicated that information exchange was critical or somewhat important in emergency situations. Nearly 96% also indicated that interaction with other organizations resulted in important opportunities for organizational learning.

DISTINGUISHING AMONG EMERGENCIES: CATASTROPHIC DISASTERS VERSUS ROUTINE DISASTERS

Emergencies come in different sizes. Generally speaking, the names given to the smallest emergencies are *hazards*, *incidents*, or simply *emergencies*, and the expectation is that the response will be handled entirely at the local level. Moderate-sized emergencies are often called *disasters* and are events that cause considerable loss of life or property damage. They may be handled entirely at the local level, but they often involve a regional response with multiple agencies providing direct assistance and perhaps even triggering state assistance. Examples vary enormously from small floods, most tornadoes, small hurricanes, earthquakes with low magnitude, multicar freeway pileups, moderate-sized industrial accidents,

large fires, and so on. Quarantelli and Dynes (1977) define disaster as the disruption to society after the "event." Hence, it is not the earthquake that is the disaster but the extreme stress on society that it causes that is the disaster. Disasters may be relatively large but still fall at this level of local-regional support (Haddow & Bullock, 2003).

The top level of emergency is often called a *major disaster*, *catastrophic disaster*, or *extreme event*. Catastrophic disasters are occurrences that are notable, rare, unique, severe, and profound in terms of their impact, effects, or outcomes. "Extreme events are not only [rare and] severe, but also outside the normal range of experience of the system in question" (Bier, Haimes, Lambert, Matalas, & Zimmerman, 1999, p. 84). They generally affect the natural, social, and human systems simultaneously, no matter whether the "triggering event" is natural or man-made (Red Cross, 2001). The Comptroller General defined "catastrophic as any disaster that overwhelms the ability of state, local, and volunteer agencies to adequately provide victims with such life-sustaining mass care service as food, shelter, and medical assistance within the first 12–24 hours" (Bowsher, 1993, p. 6).

Although catastrophic disasters are a class of emergencies and share commonalities with them, they are also distinctive in four important ways. First, they are unpredictable and often quite unexpected. Ironically, routine emergencies are predicable and fit well into bureaucratized management protocols that increase the speed and quality of responses while minimizing expenses. However, responses in extreme events must make substantial deviations from conventional emergency plans or protocols because of the size or uniqueness of the event. In the case of the WTC, the use of commercial airliners as weapons of mass destruction was unanticipated.[13] Furthermore, the unsuccessful bombing of the WTC in 1993 provided a false sense of impenetrability. No contingency plan imagined the destruction of the WTC.

Second, catastrophic disasters cause disruptions to normal communications channels, such as telecommunications and information technology infrastructures. Both routine operations and data collection for decision making depend on a stable communication system. The communication towers of the region's major telecom provider, Verizon, sat atop the WTC and thus were destroyed. Because most competitors leased capacity from Verizon and used the same infrastructure, the cellular phone capacity crashed the morning of 9/11. Both cell phones and land lines were unavailable to most of lower Manhattan for hours or days. In addition, Internet service provider networks and integrated services digital networks were temporarily lost in the area as well because of their partial reliance on the phone systems.

Third, extreme events cause disruptions to decision making, even as the need for important decisions increases because the distinctiveness or magnitude of the event causes special threats and unusual needs. The disruptions to decision making in the 9/11 disaster were substantial. The New York City Office of Emergency Management—the planned nerve center for just such an event—was located in the WTC and was thus destroyed. It was initially moved temporarily to the police academy and later to Pier 92. Some of the top personnel who would have been responsible for major response efforts were killed in the event. They included the executive director and many top staff of the Port Authority of New York and New Jersey, which controlled the means for the evacuation of the 250,000 people who left the area in a matter of hours. The two most important first responders in such an incident are the fire and police departments. The fire department lost 343 commanders and firefighters. The police department losses were less overwhelming but nonetheless staggering. Another key resource killed in the disaster was the developer and owner of the WTC (McKinsey & Company Report, 2002, p. 28).

Fourth, because the scale of catastrophic disasters requires the intricate cooperation of hundreds of organizations just as communication and decision systems are severely damaged, coordination is either absent or simply overwhelmed initially. Putting even more pressure on coordination of extreme events is the unusual social attention they receive, often including the president, Congress, and the national press. According to the Comptroller General, although the president declares about 35 national disasters each year, only 1 or 2 are of a catastrophic magnitude (Bowsher, 1993, p. 5). By the time of the second plane crash at the WTC, millions of Americans were already watching, aghast at the enormity of the tragedy. The public contributed $1.4 billion, and the federal government is estimated to have spent another $21 billion in the response and recovery phases. Building cooperative relationships and negotiating working agreements can be challenging even with the leisure of time and in calm settings; expanding coordination in the chaotic setting of an extreme event is an exceptionally difficult task when many of the partners in assistance do not know each other well (or at all) and may have concerns about the competence or motives of others.

Therefore, catastrophic disasters affect two of the big questions of emergency management: (a) the general explanatory model of major disasters and (b) the problem of the integration of innumerable nonprofit, private, and public sector actors. The well-received and universally used four-phase model is insufficient to explain all the important factors of emergencies, especially extreme ones (Neal, 1997). An explanatory model addressing

disaster magnitude is also necessary. Also, responsibilities and integration of emergency management can dramatically shift in extreme events, disrupting efficient routines, contingency plans, established hierarchies, and so on.[14]

DEVELOPING A MODEL FOR CATASTROPHIC DISASTERS MANAGEMENT

At an abstract level, catastrophic disasters have the same pattern that typifies all emergencies and form the basis of the all-hazards approach: mitigation, preparedness, response, and recovery (Haddow & Bullock, 2003; McIntire, Fuller, Johnston, & Weber, 2002). Mitigation involves pre-emergency risk assessment and preventive measures. Improved building codes reduce fires or help buildings withstand tremors. In the case of the Florida hurricanes, enhanced building codes minimized damage to newer and more expensive structures (e.g., Sanibel Island, which experienced a direct hit), although ultimately the increase of population in the state reduces true mitigation emphasis. Because of the innovativeness of the threat, little action was taken to mitigate the WTC event, although some believe that more could have been done with more integrated intelligence.

Preparedness involves actions taken to respond to a disaster before the event occurs, such as the preparation of plans, training of personnel, stockpiling of supplies, and articulation of interagency agreements. The preparedness of the Florida emergency system was exceptional because of (a) the general planning for hurricanes, (b) the relatively anticipated nature,[15] and (c) the seriousness with which the threats were taken. The governor had worked nonstop for days to prepare for a national disaster request (unlike Andrew) and coordinate counties and cities, communities had been aggressive in planning and public communication messages, and nonprofit agencies such as the Red Cross were in place before the first hurricane struck. New York City also had an enormous amount of emergency preparedness, which improved the response performance greatly; however, the extreme event overwhelmed the system that was in place. As one set of researchers noted, "The massive failures attending the WTC terrorist attack are ample evidence of vulnerabilities that must be addressed" (Dawes et al., 2004, p. 30).

Response involves the immediate efforts to attend to the injured and victims, arrange for the dead, stop ongoing damage, and secure against secondary effects. For example, private power companies staged more

than 10,000 utility vehicles in safe areas in northern Florida and Georgia, so the next day resources poured into Florida without further summons. Because emergency systems were—for the most part—not damaged, they functioned relatively well immediately after the calamities. On the other hand, the response in New York, although heroic in the extreme, was initially unorganized and slow because of the massive destruction. Major response activities included the evacuation of the WTC, the evacuation of lower Manhattan, the transportation of victims to hospitals, the setting up of special medical examiner offices at the disaster site, and so on.

Recovery initially involves the postdisaster activities designed to deal with the ongoing consequences of the emergency such as restoration of basic services, temporary housing, provision of food and clothing, and communication to the public. It also involves intermediate and long-term activities such as psychological counseling, emergency disbursements, loans to businesses, debris clearance, infrastructure rebuilding, and so on, all of which were in evidence in both the 2004 hurricanes and the WTC event. Quick adaptation is critical when the environment is unknown, uncertain, and turbulent (Yukl & Lepsinger, 2004). In the Florida case, recovery efforts could build on a rapid and successful response and were much aided by special Federal allocations of more than $13 billion. Although mitigation, preparedness, and response were weak in the WTC event, the recovery phase was extraordinary as all sectors poured resources and attention into the area. Within weeks the general area was functioning. Within a year the WTC had been excavated piece by piece, and ground zero was ready for redevelopment.

Although it is too soon after Katrina for a detailed and authoritative analysis, a rough critique can be advanced. The weaknesses in the levee system were well known but completely unaddressed (mitigation). The issue was when, not if, a catastrophe would occur. Despite early warnings of the hurricane's path and the early declaration of national disaster status, the preparedness of local, state, and federal governments was, in general, wholly inadequate.[16] Because the mitigation and preparedness were so bungled, the formal governmental response was appalling. Americans watched hundreds of people sit on roofs for a week, and they wondered if thousands might have drowned in low-lying attics. The recovery stage promises to be far better, as Congress has already committed three times what it contributed to the WTC disaster, with an open-ended promise for more money to come.

In addition, catastrophic disasters share a common set of four routine functionalities that must be in place for optimum performance in the all-response and recovery phases. The most obvious is the need for an

established plan and system. For example, the thousands of car accidents that occur daily must be handled efficiently with prearranged protocols, extensive training, and interorganizational agreements. In a different context, Burby and Dalton (1994) demonstrate the dramatic effect that land use plans and state mandates can have in limiting development in hazardous areas. The opposite example would be the 1900 Galveston calamity, in which the city had no evacuation plans or preparedness measures in place. Yet when another major hurricane struck Galveston 15 years later, only a few hundred died, largely because of the ability to evacuate more effectively.

Second, the success of emergency functions depends on good communication and proper use of information technologies (Comfort, 1999; Knuth, 1999; Quarantelli, 1997).[17] A highly successful example has been the introduction of tornado sirens and TV-radio warnings for hurricanes in the United States in the 20th century. Although the short-term warning systems have reduced the fatality rates of super storms in the United States dramatically since World War II, as late as 1970 nearly 300,000 died in Bangladesh in a cyclone and flood (Kaplan, 1996). Dramatic failures in the lack of state-of-the-art communication and information technology have occurred in the American context as well. The most famous instance was the installation of the then-new radar equipment at Hawaii in 1941. The new technicians detected the incoming air squadrons from the north and reported it up the chain of command but were ignored.[18]

A third element of emergency management is the need for pre-arranged decision protocols. When emergencies occur, timeliness is always critical to save lives, help victims, and prevent further damage. Emergency workers need to react as quickly as possible, only thinking about the type or class of emergency that applies and then implementing the much-rehearsed decision protocol involving who does what, how, and under what conditions. Decision protocols establish authority, save time, prevent confusion, and preserve unity of effort.

The fourth functionality in disasters, no matter whether routine or catastrophic, is the existence of formalized cooperation and effective boundary-spanning agencies (Kapucu, 2003). Early on, the American Red Cross came into existence as a volunteer response organization that built up stocks of resources and great expertise in attending to the victims of disasters. Today, it is an official part of the Federal Response Plan (now called the National Response Plan) and is the only nonfederal agency with agency status. An example of an agency being perceived to have failed its boundary-spanning role would be the Federal Emergency Response Agency during the 1989 to 1992 disasters. In particular, the agency's poor
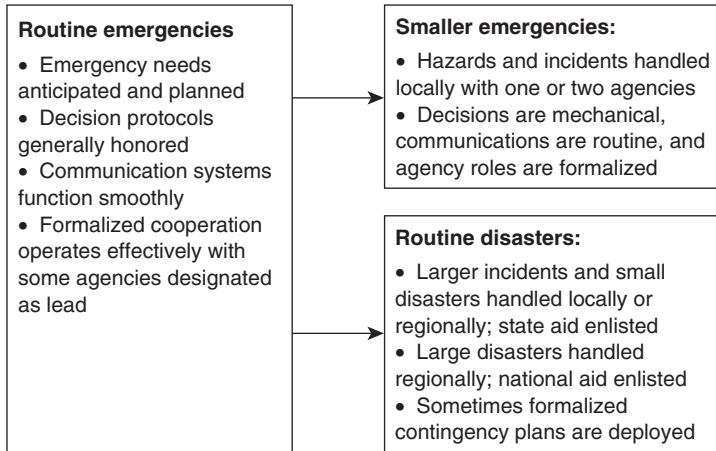
Routine emergencies	Smaller emergencies:
• Emergency needs anticipated and planned • Decision protocols generally honored • Communication systems function smoothly • Formalized cooperation operates effectively with some agencies designated as lead	• Hazards and incidents handled locally with one or two agencies • Decisions are mechanical, communications are routine, and agency roles are formalized
	Routine disasters: • Larger incidents and small disasters handled locally or regionally; state aid enlisted • Large disasters handled regionally; national aid enlisted • Sometimes formalized contingency plans are deployed

Figure 3:   Ideal Response to Routine Emergencies

response to Hurricane Andrew (coupled with the state's weak response) led many in Congress to call for the dismantling of FEMA. Although experts strongly opposed dismantling the agency (Bowsher, 1993; Mittler, 1997; National Academy of Public Administration, 1993; U.S. General Accounting Office, 1993), they did recommend a series of improvements, many of which were ultimately implemented, including rapid response teams, better state-local-nonprofit relations, streamlined response protocols in major disasters, more reliance on experts in senior and leadership positions, and less reliance on a civil defense model within the agency. Emergency management organizations are expected to respond to disasters by minimizing the disaster's impact. Learning is expected to be one of the key mechanisms through which organizations come to prevent and minimize the impact of disasters. The change of image of FEMA because of criticisms of its slow response in the wake of Hurricane Andrew became a serious issue (Carley & Harrald, 1997; Drabek, 2003; Mittler, 1997; Rivenbark, 1995; Schneider, 1998).

In routine emergencies, then, events follow familiar paths and ideally do not deviate substantially from pre-emergency expectations (see Figure 3).

Although catastrophic disasters rely on these emergency basics, their very nature demands special, sometimes crosscutting, requirements. First, there is a profound need to adapt and expand capacity as quickly as possible. Agency leaders must rapidly assess the emergency need and often

their own agency's capacities that may have been damaged or diminished by the event. Furthermore, they must assess the appropriateness of formal plans because of the inherent uniqueness of extreme events that invariably call for adaptation. This assessment means not only that agency leaders are activating formal plans but that they are requesting and integrating additional resources. In some cases, agencies will also be determining when to loan resources, often without formal agreements in place. Second, extreme events require leaders to restore communication systems that have been disrupted and/or become overwhelmed because of unusual load. Leaders must know what redundant communication systems are available and deploy them quickly. Frequently, technologically sophisticated backup systems are initially unavailable, and so low-tech or primitive systems must be pressed into service, such as the use of walkie-talkies or courier systems. Third, the need for flexible decision making and innovation means that the emergency plan must be amended on the fly, and both plans of actions and functional relationships must be adjusted. Extreme events often require so many decisions, under such adverse conditions, that important decisions must often be made at lower levels because of the disruptions (Dynes & Qurantelli, 1977). Although overarching policy making may need to stay centralized, implementation policy must often be adjusted or changed in the field to deal with local conditions in real time. Fourth, coordination and trust are major components of a resilient emergency system in an extreme event (Hardin, 1982). Because of the size and disruption of extreme events, they require a dramatic increase in the amount of coordination of the helping agencies within and across sectors. Not only is this logistically challenging, but it is psychologically demanding as well to work with many unknown partners and sometimes even rival agencies in trusting ways without the normal ability to develop and hone relationships and agreements.

Simplifying for clarity, a causal chain for catastrophic disasters that differs from routine emergencies can be developed. In catastrophic disasters, the expectations change. Although throughout much of the catastrophic disaster routine elements may continue to be the operational ideal, an additional model of functionality must be superimposed on the catastrophic disaster. See Figure 4 for a model that better articulates the additional conditions that apply.

Thus, in a large catastrophic disaster, much of the time hundreds of agencies will do their business in traditional ways, following predisaster contingency plans, communicating routinely, implementing standard decision protocols, and interacting with familiar partner organizations. At the same time, the dramatic spike in need, the disruptions of all types, the unique problems, and the need to interact with new partners or old
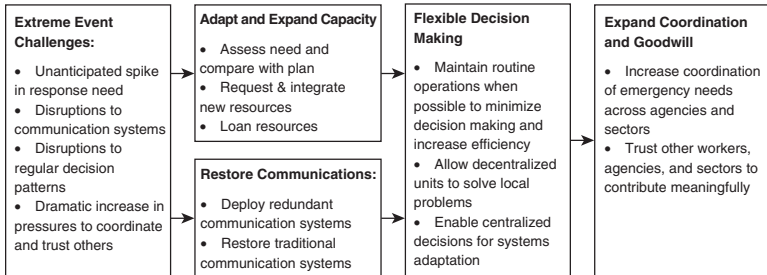
Extreme Event Challenges:	Adapt and Expand Capacity	Flexible Decision Making	Expand Coordination and Goodwill
• Unanticipated spike in response need • Disruptions to communication systems • Disruptions to regular decision patterns • Dramatic increase in pressures to coordinate and trust others	• Assess need and compare with plan • Request & integrate new resources • Loan resources **Restore Communications:** • Deploy redundant communication systems • Restore traditional communication systems	• Maintain routine operations when possible to minimize decision making and increase efficiency • Allow decentralized units to solve local problems • Enable centralized decisions for systems adaptation	• Increase coordination of emergency needs across agencies and sectors • Trust other workers, agencies, and sectors to contribute meaningfully

Figure 4:   Ideal Response to Catastrophic Disasters

partners in new ways cause changes in the way work is done, increase the complexity of decision making, and vastly increase the pressure on communication systems, despite their reduced capacity.

IMPROVING INTERORGANIZATIONAL COMMUNICATION IN RESPONSE TO CATASTROPHIC DISASTERS

Earlier in this article, four areas were identified as critical for high performance in all emergencies: a well-established emergency network, effective use of information technology, prearranged decision protocols, and effective boundary-spanning agencies with high levels of interagency trust. It was also argued that agencies in simple emergencies and routine disasters can operate with a single set of factors that allow for a high degree of bureaucratization, whereas agencies operating in an catastrophic disaster must overlay another set of competing principles that contradict the sole or excessive reliance on formalism, stove piping, past training, and up-to-date technology, important though these factors continue to be much of the time. This framework will be used to examine the positive and negative examples in the WTC catastrophic disaster and to provide some overall assessments of the performance of the response system.

FORMAL RELATIONSHIPS AND A FORMAL PLAN

By the 1980s, FEMA had instituted a federal response plan and an integrated emergency management system. These early versions were crude, civil defense oriented, and biased toward federal authority. Weak

performance of both the system and FEMA in Hurricane Iniki (1989), the Loma Prieta earthquake (1989), and Hurricane Andrew led to a revision of the federal response plan and the operating philosophy of FEMA to allow for genuine input into the system. After an upgrade in FEMA status and major changes in emergency policy, superior performance was exhibited at lesser disasters in the late 1990s and was generally expressed by experts and the media during the 2001 WTC disaster (Cohen et al., 2002). In that case, city and regional plans existed and provided the baseline for action and cooperation. However, in the philanthropic area "there was no suitable precedent to guide the response" (Seessel, 2002, p. i).

EFFECTIVE USE OF UP-TO-DATE COMMUNICATION AND INFORMATION TECHNOLOGY

Technology cannot replace good planning and coordination, but it is powerful when used in coordination with it. The most notorious lapse of technology was lack of functional hand-held radio communications by the police and fire departments, which was the same problem they had experienced 8 years earlier in the 1993 WTC terrorist attack. The radio failure obstructed communications among the departments and the commanders and their personnel with tragic consequences. Many personnel were killed when they could not be recalled after the collapse of the first tower.

However, the effective use of up-to-date technology was seen in a number of places in the WTC event. The Department of Information and Telecommunication Technology (DoITT) did an admirable job of resurrecting a defunct wireless system called Ricochet, that expanded networking capacity. Also, a small communications provider in the area, Nextel, filled in the gap for cellular and radio capabilities (Dawes et al., 2004). The star media in the event were the Internet and geographic information systems (GIS). For example, a GIS application developed prior to September 11 for notification about storms and weather emergencies proved its flexibility during the response and recovery efforts. The application showed available evacuation routes, emergency centers, and other critical information. "On September 11, the DoITT used GIS applications. Later, that same application was used to monitor the anthrax threat" (personal communication, DoITT, February 14, 2003). New York City had begun building its GIS years before the event and proved it to be an irreplaceable emergency management tool. Maps of ground zero provided pictures that helped rescue workers, firefighters, and workers removing debris and city officials making critical decisions.

PROVISION OF REDUNDANT COMMUNICATION
AND INFORMATION SYSTEMS

By definition, catastrophic disasters are likely to impair or even destroy some communication capacity. Therefore, backup systems are critical for rapid and effective response. The most striking problem in the 9/11 WTC event was the loss of the Verizon communication towers on which so many different communication systems relied. Most cellular and phone connections were cut for hours or days in south Manhattan. However, the redundancy of some systems made partial communications possible immediately and full communications available relatively quickly. Unlike other providers, Nextel did not rely on the Verizon system and was thus able to provide some coverage of the area for cellular phones and radios. Although the Internet capacity was temporarily shut down in the area, it was successfully rerouted. This flexibility was originally built into the design of the system by the military, which wanted a communications network that could survive the destruction of major communications points (Graber, 2003). The Internet often provides a more reliable means of communication because traffic is designed to route itself intelligently around the busy spots in the system. Although landline phones must pass through a particular network and mobile phones have to communicate with a limited number of radio masts, Internet routers are more flexible. Thus, almost immediately, not only was the Internet functioning in most of the area, but it was soon providing an enormous amount of technical information in Web sites for various key agencies. The American Red Cross was a key source of information about victim services, and the New York City Department of Health and the Office of the Chief Medical Examiner provided updates regarding health and safety issues, including an online hospital patient locator system, missing persons information, DNA collection protocols, counseling information, anthrax information, and death certificate applications. A later example was the 9/11 United Services Group that formed in December 2001 and provided a shared database that charities could use.

> Our office shared information and worked collaboratively with federal, state, and local government officials as well as nonprofits. We developed legalities, helped shape federal funds and formed the 9/11 United Services Group (USG). The WTC relief Web sites (http://www.oag.state.ny.us and http://www.wtcrelief.info) were two of the first sites that provided comprehensive information on aid, public assistance, advocacy, and current events. We were able to secure information from nonprofits on the form and type of relief given to primary and secondary victims. (personal communication, NY State Crime Victims Board, April 11, 2002)

NETWORK AND CONSORTIA RELATIONSHIPS

A high-performance response system requires more than good contingency plans and formal relationships in catastrophic disasters, however. It requires an operational network and consortia relationships to allow for horizontal interactions and auto-adaptation in response to system needs (Comfort & Kapucu, in press). Many fine examples of these informal networking structures were in evidence. Key among them were the Volunteer Organizations Active in Disasters (VOAD), which provided regular organizational meetings for nonprofits, and the Mayor's Voluntary Action Center (MVAC), which coordinated nonprofit communication and information sharing. Since 9/11, New York Cares has been an integral part of the recovery and response efforts. New York Cares volunteers, working with other organizations, provided critical services to the relief workers, the victims, and the families. New York City Emergency Management Office (NYCEMO) assigned New York Cares responsibility for responding to all voluntary help inquiries.

Although networking was generally considered good to very good by the recovery phase, 48.9% of the interviewees responded that still better response was hindered by lack of communication—a key indicator of the need for better networking—dwarfing lack of trust (12.8%), lack of flexibility (10.6%), lack of technical structure (8.5%), lack of leadership (6.4%), and other reasons (12.8%). In other words, networking was good but certainly had room for improvement.

EFFECTIVE INTRASECTOR COORDINATION

Generally speaking, lead agencies performed their designated coordination roles well within the various sectors. FEMA coordinated federal agencies, and the American Red Cross, MVAC, and VOAD coordinated nonprofit agencies in service delivery. The Carnegie Corporation, the Ford Foundation, and the Better Business Bureau helped to coordinate philanthropic efforts. *The New York Times*, the FEMA situation reports, and interviews all had positive reports generally. Fraud and waste, somewhat overstated in later reports, were actually remarkably low (Seessel, 2002). However, because of the enormous number of nonprofits and the occasional confusion among nonprofits, some significant criticism was aimed at the American Red Cross as a lead agency and at the Salvation Army as a partner agency. The National Communication Service, a federal organization supposedly authorized to assist communication in disasters, was inconsequential in that role. However, the New York DoITT did an

admirable job of patching together an alternative communication system (see below for details).

EFFECTIVE INTERSECTOR COORDINATION

Routine disasters require relatively little intersector cooperation, and that coordination is generally financial and technical. Formal requests are required of communities or governors to trigger state or federal assistance. However, catastrophic disasters require intricate coordination because the shrill needs for relief, security, and reconstruction all overlap. Compared to its response to Hurricane Andrew, FEMA coordinated the different sectors well, assuring that each area did its part. FEMA itself focused on debris removal and reconstruction ($6 billion) and coordinating all federal efforts at a total cost of approximately $21 billion. Other sectors coordinated victim relief and philanthropic efforts.

TRAINING WITH NETWORK PARTNERS

An important foundation for trust is competence. Competence is in turn based on general education and technical training. Few complaints were formally heard about the educational competence of the organizations in the WTC emergency network (only about 13% of respondents complained about lack of experience), although anecdotal stories were reported of experts complaining that some nonprofit workers lacked the general education to function efficiently. However, widespread self-criticism across sectors was articulated about the need for more intrasector and intersector training exercises. Such exercises have become commonplace since 9/11 in New York and around the country. Furthermore, it was argued that FEMA rarely participated in such exercises in the past. Today FEMA's participation has been far more visible.

PRIOR PERSONAL RELATIONSHIPS WITH OTHER ORGANIZATIONAL PARTNERS

Trust is also based on the knowledge that others' motives and integrity are consistent with one's own. To some degree all organizations compete for prestige, resources, authority, visibility, and credit—no matter whether they are in the private, public, or nonprofit arenas. Therefore, personal acquaintance and prior bonds make a palpable difference in performance, when flexibility and speed are of the essence. In terms of key worker competencies, interviewees in the WTC emergency systems expressed

approximately twice as much need for the emotive elements of trust (42.6%) as opposed to the technical elements of trust related to training (22.2%). About 13.0% of the respondents commented that lack of trust substantially inhibited interorganizational communication. As reported earlier, lack of communication was considered the most important deterrent for interorganizational cooperation.

LESSONS OBSERVED

Four overarching lessons can be gleaned from taking a hard and detailed look at the catastrophic disaster that occurred at the WTC on 9/11 and comparing it to large, but nonetheless routine, disasters such as the Florida hurricanes in 2004. First, the basic principles of emergency management apply in catastrophic disasters. There must be excellent contingency planning, interagency coordination, training, and up-to-date technology.

Second, some additional principles that are rarely critical in managing routine disasters emerge as vital. High performance in catastrophic disasters requires capacity assessment and adaptation, special efforts to restore and enhance communication, flexible decision making, and an expansion of coordination and goodwill among emergency agencies and personnel. If the standard emergency management model provides a highly bureaucratized system that reduces inefficiencies and redundancies through relatively rigid protocols, hierarchies, and relationships based on expected emergencies, then the extreme events management model superimposes the need for innovative problem solving, horizontal adaptation and collaboration, and relationships based on trust and the suspension of rules because of unexpected needs.

Third, the public increasingly expects better public sector leadership before, during, and after catastrophic disasters than it has seen in the past. In the 19th and even early 20th centuries, state and federal assistance was relatively rare and always ad hoc. Individuals, charities, and local governments had to function on their own in most cases. In the last half of the 20th century, local governments increased their capacity in fire, flood planning, building codes, and so on. The state and federal governments increased their abilities to assist, too, through model planning, assistance with community cooperation, and auxiliary funding in major disasters, although they often took more of a civil defense stance rather than a true all-hazards approach. Presidential declarations of disaster provide an automatic 75% federal match of relief and recovery funds to state dollars, although occasionally that percentage is increased (Sylves, 2004). Yet

even beyond financial and specialized technical assistance, state and federal leadership is now expected in catastrophic disasters. High standards of responsiveness and the ubiquitous media compel political leaders and administrative heads to coordinate resources effectively. Yet the challenges are also immense. Preparedness for catastrophic disasters requires a much greater level of resources and training for events that may never occur. Long cycles and successful prevention of catastrophic disasters naturally lead to apathy and temptation to reduce funds and resources.

Fourth, disasters are nonetheless social phenomena, and catastrophic disasters by their nature require decentralized decision making and intensive human interactions (Cleveland, 2002; Kirschenbaum, 2004; Mileti, 1999). Excessive formalism can provide excessive reliance on centralized authorities for all answers, when they neither are close at hand nor have the capacity to solve local dilemmas. The massive numbers of public, nonprofit, and private organizations involved in catastrophic disasters require extensive ability to have horizontal and vertical communication and decision making. Local adaptation of needs requires an informal flexibility that master plans and hierarchies of responsibility can overlook. Networks and consortia build up capacity as much as formal emergency systems. Thus, state and federal leadership must be careful not to supplant or squash the leadership of local governments and nonprofits that provide the bulk of relief and recovery efforts. Similarly, an excessive civil defense or paramilitary orientation to catastrophic disasters diminishes response capabilities. When this occurs, vacuums of competence, preparation, and response occur that infuriate the public (Britton, 1999).

It is clear that an increased level of professionalism will be required of those serving in the emergency management area. In the past, emergency management has largely bounced back and forth between overinflated civil defense or fire management systems and has been poorly integrated among the various levels of government and the nonprofit, private, and public sectors. The challenges are great and not always met. The Florida horde of hurricanes demonstrated an enormous disaster that was nonetheless handled routinely given the strong response of all partners. September 11 represents a catastrophic disaster in which the system collapsed but was quickly rebuilt. Andrew and Katrina represent catastrophic disasters in which the public felt abandoned and let down because the emergency management system lacked the simultaneous resilience and sophistication necessary to be effective. Intersector and interorganizational partnerships are an especially critical task for all homeland security and safety officials with the move from the more internally focused Federal Response Plan to the National Response Plan.

The National Response Plan requires significantly greater vertical and horizontal communication and private sector involvement and citizen participation as well (Tolbert, 2004).

We offer no specific policy advice on the placement of FEMA in the federal bureaucracy or the use of "emergency tsars," however significant such debates may be. Structure does matter. Yet ultimately the substantial problems in the WTC disaster, and the wholesale problems of Andrew and Katrina, were caused by problems that transcended structure such as poor or nonexistent planning, incompetent managers, political inattention before the event, and political squabbling afterwards. What is clear is that the public expects professional managers and political leaders to do an excellent job, despite the duress of catastrophic disasters, consistently. This in turn will require a deeper understanding of how coping with catastrophes is built on routine emergency management practices and systems but ultimately requires meeting the unique demands, such as for specialized advanced planning, on-the-spot policy changes, communication surge and technical resilience, systems adaptation and structural shifts of responsibility, and coordination and trust in chaotic circumstances. It is a tall order but a worthy goal.

NOTES

1. The eruption of Santorini in Greece in 1,650 B.C. was one of the largest in the past 10,000 years. About 7 cubic miles of magma were erupted.

2. The best known outbreaks in Europe occurred between 1347 and 1352. Other pandemics occurred in the 4th century and the 17th century. Exposure to the plague led to a mortality rate of more than 50%.

3. This was the so-called South Madrid earthquake.

4. The accident took place in a nuclear waste storage tank at the Mayak nuclear complex. Accidents and contamination were kept secret until relatively recently. The 1957 incident emitted approximately twice as much radioactivity as the Chernobyl accident, and with early dumping of low-radiation waste and an additional 1967 accident, the area is four times as contaminated today as the better known catastrophe.

5. This famous catastrophe brought an end to the career of William Mulholland, superintendent and chief architect of the Los Angeles Water and Power Department, who oversaw the dam project that collapsed the first time it was filled. The incident was memorialized in loose adaptation in the movie *Chinatown*.

6. The official death toll was 1,838. However, many dead were probably never counted. Uncounted victims included vegetable pickers, of whom many were undocumented aliens. Most people who have studied the storm believe the official death toll is very low.

7. There is no small irony in this assertion because the authors live in Florida and personally experienced the devastation. Despite living in the relative shelter of central Florida,

three of the hurricanes crisscrossed the region, causing several billion dollars of damage to the Orlando area alone.

8. Clara Barton (1821–1912) was the founder of the American Red Cross (1881). She personally oversaw victim response operations at Johnstown and Galveston (1900) and for many other American disasters such as a yellow fever outbreak in Florida (1887) and for war relief (Civil War, Spanish-American War). She actively organized assistance for victims in many other countries. She also founded the Missing Soldiers Office after the Civil War.

9. Although tsunami are common in the Pacific, they are uncommon in the Atlantic and Indian Oceans. A great tsunami hit Portugal in 1755, and there is no record of a great tsunami in the Indian Ocean.

10. Because our study was completed before Katrina, it was not included as a major case study. However, we feel that the analysis predicted the problems seen in Katrina with surprising accuracy. Thus, it essentially served as a test of our findings.

11. UCINET is a comprehensive software program for the analysis of social networks. The program contains several network analytic routines (e.g., centrality measures, dyadic cohesion measures, positional analysis algorithms, clique, etc.) and general statistical and multivariate analysis tools such as multidimensional scaling, correspondence analysis, factor analysis, cluster analysis, and multiple regression.

12. Hurricane Andrew was an example of poor local and state planning at the time (from building codes to evacuation plans), lack of warning to residents as the hurricane headed to land, exceptionally disorganized response with many residents unaided for weeks after the event, and very slow recovery because of the inability of the state and federal government to agree on how efforts should be implemented.

13. The last such crash into a major building in New York occurred in 1945, when a B-25 bomber accidentally hit the Empire State Building between the 78th and 79th floors. Although pictures recorded the bizarre image of a plane lodged in the side of the building, ultimately the damage to the skyscraper was insignificant.

14. The only big question that extreme events as discussed in this article do not tackle directly is the proper grouping of emergencies by types, clusters, or all-hazard. The authors accept the widely agreed on all-hazards approach as a given.

15. The term *relatively* is itself relative. In the first hurricane, Charley, the city of Tampa was evacuated, and many residents traveled to Orlando, only to discover that the hurricane veered well south of the city and blasted Orlando, where they had sought safety.

16. Of course wonderful exceptions exist. The chief medical officer for the state of Louisiana had done thorough planning and was able to set up an enormous, well-staffed, and well-equipped medical triage center in Baton Rouge within 36 hours. Despite this exceptional alacrity, patients in New Orleans hospitals lacked buses and drivers to get them to this facility for days in most cases.

17. The problem of communication between the counties and cities was the most emphasized one in the Tri-County League of Cities meeting. The meeting was held after the three hurricanes and right before Hurricane Jeanne.

18. "At 7:00 a.m., an alert operator of an Army radar station at Opana spotted the approaching first wave of the attack force. The officers to whom those reports were relayed did not consider them significant enough to take action. The radar sighting was passed off as an approaching group of American planes due to arrive that morning" (Navy Historical Center, 2006). The fleet commanders had been informed of an imminent attack somewhere in the Pacific but expected it in the Philippines. Commanders distrusted the new technology, and so the information was disregarded with tragic consequences.

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