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A BRIEF SUMMARY OF
SEARCH AND RESCUE LITERATURE:
A REPORT TO COT NETHERLANDS

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Basic Premises

The accumulated of research on search and rescue (SAR) allows us to identify repeating patterns that should be considered in the development of an effective plan for national emergency response: (1) SAR is not simply an organizational activity, it necessarily includes the social and collective behavior of volunteers; (2) Preexisting and emergent organizations, social statuses and social identities, such as neighborhood and work place relationships and family and neighborhood social identities, serve as a basis for the emergence of new SAR groups and constitute the fundamental concepts and categories that are needed to understand and improve SAR activities; (3) SAR activities do not emerge from a vacuum; as an example of the principle of continuity advocated by Quarantelli and Dynes (1977), there are always elements of the traditional social structure embedded within collective behavior entities, and their emergent division of labor, role structure, and activities are also dependent on prior social relationships and forms of social organization in the community or region; (4) Breakdown models of social organizational patterns in disaster are not useful to understand SAR. Television reports and misinformed reporters often misinterpret throngs of people moving seemingly at random at the sites destroyed by various hazards, and assume that the people were disoriented immediately after impact and had lost their ability to enact social roles. Despite these reports, scientific research shows the absence of widespread confusion, lack of coordination, and panic (Aguirre, 2005). The seeming disorganization and aimless movement of people is the result of their individual and collective acts as they try to accomplish multiple individual and collective goals under severe time constraints (c.f. Fritz & Mathewson, 1957). Creative problem-solving and rationality is a more accurate way of understanding their actions (Aroni & Durkin, n.d., p. 30). In short search and rescue (SAR) activities are part of the complex emergency response system that emerges in response to disasters.

A number of researchers in the USA have conducted systematic studies in order to understand what accounts for successes and failures of SAR activities. These works have chosen to explore everything from patterns of collapse to the effects of human use on the likelihood of being caught in a void space. For a near-exhaustive literature review see Poteyeva 2005 and Wenger et al 1990¹. They came to the following conclusions:

- (1) Volunteer and emergent group response is of critical importance.
- (2) Volunteers and emergent groups accomplish most initial SAR activities.
- (3) Since most survivors are rescued within the first 2 days, this emergent and volunteer activity is critically important to the rescue effort, especially because buried and entrapped victims are likely to suffer from injuries that require rapid life-sustaining intervention including compromised access to air, severe loss of blood and body fluid, crushing injury, and internal damage to essential organ systems.
- (4) Despite the attention they usually receive from the mass media (Quarantelli, 1991), most of the time urban search and heavy rescue (US&R) teams arrive too late to rescue anyone; instead, they undertake highly specialized recovery activities requiring sophisticated skills and equipment. This is due in large part to the particular nature of the social geography of disasters in which US&R teams are hampered by problems of timely access.
- (5) The integration of volunteer and established organizational activities is seldom efficiently achieved; many official responding organizations, particularly those from national governments, usually do not appreciate the work of the volunteers in SAR operations since they are often perceived as lacking sufficient credentialing, specialized training, and tools. In turn, the absence of disaster planning about how to use volunteers creates problems of its own as large number of volunteers converges on disaster sites (Quarantelli, 1996c). Problems of management of rescue activities are serious and include difficulties in coordinating activities across independent,

¹ For information on SAR during the Kobe, Japan earthquake of 1995 see Kunii, Akagi, & Kita, 1995; for the Kocaeli, Turkey earthquake of August of 1999 see Mitchell, 1999; for the Bam, Iran earthquake of December 2003 see Memarzadeh, Loghmani, and Jafari, 2004);

autonomous organizations, disagreement over rescue strategy, and ambiguous authority relationships.

Types of Responders

Despite the level of focus most people place on formal organizational SAR response there is a range of actors that engage in these efforts all of which have been studied extensively. Of all these efforts, the most extensive study of SAR activity was undertaken during the late 1970s by Drabek, Tamminga, Kilijanek, and Adams (1981.) These researches conceptually recast search and rescue not only as a professional activity, but also as an emergent, inter-organizational activity. While reaffirming a number of the previous observations made in the literature up to that time, their study highlighted the inter-organizational and managerial difficulties inherent in SAR. They found four common operational problems: (1) difficulties in interagency communications, (2) ambiguity of authority, (3) poor utilization of special resources, and (4) unplanned media relations. Quarantelli (1983) analyzed the problem of locating victims and managing their entrance into the emergency medical system. Glass et al. (1977, 1979) provided epidemiological evidence on the etiology of injuries and deaths that had obvious implications for SAR behavior. The contrasting effectiveness of local SAR voluntary organizations and formal organizations such as fire departments in locating and rescuing victims is in part a result of the interaction of ecological characteristics of the site of the disaster with other factors such as the (1) the social, cultural, and behavioral patterns and social relationships between victims and responders; (2) behavior of victims during entrapment; and (3) nature of the buildings and other structures and their collapse configuration. Here we explore the three main types of actors that engage in SAR.

Unaffiliated volunteers

Many studies have highlighted the importance of volunteer and community based responders. Building on Dynes and Quarantelli (1980) four types of disaster volunteers including organizational volunteers, group volunteers, volunteers in expanded roles, and volunteers in new roles. As (Dynes 1970) had theorized earlier, in the typical SAR site all of these types of volunteers become part of the process. Others have even gone as far as to suggest these are often the most important for SAR activities (Quarantelli, 1999). Quarantelli goes on to suggest that these preexisting networks of human relationships are often the most useful for alleviating novel

and unexpected collective problems that demand attention. People typically expand their sense of responsibility toward each other, and in the case of disasters often do so by becoming members of new emergent groups that carry out SAR activities. These works suggest that SAR activities are part of the mass assault phase of disaster. As such, multiple individual and collective actors participate in it. Many trapped victims are rescued by the uninjured bystanders and surviving local emergency responders (Aguirre et al., 1995; Auf der Heide, 2004; Durkin, Coulson, Hajar, Kraus, & Ohashi, 1987; Durkin & Murakami, 1988; Kunkle, 1989; Noji, 2003; see other literature in Poteyeva, 2005; Prater et al., 1993).

For example, in southern Italy, in 1980, 90% of the survived trapped victims were extricated by untrained, uninjured survivors who used their bare hands and simple tools such as shovels and axes (Noji, 2003). Following the 1976 Tangshan earthquake, about 200,000 to 300,000 entrapped people crawled out of the debris and went on to rescue others (Noji, 2003). These volunteers became the backbone of the rescue teams. Durkin and colleagues (1987, 1988) specified that the primary rescue technique used by the SAR teams and volunteers was the human voice of victims as they tried to alert their rescuers or as the rescuers called them, crying for help or making noise with available objects.

Volunteer organizations

Another important mechanism of SAR in the US is the thousands of local volunteer organizations that carry out SAR activities throughout the United States. The majority of these volunteer organizations came about soon after there was a mass emergency, a disaster, or there were cases of missing persons in their communities for which there was no organization available to assist in the response. In a recent ongoing attempt to quantify this activity, we have identified more than 1000 SAR voluntary organizations in all 50 states, with more than 50 organizations in some states. Initially, most of these organizations were involved in mountain and wilderness search and rescue activities, although nowadays they engage in water rescue as well as a host of other response activities in the aftermath of mass emergencies and disasters. The most frequent team capabilities are: K-9 teams---31% of the teams had them; water rescue, 26%; technical rescue, 22%; wilderness rescue, 21%; and mine rescue, 17%. Seventy-one percent of the organizations are supported by public donations, fund raising, and membership support; the breakdown for main sources of support mentioned by our respondents is: donations-

-- 56% of the teams mentioned it; sponsors, 41%; fundraising, 21%; member support, 13%; private grants, 8%; city, county, state governments, 15%; others, 6%. They compose a nascent industry in which, despite the recent effort by the Federal Emergency Management Agency (FEMA) to create a National Mutual Aid and Resource Management Initiative, there are at present no uniform training standards or certification. Instead, these organizations follow various professional standards such as those of the National Association of Search and Rescue (NASAR) and FEMA, although many are not certified by these national organizations; most have developed their own regulations: 6% of the teams in our sample train to NASAR standards and 2% to FEMA standards. NASAR estimates more than 50,000 SAR missions annually. Unpaid professionals carry out more than 90% of these missions. While not all of their activities are associated with mass emergencies and disasters, the sheer numbers still give a sense of the importance of these voluntary organizations. Perhaps the most splendid recent example of this type of activity was the heroic efforts of people who owned boats and engaged in rescuing their fellow citizens in the aftermath of Katrina, supporting governmental organizations carrying out these operations. They saved 1000s of people who would have otherwise drowned.

Formal Organizations

In contrast, another type of social actor, the urban search and rescue taskforces, has received a great deal of financial support and public attention. In the United States, the Urban Search and Rescue System (US&R) is a collection of multidisciplinary taskforces created from local emergency responders organized under a federal framework for response in the aftermath of structural collapses. These task forces arrive at the site complete with the necessary tools, equipment, specialized training, and skills. They were created to be deployed by FEMA at times of catastrophic structural collapse to engage in such varied activities as structural shoring, canine searches, complex rope systems, confined space entry, and technically assisted void search procedures, although for a number of reasons explored elsewhere (Trainor & Aguirre, 2005) they are now being used to do many other things not initially contemplated when the system was formed. In parallel, other taskforces are being formed by state governments in the United States and by national governments. FEMA's US&R System is of fairly recent origin, with the first US&R taskforce certified in 1991. The development of heavy rescue search capability was initiated in California, after the 1971 San Fernando Earthquake (Naum, 1993). In 1990, FEMA,

fresh from the problems created by Hurricane Hugo and the Loma Prieta Earthquake, organized a week-long meeting in Seattle, Washington where more than 90 specialists representing various constituencies met and developed the outlines of the program. They set up a system of local US&R taskforces that would be made up of personnel from local agencies and who would be federalized and deployed nationwide at the request of FEMA. State emergency management agencies were only marginally involved in the organization, which instead instituted an organizational link between the taskforces and FEMA. The taskforces have structural engineers to assess risks created by the configuration of collapsed structures, medical and hazardous material personnel, canine units, and very extensive cache of sophisticated tools and equipment for use in heavy rescue environments. When fully implemented each has more than 200 people. Today there are 28 US&R taskforces. One of the great paradoxes of the present system is that U.S. federal and state funding is directed to these taskforces even though they too often arrive too late to save anyone, and that this is done to the near exclusion of the thousands of voluntary SAR organizations that do most of the rescuing and savings of lives in the United States.

Search and Rescue and Death and Injury

The morbidity and mortality patterns associated with disasters depend on many factors. Recently, Bourque, Siegel, Kano, and Wood (2006) reviewed the causes of death in disasters. They write: In most disasters, the majority of deaths occur because people drown, are crushed by collapsing buildings or other structures, are hit by moving objects, or are thrown against structures and objects. People drown in hurricanes, tsunamis, and floods, with death often occurring instantaneously. People die from crush and multiple traumatic injuries in tornadoes, earthquakes, hurricanes, tsunamis, and terrorist bombings. In hurricanes, floods, and tornadoes, people who are in motor vehicles, motor homes, and outdoors are at greater risk of injury or death; in earthquakes, people who are outdoors are at less risk of injury or death. Burns and asphyxiation are major causes of death and injury following volcanoes, terrorist bombings, and probably in wildfires. Many of these deaths could be avoided if warnings and evacuation plans were better and more effectively disseminated. Physical injuries are the primary cause of nonfatal casualties after all disasters; the majority is soft tissue injuries and fractures, generally to the arms and legs. When electrical service is disrupted, the use of generators and other sources of light and heat lead to increased incidents of carbon monoxide poisoning and burns. After every

disaster, certain myths emerge about how disasters affect the health of populations. Prominent among them are the misconceptions that dead bodies cause disease, epidemics and plagues follow every disaster, local populations are in shock and unable to function, and outsiders are needed to search for bodies and bring supplies. In particular, our review did not find any evidence to support the popular belief about disasters and the occurrence of infectious disease outbreaks. Jean Luc Poncelet, Claude de Ville de Goyet, and Eric Noji have been among the most persistent in trying to address these misconceptions (e.g., de Ville de Goyet, 2004; Noji, 2005, n.d.; Poncelet, 2000).

Culture

Cultural and social arrangements are often of primary importance (Pomonis, Sakai, Coburn, & Spence, 1991). Reflecting cultural practices, occupancy of buildings by time of day and season is significant in determining occupant exposure to specific hazards (Durkin et al., 1987; Tiedemann, 1989). Kuwata and Takada (2002), in their study of the 2000 Western Tottori earthquake noted the low occupancy of buildings at the time of the disaster as a major reason for the low number of dead and injured; the earthquake occurred at 1:30 p.m. on a weekday, meaning that the inhabitants of the building were awake and at once perceived the dangers of the earthquake. In addition, the most important factor was that the majority of people were not at home; the inhabitant occupancy was estimated at 27%. Another issue is the increased vulnerability to disasters of minority group members and residents of low-income households. These categories of people have lower ability to protect themselves from disaster. Income is positively related to access to better and safer housing and location. Older, un-reinforced masonry buildings and mobile homes, which are highly susceptible to collapse in earthquakes, constitute an important source of affordable housing for lower-income residents in earthquake-prone cities such as San Francisco and Los Angeles. Religious and ethnic minorities are often impacted by a number of erroneous assumptions about the management of the dead in the aftermath of major disasters which are often used to guide SAR activities. In Nicaragua, in 1998, because of an avalanche at the Casitas Volcano brought about by heavy rains from Hurricane Mitch, more than 2000 people died. Acting under the erroneous belief that human bodies are public health risks, and violating the rights of victims and their relatives to a burial in accordance to religious beliefs and local cultural practices governing the handling of the dead, the army

incinerated more than 1000 victims; the rest were buried. None were identified. To this day they are listed as persons that are missing, an ambiguous status that creates legal and other difficulties for their surviving kin (Pan American Health Organization, 2004, pp. 163-170).

Time

Several studies examine the relationship between changes in response time and the saving of trapped victims (Coburn & Hughes, 1987; Kunkle, 1989; Pomonis et al., 1991; Quon & Laube, 1991). Kunkle claims that 80% to 90% of entrapped victims who survive are recovered in the first 48 hours after the disaster impact, and that many more entrapped victims could survive with timely delivery of appropriate medical care. Comfort (1996, p. 134) reports that in the 1995 Kobe, Japan earthquake the percentage of those rescued who survived was 80.5% for the first day after the earthquake, 28.5% for the second day, 21.8% for the third, 5.9% for the fourth, and 5.8% for the fifth day. Quon and Laube developed a predictive model that suggests that a 10% to 20% reduction in response time would yield a 1% to 2.5% reduction in fatalities. In the 1988 Armenia earthquake, 89% of those rescued alive from collapsed buildings were extricated during the first 24 hours. Noji et al. 1990; see also Olson & Olson, 1987) documented that most lives are saved and victims rescued during this immediate post-impact period. The probability of being extricated alive from the debris declined sharply over time, with no rescues after day 6. Noji (1991) points out that people have been rescued alive after 5, 10, and even 14 days of entrapment, but these constitute rare events. Pomonis et al. (1991) stress the importance of a victim's health condition inside a collapsed building at any given time; surviving entrapment can be expressed as a function of time and the injury level sustained at the moment of entrapment. Other factors need to be accounted for as well, such as exposure; dehydration or starvation after a long period of time; weather conditions and the amount of air voids that are created within the rubble; the weight of the rubble above the victim; and the victims' pre-entrapment health condition. Pomonis et al.'s study provides a number of empirical illustrations of the potential interplay among the mentioned factors. Entrapment is the single most important factor associated with death or injury (Durkin & Murakami, 1988). As Noji (2003) states, in the 1988 Armenia earthquake, death rates were 67 times higher and injury rates more than 11 times higher for people who were trapped than for those who were not.

Victim Age

Certain age groups are more vulnerable and have an increased risk for death and injury in disasters and others. People older than 60 years of age have a death rate that can be five times higher than that of the rest of the population during earthquakes. Children between 5 and 9 years of age, women, and the chronically ill also have an elevated risk for injury and death (Glass et al., 1977). As Noji (2003) points out, limited mobility to flee from collapsing structures, inability to withstand trauma, and exacerbation of underlying disease are factors that may contribute to the vulnerability of these groups. He also stressed the effect that certain social attitudes and habits of different communities may have on mortality distribution by age. For example, in some societies young children sleep close to their mothers and may be more easily protected by them.

Behavior of victims

Scientific studies of the behavior of victims in disasters are infrequent. While in need of replication, the few studies that have examined issues ranging from general behavioral patterns of communities during disasters to what building occupants did during the actual period of a disaster and experiences of trapped victims during SAR operations show that the much-feared social disorganization during the disaster periods is extremely rare (Aguirre, 2005; Durkin, 1989; Dynes, 1970), although conditions under which panic does occur have been identified in the literature (Dynes, 1970; Johnson, 1988). An atmosphere of human solidarity and cooperation characterizes the behavioral processes during and in the aftermath of a disaster. Residents of disaster-stricken areas are proactive and willing to assist one another. Research findings show that volunteer activity increases at the time of disaster impact and remains widespread during the emergency period (Dynes, Quarantelli, & Wenger, 1990). In the Guadalajara Gas explosion community residents who were not trapped or freed themselves from entrapment went to great lengths to search for their kin and neighbors (Aguirre et al., 1995). There were instances when individuals would call attention to other victims who were trapped nearby and could not free themselves; they would also speculate about the possible location of other victims, provided rescuers with information about the inner settings of the house, and reconstructed the architectural topography of the streets turned to rubble. Sometimes the victims, when trapped, were able to hear what was going on above or next door and thus maintained social ties with the world around them. They also engaged in imaginary interaction with significant others and saints, seeking spiritual and psychological support, which is so important for survival. More

recently, Scanlon in a recent observation (2005) of the London Underground July 7th 2005 terrorist explosion also shows that victims helped fellow victims, that staff operating the trains helped the passengers, and that the first responders were not emergency personnel but people nearby, among them medical doctors who worked at the British Medical Association as well as workers from other commercial establishments. Studies have paid particular attention to the importance of family as an institution during mass emergencies and disasters (Form & Nosow, 1958; see also Aguirre et al., 1995; Alexander, 1990; Quarantelli, 1988). Family is a very powerful unifying factor for disaster victims, and, as Alexander points out, its influence could immediately dissolve other groupings such as friends. Family members are the first to be rescued by their kin. As soon as the nuclear family is reunited they concern themselves with other relatives. Second in importance is the concern for immediate neighbors and other nearby residents, and then other people farther removed from the spheres of everyday interactions (Aguirre et al., 1995). While in need of replication, a research finding is that the chances of people surviving the Guadalajara explosion were directly proportional to the presence among the searchers of a person or persons who acted as proxies for the victims, reminding the searchers that the family member was missing, and supplying information about their possible location. Preliminary results from studies of building occupant actions during disasters and trapped victims behavior suggest that victims behave actively and assume responsibility over their rescue to the extent that they can do so. Thus victims trapped as a result of the Guadalajara gas explosion moved their bodies ever so slowly to create more room in the rubble; others called attention to themselves by screaming and making noise on the nearby debris (Aguirre et al., 1995). Seven of the eighteen victims trapped in the dormitory after the 1985 Mexico earthquake attempted to escape (Durkin et al., 1987).

Conclusions

The goal of this review was to present a number of findings related to the research on search and rescue conducted in the USA context. It is important to reiterate several of the most important ideas presented throughout the document that should be taken into account.

1. Search and rescue activities are undertaken by a number of different types of actors including unaffiliated volunteers, organizational volunteers, and formal

organizations. Measures should be taken to most effectively utilize all of these resources.

2. It is important to take steps to empower local organizations and build local capacity because time is of the essence in these situations.
3. While formal organizations are the most technically proficient they are often hampered by their geographical distance from disaster sites.
4. It is important to recognize the importance of local cultural knowledge in helping to predict locations of victims and to assist in searches.

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