Decision-Making as Community Adaptation: The Human Ecology of Emergency Management[1]

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[1]This work was supported primarily by the Engineering Research Centers Program of the National Science Foundation under NSF Award Number 0313747. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect those of the National Science Foundation. I am highly indebted to Havidán Rodríguez and Russell Dynes for their helpful comments on this paper. I would also like to recognize the contributions of our undergraduate research assistants Cory Abbey, Desiree Grainger, and Jessica Rothrock, for their valuable assistance.

This paper explores how emergency managers make judgments regarding long-term policy and offers a sociological account of organizational decision making within an ecological context. Discussions with emergency managers focusing on the relative merits of rainfall estimation and tornado detection served as data to address these issues. Among the thirty-nine (n=39) interviewees, a consensus emerged favoring tornado detection over rainfall estimation. From these findings, the paper attempts to a) understand why emergency managers prefer tornado detection over rainfall estimation and b) develop theoretical generalizations explaining trends in these preferences. Concerning the first goal, analysis revealed emergency managers stressed the relative threats of common hazards in Oklahoma, the capabilities of technology in hazard mitigation, and public opinion. Given the environmental, technological, and social concerns reflected in this reasoning, there appears to be a strong ecological context driving the need for tornado detection among emergency managers. Implications and concerns are presented in the final section.

Introduction

Technology today plays an increasingly vital role in the decision-making activities of emergency managers (Committee on Emergency Management 1982), yet further research is necessary to determine how to effectively coordinate a rapidly-growing body of skills and tools with the needs of complex organizations. In a study that touches on these issues, Sorenson and Mileti (1987) evaluated warning responses among 39 emergency organizations and detected strong psychological and social forces at play in the decision-making processes of emergency managers. While their analysis explored the dynamics of short-term judgments, the following research investigates long-term policy aimed at coordinating the use and management of weather information. Through the analysis of interviews with emergency managers, scientists, and other pubic safety officials, we seek to 1) identify and describe relevant factors in the emergency-management decision-making process and 2) use an existing theoretical perspective to organize findings into a framework describing the relationship between emergency management decision making and forces at the community level. Results should provide

emergency managers, planners, and policy-makers with more comprehensive guidelines upon which to resolve long-term weather information needs, as well as to recommend a theoretical perspective within which to continue work on organizational decision making.

Background and Context

Located within "Tornado Alley," Oklahoma experiences one of highest tornado severe weather casualty rates in the nation (Storm Prediction Center 1999). For some, the problem rests with inaccurate and infrequent weather updates potentially resolved, they argue, through the development of more sophisticated radar technology and remote sensing techniques. Armed with more accurate information and quicker weather updates, emergency managers could theoretically make better public-safety decisions (such as disseminating warning information more quickly), thus reducing the threat posed by tornadoes and other severe weather events.

This demand for improved weather information led to the establishment of the Engineering Research Center for the Collaborative Adaptive Sensing of the Atmosphere (CASA), an interdisciplinary research center, funded by the National Science Foundation (NSF), the primary goal of which is to protect communities through the development of enhanced radar technologies and remote sensing techniques. CASA's emphasis on multidisciplinary research introduced the need for an end-user integration team to provide feedback about the needs, opinions, and preferences of those for whom radar technology fulfills critical decision-making needs. Through their research, the end-user component found a strong social foundation upon which emergency management decision-making is built. This information guided system design for CASA while generating further

questions regarding the potential effectiveness of technological integration *lacking* a parallel and sustained social integration.

Demographically, Oklahoma is primarily rural, although there are a number of large cities within its borders, such as Oklahoma City, Tulsa, and Norman. Compared to the national average, Oklahoma has a much smaller urban population (national average=79%, OK=65%), a larger percentage of persons living below the poverty level (national average=12%, OK=15%), and a much larger population of Native Americans (national average .8%, OK=7%) (U.S. Census Bureau 2005). The emergency management structure in Oklahoma reflects that of other U.S. states: it is composed of a state emergency manager, county emergency managers, and local emergency managers responsible for the protection and towns and cities. County and city emergency managers appear to be well-equipped, well-trained, and firmly integrated into the emergency management structure of the state. Rural communities, conversely, lack the "geographic capital" and economic resources necessary to acquire the latest technologies and training. For instance, the growing use of the Internet as a means by which to acquire weather information places rural emergency managers at a strong disadvantage, for, as Nicholas (2003) observed, remote communities often experience restricted Internet access. This is part of a broader issue known as "the digital divide," which researchers and policy-makers acknowledge as playing a central role in limiting access to technology (DiMaggio et al. 2004, National Telecommunications and Information Administration 2001, Rogers 1995). Such inequality is an important feature distinguishing rural from county and city emergency management agencies, an inequality no doubt firmly established by the weaker economies characteristic of rural communities.

Central to the problem of public safety in Oklahoma remains an uncertainty regarding weather information needs. One of the specific needs over which there exists considerable debate regards rainfall estimates and tornado detection. Rainfall estimation —for instance, Quantitative Precipitation Estimates (QPE)—approximates rainfall quantities within a given period of time and offers a useful means of detecting potential flooding. Tornado detection, on the other hand, would allow radars to more effectively identify conditions favorable for tornado development. Understanding the relative importance of these two techniques is important to CASA for two reasons. First, the proposed CASA system is *end-user driven*: emergency managers, through their needs, preferences, experiences, and recommendations directly guide development of the radar technology. Second, the simultaneous incorporation of both techniques could impose unreasonable demands on system resources, so it may only be possible to include *either* rainfall estimation *or* tornado detection.

In-depth interviews with emergency managers about these (and other) issues provided useful information for system design and also reveals the socio-cultural and broader human ecological significance of emergency management decision making. Although emergency managers strongly believe that better tornado detection would enhance decision making given the climatology of Oklahoma, their reasoning reflected as much an awareness of the community as it did of the weather.

Review of Literature

The organizational and management literature commonly treats decision making as a function of individual psychology and organizational structure (Wally and Baum 1994), organizational culture and situational context (Trevino 1986), or power

(Eisenhardt and Bourgeois 1988). Studies appear rooted at the micro- and mesolevels of analysis with few attempts at shifting towards a stronger macrosociological focus. This paper is concerned with the manner in which decision making is affected by broader community factors outside of the cognitive, structural, and cultural qualities of any particular organization. In Oklahoma, evolving technological capabilities coupled with a demographically-diverse population raises issues related to how human societies, through their organizations, relate and adapt to different environments.

Originally concerned with the socio-spatial dynamics of metropolitan communities (Park 1936), human ecology moved beyond the study of urban environments in the later work of Duncan (1959), Duncan and Schnore (1950), and Hawley (1950). Hawley maintains that society responds to environmental changes by developing functional relationships through which a systematized process of community adjustment is enabled. Duncan (1959), and to a greater extent, Duncan and Schnore (1950), expand Hawley's notion of social-organizational response, locating additional sources of adaptation within the demographic structure and technological capabilities of society. This led to the development of the well-known POET model of human ecology, (an acronym for *P*opulation, *O*rganization, *E*nvironment, and *T*echnology), which posits that human ecosystems are self-correcting and therefore tend towards equilibrium. For example, within the population component, major declines in mortality or growths in fertility may produce large populations unsupportable by the ecosystem. However, within the context of human ecology, such immense changes encounter concurrent adjustments within the organizational, environmental, and technological components that stabilize and balance the population component. So, for instance, advances in

agricultural production, urban planning, and warfare techniques occur out of a need to acquire new land to accommodate populations of a size untenable within the current ecosystem. In another instance, Aguirre et al. (1993) demonstrated how changes in the demographic and organizational components of society impacted the frequency of severe weather. Within the current research, shifts in policy or decision-making strategies (organizational components of the human ecosystem) may be expected to represent adaptation driven by environmental, technological, and social pressures within a human ecosystem.

It must be emphasized that this paper is not necessarily concerned with the individual activities of emergency managers, but rather a process of community adaptation. It has been strongly argued that disasters, too, can be understood from the perspective of human ecology (Bates and Pelanda 1994; Burton, Kates, and White 1978; Hewitt and Burton 1971), as hazards constitute a "shock" to the stability of human ecosystems, the effect of which is to immediately trigger the counterbalancing and stabilizing forces of society.

Methods

For our purposes, "end-users" comprise an extensive network of individuals, groups, and institutions relying on radar data for the purposes of predicting, detecting, tracking and issuing warnings about weather events (e.g., National Weather Service (NWS), media), responding to severe weather (e.g., state, county, and local emergency managers), making decisions about preparedness and evacuation (e.g., general public), and conducting research (e.g., DRC, Center for Applied Social Research (CISA), and CASA). In total, thirty-nine (N=39) in-depth interviews were conducted with local,

county, and state emergency managers; National Weather Service (NWS) representatives; amateur radio (HAM) operators; and a number of other individuals involved either directly or indirectly in Oklahoma's emergency management community. Data used for analysis were gathered for a broader study on end-user integration funded by the National Science Foundation (NSF). All interviewees were informed of their rights as subjects and informed that all information collected from them would remain confidential. Snowball sampling was used in a minority of cases to obtain interviews. However, through purposive sampling techniques, the study selected and successfully interviewed emergency managers from diverse communities. This was done to ensure that findings do not only include the population of well-trained, highly-equipped emergency managers, but also other emergency managers lacking comparable resources. Data were transcribed, coded, and analyzed by researchers at the DRC.

Findings

Analysis revealed three modes of reasoning guiding the decision-making process of emergency managers in Oklahoma. First, weather hazards are distinguished by unique traits, some of which are inherently more threatening to life and property. Second, while Oklahoma experiences a range of severe weather events, mitigation strategies have been applied more rigorously and effectively to some hazards. Finally, emergency managers appear conscious of the social meaning and implications of their decisions: specifically, many possess a keen awareness of public opinion and how its focus on certain hazards limits the range of available decisions. Thus, we discovered a high degree of complexity associated with emergency management decision making regarding long-term weather policy.

The physical characteristics or environmental features of tornados prompt emergency managers to favor tornado detection over flood estimation. Every hazard event—whether a tornado, earthquake, flood, or hazardous chemical spill—presents unique difficulties to public safety. Tornados, emergency managers widely agree, do so primarily for two reasons. First, phenomena associated with tornados demonstrate highly irregular and rapid changes uncharacteristic of other hazardous events. The utility of tornado predictions, therefore, erodes more quickly over time relative to predictions associated with flooding, which, along with hail and lightning, frequently impacts the state of Oklahoma. Such uncertainty introduces extraordinary difficulties into the decision-making process, frequently defeating most attempts on the part of emergency managers to effectively respond to and prepare for severe weather. Second, some emergency managers assert that flooding, due to the long-term nature of its impact, can be ignored when meteorological conditions commonly signaling the presence of tornados appear.

Flooding, the interviews revealed, is a seasonable phenomenon the consequences of which rarely go beyond property damage. Based on past experience, emergency managers can determine with relative accuracy the time, location, and scope of such events, which leads to accurate and reliable predictions. On the other hand, while tornados too occur within a specific time period (generally May to July), the ability to detect and predict *specific* tornado events is overwhelmingly more difficult, if not impossible. Numerous examples from the interview data support this point. Recalling a recent event that caught his community by surprise, one emergency manager exclaims, *"[the tornado] came from the…southwest. Strange. So we didn't get that one predicted*

actually, but nobody did, I mean, who could have? The storm was just kind of…swirling." Also cited were problems related to "*undeveloping and developing funnels.*"

Attempts to moderate or eliminate these difficulties have heretofore remained unsuccessful; currently there is little that can be done to obtain knowledge about specifically where, when, and to what extent any single tornado event will impact communities. Summarizing this view, one emergency manager declares that "*[w]hether I have the other resources or not I'm still going to concentrate on it [the tornado] because that's the most unpredictable catastrophic of the two events, even though given the right conditions the flood could be more catastrophic, history tells me here that it's not."* Mirroring this statement, another emergency manager cogently states, "*the most traumatic thing we look for is tornadoes because you never know where they are going to pop up.*" In some cases, placid weather conditions camouflage a developing severe weather system. One interviewee discloses, "*[O]ut of Velma about six weeks ago. Same thing; we knew it was coming but you know, supposed to be able to feel the wind and… It got sunny and I get over there and it looked like a major tornado.*" In summary: "*you never really know until the thing is past you if it's gonna hit you, miss you, or what.*" These data are representative of a strong consensus among emergency managers that tornados constitute a much greater threat than flooding.

The short-term nature of tornado events offers a second reason for a greater emphasis on tornado detection. The distinction some emergency managers draw between a rapid-onset and a long-term event provides important insight into decisions regarding rainfall estimation or tornado detection. Most emergency managers appear more

concerned with short-term events like tornados, rather than long-term events like flooding. *"Flooding,"* according to one emergency manager, *"normally is caused by persistent long term rain. They [the public] can see the water rising, they have a lot of time to respond, whether they choose to do that or not is another story. Tornados are not that way. Just like the one happened last week, I mean, BAM!—it was there."* Tornados generally endure for shorter periods than floods and present greater threats to life within that short period. According to a sizable majority of emergency managers, flooding is, in the long term, an event less threatening than tornados due to local knowledge of exactly where water is most likely to accumulate. One emergency manager advises, *"Severe thunderstorms and tornadoes are short-term events for a given point, a given geographic area. They're shorter-term events. So I might be able to forget about living with the flooding for 20 minutes and live with the tornado issue for 20 minutes and then it's gone away and I can get back to looking at the flooding."* The key implication of these two findings—that tornados are highly unpredictable and emergency managers are more concerned with short-term events, like tornados—is that resources should be devoted to tornado detection. More importantly, for the research community, it gives us strong insight into the first mode of rationale emergency managers use when making decisions.

According to several emergency managers, effective mitigation strategies have reduced the danger posed by flooding in most communities; in fact, in the words of one interviewee, flooding has become more of a "nuisance" than a threat. Representing a second rationale on which the preference for tornado detection rests, mitigation techniques, and the technologies used to implement them, correspond to a stock of tools and knowledge communities use to prepare for and mitigate against certain hazards. By

and large, it is evident that communities in Oklahoma have disproportionately employed flood mitigation tools, and as a result, threats posed by flooding have been significantly reduced. As one emergency manager recalls, flooding was "much worse" years ago. He remembers places that would "always" flood prior to the establishment of mitigation practices, such as retention ponds and floodplains.

While hazard reduction should be the goal of all communities as a means by which to strengthen resilience, some hazards, by their nature, resist effective mitigation. This appears to be particularly true in the case of tornados, as it is much easier to mitigate the effects of flooding than it is, for instance, to purchase and distribute wind-resistant housing. In Oklahoma, emergency managers referred to numerous ways in which the dangers of flooding have been reduced—drainage basins, monitoring devices, and drainage and retention ponds; tornado mitigation, on the other hand, was not mentioned. Overall, technology has made flooding for EM a commonplace and routine event. Nevertheless, there appears to be a strong ecological context that determines how dangerous flooding is.

One urban emergency manager summarizes: *"We'll get some minor road flooding, more often than not. We don't get the big floods like we used to back when I first got started. The city's done a good job of drainage and working on retention ponds and things like that."* Illustrating how ecological context influences decision making, another emergency manager responded to a similar question by taking into account the distinctive landscape in which rural communities are situated: *"We have a lot of low-lying areas and we have to deal with a lot of flooding events. We have a lot of rural areas that are dependent heavily on county roads and when we have flash flooding, a lot of our water*

runs across roads." Even though some argue that urban areas are more vulnerable to disasters (Mitchell 1999), emergency managers and floodplain managers in urban areas tend to possess more resources—money, personnel, other resources—through which to purchase mitigation tools. However, as a general rule, emergency managers in both contexts believed that tornados are more dangerous, irrespective of geographic context: *"[W]e can monitor the flooding threat or the rainfall threat pretty well. And so I would be biased towards allocating, splitting the resources and putting more resources into the tornado detection.*"

Finally, as an emergency manager, retaining one's position in public office demands an acute awareness of public opinion, as well as a strong ability to incorporate it meaningfully into the decision-making processes. Lacking such an awareness, elected and appointed officials may soon find themselves in a political dilemma, as their policies neglect the sentiments of those for whom such policy is most relevant—the community. Further complications arise in that public opinion varies within different socio-cultural settings. Therefore, as elected or appointed officials, emergency managers ultimately face the problem of building a policy agenda based on a skillful attentiveness to public attitudes. Fortunately, it appears that many emergency managers in Oklahoma hold a strong awareness of what concerns local communities: severe weather. Indeed, as one emergency manager reveals, Oklahomans are on the whole are "*more severe-weather conscious than the average population*." Given such popular concern about severe weather, there is little surprise that a considerable amount of anxiety exists over the threat of tornados. Therefore, while other mistakes may be overlooked, emergency managers finding themselves unprepared for major tornado outbreak will likely suffer an immediate

and sustained public backlash. Bearing this in mind, the final reason emergency managers favor better tornado detection is for its ability to provide accurate information that would, in turn, allow better public safety decisions, thus enhancing public confidence.

With such great attention paid to tornados, a consistent record of failed tornado preparedness and mitigation reduces considerably the occupational longevity of emergency managers. As one emergency managers reports, *"[I]f I don't give the warning for a flood, I'm still going to be here tomorrow; if I don't give the warning, if I don't blow the sirens before the tornado hits the city limits, I won't be here tomorrow."* Public opinion sanctions and controls what emergency managers are allowed to do and what decisions they are allowed to make. In some cases, argues one emergency manager, public demands coupled with credibility concerns may, in fact, lead to inappropriate decisions. The public's strong orientation towards tornados affects public safety in a negative way: *"[a spotter may feel] that he has an obligation to tell that person or persons what's going on. And he may or may not know what actually…what he thinks he sees and what may be happening are two different things. That's been some problems I've seen in my ten years where I've been at.*"

Along with emergency managers, local media institutions also routinely undergo public scrutiny, further evidence that the *vox populi* cannot be ignored in the decision-making process. Referring to a news meteorologist recently fired for issuing too many false alarms, one emergency manager states, "*After that, every time something happened [and] they predicted it [wouldn't] happen they lost a little bit of credibility, so eventually he [the meteorologist in question] got booted out*."

False alarms reflect one of the many ways in which inaccurate tornado information may erode public confidence in emergency management institutions. Indeed there is the strong belief that one's legitimacy as an emergency manager suffers greatly with increasing false alarm rates, consistently inaccurate weather reports, and poor preparation. *"The only time that they will nail you to the wall,"* complains one emergency manager, *"is if the sirens for some reason they get sounded…and the notification wasn't [communicated] to the public quick enough, is when you're going to get hung to the wall."* The media, in turn, appear to streamline reports of false alarms to the public and assign blame to emergency managers: *"if we don't issue a warning and something bad happens and the camera crews and the microphones show up, it's gonna be my face and I will be the one that will ultimately be held responsible for our performance in any one of those things*." Combined with the difficulty of predicting the specific paths and locations of tornados, this creates somewhat of a tightrope-walking act for emergency managers. On the one hand, if they issue a tornado warning and nothing happens (which is often likely), they experience strong public criticism; nevertheless, issuing alarms at the slightest hint of meteorological activities produces public outcry as well. *"It's one of those situations where you're not going to please everybody all the time I don't think. There's going to be people that are upset because you sounded them there's going to be people that are upset because you didn't sound [the sirens] soon enough.*"

Human Ecology: Emergency Management Decision Making as Community Adaptation

The data demonstrate a clear trend: when it comes to the long-term decision-making among emergency managers—in this case, the preference for tornado detection over rainfall detection—there is great consideration given to both environmental *and* social factors. In the case of the former, emergency managers take into account the nature of the hazard—namely, its predictability, dangerousness, and duration. In the case of the latter, emergency managers largely considered the state of current technology, as well as how to satisfy the needs of the public in order to sustain credibility. Although up to this point the term "decision-making" has been used to describe the actions of an individual, the term itself is a bit of a misnomer. To be sure, "decision-making" implies the existence of a decision-maker, and while it would indeed be difficult to argue that emergency managers are absent in the process of enacting hazards policy, long-term policy planning is in the final analysis a product of larger forces operating at the community (rather than at the individual) level. What are these forces? Again, they stem from the environmental, social, and technological characteristics of communities.

Locating factors that influence decision-making at the level of the community (rather than the level of individuals' attitudes, thoughts, or preferences) forces us to reconsider the process of emergency management decision making. The evaluation and enactment of any policy cannot be explained by a single action or choice, but only as a mechanism by which the previously-identified forces attempt to adapt human communities to the context of current and forthcoming hazards. Given the presence of these forces in the decision-making process, it would be best to conclude that a decision made by an emergency manager is ultimately an expression of the community attempting

to adapt. If we are to view decision-making as an adaptive mechanism inescapably linked to social and environmental forces, a human ecological perspective becomes useful. The following is an attempt to organize the previous analysis within a human ecological framework.

Environment. The unpredictable, violent, and short-term nature of tornados introduces the greatest threat to human life in Oklahoma and, accordingly, elicited great concern from emergency managers. While flooding, hail, and lightning will not be ignored (in fact, a sizable minority of the interviewees cited such events—particularly lightning—as more dangerous than tornados), they will nonetheless carry less weight in long-term decision making.

Technology. Technology deployed in many Oklahoman communities appears to successfully mitigate against the effects of flooding. Therefore, the technological component of the community ecosystem diverts attention from flooding threats due to greater levels of flood preparedness and mitigation at the organizational level. Events for which there is weaker preparedness and mitigation strategies (in the current analysis, tornado) will thus elicit greater concern and, *ipso facto*, greater policy focus.

Social Organization and *Population*. Public opinion, which is strongly tied to the social organization and population characteristics of a community, is the final ecological characteristic influencing the decision-making process of emergency managers. As public opinion is a product of society, it changes with context. Although the reasons for why public opinion is so geared towards tornados in Oklahoma are elusive, it is commonly—though falsely—believed that such orientation of public opinion occur because tornados are the most common event in Oklahoma. However, tornados are not

the most common event in Oklahoma—while many emergency managers believe that such events are clearly the most dangerous event to face Oklahoma, many do not believe tornado occur with the same frequency as flooding, hail storms, or lighting strikes. Indeed, according to some, tornado events are quite rare. A better explanation might be that tornados, because of the immediate devastation they cause, as well as perhaps their unpredictable nature, evoke a strong sense of risk on the part of the population in Oklahoma. While floodwaters may rise slowly, tornadic winds decimate within seconds large residential complexes, factories, and other infrastructure, thus evoking a strong sense of fear and risk within the population. However, regardless of the source of public sentiment, and whether it is true or not, public opinion strongly impacts decision-making trends among emergency managers, and thus adaptive directions, of communities. As sociologist W.I. Thomas (1932: 572) once wrote: "If men [and women, we should add] define things as real, they are real in their consequences."

Discussion and Conclusion

The research demonstrates a need to consider how social, environmental, and technological forces shape the organizational decision-making processes of emergency managers. Viewing policy planning for long-term weather needs as a reaction to ecological forces at the community level is grounds for moving away from the idea that policies express the sum of individual judgments: judgments clearly reflect social context. These broader influences, findings indicate, attain greater visibility as organized public safety institutions facilitate adaptation to environmental threats, which, in the end, demonstrates that decision making is not a single act, but the instantiation of environmental, technological, and social influences in the form of emergency

management policy. Viewed in such a manner, we are forced to refocus our attention away from the characteristics of individuals, which, while important, simply cannot account for the total variation in decision making between communities. More precisely, an emergency manager may indeed be a skilled decision-maker, but the use of such skills is shaped and limited by the ecological context.

The current data permit only limited predictions. To move foreword in our analyses of decision making, future research would combine investigations of the influence of public opinion with an understanding of population characteristics to obtain a better grasp of community adaptation. The potential for the effective use of human ecology in understanding disasters and communities is illustrated by Smith (1992), who argues that cities, in comparison to rural areas, constitute regions whose distinct geo-morphological characteristics generate serious flooding risks. He makes a strong case that greater flood risks are due to impermeable surfaces, reduction of carrying capacities due to construction, and the inability of sewage systems to handle massive urban-generated runoff. Other research—both conceptual and empirical—demonstrates that geographical location, such as whether a community is located in a rural or urban setting, also produces consequences for emergency planning (Kumagai and Nojima 1999; World Health Organization 1987; Uphold, O'Keefe, and Schaeffer 1986).

It is very important that further research on hazardous events gives equal weight to human and natural systems, but it must do so while paying strong attention to power and inequality between social groups. An unintended consequence of this research has been to imply a functional relationship between social institutions and disasters. While this may be true at the level of operational communities, such as emergency management,

admittedly beyond the scope of this paper is an analysis of the demonstrated vulnerability of marginalized populations (Blaikie et al. 1994). While useful, human ecology ultimately fails to explain why these marginalized groups often experience blocked access to the resources generated from successful adaptation, a phenomenon observed throughout the recent work of Peacock, Morrow, and Gladwin (1997). Mitchem (2003) discovered that African-Americans were less likely than whites to understand warning messages prior to the September 20, 2002, tornados that struck Indianapolis, while additional evidence indicates that individuals with more education are more likely to hear and understand a warning message (Perry and Greene 1982; Turner et al. 1979). Additional findings suggest that education (Balluz et al. 2000), age (Gulaid, Sacks, and Sattin 1989), disability (Pearson and Joost 1983) , gender (Morrow and Enarson 1996), and geographical location (Quijia, Xinling, Guomin, and Rouwei 1992; Klein, Nicholls, and Thomalla 2003) influence warning response behavior. Future research should combine analysis of emergency management and other public safety institutions with a demographic analysis of vulnerable groups in order to move towards achieving a "political ecology" envisioned in the work of Oliver-Smith (1998).

Finally, it is important to note that while ecosystems intend to reach a state of equilibrium, there is no guarantee that policy decisions will ultimately be capable of achieving this. Take, for example, emergency mangers' belief that tornados present greater danger due to the implementation of effective flood mitigation. Although the widespread development and implementation of flood mitigation has been useful in protecting lives and property, it is somewhat worrisome the degree to which some emergency managers believe that channelizing local creeks and rivers, monitoring water

levels, and adding drainage and retention ponds in flood-prone areas will continue to protect life and property. Flash flooding, for instance, raises an important concern: it is theoretically possible that the recent improvement in mitigation strategies has had a negative effect on the level of individual flood preparedness. If this is the case, there exists a strong potential that major flooding might cause significant casualties. Individuals residing in communities protected by strong mitigation initiatives may have forgotten—or worse, never learned—the location of escape routes, their major points of access, and how to interpret the meanings and instructions of flood warning messages. Strong consideration should be given to the role played by acquiescence in producing vulnerability. This is a plausible scenario, given that Janda et al. (1996: n.p.) recently discovered in their assessment of the public response to the Lahar Hazard around Mount Pinatubo that "dikes and other sediment-control structures offered a false sense of security that delayed evacuations."

These findings should resonate strongly with concerns vis-à-vis the well-known levy and flood-wall failures following Hurricane Katrina, which resulted in major flooding responsible for a large number of deaths. Recent evaluation research announced by Defense Secretary Donald Rumsfield (*The Times – Picayune* 2005) aims to discover the causes of the structural failure. However, although developing more effective flood mitigation techniques will be crucial to preventing future catastrophes in New Orleans, additional social research must be conducted on evacuation behavior to determine if the presence of the levies and flood walls themselves had not given the population a false sense of safety. In more precise terms, among members of threatened communities there may have developed what social scientists refer to as a "normalcy bias" (Okabe and

Mikami 1981), the result of which is vulnerability produced, ironically, through the *long-term effectiveness* of levies, flood walls, and other mitigation strategies. The point of this discussion is that while broader ecological forces are shaping what the emergency manager does, there is still a strong level of variability at the individual level of analysis, a fact that should not be ignored.

The findings, while focusing on emergency management institutions in Oklahoma, are applicable in both a broader domestic as well as international context. Although distinct geographic and demographic characteristics make Oklahoma a special case, the utility of human ecology (operating at the community level) lies precisely in its ability to describe how variation in morphological and social contexts influence organizational decision making. Moreover, before technology can be used by emergency managers, it must be *incorporated* into a preexisting ecological context, and, as we demonstrated, social forces played a central role in this process of incorporation. This was because there was a) a strong public opinion in favor of one type of decision-making and b) a means, through the media, of channeling emergency management mistakes. Thus, when local planning committees or Emergency Operation Centers (EOCs) are organized, decision making must be made not only in accordance with the specific threat or the technological capability of responding to that threat, but also of the social context in which the threat emerges.

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