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Emergency Information Management and Public Disaster Preparedness: Lessons from the 2004 Florida Hurricane Season

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A key task of emergency management is to ensure that the public is adequately prepared for impending disasters in order to minimize loss to life and property. The consecutive strikes of four major hurricanes during a six-week period in Florida in 2004 provide a unique opportunity to study how governments manage and deliver emergency information for this purpose. Based on a comprehensive survey of Florida county emergency managers (91.7 per cent response rate), this study finds that 1) 23.4 per cent of respondents perceive that residents in their jurisdictions were well-prepared, 50.0 per cent state that residents were somewhat prepared, and 26.6 per cent state that residents were not well prepared, and 2) counties that use GIS systems, obtain and disseminate location specific information, provide targeted information for different population groups, maintain a website about impending disasters, and provide press conferences with three hours intervals or less report higher levels of perceived public disaster preparedness. This article concludes with lessons and recommendations for further improving public disaster preparedness.

Key words: Emergency information management, disaster preparedness, sense making, emergency communication.

Introduction

A key task of emergency management is to ensure that the public is adequately prepared for impending disasters in order to minimize loss to life and property. A common model of emergency management process has the following elements: mitigation, preparedness, response, and recovery. Mitigation represents activities that prevent a disaster, reduce the chance of it happening, or reduce its damaging effects; preparedness represents those actions taken before impact, including plans and preparations for disaster; response represents actions taken during the initial impact of a disaster, including those to save lives and prevent further property damage; and recovery, those actions taken after the initial impact, including those directed toward a return to normality (Curtis and McBride 2004; Donahue and Joyce 2001; Farazmand 2001; Haddow and Bullock 2003; McEntire 2002; McEntire, Fuller, Johnston, and Weber 2002; McLoughlin 1985; Tierney, Lindell, and Perry 2001; Tobin and Montz 1997; Waugh 2000). Emergency information management has critical importance in the preparedness stage of emergency management, which is the main focus of this article.

In the state of Florida, by statute, counties are the responsible local government agencies in managing disasters. Section 252.38 requires counties to develop emergency management programs that involve all organizations with responsibilities in emergency management; implement public awareness, education, and 24 hour information programs that reach all county citizens, including those with special needs and non-English speakers; coordinate public information activities during emergencies; and provide for sheltering persons evacuating from any jurisdiction (Florida State Emergency Operations Center, 2004: 13). Counties have an important role to fulfill in collecting and disseminating information because they are close to affected populations (Aguirre, 2004; MacManus and Caruson, 2006; McEntire, 2002; Neuby, 2003). Yet, a recurring theme in analyses of such events as Hurricane Andrew in 1992, the 9/11 terrorist attacks in 2001, and Hurricane Katrina in 2005 is that information collection and sharing among counties as well as the public and other agencies was deficient, causing a slow and inadequate rescue and recovery response (Kapucu 2006; Kettl 2004; Wise 2006). Although government responses to Hurricane Katrina showed many problems, they also illustrated a problem of information collection and dissemination. Hence, a need exists to better understand how well counties are fulfilling their role of collecting and disseminating information for public disaster preparedness (Cigler, Stiftel, and Burby 1987; Comfort, 2006; Schneider 1995; Waugh 1994).

The 2004 hurricane season provides a unique opportunity to assess the methods and strategies used by counties for collecting and disseminating emergency information. In 2004, four major hurricanes struck Florida in rapid succession. Hurricane Charley made landfall on August 13, Hurricane Frances on September 5, Hurricane Ivan on September

16, and Hurricane Jeanne on September 25, 2004. Collectively, they killed 117 people and caused more than US$45 billion in estimated damages (Bell and Smith, 2004; FSEOC, 2004; Newman, 2004). Florida experienced other hurricanes too, notably Hurricane Andrew in 1992, which has provided the state with many learning opportunities. Acknowledging the lessons learned, a special issue of the Annals of the American Academy of Political and Social Science, *Shelter from the Storm: Repairing the National Emergency Management System after Hurricane Katrina* (Waugh, 2006), recommended that Florida's emergency management system should be studied as a model for the entire United States. However, very little is known about how these counties gather and disseminate emergency information. Although counties in Florida, as in many other states, are required to develop a comprehensive emergency management plan, very few studies exist about the role of counties in emergency management (Perry 1985; Schneider 1995; Waugh 1994) This is in contrast to the many disaster studies that focus on disaster preparedness and response by individuals and households (Drabek 2001; Dynes and Tierney 1994; Peacock, Morrow, and Gladwin 1997).

This article is based on systematic mail surveys and in depth interviews of emergency managers. The research findings provide insights for how governments can better collect, prepare, and disseminate emergency information to enhance public preparation during emergencies (Aguirre 2000; Tierney 2000). The remainder of this paper begins by examining the relevance of the literature on organizational sense making to hurricane preparedness and identifying specific research questions. Next, we turn to a description of the data collection methods and the data analysis results. The paper concludes with a discussion of the study's theoretical and practical implications, its limitations, and directions for future research.

Sense Making and Emergency Information Management

This article uses *sense making* as a theoretical approach to understanding information collection, processing, and disseminating in the context of emergency information management. Sense making states, first, that there is a need to collect as much information as possible, because abundance of information is always better than a lack of information for decision making. Second, unassessed or unprocessed raw information is often not of much use to decision making, as it may be not specific enough, distorted, untrue, or misleading. Indeed, it is widely held that raw information needs to be assessed and processed in order for it to be meaningful and useful to emergency managers (Brown 2000; Perry and Nigg 1985; Savolainen 1993; Weick 1995). A task of emergency information management is to produce information for decision making that is specific, relevant, and accurate, and then help users of this information to understand it as well (Dervin 1992; Weick 1993, 1995). Accurate and well organized information is especially

important for the dynamic context of disasters in which users of information typically have very little time and ability for engaging in their own analysis (Comfort 1999).

Weick and Sutcliffe (2001) present sense making in emergency management as a process of scanning the environment for information and using it to develop plausible courses of action. Many sources are used to gather information about the environment, and this information must be timely, transparent, and comprehensive for informed decision making. Managers make sense of their situations by comprehending a continuing inflow of new information; dealing with rumors, misinformation, or surprises; constructing meaning from new information; and interacting to make decisions (Greenberg 1995; Weick 1993). In turn, they must produce accurate and relevant information because "citizens want the unvarnished truth, regarding the situations that they must manage. ... Public affairs specialists rarely have the substantive and analytical skills needed to identify that information. Their predisposition to spin facts may make their organization look more capable than it actually is, setting the stage for it to disappoint those who rely on it" (Fischhoff 2006:83).

The literatures on communication, implementation, and networks also cite the need to evaluate and interpret information for others. In the implementation literature, policy and program goals need to be interpreted and then specified for others—such as lower ranking officials and program clients—so they know how to interpret and apply new mandates and resources (Allison and Zelikow 1999; Kingdon 1995; Matland 1995; Sabatier and Jenkins-Smith 1999; Weiss 2003). In the communication literature, organizations are seen as interpreting facts in an effort to understand their environment as well as using them (or "spinning" them) to influence citizens' sense making and decision making (Coombs 1999; Fischhoff 2006; Nigg 1995). In the network literature, sense making is sometimes described as a process of consensus building as well as persuading and bargaining. In "loosely coupled" systems, networks are composed of elements or subsystems that are autonomous; individual participants have great latitude interpreting and implementing directions. Through communication, participants collectively interpret and make sense of information in their environment (Boin, 't Hart, Sterm, and Sundelius 2005; Drabek 1990; Orton and Weick 1990).

The ability to act depends on the capacity for rapid information collection, processing, decision making, and dissemination (Comfort and Kapucu 2006; Kettl 2004; Brown and Miller 2000). Emergencies also create high uncertainty for managers by disrupting established structures and expectations and by prompting the search for information (Seeger et al. 2003). Based on sense making theory, emergency information management (EIM)—the activity of information collection, processing, decision making, and dissemination—should consist of three steps as noted in Figure 1. Information collection (search) is the first step, in which information sources are identified and availability of information is assessed. This step also involves an initial assessment of the

integrity or truthfulness of information sources to filter out possible rumors or misinformation. The second step of information processing involves strategies to identify or specify useful information in a format that is suitable for decision making. For example, a hurricane warning can be produced with specific action to be taken by the public. A storm weather prediction can be made with specific locations and evacuation possibilities. The last step is information dissemination and exchange that emphasizes the modes of information delivery (e.g. what is the most effective way of delivering information to decision makers?) and timeliness of information delivery (e.g. how soon should decision makers receive information?). This sense making process is equivalent to emergency assessment, which emergency managers need to make decisions about hazard operations, population protection, and incident management actions (CDRSS 2006; Lindell et al. 2007). In the following section these three steps are explained in detail to illustrate how to achieve specific, relevant, and accurate information before, during, and after emergencies.

Figure 1: Emergency Information Management Process

EIM Steps	*Purposes*	*Examples of Actions in Response to Hurricanes*
Information Gathering ↓	Gather sufficient and accurate information	• Gather information from a variety of sources such as weather services • Communicate with community leaders on community conditions • Create information hotlines • Assess truthfulness and integrity of initial information from first responders
Information Processing ↓	Create usable and presentable information methods	• Develop simple and easily understood languages for information presentation • Develop information messages that target different segments of community such as minority groups or the elderly • Develop visual images
Processed Information Dissemination	Effective decision making and coordination of information users	• Use timely information sharing among stakeholders during hurricanes • Provide frequent Information update to stakeholders during hurricanes • Use electronic roadway signs for hurricane information delivery

Emergency Information Gathering

The very first step in EIM is collecting accurate information about the threat as well as community conditions and public awareness about the impending danger. Experts and public officials responsible for public disaster preparedness cannot assume that the public perceives risk levels in the same ways as they do. Thus, these officials must assess the level of public awareness as well as community conditions (Beck et al. 2005; Dow and

Cutter 1998; Fischer 1998, 1999; Nigg 1995; NRC 1989; Tierney 2000). Although hurricane statements issued by local or National Weather Service offices now provide detailed information about local area storm impacts (FEMA 2004; Fitzpatrick 1999; Pielke and Pielke 1997), the actual conditions of local rivers, creeks, roads, and building structures must be gathered at the local level. Officials must decide what information is needed and how to obtain it. Coordination and input from other organizations often is essential. Even though emergency management involves many planned procedures, improvised procedures are also required (Kreps 1991). Emergency operations plans (EOPs) and standard operating procedures (SOPs) are designed to obtain information quickly and accurately. Data collection methods include observation of traffic patterns (e.g., residents fleeing the area), last minute preparedness purchases (such as runs on supermarkets and do it yourself superstores like Home Depot or Lowe's), public inquiries (e.g., email or public information hotlines), local reports on TV and radio, shelter and hotel capacity utilization, and information obtained from community leaders involved in emergency efforts. These assessments need to be ongoing, as threat conditions rapidly change, sometimes hourly. Surveys conducted during emergencies oftentimes receive very low response rate because no one risks responding while lives and properties are at stake. It is therefore not good time to design and implement scientifically valid surveys as a method of data collection.

Emergency Information Processing

Data gathered must be vetted for accuracy, processed, and compiled in ways that make it meaningful for users. Emergency managers collect information from various sources such as fire, public works, and law enforcement, which provide information about the condition of local infrastructure, public behavior, and immediate needs. It is left to the emergency managers and public information officers to determine the accuracy of information when the public calls in notifications. Emergency managers collect the information from public calls, give reports to other departments for initial assessments and, based upon these assessments, determine the deployment of resources. For example, the City of Orlando Emergency Operations Center does a situation update two times daily, in the morning and afternoon. These updates consolidate department reports into one city wide report, which is then distributed to the mayor, city department heads, and the county (City of Orlando OEM 2005).

The importance of information processing and presentation is that it must be readily understood by the public and thus effectively aid in changing public behavior and furthering preparedness (Seeger et al. 2003). "Although you cannot control how others perceive your crisis message, you can put thought into how to frame communications and how to send message so that they are more likely to be understood" (Lampen 2002:10). The nature of information involving hurricane threats is highly complex and scientific,

but in recent years considerable effort has gone into data processing, thus allowing lay persons to become familiar with it. For example, the public website of the Tropical Prediction Center of National Oceanic and Atmospheric Administration contains information that few people can understand and evaluate. However, the National Weather Service also supplies forecasts and warnings emergency managers can use to prepare people, and evacuate them if necessary. Additional general guidelines are available from other federal and state agencies, but local officials must make their own determination concerning how they will package available information and what guidance to give residents regarding protective action. In each instance, the responsibility to warn and protect the public and its properties must be balanced with the level of threats about disrupting community with potentially untrustworthy information (Fischer 1999; Mileti 1999; NRC 1989).

Emergency Information Dissemination

Much has been written about emergency information dissemination and communication (Baker 1991; Beck et al. 2005; Bristow 2004; Drabek 2003; Mileti and O'Brien 1992; Mileti and Sorensen 1990; Williams and Olaniran 1998; Witte 1994). Emergency information communication can be defined as the sending and receiving of messages "to prevent or lessen the negative outcomes of crisis and thereby protect the organization, stakeholders, or industry from damage" (Coombs 1999:4). To ensure timely, transparent, and comprehensive information dissemination and allow for informed decision making, risk communication experts suggest that threat warnings should include a) multiple communication methods, b) timely notification, c) specific threat information and guidance on actions to take in response to emergencies, and d) speaking with a single voice to secure the accuracy and authenticity of information (Boin et al. 2005; Douglas and Wildavsky 1982; Fitzpatrick and Mileti 1994; GAO 2004; Smart and Vertinsky 1977). The "clarity of the warning message, the consistency of the message, the frequency of the warnings, the type of authority giving the message, the accuracy of past warnings, and the frequency of disaster agent" can increase the chance of a warning being taken seriously and acted upon accordingly (Fischer 1998, p. 9). The public must not only understand the threat but also know viable strategies in response to natural and technological disasters.

What are the outcomes of these EIM activities? Our study seeks to explain whether these information gathering, processing, and dissemination activities are associated with increased public disaster preparedness, at least as this is perceived by emergency managers. Public disaster preparedness is focused on personal responsibility and self reliance, ensuring that citizens undertake necessary actions to protect their lives and properties (Perry 1985; Perry and Nigg 1985; Tierney et al. 2001; Waugh 2000). Public disaster preparedness is furthered by providing citizens with accurate and timely

information that is consistent with the goal of protecting property and seeking shelter or, in some cases, pursuing evacuation. Lack of hurricane awareness and preparation are common threads among all major hurricane disasters. By knowing the public's vulnerability and what actions the public should take, governments can reduce the effects of a hurricane disaster. The goal of EIM is to inform the public about impending hurricane hazards and to provide knowledge about actions so information can be used to save lives and reduce property damage. Indeed, the purpose of generating and disseminating such information is to affect behavior. Timely emergency information provides the public with more opportunities to reduce property losses by boarding up homes, removing loose objects, and removing or tying down boats and the like. Timely emergency information also gives people more time to evacuate, if needed, and to prepare for impaired community conditions by stocking up on food, water, batteries and the like.

However, from an administrative perspective, EIM is also a process of coordinating efforts in governmental agencies, nonprofit organizations, businesses, and the community to maximize the use of information. Coordination processes should strengthen organizational relationships that improve the effectiveness of the response operations and public disaster preparedness (Perry and Lindell 2003). EIM also affects disaster response by providing information about evacuation plans and detailed situation reports about disasters (Dynes and Tierney 1994; Kweit and Kwelt 2004; Waugh 2000). Other factors also play a role, such as prior relationships with the media and community organizations that are designed to increase coordination. For example, preseason coordination meetings with the media and community organizations are designed to plan for effective coordination during emergencies. Another factor is leadership and support from elected officials to plan and ensure coordination, and the use of information technology to increase success of the response operations (Heath and Millar 2004; Iakovou and Dolugeris 2001; NAPA 2001).

Based on the sense making perspective, this article addresses three research questions.

1. What strategies do Florida counties use to gather, process, and disseminate emergency information to the public before and during hurricanes?
2. What strategies do emergency management agencies in counties use to communicate emergency information among public agencies and community organizations?
3. How effective are these strategies for ensuring public disaster preparedness, according to county emergency managers?

Method

Data were collected using two different methods, survey and interviews. Survey items were mainly drawn from the literature, reviews of state and county comprehensive emergency management plans, interviews with emergency managers, and the authors' previous experience in this area. A mail survey was conducted between December 18, 2004 and February 9, 2005 to emergency managers/directors in all 67 Florida counties. Following a pilot survey, three rounds of mailings and reminder email messages, 65 responses were received for a response rate of 97 per cent. Most questionnaires (83 per cent) were completed by emergency managers or directors and the remainder (17 per cent) were completed by assistant emergency directors or public information officers. Because of their varying positions, we refer to the respondents as "senior managers". On average, respondents stated that they had worked 19.6 years in government, with an average of 10.4 years of service within their present jurisdiction. Respondents averaged 7.6 years of experience in emergency management. Among respondents 92 per cent were familiar or very familiar with emergency management in their jurisdictions. Thirty nine percent of respondents were younger than 45, 35 per cent were between 45 and 54 years, and 25 per cent are over 55. Seventy two percent of the respondents were male.

Individual survey items to measure emergency information management are presented in Tables 1 and 2 in the Results section. Thirty three items were used to measure emergency information gathering (see Table 1) and 29 items were used to assess emergency information processing and dissemination. Respondents were asked to evaluate these items on a five point scale from *Did Not Use* to *Very Important* or from *Did Not Seek* to *Very Thorough*. A *Don't Know or Can't Say* category was also provided. Items measuring information dissemination timeliness were measured on a seven point scale ranging from *Strongly Disagree* to *Strongly Agree*. Individual items then were aggregated to form an index. For example, the 14 items used to measure emergency information control were averaged to arrive at an index of information control. Several items were used to measure the outcome of emergency information management (see Table 3). Respondents are asked to assess these outcome statements on a seven point scale from *Strongly Disagree* to *Strongly Agree*.

Second, we conducted seventeen in depth interviews (one fourth of all respondents) with those whose counties were struck by three or more hurricanes during 2004 hurricane season. Most of these interviewees were selected based on their locations in metropolitan areas such as Orlando and Tampa and we focused on their relationships to county emergency management agencies. These interviews assessed respondents' views regarding the adequacy of emergency management efforts and the role of public managers in the process. The interview results are also used to validate survey responses. Specifically, respondents were also asked to provide examples to substantiate their survey

responses in information gathering, processing, and dissemination. For example, we asked respondents who claimed that their jurisdictions "experience problems communicating evacuation orders to the public" to provide examples on what these problems were. We also asked interviewees "How was it determined what information was collected, when, and how? How was the accuracy of information determined?" to determine how county emergency managers validated the emergency information. We also asked respondents who said that their jurisdictions were "provided information on electronic roadway signs" to identify the locations of these signs.

This study has some limitations, of course. First, it is based on the responses of county emergency managers, rather than other actors such as citizens and community leaders, or other public and elected officials, whose opinions also are important. Nonetheless, the responses of senior public officials are important as these officials are essential to program development and implementation and their perceptions are often based on significant experience discussed below. Second, this study relies on perception data, because objective measures are largely absent in this area. Indeed, very few objective measures of emergency information management exist in the governments studied. Third, the data are limited to hurricanes, though this framework for analyzing hurricane data is relevant to other disasters. Fourth, this study examines the impact on public disaster preparedness, rather than other outcomes such post disaster response and recovery. Fifth, because the four hurricanes followed in extraordinarily quick succession, over a period of only six weeks, it was not possible to study emergency management strategies after each separate hurricane. However, the mail survey was sent to respondents soon after the last 2004 hurricane to ensure that they had still retained information of these events.

Results

Use of Emergency Information Management Strategies

Information gathering. Respondents stated that their counties gather a broad range of information from many different sources during hurricanes. This information includes updates on the hurricane related information such as transportation routes, transportation zones, evacuation zones for Saffir-Simpson categories 1-5, evacuation behavioral data, demographic data (age, language, and ethnicity), vulnerability data (number of people in evacuation areas) that were collected in response to 2004 Florida Hurricanes (FDEM 2005). For example, according to the interviewees, shelter information encompasses shelter locations, illnesses of users, shelter capacity, and special need shelters. Special needs shelters are identified to accommodate people with special needs such as "around the clock care" and serious mental illness. Table 1 shows that 97 per cent of the respondents identified the National Hurricane Center as an important or very important

source of hurricane information; other important sources as identified by respondents are local, first hand information sources such as public information hotlines (78.5 per cent), local radio stations (69.7 per cent), and municipal and community leaders (72.3 per cent and 73.8 per cent). Local government agencies have a Public Information Officer tabletop where they share information with local media and coordinate messages for the pre-, trans-, and post-hurricane emergency response as well as the short term and long term recovery (City of Orlando OEM 2005). Reports from local newspapers (36.4 per cent) and the FEMA (37.9 per cent) are perceived as less important for respondents, probably because of the delayed delivery of these paper-based reports during or after the hurricanes.

Table 1 also describes respondents' perceptions of the adequacy of information about community conditions during the hurricanes and the days that immediately followed. Seventy five percent of the respondents state that information about flood conditions was thorough or very thorough as do 83.6 per cent about road conditions. Slightly more than half of the respondents perceived information to be thorough or very thorough about traffic conditions (57.6 per cent), tree damage (57.6 per cent), fire damage (56.9 per cent), crime conditions (54.5 per cent), utility conditions (51.5 per cent), and building damage (51.5 per cent). Only about a third of respondents reported that their county governments had thorough or very thorough information to control rumors and gossip (33.3 per cent). This is an important deficiency because rumor control and counter rumor strategies are critical when the public is in dire need of information (FDEM 2005). On average, only 55.7 per cent of respondents stated that information about community conditions was thorough or very thorough. In fact, respondents stated that less than two thirds of their agencies had thorough or very thorough information on road conditions and accessibility. Only a little more than half of the agencies had thorough or very thorough information about tree damage, traffic conditions, utility conditions, and crime conditions. Further bivariate analysis shows that respondents from counties with larger populations perceived more important use for reports from hospitals (tau-c = .235, p = .025), public information hotlines (tau-c = .229, p = .029), and reports from local radio stations (tau-c = .196, p = .050). They perceived less important use for reports from state agencies (tau-c = -.247, p = .008) and from weather channels (tau-c = -.204, p = .029). Bivariate analysis showed no relationship between the thoroughness of assessed community information perceived by respondents and a county's population size or number of full time emergency operations employees.

In our interviews, emergency managers in communities with vast areas of devastation reported that they obtained information in different ways. For example, some received the damage information from first responders such as firefighters and police. Usually code enforcement and building inspectors reported more detailed damage information, but they

often did not have enough personnel to assess all damage (City of Orlando OEM 2005). Counties also sent their employees to verify and evaluate situations as they were reported.

> Damage assessments require a lot of time and training but we do immediate flood/flash assessment that we send to the state. These are done by teams who are trained to do the flash assessment and get the information off to the state as soon as possible. The public generally does not call in with information, they usually call with requests which go to the 911 call center and the firefighters or paramedics are sent out if necessary (Charlotte County OEM 2005).

We also asked respondents to assess the strategies they used for gauging public disaster preparedness in their jurisdictions. As shown in Table 1, part C, 89.4 per cent of the respondents stated that monitoring public shelters and hotel capacity utilization rates was an important or very important strategy for assessing the level of public awareness in their community. Some also monitor local television reports to monitor public disaster preparedness (mentioned by 74.2 per cent of respondents as important or very important).

Table 1: Emergency Information Management—Information Gathering

a. Information Source Control	
"How important were the following sources of information for gathering information about hurricane/tropical storm threats before and during emergencies?	Very Important or Important (%)
National Hurricane Center (NHC) (65)	97.0
National Weather Service (65)	97.0
Direct observations of county staff about community conditions (66)	80.3
Public information hotline (65)	78.5
Reports from local television stations (65)	77.3
Communications with community leaders (65)	73.8
Communications with municipal leaders (65)	72.3
Reports from state agencies (63)	69.7
Reports from local radio stations (65)	69.7
The Weather Channel (65)	68.2
Voluntary call in from citizens and leaders (65)	58.5
Reports from FEMA (64)	37.9
Reports from local newspapers (65)	36.4
Relied on reports from major hospitals (60)	22.7
Aggregate (Cronbach α = .79)	67.1

Table 1: Emergency Information Management—Information Gathering (continued)

b. Community Conditions Assessment	
"How thorough was your information about the following community conditions during the hurricane/tropical storm emergencies and the days immediately following them?	Very Thorough or Thorough (%)
Flood conditions in different parts of the county (66)	75.2
Road conditions and accessibility in different parts of the county (66)	63.6
Traffic conditions (e.g., traffic jams) in different parts of the county (66)	57.6
Tree damage in different parts of the county (66)	57.6
Fire damage in different parts of the county (60)	56.9
Crime conditions (e.g., looting) in different parts of the county (63)	54.5
Utility conditions (e.g., energy) in different parts of the county (66)	51.5
Building damage in different parts of the county (65)	51.5
Rumors and gossips in different parts of the county (59)	33.3
Aggregate (Cronbach α = .77)	55.7
C .Public Awareness Assessment Strategies	
"How important were the following strategies in gauging the level of public awareness and responsiveness to impending hurricane/tropical storm threats?	Very Important or Important (%)
Monitoring public shelters and hotel capacity utilization rates (66)	89.4
Using local television and news reports to help identify the level of public awareness (66)	74.2
Monitoring traffic patterns on major roads that reflect the level of public awareness (66)	74.2
Monitoring public actions taken in response to official warnings (e.g. boarding windows) (65)	66.7
Monitoring traffic patterns in evacuation zones (65)	66.7
Communicating with officials from other cities in our county (64)	65.2
Asking community leaders about public awareness in their community (62)	47.0
Monitoring runs on major supermarkets (e.g., Winn Dixie, Publix, etc) (65)	28.8
Monitoring runs on major home improvement stores (e.g., Home Depot, Lowe's) (64)	26.2
Monitoring Internet traffic to our emergency response website (64)	25.8
Aggregate (Cronbach α = .88)	55.1

Other strategies mentioned by respondents are monitoring traffic patterns on major roads that reflect the level of public awareness (74.2 per cent), monitoring public actions (e.g. boarding windows) taken in response to official warnings (66.7 per cent), monitoring traffic patterns in evacuation zones (66.7 per cent), and communicating with officials from other cities in our county (66.7 per cent). Fewer respondents state that monitoring runs on major supermarkets or runs on major home improvement stores was important or very important (28.8 per cent for supermarkets and 26.2 per cent for home improvement stores). Even fewer respondents mentioned monitoring Internet traffic to their emergency response websites (25.8 per cent).

Further analysis shows that there is no relationship between the size of counties (as measured by population), or the size of emergency operation (measured by the number of

full time emergency employees), and the perceived importance of public awareness strategies as perceived by respondents, except that the respondents from larger counties reported more important use of monitoring Internet traffic than smaller counties (tau-c = .253, p = .006). For jurisdictions with populations larger than the median (122,500), 29.0 per cent of the respondents stated somewhat more often that Internet monitoring is very important or important, compared with 22.6 per cent of the respondents among jurisdictions with populations less than the median who stated this.

Information Processing, Presentation, and Dissemination. Almost all (98.5 per cent) respondents stated that using simple (easy to understand) language is important or very important for presenting to the public what is going on with the storm or hurricane (see Table 2). Similarly, almost all respondents (95.5 per cent) also stated that accompanying their warning messages with specific actions that the public needs to take is important or very important. By contrast, fewer respondents stated that it is important or very important to use GIS mapping to facilitate communication (58.5 per cent), use tailored messages for people in subpopulation groups such as elders and children (57.6 per cent), for those in specific parts of the county (47.0 per cent), for those with specific cultures (29.2 per cent), for those who speak Spanish (38.5 per cent).

These latter results are somewhat surprising, given that the literature clearly states that in a disaster, information should be tailored to several audiences including age groups, ethnicity, education, income, special needs, literacy level, and fluency in English (Fordham 1999; Lampen 2002; Perry and Nigg 1985). In followup interviews, many respondents acknowledged the importance of these audience segmentation strategies as well as the need for making further improvements. One respondent stated

> When determining how information was distributed to the community, we need to know what the community needs to know. We focused on reaching a bilingual population in the last year hurricane season. We tried to give briefings in both English and Spanish which were televised on local networks, SGTV and radio, two times per day. However, we need to improve our efforts in other communication means in reaching all segments of the community (FDEM 2005).

This finding seems to support other research, too; the failure to reach poor and elderly citizens after Hurricane Katrina was a significant problem that was strongly criticized (Dyson 2006). As Tierney puts it "[d]espite the plethora of new communications devices, vulnerable populations who need accurate and timely information most during crises may be the least likely to get it" (2006, 118).

Most respondents (93.8 per cent) reported that using commercial radio stations is an important or very important strategy for disseminating information to the public. Other

important or very important strategies are disseminating information through press releases, web pages, email, and telephone. Primary information delivery means were press releases and the state emergency management division web page (FDEM 2005). Flyers, roadside signs, and meetings were used less. According to the respondents, the least important strategy of information delivery is providing Internet access to public shelters (18.8 per cent). It is probable that, at this point, this dissemination method is still new for many counties, and it may also be unavailable when hurricanes cause power outages (Seminole County OEM 2005). Bivariate analysis shows that respondents from larger counties stated that the use of electronic roadway signs was more important or very important than respondents from smaller counties (tau c = .187, p = .044). Similar results are also found with regard to the use of public meetings (tau c = -.206, p = .040).

Finally, Table 2 also shows the respondents' assessments of the perceived timeliness of information dissemination. Ninety one percent agreed or strongly agreed that they were able to communicate critical information in a timely manner to their staffs and 80 per cent agreed or strongly agreed that they were able to communicate such information in a timely way to the media and elected officials. Fewer agreed that they communicated critical information in a timely manner with the public and community organizations (78.5 per cent and 69.2 per cent, respectively). Interviewees reported that while further improvement is desirable, there is a sense that practice does make perfect.

> Were able to communicate well with one another. By the third storm we were very good at communication. The agencies that participate in coordination include the Sheriff's Office, local fire departments, municipalities, road crews, and the public. Communications were a rough spot but by the 3rd event we were good at it. When discussing what didn't work well: Being sure we are all speaking the same language and all the players are educated (City of Orlando OEM 2005).

In other interviews, some respondents noted that prior practice helped to achieve these outcomes. In one case, months before the hurricanes, emergency management agencies had a series of tabletop exercises with key players in the community and discussed the impact of a disaster on their jurisdictions. As stated by one respondent,

Table 2: Emergency Information Management
Information Processing and Dissemination

a. Information Processing and Presentation Strategies	
"How important were the following strategies for presenting information about the hurricane/tropical storm to the public?"	Important/Very Important (%)
Used simple (easy to understand) language to explain what is going on (66)	98.5
The warning message included specific action to be taken by the public (66)	95.5
Identified the most important topics, and highlighted these in our communications (65)	93.9
Provided location specific weather predictions and evacuation information (66)	84.8
Used a spokesperson with whom the public was or became familiar (64)	80.0
Used a set of consistent images and phrases in our communications (64)	76.9
Used visual images such as GIS maps to facilitate the communication of information (63)	58.5
Tailored warning messages to special populations (e.g. elderly, school children) (66)	57.6
Tailored messages to different parts of the county (64)	47.0
Had a team that sifts through the information and decided what is most important from the public's perspective (64)	40.9
Provided communications and update in Spanish (62)	38.5
Tailored warning messages to different cultures in our jurisdiction (63)	29.2
Aggregate (Cronbach α = .70)	66.8

b. Information Dissemination Modes	
"How important were the following strategies for disseminating information about the hurricane/tropical storm to the public?"	Important/Very Important (%)
Commercial radio station in our community (64)	93.8
Local television stations (61)	79.0
Press conferences (64)	76.9
Providing updated information at least once every three hours before and during the event (61)	76.6
County website (e.g. surge zone, local evacuation route maps, closest public shelters) (65)	70.8
Local newspapers (64)	63.1
Daily situation reports made available online and through mass emails (64)	58.5
Providing updated information at least every hour before and during the event (60)	57.1
Distributing flyers where/when needed (65)	46.2
Providing information on electronic roadway signs (65)	43.1
Organized public meetings (64)	38.5
Providing Internet access at public shelters for information about recent conditions (57)	18.8
Aggregate (Cronbach α = .67)	62.2

C. Information Dissemination Timeliness	
"*During 2004 hurricane season, emergency managers were able to communicate critical information in a timely manner to …."*	Agree/Strongly Agree (%)
the staff (65)	90.8
the media (65)	80.0
the elected officials (65)	80.0
the general public (65)	78.5
community organizations (65)	69.2
Aggregate (Cronbach α = .82)	79.7

Note: Number of respondents in parentheses.

> the information flowed pretty well between the community and the emergency operation center (EOC). Coordination was very high. We have 20 Emergency Support function (ESF) and 20 emergency management coordinating officers in the EOC at all times. All the county departments, all cities, theme parks, Sheriffs Offices, Fire and Rescue, growth management, community and environmental services worked together. We work with state agencies such as the Division of Emergency Management, Dept of Transportation, FEMA, and the Army Corps of Engineers. Building relationships on a day to day basis prior to activation helped improve coordination between agencies (City of Orlando OEM 2005).

Finally, technology is increasingly a critical component in communication but managers and employees need to be trained in its use. Some innovative EIM strategies were used during hurricane response operations. The City of Orlando "had a disaster information management system called *E Team*. Each department and agency has access and this is where they log in and report their activities such as closed roads or the amount of debris collected" (Charlotte County OEM 2005). However, managers also need to have alternatives and be resourceful in case their systems fail. An interesting example of how county emergency managers used technology creatively in EIM occurred when they lost the fiber optic connection to their main server; they were forced to use satellite access on a mobile truck (Charlotte County OEM 2005). Another county emergency management agency had a breakdown in traditional land communications so the manager

> put an amateur radio operator at the radio station and one at the EOC and communicated information to the radio station through HAM radio. [He] requested a blimp last year from the state because [he] had seen it used during Hurricane Andrew. None of the blimps in the state were available for a few days but [he] needed something tomorrow [immediately] so [he] got a plane and put a banner on the back with information regarding which local radio station had the local news information and it worked well (Hillsborough County OEM 2005).

In sum, these examples show that, although many counties use a range of strategies, only about half of the respondents reported that information was sufficiently thorough with regard to traffic, crime, tree damage, utilities and building damage conditions. Also, only about half of the respondents report that using tailored messages to specific populations, such as the elderly or those speaking Spanish, was an important strategy that they used.

Public Disaster Preparedness

Table 3 shows the level of perceived public disaster preparedness according to emergency managers. While most respondents (79.7 per cent) agree or strongly agree that hurricane damage to lives was minimized, only 50 per cent of them agree or strongly agree that their residents have been well prepared for tropical storms. Forty nine percent agree or strongly agree that residents responded well to hurricanes, and likewise, 48.4 per cent agree or strongly agree that residents responded well to tropical storms. Only 40.0 per cent agree or strongly agree that residents were well prepared for hurricanes and only 40.0 per cent state that damage to properties was minimized. Clearly, perceived public disaster preparedness varies among Florida counties. While these are perceptions, it is important to recall that the emergency management respondents are among the most informed public officials in their jurisdictions during emergencies.

Table 3: Outcome of Emergency Information Communication Strategies: Public Disaster Preparedness

	Strongly Agree or Agree	Somewhat Agree	DK	Disagree[1]
Hurricane damage/tropical storm to lives was minimized (64)	79.7	10.9	0.0	9.4
Our residents were well prepared for the tropical storms (64)	50.0	36.0	3.1	14.1
Our residents responded well to the hurricanes (65)	49.2	44.6	1.5	4.6
Our residents were eager to get the necessary hurricane materials (65)	49.2	29.2	9.2	12.3
Our residents responded well to the tropical storms (64)	48.4	42.2	4.7	4.7
Hurricane/tropical storm damage to properties was minimized (65)	40.0	29.2	7.7	23.1
Our residents were well prepared for the hurricanes (65)	40.0	38.5	1.5	20.0

Note: Number of respondents in parentheses.
[1] Includes *strongly disagree, disagree,* and *somewhat disagree*.

These measures were summed to construct an index of public preparedness (M = 5.30, SD = 0.443, Cronbach's α = .76). The average index score of agree or strongly agree over all seven survey items (the score $\geq$ 6.0) was defined as the cutoff for *well prepared*, whereas a score between 5.0 (somewhat agree) and 5.99 was defined as *somewhat prepared*, and a score lower than 4.99 was defined as *not well prepared*. Based on these cutoff values, we conclude that about 23.4 per cent of respondents perceive that

their jurisdictions were well prepared, 50.0 per cent perceive that they were somewhat prepared, and 26.6 per cent perceive that they were not well prepared. Although the cutoff points of these categories are arbitrary and, thus, debatable, about 73.4 per cent (= 23.4 + 50.0) of the respondents perceived that residents were somewhat or well prepared.

Further analysis shows that the index of public disaster preparedness is not significantly associated with population size, median household income, the number of full time employees, or a jurisdiction's urban versus rural status as reported by the respondents. Specifically, the corresponding measures of association are positive but none are statistically significant at $p < .05$ level. The jurisdictions are classified as urban are the counties of Miami-Dade, Palm Beach, Orange, Hillsborough, Lee, Duval, Leon, and cities of Jacksonville and Orlando.

Because the preparedness index is subjective, we asked respondents in followup interviews to provide examples that explained the basis of their assessments. One interviewee stated

> I think the public preparedness now is 50 percent more than it was last year because they are attuned to it. If we were ten years without a hurricane it wouldn't be as high. We need to continue to educate the public and put preparedness into schools so preparation will become public's second nature. Teaching preparedness is being considered around the country and being looked at in Seminole County. Seminole County EOC goes around to local schools and teaches preparedness to the kids (Seminole County OEM 2005).

We now turn to the relationship between the preparedness index described in Table 3 and the EIM strategies described in Tables 1 and 2. The indexes of the EIM strategies are called, respectively, *Information Source Controls, Community Conditions Assessment, Public Awareness Assessment, Information Processing and Presentation, Information Timeliness* and *Information Dissemination Modes*. Table 4 shows that 10 of the 15 correlations of public disaster preparedness with the EIM strategies are statistically significant at the $p < .05$ or $p < .01$ levels, which greatly exceeds the number expected by chance (.05 x 15 < 1). This suggests better communication improves public disaster preparedness during hurricanes, at least as perceived by our senior managers.

Finally, Table 5 shows a regression model examining the joint impact of all five EIM strategies on perceived public disaster preparedness. The model includes all EIM indices created above as independent variables. The model's goodness of fit measures include the adjusted R^2 and the significant level of the model's F test. Standardized coefficients (*betas*) and p values for each individual independent variable is shown. The regression model explains 17.3 per cent of variance of public disaster preparedness (adjusted R^2) and

is statistically significant at the .01 level. The *t* tests on the individual beta values suggest that using a broad range of information sources (p = .03) has a significant impact on perceived public disaster preparedness. This suggests that an effective information communication strategy should include efforts to validate and control information sources to ensure information authenticity.

Table 4: Correlations of Relevant Variables

Variable	1	2	3	4	5	6
1. Public Preparedness	1.0					
2. Information Source Control	.41**	1.0				
3. Community Conditions Assessment	.25	.19	1.0			
4. Public Awareness Assessment	.38**	.42**	.24	1.0		
5. Information Processing and Presentation	.23	.32*	.31*	.37**	1.0	
6. Information Dissemination & Timeliness	.27*	.30*	.17	.36**	.46**	1.0

**Significant $p < 0.01$ level (2-tailed), * Significant $p < 0.05$ level (2-tailed). *N*s range from 58 to 64

Table 5: Regression Results of Public Disaster Preparedness

Variable	Beta	Significance (p)
Constant		.38
Information Source Control	.31	.03
Community Condition Assessment	.22	.10
Public Awareness Assessment	.13	.36
Information Processing	.03	.85
Information Dissemination & Timeliness	.04	.77
R^2	.26	
Adjusted R^2	.17	
F probability	.01	

Conclusion and Discussion

This study has two major findings. First, about 73.4 per cent of county emergency managers state that populations in their jurisdictions were well or somewhat prepared as measured by a broad range of measures. Second, counties that report higher levels of public disaster preparedness tend to disseminate location specific information, use GIS systems to facilitate the communication of information, and provide targeted information

for different population groups as information processing and disseminating strategies and use the following modes of information dissemination: organize press conferences, provide updated information at three hours intervals or less, and maintain a website about impending disasters. Yet, these strategies are not always used. Most respondents, however, report using such sources of information as the National Hurricane Center, local and other broadcast stations and direct observations by county staff. Slightly more than half of the respondents report that information was sufficiently thorough with regard to traffic, crime, tree damage, utilities and building damage conditions. While this study shows that Florida counties have many positive practices in place, there is room for further improvement to enhance public disaster preparedness which, as perceived by public managers, was not always sufficient during the 2004 hurricane season.

Sense making theory asserts that communication performance needs to improve within and among organizations engaged in disaster response operations. The model builds on the human ability to learn and adapt to new information within the dynamic environments of disasters, but acknowledges that this capacity can only occur with the support of an appropriate information infrastructure. The theory emphasizes the importance of information management activities in collecting, interpreting, and disseminating critical decision making information to users, and it is used in this study to model the EIM practices in Florida counties' emergency agencies during the 2004 hurricane season.

How can the EIM strategies used in Florida during 2004 be applied in other disasters? The strategies used by Florida's emergency managers, such as preseason planning exercises, community awareness seminars during the off season, and educating citizens are all applicable to other types of disasters, whether natural or technological. The list of strategies used by counties is quite comprehensive. Local governments preparing their communities for possible disasters must maintain open communication with elected officials as well as the community. The strategies Florida's emergency managers employed allowed them to communicate across class and language barriers, thus fostering resilient communities during and after the disasters. Several specific lessons can be learned for EIM practices in government.

First, government must be a reliable source that delivers information during emergencies. Before emergencies such as hurricanes, many nongovernmental communication organizations such as newspapers, TV stations, and radio stations may fail to provide accurate information about disasters. During and immediately after emergencies, a lack of information, rumors, and misinformation become probable. Governments certainly have the capability and responsibility to be sources of reliable information. Governments can use information to influence public behavior, as the public generally believes in the reliability of the information provided by the government during emergencies (Weiss 2003). Our results, based on emergency managers' evaluations,

suggest that EIM strategies influence public behavior in connection with hurricane preparedness. Agencies that use EIM strategies more extensively tend to perceive a higher level of public disaster preparedness. This finding indicates the importance of delivering accurate and timely information to the public.

Governments need to process emergency information effectively to meet the needs of different users. Our results indicate that Florida county governments used a variety of information processing tools to develop specific information and share it with different users. This lesson can be applied to homeland security warning systems. Inter- and intra-agency communication and coordination is a core issue in homeland security (Kettl 2004; Wise 2006). Emergency response and prevention is one of the major responsibilities of the newly established Homeland Security Department. Coordination among 22 different agencies with different cultures, foci, and missions is not an easy task. The department needs to develop effective information management strategies to increase information sharing and coordination both within the department and other departments charged with homeland security responsibilities. It is also critical for the department to share information and coordinate its efforts with other levels of government at the state and local level, private and nonprofit agencies, and the public.

Reliable governmental information should be delivered to the information users in a timely manner. Our results show that information gathering and dissemination processes have been established within many Florida governments to deal with emergencies. County governments in Florida collect information from different sources, validate the accuracy of the information, and quickly communicate it to other government agencies, private entities, and the public at large. Nonetheless, there is room for improvement in the timeliness of information delivery. All counties need to focus on timely communication with minority populations, and efforts should be made in assessing community conditions during emergencies, in rumor control, in developing area-, culture- and language-specific information. The need for adapting strategies to different rural and urban contexts should also be considered in emergency information response operations (Drabek 1987, 1986).

Finally, the lessons learned in Florida during the 2004 hurricane season seem to be confirmed by what happened in the emergency responses for Hurricane Katrina. Lack of adequate and accurate information was apparently one of many reasons for the ineffective emergency responses during Katrina (Swope and Patton 2005). Residents were not well prepared due to the poor execution of emergency response plans (Waugh 2006). Many of them seemed confused by the information they received, as well as by multiple conflicting information messages—the result of miscommunication among emergency response agencies during and after the hurricane (Tierney 2006). An unforgettable picture of the hurricane shows people looking for shelters after hurricane landfall, but unable to obtain reliable information about shelter locations. Clearly, emergencies are times when accurate and timely information sources are needed most. Governments need to ensure

that information is accurate and that processes of interorganizational communication and information dissemination to the public is effective during times of crises.

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