PROVIDING ACCESS TO RESILIENCE-ENHANCING TECHNOLOGIES FOR DISADVANTAGED COMMUNITIES AND VULNERABLE POPULATIONS

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CONTENTS

Executive Summary

The concept of community resilience to the impact of a significant natural or manmade disaster has become an area of focus at all levels of government. However, a frequently overlooked aspect of community resilience is its extension to the most vulnerable portions of a community's population. In many cases, public or private programs that reach 90-95% of a subject population are classified as broadly successful. Yet when disaster strikes, it inevitably tends to impact most severely the portions of the population that are least able to prepare for, respond to, or recover from its effects. The outcomes can be both tragic and costly, as the already fragile social fabric that sustains the most vulnerable members of our communities is torn apart, leaving those who survive with little in the way of resources to restore their lives to their previous status. The heartrending stories on the front pages of newspapers and the opening segments of news broadcasts often feature community members who did not have much in the way of alternatives; while other, less vulnerable members of our communities prepared themselves for the coming events, avoided or responded successfully to the consequences, and rapidly organized themselves to rebuild their lives.

A considerable amount of research has uncovered ways that make communities more resilient to a disaster's affects, including recent studies that focus on the ever-evolving world of technology as a means to enhance resilience. However, little research has specifically examined technology application within the more vulnerable elements of a community. In this regard, it is critical for communities to recognize the role that social networks play in developing community capacity, which in turn can reduce the vulnerability of those members of the population at greatest risk. Emergency managers, community planners and leaders, and others involved in a community's disaster mitigation, preparedness, response, and recovery efforts can significantly enhance community resilience through an understanding of the interplay among social networks, community capacity, and technology, including the roles they play in the framework of a community.

This research project, Providing Access to Resilience-Enhancing Technologies for Disadvantaged Communities and Vulnerable Populations (PARET), focuses on the following research questions:

- Which technologies hold the most promise for helping the vulnerable members of society best deal with disasters, and in turn increase their overall resilience to the effects of disasters?
- How can community leaders, managers, and planners leverage these selected technologies to mobilize their communities to better prepare for, respond to, and recover from disasters?

To examine the more vulnerable populations in a community, this research pivots on community social organization and demonstrates the viability of technology in mitigating social vulnerability and social exclusion. A social organization, capacity-building framework, including network function, social capital, and community

capacity, is used to examine ways that communities can respond more effectively to disasters. Networks and community capacity play a definitive role in the overall scheme of disaster preparation and recovery, as the underlying structures and processes in a community must be in place before any tool or system will be effective. Effective social organization structures and processes increase the odds of achieving shared, desired outcomes such as health and well-being, community safety, and community resilience. Communities focused on such results are more likely to plan strategically and to mobilize resources in more targeted ways.

A range of technology tools and systems can be used to enable the functioning of formal and informal social networks in a community, enhancing their resilience before, during, and after a disaster. The analysis considers a broad spectrum of specific technologies, and most significantly, the barriers to the use of these technologies typically experienced by the agencies charged with protecting citizens, as well as the barriers experienced by the vulnerable members of the community. Primary research in this area included surveys of residents in subject communities and extensive review of the current state of the art in emergency management technologies. The analysis then focuses on methodologies for overcoming these barriers to access and provides recommendations on potentially applicable technologies and recommends approaches to apply them within a vulnerable population.

A key insight from this effort is that there is no one-size-fits-all technology tool or implementation strategy to build resilience among disadvantaged members of a community. Community leaders and managers must carefully assess the unique dimensions of their communities, and then construct a tailored, collaborative approach to technology application. Adhering to the following broad principles is essential to the success of the community resilience-building efforts:

- ***Know the community's vulnerable populations***
  It is necessary to start with a clear understanding of the individual community's vulnerable part of the population. Having a thorough understanding of the more disadvantaged and vulnerable portion of the community will allow community leaders to successfully adopt appropriate technologies and systems to enhance their region's resilience.

- ***Enable repeated transmission of clear, concise, and consistent messages***
  Information that is continually updated and reinforced is more likely to result in action. Consistency across means and methods is equally important because messages from different sources must communicate the same thing. To ensure consistency across all potential channels, it is important for standards to be set that instruct all tiers of government to use the same disaster terminology and evacuation instructions. Synchronized, programmatic approaches will ensure the delivery of consistent messages to all segments of the population.

- ***Deliver messages via multiple channels and modes of communication***
  As consistency in delivering a message is important, so are frequency and redundancy of the message. A multimedia approach is essential, as there is not one single technology that will access all groups of a vulnerable population throughout all stages of a catastrophe. Collaborative emergency management across jurisdictions and across agencies that uses a multimedia approach is critical to ensuring that messages reach everyone.

- ***Project computer technology access into disadvantaged communities***
  As more services and updates are accessible via Internet-based applications, it is critical that all members of a community have ready-access to a computer that has wireless, DSL, or broadband service. Internet access is the pipeline to many e-Gov and 311 functions, agency or volunteer support services, as well as e-mail notifications. Community Technology Centers (CTCs) or the equivalent can serve as an excellent community resource for getting technology into the hands of all members of a community. Not only do CTCs provide a hardware (wireless and/or wired) interface for citizens to access the Internet, but they also serve as a vehicle for educating the public prior to a disaster on how to utilize computers. Education and training is important for the vulnerable members of the population, whether they access computers (and the Internet) onsite at the CTC or from their home computers after a disaster strikes. Issuing simple to use, low-cost, wireless laptop computers to members of a vulnerable population and installing temporary wireless towers immediately following a disaster are further ways that communities can ensure that everyone is 'plugged in' to recovery information and services after a catastrophe.

- ***Mobilize community networks***
  Strengthening community networks or the connections between community members can be a significant force in disaster preparedness and response. Communities can develop resilience by capitalizing on existing community networks and organizations that provide useful information and services in times of crisis, as well as contribute to overall quality of life in general. In many cases, groups that have existing connections with vulnerable populations are not equipped to also deal with both everyday situations and disaster preparedness. However, because they are involved on some basis they represent a potential portal. Getting technology into the hands of those in need requires a portal that is already functioning and hopefully trusted.

- ***Understand, exploit, and use technology to enable the "power" of a community***
  When a community undergoes a significant crisis, any number of community groups emerges to support recovery, including selfless acts (the 'altruistic community') and the accomplishment of new and unfamiliar tasks. Social organizational approaches aim to facilitate the mobilization of community members to act and to achieve results. These approaches can be crafted to include access to the most vulnerable

segments of a community's population and tailored application of technology is vital in enabling this functionality.

- ***Tailor technology application to facilitate collaborations that are broad-based and targeted***
  The complexity of disasters requires complex responses that outdistance what any single organization can accomplish, making collaboration across community networks and among various technologies a critical aspect of building community resilience. Technology applications targeted towards disadvantaged segments of a community must be affordable, understandable, and fully interoperable with the community at large.

- ***Develop ongoing and proactive sustainability mechanisms***
  Effective risk communication is an ongoing process, not a single act. Therefore, choices in information technology must provide a sustainable stream over time, particularly within the pressing circumstances faced by many disadvantaged members of our society. In the case of building community capacity as it pertains to disasters, specific technologies will change as new capabilities emerge and as information is gained about which of them are best suited and most effective. What must remain consistent is the commitment to adopt and introduce specific technologies into a community that will be the most effective and will ultimately be accessed by the largest cross-section of the population possible.

The research findings, technology assessment, and survey results indicate that a tailored application of the following suite of technologies offer the most promise to vulnerable populations, once again emphasizing that no single technology or even small grouping of technologies are adequate for all situations:

> ***Television.*** Television offers the broadest penetration to all members of community, because large audiences can hear the messages at the same time, from a number of locations, including their personal residence. It is most useful during the preparedness and recovery phases of disasters. Federal legislators should consider requiring television manufacturers to implement remote triggering of televisions via existing Emergency Alert Systems, which would make televisions even more effective for short-warning disasters.
>
> ***Radio (AM/FM/weather).*** Radio offers almost as much penetration as television does. Members of a community can receive radio messages at home, in their cars, and in boats and other vehicles. As television stations switch to digital broadcast, many televisions, particularly portable televisions, will no longer be able to receive signals. Until new generations of portable, digital televisions are readily available in the marketplace, radio will be especially important for reaching large audiences, particularly during and post-disaster when power sources may be

limited or non-existent. The number of available stations, particularly with the increase in digital high-definition bandwidth, makes it possible for communities to meet the linguistic needs of multicultural communities. It also makes it possible for communities to create dedicated emergency broadcast networks. The implementation of these dedicated networks, accompanied by a public awareness campaign, provides a constant and uninterrupted resource for the most up-to-date and accurate information about the event. As with television, physical mobility is not an issue for elderly and disabled citizens. Our recommendation for radio is consistent with our recommendation for television in that we propose that federal legislators consider enforcing radio manufacturers to implement remote triggering of radios by EAS.

Community technology centers (CTCs). CTCs show great promise in disaster scenarios, provided there are an adequate number of centers, located strategically in disadvantaged communities. Given the lower relative rates of computer presence/use among vulnerable populations, CTCs or equivalent facilities are critical to enabling use of Web-based applications and tools to enhance resilience in disadvantaged communities. These centers must be fully integrated into statewide emergency response systems. CTCs offer the most benefit during the recovery phase of a disaster, as they provide a central location from which to share resources and services. Additional research is necessary to refine methodologies and determine best practices for establishing CTCs for broader accessibility and affordability. It is important to note that an investment in funding these centers has the potential to benefit a community far beyond the building of disaster resilience. The technology skill sets offered to the members of vulnerable populations by long-established CTCs carry over into the community in many other ways. They infuse a technology-challenged community with invaluable and marketable technology skills, aid in the creation of small businesses, and can assist the vulnerable members of society by enhancing their engagement with government entities.

311 systems with an assisted evacuation plan. A 311 system, used in concert with an assisted evacuation plan and combined with GIS vulnerability mapping, provides an exceptionally robust system of identifying vulnerable populations and planning for targeted responses in the event of a disaster. It facilitates establishment of service delivery or population pickup points for affected communities for affirmative outreach. The system works well during the preparedness, response, and recovery phases of a disaster. However, this technology system is most useful when implemented well before a catastrophe, as citizens must be aware that the system exists and they must register before there is a need for the service.

Telephone/cell phone notification. A phone notification system that delivers voice and text messages is one of the most promising technologies for reaching people during a disaster with emergency information. Telephone systems offer

broad coverage due to the high proportion of the vulnerable members of society that already have access to landline telephones or cell phones. Telephone and cell phone notification is most effective during the preparation and response phases of a disaster. However, in order to reach the most economically disadvantaged members of a community, government officials must work with cell carriers to arrange cost-free additional minutes and text messaging pre- and post-disaster.

Sirens/loudspeakers. Sirens and loudspeakers can be an effective component of an integrated alert system, when combined with education/advertising efforts that inform the members of the population what to do when they hear a siren. Basic systems such as neighborhood or fire station sirens should not be disregarded as an outdated mode of communication, as they could be the only means of notification that a vulnerable member of the community, such as a homeless person, receives during a disaster.

This research effort provides a foundation for thought, discussion, and action relating to how emergency managers, community planners, and organizational leaders might enable technology as a vehicle to ensure that no segment of the community is left out as they prepare for, respond to, or recover from a natural or manmade catastrophe. It is critical to have positive emergency management policies and practices in place long before a disaster strikes. These broad recommendations can be considered by the leaders of any community.

Preface

The Community and Regional Resilience Initiative (CARRI) (see Appendix A), a program of the Congressionally-funded Southeast Region Research Initiative (SERRI) based at Oak Ridge National Laboratory (ORNL), is focused on developing an over-arching collaborative approach to making communities more resilient before, during, and after catastrophic events. A community or population postured for dealing with a manmade or natural disaster is more resilient to its short- and long-term effects than are similar localities that have not improved their readiness. Communities that wish to remain vibrant in the face of natural disasters and in a world of increasing threat of terrorism must pursue new strategies to become truly resilient (Edwards, 2007). The CARRI definition of resilience is broad, reaching further into the community than the traditionally defined "disaster relief effort," to incorporate all requirements to get the community back into operation, including returning citizens to work, reopening schools and businesses, and restoring economic and social recovery quickly (Cutter et al., 2008). CARRI studies many facets of organizations that feed into the framework of the community.

For this project, CARRI chose to focus its research effort on how the technology sector could enhance the resilience of disadvantaged communities and vulnerable populations. The CARRI team designated the Institute for Advanced Biometrics and Social Systems Studies (IABS^3) to coordinate this research effort. IABS^3, a research-focused think tank founded in 2008 as a partnership between Oak Ridge Associated Universities (ORAU) and ORNL, has an unmatched capability to bring together highly respected institutions and researchers to answer complex research questions demanding multi-disciplinary and inter-institutional approaches. With initial funding support from the SERRI Program, IABS^3 formed a collaborative team of researchers with the necessary expertise to explore the increasing role of technologies in improving disaster resilience, especially for disadvantaged communities and vulnerable populations, referred to as the Providing Access to Resilience-Enhancing Technologies (PARET) Project. This research report enhances ongoing CARRI efforts that address issues related to the Department of Homeland Security requirements.

Canvassing researchers and reference materials revealed limited data related to how existing and emerging technologies could strengthen community and regional resilience, particularly among those with fewer personal and social resources. The assumption is that utilization of and familiarity with these technologies among economically disadvantaged communities or otherwise vulnerable populations is uneven. The possible role of increased access to these technologies in improving the ability of disadvantaged populations to prepare for, respond to, and recover from catastrophic events appeared worthy of further exploration. If certain parts of a community are vulnerable, then the community at-large is more vulnerable.

The PARET Project supports the ongoing and developing efforts in the United States related to disaster recovery and relief with special emphasis on uncovering the unique relationship between resilience, community capacity, and current and emerging technologies, especially as they relate to the segment of the population classified as

disadvantaged. In the wake of the increasing number of man-made and natural disasters across the globe, many countries are formulating disaster relief and recovery plans. At this printing, several U.S. agencies are working on specific components to improve the country's ability to be more prepared for and responsive to disasters. Many of these efforts escalated following the aftermath of Hurricane Katrina and are driven by the Department of Homeland Security's guidance. Finding ways for the nation and for individual communities to be better prepared is especially important from an economic standpoint, because the American government has spent billions of dollars over the past several years on disaster recovery and relief. The American Red Cross estimates that 2008 expenses related to Hurricane Gustav alone were over $70 million, depleting their internal disaster relief fund (American Red Cross, 2008). The frequency of natural disasters, such as floods and storms, has increased approximately 8.4% per year from 2000 to 2007 (Ripley, 2008).

Bringing together a highly competent, multi-disciplinary team of investigators was critical to the success of this project. Staff members of IABS^3 identified subject matter experts within ORAU's member institutions whose knowledge and experience would best serve on the project team. The team of four university researchers brings to this project a broad range of experiences in their respective fields of sociology, anthropology, human development, information technology, and public affairs (see Appendix B for more detail). The team framed a collaborative effort to examine the research questions from three principal thrusts: social organization, collective behavior, and socioeconomic vulnerability. While the pivot point for the project is technology, social interaction (specifically the building of community capacity) is a primary mechanism for exploiting the potential of technology.

Introduction

As the economic impact, loss of lives and property, and shock factors escalate annually, the focus of identifying better ways to prepare for and recover from disasters is increasingly important to the entire nation, not only the regions directly affected. In December 2007 remarks to the National Congress on Secure Communities, Department of Homeland Security Secretary Michael Chertoff stressed the importance of being proactive in addressing disasters:

> And maybe the most important lesson we've learned is that the success to an effective response is what takes place well before the disaster: the planning, the preparation and the partnership. When you are in the middle of a disaster that is not the time to begin planning. That is the time to determine whether your plan works, and to improvise, if necessary. But the better the planning, the preparation and the partnership in advance, the shorter the distance between improvisation and success (Chertoff, 2007).

When disaster strikes, it inevitably tends to impact most severely the portions of the population that are least able to prepare for, respond to, or recover from its effects. The outcomes can be both tragic and costly, as the already fragile social fabric that sustains the most vulnerable members of our communities is torn apart, leaving those who survive with little in the way of resources to restore their lives to their previous status. Featured in the most heartrending stories that occupy the front pages of newspapers and opening segments of media broadcasts are largely those community members who did not have much in the way of alternatives; while other, less vulnerable members of our communities prepared themselves for the coming events, avoided or responded successfully to the consequences, and rapidly organized themselves to rebuild their lives.

The 1988 Stafford Disaster Relief and Emergency Assistance Act requires all states to have written Emergency Operation Plans (EOPs) in order to be eligible for federal relief funding. However, even though billions of tax dollars have been spent on homeland security in the past 6 years, a recent study conducted by George Mason University (2008) revealed that 22 states were unable to provide EOPs, giving cause for residents to question the preparedness of their states to deal with a disaster. These facts bring to light the increased awareness and need for finding tools to make communities more resilient and better prepared to deal with any disaster that may strike. Our expectation is that, through this investigation, community and state leaders will look closely at the technologies that can help them be better postured in their planning

efforts. Dealing with disasters is much more complex than in the past due to the increasing number of natural disasters, the population density in coastal areas in particular, and the many components of a community that must be mobilized to assist with recovery and response efforts. It is essential to look through these various layers of a community to find solutions for empowering citizens, especially those considered more vulnerable, to recover more quickly and efficiently from a disaster.

For this project it was evident that a keen understanding of social organization and community capacity is just as critical to building resilience as the application of tools and technologies. Australia recently released a national set of principles for disaster recovery which links community capacity, coordination, and communication (Government of South Australia Department of Families and Communities, 2004). The principles illustrate that success in the recovery effort and the long-term resilience of the population lies deep within the framework of a community, including how it is organized, whether it anticipates disasters, and whether it is intentional about building its capacity. Finding tools and methods for increasing a community's resilience is a multifaceted issue as many community layers must be understood and engaged in order to increase collective community resilience before, during, and after a disaster. While the pivot point of this project effort focuses on one specific, yet collective, tool — technology— the project's social organization framework is designed with an understanding of the importance of building community capacity, including social networks. Many community components or networks are important to the underlying success of disaster response and recovery, including, but not limited to, government officials, emergency managers, faith-based organizations, schools, employers, medical providers, social services agencies, neighborhood organizations, families and extended families, as well as the individual community members. Community networks must work collaboratively to ensure that resilience is achieved.

This project focuses on technological means to enhance the resilience of these disadvantaged communities and vulnerable populations. It seeks to better understand the nature of these elements within our broader social structures, the ways that current and emerging technologies are being applied in their environments, what are the barriers that confront broader application of these technologies, and finally, how communities can overcome these barriers, successfully employing these technologies to raise the resilience of these vulnerable individuals and groups, and avoid some of the most devastating consequences of the natural or man-made disasters they might experience.

This comprehensive project report is comprised of six sections which are outlined below:

- The first section discusses the composition of a community from a theoretical standpoint and lays out the collective definitions used throughout the report.
- The second section defines and differentiates the segments of communities most likely to be vulnerable to the effects of hazards or disasters. Some entire communities are less resilient than others. And, in any community, economic, social, political, cultural, and/or physical conditions are likely to cause some

community members to be more vulnerable or disadvantaged when it comes to mitigating, planning, preparing, and responding.

- The third section defines the various roles that technology plays and discusses the trends in the use of technology. And, in order to fully understand how technology can make communities more resilient, the second part of this section provides a comprehensive technology matrix to assess the current state of various technologies and their likely availability to various segments of the population. The assessment outlines each technology's requirements, possible uses, and possible access barriers, as well as within what stage of a disaster cycle it might be implemented to be of utility to a community. The PARET team then considers all the barriers to access and acceptance associated with inserting the specific technological tools into groups that are considered vulnerable. It became evident that there could not be a "one-size-fits-all" approach because each disaster has special considerations, as does each individual community.
- The fourth section of this report reflects the current levels of technology access and use among representative disadvantaged communities and vulnerable populations, especially in a disaster context, through reporting the findings from a phone survey of one coastal community. The survey focused specifically on what technologies the respondents use on a daily basis, and would likely use in a crisis response. It also examined the use of community structures and social networks, particularly how technology was likely to be used to connect people and resources.
- The fifth section of the report focuses on how current and emerging trends may serve to lessen technology barriers. Also included in the fifth section is a short subsection on practices that some communities have adopted that relate to the use of technologies in hazard response. These examples deserve recognition for their merit in merging technologies with existing community structures.
- The sixth section presents recommendations on how to most effectively leverage technology in building community resilience, especially among the vulnerable groups.

We intend for this report to provide cause for thought, discussion, and action concerning how technology can improve the resilience of a community, including its most vulnerable populations. It is important to have positive emergency management policies and practices in place to assure that these community members are not left out when new technologies are adopted. We feel that there are many potentially beneficial areas for continued research related to technology, community capacity building, and increasing the resilience of entire communities, especially related to creating policies, standards, and awareness of vulnerable members of the population.

The goal of this project was to understand the role of technology in addressing both natural and man-made disasters. Hazards, and the disasters they may create, that have an element of human intent, negligence, or error or involve the failure of a

technological system are typically referred to as *man-made* disasters. When they involve hazards such as airplane crashes, chemical spills, radiation emergencies, terrorism, or dam failures, they are considered to be *technological* disasters. However, pandemics and diseases are also often included in man-made hazards. There is some debate as to whether man-made and natural hazards or the disasters they produce are qualitatively different in terms of the preparedness and response behaviors they stimulate (Mileti & Kuligowski, 2003). Exposure is not equally distributed in the United States' population. For example, environmental hazards, such as toxic waste facilities are more likely to be located in poor, often minority neighborhoods (Cutter, 2001). Also, there is considerable evidence that man-made disasters produce different responses. For example, compliance with warnings is generally high. On the other hand, man-made disasters are more likely to result in serious and long-lasting mental health problems (Erikson, 1994).

While it is difficult to address all scenarios related to disasters in this limited study, the project scope incorporates how technology can be best used in both man-made and natural disasters. The larger context in which this analysis of technology and vulnerable groups is imbedded is community social organization. Accessing this contextual approach enables extension of the discussion to important aspects of communities that can be mobilized to make a difference in the role of technology in supporting those vulnerable groups. Vulnerable citizens include those with lower economic resources, as well as elderly people, citizens with special needs from a mental or physical standpoint, individuals without affinity for the English language, people living alone, transient community members, and others who due to current social or economic factors require more assistance.

Recognizing and responding to the needs of the vulnerable members are critical steps in getting a community back up and running after a disaster strikes, because the vulnerable community members are likely to be the hardest hit during a natural disaster, especially due to their lack of economic and social capital. The underlying questions of this research are as follows:

- What can be done to better serve the vulnerable population to ensure that no person or group is left out of the planning stages of disaster preparation, response, and recovery?
- How can technology be a vehicle that serves and tends to these community members who are often overlooked?
- And, what role does community capacity building play in these disaster scenarios?

Our intent is that this report will bring to light many concerns related to technology use and will uncover practices that can be applied in any community to better prepare them to deal with disasters. Since the overwhelming responsibility of making sure that all citizens are taken care of often falls to the emergency managers of a community, this report is designed to provide them and their associated colleagues (i.e., planners, managers, leaders from community organizations, and government officials) with an understanding of the available tools and technologies that can make their jobs of dealing with the vulnerable populations easier. If this part of their job is streamlined,

they can focus the bulk of their time, energy, and resources on improvements that will affect the entire community. Emergency managers are not able to avoid disasters, but with the right tools, they are able to be better situated to deal with catastrophes and in the long run, improve the overall resilience of the community where they serve. The success of community resilience lies in the collective partnership of people, social networks, and available tools. In this case, technology is the tool we focus upon.

A Framework for Understanding Communities

Community social organization has proven a productive way to promote an understanding of how communities work and function and, more importantly, how then to build the capacity of communities and their members to succeed during times of crisis (see Appendix F for a glossary of terminology used throughout this report). A social organization approach is multi-layered, elevates natural sources of resilience in communities, and assists in identifying desired community results that lead to greater community well-being. Because of its focus on networks, social organization leads toward a clearer understanding of the relationships among individuals, families, and their communities (Mancini, Bowen, & Martin, 2005) and also toward pragmatic methods of building community capacity that are targeted to particular issues and situations, including disasters, vulnerable groups, and the role of technology (Chaskin, Brown, Venkatesh, & Vidal, 2001; Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008). Community capacity-building efforts often subscribe to the same goals: to find ways communities can build their resilience, be in greater control of what they experience as a collective, and at the "end of the day," determine that life is improved. An underlying assumption is that the collective efforts of community members or of groups within the larger community increase the odds that positive changes can occur. Moreover, it is assumed that communities already possess the raw material necessary for a significant degree of resilience. Our capacity-building/social action approach is mainly about well-being and assets and less about welfare and deficits (Kretzmann & McKnight, 1993) and suggests that technology is a primary, contemporary tool that can effectively support community resilience.

The Nexus of Technology, Disasters, and Vulnerabilities

The significant focus for the present discussion and application of a social organization framework is the intersection of technology, natural and man-made disasters, and vulnerable community members. Primary questions include the following:

- Which technologies hold promise for helping vulnerable groups best respond to and deal with disasters?

- How do we leverage these technologies to help mobilize communities to prepare for, respond to, and recover from disasters?

The significance of these questions is found in the reality that in many communities, family, neighbor, and friend networks may be relatively weak. These principal questions bring together a focus on situations (disasters and vulnerability), process (community networks, both formal and informal), and method (technology). Each represents complex phenomena not readily addressed individually. For example,

motivating people to respond in beneficial ways is neither predictable nor easy, as the risk behavior literature shows (McEntire, 2007). In our examination, the question is how to best position vulnerable groups to use leading-edge, effective technology when disaster is predicted (as in many weather events) or not (most man-made disasters), informed by an understanding of community social organization, the nature of vulnerability, technology systems, and normative and unusual barriers to vulnerable groups' success in accessing technology.

Social Organization

Social organization is the "collection of values, norms, processes, and behavior patterns within a community that organize, facilitate, and constrain interactions among community members" (Mancini, Martin, & Bowen, 2003, p. 319). Social organization is the:

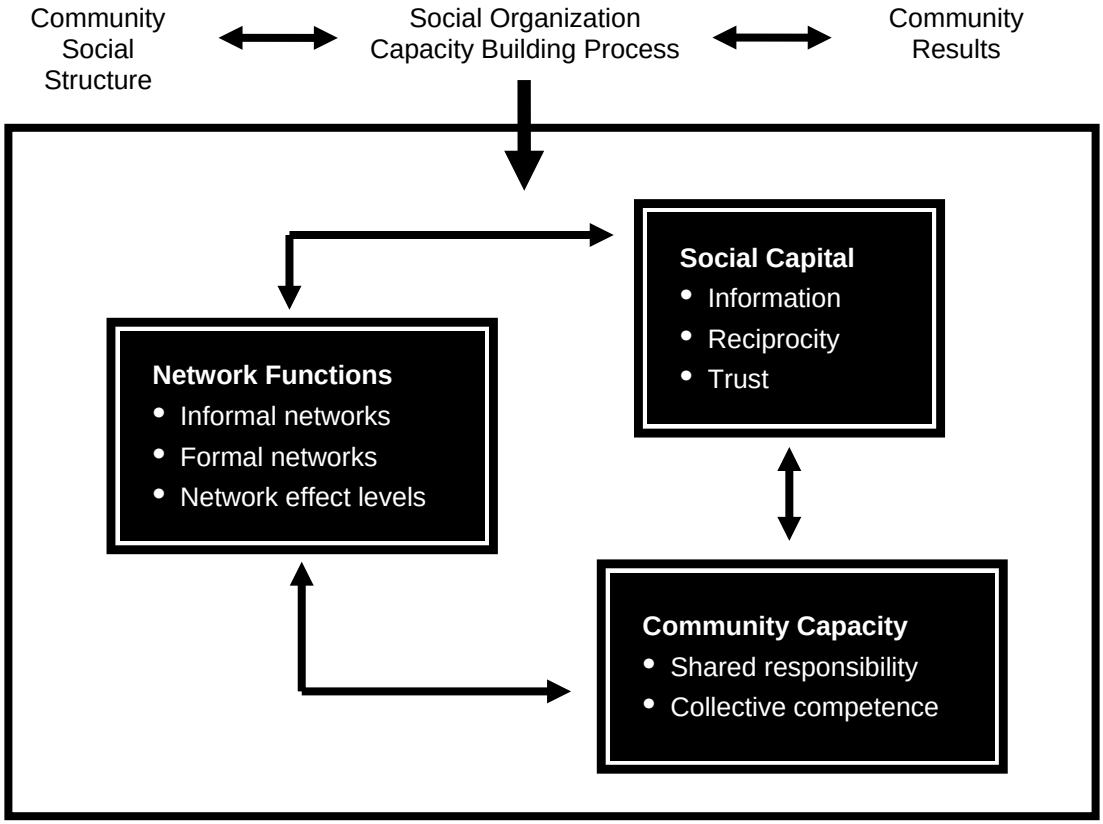
> Process by which communities achieve their desired results for individuals and families, including the ability of individuals and families to demonstrate resiliency in the face of adversity and positive challenge. Social organization includes networks of people, the exchanges and reciprocity that transpire in relationships, accepted standards and norms of social support, and social controls that regulate behavior and interaction (Mancini, Bowen, & Martin, 2005, p. 572).

Though over the years social scientists have described social organization in varying ways (Cantillon, Davidson, & Schweitzer, 2003; Furstenberg & Hughes, 1997; Janowitz, 1991; Kasarda & Janowitz, 1974) and have used the approach to explain varying phenomena, the approach described here elevates *networks*, *social capital*, and *community capacity* as key elements (see Figure 1). Ultimately, social organization is viewed as a lens sufficiently broad enough to capture the many nuances of community life, and the many challenges faced, both normative and unusual (such as a disaster); it also allows capturing the depth and detail of community processes, such as those associated with the information systems necessary for disaster preparation and response.

Figure 1 displays the main parts of the model and highlights foundational community processes. This model is dynamic, as shown by arrows indicating mutual influence. It is shown that community social structure and what ultimately occurs in the lives of community members is mediated by social organization processes; at the same time, these processes are subject to social structures (how communities are organized and bounded) and particular characteristics of the people that comprise communities.

This framework provides several leverage points that communities can access to solve problems and, therefore, can be considered a theory of social action.

Figure 1: **Elements of social organization**
(Arrows indicate mutual influence)



Adapted from Mancini, J.A., Bowen, G.L., & Martin, J.A. (2005). Community social organization: A conceptual linchpin in examining families in the context of communities. *Family Relations: Interdisciplinary Journal of Applied Family Studies*, *54* (4), 570-582.

Community Social Structure versus Social Organization Process

It is important to distinguish structure from process. The former (community social structure) includes interconnecting parts, a framework, organization, configuration, and composition, whereas the latter (community process) refers to a course of action, functions, operations, and methods of working. Knowing one without the other provides an incomplete lens for understanding communities and therefore constrains elaborating the breadth of leverage points (those points where change efforts are likely to be successful) relevant for community change. To reiterate, the focus here is mainly on social organization *processes*. Applied to communities and disaster preparation, response, and recovery, understanding how neighborhoods, towns, counties, and regions are structured is instructive for knowing how easy or difficult it is

for individuals and families to band together, rely on one another, or provide information to one another when needed. However, once structure is understood, attention must turn to what actually occurs in communities, including its informal collections of citizens.

Returning to the model as outlined in Figure 1, there are several important change-oriented descriptions of the main concepts: network functions, social capital, and community capacity. Of greater importance is the location of these concepts in a larger social action and change model, one anchored in desired community results, especially community resilience.

Principle Elements of Social Organization

Network functions. Networks are essential for providing support, both in terms of normative everyday life community issues, as well as in crisis situations. Networks are discussed in terms of informal, formal, and effect levels. Change in communities does not occur in the absence of networks because they are the collective vehicles through which actions evolve. Ultimately, informal networks are what change communities, that is, the actions taken by people themselves. Consequently, we contend that a primary function of formal networks is to enhance informal networks. When we speak of mobilizing communities, we mean activating networks to function in concert around a common cause, such as when a disaster occurs, or is likely to occur. The power of informal networks is reflected in the influence of family, friends, and neighbors on evacuation decisions (Gladwin & Peacock, 1997; McEntire, 2007; National Research Council, 2006; Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008).

Informal networks are those relationships with work colleagues, friends, and neighbors, mainly voluntary relationships characterized by mutual exchanges and reciprocal responsibility (Mancini, Bowen, Ware, & Martin, 2007). On average, individuals have a great deal of choice in the development and maintenance of their informal networks. According to Cohen, Underwood, and Gottlieb (2000) functions of informal networks include: emotional (to deal with despair and worry), instrumental (to accomplish practical tasks), informational (to achieve better decisions), companionate (to spend time in a context for support), and validation (to support feeling worthwhile, competent, and hopeful). All of these informal network functions come into play in disaster situations. McEntire (2007, pp. 23-24) notes that immediately after a disaster, the "citizen role" is expanded, indicating the involvement of community members in activities that support others in their neighborhoods, including providing relief supplies.

Formal networks are associated with agencies and organizations, in which there is an element of obligation (e.g., job descriptions, a mission, organizational goals and responsibilities, and associated expectations). In a community, social service

agencies, hospitals, schools, and the like are formal organization networks of social care. Of special concern to this report is the layer of formal organizations dedicated to disaster-related functions, including emergency management. Formal networks are significant in forwarding change and supporting resilience because of their mission of providing support programs and services. From our perspective, formal networks of social care are stronger when they are diverse and comprehensive, when outreach becomes a primary activity, and when particular entities in a community's formal system collaborate, thereby avoiding stand-alone approaches to community support. This is especially significant when a community confronts disaster. Leverage points for change are opened wider under these conditions.

Of particular importance is the role of formal networks in supporting and enabling the operation of informal networks. The success of formal systems should in part be gauged by how well they establish a community network of support and how well informal networks are functioning in a community as a result of that effort. This can be an important indicator of community resilience. Informal networks can make a substantial difference in increasing the appropriate response of citizens to hazards risk, because citizens can influence one another's behavior to seek shelter, evacuate, or heed other warnings. In terms of positioning communities to make positive changes, informal networks contribute the power of interpersonal relationships to the mix, and formal organizations contribute specialized expertise (educators, community organizers, and health-care professionals).

Networks are primary community entities through which much of community life is enacted; interaction occurs through networks, and may be among friends and neighbors, among service providers and their organizations, or among community members and service providers. Most people are part of multiple networks, but some are entirely isolated from network participation. It is likely that vulnerable groups are more isolated and socially excluded, either because of low levels of economic and other resources or because of personal conditions, such as poor health or disabilities. For these reasons, when disaster resilience is considered, the pervasiveness and vitality of networks in a community must also be considered.

A final and most significant note about networks involves their connection. Small and Supple (2001) have discussed levels of network effects. First-order effects occur within a homogeneous network, such as a family support center, or among friends and neighbors. Efforts to deal with an issue or problem are contained within the single network. Putnam (2000) discusses the idea of "bonding" that occurs within a network, and its importance for enacting change. Second-order effects occur between similar networks, such as a family support center and a community health center, or among contiguous neighborhoods. While the assets

to enact change are expanded, they are still homogeneous, according to this split of formal and informal networks. Third-order effects are derived from dissimilar networks, such as partnerships between community agencies and neighborhood groups. Putnam's term is "bridging," reflecting the intermingling of informal and formal networks. From our perspective, technology becomes an element that bridges formal and informal networks. The assumption is that when dissimilar networks focus on common issues, odds of making positive differences in communities increase.

The role of technology in enabling these network connections is critical. When the linkages are functioning properly, social capital develops within these networks, and it is from within these networks that community capacity evolves.

Social capital. Social capital is an important component of community social organization. From the social organization perspective, social capital is the aggregate of resources that arise from reciprocal social networks and relationships and that result from participation in formal and informal networks (Putnam, 2000). Information and the exchange of information are at the core of social capital, as is the reciprocity between citizens (transaction) that occurs via interaction, and the trust that emanates from successful exchanges. The development of social capital is seen in the actions of civic and social advocacy groups, local faith communities, and other community-based membership groups; social capital is also built from the informal relationships citizens have with one another. There is considerable potential when citizens have information that benefits them and their associates and have information that is also provided by and reinforced by the community groups in which they participate.

Community capacity. Two elements of community capacity are the way people in the community demonstrate a sense of shared responsibility for the general welfare of the community and its members and the way they demonstrate collective competence by taking advantage of opportunities for addressing community needs and confronting situations that threaten the safety and well-being of community members (Bowen, Orthner, Martin, & Mancini, 2001). The relevance of shared responsibility and collective competence in disaster resilience is very clear: community members who feel some responsibility for those around them are more likely to activate and translate that sentiment into action helpful to themselves and to others. Chaskin and colleagues (2001) identify human capital, organizational resources, and social capital as elements of community capacity. Sampson's (2003) concept of collective efficacy, a close relative of community capacity, focuses on community members' shared beliefs that result in action to meet a community goal. Goodman et al. (1998) conceptualize community capacity as involving characteristics of communities that may affect their ability to mobilize and the development of knowledge, skills, and resources

that interact with change. Applied technologies can be instrumental to the processes that allow creation of community capacity.

Community capacity reflects several attributes: concern is expressed both for the community in general and for parts of the community; capacity occurs in degrees, rather than being present or absent; action clearly goes beyond the expression of positive sentiments; action seizes opportunities rather than being reactive; actions occur in terms of normative everyday life situations (such as preparedness) in addition to situations of threat (actual responses to catastrophe). This approach to building community capacity as a component of resilience emphasizes *demonstrating* capacity rather than only discussing capacity-related sentiments. Community capacity is anchored in taking action that produces observable results.

Community results. The right-most part of Figure 1 is labeled community results. This framework comes alive with the focus on results, thus addressing the issue of what is ultimately expected to be different. What should be different about preparedness for a disaster? Because of certain technologies, what should be different in the midst of a disaster? How will vulnerable populations better prepare for hazards, respond more effectively, and recover more quickly post-disaster? Being clear about desired community results is of substantial importance for effective planning, in effect giving meaning to building community capacity. We postulate that effective social organization increases the odds of achieving shared, desired outcomes such as health and well-being, community safety, and community resilience. Communities focused on results are more likely to plan strategically and to mobilize resources in more targeted ways. In this social organization approach, the focus is on managing results, rather than focusing on program activities per se. This pivots attention around end-of-the-day expectations rather than on shotgun approaches to solving community issues and problems. Results that are identified and valued by individuals, families, and communities, as well as community leadership, provide direction for targeted application of resources. The intentionality that develops provides a clearer sense of desired change and in a pragmatic way enables communities to have a better sense of what actually works on their behalf to improve community life. The approach becomes action oriented, rather than just representing ways to describe community activities (Mancini, Huebner, McCollum, & Marek, 2005; Orthner & Bowen, 2004). Understanding elements of social organization positions communities to identify mechanisms for change, also called leverage points.

Resilience and Vulnerability

The term resilience appears in many discussions of preparing communities to deal well with difficulties they may confront. There may be many conceptualizations of resilience, some of which can be useful for community leaders to use in planning. Of primary importance is agreeing on the nature of resilience.

The Nature of Resilience

There are many definitions of resilience (Cutter et al., 2008), but the term is typically used to describe a community's or region's ability to effectively prepare for, respond to, and recover from a disaster, including the ability to quickly restore the essential services needed for a full and swift economic and social recovery (Community and Regional Resilience Initiative, n.d.). Words associated with resilience include: bounce, elasticity, spring, flexibility, suppleness, and buoyancy. A community that maintains, regains, or establishes favorable community results over time despite adversity (clear crises) or positive challenges (more normative, everyday life events) is considered to be resilient. Resilience is an important part of the "roadbed" in this social organization and capacity-building approach. In a very large sense, building resilience is about establishing and sustaining community capacity. Understanding resilience includes: identifying particular aspects of communities that are considered assets, and noting which are especially strong, which are moderately so, and which need attention; a focus on how community members (or service industry professionals in the community) understand and access these assets; and analyses on how community resilience factors or assets have been "tested" in the past.

One framework approach applicable to understanding resilience first emerged in sociological research after World War II. In the ABC-X model of resilience, "A" refers to a circumstance, event, or situation, such as a disaster; "B" refers to existing resources at the disposal of an individual, a family, or a community, such as strong community networks or leading-edge and efficient technology; "C" refers to a perception that an individual, a family, or a community has about the situation or circumstance (A); "X" is a result, that may include mental health, family conflict or cohesion, feelings of being alone or of being connected, being able to respond to a crisis, and so on (Boss, 2006; McCubbin & Patterson, 1983). In this ABC-X scheme, B and C are leverage points because both can be manipulated or influenced by informal and formal networks. In resilient communities there is a larger reservoir of resources available to individuals and families and to the community itself (B). The sense that individuals and families make of a circumstance is also amenable to change in more productive ways and is partially independent of resources.

Of particular note is a community resilience framework targeted on disaster readiness (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008). These authors define community resilience as a process linking a set of networked adaptive capacities to a positive trajectory of functioning and adaptation in constituent populations after a

disturbance. Schoch-Spana (2008) summarizes the Norris and colleagues (p. 130) approach to a disaster-resilient community, noting these characteristics and processes: formal networks know their roles prior to a crisis; people in the community concur that coalescing is to their benefit; community members rely on social ties during an emergency; trusted information sources convey accurate and efficiently-accessed information; and the community has diverse resources at its disposal.

Building toward resilience is at the core of this project, and technology is determined to be a primary tool. Underlying the notion of resilience is capacity building. In summation, building community capacity is building resilience that can come into play as needed by a community. Value systems are part of a social organization approach and include prevailing values about what is important in community life (and therefore what related goals should be established) and the norms that accompany those values. While resilience itself is difficult to translate into a specific desired result, focusing on elements of community capacity building provides relatively more concrete touch points. An example that comes to mind is building collaborative networks that can be activated when needed, such as the case when a community identifies and aligns its resources in advance of a natural disaster. Communities that are prepared to deal with disasters build functioning, communicating networks of agencies and organizations, and of neighborhoods, each with a protocol for mobilization. Technology becomes an important asset in these functional and mobilization processes.

Leverage Points for Building Resilience

The social organization, community capacity-building approach is a social action and change framework. The idea of leverage points is significant, referring to spots where prevention and intervention activities are likely to make a difference, in effect changing what the end-of-the-day looks like (Bowen, Orthner, Martin, & Mancini, 2001). Given the current focus, the question is what are the ways to inject effective technology into the lives of vulnerable groups and those who care about them? These are the leverage points. Most likely leverage points in communities are associated with networks, both formal and informal. This is tangible because networks are visible, vibrant, and where most people connect. The assumption is that collective activities increase the potential for changing the status quo, the usual way of doing business or the common state of affairs, in a community. Particular leverage points become clearer as communities identify desired results and take stock of their limitations and assets that have to be accounted for in considering community change. Social organization is a theory of change, in much the same way as evaluation science researchers discuss change theory (Weiss, 1995). In that discipline, attention is placed on assumptions behind parts of a change model (asking the question,which are reasonable?), the many steps that must occur between an intervention and a desired outcome, and the exact linkages between those steps.

There are leverage points associated with all parts of the social organization framework and that are relevant for community resilience. For example, even in the process of differentiating community social structure and social organization process, it

becomes evident which aspects of a community are fluid and therefore open to variability and which are static (such as gender).

The *structure* of a community includes how support services are organized, where they are located, where pivotal community organizations have influence, and how easy it is for organizations to contact and inform vulnerable groups. Community *processes* include exactly how these organizations function, including, for example, whether they collaborate with other similar or dissimilar organizations when there is an overwhelming catastrophe. Within social organization processes there are other leverage points. In this framework the information aspect of social capital is highlighted and identified as what is often exchanged in social relationships, as individuals coalesce around common and desired results. Information becomes a powerful element in the process of community members connecting, especially if its companion reciprocity becomes the norm. Critical to these community processes are the technologies that facilitate the speed, clarity, and comprehensiveness of the back-and-forth flow of this information.

Networks have already been mentioned as primary leverage points (refer to the earlier discussion of informal network functions). The discussion of network effects levels draws out how multiple networks become agents of community change and, particular to our focus here, how community resilience is strengthened. Change is also associated with community capacity itself, if capacity is seen as requisite to community members coming together around shared goals and making decisions to take action. Consequently, as a leverage point, building community capacity becomes a focus on assessing levels of shared responsibility and collective competence among community members (research on sense of community in effect does this exactly). A line of reasoning here is that if people are connected by virtue of being part of the same networks and if interaction and transaction occur in those networks then odds of shared responsibility increase and then odds of demonstrating collective competence also increase.

The Nature of Social Vulnerability

Vulnerability is commonly used to describe "pre-event, inherent characteristics or qualities of systems that create the potential for harm or differential ability to recover following a crisis or hazard event (Cutter, et al., 2008, p. 2). Vulnerability can be associated with conditions at any level of social structure or social system. Some nations are more vulnerable to the effects of hazards and disasters, as are some communities, some neighborhoods, some families, and some individuals (Wisner, Blaikie, Cannon, & Davis, 2007). While risk, in contrast, can be defined as the degree of exposure to a hazard, vulnerability refers to its differential affects on those caught in its path. All residents of barrier islands, for example, may be at equal risk for hurricanes, but they vary in the extent to which each is vulnerable to a hurricane's impact or consequences. This variation can be the result of numerous factors associated with the capacity for hurricane mitigation, preparation, response, and recovery, (i.e. with resilience). The term *social vulnerability* is recognized as generic for vulnerability associated with economic,

social, cultural, and/or political conditions that can limit available resources and response capacity of any social unit at any stage in a disaster cycle (Bolin & Stanford, 1998).[1]

Considerable evidence documents how certain attributes and circumstances are often associated with vulnerability (The Heinz Center, 2002; Morrow, 1999). Any characteristic or situation that can result in reduced capacity to respond is considered a vulnerability factor.[2] The term *capital* is often used to describe a wide range of factors that determine social vulnerability. This capital is multidimensional. *Human capital* describes characteristics internal to the individual, such as knowledge, education, literacy, experience, and personal efficacy, including health and physical abilities.[3] *Political capital* includes social and political influence within the larger social unit, such as that associated with being the member of a majority or powerful group, including playing a leadership role. As previously discussed, the extent to which a person or group is immersed in social relationships and networks can be thought of as *social capital*. The most fundamental capital associated with disaster resilience is *economic capital*, such as having the money to purchase hurricane shutters or hazard insurance. There are some situations where economic capital can be used to compensate for deficits in other types of capital. As one example, a disabled person living alone with economic resources can hire someone to assist with response tasks. In the opposite case, someone without economic resources, such as an automobile with which they could evacuate, may have social capital (i.e., family and friends) to take them out of a threatened area. The importance of human, political, social, and economic capital can be applied to other entities, such as neighborhoods, communities, and political jurisdictions. Some people are infused with capital of all types, while others struggle from lack of capital, making them especially vulnerable to the effects of hazards.

Similarly, in any community, some people and groups are at a disadvantage when it comes to preparing for and responding to any crisis, including a hazard or disaster (Colten, Kates, & Laska, 2008; The Heinz Center, 2002). Specific conditions (attributes and circumstances) found to be associated with the capacity to respond to hazards are summarized in Table 1. It should be emphasized that all members of a vulnerable category are not equally vulnerable. Hurricane Katrina in New Orleans brought to the forefront how preexisting vulnerable conditions can turn a hazard into a disaster with dramatic, unequal impacts (Laska & Morrow, 2006). If segments of a community are especially vulnerable, then the overall resilience of the larger community is compromised. An important element of social vulnerability is social justice (Morrow, 2008). In the case of New Orleans, it is not just about building stronger buildings or levees but equity and justice in resource management. This is facilitated when all segments of the community are involved in developing the resources (capital) needed in order to mitigate, prepare for, respond to, and recover effectively from disasters. For the

[1] It is nearly impossible to separate economic factors from social factors, (i.e. poverty and social inequalities coexist). Thus, it is useful to include economic vulnerability as part of the social vulnerability discussion.
[2] For 26 different definitions used by authors, see Mayunga (2007).
[3] Closely related to human capital, the term *cultural capital* is sometimes used to refer to the beliefs, norms, and values received from family and social interactions.

purposes of this project, this includes access to the technologies that promote disaster resilience.

A task for local community leaders is to determine where vulnerabilities are located and the intensity of those vulnerabilities. These vulnerability factors are an important recognition of the effects that certain attributes and conditions *tend* to have on disaster vulnerability. Equally important is the recognition that they do not usually occur in isolation, but tend to be clustered in ways that cause some individuals, families, neighborhoods, communities and nations to be highly vulnerable (Colten, Kates, & Laska, 2008).

Table 1: **Factors associated with disaster response**

Positive Response		Negative Response
Affluence	↔	Poverty
Physical ability	↔	Disability/Illness
Younger	↔	Older
Racial/ethnic majority	↔	Racial/ethnic minority
Socially connected	↔	Alone or isolated
More education	↔	Less education
Established resident	↔	New, transient, tourist
Homeowner	↔	Renter

As expected, those who have adequate financial resources, good health, and physical ability; are well educated and/or belong to a racial or ethnic majority; are established residents and/or own their own homes; and are embedded in social networks are more likely to respond appropriately and effectively, such as to evacuate from flood-prone areas. Groups of people who are more likely to have response difficulties include the poor, minorities, those with disabilities, elderly people, those who are less educated, immigrants, migrant or seasonal workers, new residents, tourists, renters, and people who live alone and/or are isolated from family and friends, such as the homeless. There is a gender dimension as well, with women being more likely to possess several of these risk factors, such as poverty, age, and tenancy. From a disaster management perspective, those with special needs are defined by the Federal Emergency Management Agency (FEMA) as "populations whose members may have additional needs before, during, and after an incident in functional areas, including but not limited to: maintaining independence, communication, transportation, supervision and medical care" (FEMA, 2008, p. 4). An effective place to begin to improve community resilience is by developing proactive plans that address the needs of the most vulnerable, such as poor, elderly women with health problems.

Demographics reveal there is widespread social vulnerability in the United States. While remaining an affluent nation, the United States has the highest or near-highest poverty rates for children, individual adults and families among 31 developed countries (Luxembourg Income Study [LIS], 2004). Nearly 37 million people live at or below the poverty rate, and 43% of these (nearly 16 million) are now living in deep or

severe poverty. This is an aging nation; in 2001 the elderly population was 13% of the total but by 2030 is expected to reach 20%. Of special interest to emergency managers is the growing number of frail elderly people who will require special attention (Fernandez, Byard, Lin, Benson, & Barbera, 2002). About 19% of the U.S. population, approximately 50 million people, have a self-reported disability (Waldrop & Stern, 2003). One in three (100 million) is a racial and/or ethnic minority (Bernstein, 2007). About 18% of the population speaks a language other than English at home, an important factor in emergency response (Shin & Bruno, 2003).

One in four households consists of a person living alone (U.S. Census Bureau, 2000). About one-third, or over 100 million, of the nation's households are renters (Bonnette, 2003). Compounding this is the fact that these socially vulnerable populations often live in areas with high environmental risk to hazards (Cutter, Boruff, & Shirley, 2003). Examples seen all too often in the Hurricane Katrina disaster were poor, black, elderly, and/or disabled victims who often lived in the areas least protected from flooding (Laska & Morrow, 2006; Pastor et al., 2006). They suffered disproportionately at all stages of the response and have had the most difficulty recovering (Cutter et al., 2006). In effect, not only are individuals socially excluded, but entire groups of citizens can be excluded and positioned less-well to fend for themselves and their communities.

Essential to effective emergency and disaster management is well-grounded knowledge about the community, including the extent to which vulnerable groups reside there, the geographical locations where they tend to cluster, and the specific nature of their vulnerabilities, including their potential needs in an emergency response (Morrow, 1999). Some, but not all, of this information can be acquired from census data (e.g., the number of poor elderly persons living alone). However, it will need to be supplemented with community-specific inquiry into areas not covered by the U.S. Census Bureau, such as the specific nature of disabilities and medical needs as well as transportation needs in an emergency evacuation. Local sources of this information include social and health service agencies, utility companies, clinics, churches and other faith-based organizations, neighborhood associations, and other service providers, which have been identified in this report as the formal network aspect of social organization.

This section has included a range of conditions and life situations that reflect vulnerability and that may position community members to be less prepared to deal with disasters. The social organization context in which vulnerabilities have been discussed suggests leverage points that can lessen those vulnerabilities, a primary one being information (an element of social capital). This report provides an array of technologies proven to provide the information citizens need to deal well with disasters; these technologies and their characteristics are now presented as tools for decreasing vulnerability and increasing community capacity, as well as resilience.

Building Resilience and Community Capacity through Technology

Tools that revolve around technology can be used in many ways to increase community resilience, especially during a disaster scenario. If appropriately deployed, information technology can educate a population months prior to an event, inform a population about a risk immediately beforehand, and provide updates during and post disaster. Information technology is the critical subsystem within an interdependent network of social, political, and technological systems that can increase community resilience. It plays a key role at the various leverage points where formal and informal community networks interact.

The Role of Technology

Information technologies considered for *informing* populations must perform several major functions to be effective during a disaster. As a minimum, technology should serve in the following capacities:

Build social capital and community capacity by enabling and enhancing connections through social networking. Many community groups now have e-mail lists and alerts that they activate for a variety of reasons. This is the function where technology shows the most promise and potential utility to community organizations, allowing the utility to trickle down to the citizen level as it effectively ties together individuals, communities, resources and authorities that link formal and informal networks. Unfortunately, this remains the area where information technologies have been underutilized (George Mason University, 2008) mainly because of high costs, but also because of the unfamiliarity of emerging technologies by the emergency managers and planners, as well as a misconception about the potential application of technology. While the community leaders and emergency managers are skilled and trained on technologies that they employ daily, such as radios and Hazmat warnings, they are not always informed about the latest technological advances available in the marketplace, nor are they aware of the best way to apply the technology to the vulnerable populations. In an era where many community members are more likely to associate with others outside their neighborhoods, having established means of connecting people and social support needs at a distance becomes significant. Technology can be a tool that builds connections and relationships.

Provide educational information to citizens that they can readily access at any time via an Internet connection or physical viewing. One example of this function is accessing detailed and interactive flood maps on Web sites, such as http://chart.uno.edu/peri/map.htm, or reviewing the hurricane tracking data updated four times per day on the National Hurricane Center's Web site, http://www.nhc.noaa.gov/. Other examples are the electronic message boards being implemented at churches, universities, and schools. Virginia Polytechnic Institute and State University recently improved its emergency notification system to ensure rapid dissemination of important information to the university community. On the Blacksburg campus, the university installed electronic message boards in all 165 general assignment classrooms to be used for emergency notifications. When an important message is posted to the electronic message boards, a brief audible tone is heard to alert those in the classroom that a message will appear. When not in use, the message boards display the current date and time. We emphasize that any technological system for providing information must be accompanied by an awareness campaign, with particular emphasis placed on informing a community's vulnerable populations about the existence and use of the system. In many cases, governments should consolidate related information on local Web sites, providing a "one-stop shopping" approach. For example, during the recovery phase of Hurricane Katrina, myriad programs were implemented to assist citizens in rebuilding their communities. Some programs were offered through federal, state, local, and non-profit programs and some through the private sector. Citizens, often unaware of many of these programs, were given no central place to locate and identify all the programs that could assist them in their recovery. This lack of awareness and knowledge gap significantly slowed the recovery effort.

Help emergency managers plan and manage resources. Emergency managers and emergency operations centers (EOCs) blend a variety of technologies to ensure that they are utilizing resources effectively and to leverage the technological benefits from the judicious combination of multiple technologies. For example, the Dade County EOC in Miami recently upgraded their facility through use of a multi-modal technology approach.

Locate people in relation to hazards[4] via tools, such as geographic information systems (GIS) vulnerability maps. For example, in Florida's multiple-hurricane disaster of 2004, local human services agencies played a major role in response efforts. The disaster exposed the disproportionate vulnerability of lower-income communities and their concentrated need for post-disaster assistance. The Lee County Department of Human Services has developed a predictive "Vulnerability Index" in GIS based on inputs of socioeconomic factors, such as income and housing tenure. Unlike forecasting tools that focus on natural

[4] See http://www.sydneycoastalcouncils.com.au/documents/SCCFactSheet-CoastalFloodModellingProject.pdf

conditions and physical infrastructure risk, the GIS index maps the geographic concentrations of human vulnerability and risks to the social infrastructure. Vulnerability indicators were selected, weighted for predictive value, and mapped for county subdivisions (Faris, Bizelli, Hoyt, & Sullivan, 2005).

Provide emergency alerts and warnings, including targeted messages (e.g., reverse 911; text messages).[5] In many communities, such as Hancock County, Mississippi, senior citizens can have their telephone numbers placed on the county's reverse 911 list, a service that records their numbers and automatically calls them when disaster alerts are issued.

Facilitate response, including evacuation (e.g., through using intelligent signs on highways).[6] Intelligent signs are activated by real-time warning messages. These signs can be placed not only on highways, but in other areas, including neighborhoods, churches, community centers, etc., where their messages can reach significant numbers of affected people.

Connect responders through a wireless communications network (e.g., FEMA radio – cell facilitation). In 1999, San Diego County and neighboring Imperial County to the east deployed a shared public safety and public service wireless radio communication network called the Regional Communications System. It provided the primary communication links for 163 local, county and state governmental agencies throughout the 4,500 square mile San Diego County and another 28 agencies and 5,500 square miles in Imperial County. The system's 43 networked radio repeater sites use over 150 800–MHz frequencies and provide more than 97% coverage of the roadway network with capacity for 13,000 users. The system utilizes one network for voice and another for data communications.

Direct responders (e.g., GPS in phones). A critical component of any successful rescue operation is time. Knowing the precise location of landmarks, streets, buildings, emergency service resources, and disaster relief sites reduces time — and saves lives. This information is critical to disaster relief teams and public safety personnel in order to protect life and reduce property loss. GPS serves as a facilitating technology in addressing these needs. GPS has played a vital role in relief efforts for global disasters such as the tsunami that struck the Indian Ocean region in 2004, Hurricanes Katrina and Rita that wreaked havoc in the Gulf of Mexico in 2005, and the Pakistan-India earthquake in 2005. Search and rescue teams used GPS, GIS, and remote sensing technology to create maps of the disaster areas for rescue and aid operations, as well as to assess damage. Incorporation of GPS in mobile phones places an emergency location capability in the hands of everyday users.

[5] See http://www.reverse911.com/index.php

[6] See http://science.howstuffworks.com/intelligent-highway.htm/printable

Keep track of medical information (e.g., telemedicine) (Garshnek & Burkle, 1999). The merger between people and Web-based computer applications allows health care information to be shared from one doctor's office to another medical facility and from a distant location to a triage area. The use of telemedicine in disaster situations warrants heightened awareness by emergency health care providers due to its success rate in administering care via telecommunications during disasters in both military and civilian settings.

Deploy resources (e.g., GIS-based maps and inventories). For example, when deploying fire-fighting personnel and equipment, dispatchers have an important responsibility to process emergency calls and send the appropriate public safety resources to the emergency location based on the type and urgency of the incident. GIS is an important component of the dispatch system. Dispatch systems typically contain a file called the Master Street Address Guide. This file contains street address information and service areas for the jurisdiction serviced by the dispatch center. As emergency calls are received, they may be accompanied with address information from the telephone company's emergency phone record database. Many computer-aided dispatch systems have begun to integrate GIS technology. GIS takes the address and automatically "geocodes" the incident and displays it on a map.

Provide recovery information and assistance (e.g., E-gov).[7] Mississippi State University's Web site (http://msucares.com/disaster/index.html) provides a comprehensive overview of tips related to disaster recovery, covering everything from how to clear debris after a storm to the health ramification of dealing with mold and fungi after a flood. In essence the Web site offers a central location for finding fact sheets, news releases and infinite Web site links related to rebuilding and recovery efforts.

Document the recovery progress (e.g., GIS-based maps). For example, in Mississippi, the Moss Point Housing Task Force is charged with identifying solutions to meet the housing needs of the city. The task force has formed a Data Collection & Assessment Committee to perform a study to determine housing needs. The committee's goal is to increase Moss Point's tax base through residential developments in run-down areas with derelict housing, one of the major challenges facing the city in the midst of its recovery process. The transfer of technology may be the single-most important aspect of GIS involvement in the Moss Point recovery process. All of the technology and data compiled are eventually handed over to the communities to utilize and implement on their own.

[7] See http://www.road2la.org/

Merely communicating risks through a systematic injection of technology does not guarantee that a population will take appropriate actions. Even when appropriately deployed across an acceptable range of the vulnerable population, technology alone cannot ensure community resilience; it functions as merely one enabler for the social organizational structures and processes that underpin community capacity. Many factors play an important role in the effectiveness of technology. These factors include: trust or mistrust in government leaders and/or the messenger (data show socioeconomic status to be a significant variable) (Lasker, 2004), the ability of affected citizens to take action, the level of resources available to affected citizens, the number of times citizens have been subject to "false alarms," as well as the number of times citizens have "successfully" survived by choosing not to evacuate in previous disasters.

General Trends in Technology Utilization

The digital divide between those who have access to technologies and those who do not is closing (National Telecommunication and Information Administration/ U.S. Department of Commerce [NTIA/DOC], 2000). This suggests trends that could be beneficial to disadvantaged and vulnerable segments of the population at large, provided appropriate attention is paid to addressing access issues for these individuals and related groups. Internet use is increasing rapidly, expected to reach 77% of U. S. households by 2012 (Reed, 2008). Even schools in remote areas usually have some access to the Internet. Some educational initiatives are developing special programs to teach parents about technology and to connect them directly with their children's schools. Most of the major school systems now have Web-based systems where parents can monitor their children's progress. This is a driving force to introducing many parents to computers and the Internet.

Cell phone usage is growing rapidly due to a combination of lower costs and more complete coverage. By one account over 50% of U. S. children have their own cell phone (Cellnumbers.com, 2007). In a study of over 900 sheltered persons in four locations around the country after Hurricane Katrina, African Americans were more likely to report having sought information about evacuation and sheltering, both from authorities and interpersonal sources; cell phones were an important vehicle used by over three-fourths of them (Spence, Lachlan and Griffin 2007). In other words, cell phones and their availability are important to African Americans for hurricane response.

Usage of technology in all age groups is growing, including elderly people. In a recent study of persons 100 years of age or older, 12% reported using the Internet (Evercare, 2008). There are now Web sites and programs, such as seniornet.org, designed specifically for elderly people. Companies are marketing computers as a way to keep in touch with grandchildren.

Federal and state grants are making it possible for smaller communities with fewer resources to have new technologies such as Reverse 911 and GIS-based data systems. GIS is making it possible for geographically isolated areas to be connected into larger response systems (Zakour & Harrell, 2003). The development of 311 non-

emergency information services by many local municipalities is lightening the load for often over-burdened 911 services (McMahon, 2002).

There are numerous examples of the important trend of using the Web to develop, maintain and distribute hazard-related information. The National Institute of Environmental Health Sciences has developed an Internet portal by using GIS to provide health-related data on vulnerable groups (Pezzoli, et al., 2007). The American Red Cross (n.d.) has a Web-based "safe and well list" for facilitating the connection of disaster victims with family and friends. More recently the American Red Cross has developed the Community-Based-Disaster Preparedness (CBDP) national database of information and resources that is interactive, allowing local chapters to input resources and access information about where to locate them when necessary (Troy, Carson, Vanderbeek, & Hutton, 2007). Similarly, the Coordinated Assistance Network (n.d.) has been developed by several non-profit organizations active in disasters to communicate with each other about client needs and services offered. It is currently being piloted in several locations.

The Coastal Services Center, organized under the National Oceanic and Atmospheric Administration (NOAA), offers a CD-ROM version of their Community Vulnerability Assessment (CVA) tool. These risk and vulnerability assessments can be targeted to a national, community, or informal network level and offer a snapshot view of vulnerabilities related to social networks, environmental factors, and economic concerns.

Various programs have been developed to assist smaller, more rural communities, including emergency managers, to gain Internet access, sometimes through wireless connections. Small companies and volunteers set up wireless service in New Orleans and the Houston Astrodome after Hurricane Katrina (Shankar, 2008). The Department of Homeland Security recently announced a pilot program that will allow local public safety officials to communicate on one network, linking land and wireless communication without the need to purchase new equipment (Nagesh, 2008).

As we combed information of existing technologies in communities, we found that some efforts that leverage technology are large-scale initiatives while others are localized activities used by community members to exploit the capabilities of an individual technological tool. In selecting suitable technologies for informing vulnerable populations and increasing their disaster resilience, the PARET Project team suggests the following guidelines for exploring technologies that could be used by emergency managers, community planners, and other concerned citizens and organizations:

- Technologies selected should be those that are most readily deployable to vulnerable populations.
- Technologies selected should use an all-hazards approach.
- Technologies selected should have some degree of utility throughout all four phases of a disaster (planning, preparedness, response, and recovery).
- Technologies selected should be able to involve three tiers of the community, and thus maximize network functions (discussed in the earlier section on social organization):

  - The emergency management level to include emergency managers and first responders
  - The broader community level to include non-government organizations, community volunteers, faith-based networks, subject matter experts (formal networks)
  - The citizen level to include individual members of the community, family units and households (informal networks)
- Technologies must be considered with the recognition that vulnerable populations are unique and composed of myriad sub-populations, pointing out that a one-size-fits-all approach is not a good one. Special consideration must be given to technologies that are appropriate for varying sub-populations within the vulnerable classification.

Technology Assessment

We now systematically review specific technologies (tools and broad scale initiatives), addressing the current state of utility (including case studies of how communities have adopted and utilized the specific programmatic approaches to technology in their planning and operations phases), barriers to access, how those barriers can be overcome to make the specific technology more accessible to our target vulnerable populations, and what stage of a disaster the technology would be most effective. An overview matrix of the technologies reviewed is provided in Appendix C.

Electronic Government Initiatives

Electronic government (eGov) refers to the use of a variety of technologies, including Internet technology, kiosks, and mobile devices as a platform for exchanging information, providing services and transacting with citizens, businesses, and other arms of government. Traditionally, eGov may be applied by public agencies in order to improve internal efficiency, deliver public services, or expedite the processes of democratic governance. Four kinds of activities, all of which could be useful during various stages of disaster mitigation, response, and recovery, take place in eGov:

- Pushing information over the Internet (e.g., regulatory services, public hearing schedules, issue briefs, notifications).
- Two-way communications between the agency and the citizen, a business, or another government agency. Primarily e-mail-based, this model allows users to engage in dialogue with agencies and to post problems, comments, or requests to the agency.
- Conducting transactions (e.g., tax returns, applying for services and grants) (a good example can be found at www.irs.gov).
- Governance (e.g., online polling, voting, and campaigning).

An excellent example of eGov-based services is found at the City of Virginia Beach, Virginia Web portal (http://www.vbgov.com/). This service has received numerous awards and recognition as one of the nation's best eGov initiatives. Virginia Beach's official government Web site was recently selected as a finalist in The Center for Digital Government's "Best of the Web" competition, an annual awards program that recognizes the most innovative, user-friendly state and local government portals. This national awards program judges state, city, and county Web sites on their innovation, Web-delivery of public services, efficiency, economy, and functionality for improved citizen access. The City of Virginia Beach is the most technology-advanced city government in the nation with more than 250,000 residents, according to the 2004 Digital Cities Survey.

The most important anticipated benefits of eGov include improved efficiency, convenience, and better accessibility of public services. Successfully implemented eGov can provide robust and detailed information to a community. Within the context of our

study of disasters and vulnerable groups, eGov could improve the accessibility of hazard response and recovery information, but traditionally it has been avoided due to high cost of implementation, as well as its perceived lack of access. eGov is better suited for passing along information than for interactive purposes. The assumption is that as more services become available online, there will be fewer brochures and handouts available at community centers and agencies which in turn will further limit physical interaction with members of the vulnerable population. It is important that special attention be given to the vulnerable populations as more information is passed through electronic channels versus the more traditional channels.

While eGov is often thought of as "online government" or "Internet-based government," many non-Internet "electronic government" technologies can be used in this context. Some non-Internet modes include telephone, fax, PDA, SMS (i.e., short message service, more commonly referred to as texting or text messaging), MMS (i.e., multimedia message service, similar to SMS but can send and receive not only text, but also sound, video, and images), wireless networks and services, Bluetooth®, CCTV, tracking systems, biometric identification, road traffic management and regulatory enforcement, identity cards, smart cards and other applications; polling station technology (where non-online electronic voting is being considered), TV and radio-based delivery of government services, e-mail, online community facilities, newsgroups and electronic mailing lists, online chat, and instant messaging technologies.

The initial part of implementation of electronic governance is computerization of public offices by building their capacity for better service delivery and bringing in good governance using technology as a catalyst. The second part is provision of citizen-centric services through digital media, such as developing interactive government portals. eGov in the United States was especially driven by the 1998 Government Paperwork Elimination Act and by President Clinton's December 17, 1999, “Memorandum on E-Government,” which ordered the top 500 forms used by citizens to be placed online by December 2000 (Clinton, 1999). The memorandum also directed agencies to construct a secure eGov infrastructure. Governments may need to consider the impact by gender, age, language skills, and cultural diversity, as well as the effect on literacy, numeracy, education standards, and information technology literacy. Economic concerns include the "digital divide," or the effect of non-use, non-availability or inaccessibility of eGov or of other digital resources, on the structure of society and the potential impact on income and economics.

eGov will have its greatest utility before and after a disaster. For example, government Web sites can provide risk information and interactive 311 registration before a disaster, essential recovery information such as the status of road and neighborhood power immediately after a disaster, and important long-term recovery information in the weeks after a disaster.

The establishment of eGov is a long-term and costly process. There has been limited evaluation on the effectiveness of eGov, and no significant research on the relationship of eGov to community disaster resilience has been identified. Vulnerable communities, correlated with low to negligible technology skills and limited access to newer technologies, are often further marginalized as governments move to an electronic format. It is important that there will be a proactive initiative for all segments of the population to be connected and to ensure that there is broad penetration of higher-speed services, such as cable and DSL infrastructure, in areas where there is a large concentration of vulnerable populations.

Community Technology Centers

Community technology centers (CTCs) started in the early 1990s and were aimed at fostering positive community change by making information technologies more accessible. Their primary mission is to provide technology access and education to underserved communities. A CTC offers resources to help bridge the digital divide, primarily through public access to computers and the Internet. These centers are a key part of what is now being referred to as digital inclusion programs.

Many centers provide training that ranges from basic computing skills to digital media production as well as applied skills (e.g., online job searching). While some CTCs are freestanding operations, many others are located in public libraries, schools, social service agencies, neighborhood centers, and religious centers, therefore involving formal networks in building the abilities of individuals and the informal networks they belong to. Many organizations that provide their participants and local community with technology access and training do not think of themselves as CTCs but simply as a place to share common services and needs.

In the United States, more than 1,000 community technology centers are organized under the leadership of CTCnet, a nonprofit association headquartered in Washington, DC. CTCs are also organized under the banner of state organizations, such as the Ohio Community Computing Network. Some cities operate CTCs and/or provide financial support to these programs. One example is the City of Seattle's Community Technology Program.

CTC programs are often supported by a patchwork of resources and are often undercapitalized. Organizations running CTC programs are often very successful in leveraging and extending the resources they have. There are very few technology-centered grant programs. Organizations (and volunteer boards) often secure funds through a combination of fundraising events, donations of products and services, volunteer labor, specific program grants, and some revenue-generated programs. The mix varies considerably, depending on the capacity and nature of the organization and setting and services provided.

To date, the greatest utility of CTCs related to disasters as been in the post-disaster phase. After Hurricane Katrina struck New Orleans, "the local CTC community in Houston set up CTCs in and near the Astrodome, which was used to house evacuees. Four thousand volunteers served 16,000 evacuees in several days and provided Internet access and services that the Red Cross was not able to provide" (Shankar, 2008). Shankar goes on to say that "[t]he CTC network…helped the evacuees navigate byzantine regulations and rules for receiving disaster benefits, find loved ones, and tell others they were all right."

Telephone Notification

Telephone notification is generally implemented through a system referred to as Reverse 911. This technology, usually delivered through a private firm contracted by a municipality, uses a patented combination of database and GIS mapping technologies to deliver outbound notifications. The system will automatically call listed and unlisted telephone numbers, including Teletypewriter (TTY) and Telecommunications Device(s) for the Deaf (TDD), within the affected area and deliver a recorded message. If phone lines are busy, the system will attempt to redial those telephone numbers to make contact. If an answering machine picks up the call, the emergency message will be left on the machine.

The cost of Reverse 911 is based on several factors, such as area population and the number and types of phone lines installed. Typically, community leaders define the types of notifications that will be made. The decision maker can be a law enforcement or fire department chief, a 911 supervisor, or an emergency management director. For nonemergency uses, a committee may set policies for types of information and frequency of use. Several factors can affect speed of delivery, such as the length of recorded message and the number of available phone lines. Options such as Mass Call™ provide access to thousands of additional phone lines on an as-needed basis.

While the Reverse 911 system is generally viewed as an effective technology for providing critical information quickly, it is costly to implement. Landline telephones enjoy very broad penetration among all populations, even the most vulnerable. Yet the technology is dependent upon those affected being in proximity to their wired telephone. Additionally, the telephone number database contains only the telephone numbers listed in the white pages. As a result, unless manually added to the database, Reverse 911 will not notify people with unlisted numbers or cell phones. For example, those who rely on voice over Internet protocol (VoIP) or cell phones exclusively have to register their non-landline numbers and associate it with their addresses. VoIP and cell phone numbers are not included in the database but can be manually entered into the system and linked to a specific address. This could lead to the situation of a cell phone being notified when the user is mobile and well out of the affected area. Conversely, there could be a situation where the user is mobile, is in the affected area, but is not notified because the fixed location of the number is in an unaffected area.

Reverse 911 will not work with phone lines that have call screening features. For example, if a phone line requires an individual to identify him- or herself through a recorded message before the call is accepted, the Reverse 911 system will not work. The system is designed to play the recorded message on voice activation, such as a person saying "hello" or an answering machine recording. The Reverse 911 system will work if a phone line has private call blocking. The system automatically identifies itself, allowing the phone call to go through.

Reverse 911 is very effective for making notifications within a well-defined geographic area. Due to the outgoing call capacity of the system, the system becomes less effective as a geographic area gets larger. For this reason, Reverse 911 should be supplemented by other notification systems such as local news media and radio stations.

Telephone notification has its greatest utility before a disaster. Emergency officials can quickly target a precise geographic area and saturate it with thousands of calls per hour. The system's interactive technology provides immediate interaction with recipients and aids in rapid response to specific needs. Emergency officials can also create a list of individuals with common characteristics, such as a community emergency response team, and contact them with helpful information as needed. In addition to sending recorded voice messages, Reverse 911 can deliver text messages to wireless receivers such as digital pagers. The system can be utilized for those with special needs. Reverse 911 has the ability to call TTY/TDD devices. In addition, call recipients can choose which languages they prefer for future calls. A message can be recorded in multiple languages to serve multilingual needs.

Cell Phone Message Notification (Voice and SMS)

The cell phone is commonly utilized across a broad spectrum of society, including populations vulnerable to disasters. SMS systems can quickly blast out text messages and can even call the cell phones with a spoken message. An emergency manager can type the message and press send. Administered through a private contractor, the system will send the signal convert the text to speech, and call the phones. The ability to convert text to speech over cellular technologies holds significant promise for subgroups of vulnerable populations, specifically elderly populations, who traditionally have limited texting skills.

The mobile phone has become an ubiquitous piece of technology, and its usage continues to rise rapidly. In 2001, 23% of households had someone with a cell phone. By 2004, 64% of households had cell phones, of which 7–9% were cell-only households (Rainie & Keeter, 2006). Interestingly, in the Rainie and Keeter study of those with cell phones, 74% reported having used theirs at least once in an emergency.

There are three barriers to implementation of cellular telephone messaging that must be considered:

- People must have a working cell phone.
- Unless it is manually added to the database, cellular telephone messaging will not notify people. Those who rely on cell phones have to register their numbers and associate them with their addresses. The cellular number is linked to a specific address that could lead to a cell phone being notified when the user is mobile and well out of the affected area or a situation where the user is mobile, is in the affected area, but is not notified because the fixed location of the number is in an unaffected area.
- Cellular technology is highly dependent on infrastructure. Hurricanes and tornados that destroy cell towers can significantly impact the effectiveness of the cellular system. However, cellular companies are making strides in ensuring system redundancy. All of the major mobile carriers took steps before Hurricane Gustav struck to ensure that there would not be a repeat of the communications disaster that occurred during Hurricane Katrina in 2005. Verizon Wireless spent more than $137 million in the Gulf Coast region during 2008 to strengthen and enhance its wireless network. Sprint spent $59 million specifically for hurricane preparation in storm-prone communities, including the installation of permanent generators for cell towers and mobile cell sites that can be rapidly deployed. T-Mobile also took steps to ensure its network would remain up or could be quickly fixed. AT&T provided at least 2,000 of its prepaid GoPhone handsets with $15 of air time to residents who were ordered to evacuate their homes due to Hurricane Gustav (Perez, 2008). Several carriers, including Alltel and T-Mobile, have provided free additional minutes to customers living in the disaster area.

The availability and pre-positioning of mobile cell towers and generators have greatly increased the resiliency of cellular systems in recent years. The persistent transmission technology of SMS has also proven to be reliable in areas devastated by severe events. There are strides being made in this area. Future cellular systems may be designed with the capability to take advantage of the geographic location feature currently required by law to be integrated within cell phones. The Federal Communications Commission (FCC) requires all new cell phones to have GPS devices that provide emergency services with location information as part of their regular features. Originally set to begin at the end of 2002, the requirement was delayed until 2005 so that all phones manufactured in the last 3 years could have that feature built in. It should be noted that the feature must be activated by the subscriber. Emergency managers may be able to identify all cellular phones within a specific geographic area that are functioning and then transmit emergency information to those cell phones as needed (although this capability is still several years away).

Cellular telephone message notification can provide information across all phases of a disaster. Before the disaster, it is useful for disseminating critical evacuation information

about risk and evacuation measures. During a disaster experience has shown that text messages, because they use a persistent transmission technology, often have the best chance of working—despite damaged infrastructure. After the disaster, information can be provided about reentry and recovery, even in an environment where much of the critical infrastructure remains dysfunctional. Telephone notification, either through landline (voice, fax) or cellular (voice, SMS), is generally regarded as the highest profile and most expeditious technology for reaching the largest number of people quickly. Specific vendors that provide a broad range of telephone notification services are provided in Appendix D.

Sirens/Loudspeakers

Sirens or centrally located loudspeakers are a relatively inexpensive tool for communities to use for disaster notification. This technology tool may be best utilized in concert with other technologies that can provide detailed information about appropriate actions to take in an emergency. Sirens are also a simple backup to other notification technologies. Local siren systems do not have the sophistication of phone mass notification systems, but they are simple, time proven, and potentially affordable. They also offer the ability to reach those who may not have a phone.

Siren-based systems, while simple to implement, are not capable of delivering fine-grained alerts as even two or three different siren "codes" may be confusing or misunderstood.

Sirens are most useful as a means of warning before a disaster. This technology is most effectively employed in concert with a larger education and awareness campaign. While not found to be the most effective means of getting the message to the masses, siren manufacturers continue to tweak the functionality of this once effective and reliable tool. See Appendix D for a non-exhaustive list of current siren vendors.

Television

Television, along with AM/FM and weather radios, relies on the Emergency Alert System (EAS). EAS is a warning system used to provide the public with immediate alert messages that affect protection of life and property. The most common reasons to activate the EAS include 911 system failures, tornados, other severe weather warnings, hazardous material incidents, evacuation orders, and other threats. The EAS is composed of broadcast networks, cable networks, program suppliers, AM/FM radio stations, TV broadcast stations, and other entities and industries operating on an organized basis during emergencies at the national, state, or local levels. The EAS may be used to provide state or local governments with a means of emergency communication with the public in their areas. The EAS may be activated at the state and local area levels by broadcast stations, cable systems, and wireless cable systems at their discretion for day-to-day emergency situations that pose a threat to life and property. Examples of natural emergencies tt may warrant EAS activation are tornados, floods,

hurricanes, earthquakes, heavy snows, icing conditions, and widespread fires. Man-made emergencies may include toxic gas leaks or liquid spills, widespread power failures, industrial explosions, and civil disorders.

Television is the most widely used source of information before, during, and after a disaster. Even in the lowest income bracket (less than $15,000), 64% of households had cable or satellite television in 2001 (Energy Information Administration, 2001). Although television enjoys broad penetration among the population, it is not well suited to provide immediate notification of an emergency, particularly an emergency occurring late at night when people are sleeping. Although the technology is not currently available, future generation digital televisions and radios are expected to include a capability that allows the set to be activated remotely. Television is highly dependent on alternating current, although battery-powered televisions are being better utilized in disaster-conscious communities. However, as digital TV becomes more prominent in 2009 due to FCC regulations, most portable televisions, especially those that are battery powered and widely used during and after a disaster when the power infrastructure is not functional, will not function.

Radio (AM/FM/Weather)

Like television, radio relies on EAS (see above section on television for a more detailed description of EAS). Radio is a medium that offers broad penetration and flexibility of use by the end user. Citizens can access radios from their home, vehicle, or from any location provided they have a battery-operated radio device.

An interesting emerging use of broadcast to create disaster resilience is through implementation of a dedicated emergency broadcast network. Although most communities have several AM and FM radio stations available to their residents for entertainment and general news broadcasting, during an emergency there is no single station that carries official local emergency notification and information. People do not have a constant, uninterrupted resource for the most up-to-date and accurate information about the event. The task of attempting to notify and/or update every area radio station, ensuring that all information is consistent and current, is difficult if not impossible, especially during the chaos of an emergency in progress. To address this problem, emergency mangers in several communities around the nation have established a permanent AM radio transmitting station. This radio station is very similar to the “travel information” stations that state and county governments use to broadcast regional highway construction information and advisories. The City of Fort Collins, Colorado, implemented this type of radio station to respond to a need that was determined after two flooding disasters in the late 1990s. The station serves as a local source of critical information related to any emergency in progress. During nonemergency periods, the station is used to transmit educational and emergency preparedness information. The system has sufficient power to reach people in their cars and homes and at their places of employment. The emergency AM radio station broadcasts 24 hours a day, 7 days a week and, because of its battery backup system, will

continue to operate even if power is lost. The station is located close to the geographic center of Fort Collins and has a coverage radius of approximately 5 miles, which reaches 98% of the city's population. The transmitter has a maximum power output of 10 watts and is broadcasting at 530 kHz on the AM dial.

Since radio signals are not dependent on electric current or on the user's location, radio notification has great utility during all phases of a disaster. Before a disaster strikes, the system can be used to inform a broad spectrum of the population. During the disaster, the system provides real-time information on community, regional, and national activities. After the disaster, the system can provide detailed information for reentry and recovery.

Like television and AM/FM radio, weather radio is dependent on signals issued through EAS. Weather radios can take advantage of a digital signaling technique developed by NOAA Weather Radio. This means that broadcasters, cable-casters, and NOAA will distribute emergency messages in exactly the same format with the identical signaling method known as specific area message encoding (SAME).

EAS relies on a dedicated receiver maintained in the home, business, or public facility to warn and inform citizens of a local emergency event or major disaster. On receipt of a warning, citizens are advised to take action to get more detailed information. For example, citizens may be instructed to:

- Tune into the local news radio or TV station for latest breaking news
- Not use their telephone or cellular phone unless it is an emergency
- Not call 911 for nonemergency calls but call 311 instead
- Listen for specific instructions, such as take shelter and close doors and windows

Weather radio is a useful tool to provide immediate warning prior to a disaster. One of the major barriers to implementation of radios, particularly weather radios, has been their tendency to provide too many alerts. The use of weather radios may be curtailed if users are awakened because of a severe weather alert in the next county, a freeze alert, etc. If these alerts, viewed by some as of little utility to them personally, are frequent, then users stop using weather radios.

311 systems

Municipalities generally use 311 systems as an information source to link various administrative offices within government. Citizens call 311 for specific guidance as to which government office should be contacted to help them with their needs. During a disaster, some communities completely dedicate the 311 system to information and instructions. Instructions may include shelter locations and preferred evacuation routes. Other communities use the 311 gateway to refer citizens to emergency services, such as evacuation assistance registration for citizens with special needs.

The most significant barrier to implementation of 311 systems is that vulnerable citizens must register through the system. This requires a proactive effort as citizens contact the government directly to provide their basic demographic information. Research has suggested that vulnerable citizens may fear being victimized if they provide this information to another party. Indeed, this fear is often exacerbated in those communities where there is distrust for local authorities or where citizens have had previous experience with government unresponsiveness.

The establishment and maintenance of a usable database often requires significant resources from a time and labor perspective. A limited number of current operations centers utilize automatic telephone verification systems to confirm residents' desire to be retained in the database, but this tool is expensive to implement. Effective methods must be implemented to advertise/notify citizens about the database and to encourage them to self-register. Yet often, government requirements mandate limited retention of data, so databases must be either purged or reconfirmed by citizens each year, requiring additional resources. One way to improve participation in the database is to gain the cooperation of community organizations in registering vulnerable citizens and in revising the database as needed. The Miami-Dade EOC uses an automated telephone system to call each registrant on an annual basis to determine their desire to remain in the database.

Finally, the government must ensure it has the resources to carry out what is promised through the 311 database. Municipalities must ensure, as promised, they have the resources to evacuate the special needs population and/or to provide other required assistance in an emergency.

Since part of the 311 system is dependent upon self-registration, this technology may be most effective in communities with more social capital or where efforts to develop social capital are implemented concurrently. As part of this effort, governments should consider a "train–the–trainer" approach using community resources such as volunteers, congregations, advocacy groups and community emergency response teams.

311 systems are only useful before a disaster, and when used in concert with another technology such as an assisted evacuation system or as an entry point for registration to receive more detailed electronic alerts.

Internet-Based Geographic Information Systems

A geographic information system (GIS) provides the ability to effectively communicate information to the public through a medium that most people can understand—a map. GIS, in concert with census or other data, can be used to effectively plan for evacuation pickup points and evacuation routes. It is used to target areas within a community for special proactive planning and outreach – areas with significant special needs or elderly populations, etc. The public needs to know about areas impacted by the disaster,

incident escalation and future potential, situation status, evacuation routes, shelter locations, food and water locations, etc.

GIS enables public information officers to generate a map of a disaster that can contain a comprehensive view of an incident. The map can be given to the media, published on a Web site, posted at community centers, or distributed to neighborhoods that are either impacted or threatened. In addition, GIS provides an effective means to educate citizens. Information on risk areas (natural fire and flood zones) can be provided in the context of a map. Providing the public with information assists authorities in prevention programs, resulting in a safer community.

GIS requires specialized technical training in order to be used effectively.
Despite the tremendous potential for this exciting new technology, there have historically been significant barriers to its widespread use. These barriers included the lack of user-friendly software, high cost of the software (~$10,000), and availability of the data. Other specific barriers to more widespread utilization of GIS include the following:

- Lack of awareness of existing data sets
- Lack of or inadequate metadata (information about data)
- Lack of uniform policies on access, cost recovery, revenue generation, and pricing
- Lack of uniform policies regarding data ownership, maintenance, and liability
- Lack of incentives for sharing
- Absence of tools and guidelines for sharing
- Absence of state-level leadership

Before, during, and immediately after disasters, logistic systems and planners are severely handicapped by the lack of accurate information related the disaster as related to the people, businesses, communities, communication, and transportation systems. GIS is a powerful tool in the decision-making process. Prior to a disaster, GIS can play a critically important role in identifying the locations of vulnerable populations. In a recent focus group in New Orleans, many advocacy groups noted the need to better identify their constituents' locations for inclusion in disaster plans. During the recent evacuation of New Orleans during Hurricane Gustav, city officials relied on community pick-up points which were identified through GIS data based on concentrations of vulnerable populations. New Orleans is continuing to refine that process, as data becomes available (Minutes of New Orleans' Elderly Evacuation Working Group Meeting, 2008). As GIS databases are being developed as part of the National Spatial Data Infrastructure mandated by an executive order, it will become increasingly important for disability factors to be incorporated as a component (Enders & Brandt, 2007).

Barriers to Technology

Our technology assessment reviewed a variety of tools and systems that could be beneficial to emergency managers, government officials and planners. While there are many levels of tools and technologies that could be implemented in any community, it would be nearsighted not to have an understanding of the risks and barriers associated with adopting specific technologies. There are general barriers that exist in communities and among end users of the technologies, especially within the vulnerable population.

Over a decade ago, a pioneer disaster researcher highlighted some of the problems associated with the increased use of technology at all stages of disaster response (Quarantelli, 1997). The expected relationship between economic resources and access to technology was likely to leave behind poorer individuals, households, and communities. Similarly, larger, more formal response organizations would have greater access than the smaller, informal, local organizations that have proven critical to disaster response.

Greater reliance on technology could become a "means" into itself, leading to a paradigm where the problems most amenable to technology are emphasized to the determent of more difficult vulnerability and response issues. Disaster management and planning is essentially a social activity that requires social interaction and human understanding that cannot be achieved by technology alone. Nevertheless, there are important ways in which technology can be used to reduce hazard vulnerability, including social vulnerability. To that end it is important to understand the types of barriers to technology use that are apt to prevent its full and effective utilization in the disaster context. Outlined below are four broad categories of barriers that may limit the utilization of technology:

> ***Availability.*** A prerequisite for the use of a particular technology is the extent to which it is available to the population in question. Obvious examples of availability as an issue are when there are limited or non-existent cable or satellite television access and haphazard cell phone or broadband coverage such as in mountainous or isolated regions of the country.
>
> Renters may not have access to cable or satellite TV because it is not available in their buildings. Emergency managers in some remote areas may be unable to use wireless technologies. Most television and radio stations now belong to a few large companies, thus reducing the coverage of local news, including information related to hazards.
>
> ***Affordability.*** It is not enough for technology to be available if it is unaffordable. The latest technologies are beyond the financial reach of many, and this is especially true among the most vulnerable populations. Similarly, smaller, poorer communities often cannot afford the latest in disaster and emergency management systems and equipment (Furby et al., 2006). Smaller organizations

and organizations that are more informal are not likely to be able to afford the latest computer and communication systems (Quarantelli, 1997).

Systems such as eGov and Reverse 911 require significant community investment, and municipalities are often reluctant to commit to the costs, especially since to date there has been inadequate evaluation related to overall effectiveness of eGov.

Accessibility. Even when certain technologies are available, personal or situational circumstances may limit their effective utilization. Visual, auditory, and cognitive disabilities can make it difficult, if not impossible, to benefit from disaster information provided via television, computers, sirens, intelligent signs and so forth. Many have a problem with television graphics moving too fast (National Center Assessible Media, 2006). Estimates show that about 60% of persons with reported disabilities have never used a computer (NTIA/DOC, 2000). Emerging and current Web sites with hazard information are useless to people who cannot see or understand them. For example, there is evidence that many do not understand the maps often posted on emergency management Web sites (Zarcadoolas, Boyer, Krishnaswami, & Rotenberg, 2007). Not all Reverse 9ll has TYY available. Interestingly, in one study only one in six emergency managers knew how many people with disabilities lived in their regions (Fox, White, Rooney, & Rowland, 2007). Clearly, leaders and emergency managers often do not consider the vulnerable community members when they choose technologies or plan their programs.

Vulnerable communities, correlated with low to negligible technology skills and with limited access to newer technologies, are often further marginalized as governments move to an electronic format. For example, the CTC experience in Houston, while generally successful in reuniting evacuees with other family members and friends, showed that many of the vulnerable population of evacuees had never used a computer or the Internet (Shankar, 2008). In addition, vulnerable populations, especially those in lower socioeconomic groups and rural areas, are often located in areas where higher speed services, such as cable and DSL infrastructure, have experienced limited penetration.

Landline telephones enjoy very broad penetration and accessibility among all populations, even the most vulnerable. Reverse 911 works well with landlines, but the transient population who often rely on cell phones as their primary mode of communication may not receive Reverse 911 notifications if they fail to register their cell phone. As noted in the technology assessment section, one downfall is that when a cell phone user registers the number with Reverse 911, they also must register their address. The static address that a cell phone user registers can be in an area affected by the disaster, but the user could be elsewhere. However, emergency management officials are working on a new technology that will

address concerns related to locality of the actual cell phone (Providing Access to Resilience-Enhancing Technologies [PARET] Project Research Team Visit, 2008).

Acceptability. Some people are reluctant to use technologies due to factors such as age, culture, educational level, experience, or personal traits. People can generally be classified into those who embrace technology and those who are reluctant to use it (Putt, 1981). In general, young people are the first to adopt a new technology. Time and experience are needed before most new technologies are embraced by the general public, and even then they are likely to be rejected by the technophobic. There is some evidence that minorities are less accepting of media outlets when it comes to hazard information (West & Orr, 2007).

Technology plays a significant role in disaster planning, preparation, response, and recovery efforts by being an important thread that integrates community competencies across the disaster lifecycle. Of particular note is how technology can enhance how well vulnerable groups fare across the various disaster cycles. Throughout, we have discussed touch points between technology and aspects of social organization, namely the formal and informal networks. There must be intentional mechanisms for connecting network members, whether they are professionals working in the community's social support agencies, congregation members in the faith-based community, or neighborhood residents. Twenty-first century enhancements to technology hold enormous promise to join various groups from a community together when they are threatened by disaster. The greatest challenge lies in extending these mechanisms to *every* element of the community, no matter how disadvantaged.

Case Study—Technology Use Among the Vulnerable Populations

Some countries have conducted extensive national surveys on the use of technologies by different segments of the population (Canada's National Statistical Agency, 2006). However, relevant data in the U.S. appears to be limited to that occasionally reported by technology companies. In order to better understand the relationships between the use of major technologies and characteristics found to be associated with hazard vulnerability, the PARET Project team had the Institute for Public Opinion Research at Florida International University conduct a sample survey in one coastal community.

Methodology

A stratified sample of residents of Charleston, South Carolina was interviewed to determine their familiarity with technologies that could enhance individual and community resilience in the face of disasters. Charleston was selected due to the community's past experience in dealing with debilitating hurricanes of mass scale. While many members of Charleston's current population can recall past disasters like Hurricane Hugo in 1989, time has distanced the residents from the emotions and allowed them to answer the survey questions from an unbiased viewpoint. Charleston's positioning on the eastern seaboard makes that community vulnerable to future hurricanes and also to earthquakes. The survey focused on the use of technologies that could be used to mitigate vulnerability. The sample targeted both low income and affluent neighborhoods to allow for comparison of socioeconomic effects. A description of the sample and a list of the survey questions and frequencies of response are presented in Appendix E. Survey demographics showed a significant portion of the sample measured high on variables associated with vulnerability, 37% were over 65 years of age, 39% identified themselves as Black, 32% were renters, about 20% had less than a high school education, and nearly half reported income under $30,000. As typically happens on surveys, women were over represented (64%). Overall, the survey is a good indicator of differences between vulnerable and more affluent populations, but, given the areas selected for sampling, it does not necessarily represent an accurate estimate for the entire city of Charleston.

Findings

The purpose of this survey was to examine the use of technology among various segments of the community, particularly the more vulnerable. Questions were asked about several technologies that can be useful sources of information and assistance during a disaster – cell phones, text messaging, home computer, and the Internet. Examining the results for each of the technologies yields some interesting observations.

Attributes often associated with vulnerability, such as low income, were analyzed statistically for various types of technology, such as cell phones. The results were analyzed according to respondent characteristics such as age and gender. The results of chi-square analysis of the associations between use of the target technologies and relevant respondent attributes are reported in Table 2 .

Table 2: **Attributes Associated with Technology Use**

Technology	Age	Gender	Race	Education	Income	Home Owner
Cell Phones			*	**	**	**
Texting	**			**	*	**
Home Computer			*	**	**	**
Internet Service			*	**	**	**

* Repeated surveys with this sample size (566) would show the same relationship 95% or more of the time.
** The relationship should be shown 99% of the time.

As would be expected there are strong associations between the use of these technologies and variables associated with socioeconomic status, such as education, income and homeownership. While less significant, there is also a relationship between the use of cell phones and computers, and race, with African Americans less likely to have access. It is important to note, however, that these racial differences disappeared in regression analysis where the effects of income were controlled. Therefore, it would appear that the racial differences in use are associated with socioeconomic status rather than minority status. Not surprising, there was a strong association between age and texting, with young people more likely to use this technology at the present time. No important gender differences emerged in this sample.

Cell phones and text messaging. Looking at the sample as a whole, a majority (70%) has cell phones and two-thirds of these say others in their households also have them. Even among those 65 years or older, 67% reported having a cell phone. The rate for African Americans was 60%, compared to 77% for whites. Even among renters, 51% owned a cell phone. Only among the poorest, those with incomes less than $20,000, does cell phone usage drop below a majority (31%), and it jumps to 74% in the next income category (between $20,000 and $30,000). There were similar differences in text messaging rates. As might be expected, though the age differences for texting covered a larger range, with 56%

of the younger group (under 29 year old) using it, compared to 6% in the oldest group. Even though elderly people are much less likely to use it, many of them live where younger household members could conceivably pass along text emergency messages. There were no racial differences in text messaging rates. These numbers suggest that there is wide enough usage of cell phone and text messaging for these to be important information vehicles during emergencies and disasters. However, it cannot be over-emphasized that some of the most vulnerable sectors of the population – poorer, less educated, minority, renters – are the least likely to have cell phones and text messaging. Therefore, these cannot be relied upon by authorities as the sole source of information.

Computer and Internet access. Sixty percent of respondents reported having a computer in their home, and most of these (92%) had Internet access. While age and gender do not differentiate users in a significant way, race does with 64% of whites reporting that they have home computers, compared to 52% of blacks. All of the socioeconomic-related variables show highly significant relationships. There were similar differences in Internet availability (61% compared to 47%). One quarter of the poorest had home computers, and 24% of these reported having Internet service. It is interesting that 46% of the elderly people had home computers and 40% of these had Internet service. Thus, similar to the case with cell phones and text messaging, most in this sample had home computers with Internet access. However, those least likely to have this technology are among the most vulnerable. When asked to estimate their level of computer skill, 18% said they were beginners, 37% intermediate, 16% expert and 29% said they did not know. As expected, lower income groups reported lower computer skill levels. In fact 69% of those with income under $20,000 said they did not know how to use a computer or were beginners.

Radio. Most (76%) of respondents have access to a battery-powered radio and 23% said they have a NOAA weather radio.

Sources of hurricane warning information. Respondents were asked about different ways they would get information if a hurricane threatened Charleston. Reported sources were: television (90%), radio (72%), Internet or e-mail (34%), other people in household (33%), people they talked to on the phone (35%), and people at work or church (38%). They were then asked to review their choices and pick the most important. Television was most important for 68%, followed by 16% for radio, and 7% for Internet/e-mail. About 6% cited information received from other people as their most important choice of information. Respondents were asked a follow-up question as to whether there was another source of information that they did not have but would be helpful. Probably because it was mentioned earlier, the only frequent answer was NOAA weather radio (21%), while 75% said there was no other source of information needed.

Reverse 911. About two-thirds said they would sign up for an emergency notification system where they would be contracted directly if their area was threatened, 15% said they would not sign up, and the rest could not decide. Interestingly, 60% of those who said they would sign up also said they would also be willing to pay a $25 per year fee for this service. The results do not vary significantly by income level.

Receiving information during event. Radio is the most frequently mentioned way to receive information from authorities during evacuation; it was chosen by 60% of the respondents. Between 10%-15% mentioned TV, landline phone, and cell phone.

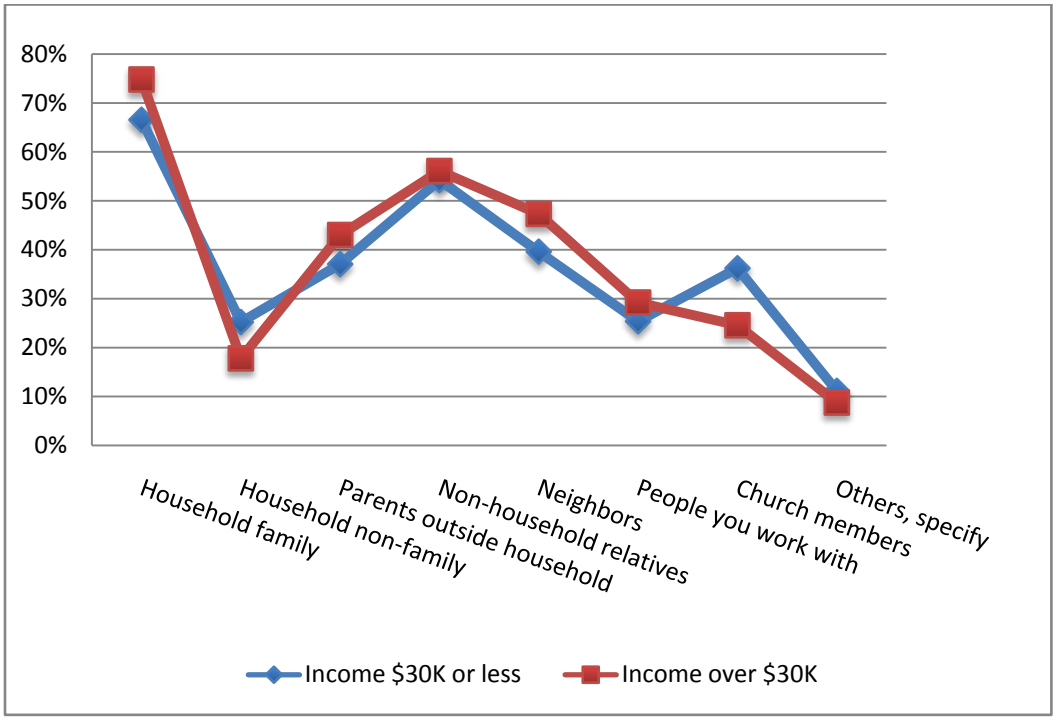
Short warning emergency announcement. Respondents were asked what they thought would be the best way for authorities to let them know that an immediate emergency, such as a tornado or chemical spill, threatened their area. As expected, television was most frequently cited (63%), followed by radio (44%), landline telephone (26%), cell phone (20%), siren (19%), police loudspeakers (14%), weather alert (8%) and e-mail (3%).

Assistance from community organizations. In keeping with the community organization framework of the PARET Project, several questions were asked about respondents' social networks as indicators of social capital. When asked if they belonged to any organizations, groups, or church congregations that could help them in a major hurricane or other disaster, 60% reported yes. Of particular importance is the fact that lower income respondents were more likely to belong to such an organization (75%). In both income groups, these organizations were most likely to be faith-based.

Social networks in disaster preparation. A series of questions was asked related to who respondents would need to be in touch with if a hurricane was expected in two days.

Contact networks before hurricane. When asked what persons they would contact before a hurricane, the most common answer was family members living in the respondent's household. Relatives not living with the respondent came second, cited in slightly over half of the interviews, followed by neighbors and parents not living with the respondent. The following graph illustrates the answers with the sample divided into income groups, under and over $30,000. Differences between the two income groups are minimal. However, lower income respondents are somewhat more likely to list church members as people they have to get in touch with.

Figure 2: **Persons to Get in Touch with if Hurricane is Imminent**



Technologies for communicating with social networks. Respondents were asked how they would get in touch with household members who were not at home when plans for the impeding hurricane were being made. By far the most preferred method is telephone, but there was a major difference between higher and lower income groups on what kind of telephone (see Figure 3). Households with incomes over $30,000 were much more likely to use cell phones. Similar results were found when asked how they would get in touch with non-household family (see Figure 4). This is no doubt a direct result of the fact that 90% of respondents with incomes of $30,000 or more reported having a cell phone, while only 51% of those with lower incomes had one. It should be mentioned that Charleston has low elevation and the entire area is expected to evacuate for a major hurricane. Once a person who does not have a cell phone evacuates, it is much more difficult to communicate with family members or others. Similar results occurred when they were asked how they would get in touch with family members outside the household.

Figure 3: **How Would You Get in Touch with Household Members Not at Home?**

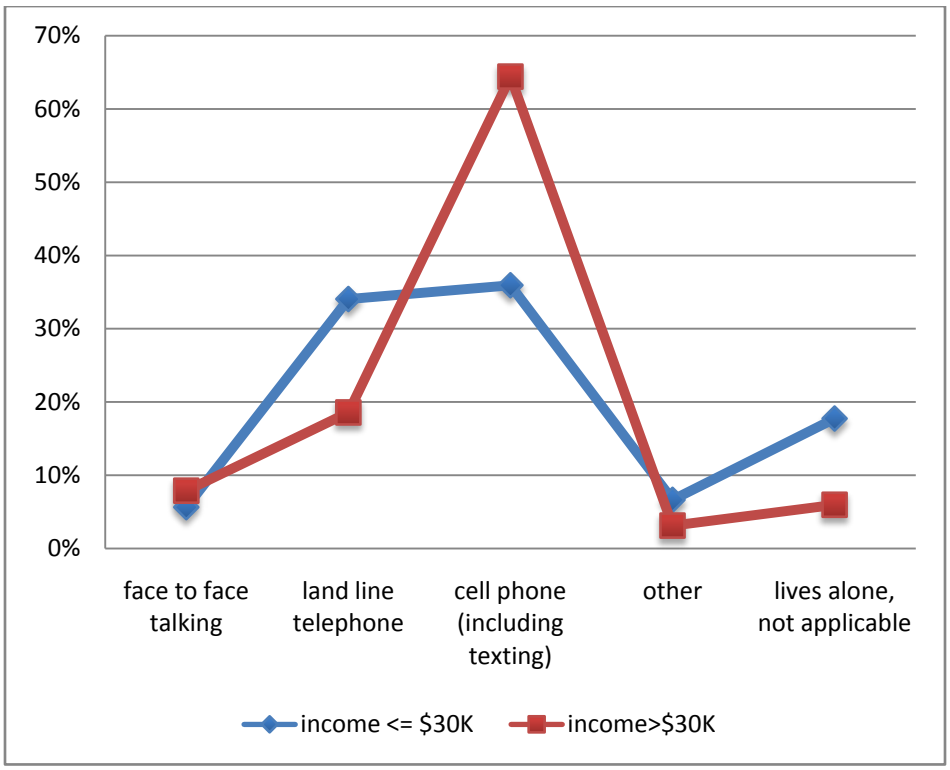
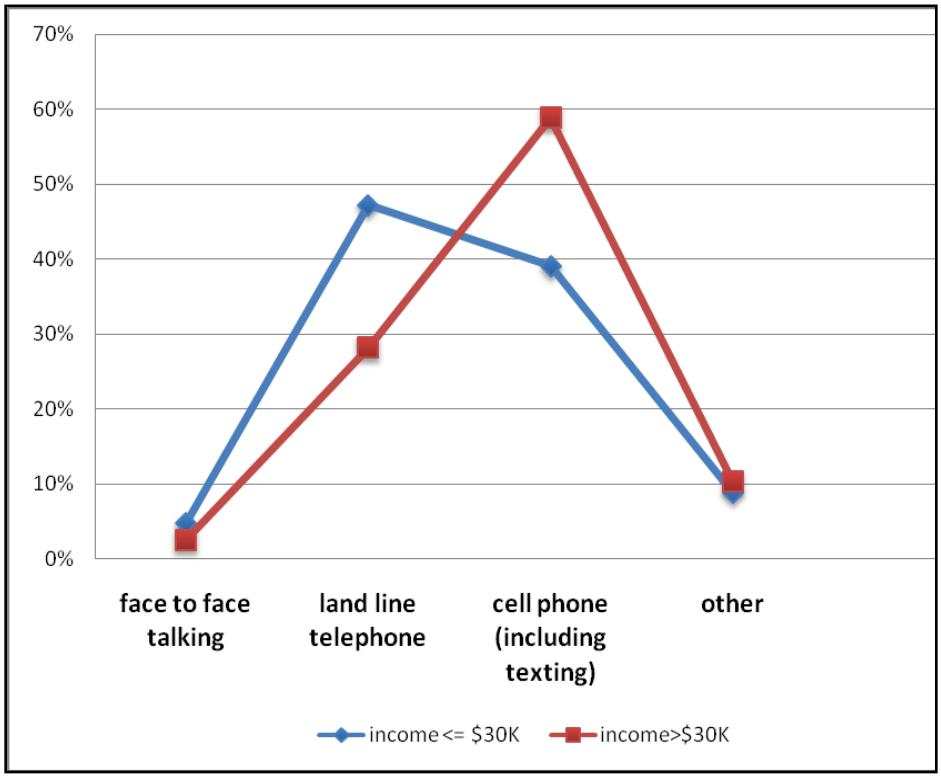


Figure 4: **How Would You Get in Touch with Family Members Who Do Not Live in Your Household?**



Factors related to evacuation planning. An important issue related to social vulnerability is that of evacuation from an area threatened by a hazard. When people who said they would evacuate for a major hurricane were asked how they would hope to keep in touch with family and friends during the evacuation, 61% said cell phone and 24% landline phone, while 14% indicated that they would not have anyone they would be in touch with. The same pattern by income prevails here: lower income households were more likely to say they would use landline phones. When asked if they would use a different method to reach household members not at home in an emergency with virtually no warning, such as a chemical spill or terrorist attack, 82% said they would use the same method as for a hurricane.

In many cases, such as when surge and/or inland flooding threaten a low-laying area, evacuation is the appropriate way to avoid harm. The reasons some do not leave when authorities call for mandatory evacuations are complex, but often the reasons relate to social vulnerability. It takes capital to evacuate. A means of transportation, funds for food and lodging, and a place of refuge, preferably the home of family or friends. Another reason why people evacuate is because their home does not have the necessary hazard mitigation, such as hurricane shutters. Renters do not have control over mitigation, so they are especially vulnerable to the effects of hazards – another example of the effects of economic capital.

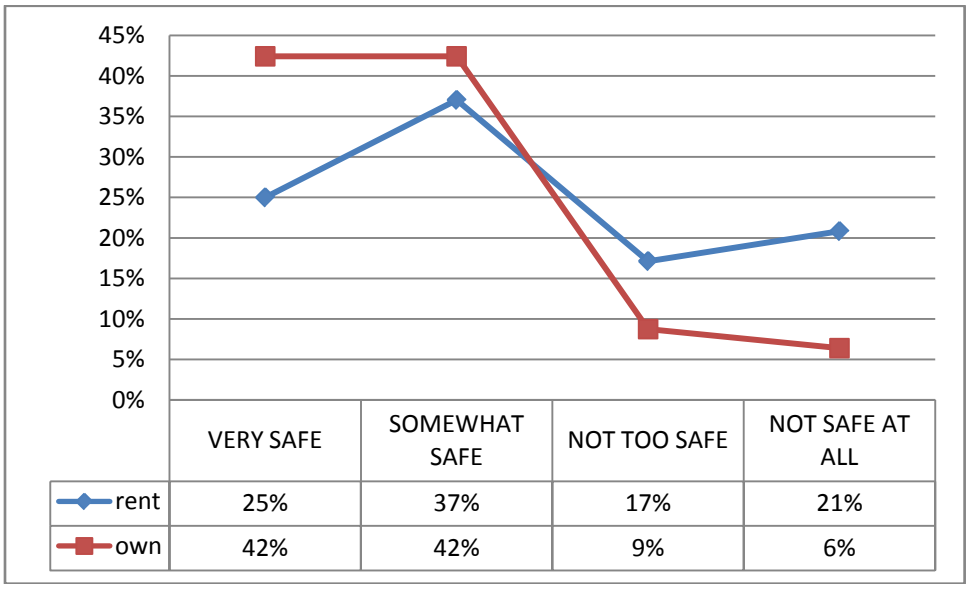
In order to get a better sense as to why people in the Charleston area might not leave, several questions related to evacuation were included in the survey. Evacuation for a major hurricane is required for the entire study area. Reassuringly, only 17% of these respondents said they would not evacuate. The only socioeconomic variable significantly related is home ownership, with 22% of homeowners saying they would not evacuate, compared to 9.5% of renters.

Previous experience has a large impact. Among people who had previously evacuated, only 8% said they would not evacuate again, compared with 24% of those who had never evacuated. The effect is reversed for hurricane experience. Among people who reported being in a hurricane, 20% said they would not evacuate, compared with 8.5% of those who had never been in a hurricane. These findings apply equally to higher and lower income groups. It should be noted that it is unlikely that most of these have actually experienced full hurricane force since Charleston has not had a direct hit in decades. (Hurricane Hugo came ashore north of the city.) For those who experienced some of Hugo's fury there may be a false belief in their safety for future hurricanes.

Respondents were also asked how safe they felt their home would be if a major hurricane hit Charleston. Most felt their homes were very safe (35%) or somewhat safe (39%), compared to those who felt theirs was not too safe (12%), or not safe at all (14%). Lower-income respondents were somewhat more likely

to feel their homes were not safe. Similarly, renters were much more likely to say their homes are less safe than homeowners (see Figure 5).

Figure 5: **Opinions Regarding Home Hurricane Safety**



As one might expect, people who feel their home will be safe in a hurricane are less likely to say they will evacuate. This joins homeownership, hurricane experience, and evacuation experience as factors that affect whether people say they will leave.

Logistic regression is a good way to look at the unique influence of each of these factors as drivers for making people more or less likely to evacuate during a major storm. As shown in the next table (Table 3), each is a fairly strong predictor.

Table 3: **Logistic Regression of Factors that Influence Evacuation Decisions**

	Odds of Stating Intent To Evacuate	**Probability**
A Renter	3.2 times greater	.002
Believe House is Safe	2.3 times greater	.051
Have Evacuated Before	7.0 times greater	.000
Been Through a Hurricane	2.3 times greater	.003

Confidence in Authorities. Respondents were asked how confident they are in the messages delivered and the advice provided by different types of officials. Table 4 shows the percentages of people who were either very confident or mostly confident in the various sources of delivery. The National Hurricane Center and local National Weather Service received the highest rating (89%), followed by local TV stations (84%).

Table 4: **Percentage of Confidence in Authorities**

Source	% Very or Mostly Confident
National Hurricane Center and NWS - Charleston	89.0
Local Officials	80.4
Local TV Stations	84.0
Weather Channel	76.3
Local Emergency Managers	74.5
Information on Internet	35.2

Important Factors in Hurricane Decision. Respondents were asked about factors that would be important to them in deciding what to do if a hurricane approaches. They were asked to rate each as very important, important, somewhat important, or not an important factor in deciding what to do. The results are reported in Table 5.

Table 5: **Factors Influencing Hurricane-Related decisions**

	Percent saying very important or important	Percent choosing this as the most important factor
Where hurricane is forecast to hit	93%	34%
Having transportation to leave if needed	82%	14%
Being able to keep family members together after the hurricane	84%	13%
Strength of hurricane winds	95%	8%
Having enough money to evacuate if needed	85%	6%
Possibility of flooding or storm surge	77%	5%
Evacuation orders given by government	84%	4%
Amount of time left before the hurricane arrives	92%	4%
Medical or other needs of self or other household members	60%	3%
The needs of pets or animals	47%	2%
Being able to return home right after the hurricane	79%	2%
How ready home is to withstand hurricane winds	84%	2%
Being able to protect home from crime	82%	2%
Possibility of traffic delays	81%	1%
Requirements of job or the jobs of family members	48%	1%

Discussion of Survey Findings

The major finding of this exploratory survey confirms the issue of the unequal availability of many of the technologies being promoted to reach people during emergencies and disaster. In particular there are indications that coastal residents who are black, have less education, lower income, and do not own their home are the least likely to have use of cell phones, text messaging, home computers and the Internet. All four of these characteristics are already associated with hazard vulnerability. While these technologies have the potential for lessening that vulnerability, it is clear that many of those at highest risk do not benefit from their use at the present time.

Another way of looking at the data, however, is to focus on the finding that *most* of these community members, including a majority of the most vulnerable, *do* have these technologies. The issue then, is how to overcome the barriers preventing the others from the increased resilience associated with their use.

Enhancements to Technology Utilization

Previously, we outlined the general barriers and risks of implementing specific technologies. In the next section we discuss the advancements being made within the technology sector with special emphasis on deploying them for use by vulnerable populations. In a very general framework, there is an often-cited digital divide between those who have access to technology and those who do not. The vulnerable populations are overrepresented in the latter category. The term digital divide refers to the gap between those people with effective access to digital and information technology and those without. It includes the imbalances in physical access to technology as well as the imbalances in resources and skills needed to effectively participate as a digital citizen. In other words, the digital divide is the unequal access by some members of the society to information and communications technology, and the unequal acquisition of related skills. Factors often discussed in the context of a digital divide include gender, income, race, and location (Rice & Katz, 2003).

It is important to recognize that neither technology nor community capacity are static. The encouraging news is that in the ever-evolving world of technology, strides are being made that address the barriers to access.

Promising Advances

Availability. Broadband service is rapidly expanding across the nation, making it possible for more households to receive high-speed Internet connections. Satellite broadband has made it possible for many remote areas without cable to receive the full spectrum of television and broadband services. Similarly, wireless technologies have made telephones and Internet service available to people without being tied to one place. This is especially important to renters, tourists and other transients, and the homeless. The movement to digital is opening up new frequencies that can be used to create new local radio stations. GPS is now a part of most cellular phones and this will enable first responders to locate callers during emergencies. There has been a rapid increase in the use of GIS-based platforms by planners and emergency managers.

Affordability. The costs of new technologies typically goes down as more people use them. This has certainly been true with cell phones and computers. Many relatively inexpensive computers are now entering the market, some under $500. Prepaid and fixed-payment cellular telephone plans have been introduced, making them more affordable to those with limited resources. Free Internet access is available in many public places, such as libraries and government offices. Also, many private businesses, such as coffee shops and restaurants, offer free wireless connections; this is especially true in urban areas.

Accessibility. Numerous forces are moving toward making technologies more accessible to all segments of the population. The market is an important motivator. One example is the Jitterbug phone advertised for its *lack* of complex features, its large numbers, its easily accessible emergency service, and its loud ring tones (www.jitterbug.com). It offers a relatively inexpensive prepaid plan and is being marketed to the elderly population. Similarly, new, simpler computers, such as the Mini Mac that can be carried into a class or store for assistance, are popular among older users. When designing risk communication for older adults, it is important to stick with technology with which they are comfortable, such as the telephone and Reverse 911. In addition, the message and mode of communication selected should compensate for age-related changes in perception and physical abilities (Mayhorn, 2005).

There has been significant movement at the federal level toward better meeting the needs of the disabled during emergencies and disasters. An executive order was signed after Hurricane Katrina to "ensure that the Federal Government appropriately supports safety and security for individuals with disabilities in situations involving disasters…" (Jones, 2005). There is a federal requirement that all Emergency Alert System messages include both audio and visual messages. The new public and private partnership to develop an Integrated Public Alert and Warning System (IPAWS) specifies that it be designed to send voice, and text messages, as well as e-mail (Moore, 2008). This has led to the development of federal guidelines by several agencies, including the *Interim Emergency Management Planning Guide for Special Needs Populations* (FEMA, 2008), the *Public Health Workbook to Define Locate and Reach Special, Vulnerable, and At-Risk Populations in an Emergency* (in process), and *An ADA Guide for Local Government* (U.S. Dept. of Justice, n.d.).

Recommendations for meeting the needs of the disabled have been developed by several groups, including the Deaf and Hard of Hearing Consumer Advocacy Network, the National Council on Disability (2005), and the National Center for Accessible Media. The latter received a 3-year grant to develop ways to make media more appropriate for use by people with disabilities (Brooks, 2006).

An international effort sponsored by the Web Accessibility Initiative (2008) is working toward making Web sites more easily understood by all segments of the population.

Acceptability. Various technologies, such as cell phones and computers, are being made more acceptable to reluctant segments of the market. According to a CTIA (2008) study, the fact that there are over 262 million wireless telecommunications subscribers in the United States leads us to believe that Americans are very accepting of cell phones and Internet usage and the fact that

10 times more SMS/text messages were sent in 2008 than in 2005, indicates that individuals are becoming more accepting of this use of technology.

Innovative Practices

In addition to the general trends and advances that are bringing down the technology barriers, several innovative programs may pave the way for greater use of technology in reducing hazard vulnerability. We endorse these programmatic approaches for leveraging technology to build community capacity and enhance resilience. They warrant further research, in particular regarding varied application scenarios.

- The Dade County EOC in Miami, Florida recently upgraded their facility to include: 72 computerized workstations, advanced electronic information displays and telecommunications, a media center with production capability, a radio communications room, seven conference rooms, direct audio and video feeds, a 38-station call center with hearing impaired telephony, CCTV, and media monitoring stations. The EOC central command area prominently broadcasts all local television news stations and cable news networks on plasma screens in the same command room where the computerized and telephone workstations are housed. Collaboration across a broad variety of community networks is enhanced by providing those agencies with representation in the EOC through assigned spots in the command center. These include, but are not limited to, the following: first responders, government officials from all levels, school district administrators, the National Park Service, nonprofit organizations, and faith-based groups. Planning is further enhanced during the off-season by utilizing GIS technology to map various areas to identify vulnerable population concentrations, plan pick-up sites, and appropriately position assets. The Dade County 311 Service Center is also housed in the same building. The ongoing effort exhibited by this EOC shows that planning for and managing disasters is a collaborative effort, involving people and technology as two key components.

- Japan, located in one of the most seismically-affected regions of the world, began using cell phones for short-fuse disaster warnings in 2007 (Tech-On!, 2007). The system works much like Reverse 911 and uses GPS in the cell phone to send out messages via a dedicated ringtone to specific areas that may be affected by an immediate disaster. Warnings delivered even minutes prior to an earthquake could be beneficial in saving lives and other resources. Japan is also developing cell phones with voice recognition and voice translation capabilities which could be beneficial for a transient who is not familiar with the native language.

- A pilot program in Tennessee is providing free cell phones to some of its poorest citizens (Johnson, 2008). This is in response to the ideas of Nicholas Sullivan

(2007) related to the importance of phone access in helping the poor find jobs, but it will also have the effect of connecting the poor, including homeless, with emergency information and assistance.

- Several programs introduce elderly people to computers and the Internet (Reuters, 2008), including a program where the City of Miami and Microsoft teamed up to provide specially designed computers and classes (Microsoft, 2007).

- The AM Radio Station Project in Fort Collins, Colorado, is an example of how digital technology will result in more radio stations dedicated to providing emergency information over small areas (http://fcgov.com/oem/overview-amradio.php).

- Citizens of Charleston, South Carolina, are connected through over 100 officially recognized neighborhood associations, many of which use e-mail to connect with each other and with the Mayor's office. Among other responsibilities, they report on neighbors with special needs.

- Computer scientists are designing new ways to help elderly people maintain their independence through such innovations as "technology coaches"— home computers that tell them when to take their medications and can send weather and emergency information directly to them (Science Daily, 2007). Family members located in other areas can monitor the activities of their loved ones.

- Technologies, such as barcodes, biometrics, and GPS tools, are being used to track disaster victims (Pate, 2008), tying their identifications to medical records. This is particularly important for vulnerable groups such as elderly and ill people.

- It is now possible for many citizens to sign up to receive weather and emergency messages via personal pagers and/or e-mail addresses. Examples of two innovative systems are the Oklahoma OK-Warn program (www.nssl.noaa.gov/edu/safety/pagers.html) and the Tropical Cyclone Advisory List (http://www.nhc.noaa.gov/signup.shtml).

- A pilot program in South Portland, Maine, uses pagers and special radios to inform the deaf and hard-of-hearing in emergencies (Portland Press Herald, 2005). Many of these systems can convert text messages to voice messages for the visually impaired.

Conclusion: Perspectives and Prospectives

This report has highlighted essential aspects of community processes, laid-out the role of technology, and presented a specific menu of technology systems. Potential barriers have been noted, especially as they pertain to vulnerable groups. All of these elements have a bearing on how well communities can utilize technology as they plan for, prepare for, contend with, and recover from disasters. For technology to reach its maximum effectiveness, communities must integrate it into everyday life and not only when there is a disaster. Consequently, those technologies that are already part of everyday communication hold much promise; citizens are already familiar with them. What remains is getting more of the everyday life technology into the possession of vulnerable groups.

The technology gap is closing. There has been a rapid increase in emerging technologies and new ways of making them available, affordable, accessible, and acceptable. These technologies are increasingly relied on in disaster response at every level from individuals through all levels of government. Since the Internet and other electronic resources are now being used to transmit hazard education information, emergency information and alerts, and to form social networks to link community members, ready access becomes essential. This makes it even more serious when segments of the community are cut off from the information and services now available through these technologies. Thus, while the number without access is lessening, the ramifications for them may actually be increasing as more messages pertaining to disaster warnings and response are delivered via technology channels.

In every community some people and groups are left behind by the "technology explosion." Of special concern here is the relationship between technology access and disaster vulnerability. Those individuals, households, neighborhoods, communities, and even regions with less accessibility to the latest technologies tend to also be among those most vulnerable to the effects of natural and man-made hazards. However, it is important to note that this is not a static situation. Technologies change rapidly, as do the conditions that affect their access and use. Many of these changes are creating conditions that increase technology availability, affordability, accessibility, and acceptability, even among the most vulnerable.

Most likely to experience barriers to using new technologies are people living in rural or remote regions as well as inner cities, the homeless, transients, the poor, those with vision, hearing or cognitive impairments, some elderly people, some minorities, the less educated, and those with limited experience in their use of technology (NTIA/DOC, 2000). For example, there is evidence of public warning systems or emergency messages not being accessible to people with hearing or vision problems after September 11, 2001, during California wildfires, and during Hurricane Andrew response (National Council on Disability, 2005). The medical services in rural areas are less prepared to handle emergencies, including having less access to technology (Furby et al., 2006). Not surprisingly, those in the lowest income bracket (defined as less than $15,000 in 2001) had much lower occurrences of having cable or satellite television and cell phones (Energy Information Administration, 2001).

Our research indicates that it would be prudent for the United States to implement a national survey, similar to the Canadian one (Canada's National Statistical Agency, 2006), to provide more accurate data on the current state of technology utilization among various segments of the nation's population. This would provide a clearer picture of the gaps in technology access and would serve as the first step in narrowing and reducing the digital divide.

Technology Recommendations

The value of this research lies in helping communities and municipalities of any size and in any location select proper tools and technologies from the comprehensive assessment to develop a customizable, programmatic solution to meet the needs of the individual community. Our technology assessment, research findings, and survey results indicate the following suite of technologies offer the most promise to the vulnerable population, once again emphasizing that no single or even small grouping of technologies are adequate for all situations.

Television. Television offers the broadest penetration to all members of community, as large audiences can hear the messages at the same time, from a number of locations, including their personal residence. Television messages are visible and audible and do not leave out people with vision or hearing impairments. Someone without a strong understanding of the English language is likely to understand the pictures, maps, and warnings announced on the television. Elderly and disabled people can sit in the comfort of their own homes and apartments and receive the messages, so physical mobility is not an issue. Since television messages can be delivered to mass audiences simultaneously and via live broadcast, the messages are consistent. During a television broadcast, a news anchor or another community leader can give specific instructions to the citizens, instructing the people about what to do and point out what the consequences will be if they do not follow the instructions. Televisions can be used during the preparedness and recovery phases of disasters. We recommend that federal legislators consider enforcing television manufacturers to implement remote triggering of televisions by EAS, which would make televisions even more effective for short-warning disasters. If this type of legislation is passed, televisions would become an even more prudent tool to assist the vulnerable members of a community during disasters. While television use is extremely effective, we must emphasize that its accessibility may be hampered, particularly next hurricane season, by those who rely upon portable analog televisions, which without upgrades will not work on digital systems implemented after February 2009.

Radio (AM/FM). Radio offers almost as much penetration as television does. Members of a community can receive radio messages at home, in their cars, and in boats and other vehicles. As television stations switch to digital broadcast, many televisions, particularly portable televisions, will no longer be able to receive signals. Until a new generation of portable, digital televisions are readily available in the marketplace, radio will be especially important for reaching large audiences, particularly during and post-disaster when power sources may be limited or non-existent. The number of available stations, particularly with the increase in digital high-definition bandwidth, makes it possible for communities to meet the linguistic needs of multicultural communities. It also makes it

possible for communities to create dedicated emergency broadcast networks. The implementation of these dedicated networks, accompanied by a public awareness campaign, provides a constant and uninterrupted resource for the most up-to-date and accurate information about the event. As with television, physical mobility is not an issue for elderly and disabled citizens. Our recommendation for radio is consistent with our recommendation for television in that we propose that federal legislators consider enforcing radio manufacturers to implement remote triggering of radios by EAS.

Community technology centers. CTCs show great promise in disaster scenarios, but before they can serve as a programmatic approach to making communities more resilient, there need to be more of them available. And, they need to be integrated into the statewide emergency response system. CTCs offer the most benefit during the recovery phase of a disaster, as they provide a central location from which to share resources and services. If there were more grants to fund CTCs, there could be more programs at these centers designed for vulnerable populations. A pilot program could be launched to determine the best practices for setting up a CTC for better accessibility in a disaster. For CTCs to be more widely accepted and accessible, states and municipalitites should champion their development as a tool for building community capacity.

311 system with an assisted evacuation plan. When a 311 system, used in concert with an assisted evacuation plan is combined with GIS vulnerability mapping, it provides an even more robust system of identifying vulnerable populations and becomes much easier to establish ideal pickup points and target communities for affirmative outreach. This system worked extremely well in New Orleans during Hurricane Gustav. The 311 system works well during the preparedness, response, and recovery phases of a disaster. However, this technology system is most useful when implemented well before a disaster; citizens must be aware that the system exists and they must register before the service is needed. The pairing of the 311 system with an assisted evacuation plan is effective, but before launching this type of effort, municipalities must ensure that they have the necessary resources to actually carry out an assisted evacuation as promised.

Telephone/cell phone notification. A phone notification system that delivers voice and text messages is one of the most promising technologies for reaching people with emergency information during a disaster because it offers broad coverage rates due to the high number of the vulnerable members of society that report to have ready access to landline telephones or cell phones. The text or voice messages can be surgically targeted, can be delivered only to those citizens who register, and text messages, due to new GPS technologies, can even be directed to cell phones within a specific geographic area. Cell phone voice notification can be used along with text messaging notification, thus making the

message redundant and consistent with an expectation that citizens will be more likely to act on the repeated message. Some providers and phones also allow for multilingual and text-to-speech translation of messages. Although end users are equipped with the technology to receive messages, the capital investment to implement a computerized notification system in a municipality is costly. Telephone and cell phone notification is used during preparedness and response phases of a disaster. Before a program like this can be reach all citizens, especially the poorer members of a community, government officials must work with cell carriers to encourage them to provide free additional minutes and text messaging pre- and post-disaster. It is also important to note that there is a strong correlation between the use of phone notification system and age, with the younger members of a community being much more likely to adapt to them. There is alos a strong correlation between age and Internet use, with elderly people being the least likely to use computers and the Internet. (Browne, 2000).

Sirens/loudspeakers. Sirens and loudspeakers must be part of an integrated system and combined with an advertising campaign that informs people what to do when they hear a siren (i.e., go indoors, consult a television or radio for more information). Sirens and loudspeakers were used effectively for many decades during the response phase of a disaster. Just because they are not high tech, basic systems such as neighborhood or fire station sirens should not be disregarded, as they could be the only means of notification during a disaster that a vulnerable member of the community, such as a homeless person, receives.

Broad Principles for Technology Application and Community Capacity Building

As this complex research venture transpired, the consensus is that as community leaders, emergency managers, and government officials select appropriate technologies for informing vulnerable populations and increasing their disaster resiliency, they must strive towards adhering to the following broad principles to enhance the overall effectiveness of technology as a means for building resilience. Included are specific points regarding technology application, as well as critical approaches for building community capacity.

- ***Know your community's vulnerable populations.*** It is necessary to start with a clear understanding of the individual community's vulnerable part of the population. Where are more vulnerable citizens likely to reside? What community organizations are in touch with citizens who are more vulnerable? Community leaders, emergency managers, and planners must understand who the vulnerable members are, where they live, and what their challenges are in order to best select technologies that fit the community's needs. Leaders must also be aware of existing and proven ways of contacting and engaging vulnerable groups. One way in which technology serves this function is through the Community Vulnerability Assessments which are being done by emergency managers in many communities.[8] The Coastal Services Center, organized under NOAA, offers a CD-ROM version of their Community Vulnerability Assessment program. These risk and vulnerability assessments can be targeted to all levels of communities: national, neighborhood, or a specific network level, offering a snapshot view of vulnerabilities related to social networks, environmental factors, and economic concerns. Defining the locations of clusters of various vulnerable groups should be a part of any vulnerability assessment or included in an emergency operations plan. In fact, adding questions to the national examination for emergency managers related to identifying and communicating with disabled people could be an important step in changing the culture of emergency management, as the emergency management professional culture needs to embrace and use technology more effectively (Fox, White, Rooney, & Rowland, 2007; Marincioni, 2007). Having a thorough understanding of the more disadvantaged and vulnerable portion of the community will allow community leaders to shape programmatic approaches to enhance their region's resilience.

- ***Transmit clear and concise messages repeatedly.*** Information that is relayed through multiple sources or channels is more likely to result in action. Consistency across means and methods is equally important because messages from different sources should say the same thing. There is ample evidence that messages were unclear and ambiguous for the Hurricane Katrina evacuation (Eisenman, Cordasco, Asch, Golden, & Gilik, 2007). Messages should combine

[8] The Coastal Services Center provides a GIS-based tool for this purpose at http://www.csc.noaa.gov/rvat.

verbal and visual information when possible. Information must provide specific guidance, not generalities, to people to tell them what to do (e.g., not just "get ready"). Information must tell people why they should act on the guidance. For example, the message should name the consequences and point out that failure to take action will result in losses of life and/or property. The message should be "how actions can cut losses." In order for messages to be clear and consistent, it is important that the messenger and the person benefitting from the message receive education or training prior to the disaster, so there will be a clear understanding of the message content and context. It is important to merge person-to-person exchanges with those sustained through technology (Marincioni, 2007). Most emergency and disaster-related communication problems are the result of interpersonal or interorganizational communications rather than issues related to equipment (McEntire, 2007). Technologies must be implemented on a regional basis and programmatic approaches must be synchronized to ensure delivery of consistent messages. Information must be transmitted in a coordinated way, providing uniformity of instructions as well as coordinated timing of information releases. This is much easier to coordinate on a regional level versus a statewide or national level.

- ***Deliver messages via multiple channels and modes of communication.*** Consistency in delivering a message is important, as are frequency and redundancy of the message. If community members hear the same message on a TV news broadcast that they read in a cell phone text message, then the trust factor is increased, thus raising the call to take action. In order for messages to be consistent across all potential channels, it is important for standards to be set that instruct all tiers of government to use the same disaster terminology and evacuation instructions. This process will require mitigation and community education strategies. To uncover one ideal technology solution that could be interjected into any community would have been immeasurable for our research, but we determined early in the process that no singular mode of technology could meet the needs of each community. The case study indicates that cell phones are especially critical in reaching the vulnerable population, including renters and transients, but just because the role that cell phones can play is significant does not mean that they can be effective in the absence of auxiliary tools and technology. In the rush to embrace new technologies, it is important not to abandon low-tech means of communication, such as street signs, sirens, and public address system announcements. For some, this may be their only access to life-saving information. A multimedia approach is essential, and there is no single technology that alone can improve the outcome of a disaster. Collaborative emergency management across jurisdictions that uses a multimedia response is an important way of assuring that everyone is served. One prototype is the State of Florida response during the 2004 Florida hurricanes (Kapucu, 2008). Through the use of multiple disaster response Web sites, a state-coordinated operations center, and GIS mapping, the State orchestrated an

effective recovery initiative in the midst of a series of major storms in a two-month period. Their prototype confirms that the best advice is to not rely on any one technology alone, but to plan for redundancy (i.e., a "mixed bag of tools" that can be tailored to individual situations and needs).

- ***Project computer technology access into disadvantaged communities***. As more services and updates are accessible via Internet-based applications, it is critical that all members of a community have ready-access to a computer that has wireless, DSL, or broadband service. Internet access is the pipeline to many e-Gov and 311 services, as well as e-mail notifications. Many agencies and community-based informal networks frequently use e-mail as the vehicle to send out emergency notifications and alerts. CTCs serve as an excellent community resource for getting technology into the hands of all members of a community. Facilitating the strategic linkage of CTCs to large concentrations of vulnerable members of the community is important Not only do CTCs provide a hardware (wireless and/or wired) interface for citizens to access the Internet during all phases of a disaster, but they also serve as a vehicle for educating the public before a disaster on how to utilize computers. That education is important whether the vulnerable members of the population later access computers (and the Internet) onsite at the CTC or from their home computers. Issuing simple to use, low-cost, wireless laptop computers to members of a vulnerable population and installing temporary wireless towers during a disaster are two potential ways that communities can ensure that everyone is 'plugged in' to recovery information and services after a disaster.

- ***Mobilize community networks.*** Engage your community in developing its resilience by capitalizing on the community networks and organizations that can provide useful information and services in times of crisis and can contribute to the quality of life in general. It has been stated in an earlier section that making positive changes in communities is related to community members feeling some responsibility for the well-being of others which is the essence of building community capacity. Capacity is increased the more that community members experience working together in ways that improve community life. Research data shows that when disaster strikes many community members reach out to others and also that neighbors can influence one another to make life-saving decisions when there is a disaster (McEntire, 2007). Strengthening community networks or the connections between community members can be a significant force in disaster preparedness and response. In general, technology has an important place in contemporary connections among family members, friends, neighbors, and work associates. What is less clear is how vulnerabilities intervene in how people are connected. Because vulnerability can lead to more social isolation, a primary task certain community groups can take on is connecting vulnerable community members with other community members or with particular community organizations. Groups that already have connections

with vulnerable populations probably are not equipped to also deal in disaster preparedness, but because they are involved on some basis they represent a potential portal. And getting technology in the hands of those in most need requires a portal that is already functioning and hopefully trusted. An important desired outcome of the information/technology mix is to produce "milling." Mileti (1999) defines milling as conversations over time among people where they live, work, shop, eat, and socialize. He argues that causing people to think and talk about the information they are provided is more effective than just telling them what to do and that leaving them with enough information to encourage conversation is most effective. Social capital is enhanced as informal networks focus on critical issues not only when danger is imminent.

- ***Understand, exploit, and use technology to enable the "power" of a community***. Community can be considered as a place, a target, and a force for prevention and intervention (Mancini, Nelson, Bowen, & Martin, 2006). It has also been suggested that when there is a community crisis, any number of community groups emerge to support recovery, including selfless acts (altruistic community) and the accomplishment of new and unfamiliar tasks (Drabek & McEntire, 2003). Taking this view on community also uncovers leverage points for change and transformation. First, community should be considered as a place for prevention. Prevention and intervention efforts need to account for boundaries, because they signify resources such as agencies, faith-based organizations, and other close-knit groups, as well as deficits. If we consider community in a variety of ways (e.g., geographic, geopolitical, and social/emotional), we open up the roadmap available to professionals and their organizations who are working to improve community life, including the capacity to deal effectively with disasters. An ecology of the community emerges that peels back the layers of the community and shows sources of influence on people and their situations. Second, community can be viewed as a target for prevention and intervention. In this sense, the community capacity aspects of social organization focus on the development of informal social care networks to enhance community life and move closer to achieving desired results (recall the earlier discussion on how results play into the social organization framework). This approach points toward identifying and targeting community norms as they apply to specific issues (e.g., reliance on others in troubled times), which is a primary consideration in change. Third, community can be seen as a force for prevention and intervention. The social organization approach aims to facilitate the mobilization of community members (helping professionals and citizens) to enact change, to be in the lead on change rather than to be led toward change. Conceptualizing community as a place, a target, and a force, takes it from a passive location that is merely descriptive to an entity having potential to help articulate a roadmap for transformation, change, and capacity building. The articulation of leverage points in a community in part depends on how the community is viewed, understood, and defined. Disaster planning and

preparedness should include intentionality about how the community itself becomes a primary resource that can be accessed.

- ***Tailor technology application to facilitate collaborations that are broad-based and targeted.*** Collaboration across community networks and among various technologies is a significant aspect of building community resilience because the complexity of disasters requires complex responses that outdistance what any single organization can accomplish. No single agency or organization is equipped to single-handedly deal with a disaster, consequently collaboration and partnerships need to be in place to increase response effectiveness (and preparation effectiveness, for that matter). The discussion on social organization framework outlined network effects levels, the second and third levels involving collaboration, either between very similar networks or dissimilar networks. This collaboration engagement approach suggests that community leaders and community members can collectively approach disaster preparedness and ultimately have better prepared citizens (Mancini, 2007).

- ***Develop ongoing and proactive sustainability mechanisms.*** Effective risk communication is an ongoing process, not a single act. Therefore, choices in information technology must provide a sustainable stream over time, particularly within the pressing circumstances faced by many disadvantaged members of our society. Communities must be intentional about how they will "sustain" community resilience. All too often, initiatives are filled with high energy and focus early in their life cycles, but as time passes, so does the focus. Sustaining any community-based initiative relies on these elements: leadership competence, effective collaboration, understanding the community, maintaining focus on program results, strategic funding, program staff commitment, and initiative flexibility (Mancini & Marek, 2004). Sustainability is the *capacity* of a program or initiative to respond to community issues and its primary goal is to provide continued benefits to community members, regardless of particular activities, methods, or approaches. In the case of building community capacity as it pertains to disasters, specific technologies will change as new information is gained about which of them are best suited and most effective. What should remain consistent is the commitment and mechanisms whereby the most effective, specific technologies can be introduced into a community and ultimately accessed by the largest cross-section of the population possible.

Final Thoughts

The ultimate goal in hazard response and in building community resilience is to assist people in mobilizing their available capital in order to respond effectively. For many of the most vulnerable, network social capital is a most important resource. Technology can be critical to connecting them with friends and family. It is also essential to connecting them with the larger community and its resources. While it is very important to be forward thinking and strive to better connect vulnerable groups through technology services and tools, it is equally important to be proactive in identifying ways to address the circumstances that contribute to the vulnerability of specific groups, realizing that some attributes and situations are negotiable and changeable while others are static. Accounting for community social organization becomes a tool in that process. Employing a community social organization framework is the connection between technologies, natural and man-made disasters, and vulnerable community members. This discussion and analysis has centered on two questions:

- Which technologies hold promise for helping vulnerable groups best respond to and deal with disasters?

- How do we leverage these technologies to help mobilize communities to prepare for, respond to, and recover from disasters?

Resilient communities not only cope well with difficulties, but they also become better communities because of those difficulties. Consequently, being intentional about what contributes to building community capacity is essential. Moreover, communities in which certain groups are marginalized and socially excluded are less able to maintain resilience, and this becomes painfully obvious when there is a disaster. Though technology is not the panacea for social ills and disparities, when it involves having informed citizens who can fend for themselves and for others during a crisis, it emerges as a linchpin in connecting people and organizations that support them. Technology application, through community social organization, becomes a primary ally in building resilience, especially for the vulnerable members of the community.

References

American Red Cross (ARC), Providing safe and well information. (n.d.). Retrieved August 29, 2008, from American Red Cross (ARC): https://disastersafe.redcross.org/default.aspx

American Red Cross. (2008, September 29). Trio sells lemonade to raise disaster funds. Retrieved October 1, 2008, from The American Red Cross: http://www/redcross.org/article/printer/0,1075,0_312_8251,00.html

Bernstein, R. (2007, May 17). Minority population tops 100 million. Retrieved October 9, 2008, from U.S. Census Bureau News: www.census.gov/Press-Release/www/releases/archives/population/010048.html

Bolin, R., & Stanford, L. (1998). *The Northridge earthquake: Vulnerability and disaster.* London: Routledge.

Bonnette, R. (2003, May). Housing costs of renters. Retrieved September 3, 2008, from U.S. Census 2000: http://www.census.gov/prod/2003pubs/c2kbr-21.pdf

Boss, P. (2006). *Loss, trauma, and resilience: Therapeutic work with ambiguous loss.* New York: W.W. Norton.

Bowen, G., Orthner, D., Martin, J., & Mancini, J. A. (2001). *Building community capacity: A manual for U.S. Air Force family support centers.* Chapel Hill, NC: A Better Image Printing.

Brooks, M. (2006, May 15). Access to emergency alerts, Powerpoint presented to Third Conference on Information Systems for Crisis Response and Management. Retrieved August 24, 2008, from www.incident.com/access/images/a/ab/ISCRAM06_Brooks.ppt

Browne, H. (2000). Accessibility and usability of information technology by the elderly. Retrieved August 24, 2008, from unpublished paper: www.otal.umd.edu/uuguide/hbrowne

Canada's National Statistical Agency. (2006, August 15). Canadian Internet Use Survey. Retrieved July 30, 2008, from The Daily: http://www.statcan.ca/Daily/English/060815/d060815b.htm

Cantillon, D., Davidson, W., & Schweitzer, J. (2003). Measuring community social organization: Sense of comminity as a mediator in social disorganization theory. *Journal of Criminal Justice, 31*, 321–339.

Cellnumbers.com. (2007). Cell phone usage statistics. Retrieved September 25, 2008, from www.cellnumbers.com/cell-phone-usage.aspx

Chaskin, R. J., Brown, P., Venkatesh, S., & Vidal, A. (2001). *Building community capacity.* New York: Aldine DeGruyter.

Clinton, W. J. (1999, December 17). Memorandum for the heads of executive departments and agencies, Office of the Press Secretary Release. Retrieved September 12, 2008, from http://govinfo.library.unt.edu/npr/library/direct/memos/elecgovrnmnt.html

Chertoff, Michael (2007, December 17). Speech to the National Congress on Secure Communities. Washington, D.C.

CTIA The Wireless Association (2007). Wireless quick facts: Mid-year figures. Retrieved December 3, 2008, from www.ctia.org/advocacy/research/index.cfm/AID/10323

Cohen, S., Underwood, L. G., & Gottlieb, B. H. (Eds.). (2000). *Social support measurement and intervention: A guide for health and social scientists.* New York: Oxford.

Colten, C. E., Kates, R. W., & Laska, S. B. (2008). *Community resilence: Lessons from New Orleans and Hurricane Katrina.* CARRI Research Report 3, Community and Regional Resilience Initiative, Oak Ridge National Laboratory, Oak Ridge.

Community and Regional Resilience Initiative. (n.d.). CARRI [Fact Sheet]. Retrieved June 10, 2008, from Community and Regional Resilience Initiative (CARRI): www.resilientus.org/library/carri_fact_sheet_x1_june_2008_1222964548.pdf

Coordinated Assistance Network (CAN). (n.d.). About: CAN. Retrieved September 7, 2008, from CAN: www.can.org/about.htm

Cutter, S. L. (2001). *American hazardscapes: The regionalization of hazards and disasters.* Washington: National Academies Press.

Cutter, S., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., et al. (2008). *Community and regional resilience: Perspectives from hazards, disasters, and emergency management.* CARRI Research Report 1, Community and Regional Resilience Initiative, Oak Ridge National Laboratory, Oak Ridge.

Cutter, S. L., Boruff, B., & Shirley, W. (2003). Social vulnerability to environmental hazards. *Sociological Quarterly* (84), 242–261.

Cutter, S. L., Emrich, C., Mitchell, J., Boruff, B., Gail, M., Schmidtledin, M., et al. (2006). The long road home: Race, class, and recovery from Hurricane Katrina. *Environment: Science and Policy for Sustainable Development, 48* (2), 8–20.

Drabek, T. E., & McEntire, D. A. (2003). Emergent phenomena and the sociology of disaster: Lessons, trends and opportunities from the research literature. *Disaster Prevention and Management, 12* (2), 97–112.

Edwards, W. (2007, October). Resilient communities key to economic success. *CARRI News* , pp. 2–3.

Eisenman, D. P., Cordasco, K. M., Asch, S., Golden, J. F., & Gilik, D. (2007). Disaster planning and risk communication with vulnerable communities: Lessons from Hurricane Katrina. *American Journal of Public Health, 97* (Supplement 1), 09–15.

Enders, A., & Brandt, Z. (2007). Using geographic information system technology to improve emergency management and disaster response for people with disabilities. *Journal of Disability Policy Studies, 17* (4), 223–229.

Energy Information Administration (EIA). (2001). The effect of income on appliances in U.S. households. Retrieved August 24, 2008, from EIA: www.eia.doe.gov/emeu/recs/applicances/applicances.html

Erikson, K. T. (1994). *A new species of trouble: Explorations in disaster, trauma, and community.* New York: W. W. Norton & Company.

Evercare. (2008, July). Evercare 100@100 Survey: Report of findings. (GfK Roper Public Affairs and Media, Ed.) Retrieved September 2, 2008, from Evercare: www.evercarehealthplans.com/pdf/2008_Evercare_100@100_Survey.pdf

Faris, R., Bizelli, J., Hoyt, A., & Sullivan, C. (2005). *Disaster preparedness for human services: A GIS vulnerability index.* Technical Paper in 2005 ESRI User Conference Proceedings.

Federal Emergency Management Agency (FEMA). (2008, August). Interim emergency management planning guide for special needs populations. Retrieved September 7, 2008, from Federal Emergency Management Agency (FEMA): www.fema.gov/news/newsrelease.fema?id=45435

Fernandez, L. S., Byard, D., Lin, C.-C., Benson, S., & Barbera, J. A. (2002). Frail elderly as disaster victims: Emergency management strategies. *Prehospital and Disaster Medicine, 17* (2), 67–74.

Fox, M., White, G. W., Rooney, C., & Rowland, J. L. (2007). Disaster preparedness and response for persons with mobility impairments. *Journal of Disability Policy Studies, 17* (4), 196–205.

Furby, P., Coben, J. H., Smyth, S. K., Manley, W. G., Summers, D. E., Sanddal, N. D., et al. (2006). Realities of rural emergency medicial services disaster preparedness. *Prehospital and Disaster Medicine, 21* (2), 64–70.

Furstenberg, F. F., & Hughes, M. E. (1997). The influence of neighborhoods on children's development: A theoretical perspective and a research agenda. In J. Brooks-Gunn, G. J.

Duncan, & J. L. Aber (Eds.), *Neighborhood poverty (Vol. 2): Policy implications in studying neighborhoods* (pp. 23–47). New York: Russell Sage Foundation.

Garshnek, V., & Burkle, F. M. (1999). Applications of telemedicine and telecommunications to disaster medicine: Historical and future perspectives. *Journal of American Medical Informatics Association, 6* (1), 26–37.

George Mason University. (2008, October 27). Nearly half of the US states fail on emergency plan communication, new study shows. Retrieved September 4, 2008, from www.sciencedaily.com/releases/2008/10/081023113101.htm

Gladwin, H., & Peacock, W. G. (1997). Warning and evacuation: A night for hard houses. In W. G. Peacock, B. H. Morrow, & H. Gladwin (Eds.), *Hurricane Andrew: Ethnicity, gender, and the sociology of disasters* (pp. 54–74). London: Routledge.

Goodman, R., Speers, M., McLeroy, K., Fawcett, S., Kegler, M., & Parker, E. (1998). Identifying and defining the dimensions of community capacity to provide a basis for measurement. *Health Education & Behavior, 25*, 258–278.

Government of South Australia Department of Families and Communities. (2004). National principles for disaster recovery [Brochure]. Retrieved September 3, 2008, from Government of South Australia: www.familiesandcommunities.sa.gov.au/default.aspx?tabid=1549

Janowitz, M. (1991). *On social organization and social control.* (J. Burke, Ed.) Chicago: University of Chicago Press.

Johnson, L. L., II. (2008, August 18). Free cell phones offered to low-income Tennessee residents, AP release. Retrieved September 12, 2008, from www.youcanhearmenow.com/?p=120

Jones, N. L. (2005). The Americans with Disabilities Act and emergency preparedness and response. Congressional Research Service Report RS22254. Retrieved September 4, 2008, from www.ncesonline.org/NLE/CRSreports/06Jul/RS22254.pdf

Kapucu, N. (2008). Collaborative emergency management: Better community organising, better public preparedness and response. *Disasters, 32* (2), 239–262.

Kasarda, J. D., & Janowitz, M. (1974). Community attachment in mass society. *American Sociological Review, 39*, 328–339.

Kretzmann, J. P., & McKnight, J. L. (1993). *Building communities from the inside out.* Chicago: ACTA.

Laska, S., & Morrow, B. H. (2006). Social vulnerabilities and Hurricane Katrina: An unnatural disaster in New Orleans. *Marine Technology Society Journal, 40* (4), 16–26.

Lasker, R. D. (2004). *Redefining readiness: Terrorism planning through the eyes of the public.* New York: New York Academy of Medicine.

Luxembourg Income Study. (2004). Luxembourg Income Study (LIS). Retrieved March 3, 2008, from LIS: www.lisproject.org

Mancini, J. A. (2007, November). *Building community capacity: A collaboration engagement framework.* Annual meeting of the United Kingdom Evaluation Society, Leeds, England.

Mancini, J. A., Bowen, G. L., & Martin, J. A. (2005). Community social organization: A conceptual linchpin in examining families in the context of communities. *Family Relations: Interdisciplinary Journal of Applied Family Studies, 54*, 570–582.

Mancini, J. A., Bowen, G. L., Ware, W. B., & Martin, J. A. (2007). Engagement, participation, and community efficacy: Insights into social organization. Hawaii International Meeting on the Social Sciences. Honolulu.

Mancini, J. A., Huebner, A. J., McCollum, E. E., & Marek, L. I. (2005). Program evaluation science and family therapy. In D. H. Sprenkle & F. P. Piercy (Eds.), *Research methods in family therapy* (2nd ed.) (pp. 272–293). New York: Guilford.

Mancini, J.A., & Marek, L.I. (2004). Sustaining community-based programs for families: Conceptualization and measurement. *Family Relations: Interdisciplinary Journal of Applied Family Studies, 53,* 339–347.

Mancini, J. A., Martin, J. A., & Bowen, G. L. (2003). Community capacity. In T. P. Gullotta & M. Bloom (Eds.), *Encyclopedia of primary prevention and health promotion* (pp. 319–330). New York: Kluwer Academic/Plenum.

Mancini, J. A., Nelson, J. P., Bowen, G. L., & Martin, J. A. (2006). Preventing intimate partner violence: A community capacity approach. *Aggression, Maltreatment, and Trauma, 13* (3/4), 203–227.

Marincioni, F. (2007). Information technologies and the sharing of disaster knowledge: The critical role of professional culture. *Disasters, 31* (4), 459–476.

Mayhorn, Christopher B. (2005). Cognitive Aging and the Processing of Hazard Information and Disaster Warnings. *Natural Hazards Review, 6* (4): 165-170.

Mayunga, J. S. (2007, May). *Understanding and applying the concept of community disaster resilience: A capital-based approach.* Paper delivered at 2007 Summer Academy. Megacities: Social Vulnerability and Resilience Building, Munich, Germany. Retrieved on May 5, 2008, from www.ehs.unu.edu/file.php?id-349

McCubbin, H. I., & Patterson, J. M. (1983). The family stress process: The double ABCX model of adjustment and adaptation. *Marriage and Family Review, 6*, 7–37.

McEntire, D. A. (2007). *Disaster response and recovery: Strategies and tactics for resilience.* New York: Wiley.

McMahon, P. (2002, March 5). 311 Lightens load for swamped 911 centers. Retrieved July 30, 2008, from USA Today: www.usatoday.com/news/nation/2002/03/05/usat-311.htm

Microsoft. (2007, October 29). Microsoft, Miami offer seniors free computer training, customized PCs. Retrieved September 4, 2008, from Microsoft PressPass: www.microsoft.com/presspass/press/2007/oct07/10-29eSeniorsPR.mspx

Mileti, D. S. (1999). *Disasters by design: A reassessment of natural hazards in the United States.* Washington, DC: Joseph Henry Press.

Mileti, D. S., & Kuligowski, E. (2003, June 2). Changing People's Readiness Behavior. PowerPoint presentation given at the FEMA 11th Annual Emergency Management Higher Education Conference in Emmitsburg, MD.

Minutes of New Orleans' Elderly Evacuation Working Group Meeting attended by John Kiefer, Ph.D. (2008, October 28). Held at University of New Orleans . New Orleans, Lousiana.

Moore, L. K. (2008). The emergency alert system (EAS) and all-hazard warnings. Retrieved August 25, 2008, from University of North Texas Libraries: http://digital.library.unt.edu/govdocs/crs/permalink/meta-crs-9904

Morrow, B. H. (1999). Identifying and mapping community vulnerability. *Disasters, 23* (1), 1–18.

Morrow, B. H. (2008). *Community resilience: A social justice perspective.* Community and Regional Resilience Initiative, Oak Ridge National Laboratory, Oak Ridge, TN.

Nagesh, G. (2008, August 27). DHS unveils wireless radio for emergency response. Retrieved September 12, 2008, from Nextgov—Technology and the Business of Government: www.nextgov.com/nextgov/ng_20080827_1113.php

National Center for Accessible Media (NCAM). (2006, February). Access to emergency alerts for people with disabilities. Retrieved September 2, 2008, from National Center for Accessible Media (NCAM): http://ncam.wgbh.org/alerts/fgroupsummary.html

National Council on Disability. (2005, April 15). Saving lives: Including people with disabilities in emergency planning. Retrieved August 24, 2008, from National Council on Disability Newsroom: www.ncd.gov/newsroom/publications/2005/saving_lives.htm

National Research Council. (2006). *Facing hazards and disasters: Understanding human dimensions.* Washington: National Academies Press.

National Telecommunications and Information Administration & U.S. Department of Commerce (NTIA/DOC). (2000). Falling through the Net: Toward digital inclusion. Retrieved August 25, 2008, from National Telecommunications and Information Administration (NTIA) & U.S. Dept. of Commerce (DOC): www.ntia.doc.gov/ntiahome/fttn00/Falling.htm

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology, 41*, 127–150.

Orthner, D. K., & Bowen, G. L. (2004). Strengthening practice through results management. In A. R. Roberts & K. Yeager (Eds.), *Handbook of practice based research* (pp. 897–904). New York: Oxford University Press.

Pastor, M., Bullard, R. D., Boyce, J. K., Fothergill, A., Morello-Frosch, R., & Wright, B. (2006). *In the wake of the storm: Environment, disaster, and race after Katrina.* New York: Russell Sage Foundation.

Pate, B. L. (2008). Identifiying and tracking disaster victims: State-of-the-art technology review. *Family & Community Health, 31* (1), 23–24.

Perez, M. (2008, September 2). Wireless carriers prepared for Hurricane Gustav. *Information Week*.

Pezzoli, K., Tukey, R., Sarabia, H., Zaslavsky, I., Miranda, M. L., Suk, W. A., et al. (2007). The NIEHS environmental health sciences data resource portal: Placing advanced technologies in service to vulnerable communities. *Environmental Health Perspectives, 115* (4), 564–571.

Portland Press Herald. (2005, March 12). NCAM access alerts—Subject-related articles. Retrieved August 24, 2008, from National Center of Accessible Media (NCAM): ncam.wgbh.org/alerts/articles/maine.html

Providing Access to Resilience-Enhancing Technologies (PARET) Project research team visit to Miami-Dade Emergency Operations Center. (2008, October 14). Miami, FL.

Putnam, R. D. (2000). *Bowling alone.* New York: Simon & Schuster.

Putt, A. (1981). *Putt's law and the successful technocrat.* Smithtown, New York: Exposition Press.

Quarantelli, E. L. (1997). Problematic aspects of the information/communication revolution for disaster planning and research: Ten non-technical issues and questions. *Disaster Prevention and Management, 6* (2), 94–106.

Rainie, L., & Keeter, S. (2006, April). Pew Internet project data memo. Retrieved September 4, 2008, from Pew/Internet: www.pewinternet.org/pdfs/PIP_Cell_phone_study.pdf

Reed, B. (2008). Broadband said to hit 77% of US households by 2012. Retrieved September 8, 2008, from PC World: www.pcworld.com/printable/article/id_148978/printable.html

Reuters. (2008, July 21). Experts to outline the three key things seniors need to know now about using cell phones to be safer. Retrieved September 8, 2008, from Reuters: www.reuters.com/article/pressRelease/idUS119867+21+Jul-2008+PRN20080721

Rice, R., & Katz, J. (2003). Comparing Internet and mobile phone usage: Digital divides of usage, adoption, and dropouts. *Telecommunications Policy, 27* (8–9), 597–623.

Ripley, A. (2008, September 3). Why disasters are getting worse. Retrieved September 4, 2008, from Time in Partnership with CNN: www.time.com

Sampson, R. J. (2003). The neighborhood context of well-being. *Perspectives on Biology and Medicine, 46* (3 supplement), 553–564.

Schoch-Spana, M. (2008). Community resilience for catastrophic health events. *Biosecurity and Bioterrorism: Biodefense Strategy, Practice and Science, 6* (2), 129–130.

Science Daily. (2007, November 1). Digital grandparents: Computer scientists create new technology for elderly home owners [Science Video]. Retrieved August 24, 2008, from Science Daily: http://www.sciencedaily.com/videos/2007/1102-digital_grandparents.htm

Shankar, K. (2008). Wind, water, and wi-fi: New trends in community informatics and disaster. *The Information Society, 24*, 116–120.

Shin, H. B., & Bruno, R. (2003, October). Language use and English-speaking ability. *Census 2000 Brief*.

Small, S., & Supple, A. (2001). Communities as systems: Is a community more than the sum of its parts? In A. Booth & A.C. Crouter (Eds.), Does it take a village? Community effects on children, adolescents, and families. (pp. 161-174). Mahwah, NJ: Erlbaum.

Spence, P., Lachlan, K. Q., & Griffin, D. R. (2007). Crisis, communication, race, and natural disasters. *Journal of Black Studies, 37* (4), 539–555.

Sullivan, N. P. (2007). *You can hear me now.* Hoboken: Wiley.

Tech-On! (2007, November 5). *New* Japanese phones offer earthquake early warning alerts. Retrieved September 4, 2008, from MobileMentalism: mobilementalism.com/2007/11/19/new-japanese-phones-offer-earthquake-early-warning-alerts

The Heinz Center. (2002). Human links to coastal disasters. Retrieved from The H. John Heinz III Center for Science, Economics, and the Environment: http://www.heinzctr.org/publications/PDF/Full_report_human_links.pdf

Troy, D. A., Carson, A., Vanderbeek, J., & Hutton, A. (2007). Enhancing community-based disaster preparedness with information technology. *Disasters, 32* (1), 149–165.

U.S. Census Bureau. (2000). Historical census of housing tables: Living alone. Retrieved September 9, 2008, from U.S. Census Bureau: Census of Housing: www.census.gov/hhes/www/housing/census/historic/livalone.html

U.S. Department of Justice. (n.d.). An ADA guide for local government: Making community emergency preparedness and response programs accessible to people with disabilities. Retrieved August 25, 2008, from Emergency Preparedness Guide: www.ada.gov/emerprepguideprt.pdf

Waldrop, J., & Stern, S. M. (2003, March). Disability status: 2000. Retrieved from Census 2000: http://www.census.gov/prod/2003pubs/c2kbr-17.pdf

Web Accessibilty Initative (WAI). (2008, October). Evaluating Web sites for accessibility: Overview. Retrieved September 8, 2008, from Web Accessibilty Initative (WAI): www.w3.org/WAI/eval/Overview.html

Weiss, C. H. (1995). Nothing as practical as good theory: Exploring theory-based evaluation for comprehensive community initiatives for children and families. In J.P. Connell, A.C. Kubisch, L.B. Schorr, & C.H. Weiss (Eds.), *New approaches to evaluating community initiatives: Concepts, methods, and contexts* (pp. 65–92). Washington DC: Aspen Institute.

West, D. M., & Orr, M. (2007). Race, gender, and communications in natural disasters. *The Policy Studies Journal, 35* (4), 569–586.

Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2007). *At risk: Natural hazards, people's vulnerability and disasters* (2nd ed.). London: Routledge.

Zakour, M. J., & Harrell, E. B. (2003). Access to disaster services: Social work interventions for vulnerable populations. *Journal of Social Science Research, 32* (2), 27–54.

Zarcadoolas, C., Boyer, J., Krishnaswami, A., & Rotenberg, A. (2007). GIS maps to communicate emergency preparedness: How useable are they for inner city residents? *Journal of Homeland Security and Emergency Management, 4* (3).

Appendix A: Community and Regional Resilience Initiative

Oak Ridge National Laboratory's (ORNL) Community and Regional Resilience Initiative (CARRI) is a program of the Congressionally funded Southeast Region Research Initiative. CARRI is a regional program with national implications for how communities and regions prepare for, respond to, and recover from catastrophic events. CARRI will develop the processes and tools with which communities and regions can better prepare to withstand the effects of natural and human-made disasters by collaboratively developing an understanding of community resilience that is accurate, defensible, welcomed, and applicable to communities across the region and the nation.

CARRI is presently working with three partner communities in the Southeast: Gulfport, Mississippi; Charleston/Low Country, South Carolina; and the Memphis, Tennessee, urban area. These partner communities will help CARRI define community resilience and test it at the community level. Using input from the partner communities, lessons learned from around the nation, and the guidance of ORNL-convened researchers who are experts in the diverse disciplines that comprise resilience, CARRI will develop a community resilience framework that outlines processes and tools that communities can use to become more resilient. Of critical importance, CARRI will demonstrate that resilient communities gain economically from resilience investments.

From its beginning, CARRI was designed to combine community engagement activities with research activities. Resilient communities are the objective, but research is critical to ensure that CARRI's understanding is based on knowledge-based evidence and not just ad hoc ideas—we want to get it right. To help with this, CARRI has commissioned a series of summaries on the current state of resilience knowledge by leading experts in the field. This kind of interactive linkage between research and practice is very rare.

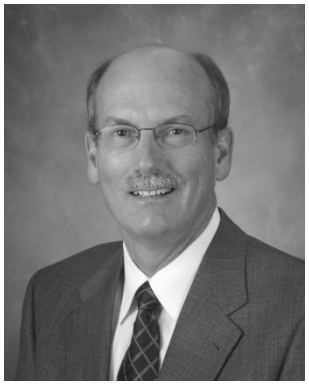
In addition to its partner communities and national and local research teams, CARRI has established a robust social network of private businesses, government agencies, and non-governmental associations. This network is critical to the CARRI research and engagement process and provides CARRI the valuable information necessary to ensure that we remain on the right path. Frequent conversation with business leaders, government officials, and volunteer organizations provide a bottom-up knowledge from practitioners and stakeholders with real-world, on-the-ground, experience. We accept that this program cannot truly understand community resilience based only on studies in a laboratory or university. CARRI seeks to expand this social network at every opportunity and gains from each new contact.

www.resilientUS.org

Appendix B: Project Team

Dr. John J. Kiefer is Assistant Professor of Political Science and Public Administration at the University of New Orleans (UNO). His role in the PARET Project was to explore existing and future information technologies that may prove useful for improving the resilience of vulnerable populations to disasters. His research has been published in *Public Administration Review*, the *Journal of Emergency Management*, *Public Works Management and Policy*, and the *Journal of the Global Awareness Society International*. As a faculty associate at UNO's Center for Hazard Assessment Response and Technology, Dr. Kiefer participates on several interdisciplinary, FEMA-funded research teams studying flood loss and disaster resilience. He has been principal evaluator for a broad range of programs funded by the U.S. Department of Education, the State of Louisiana, and several cities. He has delivered numerous papers and chaired panels at professional meetings in the United States and Canada. Dr. Kiefer serves on the Executive Board of the Section on Crisis and Emergency Management of the American Society for Public Administration and on the Executive Board of the Southeastern Conference for Public Administration. His current research interests include hazard policy, emergency management, and program evaluation. Prior to entering academe, Dr. Kiefer served for over 20 years as an active duty Marine officer, retiring in 1996.

Dr. Jay A. Mancini is a Professor of Human Development and the Senior Research Fellow at the Institute for Society, Culture and Environment at Virginia Polytechnic Institute and State University (Virginia Tech). His role in the PARET Project was to consult on community social organization and building community capacity. His research and theorizing on community systems has focused on prevention of intimate partner violence, health and well-being, and family support systems. Dr. Mancini's current research focuses on sustaining community-based programs for at-risk families, the effects of deployment on youth in military families, and on social exclusion and homelessness among veterans. He also recently consulted with social service professionals in New Orleans and Mississippi on sustaining family support programs in the aftermath of Hurricane Katrina. He conducts cross-national research with colleagues in the United Kingdom. All of his research and theoretical work concerns vulnerable families and communities. Dr. Mancini is a Fellow of the National Council on Family Relations, and a Fellow of the World Demographic Association. He received the 2007 Distinguished Alumni Service Award from the University of North Carolina at Greensboro and the 2008 Distinguished Alumni Research Award from the College of Human Ecology at Kansas State University. He is the editor (with Karen A. Roberto) of *Human Development Across the Lifespan: Antecedents, Processes, and Consequences of Change* (Lexington Books).



Dr. Betty Hearn Morrow is Professor Emeritus in Sociology at Florida International University and former director of the Laboratory for Social and Behavioral Research at the International Hurricane Research Center. Her contribution to the PARET Project was in the area of vulnerable populations and their access to technologies used in disaster response. Her research focuses on improving the disaster resiliency of individuals, households, and communities, with special emphasis on overcoming disadvantages created by economic, social, cultural, and/or physical factors. Retired from academia, Dr. Morrow continues an active research agenda as a consulting sociologist for many public entities, such as the National Weather Service, Coastal Services Center, Federal Coordinator of Meteorology, University Corporation for Atmospheric Research, and Oak Ridge National Laboratories. Much of her work focuses on warning messages and disaster response, including a current project (with National Center for Atmospheric Research [NCAR] and the University of Oklahoma), *Communicating Hurricane Information*, funded by the National Science Foundation. She edited (with Brenda Phillips) *Women and Disasters: From Theory to Practice* , (with Elaine Enarson) *The Gendered Terrain of Disaster*, (with Walter Peacock and Hugh Gladwin) *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disaster*. Her most recent professional service includes serving on the Transportation Research Board's Committee on the Role of Public Transportation in Emergency Evacuation, the Advisory Board of the NCAR Societal Impacts Program, and on the editorial boards of the *Natural Hazards Review* and *Environmental Hazards*. She is a recipient of the Mary Fran Myers Award from the *Gender and Disaster Network*.

Dr. Hugh Gladwin is the Director of the Institute of Public Opinion Research (IPOR) at Florida International University (FIU) where he is also Associate Professor of Sociology and Anthropology. Dr. Gladwin's role in the PARET Project was to study populations and responses to disaster, as well as design, direct, and analyze a phone survey of 500+ socioeconomically disadvantaged households in Charleston, South Carolina. The analysis of the survey provided new information on the utilization of technology by vulnerable populations to sustain themselves in disaster situations. His related research areas of interest include ethnicity and gender issues related to disaster, studying and modeling values and decision-making in culturally diverse settings, and research on socioeconomic and public opinion factors in adaptation to and mitigation of climate change. As Director and Lead Researcher at IPOR he has developed its capabilities as a provider of sound GIS-based analysis procedures, sample designs, call procedures, and multi-mode survey methods. With Betty Morrow and Walter Gillis Peacock, he edited the book *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disaster*, one of many social science hurricane studies produced by their research group at FIU that began work immediately after Hurricane Andrew in 1992. Most recently he has received two grants from the National Science Foundation to begin in January 2009 studying and modeling communication of and response to hurricane forecasts and evacuation orders.

Terina Stewart is a Project Manager and Research Associate at the Institute for Advanced Biometrics and Social Systems Studies, a component of Oak Ridge Associated Universities, in Oak Ridge, Tennessee. Her role in the PARET Project was to provide project oversight and management of the collaboration team, as well as serve as a contributing author and technical editor. Her project management experience includes co-managing a flight training and simulation instruction contract through the U.S. Department of Defense for the 160th Special Operations Aviation Regiment at Fort Campbell, Kentucky. More recently, she was responsible for coordinating company-wide product rollouts and implementations, as well as managing an annual procurement budget of over $30 million and was instrumental in managing public relations efforts for the Smart Eating campaign at the international support services center for Ruby Tuesday, Inc. in Maryville, Tennessee. She has a Bachelor of Art degree in communications with a minor in technical English from Jacksonville State University in Alabama.

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Family and Community Research Laboratory, Department of Human Development, Virginia Polytechnic Institute and State University

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Rita Durst, Coordinator, Research Programs

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Johelen Stephenson, Freelance Editor, Oak Ridge, Tennessee

Appendix C: Target Technology Matrix

						Would this technology help in…			
Technology Name	Description	How Do We Create Penetration of Technology? What Members of the Community Network Would Have to Be Involved?	Currently Available in Community YES or NO	Capital Needed to Implement	Requirements	Anticipating Event	Reducing Vulnerabilities	Response	Recovery
E-Government	Use of Web sites and a variety of other electronic means for government contact with individuals	Would require access, registration, etc; a long-term process. Generally results in community power shifts -- less power to technology challenged populations, more power to technology literate. Requires significant commitment of governments, agencies and private sectors.	In some capacity	Significant	Computer + Web Access	*	*	*	*
Text messages via cell phone	Owners of cell phones can receive communications about emergencies	Municipal offices of emergency management; private sector	Yes	Minimal	Cell phone	*	*	*	*
AM/FM and dedicated weather radios	Owners receive emergency weather station warnings	Private sector, National Weather Service	Yes	Minimal	Radio + battery power	*			
Reverse 911 service	Requires database and land-line phone service for all.	Municipal government; sometimes private contractor	Yes	Expensive	Telephone landlines	*	*	*	
311 system	Requires registration process and ongoing database verification	Municipal government; private contractor	Yes	Low to significant, depending on level of service to be provided.	Any phone (landline or cell phone), fax, e-mail, text messgaging	*	*		
311 system PLUS– http://www.responseforce1.com/ or Connect-CTY or FirstCall	Generally dependent on trust that 311 system (used for a broad range of city service connections between city and citizens) will provide accurate and timely information. Some problems in New Orleans when citizens are referred to numbers or offices that don't respond.	Municipal government; private contractor	Yes	Moderate	Any phone (landline or cell phone), fax, e-mail, text messaging	*	*		

						Would this technology help in…			
Technology Name	Description	How Do We Create Penetration of Technology? What Members of the Community Network Would Have to Be Involved?	Currently Available in Community YES or NO	Capital Needed to Implement	Requirements	Anticipating Event	Reducing Vulnerabilities	Response	Recovery
Weather alert siren	Old fashioned siren	Municipal government; public service announcements	Yes	Minimal	Possible upgrades to current systems	*	*		
GIS	An organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, integrate, analyze, and display all forms of geographically referenced information.	Municipal governments; commercial vendors	Yes	Minimal	Appropriate GIS skills and accurate database requiring ongoing updates	*	*	*	*
Emergency Alert System (EAS)	Transmits warnings from the National Weather Service. EAS is a national initiative of over 13,000 radio, television and cable systems that voluntarily organize and plan for warning of local communities.	Currently the most effective technology for passing emergency information. Reliant upon National Weather Service and local broadcast stations. Future generations of digital TVs and radios will be able to turn themselves on when emergency broadcast is issued. That technology is, however, several years away.	Yes, except for digital signaling, which is several years in the future.	National level implementation.	Television, radio, electricity, signaling station	*	*	*	
Intercoms, teletypewriters, telephone devices and strobe lights	These systems warn deaf people and people in large buildings. However, they have limited use and do not warn a large number of people.	Advocacy groups, OSHA?	Yes	Minimal		*	*		

Technology Name	Description	How Do We Create Penetration of Technology? What Members of the Community Network Would Have to Be Involved?	Currently Available in Community YES or NO	Capital Needed to Implement	Requirements	*Would this technology help in…* Anticipating Event	Reducing Vulnerabilities	Response	Recovery
Loud speakers, door-to-door notification, and weather radio	Police can drive through neighborhoods and use bullhorns and speakers to broadcast warnings. However, they have the same drawback as sirens in that they warn a limited number of people, and people inside may not hear the warning.	Police & fire	Yes	Minimal		*	*		
Community Technology Center (CTC)	Promotes community change by making information technologies more accessible. Provides technology access and education to vulnerable populations. Provides resources to help bridge digital divide through public access to computers and the Internet.	Develops specific disaster focus for vulnerable populations through partnership with CTCnet, a non-profit association. May also be a partnering opportunity in limited number of states that have similar state organizations.	Limited	Minimal to moderate	Computer + Web access; volunteers with moderate computing skills to act as trainers.	*	*		*
Television	Most widely used source of information before, during, and after a disaster.	Already enjoys most significant level of penetrations	Yes	Minimal	Television and power source	*	*		*

"*" indicates yes; "blank" indicates no.

Appendix D: Telephone Notification Companies and Siren Vendors

Provided below is a non-exhaustive list of telephone notification companies:

http://www.amcomsoft.com/notification.cfm
http://www.athoc.com/AtHocSite/default.asp
http://www.coderedweb.com/
http://www.codespear.com/MassCitizenAlert_4679.aspx
http://www.dccusa.com/high-speed-notification.asp
http://emtel911.com/
http://www.enera.com/
http://www.e2campus.com/
http://www.group2call.com/
http://www.madah.com/
http://www.messageone.com/crisis-communications/
http://ntigroup.com/
https://www.onecallnow.com/index.asp
http://www.redalertsystem.com/
http://www.reverse911.com/index.php
http://www.sendwordnow.com/crisis_communications.aspx
http://www.swiftreach.com/srn2/
http://www.teleminder.com/
http://www.tfcci.com/
http://www.tti.net/
http://www.3nonline.com/

Provided below is a non-exhaustive list of siren vendors:

http://www.americansignal.com/
http://www.atisystem.com/
http://www.federalwarningsystems.com/
http://www.hormannamerica.com/
http://www.klaxonsignals.com/
http://www.sentrysiren.com/
http://www.whelen.com/

Appendix E: Telephone Survey Methodology and Findings

Telephone Survey Data Collection

A telephone survey of persons 18 and older living in Charleston, South Carolina was initiated to measure present and potential technology use and other factors related to disaster vulnerability. The sample design provided a contrast between lower income and more affluent residents. A two-part random probability sample was generated for telephone exchanges centered in downtown Charleston, an area identified as having a high proportion of rental and minority households. The first part used a random-digit-dial (RDD) sample for which random numbers were generated for these telephone exchanges. This ensured that all land-line phones in the study area had an equal likelihood of being selected. The second part of the sample consisted of address-listed telephone numbers located in lower-income areas of the city. This was done because Charleston, like many coastal cities, has low income and affluent areas living in close proximity, and it was important to get interviews from lower income areas due to the correlation between low socioeconomic status and vulnerability.

The questionnaire was developed interactively by the project team and underwent testing through mock interviews and feedback from experienced interviewers at the Institute for Public Opinion Research (IPOR). The IPOR interviewers, many of whom had previous experience working on hurricane-related studies, were able to conduct the survey in English or Spanish. The interviewing process began on September 25 and was completed on October 11, 2008. While 600 interviews were conducted, further investigation revealed that a few from the RDD sample were located outside of Charleston; thus 34 interviews were not used, resulting in a final sample of 566 interviews. This sample size gives the overall study a margin of error of plus or minus 4.0% at a 95% confidence interval. This indicates that 95 out of 100 times a repeated survey of this Charleston population with the same sample size would produce results within a 4% margin (more or less) of the results in this survey.

To complete the original 600 interviews, interviewers called 17,310 telephone numbers. Each number received up to ten callbacks to resolve its status. The final results of numbers called are listed in table 1 below.

Table 1: **Results of Numbers Called for Charleston, SC Phone Survey**

17310	Total phone numbers called
8390	Phone numbers that were disconnected or were businesses, fax machines, or non-residents
630	Phone numbers that were busy
2854	Phone numbers were answered by answering machines and we did not leave a message
3476	Phone rang, but was never answered
1226	Initial refusals – not interviewed
34	Call not completed due a mid-call termination
222	A call back was scheduled, but interviewer was unable to reach
600	Total number of completed phone interviews

In telephone surveys answering machines, phones not answered, numbers that are always busy, and incomplete call-backs, and refusals must always be considered potential sources of bias. Calls that terminate mid-survey are the most serious problem because respondents may make a decision not to continue based on the subject matter of the survey, thus their responses would have been important. In this case, the call results do not indicate a problem in terms of a non-response bias related to the subject matter of the survey. On the other hand, initial refusals and answering machines not picked up are likely to lead to a bias in the demographics of the final sample. Many studies have shown that women and older people are more likely to complete telephone interviews than men or younger people. The normal procedure to adjust for this bias is to weight the survey results using current census figures for age and gender. Weighting for this survey used gender and four distinct age category figures from the 2007 American Community Survey (ACS). All the results from the survey in this report use weighted estimates.

Telephone Survey Questionnaire with Response Frequencies

1. Do you have at least one television in your home?

Total	Answer
97.1%	YES
2.9%	NO
100.0%	

2. Do you get regular channels on a TV that uses an antenna or do you have cable or satellite channels?

Total	Answer
15.0%	ANTENNA TV
85.0%	CABLE/SATELLITE
100.0%	

3. Do you have regular wired telephone service?

Total	Answer
97.2%	YES
2.8%	NO
100.0%	

4. Do you have a cell phone?

Total	Answer
70.5%	YES
29.5%	NO
100.0%	

5. Do you use text messaging?

Total	Answer
48.1%	YES
51.9%	NO
100.0%	

6. Does anyone else in your household, besides you, have a cell phone?

Total	Answer
66.6%	YES
26.2%	NO
7.2%	I LIVE ALONE
100.0%	

7. Do they use text messaging?

Total	Answer
67.4%	YES
32.6%	NO
100.0%	

8. Do you have a computer in your home?

Total	Answer
59.2%	YES
40.8%	NO
100.0%	

9. Can you connect to the Internet?

Total	Answer
91.70%	YES
8.30%	NO
100.00%	

10. How do you usually connect to the Internet?

Total	Answer
11.6%	DIAL-UP MODEM
37.2%	DSL
48.1%	CABLE
3.1%	OTHER
100.0%	

11. Does your computer have wireless capability?

Total	Answer
56.0%	YES
44.0%	NO
100.0%	

12. How do you rate your skill level with a computer?

Total	Answer
24.7%	BEGINNER
52.6%	INTERMEDIATE
22.7%	EXPERT
100.0%	

13. Do you have a NOAA weather radio, that is, a special radio that broadcasts weather and emergency alerts?

Total	Answer
23.4%	YES
76.6%	NO
100.0%	

14. Do you have a battery-powered radio in your home that you could use if the power was out?

Total	Answer
75.7%	YES
24.3%	NO
100.0%	

15. If a hurricane was threatening the Charleston area, how would you expect to get information about it? Answer yes or not regarding whether you have this source of information available to you.

Total	Answer
25.5%	TV
20.6%	RADIO
9.1%	INTERNET SITES
9.4%	PEOPLE IN YOUR HOUSEHOLD
8.5%	PEOPLE AT WORK
7.4%	CHURCH
1.9%	ANOTHER PLACE
10.0%	PEOPLE YOU TALK TO ON THE PHONE
5.3%	E-MAIL FROM OTHER PEOPLE
2.3%	SOME OTHER WAY, SPECIFY
100.0%	

16. Which is most important?

Total	Answer
68.4%	TV
15.7%	RADIO
5.6%	INTERNET SITES
2.6%	PEOPLE IN YOUR HOUSEHOLD
0.9%	PEOPLE AT WORK
0.5%	CHURCH
1.6%	PEOPLE YOU TALK TO ON THE PHONE
1.3%	E-MAIL FROM OTHER PEOPLE
3.4%	SOME OTHER WAY, SPECIFY
100.0%	

17. Is there another source of information on an approaching hurricane that you don't have now, but which you think would be a big help if you had it?

Total	Answer
29.9%	YES, SPECIFY
70.1%	NO
100.0%	

18. If a hurricane was expected in two days and you had to get ready, who are the *main* people you would want to get in touch with as you made plans?

Total	Answer
25.2%	FAMILY MEMBERS LIVING WITH YOU
7.8%	NON-RELATIVES LIVING WITH YOU
11.2%	PARENT(S) NOT LIVING WITH YOU
18.4%	OTHER RELATIVES NOT LIVING WITH YOU
15.6%	NEIGHBORS
8.9%	PEOPLE YOU WORK WITH OR AT YOUR JOB
9.6%	CHURCH MEMBERS
2.9%	OTHERS, SPECIFY
0.4%	DON'T KNOW
100.0%	

19. Is there anyone living in your home with special medical equipment or disabilities that you would need to consider when making plans?

Total	Answer
16.2%	YES
83.8%	NO
100.0%	

20. Is this person registered with authorities as having special needs in an emergency?

Total	Answer
40.0%	YES
60.0%	NO
100.0%	

21. How would you expect to get in touch with members of your household who might not be home when you are planning what to do with a hurricane coming?

Total	Answer
8.2%	FACE-TO-FACE TALKING
29.7%	LAND-LINE TELEPHONE
42.9%	CELL PHONE (VOICE)
3.1%	E-MAIL
3.6%	TEXTING
1.6%	FACE-TO-FACE TALKING TO SOMEONE WHO'D RELAY MESSAGE
0.7%	CELL PHONE TALKING TO SOMEONE ELSE WHO'D RELAY MESSAGE
0.3%	E-MAIL TO SOMEONE ELSE WHO'D RELAY MESSAGE
0.4%	TEXTING TO SOMEONE ELSE WHO'D RELAY MESSAGE
9.5%	LIVES ALONE, NOT APPLICABLE
100.0%	

22. Which of the ways you mentioned is *most* important for getting in touch with members of your household who might not be at home?

Total	Answer
7.5%	FACE-TO-FACE TALKING
30.0%	LAND-LINE TELEPHONE
54.0%	CELL PHONE (VOICE)
1.2%	E-MAIL
2.3%	TEXTING
0.5%	FACE-TO-FACE TALKING TO SOMEONE WHO'D RELAY MESSAGE
0.4%	CELL PHONE TALKING TO SOMEONE ELSE WHO'D RELAY MESSAGE
0.2%	TEXTING TO SOMEONE ELSE WHO'D RELAY MESSAGE
3.9%	OTHER, SPECIFY
100.0%	

23. Is there some device or equipment you don't have now for communicating with family members, who might not be home, which would be a big help if you had it?

Total	Answer
16.6%	YES, SPECIFY
83.4%	NO
100.0%	

24. How would you expect to get in touch with members of your family who do not live in your household?

Total	Answer
4.6%	FACE-TO-FACE TALKING
43.3%	LAND-LINE TELEPHONE
43.3%	CELL PHONE (VOICE)
5.3%	E-MAIL
1.7%	TEXTING
0.6%	FACE-TO-FACE TALKING TO SOMEONE WHO'D RELAY MESSAGE
0.5%	CELL PHONE TALKING TO SOMEONE ELSE WHO'D RELAY MESSAGE
0.3%	E-MAIL TO SOMEONE ELSE WHO'D RELAY MESSAGE
0.4%	TEXTING TO SOMEONE ELSE WHO'D RELAY MESSAGE
100.0%	

25. Which of the ways you mentioned is MOST important for getting in touch with family who do not live in your household?

Total	Answer
3.7%	FACE-TO-FACE TALKING
38.9%	LAND-LINE TELEPHONE
47.4%	CELL PHONE (VOICE)
0.7%	E-MAIL
0.9%	TEXTING
0.3%	FACE-TO-FACE TALKING TO SOMEONE WHO'D RELAY MESSAGE
0.1%	CELL PHONE TALKING TO SOMEONE ELSE WHO'D RELAY MESSAGE
0.6%	E-MAIL TO SOMEONE ELSE WHO'D RELAY MESSAGE
7.4%	TEXTING TO SOMEONE ELSE WHO'D RELAY MESSAGE
100.0%	

26. Is there some device or equipment you don't have now for communicating with your family members, who do not live in your household, which would be a big help if you had it?

Total	Answer
13.1%	YES, SPECIFY
86.9%	NO
100.0%	

27. Are there family members, such as your parents, living outside your home but in the Charleston area that you would be concerned about if a hurricane was approaching?

Total	Answer
49.4%	YES
50.6%	NO
100.0%	

28. Do they have special medical equipment or disabilities that you would need to consider when making plans?

Total	Answer
18.4%	YES, SPECIFY
81.6%	NO
100.0%	

29. Would you plan to evacuate if a major hurricane was approaching Charleston?

Total	Answer
83.0%	YES
17.0%	NO
100.0%	

30. What would be the reason that might cause you to not evacuate?

Total	Answer
14.0%	NOT RECEIVING COMMUNICATION IN TIME
8.8%	NOT UNDERSTANDING THE EVACUATION ORDER
18.1%	NO DESIRE TO LEAVE
13.6%	NOT HAVING TRANSPORTATION TO LEAVE
5.7%	NOT HAVING ANYWHERE TO GO
12.6%	DON'T LIVE IN EVACUATION ZONE
19.3%	FEEL MY HOUSE WOULD BE SAFE IN HURRICANE
7.9%	NOT BEING ABLE TO RETURN QUICKLY AFTER STORM
100.0%	

31. Which would be the reasons that might cause you to not evacuate if a hurricane approached?

Total	Answer
15.9%	WOULD NOT EVER EVACUATE
15.8%	WOULD NOT EVACUATE IF IT DID NOT SEEM LIKE A STRONG HURRICANE FROM THE FORECAST
11.9%	WOULD EVACUATE IN ANY CASE
11.8%	NOT RECEIVING EVACUATION ORDER/COMMUNICATION IN TIME
10.4%	LACK OF TRANSPORTATION, TRANSPORTATION PROBLEMS
10.1%	HOUSE IS SAFE, SECURE, NO NEED TO EVACUATE
8.0%	DO NOT LIVE IN EVACUATION ZONE OR PLACE I NEED TO EVACUATE FROM
4.3%	NOT BEING ABLE TO RETURN QUICKLY AFTER STORM
4.2%	NOT UNDERSTANDING THE EVACUATION ORDER
1.6%	DON'T KNOW/NO RESPONSE
1.6%	OTHER
1.4%	TOO SICK, OLD TO GO
1.0%	HAVE JOB THAT WOULD REQUEIR ME TO STAY
1.0%	NOWHERE TO GO, NO MONEY
0.9%	CONCERN ABOUT PETS, ANIMALS
0.1%	CONCERN ABOUT LOOTING, CRIME, IF I LEAVE
100.0%	

32. What would be the best way authorities could let you know that an *immediate* emergency, like a tornado or chemical spill, threatens your area?

Total	Answer
12.3%	LAND-LINE TELEPHONE CALL
9.3%	CELLULAR PHONE CALL
2.4%	TEXT MESSAGE TO CELL PHONE
0.1%	FAX
1.6%	E-MAIL
20.7%	RADIO
29.9%	TELEVISION
3.9%	WEATHER ALERT
9.1%	SIREN
6.8%	POLICE LOUDSPEAKERS
3.9%	OTHER, SPECIFY
100.0%	

33. Are there any organizations, groups, or churches in Charleston that you belong to that would be able to help in a major hurricane or other disaster?

Total	Answer
63.6%	YES
36.4%	NO
100.0%	

34. What kind of organization is it/are they?

Total	Answer
7.7%	NEIGHBORHOOD ASSOCIATIONS
4.6%	FRATERNAL/CLUBS
67.6%	CHURCHES/RELIGIOUS
6.4%	SUPPORT GROUPS
13.7%	OTHER, SPECIFY
100.0%	

35. If the city or county offered a voluntary special emergency notification system, such as Reverse 911, where they would contact you directly if your area were threatened, would you sign up for it?

Total	Answer
82.3%	YES
17.7%	NO
100.0%	

36. Would you sign up for it there was a $25 per year fee?

Total	Answer
58.7%	YES
41.3%	NO
100.0%	

37. Have you ever evacuated for a hurricane (this refers to anywhere)?

Total	Answer
41.6%	YES
58.4%	NO
100.0%	

38. Have you ever experienced a hurricane?

Total	Answer
73.2%	YES
26.8%	NO
100.0%	

39. How safe do you feel your present home would be if a major hurricane hit Charleston?

Total	Answer
35.2%	VERY SAFE
38.9%	SOMEWHAT SAFE
11.8%	NOT TOO SAFE
14.1%	NOT SAFE AT ALL
100.0%	

40. How confident are you in the messages and advice provided by local emergency managers?

Total	Answer
38.8%	VERY CONFIDENT
37.0%	MOSTLY CONFIDENT
15.2%	A LITTLE CONFIDENT
3.9%	NOT AT ALL CONFIDENT
5.1%	NEVER GET INFO FROM THIS SOURCE
100.0%	

41. How confident are you in the messages and advice provided by local officials?

Total	Answer
43.9%	VERY CONFIDENT
38.0%	MOSTLY CONFIDENT
13.7%	A LITTLE CONFIDENT
2.4%	NOT AT ALL CONFIDENT
2.0%	NEVER GET INFO FROM THIS SOURCE
100.0%	

42. How confident are you in the messages and advice provided by the National Hurricane Center and the National Weather Service in Charleston?

Total	Answer
71.3%	VERY CONFIDENT
19.0%	MOSTLY CONFIDENT
6.5%	A LITTLE CONFIDENT
0.7%	NOT AT ALL CONFIDENT
2.5%	NEVER GET INFO FROM THIS SOURCE
100.0%	

43. How confident are you in the messages and advice provided by the television stations in Charleston?

Total	Answer
50.4%	VERY CONFIDENT
33.8%	MOSTLY CONFIDENT
9.9%	A LITTLE CONFIDENT
4.1%	NOT AT ALL CONFIDENT
1.8%	NEVER GET INFO FROM THIS SOURCE
100.0%	

44. How confident are you in the messages and advice provided by the Weather Channel?

Total	Answer
54.3%	VERY CONFIDENT
22.4%	MOSTLY CONFIDENT
7.2%	A LITTLE CONFIDENT
3.3%	NOT AT ALL CONFIDENT
12.8%	NEVER GET INFO FROM THIS SOURCE
100.0%	

45. How confident are you in the messages and advice provided by information on the Internet?

Total	Answer
19.4%	VERY CONFIDENT
17.1%	MOSTLY CONFIDENT
10.1%	A LITTLE CONFIDENT
5.0%	NOT AT ALL CONFIDENT
48.4%	NEVER GET INFO FROM THIS SOURCE
100.0%	

The next set of questions deal with things that might be important to you in deciding what to do if a hurricane is approaching where you live.

46. Importance of where the hurricane is forecast to probably hit.

Total	Answer
84.5%	VERY IMPORTANT
10.9%	IMPORTANT
3.6%	SOMEWHAT IMPORTANT
1.0%	NOT IMPORTANT
100.0%	

47. Importance of how strong the hurricane's wind is.

Total	Answer
84.8%	VERY IMPORTANT
10.6%	IMPORTANT
3.3%	SOMEWHAT IMPORTANT
1.3%	NOT IMPORTANT
100.0%	

48. Importance of the possibility of traffic delays.

Total	Answer
57.2%	VERY IMPORTANT
23.9%	IMPORTANT
9.9%	SOMEWHAT IMPORTANT
9.0%	NOT IMPORTANT
100.0%	

49. Importance of the amount of time left before the hurricane arrives.

Total	Answer
72.8%	VERY IMPORTANT
19.8%	IMPORTANT
4.6%	SOMEWHAT IMPORTANT
2.8%	NOT IMPORTANT
100.0%	

50. Importance of evacuation orders given by government.

Total	Answer
60.5%	VERY IMPORTANT
24.1%	IMPORTANT
10.4%	SOMEWHAT IMPORTANT
5.0%	NOT IMPORTANT
100.0%	

51. Importance of how ready your home is to withstand hurricane winds.

Total	Answer
54.8%	VERY IMPORTANT
30.0%	IMPORTANT
7.9%	SOMEWHAT IMPORTANT
7.3%	NOT IMPORTANT
100.0%	

52. Importance possibility of flooding or storm surge.

Total	Answer
62.7%	VERY IMPORTANT
15.7%	IMPORTANT
10.5%	SOMEWHAT IMPORTANT
11.1%	NOT IMPORTANT
100.0%	

53. Importance of being able to return to your home right away after the hurricane.

Total	Answer
55.1%	VERY IMPORTANT
23.9%	IMPORTANT
15.3%	SOMEWHAT IMPORTANT
5.7%	NOT IMPORTANT
100.0%	

54. Importance of being able to protect your home from crime.

Total	Answer
61.0%	VERY IMPORTANT
21.2%	IMPORTANT
11.5%	SOMEWHAT IMPORTANT
6.3%	NOT IMPORTANT
100.0%	

55. Importance of being able to keep family members together after the hurricane.

Total	Answer
70.9%	VERY IMPORTANT
15.1%	IMPORTANT
4.9%	SOMEWHAT IMPORTANT
9.1%	NOT IMPORTANT
100.0%	

56. Importance of requirements of your job or the jobs of other members of your household?

Total	Answer
28.8%	VERY IMPORTANT
19.7%	IMPORTANT
16.6%	SOMEWHAT IMPORTANT
34.9%	NOT IMPORTANT
100.0%	

57. Importance of medical or other needs you or other members of your household might have.

Total	Answer
44.2%	VERY IMPORTANT
16.3%	IMPORTANT
6.7%	SOMEWHAT IMPORTANT
32.8%	NOT IMPORTANT
100.0%	

58. Importance of the needs of pets or livestock.

Total	Answer
31.9%	VERY IMPORTANT
16.0%	IMPORTANT
5.4%	SOMEWHAT IMPORTANT
46.7%	NOT IMPORTANT
100.0%	

59. Importance of having enough money to evacuate if needed.

Total	Answer
63.9%	VERY IMPORTANT
21.7%	IMPORTANT
8.3%	SOMEWHAT IMPORTANT
6.1%	NOT IMPORTANT
100.0%	

60. Importance of having transportation to leave if needed.

Total	Answer
66.3%	VERY IMPORTANT
18.1%	IMPORTANT
5.0%	SOMEWHAT IMPORTANT
10.6%	NOT IMPORTANT
100.0%	

61. Do you or your family own your home or rent?

Total	Answer
55.4%	OWN
41.7%	RENT
2.0%	OWN MOBILE HOME
0.9%	OTHER, SPECIFY
100.0%	

62. What is your marital status?

Total	Answer
24.1%	SINGLE
40.7%	MARRIED
10.1%	WIDOWED
6.9%	DIVORCED
3.3%	SEPARTED
11.7%	NEVER MARRIED
3.2%	OTHER (including living together not formally married)
100.0%	

63. What is the highest grade of school you've completed?

Total	Answer
8.1%	SOME HIGH SCHOOL
12.0%	HIGH SCHOOL GRAD
33.7%	SOME COLLEGE
23.5%	COLLEGE GRADUATE
22.7%	GRADUATE DEGREE
100.0%	

64. With which of the following racial groups do you identify yourself?

Total	Answer
55.9%	WHITE
37.4%	BLACK
0.3%	ASIAN
0.4%	AMERICAN INDIAN
6.0%	OTHER, SPECIFY
100.0%	

65. Are you Hispanic or of Latino descent?

Total	Answer
16.2%	HISPANIC
83.8%	NOT HISPANIC
100.0%	

66. What language is most often spoken in your home?

Total	Answer
84.2%	ENGLISH
11.9%	SPANISH
3.9%	BOTH ENGLISH AND SPANISH
100.0%	

67. Approximately, what is you annual household income?

Total	Answer
14.6%	UNDER $10,000
17.0%	$10,000 - $20,000
19.3%	$21,000 - $30,000
20.4%	$31,000 - $50,000
11.1%	$51,000 - $80,000
17.6%	OVER $80,000
100.0%	

68. What gender are you?

Total	Answer
47.1%	MALE
52.9%	FEMALE
100.0%	

Appendix F: Glossary of Terms

community	A group of people living in a particular local area and interacting with one another
community capacity	Involves a shared sense of responsibility and collective competence
disadvantaged	Lacking the basic resources or conditions believed to be necessary for equality in society (housing, finances, access to education, medical facilities, and civil rights)
disaster	For the general purpose of the project: natural tragedies and disruptions, such as hurricanes, tornadoes, earthquakes, and floods, noting that disasters can also be manmade.
disaster (social) vulnerability	The extent to which an entity (individual, household, community, region, organization) is susceptible to the impact of hazards
formal networks	Associated with government agencies and "official" organizations
informal networks	Comprised by a web of relationships with friends, neighbors, co-workers, associates, and fellow members of church congregations or other social organizations
population	The people who inhabit a territory, region, or state
process	A particular course of action; specific steps to be followed
resilience	Ability to effectively prepare for, respond to, and successfully recover from a disaster
risk	The degree of exposure to the hazard
social organization	Values, norms, processes, and behavior patterns that organize, facilitate and constrain; process by which communities achieve the desired results
social vulnerability	Vulnerability associated with economic, social, cultural and/or political conditions that can limit available resources and response capacity at any stage in a disaster cycle (Bolin with Stanford 1998).[9]
structure	A system or organization made up of interrelated parts functioning as a whole; framework
technology	Dealing with the study, development, and application of devices, tools, techniques, and machines for practical use
vulnerable	Unprepared to act on one's own behalf in the wake of a disaster

[9] It is nearly impossible to separate economic factors from social factors, i.e. poverty and social inequalities coexist. Thus, it is useful to include economic vulnerability as part of the social vulnerability discussion.