# Building Community Resilience: A Summary of Case Studies from Charleston, Gulfport, and Memphis

## CARRI Research Report 9

Community & Regional RESILIENCE Institute

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# BUILDING COMMUNITY RESILIENCE: A SUMMARY OF CASE STUDIES FROM CHARLESTON, GULFPORT, AND MEMPHIS

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## RESEARCH FINDINGS ABOUT COMMUNITY AND REGIONAL RESILIENCE

One of the commitments of the Community and Regional Resilience Institute (CARRI) is to understand what resilience is and how to get there, based on research evidence.

As one resource for this effort, CARRI has commissioned a number of summaries of existing knowledge about resilience, arising from a number of different research traditions. This report is one in a series of such summaries, which will be integrated with new resilience explorations in several CARRI partner cities and with further discussions with the research community and other stakeholders to serve as the knowledge base for the institute.

For further information about CARRI's research component, contact Thomas J. Wilbanks, wilbankstj@ornl.gov, or Sherry B. Wright, wrightsb@ornl.gov.

## COMMUNITY AND REGIONAL RESILIENCE INSTITUTE

Oak Ridge National Laboratory's (ORNL) Community and Regional Resilience Institute (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 conversations 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

## LIST OF RESEARCH PAPERS BY NUMBER

CARRI Report 1: Susan L. Cutter, Lindsey Barnes, Melissa Berry, Christopher Burton, Elijah Evans, Eric Tate, and Jennifer Webb, *Community and Regional Resilience: Perspectives from Hazards, Disasters, and Emergency Management*, September 2008.

CARRI Report 2: Susanne C. Moser, *Resilience in the Face of Global Environmental Change*, September 2008.

CARRI Report 3: Craig Colten, Robert Kates, and Shirley Laska, *Community Resilience: Lessons from New Orleans and Hurricane Katrina*, September 2008.

CARRI Report 4: Betty Hearn Morrow, *Community Resilience: A Social Justice Perspective*, September 2008.

CARRI Report 5: Lance Gunderson, *Comparing Ecological and Human Community Resilience*, January 2009.

CARRI Report 6: Kathleen Tierney, *Disaster Response: Research Findings and Their Implications for Resilience Measures,* March 2009.

CARRI Report 7: Thomas J. Wilbanks, *How Geographic Scale Matters in Seeking Community Resilience,* August 2009.

CARRI Report 8: Adam Rose, *Economic Resilience to Disasters,* November 2009.

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# BUILDING COMMUNITY RESILIENCE: A SUMMARY OF CASE STUDIES FROM CHARLESTON, GULFPORT, AND MEMPHIS

## 1. INTRODUCTION

Building resilience in communities and their surrounding regions is a process that seeks to improve their ability to contend with the overwhelming impacts of hazard events.[1] Drawing on concepts from psychology, engineering, and ecology, researchers have been discussing and investigating the notion of resilience in human communities. Fitting within this broad area of study, this report summarizes three case studies prepared as part of the Community and Regional Resilience Institute's (CARRI) Practice Division directed by staff at the Oak Ridge National Laboratory. Researchers studied the Charleston/North Charleston, South Carolina, metropolitan statistical area (MSA); Gulfport, Mississippi; and the six-county Memphis, Tennessee, Urban Area (MUA) and conducted detailed investigations of existing resilience and efforts to enhance resilience in these communities. This summary report highlights the findings and presents them within a common organizational framework.[2]

Community resilience differs from ecological resilience in that humans can learn from past events and make adaptations when similar disruptions reoccur (Turner et al. 2003; Adger 2000). Community resilience seeks to infuse lessons learned in the anticipation of, mitigation of, response to, and recovery from future impacts. Resilience is an ongoing process, or as Manyena argues, it requires an enduring commitment rather than a fixed outcome (Manyena 2006). Thus, communities must sustain the elements of resilience as long as there are people at a place and at risk in that place.

The CARRI staff organized an advisory group in each community. Comprised of representatives from all sectors of the communities, the advisory groups met with CARRI staff, discussed the concept of resilience, helped identify characteristics of resilience, and deliberated local strengths and weaknesses. This process helped local participants understand the concept of resilience and identify characteristics of it (or lack thereof) in their communities, which in turn aided the CARRI program staff in learning about the characteristics of resilience in the respective communities. By design, the community advisory groups sought to be inclusive and engage all segments of the population, including organizations typically involved in emergency responses, political and community leaders, and also non-governmental organizations (NGOs) and faith-based and voluntary groups. Through their meetings the advisory groups sought to build

[1] Hazards are threats to people and what they value. They include natural events like hurricanes, tornados, pandemics, and floods, as well as human-caused events like war, terrorist attacks, or economic calamities. Ultimately they can disrupt a community's normal functions (Colten et al. 2008). They may be characterized by human casualties and damage to or destruction of the built environment and/or ecological resources.

[2] More detail on the three communities can be found in the original reports (Felts et al. 2009; Lannom et al. 2009; Lansford and Covarrubias 2008). See also, http://www.resilientus.org/publications/.

bridges throughout the community and foster effective communication and collaboration among the participants. Such interaction is foundational to nurturing effective leadership before a calamity and making cooperation more likely after an event.

Building resilience is a complex process and one that is place based (Vale and Campanella 2005). Local conditions—both in terms of a community's strengths and weaknesses—determine the strategies on which to build resilience. While all communities share certain characteristics and functions in common, it is the differences that present unique challenges and yield creative approaches to building resilience. A community's political structure, physical landscape, natural resources, demographics, economics, the particular social and political challenges it faces, the range and effectiveness of NGOs and faith-based organizations (FBOs), the connections among organizations, and community leadership are particular to each place. Each of these dimensions contributes to or detracts from a particular community's resilience.

Community, as used here, represents an area with interdependent and interrelated organizations that commonly share functions and resources that can impact its joint resilience. In addition, a sense of place and a commitment to a locality are important aspects of a community addressed by the case studies. Together the case studies demonstrate that resilience preparations must be adapted to the local setting, even while general principles of resilience guide those efforts.

The intent of this summary report is to assemble and integrate the insights gained in the three case-study communities in the Charleston Tri-County area, Gulfport, and the Memphis Urban Area such that other communities can draw on their experiences. The report uses the following definition of resilience posited by Thomas Wilbanks, CARRI Research Director, as the framework for looking at resilience in these three urban areas in the southeastern United States. A resilient community:

> *Anticipates* problems, opportunities, and potentials for surprises; *reduces* vulnerabilities related to development paths, socioeconomic conditions, and sensitivities to possible threats; *responds* effectively, fairly, and legitimately in the event of an emergency; and *recovers* rapidly, better, safer, and fairer (Wilbanks 2008).

## 2. COMMUNITY SKETCHES

CARRI has collaborated with three highly diverse communities to explore community resilience. The hope was to engage with communities, draw on their local expertise and concerns, and blend basic research with practice at the community level. To mobilize the process, CARRI partnered with communities of varying sizes, different economic and demographic characteristics, and different hazards.

### 2.1 Charleston, South Carolina

Charleston, South Carolina, has a prominent history among cities of the American South. As a major port and economic hub it endured eighteenth- and nineteenth-century military occupation, hurricanes, infestations from boll weevils, plagues, and a devastating earthquake.

The Charleston CARRI report encompasses portions of the "Tri-County" area which includes Charleston, Berkeley, and Dorchester counties (references to Charleston in this summary generally indicate the three-county study area largely focusing on the Charleston/North Charleston MSA). The city of Charleston is the core and provides much of the economic focus for an expanding urban area with more than 500,000 residents in 2000. The urban area has a strong and long-established tourism economy oriented toward its rich historical landscapes and nearby beaches, which have also attracted a growing retirement population. There is also a strong military presence in the community that provides a degree of economic stability, although the closing of the naval base in the late 1990s had an extreme economic impact on the region. Charleston has a leading medical community through the presence of the Medical University of South Carolina, which is a quaternary medical care facility and provides port facilities for its hinterland. Charleston is served with water, rail, air, and highway links to the country and the world. Relatively speaking, the metropolitan area has a large population of low-income residents, a diverse population with varying ethnicities, and a populace who range from college age to senior citizens—all of which presents challenges to community resilience.

## 2.2 Gulfport, Mississippi

Gulfport, Mississippi, is the lone single municipality included in the initial CARRI process. References to Gulfport in this summary indicate the city proper, although many participants in the CARRI process live and/or work in surrounding municipalities. Gulfport experienced rapid population growth between 1970 (just after Hurricane Camille) and 2000 when it grew from 40,000 to over 71,000. Hurricane Katrina—a defining moment in the city's history—prompted a sizable population loss, although Gulfport's population had rebounded to near pre-storm levels by 2009. Other prominent elements of the local economy include military bases, ship building, and port activities. Gulfport is diverse demographically with various ethnicities represented; low incomes and a lack of educational opportunities are dominant factors that present challenges to building resilience in the Gulfport and Gulf Coast area. The city faces numerous hazards, with hurricanes being the most prominent.

## 2.3 Memphis, Tennessee

The Memphis Urban Area (MUA) is defined as a six-county area centered on Memphis and includes the counties of Shelby, Lauderdale, Tipton, Fayette, Crittenden, and DeSoto and spans the three states of Tennessee, Arkansas, and Mississippi. The MUA community is part of the Mid-South and central United States and is diverse demographically, economically, politically, and environmentally. This region, defined by a highly urbanized metropolitan core in Memphis/Shelby County, is home to approximately 1.2 million residents within the region and distributed around the urban core. These two pieces of the region are integrated and linked through cultural, economic, and social relationships. With a nationally central location, a hub airport serving passenger and freight carriers, river navigation, and the convergence of trunk rail and interstate highways, Memphis has built a transportation-oriented economy. In addition, it is also a center for regional medical services. The MUA faces a range of hazards and has had recent

encounters with wind and ice storms. The risk of low-frequency, high-impact earthquakes is the most pronounced risk with region-wide implications. Within the MUA, each community, city, county, and state fills a role in defining and strengthening the community and its resilience. The diverse nature of the MUA is the context within which resilience exists and is stretched and reinforced.

## 3. ANTICIPATE

A fundamental trait that sets human communities apart from other biological communities is the ability to anticipate hazard events. While the timing of an earthquake or tornado might be impossible to predict and such disruptions may still arrive as a "surprise," society has learned to expect such events and prepare for their impacts. The full impact of a carefully monitored slow-moving event, such as a hurricane, may contain many surprises, but being alert to a disturbance's eventual arrival is essential to resilience. Consequently, anticipation, as defined by CARRI, is a fundamental element of resilience and reflects the adaptive capacity of human society (Turner et al. 2003; Gunderson and Holling 2002). This section presents the anticipatory steps taken in the three communities.

A first step of anticipation is to assess the exposure of a community to the multiple hazards that it may face. Hazards investigators have long noted the elemental importance of knowing the types of hazards a community faces and assessing their risk (Wisner et al. 2004). In order to provide a basis for hazard assessment, community, state, and federal agencies must assemble and maintain records of past hazard events. Compiling an ongoing record of floods, drought, storms, earthquakes, and other natural phenomena provide one basis for reliable assessment. The longer the record, the more reliable the assessment (Barredo 2007; Muller 2007). Disease records compiled at the national and international levels offer tools to gauge the threat of epidemics. National military organizations constantly reassess the potential for international conflicts, while police and firefighters stay attuned to the risk of crime and conflagration at the community level. Financial institutions track economic vagaries and trauma. Assessments operate at multiple scales, and ongoing observations and recordkeeping are often not fully integrated, even though they should be. In addition, both social and biophysical vulnerabilities must be taken into consideration (Cutter et al. 2000).

Consistent monitoring, forecasting, and warning systems follow from assessment. Monitoring conditions that are pertinent to communities is a first logical step. In the 1950s, the United States embarked on a massive project to improve hurricane forecasting and tracking. By the 1960s, radar and hurricane hunter aircraft supplemented shipboard observations and greatly improved the ability of the National Weather Service to provide more accurate forecasts and warnings (Colten et al. 2008). Global satellite networks now provide even greater monitoring capabilities along with sophisticated models that enable far greater forecast precision. While the forecasting for hurricanes has improved dramatically, there still exists a significant margin of error related to landfall projections. Twelve to 24 hour forecasts are much more accurate but sometimes result in less-than-adequate time for meaningful evacuations, especially in large urban areas. Warnings for flash floods in the Texas hill country will never match the multi-day

advance notice we see for most hurricanes, but continually monitored river gauges and warning sirens in public access areas offer the appropriate warning in small river basins subject to storm-induced, rapidly rising floods. Similarly, the monitoring of the H1N1 flu during the spring, summer, and fall of 2009 provided considerable warning for public health communities across the globe. There are ongoing efforts to monitor the less obvious geologic features that may provide advance notice of an earthquake in the Memphis area (USGS 2009). FEMA has funded the TriNet Program to provide earthquake monitoring in seismically active areas (FEMA 2009). Seismic observations may not forecast a tremor in the same way we can predict a hurricane; nonetheless, they provide critical measurements of an event that offer a degree of anticipation unavailable to previous generations.

The three CARRI case-study communities all employ assessment and monitoring capabilities. Both Charleston and Gulfport had relatively recent encounters with major hurricane strikes (Hugo 1989 and Katrina 2005, respectively) which highlighted local risks. Anticipatory systems are in place for hurricanes. Both communities are able to access to National Weather Service and National Hurricane Center monitoring and forecasting capabilities. Emergency preparedness professionals in Gulfport had evaluated the frequency of hurricane strikes as a first step in anticipation (Lansford and Covarrubias 2008, 23–26), and Charleston officials had run computerized models to assess the impact of storm surge (Felts et al. 2009, 99); both communities were part of FEMA's national flood insurance program and had flood risk maps available to residents. Additionally, Gulfport has also considered terrorism as a possible threat.

The MUA faces tornadoes and is at risk for earthquakes. The area has an integrated warning system that reportedly saved lives when tornadoes touched down in 2008 (Lannom et al. 2009, 84). Based on the earthquake history of the region, there is a 7 to 10% chance of a large New Madrid Seismic Zone (NMSZ) earthquake within the next 50 years and a 25 to 40% chance of a magnitude of 6.0 or greater over the same period of time (USGS 2007). The Center for Earthquake Research and Information seismic network records 200 earthquakes every year in the NMSZ with the majority smaller than magnitude 3.0. Seismic monitoring by the U.S. Geological Survey (USGS) and the Center for Earthquake Research and Information maintains ongoing observations of geologic threats. Their efforts are part of the Advanced National Seismic System (ANSS) that strives to provide the best guidance on earthquake potential and impacts (USGS 2007). With funding from FEMA, the Central U.S. Earthquake Consortium coordinates efforts to reduce the impacts of geologic threats to the area (Lannom et al. 2009, 24). Memphis also has identified such events as drought, severe winter storms, floods, hazardous materials, and health disasters as threats. Charleston also faces earthquake hazards, and it benefits from the seismic monitoring conducted by the USGS and the ANSS. While there have been no recent massive tremors in South Carolina, on a human timescale, nineteenth-century earthquakes proved destructive, and preparedness officials employ these geologically recent events as examples of what can occur (Steinberg 2000; Berke and Beatly 1992).

In addition to assessing the range of threats, or biophysical vulnerabilities, a resilient community must recognize its social vulnerabilities. By identifying vulnerable populations, communities enhance their ability to address the conditions that accentuate vulnerability. Memphis authorities recognize that residents with meager economic resources are less able to prepare for extreme events and have less capability to take care of themselves in the emergency

period following a disruptive event (Lannom 2009, 47). Charleston reports that lower incomes and an aging population present challenges in terms of mobility and personal health in the wake of an extreme event (Felts et al. 2009, 4–43). Gulfport has experienced rapid population growth since 1990 and within its demographic mix, a high percentage of single parents, living below the poverty level, has fallen in recent years — a trend toward a more resilient population (Lansford and Covarrubias 2008, 8). Nonetheless, after Katrina, the low-income segment of the population remained largely unchanged, and consequently a vulnerable population persists. Since low-income residents are generally more vulnerable, addressing poverty and its root causes as an anticipatory effort can reduce response and recovery challenges and costs. All three communities have seen increasing numbers of non-English-speaking residents, and it is acknowledged that effective anticipation encompasses steps to alert multilingual populations to impending hazard events.

Assessing exposure and monitoring without taking the adequate steps to put that information to use will have little positive effect on a community's resilience. The case-study communities all have assembled plans to respond to and recover from future hazard events. With its multi-hazard approach, Charleston has participated in FEMA's Project Impact, which strives to engage communities in perpetual preparedness for hazard events with the goal of reducing their impacts (Felts et al. 2009, 112–117). Reflecting its commitment to the process, the Charleston County Council maintained its support for Project Impact even after federal funds ended. Memphis, likewise, has adopted a multi-hazard approach in its planning efforts; its preparedness professionals realize that an earthquake could pose the most debilitating situation, although frequent, small-scale events may present more common threats. Among its plans are both emergency response and business resumption components. The City–County Emergency Management Plan is aligned with FEMA requirements and spells out the responsibilities for pre- and post-event actions. The MUA's Operation Safe Community provides a roadmap for law enforcement to make the community safe and functional following an extreme event (Lannom et al. 2009, 85–99). In the wake of Katrina, Gulfport has a fully updated emergency response plan that coordinates with state and federal emergency agencies. Gulfport knows that communities must prepare to respond and recover. Consequently, its plans include both mitigation and redevelopment components (Lansford and Covarrubias 2008, 51–52).

Incorporating redundancy into transportation and communication systems is a key anticipation strategy that can help communities overcome disruptions to certain portions of the infrastructure in a hazard event. Memphis sees itself as a multi-modal city in terms of transportation and is well served by rail, air, river, and highway. With one or two systems disrupted, the community could still receive emergency supplies by other means. Charleston, too, has multiple means of transportation that can minimize post-calamity delivery disruptions. It has also made transportation and communication priorities in its resiliency planning. Extensive community engagement has produced a pair of "roadmaps" to improve both components of the community's resilience (CARRI 2009a and 2009b). Recognizing the fragility of "hard" communication systems, Charleston resilience leaders have expanded plans to restore formal communication networks (e.g., telephone and cell phone) with plans to incorporate "soft" communication — such as informal networks and local media — as an organized and institutionalized communications network. Additionally, the Charleston communication system

employs redundant computer/web, radio, and landline telecommunications (Felts et al. 2009, 126). Communication failures proved highly disruptive following Katrina in 2005, and Gulfport leaders fully recognize the central importance of restoring communication networks after an extreme event (Lansford and Covarrubias 2008, 46 and 73). A CARRI-facilitated stakeholder work group also developed a communication roadmap that emphasizes communication across sectors of the community (CARRI 2009d). Planning for the unexpected can ensure that communication and transportation systems continue to function after a disruptive event.

Stockpiling emergency resources in readily accessible positions before a hazard event is another vital anticipatory measure. The impact of Hurricane Katrina underscored the importance of having not just some supplies but adequate supplies. Gulfport officials reported that the failure of transportation and communication systems produced acute shortages of gasoline, food, and water within only a few days. Although provisions had been dispatched to the region before the storm, the magnitude of the storm caused disruptions of unanticipated lengths, and road obstructions and bridge failures made efficient delivery of supplies to many people in need impossible (Lansford and Covarrubias 2008, 26–27). Charleston has assembled 18 "band-aid boxes" that are well stocked with emergency medical, communication, and subsistence supplies. These large containers have been situated strategically throughout the urban region for ready access in the event of a disruptive event (Felts et al. 2009, 3). Distribution of these resources prior to an event will ensure access to emergency supplies during the response phase, even when roadways are obstructed. Memphis also has an emergency management plan that provides for distribution of emergency supplies (Lannom et al. 2009, 86–87). Memphis and Charleston emergency response plans included emergency responders and medical facilities as services and locales where adequate supplies needed to be stockpiled before disruptive events.

Plans typically include procedures to handle donated goods and cash, but provision for cash to individuals following power failure and consequently normal access to family funds is lacking in most plans. More detailed plans and coordination with private sector financial institutions for restoring cash flow is important. An ad hoc solution in Gulfport illustrates how one bank helped put cash in the hands of citizens in the aftermath of Katrina (Ghosts of Katrina Conference 2009; Smith 2009a).

Plans for sheltering victims and evacuees are also fundamental to anticipation. Memphis, which has sheltered evacuees from Gulf Coast hurricanes in recent years, has incorporated these experiences with displaced populations into plans for sheltering its own population.

A topic of concern is that the public has a tendency to lose its sense of urgency within a few years of an extreme event. One aspect of anticipation is an ongoing public education and awareness program that maintains a sense of readiness during a lull between emergencies. Charleston, for example, has a "demonstration house" that introduces residents to safe and sustainable building technologies (Felts et al. 2009, 3). Counties in the Charleston urban region regularly prepare and circulate emergency preparedness guides to residents, and Charleston officials host public meetings to maintain awareness (Felts et al. 2009, 128). Organizations in the MUA place a high value on public engagement as officials there recognize that some of the most vulnerable may not have access, or be able to take advantage of, preparedness outreach programs. To address this situation, they have made deliberate efforts to include the region's most vulnerable citizens through popular media campaigns and multi-language information

resources. While training has been accomplished through the Community Emergency Response Team (CERT) Program for many residents, a recent Assisi Foundation study revealed that some employers provide training and information to their employees (Lannom 2009, 66). The CERT Program prepares volunteers to respond and assist their neighbors in the event of an emergency. Gulfport also participates in the CERT program, and participants reported it was a valuable asset in the wake of Katrina (Ghosts of Katrina Conference 2009). In addition, mayors in Shelby County have collaborated to create ReadyShelby and recently launched a comprehensive emergency preparedness website (www.readyshelby.org). The site is thorough in its information yet approachable in its tone. ReadyShelby is an emergency preparedness initiative sponsored by the municipal mayors of Shelby County, Tennessee, and seeks to partner with public, private, faith-based, and nonprofit sectors to share the guidelines and overall importance of emergency preparedness. The mayors, along with a local foundation, have also created a series of public preparedness messages broadcast monthly (Shelby County 2009). Regular training and exercises for emergency response professionals and crews in essential private sector services are a fundamental part of anticipation and maintaining awareness of local hazards (Lansford and Covarrubias 2008, 53; Smith 2009b).

# 4. REDUCE

Reducing the impact of future events is a critical element of resilience that underscores the human ability to adapt. There are numerous means to reduce impacts: constructing physical barriers against flooding, using earthquake-resistant building techniques, establishing security checks at airports to intercept armed passengers, stockpiling medical supplies in anticipation of a pandemic, and the list goes on. These are steps to reduce direct impacts. Indirect impacts include displaced populations, erosion of a community's economic health, a protracted or stagnant recovery, decline in educational opportunities, and diminishment of social capital. Communities must undertake different, longer-term approaches to address the indirect impacts. Also eliminating, or at least minimizing, a community's social vulnerabilities is another means to reduce the impacts of a disruption.

## 4.1 Reducing Direct Impacts

Limiting exposure can come through either structural means, such as levees and reinforced bridges, or through building codes and other regulations. Before Katrina, many homes along the Mississippi shore were raised to comply with construction codes, but they still succumbed to the massive surge and waves of that storm. Since 2005, Gulfport has implemented revised zoning and building codes to restrict coastal development, or to prompt builders to employ even more rigorous hurricane and flood proof designs (City of Gulfport 2007, 44–55; Lansford and Covarrubias 2008, 85–88). Charleston built a seawall many years ago to limit exposure to a hazard event, and it provides protection against modest storms to a limited portion of the city. Coastal-zone development in the Charleston area is a continuing problem, although federal acts have prompted some local adjustments that limit development. Nonetheless, considerable funds

continue to flow into beach restoration projects which encourage use and development. Unfortunately, conflicting policies can increase, rather than decrease, exposure and vulnerability (Felts et al. 2009, 85–86). In Memphis several key businesses have begun efforts to reduce the vulnerability of infrastructure through earthquake-proof construction (Lannom et al. 2009, 50–52). The most recent projects utilizing seismic standards in their construction are the AutoZone Headquarters and the FedEx Forum, both located in downtown Memphis. Participants in the CARRI process in Memphis have advocated retrofitting the principal trauma center to withstand tremors and to implement plans to include earthquake-proof schools (Lannom et al. 2009, 69). In addition, some buildings in Charleston are designed to withstand earthquakes (Berke and Beatly 1992).

Charleston reports that its planning efforts provide a framework for sustainable development and growth that will balance growth and resource conservation in the urban region (Felts et al. 2009, 23). There is an obvious need for improvement in the urban region's infrastructure as demonstrated by the traffic congestion before Hurricane Hugo and during daily commutes. The CARRI report emphasizes the need for longer-term infrastructure improvements and to develop a strategic, coordinated, rather than ad hoc, approach to transportation infrastructure to improve resiliency (Felts et al. 2009, 86). Discussions about "transit-oriented development" seek to incorporate public transportation as part of new developments. By creating evenly distributed transport hubs, public transit could reduce dependence on evacuation by private automobiles and thereby limit the exposure of residents with no cars. Adjustments in the transport system are burdened with considerable path dependence imposed by previous projects. Planning can be modified to incorporate resiliency concepts, and this opens the door to future adjustments and adaptations.

Despite implementation of coastal development zoning to reduce exposure following Hurricane Camille in 1969, intensive land use along the coast continued in Gulfport. State approval of waterborne casinos in 1990 sparked massive shoreline development which suffered dramatic damage when Katrina moved onshore. Other critical infrastructure, such as fire stations, city buildings, and schools, also were exposed to surge and wave damage (Lansford and Covarrubias 2008, 38 and 43). Following Katrina many businesses near the shore chose to move further inland to reduce their exposure to hurricane impacts in the future. The city's new flood prevention ordinance also seeks to guide development out of harm's way and thereby reduce both private- and public-sector losses following a hazard event (Lansford and Covarrubias 2008, 45). Also, the state permitted casinos to shift operations onshore and thereby reduce their future vulnerability, although given the modest landward movement, risk of catastrophic impact remains.

With no recent major calamity, the MUA CARRI participants identified procedures to "hazard-proof" existing infrastructure and create redundancy in critical facilities. Memphis, like other large cities, enjoys access to multiple forms of transportation — air, highway, rail, and river — and a prime concern to transportation planners is the possibility that older bridges across the Mississippi could collapse and impede both rail/highway traffic, and also block river navigation. The newer Interstate 40 highway bridge has been designed to withstand an earthquake, and efforts to reduce disruption to air traffic are under way (Lannom et al. 2009, 53–54). Redundancy in the modes of transportation will make Memphis more resilient in the

event an earthquake or other hazard cripples or disrupts one transportation mode. Utility companies within the MUA had mitigated their vulnerabilities prior to the 2003 "Hurricane Elvis" (Lannom et al. 2009, 81). In Charleston, redundancy in communication systems has been a priority with efforts to prepare for longer-term recovery (Felts et al. 2009, 4 and 126).

## 4.2 Reducing Indirect Impacts

Fundamental to reducing indirect impacts, such as economic disruption, is the maintenance of communication and cooperation among the many community stakeholders. Adversarial objectives undermined the progress of the New Orleans hurricane levee project following Hurricane Betsy in 1965 (Colten 2009) and illustrate the need for collaborative efforts by organizations that depend on one another to reduce impacts. All of the CARRI communities recognized the need for effective communication and collaboration among stakeholders in all sectors of the community as they plan to reduce impacts. Indeed, the CARRI process has served as an effective vehicle to facilitate collaboration among many partners focused on mitigating impacts. Charleston leaders criticized the ineffective communication with FEMA following Hurricane Hugo (U.S. House of Representatives 1990) and have created a roadmap for improving communication and information sharing (CARRI 2009a). The roadmap views establishing effective communication systems as not just a response need but as essential to anticipation, reduction, and recovery as well. Communication and information sharing should reach beyond emergency responders to the entire community. One of the obstacles to effective communication identified in Charleston is the fragmentation of local governments. An effective communication system will minimize this obstruction to mitigation and enable the many interdependent organizations to collaborate effectively. Gulfport's communication roadmap places primary emphasis on nurturing collaboration and communication across the not-for-profit (including faith-based), business, and government sectors to reduce the risk of ineffective communication in the future (CARRI 2009d).

There are many groups and efforts that are willing to address preparedness, response, recovery, planning, education, and outreach — all phases of the emergency cycle. Coordination of efforts among community stakeholders is a very large and growing challenge, and many of the groups that could assist with mitigation have not been yet been fully integrated into the process. One area of opportunity has the potential to expand coordination with the FBOs. These groups operate at a very local level and provide effective leadership (Lannom et al. 2009, 68) ReadyShelby recently held a mini-conference (September) with the faith-based leaders in the community to identify their roles within the preparedness concept. A very important lesson from the Gulf Coast's post-Katrina experience is that communities and regions need to have clear systems in place to coordinate volunteer services and distribute donated supplies in the aftermath of a disaster. More than 20,000 volunteers began arriving on the Gulf Coast immediately after Katrina, offering a wide range of assistance from clearing debris to disbursing clothes and supplies to providing medical care. The Mississippi State Chapter of the Voluntary Organizations Active in Disaster was established after Katrina and serves as an umbrella organization for many district organizations active in disaster response throughout the state of Mississippi. It serves to bring organizations together and enables them to understand one

another's work and facilitates collaboration while eliminating duplication of effort. There are also opportunities to coordinate training among volunteer and FBOs to ensure that they can work collaboratively when the need arises (Lannom et al. 2009, 22 and 66). Adequate preparations minimize the secondary and indirect impacts of an ineffective response to a hazard event.

Gulfport reported that it did not have an emergency coordinator in place before Katrina, and this impeded coordination. The CARRI Gulfport Team stressed the importance of coordination with and among NGOs and coordination between professionals and volunteers. The vigorous response of NGOs after Katrina brought thousands of individuals to the Mississippi shore, but an effective prearranged coordination may have enhanced their effectiveness. Key steps in taking advantage of what can be an overwhelming influx of eager arrivals include having procedures in place to register and credential volunteers, match skills with immediate needs, coordinate with government organizations that have specific response responsibilities, and shelter and feed the nonresident volunteers. Gulfport established a Hurricane Emergency Logistics Providers (HELP) organization to maintain readiness between hurricanes and to coordinate volunteers in the future (Lansford and Covarrubias 2008, 39, 48, 71–72; Gulfport CARRI Team 2009a). Gulfport's ongoing recovery is also served by new volunteer coordination capabilities through Hands On Gulf Coast and the United Way of South Mississippi's Volunteer Gulf Coast (Gulfport CARRI Team 2009c, 4).

Adequate insurance is often what enables property owners to move forward with repairs and replacements. Gulfport's recent experience highlights critical insurance concerns. If the public is reluctant to purchase coverage, there will be a clamor for disaster relief following an extreme event. The Gulfport researchers suggest that an all-inclusive *ex ante* disaster coverage would focus on future events and encourage structural modifications to mitigate damages (Lansford and Covarrubias 2008, 40). Problems that emerged in the wake of Katrina were a spike in insurance rates and company-imposed limits on the areas where policies would be available. Both corporate adjustments made it difficult for property owners to obtain policies for future events (Lansford and Covarrubias 2008, 12). Purchase of business interruption insurance is another strategy to reduce future impacts of disaster on the purchaser. Business interruption insurance payouts to the city of Biloxi after Katrina provided access to $10 million to fuel its recovery and minimize long-term indirect impacts (Lansford and Covarrubias 2008, 40).

Despite huge payouts associated with the exceptional number of hurricanes in 2005, the insurance industry experienced healthy profits in 2004 and 2006. Nonetheless, the federal government has reported that the insurance industry is unprepared to pay for a mega-disaster (Lansford and Covarrubias 2008, 41). Struggles to secure payment from insurance companies have been a fairly common complaint on the Gulf Coast (Ghosts of Katrina Conference 2009). So, even those with coverage faced challenges putting their coverage to work.

Creation of local relief funds or other financial instruments to overcome the impacts of a disruption enable a community to reduce indirect impacts and to move swiftly to rebound without relying entirely on state or federal aid. Gulfport fortunately had a budget surplus that it used to cover essential expenses while the city's economy began generating tax revenue again (Lansford and Covarrubias 2008, 40). Mississippi Governor Haley Barbour established a recovery fund to collect and coordinate the distribution of donations for hurricane victims

(Gulfport CARRI Team 2009c). The Calvert Foundation, an independent nonprofit, established a "Gulf Coast Recovery Initiative Note," and this investment tool enabled private investors to funnel proceeds to local nonprofits that were underwriting low-cost housing, micro-loans, small businesses, and other community development initiatives (Lansford and Covarrubias 2008, 47). In addition, a local credit union created Hurricane Relief Certificates of Deposit that enabled concerned investors to participate in the recovery (Lansford and Covarrubias 2008, 48). After Hurricane Hugo, the South Carolina legislature created the Local Option Sales Tax with the goal of giving communities greater autonomy in using sales tax revenue. However, this financial arrangement functions more as a tax swap rather than a new source of revenue to help with recovery. Greater local financial autonomy was recommended to improve resilience (Felts et al. 2009, 47–48).

Another mechanism to improve resilience is to promote personal savings. The notion that low-income populations are more vulnerable and the common demonstration that wealthy are able to recover with less delay after an extreme event underscores this resilience device (Morrow 2008; Enfield 2004; Cutter 2000; Liverman 1990).

Central to the concept of resilience endorsed by the three communities was the establishment of ongoing, perpetual mitigation planning and training efforts. The CARRI process functions in part to highlight and coordinate such efforts that were under way and to promote their continuation. Memphis reported that there were numerous organizations involved in its Catastrophic Planning Initiative. This effort includes scientific research on the potential impacts of an earthquake, and the results provide emergency planners with credible data for planning. The Urban Area Security Initiative provides a means for counties in the Memphis area to plan, coordinate, and conduct training exercises for emergency responses. Other state and university efforts promote awareness of hazards and thereby sustain readiness. Charleston area officials maintain and update plans for a variety of hazards in coordination with the South Carolina Emergency Management Department. In addition, the state agency conducts an annual drill involving local emergency response personnel (Felts et al. 2009, 111–128). Since Katrina, Gulfport has developed a Comprehensive Emergency Management Plan to address some of the administrative shortcomings of its prior arrangements (Lansford and Covarrubias 2008, 39). Its leaders also recognize the value of regular drills and exercises. One of the promising elements of its planning is an effort to provide training and coordination with faith-based and voluntary organizations (Lansford and Covarrubias 2008, 73–74).

A cornerstone of a resilient community is the inclusion of stakeholders from all areas of a complex society in the community decision making processes. Federal environmental policy requires that those directing actions involving federal dollars consider the impacts of low-income and minority citizens. Initially applied to U.S. EPA actions, former President Clinton's environmental justice executive order has been incorporated, with mixed effectiveness, into FEMA planning (Colten 2007). CARRI's resilience planning places a priority on inclusiveness in planning and decision making (Morrow 2008). If we consider a community only as resilient as its weakest link, then resilience planning must extend to all stakeholders. Resilience is not just a technological remedy but must embrace a community's "essential resilience" (Laska 2009). Engagement of stakeholders from all quarters has been central to the Memphis CARRI process, which includes representatives of government officials from all levels,

and also business groups, NGOs, and FBOs (Lannom et al. 2009, 14–16). CARRI Gulfport emphasized the need to strengthen strategic partnerships with community organizations and involve them in decision making and planning (Lansford and Covarrubias 2008, 49; CARRI 2009d). Charleston's resilience process sought to include the "full fabric" of the community in its advisory group (Felts et al. 2009, 139), as did the other case-study communities.

One of the more obvious lessons learned from Hurricane Katrina was the need to establish mechanisms for the full participation of emergent organizations. Particularly in the absence of an effective federal response along the Gulf Coast, voluntary and spontaneous groups filled many voids in the response and initial recovery efforts (Colten et al. 2008). Making a place for such emergent groups to participate, without interfering or sacrificing safety, is essential to resiliency. Protocols that allow emergent groups to assist professional emergency responders can accelerate the response to a calamity. Charleston has established a mechanism for the United Way to coordinate the efforts of professional and voluntary organizations (Felts et al. 2009, 128). Volunteers Active in Disasters (VOAD) is now a presence in the Charleston Tri-County region and is currently under contract with Charleston County and is housed at United Way. United Way also manages the Tri-County 211 system, which provides information on community health and human resources. One outcome of the CARRI process in Memphis is an effort to reinvigorate the VOAD to increase the community's self-reliance; encouraging participation by nontraditional agencies, private sector, and NGO groups is an opportunity to address vulnerabilities (Lannom et al. 2009, 69–70). Gulfport reported that citizen self-sacrifice was an essential element in the community's response to Katrina. Two of the CARRI Gulfport roadmaps stress the importance of ensuring effective communication among the various organizations and also the need for families and individuals to be self-reliant (CARRI 2009d and 2009e).

Efforts to establish resiliency may be less effective unless communities maintain and constantly upgrade plans and procedures. Resilience is an ongoing process (Manyena 2006), and lessons of the past must be relayed to the next generation (Colten and Sumpter 2009). Gulfport authors argued that it is essential to integrate the concept of adaptation to hazards into citizen discourse through ongoing education (Lansford and Covarrubias 2008, 9). Examples from Gulfport include the role of established NGOs and government bodies regularly providing information to small businesses. The Red Cross and the Small Business Administration help disseminate vital information on hurricane preparedness on a regular basis (Lansford and Covarrubias 2008, 47). Family and individual resilience is also a major focus of CARRI Gulfport (CARRI 2009e). The CARRI Advisory Group in Memphis, likewise, stressed the importance of ongoing training to maintain resilience. One tool used to reach the public was a series of television public service announcements and also a three-part series devoted to earthquake preparedness. A range of public outreach and education efforts is part of the Memphis resilience strategy (Lannom et al. 2009, 66). Lessons learned can then be folded into regular training and practice drills.

Social vulnerabilities, such as poverty and poor education, can reduce a community's resilience. Addressing and diminishing core social problems can enhance resilience and thereby reduce the diversion of recovery resources. Important steps include identifying those areas of a community where chronic vulnerabilities exist (Cutter et al. 2000) and then charting a course to address those ills. Charleston reported on several vulnerable populations — impoverished

residents, senior citizens, and also tourists. The large number of federal employees provides some degree of economic resilience since these workers will not suffer payroll interruptions and thus will buoy the economy after a disruption. Vigorous economic development projects continually seek to expand the employment base, but the tourism economy requires a sizable pool of low-wage workers which maintains a near-poverty population. Projects are under way to create mixed-income housing and reduce the concentration of poverty in parts of the Charleston urban area (Felts et al. 2009, 15–16). Retirees in the Charleston area tend to have adequate financial resources, but they may lack family networks, mobility, and physical capabilities to make them resilient (Felts et al. 2009, 41–42). The region continues to attract retirees, and local officials recognize the need to include them in resilience preparations.

Lack of education tends to increase vulnerability and commonly is associated with poverty — further reducing the resiliency of some citizens. Efforts are under way in Memphis to identify locations where resources for resilience are in short supply, but where community cohesion is strong. Local organizations can then target these areas for training to overcome the personal inabilities of the residents to prepare on their own (Lannom et al. 2009, 47). By identifying vulnerable populations, more efficient use of resources is possible. Another fundamental concept that the Memphis team identified was that residents must be prepared to be self-reliant for a period of time after a massive disruption (Lannom et al. 2009, 81). This concept is emphasized by the Gulfport group as well (CARRI 2009e). While these steps do not eliminate the underlying cause of poverty or inadequate education, they seek to reduce vulnerabilities that result from them and thereby enhance resilience.

Gulfport's recent experience with Hurricane Katrina ran counter to some typical discussion of vulnerable populations; that is, the most vulnerable tend to live in the most hazardous locations (Colten 2005). Provisions in the evacuation system need to be improved to enable vulnerable citizens to move out of harm's way (Lansford and Covarrubias 2008, 42). Various economic development projects after Katrina have tried to promote better employment opportunities and thereby reduce poverty (Lansford and Covarrubias 2008, 43). Affordable housing for low-income residents remains a critical concern after Katrina, as does the provision for mental health services (Lansford and Covarrubias 2008, 66 and 70; CARRI 2009c). The elimination of vulnerabilities continues to challenge the CARRI communities.

## 5. RESPOND

Hazards researchers have directed considerable attention to the response phase. It covers the initial deployment of emergency personnel and resources in the period immediately before, during, and after a hazard event. Most communities staff basic emergency response personnel (Tierney 2009) such as fire departments, police, and emergency medical responders, while states maintain National Guard units and emergency preparedness agencies as supplemental to local resources. Day-to-day operations consume the time of municipal personnel, and even before 1940s-era Civil Defense plans spelled out formal emergency response activities, they were important to a community's response to large-scale hazard events. But much of the planning for their participation has been limited to the emergency response phase, the immediate aftermath

of a disruptive event. Resilience demands that the emergency response overlap with the restoration period (Colten et al. 2008), and community response should be designed to continue seamlessly through this transition.

This section considers pre- and post-event responses (Tierney 2009). Pre-event actions include issuing warnings and putting emergency plans into operation and, when possible, mobilization of emergency personnel and equipment, evacuation, and other essential protective measures. For slow-moving hurricanes, river flooding, and pandemics, ample notice is usually available, but for tornados, earthquakes, and chemical plant explosions, the warning period is brief or nonexistent. Nonetheless, for events with minimal advance notice, pre-event response includes maintaining the capacity to respond effectively — the anticipation element of resilience. Post-event response includes such steps as emergency search and rescue, stabilizing local conditions, secondary evacuation, providing initial medical and mortuary services, and restoring fundamental social order. These actions typically occur within hours or days of an event.

## 5.1 Pre-Event Response

A first step in the pre-event response is to operationalize monitoring, forecasting, and warning systems. Charleston and Gulfport have access to National Weather Service forecasts and warnings for hurricanes, and in the pre-event response stage, communities pay close attention to that information and use it to deploy resources. These national programs provided ample warning for their most recent encounters with tropical cyclones — Hugo in 1989 and Katrina in 2005. Warnings prompt responses by South Carolina's incident command system (Felts et al. 2009, 121). Charleston County also has a reverse 911 system, an automatic telecommunication mechanism that can dial all numbers in a community and issue warnings to individual residences (Felts et al. 2009, 3). Memphis encountered a serious "straight-line" wind event in 2003. Although it has monitoring and warnings systems for tornados, the so-called "Hurricane Elvis" provided a surprise event and prompted discussion of creating a distinctive warning for such events (Lannom et al. 2009, 78–81). Truly prepared communities are constantly reassessing and adapting their response procedures.

Following warnings, communities should implement the first stages of their emergency plans. For coastal communities facing hurricanes, this typically includes evacuations. Charleston area residents staged a fairly successful evacuation prior to Hugo in 1989, and the region was able to test its evacuation plan when Hurricane Floyd bore down on the Carolina Coast in 1999. Congestion characterized both the 1989 evacuation and the 1999 trial run and enabled a reassessment of the region's transportation system. Subsequently, the area's Council of Governments developed a comprehensive transportation plan (Felts et al. 2009, 71–72), and the CARRI advisory group has issued a roadmap for transportation and mobility improvements specifically oriented toward an effective response to a hazard event (CARRI 2009b). Charleston-area CARRI participants observed that the region's infrastructure is "transit unfriendly" and advocate transit-oriented development that includes transit centers as part of new developments (Felts et al. 2009, 77). Establishing strategically distributed centers would aid emergency evacuation for those who rely on public transit. Gulfport ordered a mandatory

evacuation of the lowest areas, and many residents fled before Katrina made landfall. Higher areas, which included hospitals and their hard-to-move patients, were not subject to an evacuation order. As was the case when Hurricane Camille made landfall in 1969, some residents declined to evacuate (Barr 2005). Plans for evacuation exist, yet Gulfport has no "current hurricane evacuation study" (Lansford and Covarrubias 2008, 53). The community's recent experience (including Hurricane Gustav) provides ample data to evaluate its evacuation's effectiveness. The great promise lies in educating people as to the importance of evacuation.

Positioning emergency supplies, personnel, and finances represents the next pre-event response. All three case-study communities have well-organized plans for pre-positioning medical and public safety personnel for impending hazard events. Although many of the structures housing medical facilities are vulnerable to extreme events, redundancy, particularly in Memphis and Charleston, offers some measure of resilience in terms of the emergency response phase. Opening and making emergency facilities and shelters available is the logical sequel to positioning supplies and staff.

Communicating with populations is another critical dimension of the pre-event response. All communities report coordinated systems to disseminate warnings and guidance. The Charleston reverse 911 system is an example, as are the warnings offered by the National Weather Service. Memphis reported that poor communication following the 2008 tornados produced public dissatisfaction, thus underscoring the need for effective communication before and following an event (Lannom et al. 2009, 85). Gulfport officials found that "texting" provided a more reliable means of communication after Katrina, and now they include that mode of communication in their planning (Gulfport CARRI Team 2009b). Finally, local news teams play a vital role as well in major media markets.

## 5.2 Post-Event Response

In the immediate aftermath of a hazard event, emergency personnel initiate search and rescue for survivors, along with identifying the deceased. All communities reported plans for a coordinated emergency response. Local, state, and federal emergency preparedness organizations are poised to collaborate on emergency phase activities. Gulfport and Charleston have had recent experiences with massive hurricane strikes, and both reported that in addition to full-scale mobilization of their own personnel, having a sizable military presence in their communities added valuable human resources to the task (Felts et al. 2009, 14; Lansford and Covarrubias 2008, 27). Charleston has county-level Emergency Operations Centers that coordinate emergency law enforcement, fire, and medical responses in the region (Felts et al. 2009, 124). Memphis emergency personnel responded to "Hurricane Elvis" in 2003 and the tornado outbreak in 2008. While the responders' self-assessment found their actions satisfactory, some local residents voiced dissatisfaction with the government's outreach — suggesting room for improvements (Lannom et al. 2009, 85).

Sheltering and providing for displaced residents is the next vital step in post-event response. Gulfport has the most extensive recent experience with this phase. Shelters and provisions were in position before Katrina, although demand for food and water quickly exhausted resources on hand (Lansford and Covarrubias 2008, 26–27). While shelters and emergency facilities were

operational following Katrina, the extent of damage caused by the storm strained their ability to deliver services for an extended period of time following the event (Lansford and Covarrubias 2008, 26–27). In addressing lessons learned from Katrina, local authorities have reassessed the administration of shelters and recommended adaptive management with local leadership (Lansford and Covarrubias 2008, 45; see also CARRI 2009c).

Restoring order is another fundamental stage in a community's response. There is always the threat that civil disorder can erupt as normal conditions devolve following an extreme event (Tierney 2009). Memphis reports that its normal law enforcement plan provides a framework that will maintain order through a disruption (Lannom et al. 2009, 88). Charleston notes that the large number of military stationed in the area could provide additional assistance following an event (Felts et al. 2009, 52; Lansford and Covarrubias 2008, 28). Since the military's primary responsibility is not local response, local planners cannot expect those personnel to remain in the area if they are dispatched elsewhere. Gulfport's recent experience highlights important aspects of restoring order. Fires, both structural and woodland, broke out following the 2005 hurricane and challenged firefighting organizations that had lost equipment in the storm (Lansford and Covarrubias 2008, 27). Gulfport also noted the potential for terrorism and disease outbreak in the wake of an extreme event as concerns for local law enforcement and other members of the emergency response community (Lansford and Covarrubias 2008, 34). Fires, terrorism, epidemics, and economic failure after an event can expand the disruption and can strain already taxed mechanisms in place to maintain order.

Damage assessment and prioritization of repairs is another post-event procedure. Public utility firms in Charleston, Gulfport, and Memphis all have tested procedures to identify failures in their electrical grids and to direct crews to address them (Memphis Urban Area Capstone Meeting 2008; Charleston CARRI Advisory Group Meeting 2009; Ghosts of Katrina Conference 2009). State highway departments and municipal street and public works crews perform similar assessments with bridges and roads. Following Hurricane Hugo, for example, the Corps of Engineers assisted with damage assessment in Charleston (USACE 1990, 19). Mississippi Power put a well-rehearsed response into action after Katrina and swiftly assessed its situation and needs in 2005 (Smith 2009b).

Following damage assessment, the many interrelated companies and agencies must initiate coordinated efforts. After Katrina, Gulfport-area officials sought to open main arteries and swiftly restore energy supplies. Mississippi Power was able to deliver electricity throughout its service territory ahead of its initial projections (Ghosts of Katrina Conference 2009; Smith 2009b). Plans for the Memphis utilities, airport, and port incorporate resiliency into their strategies to mitigate vulnerabilities and to resume functions (Lannom et al. 2009, 81 and 91). After Hugo in 1989, the Corps of Engineers provided technical assistance to state agencies in reopening critical transportation links that included navigation control facilities (USACE 1990, 16–18). Charleston emphasizes the importance of effective communication to ensure the respective agencies can implement post-event responses, including repairs. The multiple responding organizations must share information, blend talents, and work cooperatively.

In addition, mobilizing human capital in response to an event is vital. Memphis found that its citizens decided to remain in the city in the face of a nineteenth-century yellow-fever epidemic. Doctors, nurses, priests, nuns, brothers, sisters, and friends all volunteered to care for

one another throughout the course of the epidemic. The duration of the epidemic was daunting and certainly influenced the expression of resilience we characterize in hindsight. The community pulling together and refusing to abandon seems critical and obvious, but combining that with leadership and opportunities in a way that is relevant was key to Memphis' existence today (Lannom et al. 2009, 77, 78). Gulfport observers, likewise, concluded that deep attachments to a place compelled citizens to stay and participate in the immediate post-Katrina response (Ghosts of Katrina Conference 2009). Charleston's plan calls for including organizations and permitting emergent organizations to participate in the response phase (Felts et al. 2009, 118; CARRI 2009a). A resilient response, therefore, relies on thorough planning, capable execution under effective management, and the dedicated efforts of individuals and organizations acting in concert.

## 6. RECOVER

Recovery from a disturbance involves several stages. Following the emergency response, the rapid recovery includes the complete restoration of basic and essential utilities and services, along with sheltering government operations, residents, and commercial activities so that they can function, and resuming the basics of educational services and the economy. The rapid recovery phase may take weeks or months. Longer-term recovery may take many years and includes more complete rehabilitation and reconstruction of private and public buildings, a full-fledged restoration of all sectors of the local economy and other services. A resilient community seeks to recover rapidly, without sacrificing safety or equity. Following a calamity, communities generally adopt a goal of making the local landscape safer and better than before the event. While this goal is not always attained, it provides initial guidance for the long-term recovery phase depending on the scale of the damages sustained (Colten et al. 2008). Long-term recovery also includes a commemorative element by which communities seek to remember the losses and the sacrifices of their residents. Although the concept of ecological resilience defines recovery as returning to a pre-disturbance state, that is not always desirable in a human community as society incorporates lessons learned into creating a better, safer, and more equitable community (Colten et al. 2008; Tierney and Burneau 2007).

Tensions will emerge over what priorities to follow and which goals to strive towards during the recovery process. Resilient communities that have developed recovery plans will be able to implement actions that were pre-agreed upon with less post-event debate, minimal delays, and with greater consensus. The nearly 2-year struggle to adopt a satisfactory recovery plan in New Orleans after Katrina is a prime example of the impediments that can emerge when a socially inclusive advance recovery plan is absent (Colten et al. 2008).

### 6.1 Rapid Recovery

Following homeland security planning efforts in 2004, recovery plans became a priority in the Memphis urban region. Public bodies and private businesses have participated in developing recovery plans that emphasize the rapid recovery phase with less detail on the longer-term recovery phase, although recovery planning includes a 2-year time frame. Steps

have been taken to identify recovery needs and possible actions to address those needs (Lannom et al. 2009, 95); in 2009 Continuity of Operation/Continuity of Government (COOP/COG) training courses were held for all Urban Area Sensitivity Initiative (UASI) counties. Charleston operates within the South Carolina incident command system that emphasizes clear lines of authority and coordination of multiple agencies in the wake of an emergency (Felts et al. 2009, 121–122). After Hurricane Hugo in 1989, FEMA reported that "the minimal loss of life from Hugo can be attributed to the development and execution of an emergency preparedness plan by the state and local governments" (FEMA 1992, 35). While the same report notes elements in the rapid-recovery phase that needed improvement, the overall planning and management of the rapid recovery proved effective.

Providing adequate medical care for injured and traumatized victims is another fundamental aspect of rapid recovery. Many of Charleston's hospitals have adopted the incident command model to coordinate with public safety and emergency management agencies (Felts et al. 2009, 122). One goal is to ensure that authorities know which facilities are operational, thereby enabling them to direct victims to functional medical sites. Gulfport's Memorial Hospital had developed and tested emergency preparedness plans during previous hurricanes and was the only fully functioning hospital in the city by the end of the day following Katrina's landfall. Local emergency medical staff (EMS) operations coordinated with hospitals during the recovery phase (Lansford and Covarrubias 2008, 53). Memphis boasts a strong medical community, and local planning includes provision for "mass care and victim services." Nonetheless, there is concern that hospitals might be unable to accommodate all victims from a major calamity, and plans for using the resources of private practices could alleviate stress on hospitals (Lannom et al. 2009, 86).

Less explicit in the local case studies are rapid-recovery provisions for reassembling dispersed families and restoring basic social networks. In the wake of Katrina, despite massive telephone service disruption, cell phones, and their texting capabilities in particular, provided a critical means for family members and organizations to contact one another (Gulfport CARRI Team 2009b). The geographic scale and frantic nature of the secondary forced evacuation from New Orleans after Katrina, however, fractured many family and social groups, and it took months for social service organizations to create databases and reassemble families and other social groups. Preexisting networks such as churches and Mardi Gras Krewes and social clubs also served as informal communication webs to reconnect dispersed residents. The Vietnamese community in New Orleans, operating through its principal Catholic church, demonstrated remarkable resiliency in terms of restoring its own social connections (Airriess et al. 2007).

Restoring basic civic institutions is an obvious element in the community case studies. In the wake of Hurricane Hugo, strong municipal leadership in Charleston directed the restoration of city government. The city set up various emergency relief programs and provided leadership as the community moved into longer term recovery (U.S. House of Representatives 1990, 125). Currently, provisions for emergency operation centers enable law enforcement, fire, and other emergency service providers to coordinate their efforts following a disruptive event (Felts et al. 2009, 124–125). Gulfport suffered massive loss of police and fire department structures during Katrina's onshore passage. Ten of its 12 fire stations were destroyed or severely damaged (Lansford and Covarrubias 2008, 43). To guide restoration of civic institutions following

disruption, Gulfport now has procedures in place to allow the mayor and the city's emergency manager to stay abreast of events and guide the rapid recovery efforts (Lansford and Covarrubias 2008, 51).

Reestablishing the basics of the local economy (hardware, grocery, pharmacy, gasoline, etc.) is imperative to allow residents to return and be present throughout the recovery. Private-sector efforts are most prominent in this element of rapid recovery. Giant chains, such as Wal-Mart and Home Depot, maintain emergency planning groups that help route supplies and reopen stores in disrupted areas (Lansford and Covarrubias 2008, 62 and 76–77; also see Colten et al. 2008). Rapid reopening of gas stations has emerged as one of the most critical functions. Not only are emergency vehicles dependent on fuel, but the massive utility and road repair crews, debris removal and cleanup teams and their vehicles, insurance adjusters, and residents returning to secure and restore their properties also require gasoline. For local business owners, restoring cash flow is essential to survival. A Gulfport restaurateur reported that he reopened as soon as power was restored and enjoyed a windfall of business preparing box lunches for utility crews operating in the devastated city after Katrina (Ghosts of Katrina Conference 2009). Rapid return of small businesses depends on adequate preparation by owners. To assist businesses that are too small to dedicate staff to emergency preparedness, the local chamber of commerce provides recovery planning assistance (Lansford and Covarrubias 2008, 76–77). The Memphis Chamber of Commerce is helping assemble preparedness checklists to aid small businesses, and classes and seminars in preparedness are available to small business owners in Charleston. Preparation of basic plans, sharing those plans with staff, and circulation of essential contact information among employees can provide solid footing for recovery.

Storm damage was particularly acute to the gaming industry in Gulfport, which by law had to operate on waterborne gaming facilities. Wind, storm waves, and surge drove most of the gambling barges onto land and forced the closure of the shoreline hotels and casinos. A massive infusion of corporate dollars enabled some casinos to reopen by New Year's Eve 2005 (Lansford and Covarrubias 2008, 63).

Charleston has a well-developed tourism economic sector, with many small businesses. Disruption by a massive hurricane could cause a severe interruption in the arrival of tourists and a related decline in tourism revenue. According to the Charleston case study, the presence of an elastic college-student labor pool, which can contract or expand as employment opportunities change, enables a resilient response by this sector (Felts et al. 2009, 56). Federal small-business loans also seek to provide a means to put local businesses back in operation. There seems to be room for expanding the connections between public recovery plans and private sector efforts.

The infusion of federal, insurance, and charitable funds for rapid recovery tend to have a positive impact on local economies. Repairs and initial reconstruction create jobs in numerous sectors — construction, food service, and lodging. While the short-term demands may strain local capacity, the infusion of funds is beneficial to the economy of impacted areas (Fontaine Company 1991, 16).

Restoring health and financial institutions is imperative to rapid recovery. Hancock Bank, based in coastal Mississippi, had plans to move its data operations to a secure location in Chicago and was able to restore basic operations remotely well before its damaged Gulfport headquarters was ready to be occupied (Ghosts of Katrina Conference 2009; Smith 2009a).

Reopening core cultural and educational institutions is the final element of the rapid recovery process. Personnel returned to examine damage at educational institutions along the Gulf Coast within days after Katrina. While some buildings remained unusable nearly 4 years after the storm, concerted efforts by local school boards and university administrators sought to reduce the time schools remained closed (Ghosts of Katrina Conference 2009; Governor's Commission 2005). The Mississippi Governor's Report on Katrina indicated that enrollment in coastal area schools had reached 75% of pre-storm levels by December 2005 (Governor's Commission 2005, 124). Longer term recovery depended in part on restoration of the gaming industry, which provided a sizable part of the tax base for education (Governor's Commission 2005, 124).

## 6.2 Long-Term Recovery

With the restoration of basic public works (roads, power, water, sewage, and garbage), public safety facilities (police and fire protection), and the rudiments of a local economy, restoration of residential housing becomes a prominent element of the longer term recovery. Hurricane Hugo, for example, damaged over 111,000 residences and destroyed over 9,000 among that number as it passed over South Carolina in 1989 (Fontaine Company 1991, 61). There was a surge of building permits, and at the 1-year mark, the governor's office reported that recovery in the housing sector was nearly complete (Fontaine Company 1991, 68). Despite the swift restoration, the governor's report expressed concern about the long-term quality of the repairs (Fontaine Company 1991, 69). And indeed, the historic preservation community reported many problems with poorly executed roof repairs that leaked after only a few years, causing a wave of delayed and secondary damages.

Following Hurricane Katrina, Gulfport and coastal Mississippi faced considerable housing challenges (Lansford and Covarrubias 2008, 11). Mississippi did not have a long-term housing recovery plan in place, but it initiated a housing needs assessment as part of its recovery effort. It sought to identify the immediate needs, select best practices for rebuilding (land-use zoning and building codes), and develop strategies to encourage safe construction in the region (Governor's Commission 2005, 65–68). The number of residences available in Gulfport was higher in 2006 than in 2000. This represents a rapid rebound in terms of houses. Yet, low-income housing was severely impacted, and the recovery of this sector was not as rapid as the overall trend, thereby limiting options for low-income residents (Lansford and Covarrubias 2008, 12). Thus, the housing recovery has been uneven. A CARRI-facilitated work group developed a roadmap for addressing certain aspects of the affordable housing challenges facing the community (CARRI 2009c).

Long-term recovery also encompasses restoration of local institutions and rehabilitation of facilities so they are safer, better, and more equitable than before the disruption. The involvement of Memphis agencies and organizations with displaced Katrina evacuees highlighted the importance of equitable recovery and brought that concern to the forefront of the Memphis resiliency discussions (Lannom et al. 2009, 96–97). Indeed, with its own low-income population, the MUA faces serious challenges, but it found elements of resilience within the most vulnerable places. Its long-term recovery planning seeks to identify, sustain, and

strengthen resilience in the places where vulnerability and resilience coexist (Lannom et al. 2009, 98). Efforts to address the conditions that create vulnerable populations before an event reduce the diversion of community-wide resources during recovery.

Gulfport also reported on an additional element of the long-term recovery that has become prominent in post-Katrina deliberations. Mental health of residents has become an item of intense scrutiny since 2005, and long-term recovery efforts must encompass mental health. Experience in Gulfport has shown that many mental health providers left, at least temporarily, after the devastating storm. All the while, there was a growing need for mental health services for residents who endured the trauma of the storm and its aftermath. Planners need to provide increased mental health care and also encourage residents to take advantage of this service (Lansford and Covarrubias 2008, 71). The Gulfport Area Interfaith Disaster Task Force addressed this pressing need as part of a broader agenda to serve vulnerable populations. The group coordinated FBOs that desired to lend a hand and identified mental health as a critical recovery need. It brought in experienced trauma counselors to provide care for the caregivers and hosts an annual summit to maintain preparedness and share the lessons learned (Avila 2009).

Expanding and improving the local economic recovery is also part of the longer term process. Gulfport has adopted the transect model to guide its recovery efforts. This model strives toward community development that includes the full range of land uses and transportation options, and this model involves land-use analysis and zoning to direct redevelopment. In addition, due to the damage to the waterborne casinos, the Mississippi legislature quickly approved onshore casino construction after Katrina to allow restoration of this economic activity in safer locations. One of the critical lessons from Katrina has been the importance of having longer-term recovery plans on hand before a disruptive event. While Mississippi and Gulfport acted rapidly to modify existing regulations and plans, revamping plans in the midst of rapid recovery can distract communities from other more immediate needs. Furthermore, hurried development of plans during the rapid-recovery stage may ignore input from some stakeholders who have been displaced following a disruptive event.

The Katrina experience helped the Gulf Coast community understand the importance of a robust nonprofit sector to support both rapid and long-term recovery, and as a mechanism to facilitate integration of the needs of more vulnerable populations. Many local nonprofit organizations lost equipment, records, and facilities to Katrina, and there has been great emphasis within that sector to be well prepared for any future disaster.

## 7. CONCLUSIONS

Several key observations emerged from the case studies that can serve as guideposts for other communities launching resiliency programs. Grouped into five broad categories, they include (1) engagement across the social and political spectrum of a community, (2) buy-in from local leaders and effective leadership, (3) communication and coordination among many interdependent organizations, (4) ongoing preparation and training that extends from anticipation and reduction, through response, to recovery, and (5) flexibility in plans to enable a more agile response to the unexpected.

Community engagement. All three case-study communities recognized that they have vulnerable populations. Some of these vulnerable populations also have important social networks and support systems that provided essential resilience. Community resilience requires the inclusion of those groups in the deliberation and planning stages not only to make sure they are not neglected but to tap their knowledge and resilient qualities. The development of viable plans demands integrating those with the greatest needs and those with technical expertise and resources to overcome existing gaps in resilience. Also, through engagement, all sectors of a community become aware of plans and resources that will be available in the event of a hazard event. Inclusive planning includes not just shelter and economic needs but provisions for mental health assistance to those who require such assistance after an event. As the Memphis authors concluded, "Resilience is about relationships" (Lannom et al. 2009, 109) — and engagement nurtures relationships.

Leadership. Effective and trusted leadership is vital to maneuvering through the challenges of preparing for and responding to a disruptive event. This quality is equally important at all levels — federal, state, local, and organizational. It also demands an effective and prearranged chain of command and allocation of responsibilities that is practiced, and refined, before an event occurs. Leaders must be responsive to their constituents and must also cooperate with their counterparts. They must be responsive to changing circumstances and be agile in dealing with overwhelming challenges. They also must support building resilience at the community level and assemble qualified and experienced teams to guide the process. It is also important that they and their teams review past responses and recoveries so that they go into a response with adequate understanding of what has worked in the past.

Communication and coordination. Through the stages of anticipate, reduce, respond, and recover, communities must establish and maintain effective and redundant means of communication and coordination. This involves both informal and formal social networks and also hard systems. The resilient community has encouraged the creation and perpetuation of communication and coordination before an event and, in doing so, has ensured it will function in the wake of a disruption. Communication must be inclusive and reach all segments of the population regardless of language. Complex interdependencies of many organizations are a characteristic of society, and effective communication and coordination maintain functional relationships.

Ongoing preparations and training. Developing resilience is a long-term process and one that demands perpetual preparation and training that extends to all segments of the population. Plans require regular reassessment and updating, and there needs to be means to pass lessons learned from the past to new leaders as they move into positions of responsibility. Regular training, drills, and exercises will maintain channels of communication and reinforce cooperation among organizations while honing skills. Appropriate educational opportunities, mitigation and response training, and dissemination of information to all segments of the community are another perpetual obligation of a resilient community. Coordinated training also increases awareness of preexisting interdependencies and strengthens working relationships among organizations and stakeholders.

Flexibility. Resilient communities plan for the unexpected and maintain a readiness not just for the expected. As recent events on the Gulf Coast have shown, many surprises can be

embedded in extreme events that exceed anticipations. Plans, while essential, cannot deal with the myriad contingencies that may erupt. Consequently, leaders, emergency-response professionals, volunteers, and citizens must all be adequately flexible to adjust as events unfold.

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