

**RESILIENCE IN THE SOCIAL AND PHYSICAL REALMS:
LESSONS FROM THE GULF COAST**

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The Academic Faculty

by

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**RESILIENCE IN THE SOCIAL AND PHYSICAL REALMS:
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To the people of Mississippi who generously shared their stories

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TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iv
LIST OF TABLES	vii
LIST OF FIGURES	ix
LIST OF SYMBOLS AND ABBREVIATIONS	xi
SUMMARY	xiii
CHAPTERS	1
CHAPTER 1: INTRODUCTION	1
CHAPTER 2: LITERATURE REVIEW	6
Resilience	6
Disasters	9
The Built Environment	16
Social Networks	17
Social Networks and Resilience	19
The Built Environment and Social Networks	23
The Built Environment, Social Networks, and Disaster Resilience	27
CHAPTER 3: BACKGROUND ON THE MISSISSIPPI GULF COAST	30
Early History	30
Late Colonial Period	32
Antebellum Period	35
Post-Civil War Era	36
Modern Era	38
Hurricane Katrina	41
CHAPTER 4: RESEARCH DESIGN	48
Conceptual Model	48
Research Questions and Hypotheses	51
Methodology	55
Stage 1: Testing the Model with Empirical Data	57
Stage 2: Case Study Analysis	61
CHAPTER 5: STAGE 1 RESULTS	65
Model Variables	66
Descriptive Statistics	78
Discussion of Model Results	79
CHAPTER 6: STAGE 2	92
Results: Social Networks	103
Results: Resilience	112

Results: Built Environment	116
Results: Other Reasons for Resilience	125
Results: Reasons for Lack of Resilience	132
Discussion of Stage 2 Results	139
CHAPTER 7: SYNTHESIS OF STAGE 1 AND STAGE 2 RESULTS	144
1) Does a certain type of built environment result in a more resilient community?	144
2) Do those properties of the built environment make communities more conducive to social networking activity?	151
3) How does the effect of the built environment measure against other factors that are significant in forming robust social networks?	153
Additional Research Propositions	154
CHAPTER 8: EXAMINATION OF POST-KATRINA COMPREHENSIVE PLANS	157
CHAPTER 9: SUMMARY AND PLANNING IMPLICATIONS	166
Conceptual Model Revisited	166
Discussion of Built Environment Variables and Resilience	170
Discussion of Additional Resilience Factors Related to Planning	172
Ideas for Further Research	178
Conclusion	179
APPENDIX A: INTERVIEW PROTOCOL	181
APPENDIX B: CONSENT FORM	183
APPENDIX C: RECRUITMENT MATERIALS	186
APPENDIX D: EXERPTS FROM COMPREHENSIVE PLAN DOCUMENTS	187
REFERENCES	197
VITA	208

LIST OF TABLES

	Page
Table 1: Mean number of disasters per county during the period from 1965 to 2008	47
Table 2: Equation variables	60
Table 3: SIC codes used in social organization density measure	70
Table 4: Variables, variable descriptions, and data sources	75
Table 5: Descriptive statistics (N=3,222 blocks)	78
Table 6: Descriptive statistics of transformed variables	79
Table 7: OLS model results with local spatial fixed effects	80
Table 8: Statistically significant local fixed effects	88
Table 9: Comparison of OLS model with and without local fixed effects	88
Table 10: Global Moran's I Summary	89
Table 11: SL model results without local spatial fixed effects	90
Table 12: Descriptive statistics, case study communities	96
Table 13: Interview questions for Stage 2 analysis	101
Table 14: Total and average number of social networks by resilience category	104
Table 15: Total and average number of social networks by case study community	107
Table 16: 990 data by case study community, 2001 to 2011	110
Table 17: 990 data for Pascagoula without credit unions, 2001to 2011	110
Table 18: 990 data by organizations named in interviews	112
Table 19: Average resilience rating by resilience category	113
Table 20: Average resilience rating by case study community	113
Table 21: Sites and places mentioned by resilience category	116
Table 22: Sites and places mentioned by case study community	118

Table 23: Types of networks and places mentioned by resilience category	123
Table 24: Community resilience indicators	126
Table 25: Community resilience scores using DROP model data for Gulfport-Biloxi Metropolitan Statistical Area (MSA)	127
Table 26: Interview subjects' responses, alternative reasons for resilience	128
Table 27: Interview subjects' reasons for lack of resilience	132
Table 28: Elements found in goals of plans	159
Table 29: Elements found in vision statements of plans	160

LIST OF FIGURES

	Page
Figure 1: Relationships between elements in the research questions	3
Figure 2: Adaptive cycle	8
Figure 3: Map of New Orleans to Mobile railroad and population centers, circa 1890	37
Figure 4: Historic hurricane tracks and level of impact to Mississippi Coast	38
Figure 5: NOAA Hurricane Katrina forecast on August 28, 2005	43
Figure 6: Hurricane strikes versus population, three coastal Mississippi counties 1850 to 2010	46
Figure 7: Conceptual model	49
Figure 8: Research hypotheses	53
Figure 9: Research methodology	57
Figure 10: Matrix of case study selection criteria	62
Figure 11: Example data for selection of case study communities in Mississippi	63
Figure 12: Example of FEMA remote sensing data	73
Figure 13: Communities chosen by resilience and built environment characteristics	93
Figure 14: Map depicting locations of four case study communities.	94
Figure 15: Types of networks by resilience category	105
Figure 16: Types of networks by case study community	108
Figure 17: Comparison of ZIP code and study area geometries	111
Figure 18: Relationship between number of networks and resilience rating	115
Figure 19: Relationship between years lived in community and resilience rating	115
Figure 20: Types of sites and places mentioned by resilience category	118
Figure 21: Types of sites and places mentioned by case study community	119
Figure 22: Heat map and convex hull geometries of sites and places by case study community	121

Figure 23: Detail of heat maps of site and place density by case study community	122
Figure 24: Relationship between number of social networks and number significant places identified in interviews	123
Figure 25: Unrestored portion of the Ohr-O’Keefe Museum of Art in East Biloxi	125
Figure 26: Interview subjects’ alternative reasons for resilience	129
Figure 27: Interview subjects’ responses for lack of resilience	133
Figure 28: East Biloxi Library	142
Figure 29: Contrast between local facilities (Fleur de Lis French club, left) and casinos (Palace Casino, right)	149
Figure 30: Simplified conceptual model	167
Figure 31: Barrier islands of Mississippi	176

LIST OF SYMBOLS AND ABBREVIATIONS

APA	American Planning Association
CDC	U.S. Centers for Disease Control and Prevention
CNU	Congress for New Urbanism
CRS	Community Rating System
DROP	Disaster Resilience of Place model
FEMA	U.S. Federal Emergency Management Agency
FHA	Federal Housing Administration
FIRM	Flood Insurance Rate Map
GCCDS	MS State University College of Architecture Gulf Coast Community Design Studio
GIS	Geographic Information Systems
GORR	Mississippi Governor’s Office of Recovery and Renewal
GRPC	Gulf Regional Planning Commission
HUD	U.S. Department of Housing and Urban Development
IRB	Georgia Tech Institutional Review Board
IRS	U.S. Internal Revenue Service
MARIS	Mississippi Automated Resource Information System
MCIDTF	Mississippi Coast Interfaith Disaster Task Force
MDAH	Mississippi Department of Archives and History
MEMA	Mississippi Emergency Management Agency
NEMIS	National Emergency Management Information System
NGA	National Geospatial-Intelligence Agency
NLCD	U.S. Department of Agriculture National Land Cover Database

NOAA	U.S. National Oceanic and Atmospheric Administration
NRHP	U.S. National Register of Historic Places
SEOC	Mississippi State Emergency Operations Center
SIC	Standard Industrial Classification System
TIGER	Topologically Integrated Geographic Encoding and Referencing
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

SUMMARY

Community resilience to disasters is defined as an affected area's ability to rebound after a catastrophic event. The mounting frequency and scale of natural disasters, increasing urbanization, a growing reliance on interdependent technologies and infrastructure systems, inflated expectations of interventions, and the emergence of a just-in-time economy are responsible for greater disaster vulnerability and demonstrate the need to develop more resilient communities. Given the increasing shocks of natural disasters, a more complete understanding of resilience is important for creating safer, more sustainable communities.

One factor that is known to impact resilience is social networking. Planners recognize the importance of social networks in planning more resilient communities and in informing the planning process in general, but it remains a fuzzy concept, as networks can be difficult to identify and measure. However, the built environment has been shown to influence social networks. Urban planning research has shown that walkable, mixed-use neighborhoods can encourage the development of social capital and place attachment through an increase in interactions and a higher likelihood of neighborhood amenities, including characteristics of the built environment that influence social networks, such as varied land uses and pedestrian-oriented design. The built environment is a physical, social, and symbolic anchor to everyday habits, a familiar framework of orientation, and a support system for social networks. In short, the built environment connects residents to a place and can serve as a benchmark for recovery. Therefore, it is possible that the traditional planning domain of urban design can be harnessed to foster greater resilience by facilitating stronger social networks.

In order to determine the legitimacy of this supposition, the proposed research asks how social networks and the built environment reinforce one another to create greater resilience to disasters. Given that social networks increase community resilience to all types of disasters, social networks are shown to be influenced by certain types of space, and the built environment

is a common intervention for planners, this research explores the potential for creating cities that are more resilient by creating spaces that foster social networks.

The Mississippi Gulf Coast was chosen as a case study area in order to explore the above relationships. In 2005, Hurricane Katrina struck at roughly the Mississippi-Louisiana border, resulting in massive wind and storm surge damage to the Mississippi Coast. Communities in the area have recovered at varying rates and levels. Therefore, this region provided an opportunity to contrast higher and lower resilience communities and to test the research questions.

The research was conducted in two stages. In the first stage, a quantitative model was developed in order to address whether there are statistically significant effects on resilience due to the built environment. A metric of resilience was the dependent variable and built environment metrics were among the independent variables in a multivariate linear regression model. Control or test variables, such as socio-demographic variables, were also included as independent variables in the model. In the second stage, a qualitative case study analysis of communities was undertaken using interviews with local residents. Four case study communities were selected for further investigation based on results the initial analysis, specifically on measures of resilience and built environment configurations. Case study communities were classified by 1) their ability to withstand and recover from the hurricane, or their resilience and 2) the type of built environment found in the community.

The results demonstrate that certain aspects of the built environment are associated with greater resilience, including intersection density, net residential density, the density of historic sites, and the density of community amenities where social networks gather. These types of features were also shown to be linked to formal and informal social networks in the interview process. Faith-based groups were the most common social networks that interview subjects engaged with. Residents of high-resilience communities tended to have greater local ties to friends, schools, businesses and local nonprofits, networks with concentrated local ties. In contrast, residents of low-resilience communities tended to have greater ties to federal, state, university, military, and national or international nonprofits, networks that are external by nature.

CHAPTERS

CHAPTER 1: INTRODUCTION

Natural disasters have received increased attention from the media, governments, nonprofit organizations, and the public at large. The mounting frequency and scale of such events, an increase in urbanization, a growing reliance on interdependent technologies, raising expectations of interventions, and the emergence of a just-in-time economy have demonstrated the need to plan for catastrophic events to ensure resilient communities.

Resilience is defined as a “...measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables” (Holling, 1973). When applied to disasters, resilience is defined as an affected area’s ability to rebound after a catastrophic event. This may mean a community returns to its previous state or status quo or that the community stabilizes into a new regime. Although the relative resilience of a community is only fully known after the fact, there are patterns of community characteristics that contribute to resilience. Understanding the contributing factors to resilience can save lives and reduce the costs to communities facing disasters. Therefore, given the increasing shocks of natural disasters, a greater understanding of resilience is important for creating safer, more sustainable communities.

One factor that is widely believed to impact resilience is the presence of strong social networks. Planners recognize the importance of social networks in planning more resilient communities and in informing the planning process in general (Healey, 1998), but it remains a fuzzy concept in some ways, as networks can be difficult to identify and measure. However, particularly when telephone and electricity services are interrupted, as after Katrina, our geographically based social ties are important for household- and community-level disaster resilience.

The built environment has been shown to influence social networks (Entwisle, 2007; Fischer et al., 1977; Rutten, Westlund, & Boekema, 2010). The built environment also matters

for resilience, as it is a physical, social, and symbolic anchor to everyday habits, a familiar framework of orientation, and a support system for social networks. In short, the built environment connects residents to a place and can serve as a benchmark for recovery. Therefore, it is possible that the traditional planning domain of urban design can be harnessed to foster greater resilience by facilitating stronger social networks.

In order to determine the legitimacy of this supposition, this research asked how social networks and the built environment reinforce one another to create greater resilience to disasters. Given that 1) social networks increase community resilience to all types of disasters, 2) social networks are shown to be influenced by certain types of built environments, and 3) the built environment is a common intervention for planners, this study explored the potential for creating cities that are more resilient by creating a built environment that fosters social networks.

The specific research questions (diagrammed in Figure 1) included

- 1) Does a certain type of built environment result in a more resilient community?**
- 2) Do those properties of the built environment make communities more conducive to social networking activity?**
- 3) How does the effect of the built environment measure against other factors that are significant in forming robust social networks?**
- 4) Based on the results, what are the implications for planners?**



Figure 1: Relationships between elements in the research questions

It was hypothesized that communities with viable public spaces such as parks, with walkable street networks, with densities that are conducive to social interaction, with many historic properties and neighborhoods, and with other strong “sense of place” characteristics produce stronger social networks and, as a result, these communities exhibit greater resilience. Conversely, communities with characteristics of the built environment such as disconnected street networks, lack of open space, or concentrations of poverty that are known to produce marginalization and undermine the generation of social ties exhibit less resilience.

To allow for comparison across many types of communities, this research focused on the response of various communities to a specific disaster that has resulted in uneven recovery: the 2005 Gulf Coast hurricane season. Evidence from a previous study conducted through the Federal Reserve Bank of Atlanta suggests that Katrina recovery has produced an increase in social mobilization, which is thought to increase adaptive capacity of communities through the strengthening of social networks (Carpenter & Montoya, 2011). As part of the Federal Reserve study, interviews with neighborhood residents of Bay St Louis, Mississippi and Broadmoor, New Orleans, Louisiana also highlighted the importance of the built environment, including the

rebuilding and preservation of historic districts and the restoration of major infrastructure, such as bridges and causeways (crucial features given the coastal topography). These structures are more than gathering places and thoroughfares; they embody the collective memory of residents, the bricks and mortar that make a community a physical manifestation of the achievements and aspirations of people. Furthermore, certain community groups characterized by strong social networks have organized or strengthened in the wake of the 2005 hurricane season with transformative effects, and other communities lacking strong social ties have faltered.

Hurricane Katrina struck the Gulf Coast in August 2005, with wind and storm surges causing devastating losses of life and property. The landfall location and strength of the storm made it among the deadliest and the most costly hurricane in U.S. history, with more than 1,300 dead, one million people displaced, \$80 billion in property damage, and 90,000 square miles of land impacted (Cutter et al., 2006). Social systems in the region were significantly altered: individuals, households, extended families, businesses, entire communities, as well as local, state, and regional agencies and organizations were affected. For months after the storm, the stories and images transmitted from the region were grim. Research from a variety of disciplines has since examined how the area responded, often focusing on success and reform from the grassroots.

This research used a mixed methods approach including first a quantitative model followed by qualitative interviews with residents in four case study communities. The study area was limited to Mississippi, although the storm impacted Louisiana and Alabama as well. The type of damage and response was very different in each area, with Mississippi sustaining wind and storm surge damage typical of a strong hurricane, while New Orleans struggled with levee failures and prolonged flooding. Investigation of the Mississippi Gulf Coast allowed comparison of a wide variety of communities impacted by a catastrophic event at a common point in time. A variety of development patterns exist in Mississippi, including high- to medium-density urban, pre-war single family neighborhoods, post-war suburbs, traditional small towns, waterfront resort communities, rural areas, and many others. Therefore, comparison

among and across several of these typologies was possible. This allowed the ability to categorize communities by built environment and to compare initial versus present conditions in order to develop theories about the interrelated issues of social networks and the built environment.

The findings dovetailed with findings from psychologists, sociologists, anthropologists, and disaster management experts. As expected, social networks were found to be critical for disseminating information and resources and providing emotional support among residents. These types of social interactions are rooted in space, naturally. In interviews, residents spoke of the importance of specific places or landmarks, even those that had been destroyed by storm damage. What emerged from this research was the notion that the built environment – the universe of buildings and other spaces constructed by humans – has an impact on resilience by supporting and reinforcing social networks. The built environment provides opportunities for interaction but is also imbued with cultural meaning and identity over time.

We are an increasingly mobile and technologically linked society, but our desire to make our homes in “livable” communities has intensified in recent decades. Creating the kinds of spaces that support *triangulation*, or the phenomenon in which activity and social interaction prompt one another (Whyte, 1980), has many economic and social benefits and is associated with safer, more resilient communities.

CHAPTER 2: LITERATURE REVIEW

The research questions are better understood with a brief background of the core concepts. Studies concerning resilience, natural disasters, social networks, and the built environment can be found in a number of disciplines. The following literature review defines and reviews relevant work related to each concept as well as connections that have been made between the concepts.

Resilience

Resilience has been defined as a “...measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables” (Holling, 1973). Thus, when applied to disasters, resilience is an affected area’s ability to rebound after a catastrophic event. For most communities, this would mean first the return of lifeline infrastructures such as utilities, food and water, and shelter. Longer term, this would mean the return of households and businesses and a return to self-sufficiency and effective governance. Most sources argue that resilience is achieved when resources and capabilities are drawn from within the community to bring these systems back online (Paton, 2000). A community’s adaptability to change or adaptive capacity is strongly related to resilience; collectively, individuals can influence resilience by affecting and responding to change in the system (B. Walker, Holling, Carpenter, & Kinzig, 2004). Reliance on one method or system can lead to instability, whereas flexibility and redundancies in a community allow for contingencies in case of a catastrophe, which is particularly evident in interdependent infrastructure systems such as the information technology and energy sectors (Cutter et al., 2008).

Cycles of change in social and ecological systems can be illustrated through the adaptive cycle (Peeples, Barton, & Schmich, 2006) (Figure 2). Within the cycle, there are four stages of rapid growth, conservation, release (or crisis), and reorganization. The rapid growth stage is characterized by weak connections and regulation; during the conservation stage connectivity is

improved and resources are accumulated (specialization and economies of scale begin to appear), and vulnerability increases due to changing conditions; the release stage occurs when major events or crises are sufficiently intense to upend the system (this includes the breaking of connections and weakening of control); and reorganization is the rebuilding stage that is experimental, inventive, and includes the creation of new connections. Rapid growth and conservation are often called the fore loop of the adaptive cycle and reorganization and release are termed the back loop. Fore loop processes are stable and predictable and allow the accumulation of capital, back loop processes are characterized by uncertainty and loss of capital. Although back loop reorganization can throw a system into disarray, it can also have positive results for a system lodged in a conservative fore loop phase. Different stages of the cycle can be experienced at different scales in a system (this phenomenon is called a panarchy, or a hierarchy encompassing all possible levels of systems) (Gunderson & Holling, 2002). Though social-ecological systems are affected by many variables, a few important often slow-moving variables drive change in the system. The adaptive cycle and panarchy concepts can be applied to urban systems in general and social systems in particular and inform our understanding of how disturbances affect communities. Identifying the stages of the adaptive cycle as they relate to a particular community may be useful both before and after a disaster.

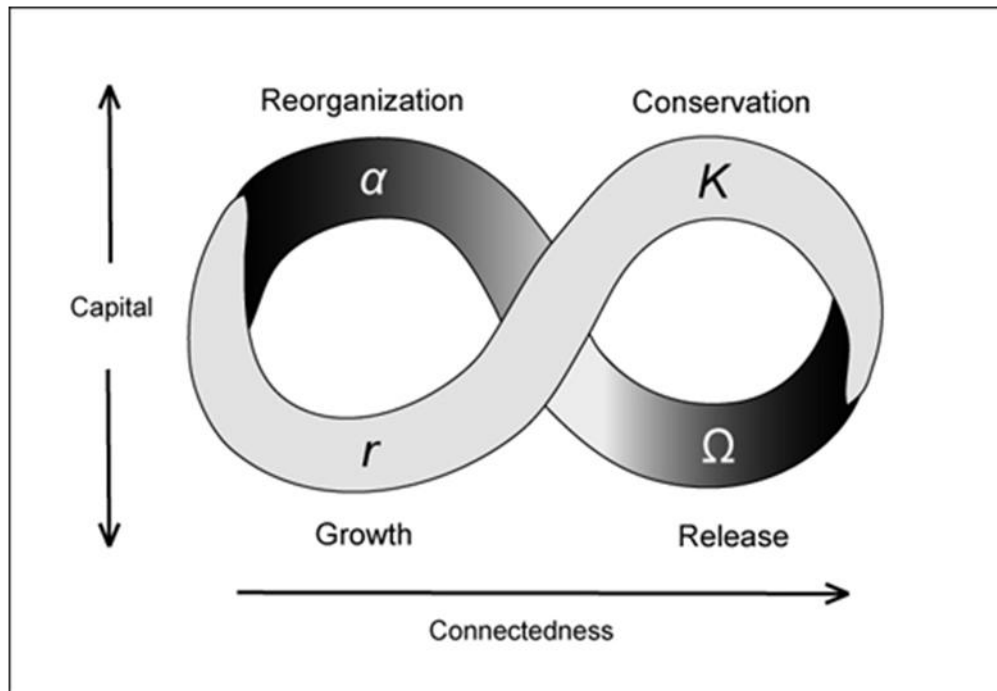


Figure 2: Adaptive cycle
Source: (Peebles et al., 2006)

The disaster resilience literature has drawn from the above concepts and contributed additional notions about the factors and processes involved in whether or not a community is able to rebound after a traumatic event. From a disaster planning perspective, a conceptual framework has been developed, consisting of interrelated technical, organizational, social, and economic (“TOSE”) dimensions that contribute to and affect resilience (Bruneau et al., 2003). Technical and organizational factors relate to infrastructure and local agencies and governance and social and economic factors are entrenched in the community at large. All four TOSE dimensions describe contributions to a community’s capacity for resilience. In addition, there are four resilience dimensions (the “four R’s”) by which resilience can be measured, including robustness, redundancy, resourcefulness, and rapidity (Bruneau et al., 2003). Robustness refers to the overall strength of a system, or its ability to withstand a stressor without failing. Redundancy is the existence of substitutable elements in the system, allowing continuation of necessary services even when some elements fail. Resourcefulness includes the ability to plan and implement disaster recovery based on established priorities and goals. Rapidity is the simply

the ability to carry out these activities quickly. The TOSE dimensions and community-level disaster resilience in general can be evaluated along each of the four R's.

Disasters

Disaster and natural hazards research has originated from scholars in a wide array of fields, although this literature review focuses on the fields of urban planning and sociology, which are most relevant for the research. It should be noted that disasters research can be found in a number of additional fields, many of which focus on climatologic or geologic phenomena. Although this work is certainly important for forecasting disaster risk, a compelling argument has been made that disasters should be conceived of as not strictly external forces that cause upheaval, but rather socially constructed events, which informs our understanding of and approach to disaster response (Mileti, 1999). In fact, disasters should be viewed in terms of social vulnerability, as various social and economic consequences arise from not only the physical damage incurred, but the various short and long term effects to housing, health, the economy, and social structures and cohesion (French, Lee, & Anderson, 2010). The field of disaster research has expanded accordingly to take into account social, cultural, and economic factors along with technical solutions.

Relevant past work in the areas of urban planning and sociology can be divided into two distinct categories – those that examined strategies for pre-disaster mitigation and those that focused on post-mortem analysis of events. In terms of pre-disaster work, there are several approaches that have been taken to exploring the effectiveness of mitigation and other pre-disaster planning activities. Perhaps the earliest views on interactions between natural disasters and human systems focused on flood plain development and the protection of property (White, 1936, 1937). Land use planning and zoning were early tools employed by planners to prevent encroachment in waterways in order to protect human property from flood damage. This work also recognized the need to evaluate flood stages based on land use changes in floodplains and drainage areas and engineering interventions such as levees and reservoirs, rather than on past

flooding trends alone. Although the impacts of flooding on social stability and prosperity of communities were acknowledged decades before, measuring these impacts was not addressed in earnest until the early 1950s (Tierney, 1989).

More recently, the role of planning in effective disaster mitigation has been advanced. For example, including mitigation in either standalone hazard plans or comprehensive plans has been shown to be a potential strategy for encouraging safer development and garnering public support for mitigation (Burby et al., 1999). Currently, federal programs focused on insuring at-risk property and providing aid after a disaster tend to discourage or even undermine local government planning efforts, as there are few incentives to plan independently. Unfortunately, development continues unabated by local government in many high risk areas. For example, despite state and local efforts to limit residential exposure and regardless of plan conformity and quality, there has been no significant effect on growth in vulnerable coastal areas in Florida (Deyle, Chapin, & Baker, 2008). It has also been shown that although land use management in flood plains has great potential in mitigating risk, communities that adopt this strategy tend to have already created a problem with previous flood plain development (Burby & French, 1981).

Pre-disaster planning in general is necessary and is most effective when combined with strong public involvement. High-quality plans informed by local interest groups were found to have the greatest impact on environmental problems, and natural hazards in particular, and to increase levels of commitment in elected officials (Burby & May, 1998). Based on these findings, it was recommended that constituencies be created for the solution of environmental problems to include a broader cross section of the population in the planning process and facilitate adoption of household-level mitigation practices through the dissemination of information about risk. In effect, strong, politically oriented social networks improve the commitment of public servants and the capacity of a community.

Building on the importance of commitment and capacity, scholars subsequently have advocated incorporating disaster mitigation in sustainability, adding disaster resilience to the existing list of economic, environmental, and social goals of sustainability (Godschalk et al.,

1999). Sustainability already incorporates techniques that protect the environment while increasing the effectiveness of human systems, for example by recommending the use of bioswales for drainage. A resilient development approach adds additional complexity to sustainability, taking into account potential natural hazards, with the intent of creating an appropriately strong and flexible built environment. The commitment to disaster mitigation should be driven by community leaders and combined with increased capacity to plan and implement mitigation programs. This demands a proactive and context-specific approach justified by sustainability's doctrine of meeting the needs of future generations.

In addition to land use planning, building codes, and other structural or engineering solutions, local communities have also used policy-based mitigation measures to stem property damage risk and minimize casualties caused by localized flooding (Brody, Zahran, Highfield, Bernhardt, & Vedlitz, 2009). This includes adaptive or flexible strategies for land and water management, public outreach, preparedness, and other approaches. Based on an examination of less adaptive, more prescriptive policy levers under FEMA's Community Rating System (CRS), localities were most likely to choose "low-hanging fruit" or the least expensive strategies rather than choosing strategies according to effectiveness. However, locally driven policies adapted over time were shown to be effective in mitigating property loss (Brody et al., 2009).

Individual households bear a considerable amount of financial burden after a disaster; however, there often appears to be a general lack of interest in household-level mitigation such as voluntary insurance programs, despite the potentially large financial losses from a low-probability, high-impact event such as a major hurricane (Kunreuther, 2006). Households have limited resources and fail to consider disaster risk in long term financial planning. They may also be following a local trend, not wishing to be the lone residence undertaking dramatic structural protection measures, when others will certainly rely on government aid. This is yet another argument for supplementing voluntary preventative measures with local planning and policies, including building codes, tax incentives, and required hazard insurance similar to requirements under the FEMA National Flood Insurance Program (NFIP).

In the second category of disaster research, post-disaster analysis has generally concentrated on case studies or other accounts of particular disasters, often comparing and drawing conclusions from patterns across time. For example, a recent case study tracked the rebuilding process in New Orleans, Louisiana after Hurricane Katrina from the perspective of urban planning professionals (Olshansky & Johnson, 2010). This work recognized the tensions between a swift recovery and a careful assessment of the situation to ensure decisions are most beneficial. Ensuring public participation and building consensus tended to be more difficult during the conflict, when past frictions were often amplified; therefore effective leadership and a clear message to the public was essential. According to Olshansky and Johnson, public meetings that informed the post-Katrina Unified New Orleans Plan were well attended and citizens were savvy enough to follow the planning discussions, but the claims of various public and private entities leading the rebuilding process were not consistent or clear.

Several studies have examined the impacts on social systems as well as the responses by formal and informal networks. For example, work has been done to examine the post-effects of disasters on social systems, including social networks (Tierney, 1989). Again, disasters are defined by Tierney as the damage and disruption to both physical and social structures. According to observations by Tierney, after a crisis, community organizations reform along two dimensions. The first is the dimension of tasks, which are either routine or nonroutine compared with pre-disaster activities, and the second is the dimension of structure, which can either remain constant or expand. Reforms along these dimensions allow organizations to respond accordingly to household recovery needs, conflicts, and community mental health needs. Pre-disaster working relationships between organizations are also important post-disaster and can affect coordination of disaster response activities.

In terms of local government and other formal municipal networks, in a case study of the Northridge, California earthquake of 1994, major disaster losses were suffered due to individual, organizational, and governmental decisions regarding planning and mitigation techniques, in addition to structural issues resulting from development patterns and building code standards and

enforcement (Tierney, 1995). Post-disaster, local governments frequently find it difficult to make use of disaster aid resources due to a lack of organizational capacity (Berke, Kartez, & Wenger, 1993). In a meta study of past disasters, a high degree of horizontal integration, or many connections between local networks, produced open communication and collaboration on local problem solving, increasing local capacity for disaster recovery and resilience (Berke, 1993). Vertical integration was also important, or ties between local and external or higher-order organizations. These two networking forces are most effective when operating simultaneously, working toward a common goal of recovery.

Such formal organizations are clearly important after a disaster. Sociologists have also examined the role of community social capital in recovery, specifically the informal networks and resources brought to bear through connections among residents. These connections have been shown to influence recovery at least as effectively as material resources, if not more (Aldrich, 2012). The mechanisms through which this is made possible include the creation of a kind of informal insurance or pool of financial aid, the ability to collectively solve common problems that interfere with recovery, and a deepening of the social fabric, which in turn increases the potency of the local voice. Further discussion of the specific role of social networks on resilience is discussed in a later section of this literature review.

Planning's post-disaster role in restoring the torn social fabric of a community as well as the built environment has also been explored. In response to the questionable effectiveness of some existing federal policies and programs like CRS, the argument has been made to reform and strengthen the state and federal regulatory roles in order to provide guidance and shore up local pre- and post-disaster efforts, which can suffer from the aforementioned lack of commitment (Berke & Campanella, 2006). This includes explicitly requiring land use management for risk reduction and infrastructure insurance at the local level. In addition to federal interventions, strong, local grassroots networks that empower citizens with lasting skills combined with greater ties between local formal networks are believed to improve recovery. These efforts can mend the torn social fabric.

Research regarding post-disaster recovery in the built environment has shown that among the various types of structures impacted by a disaster, residential damage typically constitutes the majority of total damage after a disaster and therefore housing is a major planning-related factor in post-disaster recovery. The U.S. system for rebuilding housing is largely designed to aid single-family, owner-occupied units. For the most vulnerable low-income households, short- to midterm housing is only available through Red Cross shelters and over the long term, large proportions of the affordable multifamily housing stock are not replaced (Comerio, 1997). The lack of rental housing is a recurring problem in many other case studies.

In fact, entire neighborhoods can be at risk. After the Mexico City earthquake in 1995, the government planned to clear a devastated inner-city slum and move residents outside of the city. Residents successfully organized to protest this decision. In that instance, social mobilization successfully challenged and reversed forced relocation and gentrification of the area; however, this is not always the case. Data from Hurricane Andrew in 1992 showed that long term single-family home recovery was weaker among ethnic or racial minority neighborhoods and renter-occupied households (Zhang & Peacock, 2009). Abandonment of property and long term volatility in the market were also persistent problems in recovery after Andrew.

Recovery of nonresidential sectors often experience greater delays post-disaster. After the Coalinga, California earthquake of 1983, housing recovery was relatively rapid, demonstrated by a spike in building permits following the earthquake, but the central business district and other businesses were slower to recover (French, Ewing, & Isaacson, 1984). Local residents were strongly committed to rebuilding the community, and the local development authority was instrumental in assisting the commercial sector. Overall, the impacts to the social and political fabric were less severe than they might have been due to prompt, effective rebuilding efforts. Indeed, the prompt recovery of housing as well as infrastructure is important in facilitating the return of the business sector (Olshansky, Johnson, & Topping, 2006).

Given the challenges in providing affordable housing post-disaster, it is not surprising that the dimensions of social vulnerability have been well documented in post-disaster assessments. Wealth and age have been found to be the most significant factors and other social vulnerability factors commonly cited include race, ethnicity, gender, family structure, and tenure (Cutter, Boruff, & Shirley, 2003). As an example, following a 1982 Paris, Texas tornado, African American residents in the community were privy to fewer economic aid resources such as Small Business Administration (SBA) loans and were more dependent on family and kin networks of support in emotional (but not financial) recovery (Bolin, 1986). Women are also known to be particularly vulnerable to disasters. Work in developing countries has demonstrated effects such as more pronounced and prolonged emotional distress and fewer financial resources in single parent, female headed households (Bolin, Jackson, & Crist, 1998). Despite these differences, disaster research continues to focus on families in recovery to the detriment of single-parent female or other female head of household situations.

Socioeconomic factors have also been shown to contribute to post-disaster conflicts (Bolin & Stanford, 1991). To protect vulnerable populations, adequate and representative citizen participation should be included in recovery activities. The likelihood that casualties are encountered by flooding, for example, increases with population density, and the presence of socially vulnerable populations, in addition to obvious factors such as precipitation rates, flood duration, and property damage (Zahran, Brody, Peacock, Vedlitz, & Grover, 2008). Social vulnerability, in particular among minorities, lower-income groups, and the aged, is associated with delayed evacuation, greater incurred damage, fewer resources, and slower rates of rebuilding (VanZandt et al., 2012). Furthermore, as a result of these phenomena, disasters cause neighborhood change including increased socioeconomic disparity as populations relocate (Lee, 2012).

Overall, disaster research has advanced tremendously in past decades, in part due to several events causing large-scale damage to urban areas in the U.S. in the 1980s and 1990s, when that magnitude of destruction was thought to be unique to developing countries (Comerio,

1997). However, the growing reach, complexity, and interdependencies in the built environment have made determining appropriate mitigation techniques increasingly difficult.

The Built Environment

The term built environment literally refers to all types of developed land such as cities, suburbs, and rural towns, or any other element constructed by humans. Thus, this includes structures from huts to high-rises, streets and sidewalks, lighting, signage, public art, and parkscapes. Naturally, the built environment also includes contents of those types of features such as walls, furniture, and other objects. There are many theories about the connection between people and place and the types of phenomena and behaviors that are influenced by the built environment.

Creating an ideal built environment has been central to planning and architecture for millennia. The past hundred years or so are particularly rich in various planning movements. Ebenezer Howard introduced “Garden Cities” in 1898, which promoted freedom from the city, including ample green space, with a mix of agriculture, industry, and housing and overall self-sufficiency in carefully planned and controlled towns (Howard, 1965). Only a few such towns were realized in England, but the concept was influential in the U.S. For example, Clarence Perry developed the idea for an idealized neighborhood unit in 1929, meant to encourage community and strengthen family life through neighborhood anchors such as schools and parks (Lawhon, 2009). Perry’s sometime-collaborator Clarence Stein, seeking to replicate Garden Cities in the U.S., later introduced hierarchical circulation patterns separating pedestrians, local, and through traffic at Radburn (Stein, 1949). Although they were once planning outsiders, the radical ideas of Frank Lloyd Wright’s “Broadacre City” and Le Corbusier’s “Radiant City” also attempted to revolutionize urban design for modern society (Fishman, 2003). More recently, Kevin Lynch went to great lengths to systematically understand how humans perceive their environments and navigate in a complex urban area (Lynch, 1960). Perhaps the most influential planning movements in recent decades has been New Urbanism, which has promoted a return to

traditional patterns of development, including walkable, mixed-use neighborhoods (Katz, Scully, & Bressi, 1994).

Scholars have extensively analyzed the purported outcomes of planning movements and other built environment techniques. Common research topics included the impacts of the built environment on travel, particularly trip length and mode choice (Ewing & Cervero, 2001); the effects of factors such as housing, isolation, and transportation infrastructure on public health and mental health (Srinivasan, O’Fallon, & Dearry, 2003); and building-level up to community-level impacts of the built environment on the natural environment (Forsberg & VonMalmberg, 2004). Studies also have examined the impact of catastrophic events on the built environment, such as climate change (Wilby, 2007).

Research on the built environment extends well beyond the planning and architecture domains. A December 2012 Google Scholar search on the term “built environment” (in quotes) returned 17,200 works in 2012 alone.

Social Networks

Social networks are assemblages of individuals or groups related to one another through connections such as familial ties, friendship, similar interests, similar beliefs, or other types of common circumstances. Although theories related to social networking date back at least to Durkheim at the turn of the last century, the body of knowledge has become increasingly sophisticated, spurred by an infusion of ideas from the fields of physics and graph theory and a rich laboratory of web environments (Facebook, Twitter, Second Life, etc.). A social network can be conceptualized as a web of nodes (individuals or groups) and ties (links between nodes). Within a network, nodes can be described by degree centrality (number of node connections), betweenness (how many connections include a certain node within a network), and closeness (on average, how close a node is to all other nodes). These values can be used to characterize the strength and topology of an entire network or the importance or influence of a single node

(Freeman, 1978). Other methods of measuring networks include elasticity, sociometrics, and graphing.

Social network analysis and other social network approaches can be included in many aspects of planning, including forging an understanding of power structures, fostering cooperation, and improving the flow of information (Dempwolf & Lyles, 2012). Perhaps the most applicable with respect to community-level networks is in understanding relationships involving multiple layers of government as well as informal networks in planning. Recent studies have examined the spatial impacts of networks, generally finding that community exists independent of space. However, social networks impact the planning of space in that they can be drawn upon in public participation and economic development activities.

Social networks may exist independent of physical space; however, networks are often organized or biased geographically. Particularly in times of need, ad hoc networks may form locally to mobilize resources. It should be noted that although a social network may provide economic benefits, this is not the primary motivation for joining a network (Lin, Cook, & Burt, 2001). Robust social networks are associated with many benefits to individuals, households, and organizations: physical, psychological, and social well-being (Aday, 1994; Berkman, Glass, Brissette, & Seeman, 2000); employment opportunities (Granovetter, 1973; Montgomery, 1991); access to financial resources (Ben-Porath, 1980); information seeking and utilization of social services (Birkel & Reppucci, 1983); and community mobilization (Snow, Zurcher, & Eklund-Olson, 1980). Isolation or lack of social network support is associated with the inverse of these conditions, and yet a significant population remains on the margins, unable or unwilling to associate with these supportive networks.

Social networks are considered a conduit for social capital, defined as “investment in social relations with expected returns” (Lin et al., 2001). In connecting individuals, social networks allow social capital to be transferred and accumulated in a community. Social capital has two constituent facets, which are strongly correlated: social trust and civic engagement (Putnam, 2000). Therefore, participation in formal social networking organizations, or

associational membership, promotes more trusting citizens and greater social capital. The percentage of the population participating in formal networks such as church groups, unions, parent teacher associations, has been declining for years (Putnam, 2000), creating a society with fewer formal ties through organizations, if not through other social interactions. Putnam's work outlines the benefits of association activity and the problems connected with weakening community engagements, a macro trend that does not appear to be subsiding.

Critics of Putnam and the wave of interest his work generated in social capital argue that social capital is improperly defined, misinterpreted, and conflated with other concepts such as Tocqueville's notion of civil society and that many findings lack empirical rigor (DeFilippis, 2001). However, this argument applies chiefly to work that focuses on capital or economic growth and neglects dense social networks that lack access to resources but provide other benefits.

Social Networks and Resilience

In addition to the general advantages that membership in social networks confers regarding social and economic position, networks are also instrumental in helping people cope with and recover from disasters. With respect to disaster resilience, social networks have been shown to be important for reducing vulnerability in preparing for and responding to a disaster (Cutter et al., 2003), for facilitating response and mitigation tactics such as evacuations from the bottom-up (Aguirre, 2006), and for improving household-level disaster preparedness by increasing the perception of the availability of resources (Paton, 2003). In terms of associational membership, there has been excellent research demonstrating the positive impacts of community groups in recovery efforts (Patterson, Weil, & Patel, 2010). However, disasters impact social networks by straining the support network and limiting the effectiveness of individuals that would have otherwise provided support to the more vulnerable. Although surges in support through social networks occur after a disaster (so-called new "synthetic communities"), these

support networks fall prey to pre-existing conflicts and tend to dissolve even while recovery is underway (Tobin, 1999).

During a disaster, various types of social networks are utilized or formed including familial, religious, political, economic, medical, educational, scientific, legal, risk management (insurance and first responders, etc.), mass media, communications, transportation, energy, food, water, leisure, entertainment, construction, rebuilding, land use, and environmental regulation and protection (Aguirre, 2006). Many such networks, such as faith-based organizations or citizen volunteer groups, operate in response to a disaster or emergency but are not part of formal disaster planning and management. Other networks may not have been part of original disaster planning and management plans but may become formalized and incorporated into plans and preparations for future emergencies. These types of networks are vital to surviving and recovering from disasters and either are or may become a trusted foundation for future resilience.

According to psychologists (Kaniasty & Norris, 1995), “[r]esearch strongly documents this role of social support as a provider of emotional comfort, material goods, self-esteem, or information” (p. 396). The authors outline two modes of social network support: the stress buffer and main effects models. Stress buffering encompasses how individuals in crisis are protected from resultant stress by the presence of social networks. According to this model, the benefit occurs when the stressor is applied. In contrast, main effects encompass how social support inherently benefits physical and psychological health, regardless of the situation. The benefits for community resilience therefore are more apparent when stress is applied; however, the authors believe the inherent benefits also protect the community from physical and mental health vulnerabilities ahead of a disaster. This work focused on three measures of social support: support from kin, support from nonkin and general social participation in order to show that social networks mediate stress due to disaster events. Furthermore, the authors showed that stress-inducing events act as triggers for mobilizing social support.

Another study operationalized “sense of community” as one of several “social cognitive variables” that can be used to predict preparedness and resilience to a natural hazard (Paton,

2003). Feelings of belonging related to social justice, trust, participation, and empowerment within the system were measured. People with strong feelings of belonging to a place were shown to be more likely to convert intentions of preparedness into actual household preparations. An earlier piece by the same author (Paton & Johnston, 2001) examined resilience more broadly and found that involvement in community activities increases the ability to resist and recover from natural hazards and that consensus building in decision making is a significant opportunity for empowering residents and promoting resilience.

The uneven topography of networks across socioeconomic status may impact resilience. As social and employment structures evolved in past century and economic conditions have deteriorated in inner-city poor neighborhoods, the working-class social network composition and some forms of organizational participation have been affected by neighborhood poverty (Rankin & Quane, 2000). These communities tend to lack the social networks ties that may help alleviate poverty through better employment or access to resources. Areas of concentrated poverty tend to have lower participation rates in institutional resources such as businesses, schools, social clubs, and other organizations (Rankin & Quane, 2000). Furthermore, poor communities are plagued by lower levels of trust and lowered expectations of reciprocal behavior (Stack, 1979). Therefore, there is a diminished chance that neighborhoods will aid one another and restricted social support in the face of a disaster or other crisis. Not all impoverished communities lack strong social ties – others have found that the inner-city poor and other disenfranchised groups are as well-networked as anyone else (Gans, 1962). However, they are less likely to have financial reserves in these networks to recover from a disaster.

An example of the recovery inequality faced by those without access to social networks occurred following Hurricane Andrew. In one analysis of the disaster (Peacock, Morrow, & Gladwin, 1997), communities were compared to ecological systems given the complex, interacting social ties. Community elements were seen as connected through nonhierarchical, dynamic contingency linkages through which information, resources, and even individual members flowed. All nodes in the network were dependent on others although

interdependencies were not purely reciprocal. Given the socioeconomic conditions in Miami, recovery from the storm was greatly impacted by its pre-existing social ecology, including its pervasive inequalities. For example, the Cuban community benefitted from greater access to resources than other minority groups and was thus able to recover more quickly than similarly situated networks. Recovery was impacted by levels of economic development, divisions of labor, the political system, and the size of network sub-populations.

Environmental scientists have also used a social-ecological model to explain disaster recovery in coastal areas, similar to the ecological systems model used in the Hurricane Andrew analysis (Adger, Hughes, Folke, Carpenter, & Rockstrom, 2005). The social-ecological model draws upon the recovery and resilience functions of natural ecosystems in framing the parallel role of social support networks after a disaster. For example, after a catastrophic event, ecosystems are equipped with a “memory” of biological legacies that allow diverse but intertwined organisms to reorganize as before. Similarly, social memory comes from a diverse group of individuals and institutions combining their practices, knowledge, values, and worldviews. This pooled learning creates a more resilient system, able to withstand disasters and other major disturbances. These processes could be observed after the 2004 Asian tsunami, as fishing communities on Simelue Island near Sumatra used inherited social memory as well as local institutional preparedness to survive despite being close to the earthquake’s epicenter. Formal and informal institutions with deep social and environmental knowledge, and accordingly, the networks inherent in these institutions, are vital for mitigating the effects of disasters.

A recent study examined earthquake recovery in two incidents in Japan and India with a focus on the strength of social networks in recovery and rebuilding (Nakagawa & Shaw, 2004). Similar neighborhoods in Kobe, Japan (affected by a 1995 earthquake) and Gujarat, India (affected by a 2001 earthquake) were studied. In this study, social networks defined as bonding, bridging, and linking social capital, were found to account for differences in levels of recovery. Victims were surveyed using the “Integrated Questionnaires for the Measurement of Social

Capital” developed by the United Nations. Based on the results of the survey, the communities with the highest levels of social capital (including external and internal networks), displayed the fastest recovery despite lower income levels. The Kobe earthquake shifted Japan’s national focus of disaster management from an engineering issue to a social and technical issue.

Social networks are consistently upheld as an important factor in resilience. However, criticisms generally focus on the difficulty in defining both of these terms. Resilience is difficult to measure or even recognize in certain situations. The time necessary for a community to recover may vary by the scale of the disaster and size of the community, therefore, a community may spend many years in the reorganization stage of the adaptive cycle before returning to a stage of growth. Similarly, social networks are difficult to identify and measure. Despite this, many studies have attempted to operationalize these concepts and their practical usage has not waned.

The Built Environment and Social Networks

The influence of the built environment on social networking opportunities and the ultimate structures of social networks is a common topic among scholars of various disciplines. The spatial configuration of a region impacts the social networking opportunities, particularly within and between residents and businesses. Social networks with the most potential for resiliency are rooted in the built environment, with the nature, strength, and quantity of social ties influenced by development patterns.

Building on the work of Jane Jacobs, urban planning research has shown that walkable, mixed-use neighborhoods can encourage the development of social capital and place attachment through an increase in interactions and a higher likelihood of neighborhood amenities, including characteristics of the built environment that influence social networks, such as varied land uses and pedestrian-oriented design (Leyden, 2003). New Urbanism claims that factors that influence social capital include density, street connectivity, design, and land uses. However, physical

design actually increases the probability of community building through interaction rather than creating sense of community *prima facie* (Talen, 1999).

A study of Diggs Town (Norfolk, Virginia) (Bothwell, Gindroz, & Lang, 1998) demonstrated the ability of neighborhood design to directly improve social interaction by surveying residents of a housing project after its redesign from modernist bunkers to New Urbanism-style units with front porches and defined lawns. Residents found the new layout safer in terms of traffic control and crime and led to greater sense of community and self-esteem. Planners have long desired to create a sense of community through urban design and have more recently sought to measure and define the relationship between the social and physical realms.

Problems with the social doctrine of New Urbanism and related trends have been presented. The lack of direct evidence and role of nonenvironmental factors, for example, weaken the argument that neotraditional design can encourage social mixing and social capital (Talen, 1999). Although studies have validated certain claims of New Urbanism, such as increases in pedestrian travel (Lund, 2003) and property values (Tu & Eppli, 1999), its espoused sense of community has been questioned.

Anthropologists and sociologists have also examined how the built environment reflects and influences our social connections and communications. However, in contrast to most planners and architects, the focus is on the built environment and its constituent elements as experienced by cognitive schemata and therefore spaces need not be physically defined. Spaces exist in individuals' cognitive maps of their surroundings, defined by the activities that take place there (Rapoport, 1994). Development patterns are influenced by politics, codes, and ideologies, and many elements of the built environment remain fixed over time (with new generations utilizing them). Spaces therefore transmit cultural meaning and identity over time and correspond to and promulgate social structures.

Social space can also be broken into objective and subjective components (Wilson, 1980). Objective components include the nature of people's interaction in space, which is a critical variable contributing to how individuals experience space. Activity patterns can

therefore be predicted from the type of space in question. The subjective component includes the “city of the mind,” or cognitive maps. These fields provide a basis for understanding how the built environment, even after catastrophic damage, exists in human and collective memory and is assigned greater value than the bricks and mortar from which it is crafted. Differences in theories behind physical design and social interaction are common among social ecologists, but the field has a unified intellectual tradition that space and physical design influences social structure (Bothwell et al., 1998).

Place attachment is also a significant topic in discussions of human interaction with the built environment. Place attachment is based on our past interactions and the potential for future interactions between ourselves and our physical surroundings (Milligan, 1998). Geographic space is the stage to which we assign meaning and in which social interactions are set. The bonding of people to place occurs through personal, group, or cultural processes, notably those related to social networks. Studies of destruction of place, through natural disasters or slum clearance, have been used to illustrate the strong connection between a society or community and the specific place in which it resides. Recent work in Louisiana (Burley, Jenkins, Laska, & Davis, 2007) found that cross-generational social and economic ties inspired residents of bayou communities to fight for wetland protection. Residents correctly believed that government- and industry-funded land losses exacerbated naturally occurring erosion and limited coastal protection from hurricanes. In spite of and because of the growing fragility of their community, residents of coastal Louisiana towns continued to experience strong attachment to the unique landscape and culture in which they lived. This attachment varies by community, in that it may be tied to specific sites such as unique ecosystems, cafés or parks, architectural styles, or historic development patterns.

Rooted in the field of architecture, space syntax argues that the functions of society follow form, or that various social phenomenon are likely to occur because of physical structures (Hillier, 2008). These theories are also influenced by sociology, geography, and anthropology and provide a method for measuring and analyzing the impact of space on behavior. Space

syntax literature focuses on the organizing structures that dictate human behavior, such as connectivity and sight lines that influence choice and movement in space. Specific measures include metric reach and angular reach, which quantify the connectivity of streets by identifying the length of street network accessible within a given distance or number of direction changes (Peponis, Bafna, & Zhang, 2008). Specific to space syntax, previous studies have shown that the spatial configuration of spaces affects social behavior. For example, retail and other movement-seeking land uses gravitate toward higher movement locations, which are statistically more likely to be well integrated with the urban grid (Hillier, 1999a). Additionally, it has been shown that the level of development of a neighborhood is contingent upon its embeddedness in the circulation system of a city, either preventing or encouraging economic activity and social capital (Hillier, 1999b). Finally, many factors that relate to resilience have been associated with integration, reach, and other syntax measures. These include urban poverty, economic activity, social interactions, and the distribution of land uses, among others.

The relationship between space and poverty (which is correlated with fewer networking opportunities) has been investigated and defined by recent space syntax research (Carpenter & Peponis, 2010; Vaughan, 2007; Vaughan, Chatford Clark, Sahbaz, & Haklay, 2005). Generally, access to economic and social opportunities through well-integrated spaces has been associated with a higher incidence of wealth at the smallest levels of analysis (parcels and block faces). According to Vaughan (2007), the relationship between space and poverty has been discounted by researchers and decision-makers. However, Vaughan showed that space at least partially explains the causes and persistence of poverty (Vaughan et al., 2005). Street integration was shown to greatly affect the distribution of social classes in London. There, higher-class streets tended to be significantly longer with much more direct accessibility (in terms of directional reach) than lower-class streets (Vaughan, 2005). The concentration of poverty in urban areas and increased isolation from the wealthy has been well documented (Massey, 1996). Since the formation of the earliest settlements, the density of impoverished households has been increasing in cities, with the greatest extremes seen in the current post-industrial era.

There are differences in levels of social networking among impoverished and isolated communities, however. In addition to the inherent differences in networking based on the built environment, there may be cultural or historical conditions that lead to atypical networking behavior. In fact, certain groups form local solidarity networks with positive benefits. As early as 1925, research from the Chicago School identified “natural areas” or neighborhoods formed by proximity and social contact (VanKempen, 1994). These units are analogous to and informed thinking on ghettos and slums and other sub-ecologies of poverty found in cities. Social isolation has been shown to be a contributing factor to persistent poverty and is most prevalent where real estate is undesirable and impervious to gentrification. These spaces are found clustered in cheap, dilapidated, and inaccessible areas, such as inner-ring suburbs in the U.S. Despite the limitations of exclusion, homogeneity (of income, ethnicity, or similar) may also strengthen social support ties through solidarity (Bolt, Burgers, & VanKempen, 1998). Social and geographical similarities provide necessary resources such as employment, entrepreneurial support, informal economies, and family services like child care.

Overall, the built environment is shown to impact social systems and social networks through a variety of mechanisms. Critics have questioned methodological approaches and theoretical models, as nonenvironmental factors may also be at play. However, increased sophistication in the field and greater mainstream interest has ensured its continuation.

The Built Environment, Social Networks, and Disaster Resilience

Although the link between the built environment, social networks, and disaster resilience has not been expressly connected, a few studies have identified physical manifestations of the link between social networks and disaster resilience, or artifacts of the built environment that can predict resilience.

For example, physical structures that facilitate social networks were found to contribute significantly to day-to-day recovery activities in a case study of five flood-impacted communities in the Midwest (Sherraden & Fox, 1997). In this instance, networks were most effective in

recovery when they have an organizational base, or a physical address in which activities could be centralized and staged.

A second example of the influence of the built environment on social networks and the impact of this relationship on disaster resilience is the Chicago heat wave of 1995. Prolonged temperatures above 100 degrees Fahrenheit, scattered power outages, loss of fire hydrant pressure, and surges in emergency room and hospital demand taxed the city's resources. Overall, 485 people died due to heat-related causes over the course of one week, far exceeding the 222-bay holding capacity of the morgue. A social and geographical analysis of the event (Klinenberg, 2002) illustrated the grim patterns of vulnerability in Chicago, a city described as famously divided, with distinct borders separating regions and groups that touch but do not interpenetrate. The losses of life were disproportionately felt in socially and spatially disenfranchised communities. Victims tended to be social outcasts, including the elderly, the poor, minorities, and the isolated. Geographically, these deaths were concentrated in low-income, ethnic or racial minority, and violent regions of Chicago. Further, the elderly, who comprised 73 percent of the casualties, were concentrated in public and for-profit single room occupancy dwellings in poor neighborhoods. Chicago's social problems were reflected in and reinforced by the spatial distribution of disenfranchised populations and un-networked households, reducing its overall resilience to the heat wave crisis.

In another study of the Chicago heat wave of 1995, The U.S. Centers for Disease Control (CDC) and Prevention conducted 339 matched-pair surveys of victims and control survivors and included social networks and living conditions in their data collection (Semenza et al., 1996). The results of these interviews and ensuing statistical analysis showed that living alone more than doubled the risk of death, participation in group activities reduced the risk, having friends in the Chicago area reduced the risk, not leaving the home increased the risk of death, and having a pet in the home reduced the risk. The empirical evidence offered by the CDC illustrates the impact of living arrangements and social networks on the loss of lives.

Kevin Lynch argued that “A city is hard to kill, in part because of its strategic geographic location, its concentrated, persisting stock of physical capital, and even more because of the memories, motives, and skills of its inhabitants” (Vale & Campanella, 2005). The desire to rebuild rather than retreat is somehow imprinted in society, at least in part through the social structures that transmit the emotional and cultural meanings of a place. Overall, the literature supports the notions that social networks promote resilience, that the built environment impacts social networks (and social networks influence the built environment), and that elements of the built environment may therefore be beneficial to disaster resilience. A number of theories exist as to how aspects of the social and built environments impact disaster recovery and overall community resilience. Although many conceptual models of these relationships are offered, there is consensus that socially engaged communities are most resilient and that an underlying urban design that includes well-connected streets and diverse spaces encourages social engagement. Therefore, this research sought to establish an empirical link by comparing data before and after Hurricane Katrina.

CHAPTER 3: BACKGROUND ON THE MISSISSIPPI GULF COAST

The Mississippi Gulf Coast, three counties nestled between New Orleans, Louisiana and Mobile, Alabama, is an historic region marked by river valleys, estuaries, bays, and an 81-mile long lagoon, the Mississippi Sound. Before European settlers altered the landscape, small barrier islands protected a coastline thick with magnolia, live oaks, and great pine barrens up to 90 feet in height. Geopolitical conflicts, immigration, and emerging technologies have led to significant changes to the area over several centuries. Despite prolific development beginning in World War I, the Mississippi Gulf Coast remains a humble and provincial enclave, with a distinctive culture. The built environment has also been repeatedly transformed by frequent destructive hurricanes.

Early History

Evidence of Paleo-American sites has been located along the Mississippi Gulf Coast, dating back to around 12,000 BCE ("Hancock County Historical Society," 2011). However, Native Americans populations, including the Biloxis, the Pascagoulas, the Acopissas, and two or three small tribes whose names have been lost to history (Riley, 1915), peaked and began to decline even before the arrival of Europeans. The three larger tribes each encompassed 300 to 500 members around the time that Europeans arrived. They were hunter-gatherers and subsistence farmers and lived in fortified river villages in palmetto-thatched huts. Their decline was undoubtedly hastened by the arrival of Europeans, as tribal settlements were introduced to foreign diseases and suffered a loss of tribal control.

Following the expedition of Columbus in 1492, Spanish explorers and conquistadors came to the Mississippi Coast on violent missions to discover gold. Spain's dominance over the region declined in the late 1600s, when French and English explorers began migrating from Canada and the Atlantic coast, respectively, to gain control of the Mississippi River and to claim colonial lands.

The first attempt at a permanent European settlement was by the French-Canadian explorer Pierre Le Moyne d'Iberville in 1699. France funded Iberville to control of the Gulf of Mexico coast. On a suitable deep-water natural harbor now called Ship Island, he plotted the first European fort, settlement, and capital in the area (predating the founding of New Orleans). Iberville established Fort Maurepas in present-day Ocean Springs, then known as Biloxi after the tribe. An alliance made between the French and the three native tribes lasted, more or less, for 64 years. Along with its strategic harbor, Biloxi was considered optimal for observing the Spanish settlement in Pensacola and the English settlements in Georgia, both of whom were eager to expand their land holdings in North America.

The original fortification at Biloxi stood only a few years before being moved east in 1702 to Mobile, Alabama. At this point, France and Spain had allied in a war against England, and thus the seat of French control was moved closer to the Spanish fort at Pensacola to capitalize on the strategic relationship between the two powers. Iberville was commissioned elsewhere, leaving his brother Jean Baptiste LeMoyne, Sieur de Bienville, to head the undersupplied French colonies. By this time, survival had become so difficult that many of the Frenchmen defected to live amongst the natives, sparking outrage from the many conservative Jesuits that were left behind.

After the war between England and France ended in Europe, the French crown had little use for its Gulf Coast colony and granted control to a private financier, Antoine Crozat, leading to its continued decline. The first recorded catastrophic hurricane decimated the colony in August 1717. The storm drastically altered the landscape of the coast and led to the establishment of New Orleans as a replacement for the fort at hurricane-ravaged Dauphin Island (near Mobile). Around this time, the French seat was again moved to "New Biloxi" (west of the original location and the site of the modern city of Biloxi) from Mobile. After Crozat's financial failure, France ceded the colony to another opportunistic businessman, John Law, who initiated an ambitious marketing campaign, but was eventually ousted after financially ruining his stockholders.

Commercial interests ruled for the next several decades (from about 1713 to 1731), as France was embroiled in costly conflicts abroad and remained unable to manage the colony. The first African American slaves were brought to the region and forced into labor around 1707. Plantation slave labor produced rice, tobacco, and indigo. This agricultural diversity gradually waned, as cotton proved to be the most lucrative crop. Although commerce was liberally managed, society was not. A “Black Code” was enacted in 1724, which restricted the rights of even freed slaves and named Catholicism the only accepted religion.

The capital of the French colony was moved again in 1723 to New Orleans, the year that another major hurricane struck the Gulf Coast. Because of storm damage, Biloxi was virtually abandoned and records of all coastal settlements from around this time are almost nonexistent, except mentions of two more hurricanes in 1740 and in 1746. Between 1727 and 1763, little is known about the conditions of the depleted settlements in and around Biloxi, although a few families are known to have survived past the French colonial period.

It is almost remarkable that these colonial settlements survived given the early history of natural disasters and economic uncertainty. Yet, despite the difficulty in maintaining a substantial population, Biloxi and other settlements persevered.

Late Colonial Period

England drove France from North America in 1763 following the French defeat in the Seven Years’ War, establishing English rule on the Mississippi Gulf Coast that lasted until the U.S. Revolutionary War. As an English territory, the Mississippi Gulf Coast was part of West Florida, the capital of which was Pensacola. Many French residents and native Biloxis and Pascagoulas fled west of the Mississippi River to what had become Spanish Louisiana (with an administrative capital in Havana, Cuba) rather than pledge allegiance to the English crown. Centuries later, this shift was still lamented: according to one historian, the “gay, adventurous French gave way to the thrifty, industrious English” (Riley, 1915).

The English occupied the fort at Biloxi and port at Ship Island in order to protect its holdings from the Spanish at New Orleans. However, the Gulf Coast British forces were stretched thin, allowing the remaining French living in the area, who were isolated by language and religion from the English, to live relatively unmolested. Numbering about 500, the French holdovers began illegally smuggling tar, lumber, and other products to New Orleans, a lucrative business. Despite their isolation, the French began to germinate the industries that eventually would characterize the area's economy – major tobacco and cotton operations, silviculture, and shipbuilding. However, in 1772, another catastrophic hurricane destroyed crops and settlements up to 30 miles inland, including a successful plantation in Pascagoula run by the Krebs family. Only one structure from this plantation is still standing, and it is the oldest structure in the state of Mississippi.

The onset of the U.S. Revolution resulted in a mass migration of English loyalists and Tories to Mississippi, which initially remained under English rule. Tensions between English refugees and the multiethnic locals rose as the U.S., France, and eventually Spain allied against England in the conflict. The Revolutionary years of English rule were accordingly turbulent.

Successful raids by the U.S. and a European war between Spain and Britain allowed Spain to gain control of English West Florida in 1783. In exchange for allegiance to Spain and the Catholic Church, Spain ruled over the citizens of Mississippi liberally, in an effort to appease the locals and to encourage immigration and revenue. The Spanish courted trade with natives and kept taxes low to attract investment.

The U.S. gained control of much of present-day Mississippi and Alabama north of the thirty-first parallel in 1798, years after it first laid claim to this land under the Georgia charter and after many assaults. Spain retained Florida, including the Mississippi Gulf Coast, still part of West Florida. The rest of the state was renamed “Mississippi Territory” and many American pioneers emigrated to the new territory as well as the adjacent coastal area. This led to frictions with the established French, Spanish, and Native American populations over the most valuable land.

In 1810, rebels engaged in successful uprisings in strategic locations such as Baton Rouge and Pascagoula. The coastal area was briefly (for a 74 day period) declared the independent Republic of West Florida; however, the U.S. government superseded the rebel government and claimed the Mississippi Gulf Coast (the parishes of Biloxi and Pascagoula) as part of the U.S.-controlled Orleans Territory.

Following this period of conflict, the coast was terrorized by gangs of robbers and marauders. The Orleans Territory governor authorized special agents, or justices of the peace, to eliminate the threat. According to one such justice, in 1811, Biloxi numbered 420 residents and Pascagoula 350. In order to provide postal services to the growing population, new roads were laid along the coast from New Orleans to Mobile and sailboat services between towns were initiated. Wealthy New Orleanians discovered the coast as a welcome summer retreat to escape oppressive heat and epidemics of yellow fever.

In 1812, Orleans Territory became part of the new State of Louisiana, and the coastal area entered by statute into the Mississippi Territory. Coastal Mississippians were forced to defend themselves in the War of 1812, as the Spanish (still ensconced in Florida) were allied with the enemy English against the U.S. The Spanish incited the native Creek tribe, resulting in a two-year campaign between Spain and the U.S. General Andrew Jackson led an invasion of the Creek stronghold at Horseshoe Bend, whereupon he became the defender of the Gulf Coast border against the British, with successes at Mobile and New Orleans, and a major contributor to the U.S. victory in the war.

The victory ushered in an era of nationalism and solidarity. Moreover, the belief in manifest destiny led to increased migration to the southeast frontier. With the resulting swell in population, Mississippi Territory finally achieved statehood in 1817.

This period of Gulf Coast history was also characterized by conflict and mercenary economic activity, with few major hurricanes of significance. Populations were still low but were poised to explode as new wealth entered the area.

Antebellum Period

During the antebellum period of 1815 to 1861, cities along the Mississippi Gulf Coast grew and prospered as resort spas and getaways for the urban south. This included the so-called “Six Sisters” of Shieldsboro (now Bay St Louis), Pass Christian, Mississippi City, Biloxi, Ocean Springs, and Pascagoula. Hotels, boardinghouses, wharfs, and bathing facilities were built for visitors. Small permanent populations and summer residents built cottages, villas, and small plantations. Local businesses and institutions were established as the needs of the population grew, including the second-oldest yacht club in the U.S. at Pass Christian. By 1860, the Mississippi Gulf Coast boasted 12,000 year-round inhabitants, with populations doubling or tripling in the summer. Summer festivities were grand and lively, attracting impressive wealth from New Orleans, Mobile, and Natchez.

Commercial and industrial centers were formed on the back bay of Biloxi at Handsboro (now part of Gulfport); on the Pearl River at Pearlington, Gainesville, Napoleon, and Logtown; on the Pascagoula River at Elder’s Ferry (now Moss Point); and at the head of the Bay of St Louis at Wolftown (now Delisle). These industrial towns supported the building boom occurring in adjacent resort villages. Both the resorts and commercial-industrial centers were connected by steamboat service to larger cities such as New Orleans.

In the midst of this building boom, the region was struck by another severe hurricane in 1860, which leveled structures and destroyed infrastructure, including newly built telegraph lines. Two strong hurricanes occurred shortly after, leaving residents and tourists stranded without aid.

That same year, the election of President Abraham Lincoln caused further turmoil and uncertainty. In January 1861, Mississippi became the second state to secede from the Union and the state prepared itself for war. Many local men joined the Confederate Third Mississippi Regiment, which deployed early in the war, and returned to serve the final years on the coast. Less than five percent of that regiment survived the conflict. Although fighting in coastal Mississippi was limited and local civilian casualties were very few, skirmishes occurred between

Federal warships operating off Ship Island and Confederate forces in Biloxi, Pass Christian, and Pascagoula. Furthermore, Union blockades at Ship Island and along the coast restricted commerce in local ports. Upon the Confederate defeat that resulted in the surrender of New Orleans in April 1862, the Third Mississippi Regiment retreated along with most inhabitants of the area. Those that remained were neglected by the Confederates and continually raided by the Union army and “jayhawker” draft dodgers. The Confederate states surrendered on April 9, 1865, bringing an end to the war.

Post-Civil War Era

After the surrender, the once-prosperous State of Mississippi emerged as the poorest in the nation, an unfortunate title it has retained. Pascagoula had been burned and pillaged. Other Mississippi Gulf Coast cities were relatively unscathed by battle; however, in those areas that were not directly damaged by fighting, the neglect of the war years was still apparent. Restoration began immediately, including resumption of steamboat services and reopening of hotels, mills and foundries.

In 1867, the U.S. Army instituted military Reconstruction. Slavery had been abolished, African Americans were now granted the right to own land, and public education was made available for all. Although most the Gulf Coast had largely been too poor to afford slaves prior to the war, a small contingent of free African Americans lived in the region. Racial tensions began to escalate, notably in an 1869 race riot between white firefighters and African American railroad workers traveling by steamship, in which two men were killed.

Reconstruction produced bitterness in the occupied South, but Gulf Coast residents were pleased by the government’s plans for the first railroad line in the region, completed between New Orleans, Mobile, and Chattanooga in 1870. The new railroad brought employment and renewed tourism, including visitors from the Northern and Midwestern U.S., to the region. It also increased the industrialization of Pascagoula, opened up agriculture production for export, and established new population centers at rail stations at Waveland and Long Beach. The

railroads combined with the advent of ice plants also gave rise to the seafood industry. These industries attracted immigrants from Italy, Greece, and the Balkan states (at the time, part of Austria-Hungary).

Figure 3: Map of New Orleans to Mobile railroad and population centers, circa 1890
Source: (Dyer, 1971)

An additional rail line was established in 1896 from Hattiesburg and the piney woods to the newly established city of Gulfport. The Ship Island Channel was dredged to grant direct access to Gulfport by sea. In the span of a few years, the fledgling city of Gulfport took off as a lumber and exporting hub, usurping Pascagoula and Biloxi as the commercial center for the Mississippi Coast.

strikes from 1850 to 2012 is shown in Figure 4, illustrating the concentration of damage over time in the region.

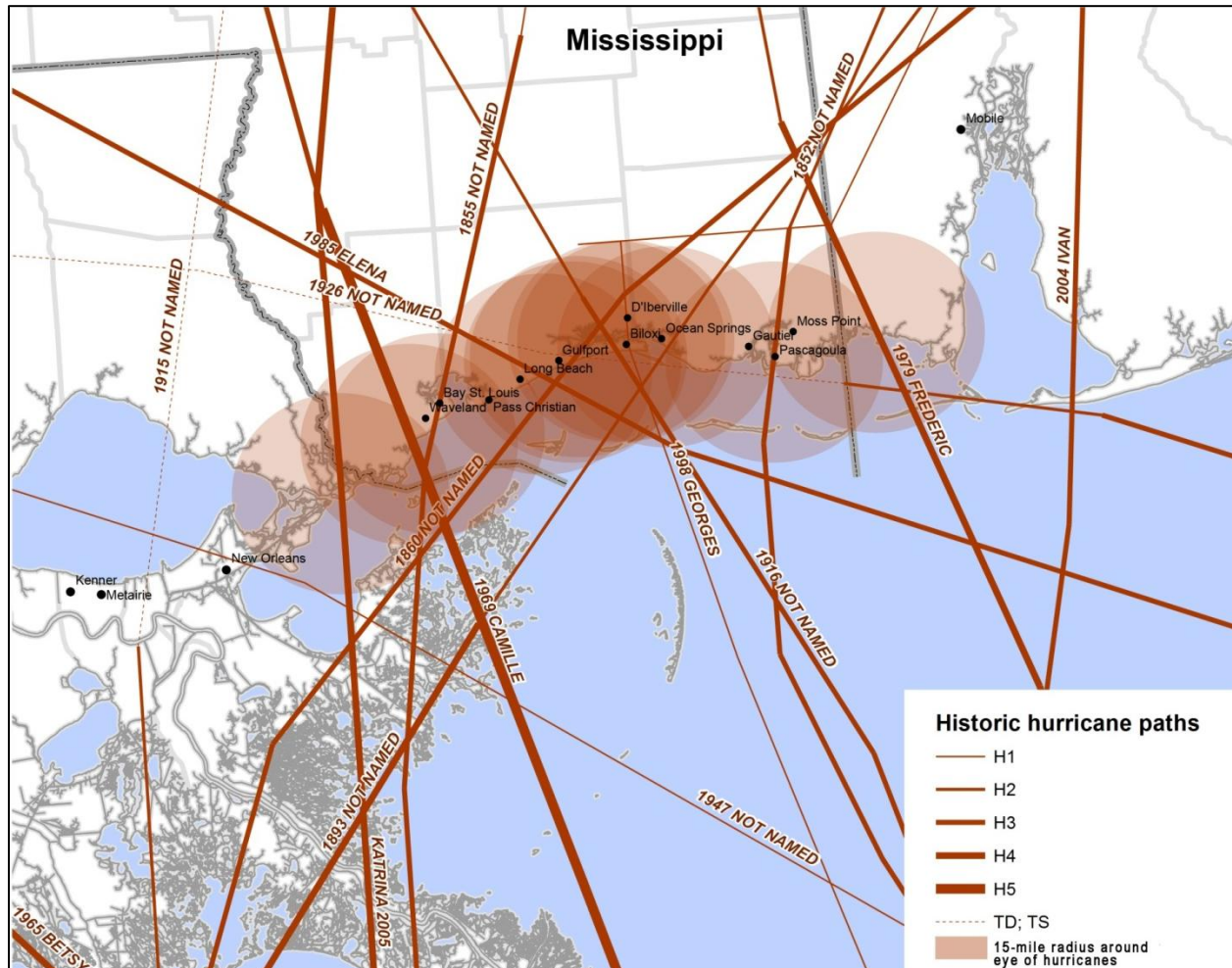


Figure 4: Historic hurricane tracks and level of impact to Mississippi Coast

Modern Era

Development intensified during the turn of the twentieth century. The Mississippi Coast was established as a center for seafood, lumber, and tourism. Technologies such as telephones, electricity, trolleys and automobiles became widespread. There were new diversions such as cinemas and air shows for tourists and residents. The first official Mardi Gras celebration in

Biloxi took place in 1908, including a parade and masked ball (informal Mardi Gras traditions date back to the French colonial period in Mississippi).

In 1914, the outbreak of World War I led to a downturn in exports of seafood and upticks in the demand for lumber and shipbuilding, accompanied by a surge in population to support these industries. Another major hurricane struck the area in 1915, with damage so severe that plans for a protective seawall were initiated. Construction began in 1924; however, before it was fully completed, the seawall was tested by another hurricane in 1926. The reinforced concrete wall, spanning 24 miles from Biloxi to Pass Christian, successfully withstood the storm. Similar walls were built in Bay St Louis and between Ocean Springs and Pascagoula. Waterfront construction exploded in response to what appeared to be a solution to erosion and flooding.

By 1925, the first U.S. highway in the area was completed, linking Mobile and New Orleans (named the Old Spanish Trail, or U.S. Highway 90). However, the 1929 crash and Great Depression brought a sudden end to the building boom along the coast. As after previous economic catastrophes, the coast eventually regrouped, once again producing ships and other war materiel for World War II. Perhaps more significantly, the coast's suitability for supporting the war effort brought new military installations established at Pass Christian, Gulfport (Gulfport Army Airfield), and Biloxi (Keesler Air Force Base). A surge in population and flood of government contracts ensued; the military influence permanently changed the character of the region.

Another major hurricane struck in 1947, prompting construction of a sandy beach buffer and improvements to the damaged U.S. Highway 90. In addition, the U.S. Army Corps of Engineers cut a deep channel along the length of the Mississippi Sound, between the barrier islands and the mainland, in order to better defend the coast from foreign invasion. These developments ushered in yet another industrial expansion, increased port activity for the existing shipbuilding and lumber sectors, and attracted chemical and energy companies.

Road construction also facilitated early suburban sprawl. In the 1960s, the first regional suburban mall was inaugurated in Biloxi, to the detriment of historic downtown commercial

centers. Biloxi and Pascagoula responded by converting historic business districts into enclosed shopping centers and by annexing suburban areas. Interstate 10 was completed in the late 1950s, running east to west through Hancock, Harrison, and Jackson Counties. The new highway was built north of and parallel to U.S. Highway 90, which subsequently became a local connector.

During the early years of the civil rights movement, although efforts such as the Mississippi Freedom Summer and the Freedom Rides concentrated in the Mississippi Delta and in Jackson, there were several instances of social upheaval in coastal cities. For example, many African American residents demonstrated and petitioned against segregation of Gulf Coast beaches. Despite harassment and violence during “wade-ins” at local beaches in 1960, segregation laws were challenged and African Americans were soon granted access to entire beach. This movement has been credited as the beginning of the civil rights movement in Mississippi (Hearn, 2004).

In 1969, the devastating Hurricane Camille struck the coast, the second-strongest hurricane in recorded history after the 1935 Labor Day Hurricane. Ahead of the storm, evacuation warnings were issued. Although this saved thousands of lives, the intense winds of more than 230 miles per hour and storm surges of 20 to 25 feet resulted in 144 deaths and \$1.4 billion in property damage. Almost no structure was spared, and many historic buildings were destroyed, such as the iconic Biloxi lighthouse built in the 1870s.

The storm had a profound impact on the psyches of residents and on the natural and human-made landscape. According to the writer Elizabeth Spencer (Jackson, 2010):

If I could have one part of the world back the way it used to be, I would not choose Dresden before the fire bombing, Rome before Nero, or London before the blitz. I would not resurrect Babylon, Carthage or San Francisco. Let the leaning tower lean and the hanging gardens hang. I want the Mississippi Gulf Coast back the way it was before Hurricane Camille. . . .

Cleaning up after Camille was laborious, with the military providing much-needed labor for clearing the carnage. Long term recovery was predominantly undertaken by the affected individuals and was facilitated by government aid. For 36 years, Camille served as the

bellwether against which all other storms were judged. Those properties that did not “get water” from the storm surge of Camille were considered (in many cases incorrectly) to be impenetrable in a hurricane of the greatest possible magnitude.

In the late 1960s and early 1970s, in the later years of the Vietnam War, South Vietnamese refugees settled in the Gulf Coast, finding the climate and geography somewhat similar their homeland, and established communities and livelihoods in the seafood industry and in tourism, even in the difficult economic climate of the time. Clashes with the established fishing community occurred over standards of navigation and acceptable catches (Starr, 1977).

During the 1970s, the term “Redneck Riviera” was popularized to describe the Gulf Coast from Mississippi to Florida’s Panhandle based on the festive but modest atmosphere. As it was in the previous century, tourism continued to be a major industry for the coast. In the 1980s, an arcane law allowing off-shore gambling in Mississippi was rediscovered, accelerating tourism, and economic growth in general, on the coast (Jackson, 2010). The number of casinos tripled by 1994, resulting in enormous surges in housing construction and reduced unemployment (Applebome, 1994). These developments consequently displaced many shrimping industry outfits and family-owned businesses.

In 2005, just before Katrina struck, the coast was experiencing continued population and economic growth – tourism and gambling, heavy industry, and the military complex were solid industries. Approximately \$1 billion in development projects were underway, including expansions of the convention center and airport, and several new hotels and casinos. The grand resorts of the coast, relics of a more provincial past, had mostly disappeared. The seawalls held smaller hurricanes at bay, but Camille demonstrated that the coast was still vulnerable to great storms.

Hurricane Katrina

Regarded as the most destructive natural disaster in U.S. history, Hurricane Katrina struck the Mississippi Coast on August 29, 2005. Initially forming as a tropical depression over

the Bahamas, the storm gained strength and first struck South Florida as a Category 1 hurricane on August 25. The storm weakened as it moved across Florida, but intensified in the Gulf of Mexico. At its peak strength in the Gulf of Mexico, Katrina was a Category 5 hurricane, with winds of 170 miles per hour and a 200 mile radius (Cutter et al., 2006). Katrina made landfall a second time, its eye crossing at the border of Mississippi and Louisiana, at 9:45 a.m. on August 29, 2005 (Figure 5). At this point, the storm was a Category 3 hurricane with wind speeds of 120 miles per hour and a radius of 140 miles and took nearly two hours to reel through the area. The landfall location and strength of the storm made it among the deadliest and the most costly hurricanes in U.S. history, with more than 1,800 dead, one million people displaced, \$80 billion in property damage, and 90,000 square miles of land impacted (Cutter et al., 2006).

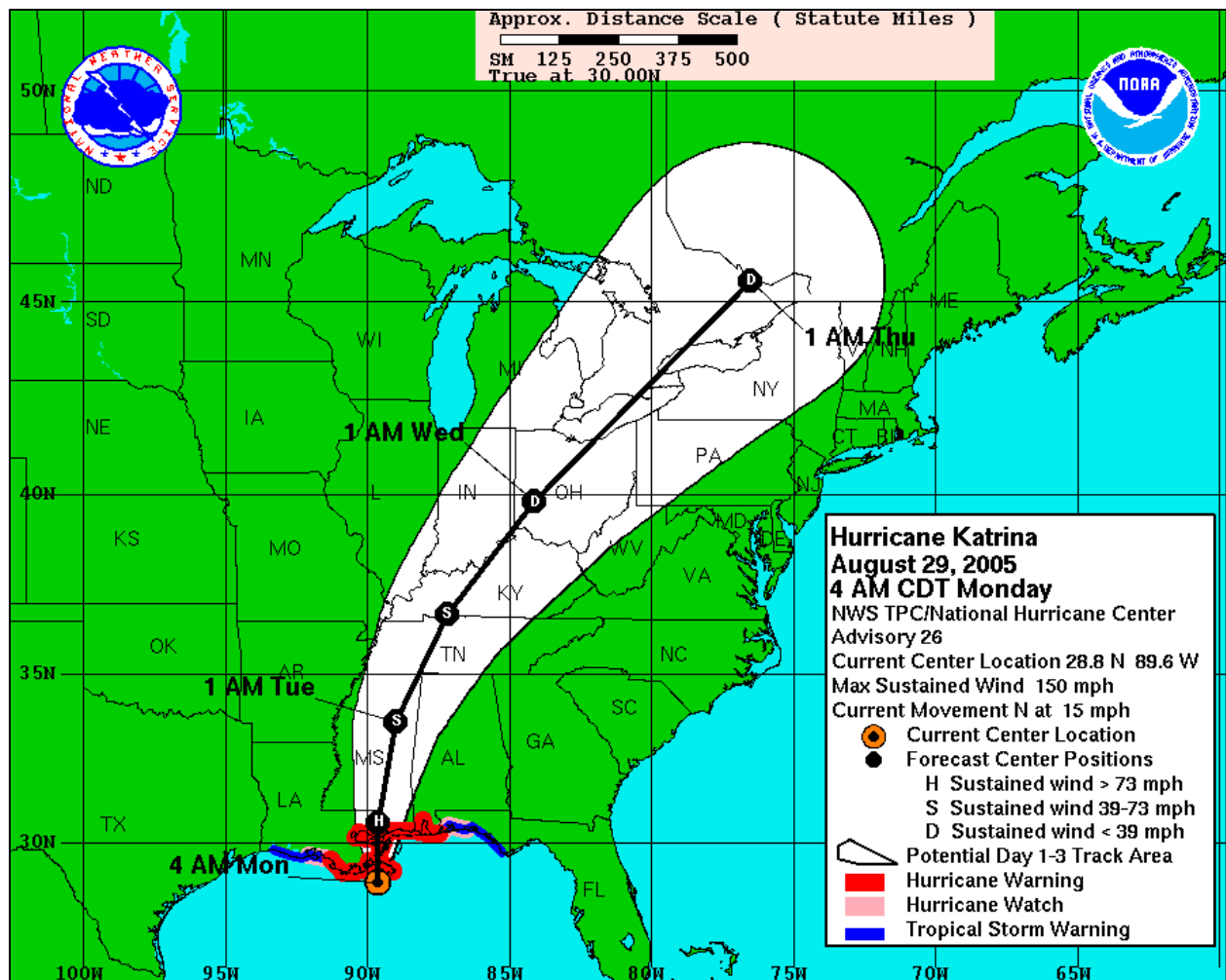


Figure 5: NOAA Hurricane Katrina forecast on August 28, 2005
 Source: NOAA and National Weather Service

Storm surges of up to 30 feet inundated the coast of Mississippi; in Mississippi alone, there were 230 deaths, more than 100,000 left homeless, and more than 200,000 homes that received some damage (Governor's Report on Recovery, 2010). The landscape appeared as if an atomic bomb had been dropped, “houses reduced to debris, a rubble-land, buildings razed as if by one of the companies that do that for a living” (Barthelme, 2005). Important economic drivers in Mississippi, such as tourism (particularly off-shore casino gambling) and the seafood industry were also decimated by the storm. Casino revenues fell by 28 percent the following

season. The under-construction, Frank Gehry-designed Ohr-O'Keefe art museum was damaged when an unmoored casino barge slammed into the structure.

The immediate emergency response in Mississippi was undertaken by federal and state authorities and local first responders. Ahead of the Katrina, Mississippi's State Emergency Operations Center (SEOC) was activated near Jackson as a unified command center for FEMA, the Mississippi Emergency Management Agency (MEMA) and other federal and state agencies. A staging area for the State Emergency Response Team, National Guard, and other response teams was established at Camp Shelby in Hattiesburg (Governor's Report on Recovery, 2010). MEMA and the National Guard deployed liaisons to the counties nearest the coast.

The relief effort in Mississippi began almost immediately after the storm cleared, orchestrated by federal and state agencies, faith-based organizations, and other nonprofits. An estimated 25,000 people from around the U.S. assisted with the effort (Governor's Report on Recovery, 2010). Emergency shelters operated through October 2005, after which FEMA provided trailers and other temporary housing.

In September 2005, Mississippi Governor Haley Barbour established the Governor's Commission on Recovery, Rebuilding and Renewal to guide long-term planning and rebuilding, which was reorganized into the Governor's Office of Recovery and Renewal (GORR) in 2006. Mississippi residents were outraged when the commission allocated \$570 million in federal housing funds from the U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant (CDBG) program to refurbish the Port of Gulfport. A contentious legal battle resulted in \$132 million directed back to housing for low- and moderate-income households. The controversy had a profound impact on the trust of survivors and constituents in state government and the use of recovery dollars.

Post-Katrina research (Pettersen, Stanley, Glazier, & Philipp, 2006) summarized the immediate social and economic impacts of the storm using empirical data from a wide variety of sources. Social impacts observed included the dispersal of 1.5 million (registered) evacuees and problems associated with administering aid to these individuals, the lack of housing and

employment opportunities limiting return to the area (coinciding with labor shortages), ethnic shifts in the area and in communities with a large influx of Katrina refugees, and impacts on the very poor, including possible displacement and gentrification.

Eight years after Katrina, the Mississippi Gulf Coast is still rebuilding and certain populations have not returned. The area is in transition, with reminders of Katrina still evident in dilapidated structures and empty lots. Even where reconstruction has occurred, the sense of loss is still apparent:

In North Gulfport, as damaged houses are razed and gas stations and fast-food restaurants are erected in their place, we lose even more of our history. "The old gas streetlamps on Main Street in Biloxi are gone," Joe [the author's brother] tells me. "They've replaced them with regular streetlights." "It's nice," he says of all the new construction on the coast, "but not the same." [his girlfriend] Aesha agrees: "The historic neighborhoods of Biloxi have disappeared," she says. "It was only a bunch of shotgun houses, but when I think of the coast, that's what I see." (Now, she tells me, the plans are to build a casino there.) (Trethewey, 2010)

Like Hurricane Camille 36 year earlier, Katrina swept away even more of the area's rich history and displaced its residents.

As shown in Figure 6, in the past 160 years the area has witnessed multiple high-intensity hurricanes that made landfall in any of the three coastal Mississippi counties. On average, the region has experience hurricane causing significant damage every 9.4 years since 1850. Of those, the 1893 unnamed storm, Camille (1969) and Katrina (2005) were the most deadly and costly. Historically, hurricanes have seemingly had little effect on population growth (see 1890 to 1910 or 1940 to 1980), or have even preceded spurts in growth (see 1850 to 1860 and 1910 to 1920). However, the impact of four major hurricanes in ten years from 1998 to 2008 has likely been responsible in part for a flattening of population growth since 1998. U.S. military action has also been a driver of population growth, with Civil War reconstruction and industrial activity associated with World War I, World War II, the Korean War, and the Vietnam War accounting for economic and population growth during this period.

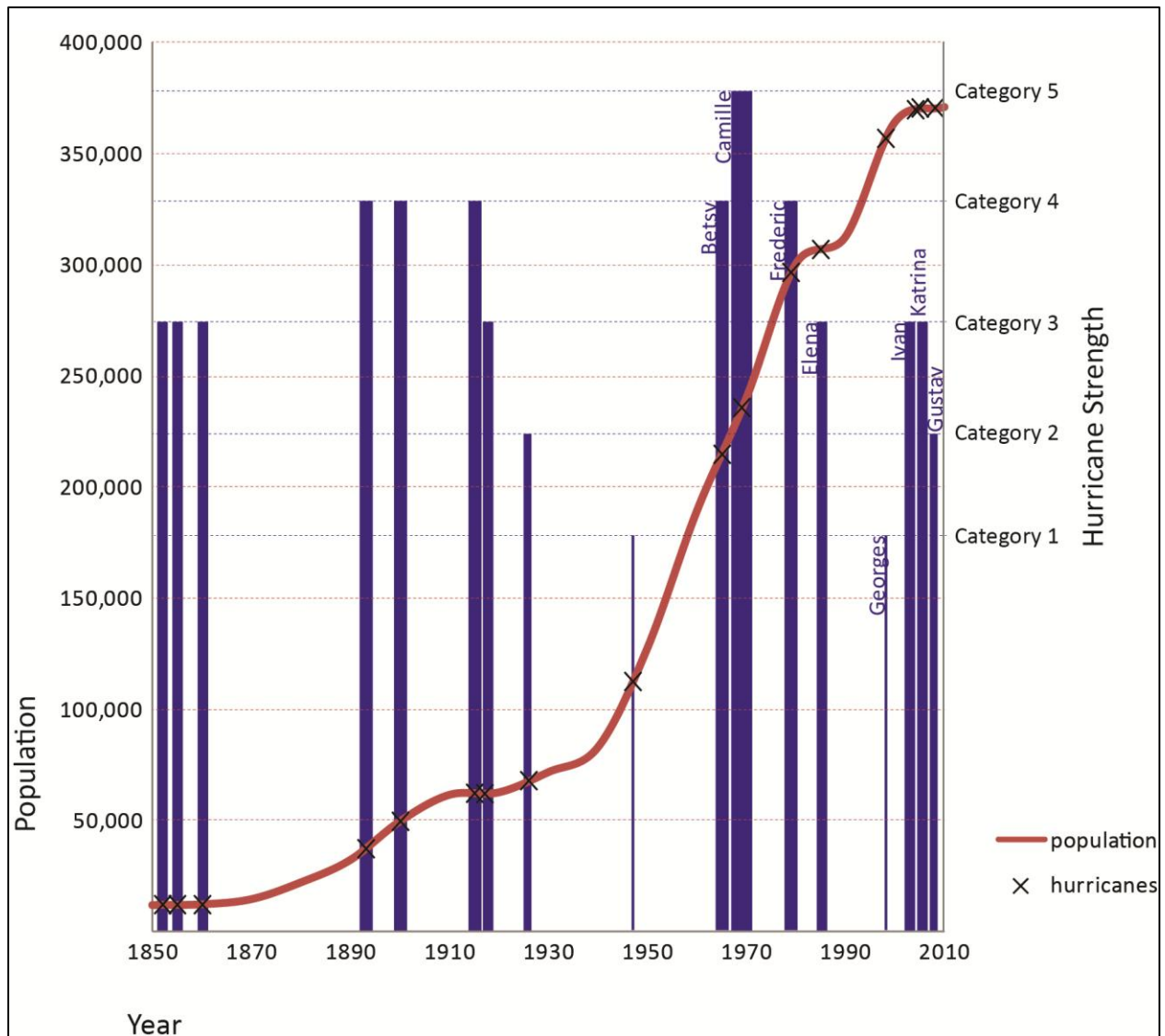


Figure 6: Hurricane strikes versus population, three coastal Mississippi counties 1850 to 2010
Source: FEMA and U.S. Census data

Compared with the rest of the country, the area is clearly more susceptible to hurricanes. The mean number of disasters per county from 1965 to 2008 is only 12.1 for the U.S., and the mean for coastal Mississippi is 19, demonstrating the increased risk and vulnerability of the area. As show in Table 1, the three coastal counties of Mississippi have experienced six times as many hurricanes than the rest of the country.

Table 1: Mean number of disasters per county during the period from 1965 to 2008

	All U.S. counties	Study area: 3 coastal MS counties
Flood	2.4	1.0
Hurricane	2.1	12.0
Severe Storm(s)	4.2	5.0
All disasters	12.1	19.0

Source: FEMA, April 1965 to September 2008

Recent 30-year forecasts predict more frequent and intense hurricanes (Webster, Holland, Curry, & Chang, 2005). Therefore, the population and economy of the coast will face enormous challenges in the future without strategic planning for greater disaster resilience. Worldwide, increasing urbanization and a growing reliance on interdependent technologies and infrastructure systems are increasing vulnerability along with disaster risk. Given the increasing shocks of natural disasters, a more complete understanding of resilience is important for creating safer, more sustainable communities.

Since Katrina, recovery has been uneven, and thus it begs the question what qualities make one community more resilient than another? Why have populations returned or even increased in certain communities and others seem unable to regain original population levels? The Mississippi Gulf Coast has endured colonial-era struggles for power, the Civil War, and numerous major hurricanes. A few communities have been abandoned, most have waxed and waned in population, and some have remained fairly constant. As in the quote above, area residents often speak of the unique built environment as a symbol of their community. Interpersonal relationships are another important factor rooting individuals in their community. Accordingly, the following research aims to determine how these concepts interrelate and what aspects are most important for determining the resilience of a community, using the Mississippi Gulf Coast before and after Hurricane Katrina as a case study.

CHAPTER 4: RESEARCH DESIGN

Conceptual Model

The research isolates a particular aspect of resilience that borrows and distills ideas from many disciplines in order to understand how physical planning impacts a community's ability to withstand and recover from a natural disaster. The conceptual model (Figure 7) summarizes the theory that communities are more or less resilient to disasters and that this is caused in part by the qualities of the built environment, which exert control on social networking activity. Essentially, the built environment supports and enhances social networks, which in turn determine resilience in the face of a disaster or other upheaval. Social networks can be difficult to measure, particularly at the scale of entire communities. Therefore, understanding the link between the built environment and social networks in this context may allow us to make assumptions about networks based on more measurable qualities of place.

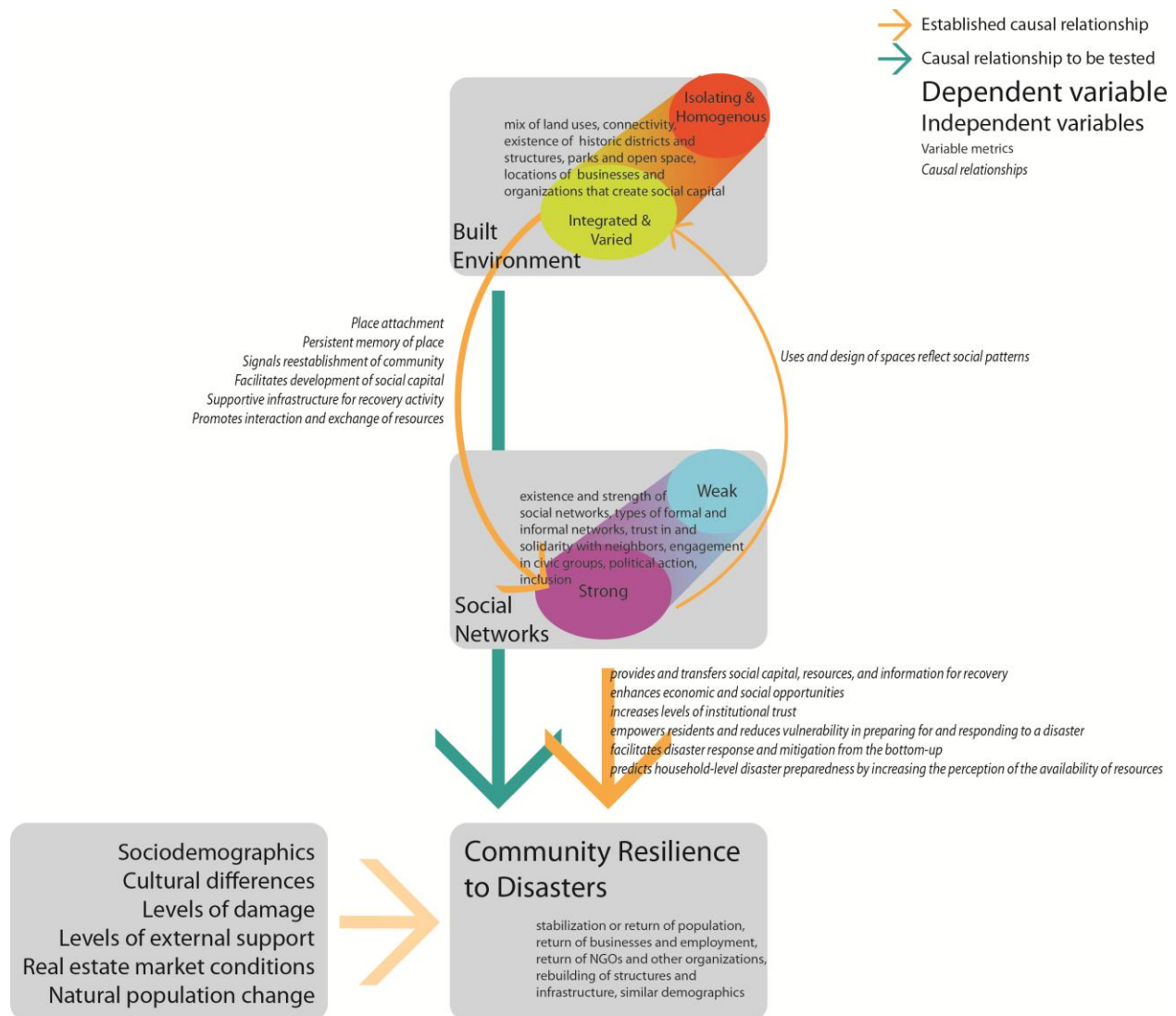


Figure 7: Conceptual model

This above model is based on the findings of the literature review. The relationships in the model between social networks and resilience and between the built environment and social networks are well understood. The link between more resilient communities and strong formal and informal social networks has been established through empirical data. For example, it has been shown that social networks are a major contributor to the resilience of a community by providing and transferring social capital, resources, and information for recovery; enhancing economic and social opportunities; increasing levels of institutional trust; empowering residents and reducing vulnerability in preparing for and responding to a disaster; facilitating disaster

response and mitigation from the bottom-up; and for predicting household-level disaster preparedness by increasing the perception of the availability of resources. Specifically, along the Gulf Coast, it has been previously shown that higher levels of civic engagement and social capital were significantly correlated with stronger levels of recovery as defined by repopulation, and reduced blight and crime (Mitchell, 1969). The effect of strong social networks on resilience, shown in the bottom of the conceptual model diagram, is the portion with the strongest causal ties, based on previous work in a variety of fields.

In previous studies, the physical structure and other elements of the built environment have been shown to contribute to greater social capital and social networks, although not specifically as they relate to disaster resilience. Features such as walkable, mixed-use neighborhoods encourage the development of social capital and place attachment and connectivity increases the probability of social interaction by increasing the potential for any origin-destination pair to traverse any point in space. Features such as open space, historic properties, and institutions that encourage socializing add to the sense of place and further both social networking opportunities and place attachment. Given the established relationship between the built environment and social networking, this research proposes that the built environment can be used to predict the resilience of a community, as it causes more or less social networking capacity, which causes greater or weaker resilience.

Income and other economic, cultural and situational differences are known to be correlated with resilience as well. In particular, income is an important factor as individual or even collective resources are generally needed to rebuild. Along the Gulf Coast, higher-income areas were more likely to be properly insured and more likely to be civically engaged (Mitchell, 1969). Lower income areas tend to be associated with fewer features of the built environment that provide social networking opportunities, further justifying the need to take income into consideration during the analysis. The amount of damage may vary by community, making overall recovery difficult to compare across geographic regions. In addition, the level of support supplied by the government and external aid organizations and the impact of other trends, such

as the state of the housing market or additional disasters like the 2010 BP Deepwater Horizon oil spill. Another confounding variable is cultural differences, for example traditional living arrangements, occupations, and manners of coping with hurricanes that are unique to landscapes along the coast. There are many such examples, such as clusters of Vietnamese shrimp fisherman, which gained attention after the Deepwater Horizon oil spill. Therefore, these types of intervening variables are included in the model to control for these effects in the analysis.

The research focused on Mississippi, although portions of Louisiana (most notably, New Orleans) and Alabama were also impacted. There are several reasons for this decision. First, the scale and even type of disaster differed by state. The eye of the hurricane hit landfall near the Louisiana-Mississippi border, therefore Alabama and western Louisiana received unequal forces of winds and rain compared with Mississippi. Damage in New Orleans occurred primarily due to the breaching of levees, which resulted in prolonged flooding rather than wind and short-term storm surge damage. Furthermore, the strategies and levels of state support and the prioritization of funds has differed by state. Finally, the Mississippi Coast, which was brutalized by the storm, has received less attention in many circles than other areas, despite the decimation of its communities. Because of these factors, and because of the substantial population and development of the Mississippi Coast, it was determined that coastal Mississippi should be examined in isolation from the rest of the Gulf Coast for this research.

Research Questions and Hypotheses

The conceptual model relationships point to the strong possibility that physical design influences overall disaster resilience. Given the increasing intensity and frequency of disasters, this has important implications for human safety and sustainability. Furthermore, in a weak economy like the present and in the wake of a significant disaster like Katrina, understanding the impacts of development patterns on future resilience could prevent further devastation. Many resources have been dedicated to rebuilding the Gulf Coast and to stabilizing neighborhoods experiencing decline and this research could inform and result in more strategic investments.

The research seeks to prove empirically that the proposed conceptual model is valid and that physical design indeed can be leveraged to create communities that are more resilient.

The research asks several questions in order to explore these concepts. It was initially expected that the built environment contributes to variation in resilience levels. The first question tested this notion.

1) Does a certain type of built environment result in a more resilient community?

Next, the link between the built environment and social networking was explored.

2) Do those properties of the built environment make communities more conducive to social networking activity?

The third question sought to understand how physical properties compare to other factors that influence social networks.

3) How does the effect of the built environment measure against other factors that are significant in forming robust social networks?

This was meant to further solidify the relationships in the conceptual model – that the built environment influences social networks, which influence resilience. A final conclusion question was based on the results.

4) What are the implications for planners?

The core theoretical questions are therefore whether 1) there are statistically significant effects on resilience due to the built environment and 2) how much these effects are due to the effect of the built environment on social networks rather than other influences on social networks and resilience in general.

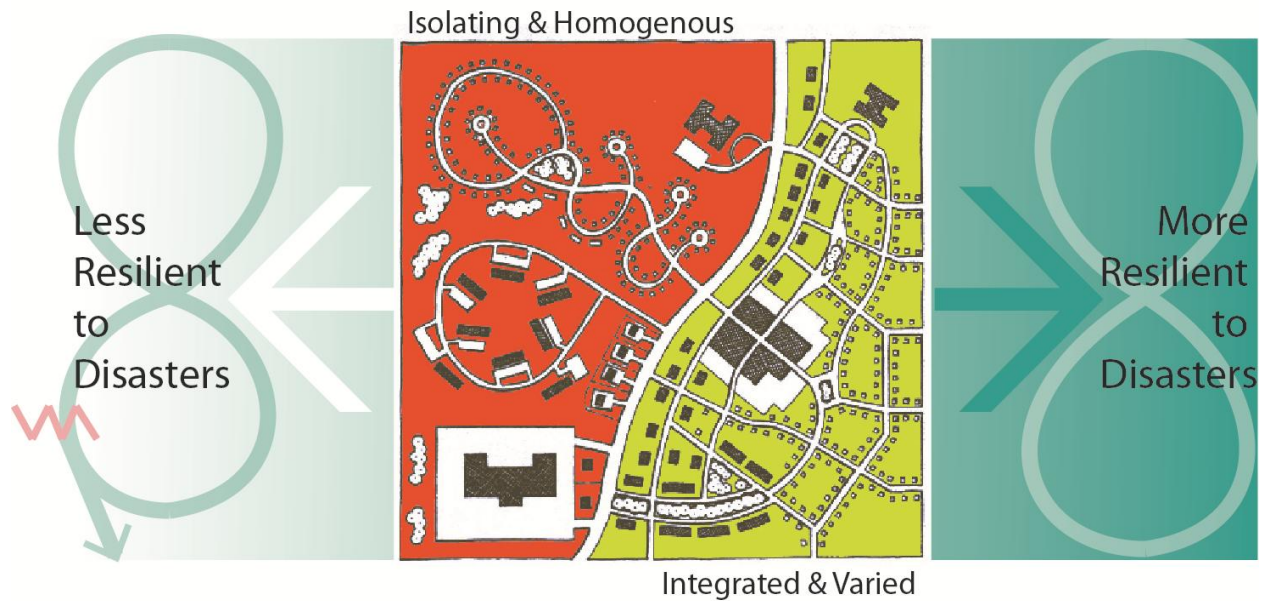


Figure 8: Research hypotheses

The research hypothesis is that a built environment with features that support social networks will result in a more resilient community, accounting for all other significant factors such as socio-demographic variables.

H0: a built environment with features that support social networks creates a more resilient community

H1: a built environment with features that support social networks has no impact on community resilience

As noted previously, the physical structure and other elements of the built environment have been shown to contribute to greater social capital and social networks, as the built environment is both the tangible and cognitive background in which social encounters take place. Despite the evidence, there may be other factors that are able to overcome deficiencies in the built environment to create more resilient communities. In order to establish the validity of these relationships with respect to disaster resilience, three research propositions, which provide more depth to the above hypothesis, were examined.

a) Social networks are important factors for resilience

b) Social networks interact with and are influenced by the physical environment

c) Communities with the strongest resilience include both strong social networks and varied and integrated physical environments

The type of built environment believed to support resilient communities is believed to be dense, has a substantial mix of land uses, and is well-connected – characteristics which bring people together physically. Proximity due to density and mixing increases the probability that any social encounter among individuals will occur in a given space. This increases the number of possible encounters and therefore the number of both acquaintances and strangers that may meet at any time. Furthermore, this mixing and density lead to an increased probability that formal and informal networks will form due to common interests and concerns and the aforementioned social mixing of geographic proximity.

The type of built environment that supports resilient communities also includes features that promote gathering and community building, such as parks and open space, private and public establishments where people convene, and historic features imprinted with the past and present social fabric. These features should be accessible, either centrally located or dispersed in such a manner that they are available to and useful for residents. Such features allow individuals and groups to forge and maintain connections. Examples include the formal headquarters of professional organizations, coffeehouses where neighbors regularly rub elbows and catch up, and playgrounds where children and their caregivers meet casually or intentionally. Finally, a built environment that promotes place attachment is known to support social networks based on solidarity of common experiences. This includes historically significant features, monuments, and other unique sites that are embedded in the cognitive maps of residents.

The built environment with these features – a mix of uses, high density and connectivity, community-building features, and historic sites – supports events that strengthen both weak and strong social ties, as well as bridging and bonding social networks, all of which have intrinsic value in creating resilient communities. Strong ties are generally with family members and close friends or coworkers. Weak ties are those made with acquaintances and are often important for

establishing new enterprises (Granovetter, 1973). Similarly, bonding networks are those made with people most similar to ourselves and bridging networks cross cultural divides. Weak ties and bridging networks are more likely to be forged in a varied and integrated built environment than strong ties and bonding networks.

A strong social network infrastructure includes some combination of the characteristics previously described. This infrastructure provides opportunities for connections to occur and also supports and maintains those connections. Social networks are integral to disaster resilience, and therefore this type of built environment will result in a resilient community. If the first hypothesis is true, it is expected that resilience measures will be positively associated with the types of built environment described above. If the second hypothesis is true, resilience measures will be positively associated with social networking activity, although a socially vibrant built environment is not necessary to achieve resilience through social supports.

Methodology

In order to substantiate the above relationships, hypotheses, and propositions, the research was conducted in several steps, with two main stages. In Stage 1, an analysis of all geographies in Katrina's storm inundation area was conducted in order to address the first research question, whether there are statistically significant effects on resilience due to the built environment. A metric of resilience was the dependent variable and built environment metrics the independent variables in a multivariate linear regression model. Control or test variables from the conceptual model, such as socio-demographic variables, were included. In Stage 2, a case study analysis of community-level geographies was undertaken. Four case study communities were selected for further investigation based on results the initial analysis, specifically on measures of resilience and built environment configurations. Case study communities were classified by 1) their ability to withstand and recover from the hurricane, or their resilience and 2) the type of built environment found in the community. The case study

stage of the research addressed the remaining research question, how the effect of the built environment measures against other factors that impact social networks.

This mixed methods approach was practical for determining the validity of the hypothesis, as it provided a deeper understanding of the relationships between the built environment, social networks, and resilience within the context of the Gulf Coast through qualitative analysis while reducing personal bias through a quantitative analysis. Mixed methods were also needed to test the hypothesis and examine the additional propositions. A qualitative study would be insufficient to determine the soundness of the model, although quantitative data cannot possibly provide a detailed understanding of the unique places and circumstances, particularly the characteristics of social networks.

The qualitative results build on the quantitative results in the manner of an explanatory two-phased mixed methods design, where the qualitative data explain initial quantitative results. The mixed methods approach used will conform to a follow-up explanations model (Creswell & Clark, 2007), where the qualitative data are used to expound upon the initial quantitative findings, particularly those extreme results that need additional explanation or do not conform to the hypothesized relationship. Accordingly, the results of the qualitative analysis were informed by the specific quantitative results associated with the case study geographies. Both sets of results inform the overall findings.

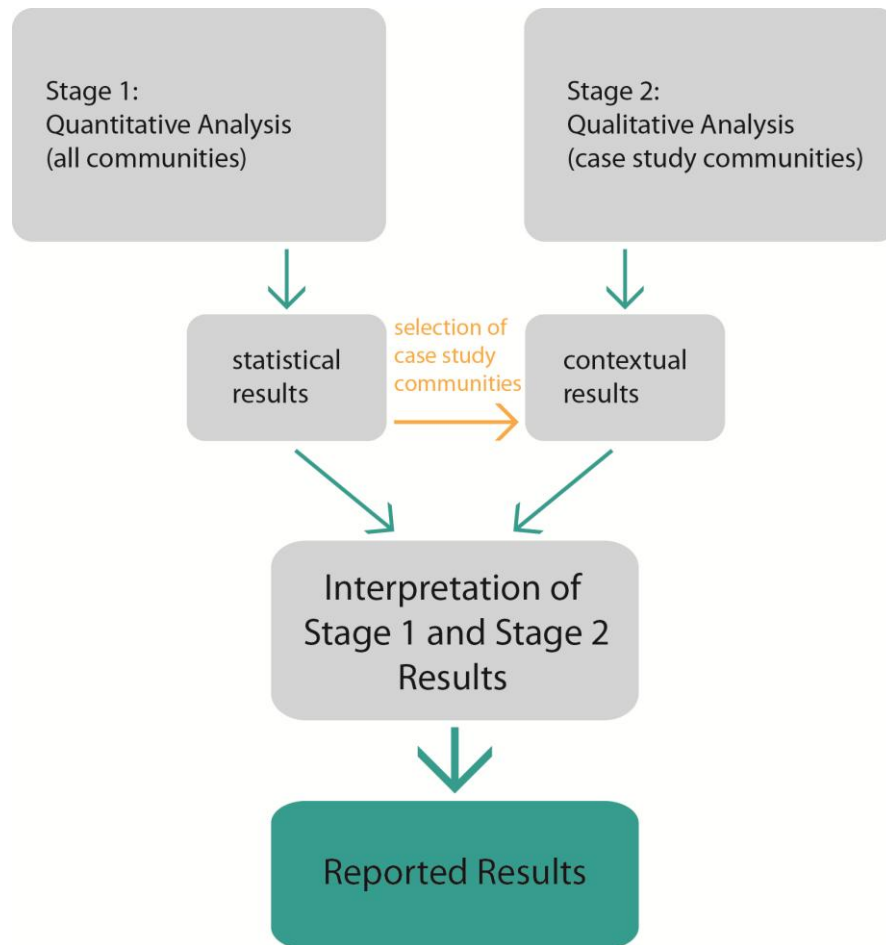


Figure 9: Research methodology

The two stage method included a quantitative analysis of all Mississippi geographies impacted by Katrina and a qualitative analysis of select case studies to be chosen based on the results of the quantitative analysis.

Stage 1: Testing the Model with Empirical Data

The first stage answered the research question, does a certain type of built environment result in a more resilient community? It tested the first hypothesis, whether a built environment with features that support social networks creates a more resilient community. For the quantitative stage of the analysis, a cross-sectional multivariate linear regression model was employed in order to establish causality and to isolate the effects of individual variables.

Resilience, measured by the relative stability of housing before and after Katrina, was the dependent variable in the model. The resilience of communities can be measured with a number of metrics. For this research, a particular aspect of resilience was targeted— how households, rather than businesses, government, or ecosystems, rebound. The longer-term recovery was measured by the adaptive capacity of the population through the restoration of the local housing stock. The surrogate measure used was the change in occupied housing units from 2000 to 2010, normalized by area. Reliable data were not available on who exactly has returned or remained in the area, therefore net numbers were used, assuming the returning population is predominantly original residents or households that would have moved to the area regardless of the storm. The specific dependent variable measure was

- Adaptive capacity of population through restoration of housing stock:
 - change in occupied dwelling units in block from 2000 to 2010 (pre- and post-Katrina), divided by area of Census block in acres

The independent variables measured how the built environment is able to support social networks. Many specific, measurable properties of the built environment contribute to greater social capital in a community. Metrics of the built environment included a set of variables and indices of the relative social vibrancy or isolation a community. Included were land use mix, housing density, and intersection density. Other variables include park and open space density and social gathering place density. These measures capture access to spaces in which people are likely to gather. Finally, historical site density was used as a proxy for place attachment, as monuments and heritage sites promote a sense of local continuity and splendor.

The built environment variables included

- Features that increase probability of social encounters:
 - land use mix
 - housing density
 - intersection density
- Features that promote gathering:
 - social gathering place density
 - parks and open space density
- Features that increase place attachment:

- historic sites density

The independent variables can be organized into community versus individual effects, although all were aggregated to the block level, with many measures taken for a larger buffer around the block (buffers were created for a walkable distance of one kilometer, which constitutes the sphere of influence of the built environment). Community effects are more intertwined with social capital and include poverty status and the year built of homes and other buildings in the area. Individual effects are those made at the household level and are often based on microeconomic phenomenon. These include the tenure status, damage to the property, insurance coverage, property values, and amount of aid received.

Several intervening variables were introduced in the model as well. These included socio-demographic variables that have been shown to be significant for resilience as well as external factors related to damage and ability or feasibility to rebuild. Growth normalized by area from the previous Census period of 1990-2000 was used to control for endogenous growth or contraction in the population. The number of occupied housing units per acre in 2000 was also included as an intervening variable to control for the large variance in block populations, as population density can vary greatly throughout the region.

The intervening variables included

- Socio-demographic status:
 - race
 - income
 - tenure
 - poverty status
- Feasibility of rebuilding:
 - housing values
 - age of housing stock
 - level of storm damage
 - federal, state, and nonprofit aid received
 - stability of population measured by population living in area in 1995
- Natural growth or attrition of the area
 - change in occupied housing units per acre, 1990-2000
 - initial occupied housing units per acre, 2000

The model in equation format is shown below (variable names are described in Table 2).

$$\text{Resilience} = \text{Built environment factors} + \text{intervening factors} + \text{control factors}$$

$$(\text{occ10-occ00})/\text{area} = \beta + \beta_{\text{lu_mix}} + \beta_{\text{hsg_dens}} + \beta_{\text{int_dens}} + \beta_{\text{soc_orgs_dens}} + \beta_{\text{park_dens}} + \beta_{\text{hist_dens}} + \beta_{\text{race}} + \beta_{\text{income}} + \beta_{\text{tenure}} + \beta_{\text{poverty}} + \beta_{\text{hsg_val}} + \beta_{\text{hsg_age}} + \beta_{\text{pc_damage}} + \beta_{\text{aid_amount}} + \beta_{\text{stability}} + \beta_{(\text{occ00-occ90})/\text{area}} + \beta_{\text{occ00}/\text{area}} + \epsilon$$

Table 2: Equation variables

Variable Short Name	Variable Full Name
(occ10-occ00)/area	Resilience (change in occupied dwelling units in block from 2000 to 2010 divided by area of Census block in acres)
lu_mix	Land use mix
hsg_dens	Housing density
int_dens	Intersection density
soc_orgs_dens	Social gathering place density
park_dens	Parks and open space density
hist_dens	Historic sites density
race	Race
income	Income
tenure	Tenure
poverty	Poverty status
hsg_val	Housing values
hsg_age	Age of housing stock
pc_damage	Level of storm damage
aid_amount	Federal, state, and nonprofit aid received
stability	Population living in same region in 1995
(occ00-occ90)/area	Change in occupied housing units per acre, 1990-2000
occ00/area	Initial occupied housing units per acre, 2000

This quantitative model was designed to determine which of the variables listed above are most significant and whether the hypothesized relationship, that the built environment influences community resilience to disasters, is valid. However, because the Stage 1 analysis is insufficient to identify a wider array of factors that may not be present in the literature or in the original conceptual model, a detailed qualitative analysis was conducted in Stage 2.

Stage 2: Case Study Analysis

The Stage 2 analysis was designed to provide additional detail for the primary research question (does a certain type of built environment result in a more resilient community?) also explored in Stage 1 and answer an additional research question (how does the effect of the built environment measure against other factors that are significant to social networks?). This stage also examined the three additional research propositions: a) social networks are important factors for resilience; b) social networks interact with and are influenced by the physical environment; and c) communities with the strongest resilience include both strong social networks and varied and integrated physical environments. The quantitative model of Stage 1 was therefore enhanced with results from the qualitative case study analysis of the social networks and intricacies of the built environment of select case study communities. The second stage of analysis also retested the questions in the first stage at a coarser-scale geography (neighborhood-scale clusters of blocks versus city blocks), with the results of each stage ultimately linked to improve overall understanding of the phenomena involved.

Using the data compiled in Stage 1, four case study communities were selected to represent discrete types of built environment and levels of resilience (change in occupied households normalized by area). The selected case study communities included two high-resilience communities with integrated and varied built environments and two low-resilience communities with integrated and varied built environments. As in Stage 1, mix of land uses, housing density, street network patterns, presence of historic buildings, and amount of open space were used to select examples of communities with more or less integrated and varied built environments and change in occupied housing units (2000-2010) per unit area was used to select examples of high and low resilience to Hurricane Katrina.

Therefore, two communities were chosen from each of the two categories in the right-hand column shown below in Figure 6; four cases total were analyzed. The unit of analysis was a cohesive yet manageable geography, Census block groups, with anticipated case study community populations between 100 and 4,300 persons, based on 2010 block group populations.

Low-resilience communities with high integration and variation (“flawed” category shown in Figure 10) and high-resilience communities with high integration and variation (“ideal”) were singled out to determine how resilience was achieved and the relative impacts of the built environment. Communities were chosen that have demographic profiles similar to the regional average, with highly unusual or overly homogenous communities excluded. Areas with relatively similar levels of damage from the hurricane and storm surge were selected.

Low-resilience communities with low integration and variation in the built environment (“undesirable”) and those high-resilience communities with low integration and variation (“redeeming”) were not examined in the qualitative analysis in order to focus on a larger sample of communities with more socially vibrant built environments, which are therefore more suited to addressing the research questions related to this type of built environment and its impact on resilience.

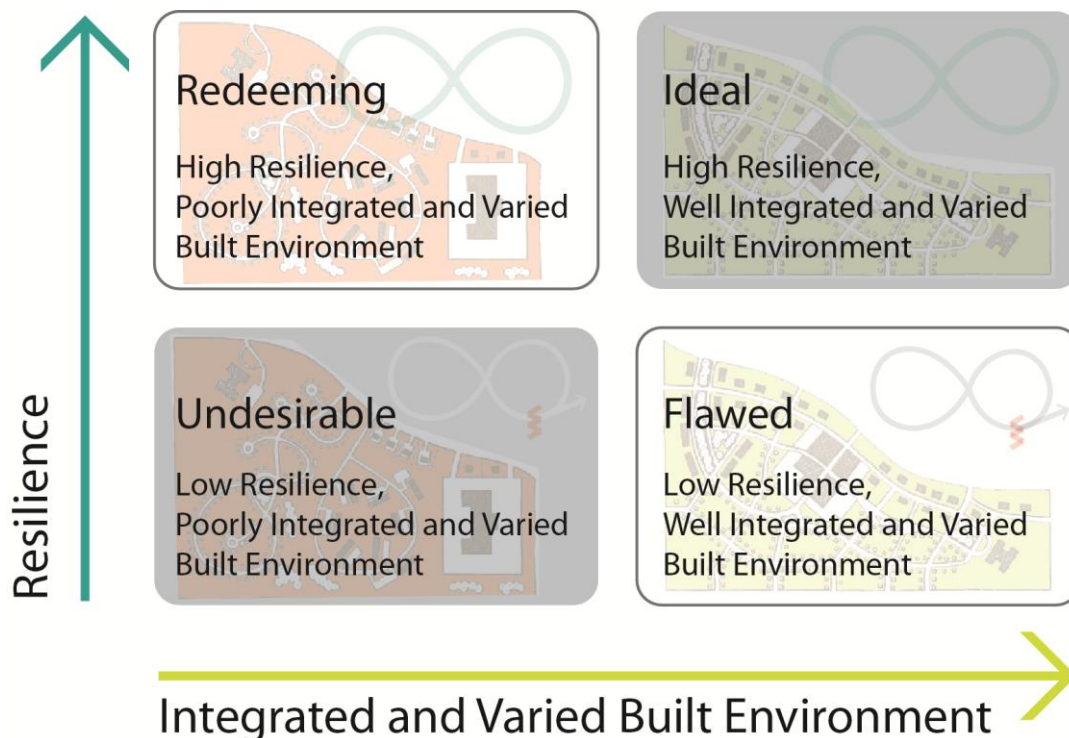


Figure 10: Matrix of case study selection criteria

The resilience metric of change in occupied housing units normalized by area is depicted in the map in Figure 11 at the level of Census block groups as an illustration of the variation in resilience levels found along the coast. The area from which case study geographies were chosen was the portion of Mississippi most affected by Katrina, including three coastal counties – Hancock, Harrison, and Jackson Counties. Although the study area contains many distinctly different enclaves, it is a relatively small geographic area that also has many similarities, particularly with respect to exposure to disasters.

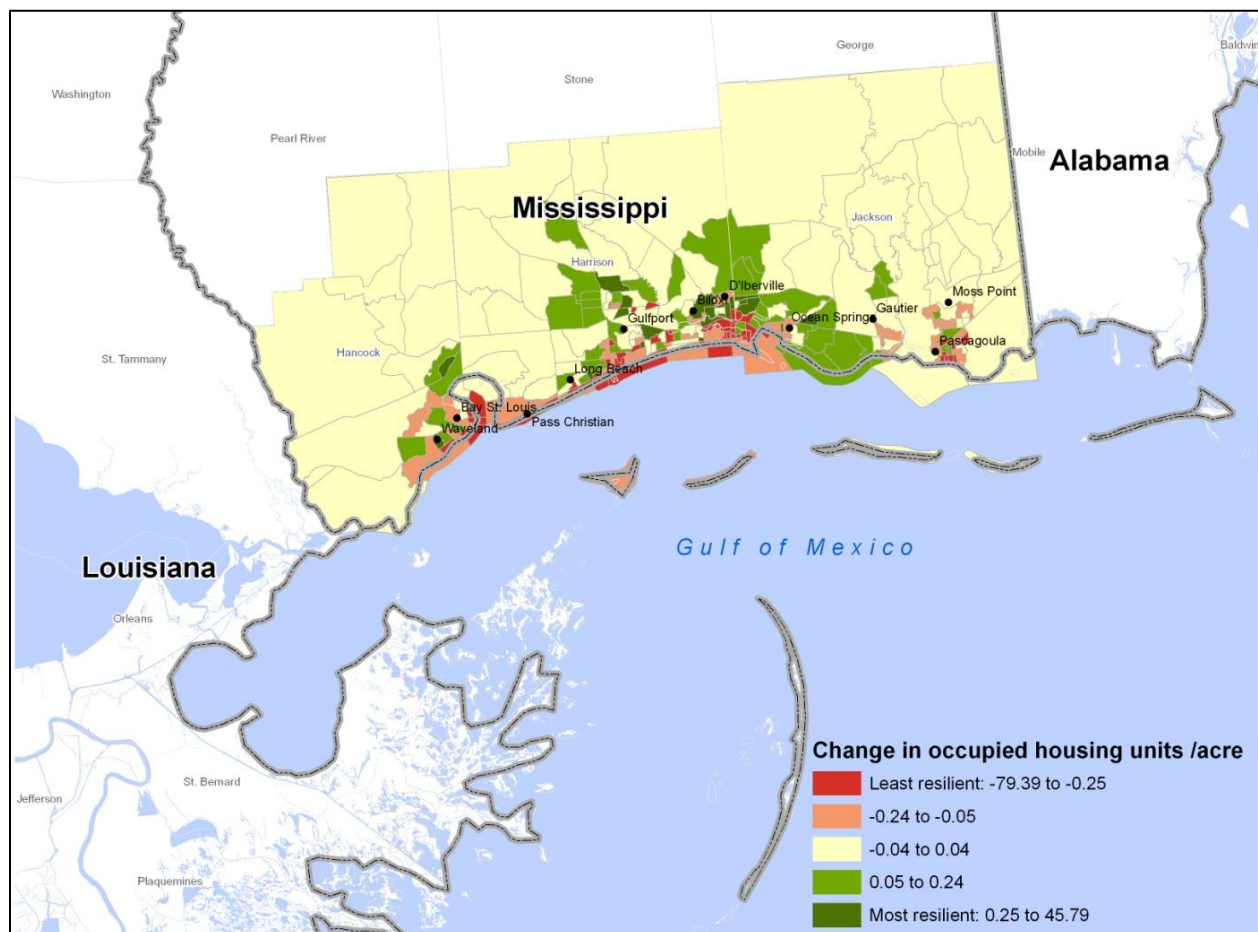


Figure 11: Example data for selection of case study communities in Mississippi

After selection of the four Mississippi case study geographies, interviews were conducted with residents and community leaders. Interview subjects were chosen via purposive, respondent-driven sampling (Heckathorn, 1997). Respondent-driven sampling is preferable to other methods in that it has been shown to produce relatively unbiased and representative results

while allowing access to hidden or disenfranchised populations. Community leaders, the initial seeds of the respondent-driven sample, were identified through existing contacts at the Federal Reserve Bank of Atlanta's Community and Economic Development division.

The sample of recruited subjects was interviewed individually in their communities or on the telephone. Interview protocol were designed to determine how individuals engage in and perceive social networks in their communities in general, how they did so with respect to Katrina, whether there are physical elements of their communities that facilitate social networks in direct or symbolic manners, and what other factors contribute to resilience in their communities.

The sampling and protocol were approved by Georgia Tech's Institutional Review Board (IRB). Once these interview data were collected, information was codified when possible. The information was cleaned and compiled to create categories with frequencies that can be compared with quantitative data and presented as descriptive statistics.

Overall, the importance of the built environment and social networks in building resilience was further explored by interpreting responses to the above questions and comparing with responses about other community characteristics that contribute to resilience. Data and results from the quantitative study in Stage 1 provided an initial snapshot of the community. The microscale data of Stage 2 were then combined with and supplemented the Stage 1 analysis.

CHAPTER 5: STAGE 1 RESULTS

The Stage 1 portion of the research was a quantitative model encompassing a wide array of data, continually refined throughout the study. The final results provide empirical support for interactions between aspects of the built environment that influence social networks and resilience.

The units of analysis chosen for the model were Census blocks, which correspond to actual city blocks, bounded by city streets, railroads, or bodies of water. Census blocks are the smallest geographic units for which Census data are available and are more suitable than other Census geometries, which tend to be larger than neighborhoods and are particularly large in sparsely populated areas. In order to capture the community or neighborhood scale, a one kilometer buffer around each block was created. There were approximately 14,000 blocks in the three-county study area of coastal Mississippi. However, blocks that did not fall in the storm inundation limit, were less than a half-acre, or had fewer than five occupied housing units were excluded, reducing the sample size to 3,222 blocks. Blocks outside the storm inundation limit were excluded to control for amount of damage (percent damage was also included as an independent variable). Very small or nearly unpopulated blocks were excluded to ensure reliability, as population counts are less accurate at such small increments.

Many independent variables were collected at the level of a one kilometer buffer around the block, as the block in which a household lives is influenced by a wider swath of the built environment, rather than the block itself in isolation. Buffers were created for a walkable distance of one kilometer to capture the greater sphere of influence of the built environment on the block. A distance of one kilometer is often cited as a distance easily walkable in 10 minutes. It is also the area in which residents are likely to encounter neighbors in their social networks.

Model Variables

As per the research design and methodology, data were selected for use in the quantitative model to measure resilience, the built environment, intervening variables to account for vulnerability, and control variables to account for previous growth trends.

Resilience indices have been advanced to determine how easily communities might rebound should a disaster strike, although these tend to be pre-disaster baseline assessments (Cutter et al., 2008). Others have developed sophisticated economic equilibrium models based on pre-disaster conditions (Rose, 2004). Social vulnerability indices and inventories include many of the same variables as the social aspects of resilience, such as race, income, and tenure status (Morrow, 1999). Fewer studies have quantified resilience by examining pre- and post-disaster conditions, which is curious given the concept of resilience is predicated on a cycle of change over time. One example is the framework developed in order to assess the technical, organizational, social, and economic (TOSE) dimensions of community resilience with respect to the “four R” properties of resilience or of robustness, redundancy, resourcefulness, and rapidity (Bruneau et al., 2003). This method can be applied both pre- and post-disaster. Building on TOSE and the four R’s, the PEOPLES model specifies indicators that measure those dimensions and properties pre-and post-disaster in the categories of population and demographics, environmental/ecosystem, organized governmental services, physical infrastructure, lifestyle and community competence, economic development, and social-cultural capital (Renschler et al., 2010). The above methods capture the theorized contributors to and components of community resilience, but it does not appear that any have been sufficiently tested in actual disaster scenarios.

Given the fact that housing comprises the greatest amount of damage in disasters (Comerio, 1997) and that commercial recovery is tied to housing recovery (Olshansky et al., 2006), an aspect of resilience that underpins all other sectors and therefore serves as a proxy for overall resilience is the return of households. For the purposes of the quantitative model stage of this research, many of the indicators used in previous research were included as independent

variables that impact resilience and resilience was measured through a simplified metric, the return of occupied housing.

Accordingly, resilience was the dependent variable in the model and was measured by the relative stability or recovery of housing post-Katrina. The indicator used was the change in occupied housing units from 2000 to 2010, normalized by area. This was taken for the individual unit of analysis, the Census block. There have been some minor changes to the block geographies over time, thus 1990 and 2000 block data and 2000 block group data were spatially assigned to 2010 blocks by overlaying the data in GIS (using the Identity function) and allocating values by areal weights.

This particular metric was selected in order to capture the return of all housing, including single-family, multifamily, mobile homes, and all other sheltering situations characterized as units of housing by the Census. Based on field visits and interviews, in some cases, structures have been rebuilt but remain vacant. In other cases, businesses would like to return but cannot find an appropriate address. The number of *occupied* housing units is uniquely able to measure the actual rebound of the people.

Although an area's capacity to rebound is also captured in the return of businesses and generally of structures and infrastructures, the return of a resident population is even more fundamental and, as noted previously, essential for the recovery of other sectors. Therefore, as housing is only one aspect of resilience, this is only a partial metric of resilience. However, because this research focused on household social networks, it is also most appropriate to examine the return of households. On a practical level, Census population counts are more accurate and available at a more refined scale than business or building permit data for this area. Unfortunately, reliable data are not available on who exactly has returned or remained in the area in 2010; therefore net numbers were used, assuming the returning population is predominantly original residents or households that would have moved to the area regardless of the storm.

The independent variables were selected to measure how well the built environment supports social networks. Many properties of the built environment contribute to greater social

capital in a community. Metrics of the built environment chosen for this research included variables and indices of the relative social vibrancy or isolation a community. All built environment variables were measured using pre-Katrina conditions, in order to capture the qualities of the built environment that impacted resilience rather than the resultant conditions from the storm. Variables included land use mix, net residential density, intersection density, the density of social network-supporting businesses and organizations, park locations, and historic site locations.

Land use mix was calculated using pre-Katrina parcel level land use data. A housing analysis database for coastal Mississippi was created in November 2008 by FEMA for the Mississippi Governor's Office of Recovery and Renewal in order to assess land use change and property value change at the parcel level. FEMA collected county land roll databases from Hancock, Harrison, and Jackson Counties with 2004 or 2005 data (the last available pre-Katrina data in each case) as well as 2007 post-Katrina data. The databases were cleaned and standardized by FEMA and each includes a land use category pre- and post-Katrina. Several other databases were also obtained, including data from the U.S. Department of Agriculture (USDA) National Land Cover Database (NLCD), the Mississippi Automated Resource Information System (MARIS), and the Gulf Regional Planning Commission (GRPC), but ultimately the FEMA parcel data were the most appropriate in terms of classification of land uses, the coverage area available, and the date collected.

Using the FEMA land use data, a land use mix index was calculated. This was an entropy measure reflecting the evenness of distribution of several land use types in each block buffer that has been used in previous work (Frank, Bradley, Kavage, Chapman, & Lawton, 2008). The land use mix index was calculated as follows where n is the number of different land use type classes in the buffer and P_i is the proportion of land in type i in the buffer.

$$\text{Land use mix index} = - \sum_{i=1}^n P_i * (\ln P_i / \ln n)$$

Only three categories were used – residential, commercial, and other – due to the large number of categories present and in order to capture the mix between residential and commercial

uses, which was of greatest interest. The resulting variable has a variance of 0 (homogeneous land use, for example, a low-density suburb) to 1 (a perfect mix of 33 percent of each land use).

Net residential density was calculated using the total number of housing units in the buffer divided by the total residential area of the buffer, using Census data for housing counts and the aforementioned FEMA land use data for residential acreage. This more accurately measures the type of housing density present over calculations using total area, as an area that is predominantly commercial may result in a very low-residential density despite the presence of dense multifamily development. In order to be consistent with the dependent variable and other variables in the model, Census data were used for housing counts.

Several measures of connectivity and street network accessibility were considered, including street length density and metric reach. Given the types of street networks found in the region, these measures were highly correlated with one another. Intersection density was used to be consistent with many planning studies, which have also shown intersection density to be strongly associated with pedestrian behavior compared with other common metrics (Ewing & Cervero, 2010). In order to compute the intersection density measure, 2000 Census TIGER street network shapefiles were prepped using the clean and build functions in the GIS software ArcInfo. A script was used to create a point at each intersection between line segments in the street network shapefile, which also calculated the number of streets converging on that point, or the valence value of the point. Points with a valence of less than three were omitted from the measure, as these points constituted dead-end roads, cul-de-sacs, interstate on ramps, and similar features. T-intersections, four-way intersections, and the like were included. The number of intersections in the block buffer was divided by the square kilometers in the buffer.

The number of organizations that support social networking per block buffer was calculated using business directory data from the commercial vendor InfoGroup. Archived August 2004 business directory data from InfoGroup's OneSource database were purchased. These were the last data collected before Katrina. The resulting dataset included 3,228 total businesses in the Standard Industrial Classification (SIC) code categories shown in Table 3. All

categories were chosen based on an oft-cited study examining social capital and associational activity (Rupasingha, Goetz, & Freshwater, 2000), which pointed to bowling alleys, public golf courses, membership sports and recreation clubs, civic and social associations, religious organizations, labor organizations, business associations, professional organizations, or political associations. Added to this were gathering places such as eating and drinking places, book stores, beauty and barber shops, cultural centers, and recreational establishments not mentioned above. Organizations and gathering places are of interest as a greater density of these locations provides opportunities for interactions and is associated with richer social networks and greater social capital (Isserman, Feser, & Warren, 2007). The number of organizations in each block buffer was divided by the area in order to create a metric of the potential for social networking for each block.

Table 3: SIC codes used in social organization density measure

	SIC code	Description	Number of locations in 3-county coastal MS area
	5800-5899	Eating and drinking places	926
Recreation and entertainment	5942	Book stores	22
	7032	Sporting and Recreational Camps	6
	7033	Recreational Vehicle Parks and Campsites	34
	7231 and 7241	Beauty shops and barbers	489
	7832-7833	Motion picture theaters	5
	7841	Video tape rental	14
	7900-7999	Amusement and recreation services	359
	8400-8499	Museums, art galleries, and botanical and zoological gardens	11
	8200-8299	Educational services	268
	8300-8399	Social services	444
	8600-8660 and 8662-8699	Membership organizations	133
	8661	Religious organizations	517

The locations of parks were found using several geolocated parks databases: OpenStreetMap, MARIS, and the FEMA land use databases described above. Some data were in point and other data were in polygon shapefile format. All polygons were converted to centroids. Park points were joined with block buffers. The number of parks in each block buffer was divided by the land area of the buffer for a park density measure. In addition, a dummy variable was computed based on whether park was present in the buffer.

Historical site density was used as a proxy for place attachment, as monuments and historically significant sites promote a sense of local continuity. The number of historic sites per area was similarly determined using a variety of data sources, compiling these databases to create the most complete coverage available. For historic sites, data were taken from the National Register of Historic Places (NRHP) and from a state historic preservation database provided by the Mississippi Department of Archives and History (MDAH). All properties extant at the time Katrina struck were included (many of these were destroyed by the storm), a total of 505 sites after duplicates were removed. However, there were several large clusters of historic houses that fell in designated districts or neighborhoods, generally in higher income areas. These were removed to prevent large spikes in concentration, particularly as other districts may have had homes of a similar vintage but lacked the means or will to list them. Listing with the national and state registries requires extensive research and can bias more wealthy areas. After removing homes, there were 126 sites in the three-county area, many of which were concentrated in population centers. Historic site points were joined with block buffers. The number of historic sites in each block buffer was divided by the land area of the buffer to obtain historic site density measure.

Several intervening variables were included in the model as well. These included socio-demographic variables that have been shown to be significant for resilience as well as external factors related to storm damage and ability or feasibility to rebuild. Socio-demographic variables included percent African American, median income, percent of housing that is renter-occupied and multifamily, and percent of the population in poverty. All variables were derived from the

Census. The percent of the population that was African American in 2000 was aggregated to the block buffer from the block level using 2000 Census Summary File 1 full population counts. The median income in 1999, the percent of housing that is renter-occupied and multifamily, and the percent of the population living in poverty were disaggregated from 2000 Census Summary File 3 (SF3) sample data on the population, disaggregated from block groups by areal weights to the buffers around each block.

Additional housing variables included median housing value and median age of structure. The median housing value was calculated from the housing values found in the FEMA database. Although values were missing for some parcels, the parcel-level scale of these data was preferable to the alternative of using a median value at the Census block group level data disaggregated to block buffers. When compared, the two data sources were comparable in magnitude at the block buffer unit of analysis. The median age of housing was taken from 2000 Census Summary File 3 (SF3) sample data on the population, disaggregated from block groups by areal weights to the buffers around each block. Median age of housing was subtracted from the data collection year, 2000, to yield the average age of structures in each block buffer. Median year built data are collected as part of the former long-form Census questionnaire, or SF3. Respondents were asked what year the original structure was built, not including improvements. The data are limited in that subjects might not know or recall when their housing was built. The data only include housing, not commercial or other structures. The measure approximates the vintage of neighborhood development in the area, however.

Damage and aid were also included as intervening variables. Several sources captured damage caused by Katrina. These included remote sensing data taken by FEMA on August 30, 2005 (polygon GIS data, shown in Figure 12) and the assessments found in the FEMA parcel database described above. The categories of damage were slightly different among these sources, with the remote sensing data listing flooded, limited, moderate, extensive, and catastrophic. The parcel database listed damaged, substantially damaged, and destroyed property. There were discrepancies in the data, as the polygon data were processed at a larger

scale. The parcel data provided a more accurate assessment of the damage, at a finer scale. Therefore, the percentage of land damaged was calculated from the sum of damaged parcels at the block level.

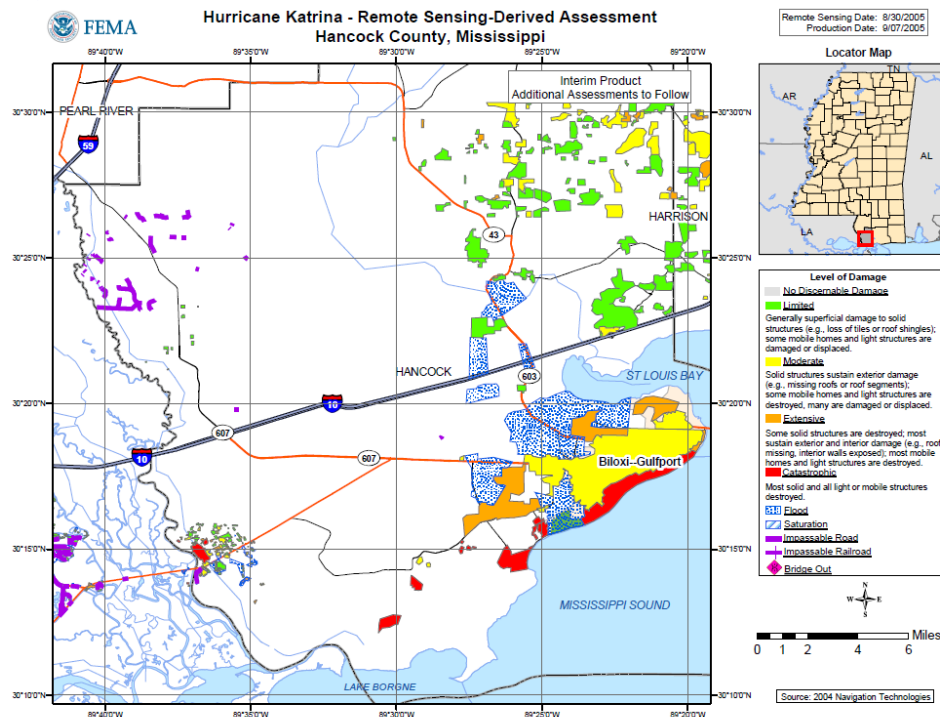


Figure 12: Example of FEMA remote sensing data
Source: FEMA

Aid amount was taken from the Public Assistance Funded Projects Summary FEMA database and disaggregated from cities, service areas (such as fire districts), and counties to the block, using an area weighted mean. The database includes money distributed under the Presidentially Declared Disasters Public Assistance Program (Catalogue of Federal Domestic Assistance [CFDA] Number 97.036), authorized by the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The database spans from 1998 (the launch of the National Emergency Management Information System, or NEMIS) to the present, but includes a disaster code number, allowing aid to Mississippi due to Katrina to be easily identified by the number

1604. This database lists all public assistance recipients (or sub-grantees) and a summary of the funded program support. According to FEMA, the grants are used for “debris removal, emergency protective measures, and the repair, replacement, or restoration of disaster-damaged, publicly owned facilities and the facilities of certain Private Non-Profit (PNP) organizations” (“Resource Record Details: FEMA Public Assistance Funded Projects Summary - Open Government Initiative,” 2012). The total amount of aid distributed to coastal Mississippi and detailed in this database was \$1,974,633,280. Although this database does not include the large outpouring of support from small nongovernmental sources, it would be difficult to obtain meaningful and consistent data for all aid distributed. Therefore, only aid received through FEMA was considered.

The percent of the population living in the area in 1995 was included as a measure of housing stability. The percent living in the same three-county Gulfport-Biloxi Census Primary Metropolitan Statistical Area (PMSA) in 1995 was taken from 2000 Census Summary File 3 (SF3) sample data on the population, disaggregated from block groups by areal weights to the buffers around each block.

Growth from the previous Census period of 1990-2000, normalized by block area, was used to control for endogenous growth or contraction in the population. This is the same measure used for resilience, but for the previous decade. The number of occupied housing units in 2000, normalized by area, was also included as an intervening variable to control for the large variance in block populations, as population density can vary greatly throughout the region.

Finally, local fixed effects were incorporated by creating a dummy variable for the local government area each block was located in, which included 27 municipal and unincorporated county areas. Therefore, 26 dummy variables were included in the model, with one of the 27 areas excluded. This was meant to capture the effects of local government efficacy and the political will of local leadership. For example, levels of infrastructure restoration and other public built environment improvements funded by local governments varied across localities.

Furthermore, some leaders were more aggressive about locating funding and ensuring residents' needs were met after Katrina.

A slightly modified version of the original model shown in Chapter 4 was used (variable names shown in Table 4, modified to reflect actual data used).

$$\text{Resilience} = \text{Built environment factors} + \text{intervening factors} + \text{control factors} + \text{local fixed effects}$$

$$\begin{aligned} (\text{occ10-occ00})/\text{area} = & \beta + \beta_{\text{lu_mix}} + \beta_{\text{net_res_dens}} + \beta_{\text{int_dens}} + \beta_{\text{soc_orgs_dens}} + \beta_{\text{park_dens}} + \beta_{\text{nrhp_dens}} + \\ & \beta_{\text{pc_af_amer}} + \beta_{\text{med_inc}} + \beta_{\text{pc_mf_rent}} + \beta_{\text{pc_pov}} + \beta_{\text{hsg_val_med}} + \beta_{\text{hsg_age_med}} + \beta_{\text{pc_damage}} + \beta_{\text{aid_amount}} + \\ & \beta_{\text{pc_same_pmsa}} + \beta_{(\text{occ00-occ90})/\text{area}} + \beta_{\text{occ00}/\text{area}} + \text{local fixed effects} + \varepsilon \end{aligned}$$

As noted in the descriptions above, data were gathered from a variety of sources. With the exception of business directory data from InfoGroup, these are all free and publicly available. A summary of all variables, descriptions, and data sources are found below in Table 4.

Table 4: Variables, variable descriptions, and data sources

Variable Short Name	Variable Full Name	Description	Data Source
(occ10-occ00)/area	Resilience (return of occupied households)	Change in occupied housing units (2000-2010) normalized by area in acres for Census block	Census
lu_mix	Land use mix in 2004/2005	$\text{lu_mix} = A/(\ln(N))$ where $A = (b_1/a) * \ln(b_1/a) + (b_2/a) * \ln(b_2/a) + (b_3/a) * \ln(b_3/a)$ a = area of land for all land uses present in buffer b_x = area in use X (residential, commercial, and other land uses) N = number of land uses with area > 0	2004/2005 land use data, FEMA parcel level analysis

Table 4 Continued

Variable Short Name	Variable Full Name	Description	Data Source
net_res_dens	Net residential density in 2000	Occupied housing units in buffer in 2000 / residential acres in block buffer	2000 Census, FEMA parcel level analysis
int_dens	Intersection density of buffer in 2000	Number of intersections where three or more street segments meet divided by square kilometers of block buffer	Imputed from 2000 Census TIGER shapefile
soc_orgs_dens	Social organization density in 2004	Number of social gathering places/networking sites in block buffer divided by acres of block buffer	ReferenceUSA/InfoGroup, 2004 archived business directory data
park_dens	Park density	Number of parks in block buffer divided by acres of block buffer	OpenStreetMap, MARIS, FEMA parcel data
nrhp_dens	Pre-Katrina historic places density	Number of sites on the NRHP and state historic registry in buffer, including those destroyed by Katrina, divided by acres of buffer	U.S. NRHP and Mississippi MDAH data
pc_af_amer	Percent African American population in 2000 of buffer	Percent of population in block buffer that was African American in 2000	2000 Census
med_inc	Median 1999 income of buffer, areal weight	Weighted median income (1999) of block buffer area	2000 Census
pc_mf_rent	Percent renter-occupied, multifamily housing in 2000 of buffer	Percent of housing units that were in multifamily structures and were renter-occupied of block buffer area	2000 Census
pc_pov	Percent of	Weighted percent of	2000 Census

Table 4 Continued

Variable Short Name	Variable Full Name	Description	Data Source
	population living in poverty, 2000	population living in poverty of block buffer area in 2000	
hsg_val_med	Median housing value in 2004/ 2005	Median housing value 2004 and 2005, of block	FEMA parcel data
hsg_age_med	Median age of housing of buffer in 2000	Weighted median age built (from 2000 Census), owner occupied units, of block buffer area	2000 Census
pc_damage	Percent storm damage caused by Katrina	Percent of land area damaged or flooded in block	FEMA parcel data
aid_amount	Amount of post-Katrina aid	Public Assistance Funded Projects, weighted to block area	FEMA Public Assistance Funded Projects Summary
pc_same_pmsa	Percent of 2000 population that lived in the 3-county coastal MS area in 1995	Weighted percent of block buffer population in 2000 that also lived in Hancock, Harrison, or Jackson County in 1995	2000 Census
(occ00-occ90)/area	Change in occupied housing units per acre, 1990-2000	Change in occupied housing units from 1990 to 2000 of block by acres in block	1990 and 2000 Census
occ00/area	Occupied housing units per acre in 2000	Occupied housing units in 2000 of block by acres in block	2000 Census
local fixed effects	Dummy variables for local government areas	Binary (0 or 1) variable indicating block is within one of 24 municipal and 2 county governments, with one	2000 Census TIGER data

Table 4 Continued

Variable Short Name	Variable Full Name	Description	Data Source
		county government area excluded	

Descriptive Statistics

Table 5 includes descriptive statistics for each variable.

Table 5: Descriptive statistics (N=3,222 blocks)

	Minimum	Maximum	Median	Mean	Std. Deviation
(occ10-occ00)/area	-45.12	45.79	-0.14	-0.47	1.99
lu_mix	0.07	1.00	0.70	0.68	0.14
net_res_dens	0.04	28.97	2.29	2.72	1.89
int_dens	0.00	0.42	0.13	0.14	0.08
soc_orgs_dens	0.00	0.20	0.01	0.03	0.04
park_dens	0.00	0.01	0.00	0.00	0.00
nrhp_dens	0.00	0.04	0.00	0.00	0.01
pc_af_amer	0.00	0.96	0.17	0.21	0.19
med_inc	\$17,209	\$78,986	\$35,503	\$36,822	\$9,175
pc_mf_rent	0.00	0.51	0.08	0.10	0.09
pc_pov	0.01	0.40	0.12	0.13	0.07
hsg_val_med	\$19,576	\$163,536	\$50,319	\$54,940	\$19,018
hsg_age_med	5.75	59.12	28.82	29.68	12.29
pc_damage	0.00	0.98	0.17	0.25	0.24
aid_amount	\$0	\$15,277,504	\$56,858	\$258,803	\$886,812
pc_same_pmsa	0.07	0.99	0.74	0.71	0.16
(occ00-occ90)/area	-28.07	40.82	0.08	0.30	1.74
occ00/area	0.00	45.12	1.39	1.88	2.07

The park density variable was converted to a dummy variable, or presence or absence of a park in the buffer. This was logical in that having one centralized park in a neighborhood would seem to be sufficient for social interaction. The conversion improved the model.

Because of a skewed distribution, a logarithmic transformation was used for two variables: social organization density and historic site density. The establishments that foster social networking tended to be highly concentrated in a relatively small number of blocks near the coast, skewing the results. Similarly, historic patterns of development occurred in a similar pattern near the waterfront, resulting in most historic site density occurring in a relatively small area. The transformation also improved the model.

Table 6: Descriptive statistics of transformed variables

Variable	Minimum	Maximum	Median	Mean	Standard Deviation
ln_soc_orgs_dens	-9.04	-1.59	-4.02	-4.20	1.47
park_dummy	0.00	1.00	0.00	0.29	0.45
ln_nrhp_dens	-9.40	-2.94	-5.65	-5.59	1.03

The amended model, with these variable transformations, is below:

$$\begin{aligned}
 (\text{occ10-occ00})/\text{area} = & \beta + \beta_{\text{lu_mix}} + \beta_{\text{net_res_dens}} + \beta_{\text{int_dens}} + \beta_{\text{ln_soc_orgs_dens}} + \beta_{\text{park_dummy}} + \beta_{\text{ln_nrhp_dens}} + \\
 & \beta_{\text{pc_af_amer}} + \beta_{\text{med_inc}} + \beta_{\text{pc_mf_rent}} + \beta_{\text{pc_pov}} + \beta_{\text{hsg_val_med}} + \beta_{\text{hsg_age_med}} + \beta_{\text{pc_damage}} + \beta_{\text{aid_amount}} + \\
 & \beta_{\text{pc_same_pmsa}} + \beta_{(\text{occ00-occ90})/\text{area}} + \beta_{\text{occ00}/\text{area}} + \text{local fixed effects} + \varepsilon
 \end{aligned}$$

Discussion of Model Results

The results of the OLS model are shown in Table 7.

Table 7: OLS model results with local spatial fixed effects

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	-2.655	0.420		-6.325	0.000***		
Built environment variables:							
lu_mix	0.221	0.254	0.015	0.868	0.386	0.528	1.892
net_res_dens	0.055	0.030	0.052	1.860	0.063*	0.203	4.930
int_dens	1.965	0.632	0.082	3.107	0.002***	0.229	4.368
ln_soc_orgs_dens	0.032	0.016	0.029	2.012	0.044**	0.751	1.331
park_dummy	-0.155	0.076	-0.035	-2.032	0.042**	0.533	1.877
ln_nrhp_dens	0.023	0.013	0.030	1.799	0.072*	0.582	1.717
Intervening variables:							
pc_af_amer	0.286	0.282	0.027	1.016	0.310	0.220	4.553
med_inc	2.69E-05	6.30E-06	0.124	4.269	0.000***	0.190	5.250
pc_mf_rent	1.818	0.469	0.080	3.880	0.000***	0.378	2.649
pc_pov	0.030	0.792	0.001	0.038	0.969	0.189	5.287
hsg_val_med	3.73E-06	2.50E-06	0.036	1.488	0.137	0.281	3.560
hsg_age_med	4.88E-05	.005	3.01E-04	0.009	0.993	0.154	6.505
pc_damage	-0.380	0.136	-0.045	-2.791	0.005***	0.618	1.618
aid_amount	-8.90E-08	3.22E-08	-0.040	-2.761	0.006***	0.780	1.281
pc_same_pmsa	1.929	0.259	0.154	7.444	0.000***	0.378	2.643
Control variables:							
d90_00_occ_area	-0.221	0.018	-0.194	-12.090	0.000***	0.627	1.595
occ00_area	-0.552	0.018	-0.575	-31.264	0.000***	0.476	2.100
Spatial fixed effect coefficients for 26 local dummies not shown here							
*** significant at 1%, ** significant at 5%, * significant at 10% confidence interval							
R² = 0.489							
N = 3,222							

The model displayed good explanatory power (R-squared of 0.489). A few variables had collinearity statistics that were slightly elevated (such as age of housing, percent of population living in poverty, and median income). Given that these were control variables, the levels of collinearity between variables known to be highly correlated, such as income and poverty, were considered acceptable. Prior iterations of the model included variables with much higher Variance Inflation Factor (VIF) statistics, and efforts were made to keep these figures as low as possible. For example, in an early run of the model, high VIFs were found for the percent

owner-occupied housing and percent multifamily housing. To reduce these values of 13.5 and 9.2, respectively, a new term was created, percent of housing that is renter-occupied and multifamily, also obtained from the 2000 Census SF3.

Of the built environment variables, intersection density had the most influential (and a positive) effect on resilience, as measured by standardized coefficients. A one standard deviation increase in intersection density (0.08 intersections per square kilometer) is associated with 8.2 percent of a standard deviation increase in resilience. This, in turn, is equivalent to an increase of 0.16 occupied housing units per acre from 2000 to 2010. Given the mean resilience of -0.47 units per acre, this is a consequential effect. In reverse order of magnitude, net residential density, historic site density, the density of social networking organizations, and land use mix all had a positive effect (the effect of land use mix was not significant, however). For net residential density, a one standard deviation increase in units per residential acre (1.89 units per acre) is associated with a 5.2 percent of a standard deviation increase in resilience, or 0.10 occupied housing units per acre. For historic site density, a one standard deviation increase in the natural log of sites per acre (1.03 sites per acre) is associated with 3.0 percent of a standard deviation increase in resilience, or 0.06 occupied housing units per acre. For the density of social networking organizations, a one standard deviation increase in the natural log of sites per acre (1.47 sites per acre) is associated with 2.9 percent of a standard deviation increase in resilience, 0.06 occupied housing units per acre. For land use mix, a one standard deviation increase in the land use mix index (a change of 0.14 on a scale of 0 to 1) results in 1.5 percent of a standard deviation in resilience, or 0.03 occupied housing units per acre. The presence of parks actually had a negative impact on resilience, in which a one standard deviation increase in parks by buffer (0.45 parks) is associated with a 3.5 percent of a standard deviation decrease in resilience, or a decrease of 0.07 occupied housing units per acre from 2000 to 2010.

Of the intervening variables, percent of the population living in the area in 1995 and median income had the most influential positive effects on resilience, which were greater than the effects of the built environment variables as measured by the standardized coefficients.

Percent multifamily rental housing had a significant positive impact similar to the magnitude of intersection density. Percent damage and amount of aid each had a relatively strong negative impact on resilience. The other intervening variables (percent African American, median housing value, housing age, and percent of population living in poverty) had a weaker positive influence than all built environment variables except land use mix.

Control values of change in occupied housing units from 1990 to 2000 normalized by area and occupied housing units normalized by area each had a significant, relatively large negative impact on resilience.

The built environment effects demonstrated the influence on resilience of many built environment features that are associated with greater social interaction and social networking activity. Intersection density, which is associated with connectedness, accessibility, and walkability was the most significant example of these effects. Although the bivariate correlation between intersection density and resilience was negative, when controlling for demographics, damage, and other significant variables, intersection density actually influenced the return of households. Better connected areas are likely to be more visible and centrally located due to street patterns in the area, where higher intersection density tends to occur near the well-traveled waterfront and central business districts. Therefore, residents are more likely to have chance social encounters and richer social networks, based on theories from the literature. This could have also had a psychological effect on residents and former residents, as returning to a remote area where few homes had been rebuilt would seem to be undesirable. Similarly, net residential density, which also had a positive effect on resilience, increases the probability of social encounters and local social networks through increasing the number of network connectors within the neighborhood. In essence, intersection density and net residential density measured social integration in the area and positively influenced resilience.

The density of historic sites, based on state and national historic designations, was used as a proxy for the age of the neighborhood and also to attempt to quantify place attachment through significant monuments and cultural icons in the area. The natural log of historic site

density produced a somewhat weak positive effect on resilience in the model. This variable was the third-most influential built environment variable with a positive impact on resilience, demonstrating historic features have some importance for resilience. This is particularly noteworthy in that historic sites in Mississippi tended to be located in more vulnerable and damage-prone areas near the coast due to historic patterns of development near the shore and other waterways. It is a testament to the draw of areas with greater historic character that these areas have seen a greater return in population.

The density of social networking organizations and land use mix also had a relatively weak positive effect on resilience. Social networking organizations included places of worship, schools, restaurants, and types of recreational facilities, among others. These have been shown to improve social networks and, not surprisingly, also had a positive impact on resilience in the model. Based on the literature suggesting that social networks are most effective in recovery when they have a physical address from which to operate (Sherraden & Fox, 1997), the impact of the density of social networking organizations is noteworthy. Though not always considered in city planning research, community centers, be they commercial endeavors, nonprofits, or publicly funded institutions, are clearly important for recovery and should be embraced and nurtured by communities.

Land use mix, which also had a weak positive, but statistically insignificant, effect on resilience, measures the evenness of three land uses – residential, commercial, and other. Land use mix increases opportunities for commercial activity and employment in a neighborhood, reduces possible trip distances, increases how easily one can navigate between places, and promotes nonmotorized traffic such as biking and walking. The measure was meant to capture whether blocks were located in a diverse and vibrant neighborhood. An increase in walkability due to greater land use mix also increases encounters with other pedestrians and therefore social networking opportunities. This measure was not significant in the model. Although the expectation was that land use mix would have a positive influence on resilience, density and the presence of certain types of enterprises that promote social networking activity were more

important. High-intensity commercial areas in low-density, disconnected development patterns are common in the region. Therefore, the type of commercial development may be more important than the mix of land uses in predicting resilience, at least in the Mississippi coast region.

The presence of parks actually had a negative impact on resilience, despite the fact that parks are also shown to increase chance encounters and provide a gathering point for neighbors. All area parks were included in calculating the dummy variable, which included 42 total parks that were within the one kilometer buffer of the 3,222 study area blocks. Almost all parks were located in Harrison and Jackson Counties, with only three parks found in Hancock County. The uneven spatial distribution of parks and the higher incidence of parks in undevelopable coastal areas that sustained great storm damage may have skewed the model; however, based on the evidence in Mississippi, parks had no influence on resilience.

Certain intervening variables behaved as expected, such as the percent of the population living in the area in 1995 and median income, which had the greatest positive effects on resilience, greater than the effects of the built environment variables. Percent of the population living in the area in 1995 captured the stability of the population prior to Katrina, but also the potential for richer social networks, developed through residents living in the area for at least a five-year period of time. Because the resilience indicator was not able to pick up actual movement of households, only net change in occupied housing, this measure was included to take into account how established the base population was prior to Katrina. It is not surprising that the indicator had a significant impact on resilience. Higher median income also positively influenced resilience, which was expected as greater income provides households the means to rebuild and is associated with reduced social vulnerability to disaster.

Percent multifamily rental housing had a surprising positive impact on resilience. This variable was created, as mentioned above, to include the effects of both tenure and higher-density housing. Owner-occupied housing as a standalone measure was associated with greater resilience but was highly correlated with percent multifamily housing. Interestingly, combining

the inverse statistic, percent renter-occupied housing, with percent multifamily housing did not have a cumulative negative effect. Because this measure, like the other independent variables, was calculated for one kilometer buffers around the block, it may be that residential density was associated with the same areas that also had greater social networking organization density and net residential density. These neighborhood characteristics had a positive influence on resilience in the model and are associated with social capital creation by planning scholars and theorists.

The sign of the percent African American coefficient was, perhaps surprisingly, positive, although it was statistically insignificant. Ethnic and racial minority populations have been shown to exhibit greater social vulnerability to disasters. However, the weak and statistically insignificant positive effect may be a product of the demographics and spatial distribution of ethnic and racial groups in the area. African American (and relatively poor) neighborhoods tended to be located further inland in coastal Mississippi where real estate was less expensive and therefore were likely to experience lower levels of damage from Katrina.

Median housing value also had a positive influence on resilience, weaker than only the built environment variables of intersection and net residential density. Similar to income, housing value is correlated with household resources and captures an economic incentive to rebuild. Larger housing values may also be correlated with levels of insurance on a home, as owners may be more likely to protect a larger investment and have the means to do so. Housing age had essentially no impact on resilience. This may have been related to tension between historic or older neighborhoods that exhibited greater resilience, based on the above factors, and the period of growth that occurred between 1990 and 2000 (discussed below). Further, storms such as Hurricane Camille in 1969 and Hurricane Georges in 1989 have destroyed many older properties, with uneven spatial effects, and therefore significantly older properties are not present in enough numbers to make a difference in the model.

Percent of population living in poverty had a very weak and almost negligible positive influence on resilience. This influence was weaker than most other variables, including all built

environment variables. Although this influence was not statistically significant, as with percent African American, this variable was expected to have a negative influence on the dependent variable of resilience based on previous studies linking poverty and social vulnerability to disasters. This measure was correlated with median income, median housing value, and percent African American, weakening the effects of poverty on the dependent variable. As noted previously, vulnerable populations based on race and income actually tended to be protected from Katrina due to spatial demographic patterns in coastal Mississippi, with relatively poor neighborhoods located further inland. Because of this, the effects of socio-demographic variables did not always behave as expected.

Percent damage and amount of aid each had a relatively strong negative impact on resilience. Clearly, damage was a factor in households returning. Aside from the difficulty and cost in repairing damaged housing units, homes with greater than 50 percent structure damage were subject to new building codes after Katrina. In many cases, this required elevating the home, which was cost prohibitive or logistically impossible for those with reduced mobility, such as elderly residents. Badly damaged areas may have also been more likely to receive aid based on need. It has been shown that local governments often find it difficult to make use of disaster aid resources due to a lack of organizational capacity (Berke et al., 1993), which may also contribute to the failure to convert aid resources to housing recovery.

The negative effects of the control variables of change in occupied housing units from 1990 to 2000 normalized by area and occupied housing units normalized by area can be explained by the high rate of growth in the time period of 1990 to 2000, when casinos were legalized and the local population was rapidly growing. During this time, many blocks reached carrying capacity for housing units and therefore could only lose and not gain housing units from 2000 to 2010. Several high growth blocks between 1990 and 2000 were multifamily structures near the waterfront. One waterfront high-rise in Biloxi was added in the time period of 1990 to 2000 and was converted to a hotel post-Katrina. A second high-rise was a senior housing tower built after Camille in 1969. The complex experienced growth in the 1990 to 2000 time period

and survived Katrina. The senior units were replaced further inland and there have been stated plans to refurbish the currently vacant 13-story tower. One inland example of high growth 1990 to 2000 was a section of land near the former Bayou Auguste homes in East Biloxi, which was converted to single family homes under HOPE VI funding during that decade. In short, previously built-out areas that could only lose housing units, as well as a few low-density areas that have been converted to condominium or higher-density housing, were responsible for the unexpected control variable effects.

Local fixed effects on resilience were mixed as expected. Only six localities exerted a statistically significant effect on resilience, and all of these six had a positive effect, demonstrating that these areas were more resilient, controlling for other variables, than the omitted place category of unincorporated Jackson County. The high-resilience areas with the largest unstandardized coefficients included Ocean Springs, which had the greatest positive impact on resilience, Gulf Park Estates, St Martin, Diamondhead, D'Iberville, and unincorporated Hancock County. Ocean Springs was noted as a standout in terms of resilience from many sources, including Stage 2 interviews. Gulf Park Estates is adjacent to Ocean Springs to the east and is an older suburban area with a small population. St Martin, like Ocean Springs and Gulf Park Estates, is in Jackson County. It is larger in area and population than Gulf Park Estates, but is also predominantly residential. Diamondhead is a low-density, mainly residential area incorporated as a city in 2012, although it was designated as a Census place prior to that. Diamondhead originated as a retirement community but has become more demographically diverse over time. It is still relatively affluent among communities in the region. D'Iberville is adjacent to and comprised of suburban residential development similar to St Martin, although the area also has significant strip commercial surrounding a mall and local access to two highways. Of these communities, unincorporated Hancock County is unique in that it is mostly rural and very low-density farm and forestland rather than suburban.

Table 8: Statistically significant local fixed effects

	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
Ocean Springs	0.698	0.192	3.628	0.000***
Gulf Park Estates	0.606	0.218	2.781	0.005***
St Martin	0.523	0.255	2.046	0.041**
Diamondhead	0.572	0.305	1.877	0.061*
D'Iberville	0.394	0.213	1.847	0.065*
Hancock County	0.363	0.206	1.765	0.078*

Other local effects were not statistically significant in the model but exerted varying positive and negative effects. Those with the largest negative coefficient values were Henderson Point and unincorporated Harrison County (B values of -0.482 and -0.344, respectively). Henderson Point is a very small coastal town that was badly damaged and likely subject to prohibitive building code revisions due to its elevation and location.

The OLS model was also run without local spatial effects. All other independent variables were included. The model without fixed local effects had a slightly smaller R-squared than the OLS model that included fixed local effects (Table 9).

Table 9: Comparison of OLS model with and without local fixed effects

Model	R ²
OLS model with fixed local effects	0.489
OLS model without fixed local effects	0.480

Given the greater explanatory power of the model when local fixed effects were present, spatial autocorrelation was possible in the OLS model. Therefore, a Global Moran's I statistic was calculated for the residuals of the OLS model with local fixed effects to determine the amount of spatial autocorrelation in the data. The statistic evaluates whether the expressed pattern of the residuals of the resilience measure in the OLS model with local fixed effects is clustered, dispersed, or random among all blocks in the sample. The statistic was calculated

using a Euclidean inverse distance method with standardized rows and a distance threshold of 10,000 meters or 6.2 miles. This distance was chosen to ensure every feature has at least one neighbor and that distances effects reached beyond municipal boundaries. As shown in Table 10, the z-score was 5.76 for the standard residuals of the above OLS model with local fixed effects; therefore there is a less than one percent likelihood that the expressed clustered pattern could be the result of random chance. Or, the spatial distribution of high values and low values in the dataset is more spatially clustered than would be expected if underlying spatial processes were random.

Table 10: Global Moran's I Summary

Moran's Index	0.011737
Expected Index	-0.000310
Variance	0.000004
z-score	5.755062
p-value	0.000000

Given this amount of spatial autocorrelation, a Spatial Lag (SL) model was produced for comparison and to determine the most appropriate method for accounting for local government and other spatial effects in the model. The SL model was run in the software GeoDa to assess the spatial heterogeneity in the estimated relationships between the independent and dependent variables. Spatial lag was used because it is believed that areas of high or low resilience have spillover effects on nearby areas. Spatial lag suggests that the dependent variable is influenced by contiguous geographies, which aligns with this theory. A Euclidean distance of 10,000 kilometers, row-standardized weight was used. The model includes these interactions in its computations. Results are shown in Table 11.

Table 11: SL model results without local spatial fixed effects

	Unstandardized Coefficients	Standardized Coefficients	Unstandardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-3.329	0.368		-9.046	0.000***
Spatial lag (resilience)	-1.819	0.158	-1.819	-11.538	0.000***
Built environment variables:					
lu_mix	0.532	0.234	0.037	2.274	0.023**
net_res_dens	0.014	0.028	0.014	0.511	0.609
int_dens	1.870	0.565	0.078	3.307	0.001***
ln_soc_orgs_dens	0.045	0.016	0.034	2.826	0.005***
park_dummy	0.062	0.068	0.014	0.901	0.367
ln_nrhp_dens	0.032	0.012	0.017	2.596	0.009***
Intervening variables:					
pc_af_amer	-0.570	0.198	-0.055	-2.876	0.004***
med_inc	3.69E-05	4.97E-06	0.170	7.425	0.000***
pc_mf_rent	0.525	0.440	0.023	1.194	0.232
pc_pov	2.642	0.691	0.097	3.825	0.000***
hsg_val_med	1.06E-07	1.70E-06	0.001	0.062	0.950
hsg_age_med	-0.014	0.004	-0.085	-3.415	0.001***
pc_damage	-0.620	0.129	-0.074	-4.820	0.000***
aid_amount	-1.44E-07	3.05E-08	-0.064	-4.709	0.000***
pc_same_pmsa	2.218	0.236	0.177	9.394	0.000***
Control variables:					
d90_00_occ_area	-0.215	0.019	-0.188	-11.556	0.000***
occ00_area	-0.555	0.018	-0.578	-31.005	0.000***
*** significant at 1%, ** significant at 5%, * significant at 10% confidence interval					
Pseudo R² = 0.454					
N = 3,222					

The SL model resulted in a comparable pseudo R-squared to the R-squared of the OLS model with local fixed effects (0.454 and 0.489, respectively). Of the built environment variables, the presence of parks switched signs from a negative to a positive effect but the significance decreased substantially, making this variable insignificant in the model. Net residential density also became insignificant and the magnitude of the positive influence decreased. Land use mix became significant in the SL model, with a positive influence on

resilience. The influence of the intersection density, the density of social networking organizations, and the density of historic sites remained positive and significant in the SL model.

In terms of intervening variables, percent African American had a negative rather than a positive effect and became significant in the SL model. This is more in line with expectations. Percent renter-occupied, multifamily housing became insignificant in the model. Average age of housing and percent poverty each became significant, with housing age exerting a small negative influence on resilience and percent poverty a significantly large positive influence. Other variables remained significant (or, in the case of median housing value, remained insignificant) and changed in magnitude, but not in direction of influence.

The built environment variables had a stronger influence on resilience in the SL model, although they were also significant in the OLS models with and without local fixed effects. Across all three models, a built environment that is varied in terms of organizations that promote social networks and historic properties and is integrated as measured by intersection density and net residential density was shown to positively influence resilience. Land use mix also had a positive influence on resilience, but was not a significant factor in each of the models. Finally, the presence of parks had a negative influence on resilience that was rendered insignificant in the SL model.

The findings of the Stage 1 model validate many strategies that have been employed in rebuilding the Gulf Coast, such as the incorporation of walkability in building codes and master plans (McKee, 2005). Creation of additional community centers and neighborhood commercial districts is outlined in several post-Katrina plans, such as the master plans for Biloxi and Gulfport. Based on the results of the model, these types of planning efforts are likely to improve overall resilience to future disasters.

CHAPTER 6: STAGE 2

As noted previously, the Stage 2 analysis was designed to provide additional detail for the primary research question (does a certain type of built environment result in a more resilient community?) also explored in Stage 1 and answer the second research question (do those properties of the built environment make communities more conducive to social networking activity?) and the third research question (how does the effect of the built environment measure against other factors that are significant in forming robust social networks?).

This stage also examined the three additional research propositions: a) social networks are important factors for resilience; b) social networks interact with and are influenced by the physical environment; and c) communities with the strongest resilience include both strong social networks and varied and integrated physical environments. The quantitative model of Stage 1 was therefore enhanced with qualitative case study analysis of the social networks and intricacies of the built environment of select case study communities. The second stage of analysis also retested the questions in the first stage at a larger geography, with the results of each stage ultimately linked to improve overall understanding of the phenomena involved.

As per the research design, communities were chosen from right two quadrants of the matrix shown in Figure 13 (a modified version of Figure 10), the high-resilience and integrated and varied built environment “ideal” quadrant and the low-resilience and integrated and varied built environment “flawed” quadrant. As noted in the figure, the case study communities chosen were block groups of Waveland, Ocean Springs, East Biloxi, and downtown Pascagoula. A map depicting the locations of the four communities is shown in Figure 14.

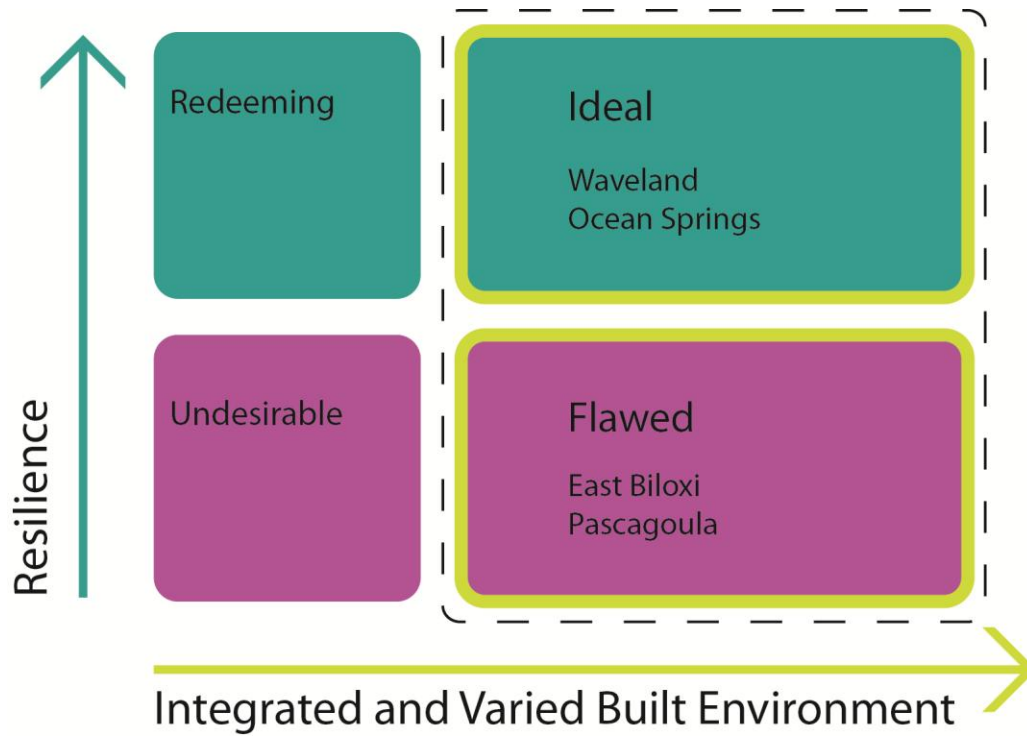


Figure 13: Communities chosen by resilience and built environment characteristics

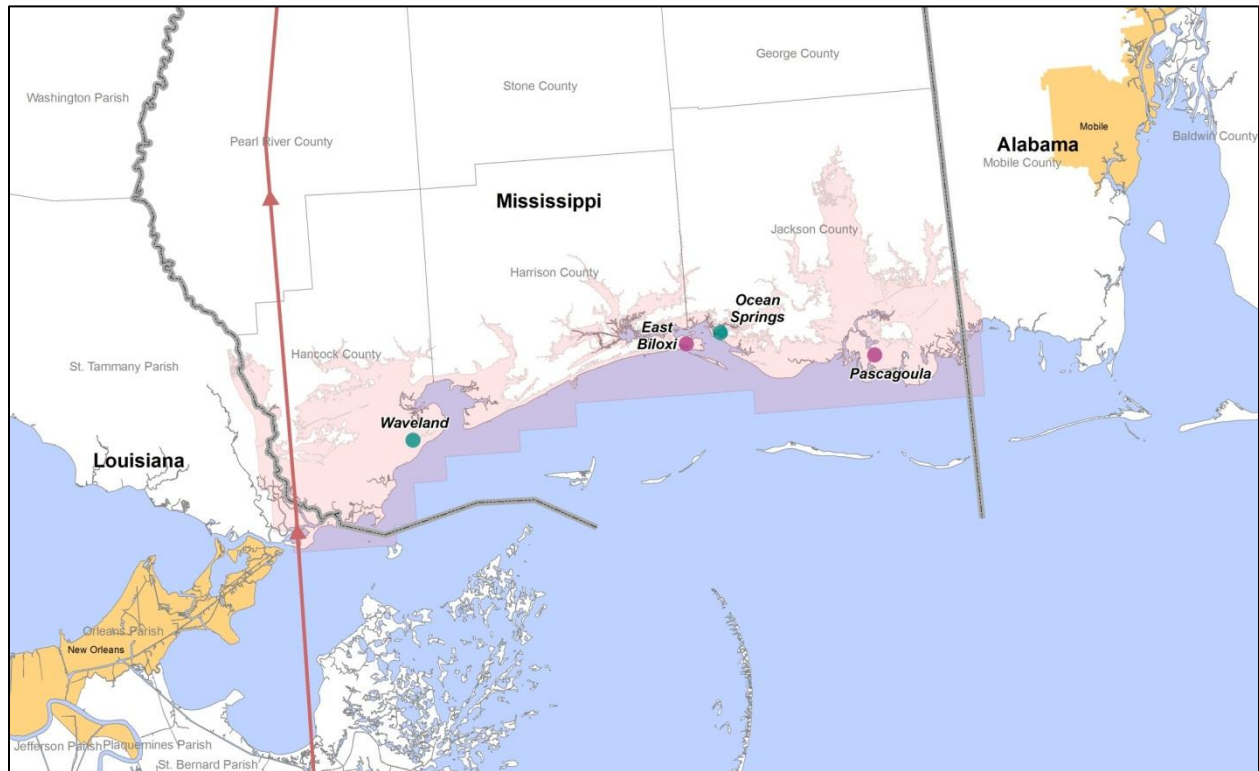


Figure 14: Map depicting locations of four case study communities.

The variables from the model in Stage 1 were used to determine high or low resilience and levels of integration and variation in the built environment and to select case study communities from which the Stage 2 interviews were recruited. These variables included the Stage 1 dependent variable of resilience, measured by change in occupied housing units normalized by area, as well as Stage 1 independent variables pertaining to the built environment. The built environment variables were land use mix, residential density, street connectivity, density of social networking sites, park density, and density of historic sites. Intervening demographic variables from Stage 1 were compared to obtain comparable communities across race, income, and tenure. All variables were aggregated or recalculated at the block group level instead of the block or block buffer level used in Stage 1. There were 270 block groups in the three-county study area, each corresponding roughly to a city neighborhood, increasing in size as population density decreases. Of these, 226 were at least partially in the surge inundation area.

The four communities were selected by overlaying the built environment variables with a moderate transparency in GIS, so that relative tint could be used to identify built environments that were more or less integrated and varied, based on the block group-level measures. Block group resilience values were also overlaid in the GIS map. Using this visual scan as a first pass, potential case study communities were determined. Demographic variables and levels of damage were then calculated in order to compare the 11 contenders from the visual scan (which included Bay St Louis, D'Iberville, East Biloxi, Ocean Springs, Pascagoula beachfront, downtown Pascagoula, Pass Christian and Henderson Point, St Martin, Waveland, and West Gulfport). After removing high-resilience communities with relatively low levels of damage as well as mismatched demographics, block groups in Ocean Springs and Waveland were selected as high-resilience communities. Similarly, block groups in East Biloxi and Pascagoula were selected as low-resilience communities. The Ocean Springs and Pascagoula are comprised on one block group each and the Waveland and East Biloxi study areas are comprised of two block groups each to capture a larger area with similar built environment and resilience characteristics. Communities were selected from each of the three counties on the coast and alternated between high- and low-resilience communities from west to east for geographic variety.

As shown in Table 12, the four communities were roughly similar when compared across the same built environment and demographic factors that were used in Stage 1, with some differences (all variables and data sources are described in depth in Chapter 5). In terms of the built environment, all four case study communities had a relatively high mix of land uses (0.75 to 0.80), although other measures tended to vary more significantly. Waveland and Pascagoula had lower housing densities, social networking location densities, and parks. Ocean Springs and East Biloxi had the highest densities and mixes of amenities. Therefore, there is some variation among the two high-resilience and two low-resilience communities, but these differences average out among all four case study communities. Overall, Waveland is the least integrated and varied of the four, although among all block groups on the coast, it is still in the top quantile.

The case study communities that were selected had the greatest similarities in built environment metrics along the coast.

In terms of demographics, some key differences also exist. Waveland and Ocean Springs had higher median incomes, a lower percentage of African Americans, and higher home ownership rates. Being the two high-resilience communities, this was not ideal; however, built environment measures were privileged in the selection of communities.

Table 12: Descriptive statistics, case study communities

	Waveland	Ocean Springs	Pascagoula	East Biloxi
Block group ID(s)	280450302002 280450302003	280590405003	280590423001	280470003004 280470004002
Resilience	high	high	low	low
Land use mix	0.77	0.80	0.75	0.80
Net residential density (HU/res. acre)	1.01	1.84	0.83	2.62
Intersection density per square kilometer	26.82	79.95	54.05	52.83
Social networking organizations per acre (2004)	0.02	0.23	0.18	0.13
Number of parks	1	3	1	2
Number of historic sites	1	14	5	23
% African American (2000)	22%	25%	56%	83%
Median income (1999)	\$34,257	\$48,393	\$25,682	\$19,012
% Multifamily rental housing (2000)	12%	0%	30%	15%
Median housing value (2004)	\$55,278	\$53,866	\$44,053	\$35,242
Median age of homes (2000)	26	48	61	47
% Living in poverty (2000)	13%	6%	19%	29%
% Living in region in 1995 (2000)	86%	78%	91%	91%
Percent land damaged by Katrina (FEMA)	100%	79%	41%	15%
Percent houses damaged by Katrina (FEMA)	77%	20%	43%	78%
Parcel-level percent land damage (FEMA)	26%	13%	19%	48%
Acres	1,345	164	585	192
Population (2000)	2,977	532	870	991

Waveland was a popular summer location prior to Katrina and is in the process of rebuilding its tourism industry. Once considered a suburb of New Orleans, it has been influenced by New Orleans culture and many year-round residents have ties to the New Orleans area. Based on OneSource data, the major employers in Waveland are the Home Depot and

Lowe's building supply stores. Waveland is often described as "Ground Zero," as it was in the direct path of Katrina. The historic central business district was only several hundred feet from the Gulf, on low-lying land, and was particularly devastated. A commercial strip on U.S. Highway 90 sustained damage as well, but has been mostly restored. Waveland is low-density and many homes near the coast have not been rebuilt, giving it an almost rural feel. Railroad tracks running east to west bifurcate the city.

Ocean Springs is an artistic, tourist-friendly city. Notable former full-time and summer residents include the artist Walter Inglis Anderson and the architect Louis Sullivan. Building styles and businesses are eclectic and the entire city is of low- to moderate-density, with pockets of expensive real estate. The major employers are the Ocean Springs Hospital, Wal-Mart, and Gulf Coast Research Laboratories (a biotech firm). Ocean Springs and the three other case study communities also have large employment bases in government – including law enforcement, public schools, and public works.

Pascagoula is a more industrialized city than Waveland, Ocean Springs, or East Biloxi. Trains pass through the heart of the city several times per day. Residents describe the area as one with a strong religious tradition (particularly within the Catholic faith). Despite being the furthest case study community east of the eye of the hurricane, damage was severe, with the United Way estimating that 95 percent of all homes flooded. Renters, including commercial tenants, have had a difficult time returning due to their dependence on landlords. The major employers are Ingalls/Northrop Grumman Shipbuilding and U.S. Navy Engineering. Even through major downturns in the economy, Pascagoula's specialized industrial base has been preserved, more or less, recently aided by the announcement of the new Airbus plant in nearby Mobile, Alabama.

East Biloxi is separated from the western peninsula and northern mainland portions of Biloxi by Keesler Air Force Base. Bridges connect East Biloxi to Ocean Springs to the northeast and D'Iberville to the north. East Biloxi is dominated by gambling – the five top employers in its ZIP code are all casinos. A diminished number of seafood canneries and docks still exist in

the area. The coastline is dotted with modern, large casinos like the Beau Rivage as well as modest motels and souvenir shops. The historic downtown core and residential district is located a few blocks inland. Before Katrina, East Biloxi had a high percentage of home ownership and had a low rate of insurance due to the high costs of premiums in the area.

Seven subjects were interviewed in each of the four communities. Subjects were identified using a purposive, respondent-driven sampling technique. After first making contact with community leaders in each study area, each leader was asked to identify other residents. In this way, subjects were from a diverse cross-section of each community in terms of age, race, and occupation. This method was used due to its ability to reach hard-to-reach populations.

The first group of subjects was identified through two sources. First, subjects were identified through contacts of the Federal Reserve Bank of Atlanta's list of community and economic development contacts developed by the New Orleans branch, which serves nonprofits, financial institutions, and other stakeholders on the Mississippi Coast. Second, interview subjects were located through the ReferenceUSA and OneSource databases that were also used to locate social networking organizations. These databases are managed by InfoGroup, a private company that culls business directory data from a large number of sources, including the Yellow Pages and Reuters. Data are rigorously monitored for quality assurance; however, such databases are known to undercount very small and marginalized businesses and organizations, particularly those that are owned by ethnic or racial minorities.

The ReferenceUSA and OneSource databases include a physical address and Standard Industrial Classification (SIC) code; therefore, all formal community organizations operating in each study area were easily identified. After removing 15 nonverifiable or otherwise inappropriate locations, 59 organizations from industry sectors of educational services, social services, museums and cultural institutions, and membership organizations were identified among the four communities. Of these 59, 10 were in East Biloxi, 13 in Ocean Springs, 26 in Pascagoula, 10 in Waveland. About half were faith-based organizations. The database also yielded phone numbers, most senior executive name, email, and websites. Contacts were then

cold-called. Of those that could be directly reached, 100 percent consented to an interview. A small number had moved after Katrina but current staff recommended other names within their organizations. This method in conjunction with the Federal Reserve contact list yielded a diverse cross-section of residents but was limited in that only directors and other primary contacts involved with organizations in the area were identified.

These initial Federal Reserve and business directory contacts provided 19 interview subjects. Those subjects were asked to identify fellow community members. An additional nine were identified through the first wave of cold calls. The recruited interviews were selected to represent at least one resident from the business, faith-based, education, housing, municipal government, and local nonprofit sectors, although not all interviewees fit in these categories. There were two exceptions where a representative could not be contacted for a certain category. In East Biloxi, the historic African American school that had been in the study area closed after Katrina; therefore, no representatives from education were located. In Waveland, only one of four faith-based organizations identified in the area had a valid telephone number, and that church was not responsive. In these cases, other interviews touched on the education and faith-based community response, respectively, and after several attempts over several months, efforts to locate these interviewees were abandoned. Finally, at least one interviewee in each community was selected due to their work with or knowledge of special needs or functional needs populations such as ethnic or racial minority, immigrant, elderly, or homeless populations.

Although many interview subjects were leaders from the sectors mentioned above (business, faith-based, education, housing, municipal government, and local nonprofit), a few could be described as laypeople who were not directly involved in organized relief or rebuilding efforts. These included maintenance workers, retirees, and teachers, for example. Despite efforts to capture the most vulnerable populations in each community, in some communities this was not accomplished. Although elderly, ethnic and racial minority, and (self-described) lower-income subjects were found in the greater sample across all four communities, this was not the

case within each individual community. However, as noted above, individuals with intimate knowledge of these populations were available with very few exceptions.

Many interviews were conducted in person at four locations and dates: July 9, 2012, at the Pascagoula Library; July 10, 2012, at the East Biloxi Library; July 11, 2012, at the Ocean Springs Library; and July 12, 2012, at the Waveland Library. A few were conducted at the personal offices of the subjects. All other interviews were conducted via telephone. Most interviews were between 30 and 45 minutes. All subjects were asked the same core questions (Table 13 and Appendix A), with follow-up questions, if necessary. All subjects signed the approved Georgia Tech Institutional Review Board (IRB) consent form (Appendix B). All interview subjects consented to the interview and to an audio recording to be transcribed for analysis.

Table 13: Interview questions for Stage 2 analysis

<p><u>BACKGROUND INFORMATION:</u></p> <p>How long have you lived in this community? How long have you been with your organization [for community leaders]? Did you evacuate or stay during Katrina? If so, when did you return?</p>
<p><u>SOCIAL NETWORK QUESTIONS:</u></p> <p>Think of organizations, networks, associations that you or any member of your household belong to. These could be formally organized groups or just groups of people who get together <i>regularly</i> to do an activity or talk about things. Of how many such groups are you or any one in your household a member? Please describe them.</p> <p>Which of these groups or networks were you engaged in most actively before Katrina? During? After?</p> <p>Which of these groups or networks disbanded or have been formed after Katrina?</p>
<p><u>RESILIENCE QUESTIONS:</u></p> <p>Think about how your community has coped after Katrina. Resilience is the ability of a community to rebound, or to bend but not break, after a disaster. In your opinion, how resilient is your community to disasters? (1-10, 1 being not at all resilient, 10 being very resilient)</p> <p>On what factors do you base your score?</p> <p>By your estimation, what percent or proportion of your neighborhood has returned after Katrina? Of your city?</p> <p>Have vulnerable populations returned, such as the elderly or very poor? Why or why not?</p>
<p><u>BUILT ENVIRONMENT QUESTIONS:</u></p> <p>Think about the physical characteristics of your community – homes, buildings, open and green space, streets and sidewalks, landmarks and monuments, historic sites, businesses, institutions, natural features. Which of these places or features are most important, memorable, or symbolic to your community in your opinion before Katrina? After?</p> <p>What locations are used by your formal and informal social networks for gathering before Katrina? After?</p> <p>With respect to the community pre- and post-Katrina, does your community offer amenities in walking distance to your home? What is the availability of parks and open space?</p>
<p><u>RECRUITMENT:</u></p> <p>Who else should I talk to in your neighborhood?</p>

The sample included individuals that lived on the Gulf Coast prior to Katrina. Eight subjects, or 29 percent, had lived in their respective communities their entire life. The others resided in the area between seven and 59 years, with an average of 30 years. Many subjects remarked specifically on the tendency for generations of families to remain on the coast, often in the same neighborhood. This phenomenon was also acknowledged by newer residents to the area. Several subjects (29 percent) mentioned ties to New Orleans, more common in Waveland

and Hancock County, or to Mobile (18 percent). A small number (7 percent) mentioned that the Keesler Air Force Base brought them to the area. These subjects ended up remaining in or retiring in the area.

In several instances, subjects described the three counties of the Mississippi Gulf Coast as a cohesive region, with residents frequently moving between communities for work, recreation, and shopping. With the exception of political boundaries formed by bodies of water, the boundaries between the communities tend to be blurred by residents. However, most highlighted central nodes in each community, such as downtown districts, shopping malls, and the casinos. The blurring of boundaries occurred in part due to utilitarian necessity, as most communities lack certain amenities that residents require. Of the case study communities, Ocean Springs was commonly described as the best place to eat a meal, Pascagoula as an employment center, East Biloxi as a place for nightlife (casino gambling and a faded bar scene), and Waveland as a recreation center with points of interest such as Buccaneer State Park and a former water park. Pascagoula and Waveland are 54 miles apart, but connected by Highway 90 on the beach or Interstate 10 further inland. Although there is very little public transportation, particularly between rather than within communities, many residents move between various parts of the region daily. This tended to make identification of community-specific phenomena difficult, therefore subjects were asked and reminded to remark primarily on the community in which they resided and were shown a map of the area during in-person interviews as a reference point.

When subjects were asked whether or not they evacuated for Katrina, 12 (46 percent) said they remained in their homes, two (8 percent) evacuated to a home on higher ground but remained in their community, and two were not in the area at the time, either on vacation, or temporarily living elsewhere. Of the 14 that evacuated, most returned within one week and half were able to resume living in their homes (often despite major damage) within one week. Two subjects reported that it took more than one year to rebuild their homes and two additional subjects were still working on repairs, seven years after the hurricane. It was suggested by an interviewee and first responder that the people who did not evacuate, or who came back most

quickly, were more likely to stay and rebuild. Those that evacuated, particularly those that evacuated and did not come back until more than a few weeks later, came back to a desolate landscape and ultimately were more likely to choose not to stay. However, there were some complications to returning immediately, including reports that the Mississippi State Police were blocking access to the area.

Results: Social Networks

The first set of interview questions pertained to subjects' social networks. Subjects were asked to think of organizations, networks, associations that they or members of their household belonged to before and after Katrina. Most began with a description of their formal organizations – churches or other faith-based organizations, school groups, and professional organizations – followed by their core informal groups such as family, friends, and neighbors.

Overall, 294 formal and informal social networks were identified by 28 interview subjects across the four case study communities. As interviews were conducted in two high-resilience and two low-resilience communities, each with similar built environment factors, these networks of support were first aggregated by level of resilience to determine trends in high-versus low-resilience communities.

As shown in Table 14, the number of organizations described by interviews from high-resilience communities was not significantly different and only slightly higher than the number of networks described by those in low-resilience communities. High-resilience communities identified 149 networks, or 10.64 networks per person on average and low-resilience communities identified 145 networks, or 10.36 networks per person on average.

Table 14: Total and average number of social networks by resilience category

	All high-resilience interviews	All low-resilience interviews	Total, all interviews
Sum, number of networks mentioned	149	145	294
Average number of networks mentioned	10.64	10.36	10.5

Interestingly, high-resilience communities were more likely to mention organizations that had a negative impact on recovery (these organizations are not included in the above totals). Low-resilience interviewees tallied seven mentions and high-resilience interviews tallied 18 mentions of organizations that were either limited in their ability to help or actually complicated response. Those 25 negative statements were comprised of only a few unique organizations discussed in a negative light. This includes city leadership in Biloxi and Waveland, which was seen as ineffective or working at cross-purposes with those trying to rebuild; FEMA, which was thought to be similarly ineffective and out of touch with the needs of locals; and the American Red Cross, due to long lines and extensive administrative requirements. It should be noted that there were more positive mentions than negative of FEMA and the Red Cross and that the local governments of Ocean Springs and Pascagoula were seen as quite effective post-Katrina.

Although the numbers of networks that community members belonged to and sought help from was not significantly different, the types of networks were (Figure 15). In both cases, faith-based organizations were the most frequently mentioned (23 percent of networks in low-resilience communities and 21 percent of networks in high-resilience communities). However, high-resilience communities were networked with local nonprofits, schools, friends, businesses, and municipal organizations in higher numbers. Conversely, low-resilience communities were networked with state, national or international groups, military, and federal organizations, as well as family. The different types of organizations identified by the two groups point to the effectiveness of local networks of support, including friends and the public and nonprofit sector. Although high-resilience communities seemed to fall back on local networks, low-resilience communities were more likely to turn to federal aid and the support of national organizations.

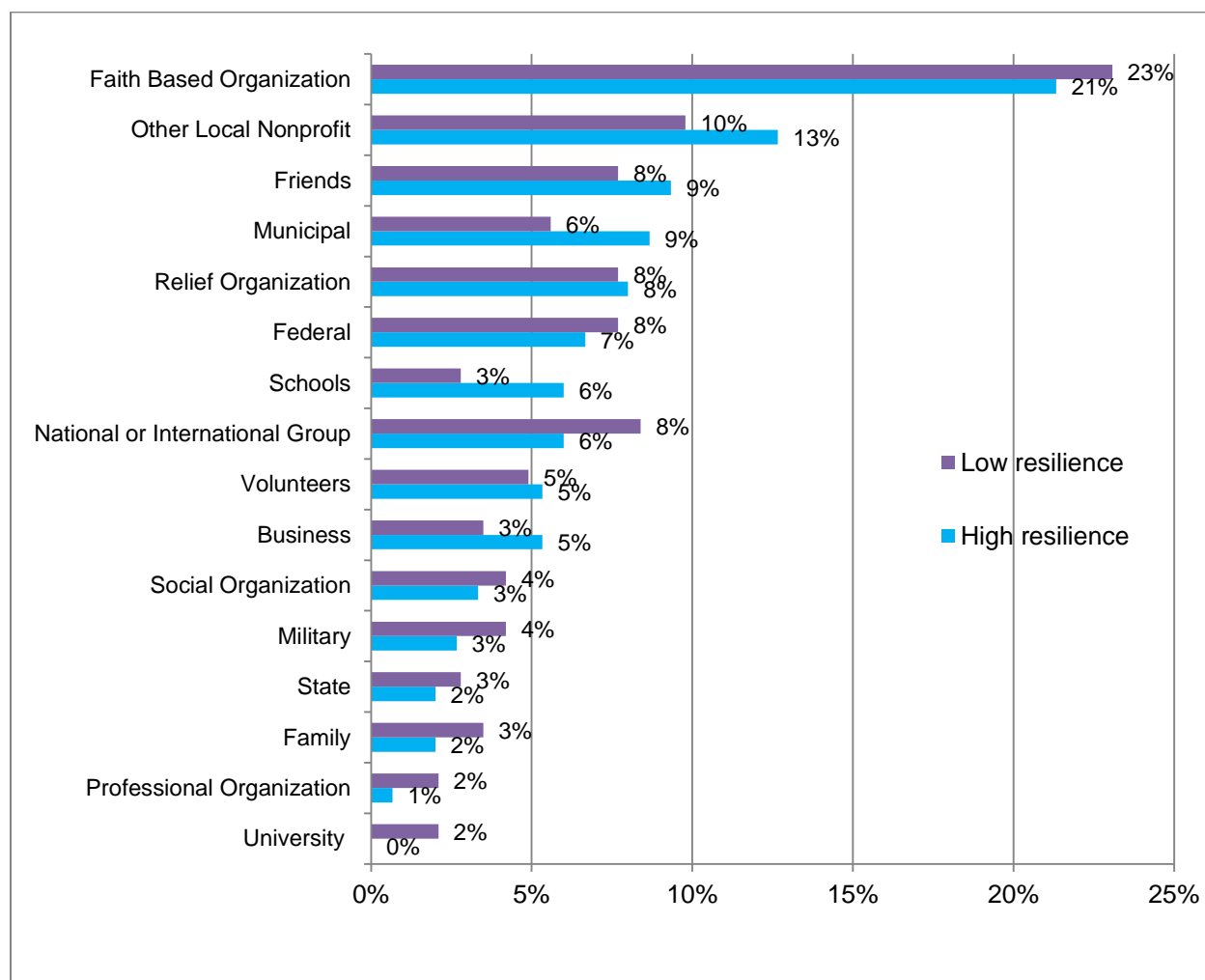


Figure 15: Types of networks by resilience category

Many interview subjects spoke of their own strong faith and that of their neighbors. For a majority of the subjects, a faith-based organization was their most important social network. Further, faith-based organizations were the most consistent source of support in recovery, as distribution points for supplies and in clean up and rebuilding. In fact, the percent and number of faith-based organizations is low, as many subjects were unable to name the entire roster of churches and other organizations from around the world that came to help. Therefore, in some interviews, the catchall of “churches” was noted yet it was not clear if two or 20 churches were part of the subjects’ networks. Many faith-based groups mentioned were from outside the study

area (generally from nonaffected U.S. states); however, these groups almost always had a local tie, pointing to a greater national network of faith-based support. For example, after seminary, a Catholic priest may retain ties with a number of classmates that are called to various points around the nation or the world. For those faith-based groups that came to the area without a local tie, in some cases a bond was formed that has continued. Interview subjects pointed to several such networks that have outlasted the recovery. Subjects also spoke of outreach conducted by Gulf Coast churches in other disaster-affected areas, such as the communities destroyed by the 2012 Alabama tornados.

The importance of faith-based organizations has been frequently examined in the field of community development. According to one source, faith-based organizations that are more active in traditional economic development activities, including housing and social services that are important for disaster recovery and resilience, tend to have more staff and pledge income and a theological world view stressing building community and economic justice (Reese & Shields, 2000). Faith-based organizations are uniquely able to provide various types of support several reasons. Such institutions tend to remain in place no matter what kinds of disinvestment occur in a neighborhood, the mission of most (if not all) faiths includes community building, they have unique types of local and external networks, and because of their ability to provide valuable spiritual support even when resources are not available (Cisneros, 1996).

When the numbers and types of social networks were aggregated by individual case study communities rather than by level of resilience, there were additional differences in the numbers and types of networks described. First, subjects from high-resilience Waveland and low-resilience East Biloxi reported higher numbers of total and average networks (Table 14). These two communities were closer to the eye of the hurricane when it made landfall, resulting in greater damage, which may have resulted in an increased amount of attention and greater activity during the recovery period.

Table 15: Total and average number of social networks by case study community

	Waveland	Ocean Springs	Pascagoula	East Biloxi	Total, all interviews
Sum, number of networks mentioned	82	67	67	78	294
Average number of networks mentioned	11.71	9.57	9.57	11.14	10.5

The types of social networks engaged in also differed somewhat by case study community. Again, faith-based organizations dominated in all locations (22 percent of total responses in all four communities), although other local nonprofits were most widely cited in Waveland and East Biloxi (17 percent of responses in both communities). Federal support was most cited in Pascagoula (15 percent of responses). Interestingly, East Biloxi, which neighbors Keesler Air Force Base, was the only community that did not cite the military as a network, either socially or as a resource in recovery. Before Hurricane Camille struck in 1969, this may have been more overt. To many in the area, the young men on the base were seen as a nuisance. However, their assistance in cleaning up and rebuilding after Camille repaired their image in the community. Although East Biloxi is adjacent to the base, there is still a disconnect between the base and the neighborhood.

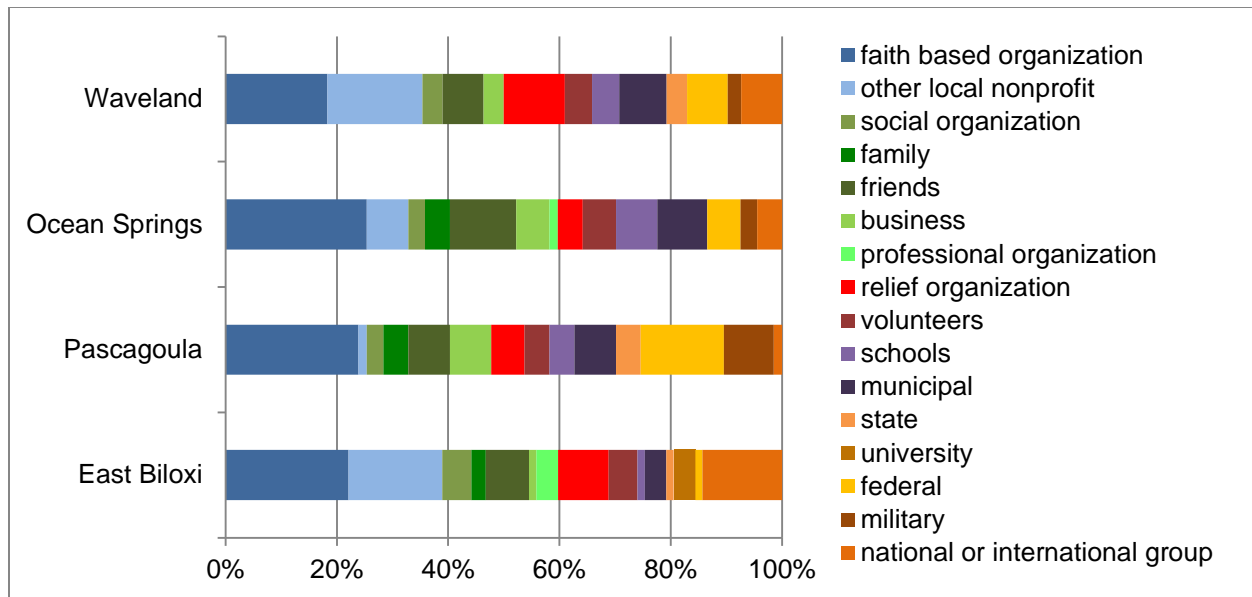


Figure 16: Types of networks by case study community

In addition to the accounts of personal social networks, many interviewees spoke of the generally high rates of volunteerism and philanthropy in the Gulf Coast region of Mississippi. Despite having one of the lowest per capita income levels in the country, the state of Mississippi was ranked first or second on the Catalogue for Philanthropy's Generosity Index from 1995 to 2005 ("Generosity Index," 2006). According to the Chronicle of Philanthropy, in 2012, the average Mississippi household donated 7.2 percent of its discretionary income to charity ("How America Gives: How States Stack Up in Generosity," 2012), making it the second most generous state in the country by this metric.

This local generosity was very beneficial, as Mississippi received a significantly smaller amount of post-Katrina funding than New Orleans and Louisiana ("Philanthropy Today: Charities Work to Foster Mississippi Philanthropy," 2007). In interviews, residents were aware of the discrepancy and often pointed out the attitude among residents of taking care of oneself and one's neighbors, rather than waiting for intervention from the government or nonprofits. Those entities providing aid were important for recovery, particularly faith-based and relief organizations; however, for most they were a last resort. Those who had the resources to help themselves or their neighbors did so willingly and immediately.

Although the number and type of formal and informal networks of support yielded interesting results, the question of capacity remained. In order to gauge the amount of resources available by location and by organization, U.S. Internal Revenue Service (IRS) Form 990 and Form 990EZ data were obtained from the Foundation Center's online database ("990 Finder," 2012). Form 990 is meant to monitor tax-exempt organizations and includes financial information for nonprofits. Total assets are collected in this annual disclosure and the Foundation Center database includes assets over multiple years for each organization. Due to multiple data gaps, the annual assets by organization were averaged for all years available (2001 to 2011) in order to ensure a greater number of data points. The average values by organization over these years were aggregated for a sum of assets by case study community and an average of assets for all organizations in each case study community (Table 16). Organizations were queried by ZIP code field. ZIP codes are larger than the study area geometries used in this analysis; however, no other geographic identifiers were available (Figure 17).

Based on these data, Pascagoula clearly had the largest total assets and the highest average assets per organization and Waveland had the fewest total assets and lowest average assets per organization. This is largely because of the presence of three credit unions with large assets in Pascagoula. There were no other credit unions listed in the database for the other three communities. When the Pascagoula credit unions were removed, as these assets represent a very different type of individual capacity, the sum and average assets drop well below the other case study communities (Table 17). The ZIP codes that house East Biloxi and Ocean Springs also have the highest populations. Total assets normalized by the 2000 population of each ZIP code are also shown in Table 16 and Table 17. Waveland and Pascagoula had the lowest levels of nonprofit capacity per capita and per organization, demonstrating limited nongovernmental resources. Ocean Springs and East Biloxi exhibited higher levels of capacity per capita and per organization, with East Biloxi having the greatest resources by each metric. Based on this, financial resources of local nonprofits appeared to be unrelated to resilience, as East Biloxi has been the least resilient of the four communities.

Table 16: 990 data by case study community, 2001 to 2011

	Total assets of all organizations in database	Average assets per organization for all organizations in database	ZIP code tabulation area population 2000	Average assets per capita based on 2000 population
Waveland	\$3,104,389	\$310,439	6,959	\$446
Ocean Springs	\$36,693,275	\$601,529	31,819	\$1,153
Pascagoula	\$246,804,065	\$7,478,911	13,756	\$17,942
East Biloxi	\$44,213,457	\$1,105,336	17,214	\$2,568
Total	\$330,815,186	\$2,297,327	69,748	\$4,743

Table 17: 990 data for Pascagoula without credit unions, 2001to 2011

	Total assets of all organizations in database	Average assets per organization for all organizations in database	ZIP code tabulation area population 2000	Average assets per capita based on 2000 population
Pascagoula	\$7,690,657	\$256,355	13,756	\$559

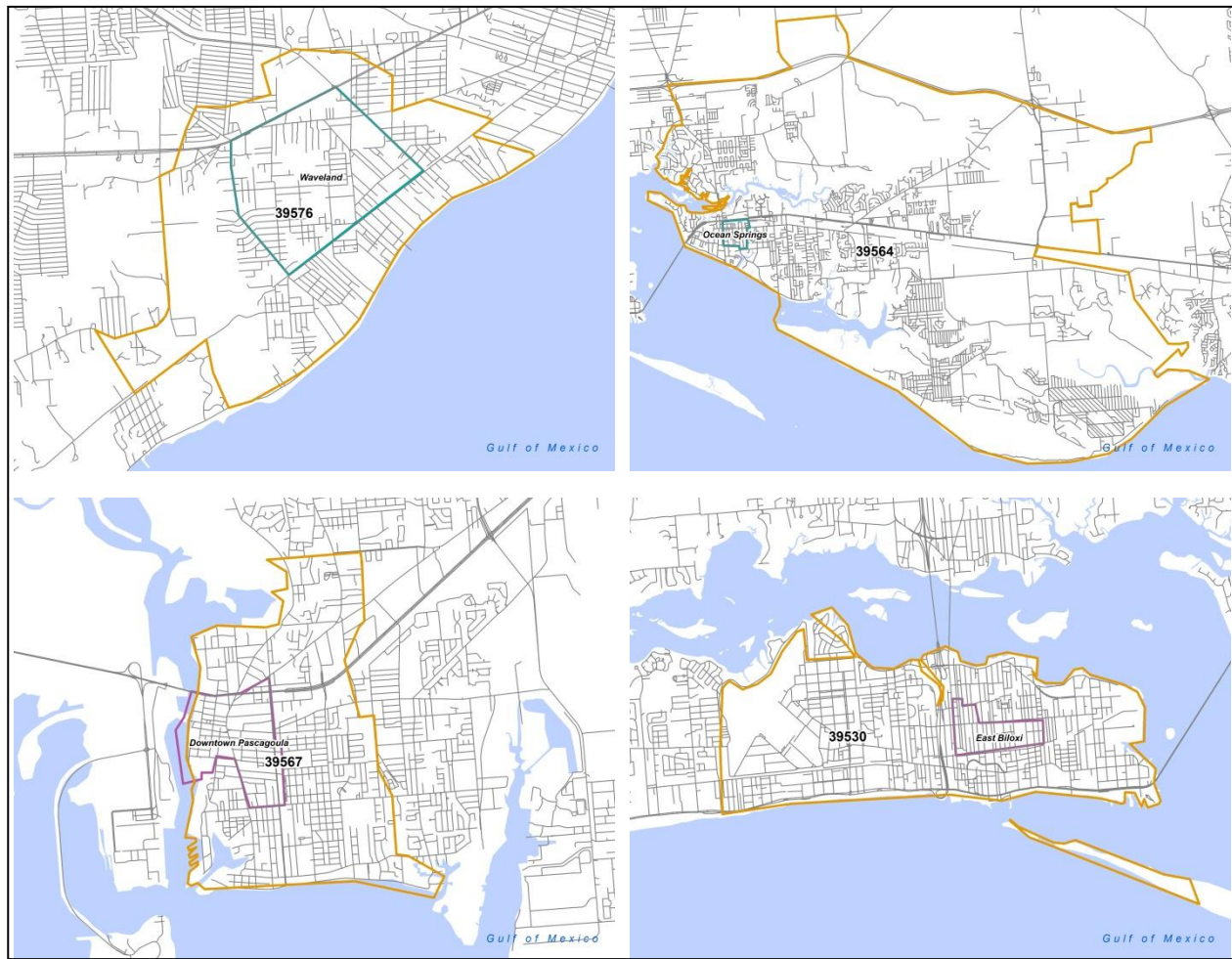


Figure 17: Comparison of ZIP code and study area geometries

Within the Foundation Center’s online 990 database, 18 organizations specifically cited by subjects during interviews were available (Table 18). These ranged from only \$24,410 (St Vincent de Paul Society) to over \$18 million (Ohr O’Keefe Museum) in assets. Once again, the assets were averaged over all available years in the database to control for gaps and noise in the data. Of these, certain organizations widely praised for their contributions had relatively modest resources, such as the Mississippi Coast Interfaith Disaster Task Force (MCIDTF) and the Steps Coalition. Financial resources of local nonprofits appeared to be unrelated to their ability to contribute and support local recovery.

Table 18: 990 data by organizations named in interviews

	Average assets, 2001-2011	Location
Hancock Housing Resource Center	\$326,529	Waveland
Nereids Inc.	\$232,942	Waveland
Mary C. O’Keefe Cultural Center	\$243,277	Ocean Springs
Mississippi Gulf Coast YMCA Inc.	\$2,760,961	Ocean Springs
Ocean Springs Chamber of Commerce	\$373,114	Ocean Springs
The O’Keefe Foundation	\$105,598	Ocean Springs
Walter Anderson Museum of Art Inc.	\$9,686,299	Ocean Springs
St Vincent De Paul Society East Jackson Co	\$24,410	Pascagoula
United Way for Jackson and George Counties Mississippi, Inc.	\$2,757,802	Pascagoula
Habitat for Humanity of Jackson County Inc.	\$1,405,301	East Biloxi
Harrison County Habitat for Humanity	\$1,621,990	East Biloxi
Hope Community Development Agency	\$1,614,573	East Biloxi
Junior Auxiliary of Biloxi-Ocean Springs	\$75,468	East Biloxi
Mississippi Coast Interfaith Disaster Task Force	\$136,271	East Biloxi
Ohr-O’Keefe Museum of Art Inc.	\$18,313,711	East Biloxi
Steps Coalition	\$140,005	East Biloxi

Results: Resilience

After being asked about formal and informal social networks, interview subjects were next asked about how resilient they perceived their community to be after Katrina and why. Resilience was defined for each subject in the same manner it was quantified for Stage 1 of this research, or how well the community has rebounded to its prior state, specifically in the return of occupied housing. Interview subjects spoke of and were asked about other aspects of resilience, such as the return of businesses and institutions, but the focus of the interview was on households.

Surprisingly, when asked to rate the resilience of their communities on a scale of one to ten, with ten being totally resilient (or all households restored), the interviewees from high-resilience communities rated their communities lower than those from low-resilience communities (Table 19). Several interview subjects gave a mixed rating and were excluded from the average in Table 19; therefore, the averages are based only on the 21 valid numerical

responses collected. For example, many rated the people versus the city government or the core versus the periphery differently. Others did not feel they could give a numerical value at all or gave a generic high or low rating, which were also excluded.

Table 19: Average resilience rating by resilience category

	All high-resilience interviews	All low-resilience interviews	Total, all interviews
Average rating of resilience on a scale of 1 (least) to 10 (most resilient)	7.91	8.45	8.17

The discrepancy in calculations of the resilience variable (return of occupied households from 2000 to 2010, normalized by area) and the ratings above was also quite clear throughout the interview process. In fact, the case study area of Pascagoula was seen as quite resilient by interviewees and Waveland was generally given a low resilience score. As shown in Table 20, this was manifested in the ratings estimates given in each case study communities.

Table 20: Average resilience rating by case study community

	Average rating of resilience on a scale of 1 (least) to 10 (most resilient)
Waveland	6.70
Ocean Springs	8.92
Pascagoula	8.86
East Biloxi	7.50
Total	8.17

There were a number of reasons for the unusual results above. First, although case study communities were drawn around smaller neighborhood-scale areas using Census block groups, as mentioned previously, residents tended to blur formal boundaries and in some cases thought of their communities as being larger than city, let alone neighborhood, boundaries. For example, Bay St Louis and Waveland and Pascagoula, Moss Point, and Gautier have historical and

practical ties. Further, residents' perceptions of resilience tended to be rooted in their areas of expertise. Therefore, a faith-based leader whose entire congregation returned might feel their community is very resilient while a social justice advocate in the same area might feel the same community is not resilient based on the impact on a vulnerable ethnic or racial minority population. The term resilience has also been long applied at the individual rather than the community scale, thus many subjects in low-resilience areas looked to the population that did stay as being very resilient, given the hardships faced in rebuilding among the ruins.

Overall, the resilience rating demonstrated the wide range of emotions and meanings assigned to the term and the individual perspectives of subjects. Because it was not particularly meaningful aggregated to the community level, the resilience ratings by subject were compared with other data from the interviews.

When resilience ratings were compared with the number of social networks mentioned in interviews, the relationship was weak but negative. Figure 18 shows data points for all interview subjects that gave a valid numerical resilience rating for their community, plotted against the number of social networks mentioned in the subject's interview. As in the relationship described in a previous section, where low-resilience and high-resilience communities did not differ in the number of social networks engaged in per person, self-reported resilience ratings had little relationship with the number of social networks engaged in per person.

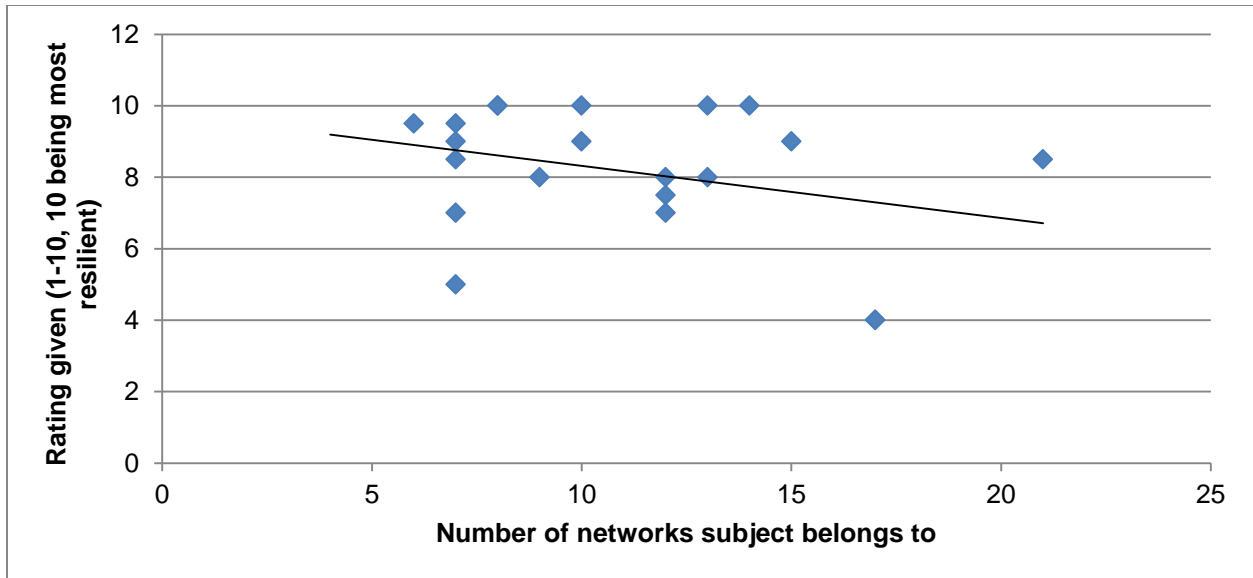


Figure 18: Relationship between number of networks and resilience rating

When compared with the number of years a subject lived in the community, there was a similarly weak and positive relationship. Although the results are weak, again, these comparisons point to the individual attitudes about resilience encountered during the interviews and demonstrate the difficulty in quantifying the concept of resilience in this manner.

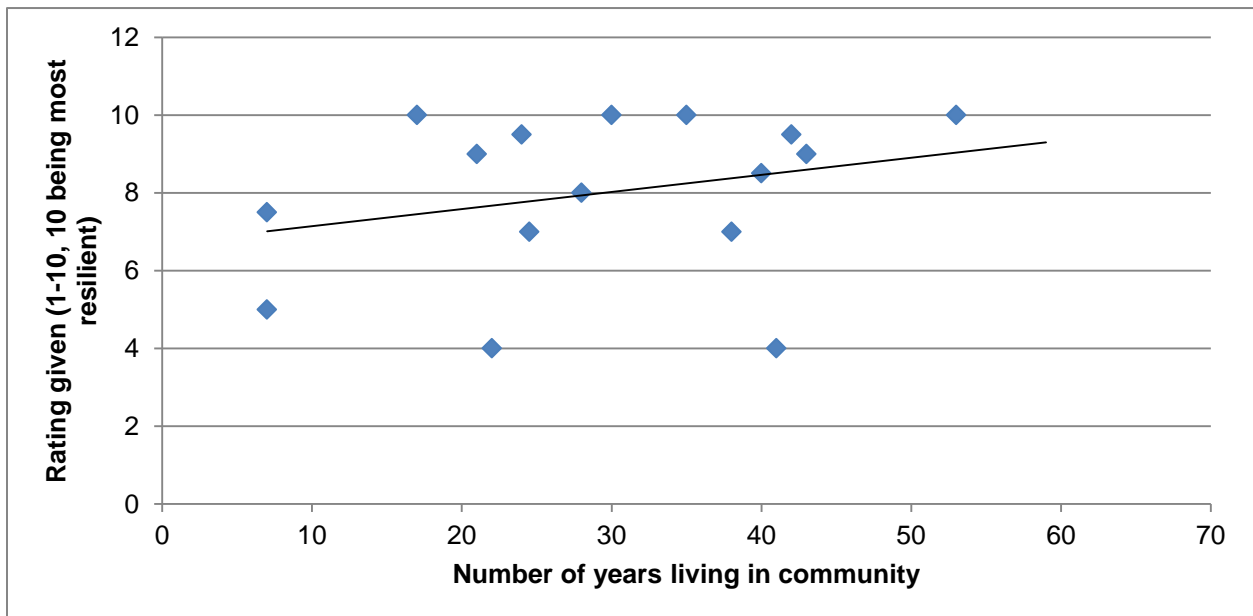


Figure 19: Relationship between years lived in community and resilience rating

Results: Built Environment

In addition to questions about social networks and resilience, interview subjects were also asked a series of questions about the built environment in their community. They were first asked to think about the physical characteristics of their communities, which were defined for them as homes, buildings, open and green space, streets and sidewalks, landmarks and monuments, historic sites, businesses, institutions, and natural features. They were asked which places or features are most important, memorable, or symbolic to their communities before and after Katrina. They were also asked which places are or were used by social networks for gathering before and after Katrina. Finally they were asked, in general, if their communities offer amenities such as restaurants, shopping, schools, and parks within walking distance to their homes.

First, when asked to identify physical characteristics of their communities that are most symbolic and important, residents of high-resilience communities listed an average of 12.36 sites per person and residents of low-resilience communities listed only 9.64. This difference was not significantly different based on a T test, with a p value of 0.17. However, numbers and types of places described as symbolic and important did differ among high and low-resilience communities and between the four communities.

Table 21: Sites and places mentioned by resilience category

	All high-resilience interviews	All low-resilience interviews	Total, all interviews
Sum, number of places mentioned	173	135	308
Average number of places mentioned	12.36	9.64	11.00

The sites listed by subjects were categorized as institutions, commercial establishments, parks, districts, infrastructure, recreational facilities, beaches, housing, historic sites, churches and other places of worship, and other natural features. Institutions included municipal and

public safety facilities, nonprofit organization headquarters, community centers, libraries, schools, and clubs such as fraternal halls. Commercial establishments were primarily retail and restaurants and bars, although casinos, barber shops, and movie theaters were also mentioned. Parks included neighborhood-scale parks and playgrounds, state parks, and national parks. Districts included downtown or central business districts, other neighborhoods, and streets. Infrastructure included bridges, highways, streets and sidewalks in general, lighting, docks, and airstrips. Recreational facilities included ball parks, pedestrian and cycling trails, venues such as fairgrounds and coliseums, marinas, bowling alleys, and skating rinks. Beaches were commonly mentioned in interviews due to the prominence of the waterfront in the area. Housing included multifamily, single-family, and special needs housing. Historic sites included landmarks such as the remaining grand hotels, lighthouses, forts, monuments, and specific homes such as the cottage of architect Louis Sullivan. Churches and other places of worship were primarily Christian denominations, with one Buddhist temple given as a response. Other natural features included bodies of water, islands, and vegetation in general, not specific to parks or recreational areas.

Of the 173 total places recognized by residents from high-resilience communities, there was a greater percentage of institutions, parks, infrastructure elements, recreational sites, beaches, and housing (Figure 20). Of the 135 places recognized by residents from low-resilience communities, there was a higher percentage of commercial sites, districts, historic sites, and churches. The higher number of sites identified by high-resilience communities and the more even distribution of types of sites could indicate a larger and more varied number of landmarks or simply a greater pride in and place attachment to community in more resilient communities. Most striking was the higher number of churches singled out by low-resilience communities. Both East Biloxi and Pascagoula have some of the larger congregations and places of worship, notably St Michael Parish, also known as the Fisherman's Church, in East Biloxi and First Baptist Church in Pascagoula. East Biloxi and Pascagoula, as noted in Chapter 3, were established earlier than Waveland and Ocean Springs, therefore more places of worship have

likely been founded and have remained in these communities. Historic structures were also more prominently mentioned in the low-resilience communities of East Biloxi and Pascagoula, quite likely for the same reason.

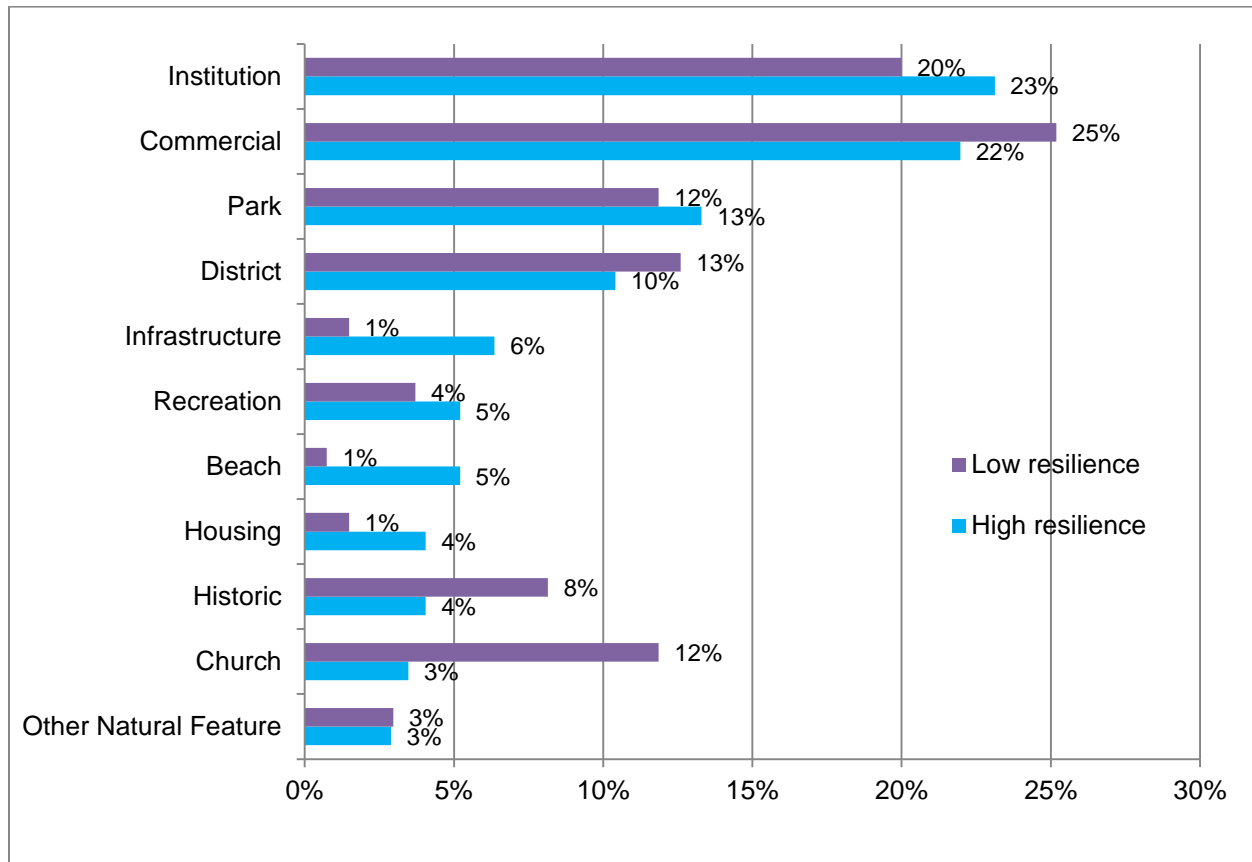


Figure 20: Types of sites and places mentioned by resilience category

The number of sites and places mentioned differed by case study community as well (Table 22). Waveland reported the most significant places and Pascagoula reported the fewest.

Table 22: Sites and places mentioned by case study community

	Waveland	Ocean Springs	Pascagoula	East Biloxi	Total, all interviews
Sum, number of places mentioned	95	78	50	85	308
Average number of places mentioned	13.57	11.14	7.14	12.14	11.00

When the types of sites and places were compared by case study community, other differences emerged (Figure 18). Churches were most prominent in East Biloxi (14 percent of responses) and least prominent in Waveland (2 percent of responses). Other institutions such as schools, conversely, were most prominent in Waveland (27 percent of responses) and least prominent in East Biloxi (16 percent of responses). Various types of green space, including beaches, other natural features, parks, and recreational facilities, were most prominent in Ocean Springs (35 percent of responses) and least prominent in East Biloxi (14 percent of responses). This is understandable, as Ocean Springs has made a great effort to enhance its beachfront and community parks and East Biloxi's coast is still dominated by casinos and the seafood industry. As noted previously, the prominent churches of Pascagoula and East Biloxi were often cited in those communities. Responses of housing and infrastructure were by far more common in Ocean Springs than any other community (19 percent of responses in Ocean Springs, versus only 3 percent of the responses of the other three communities combined).

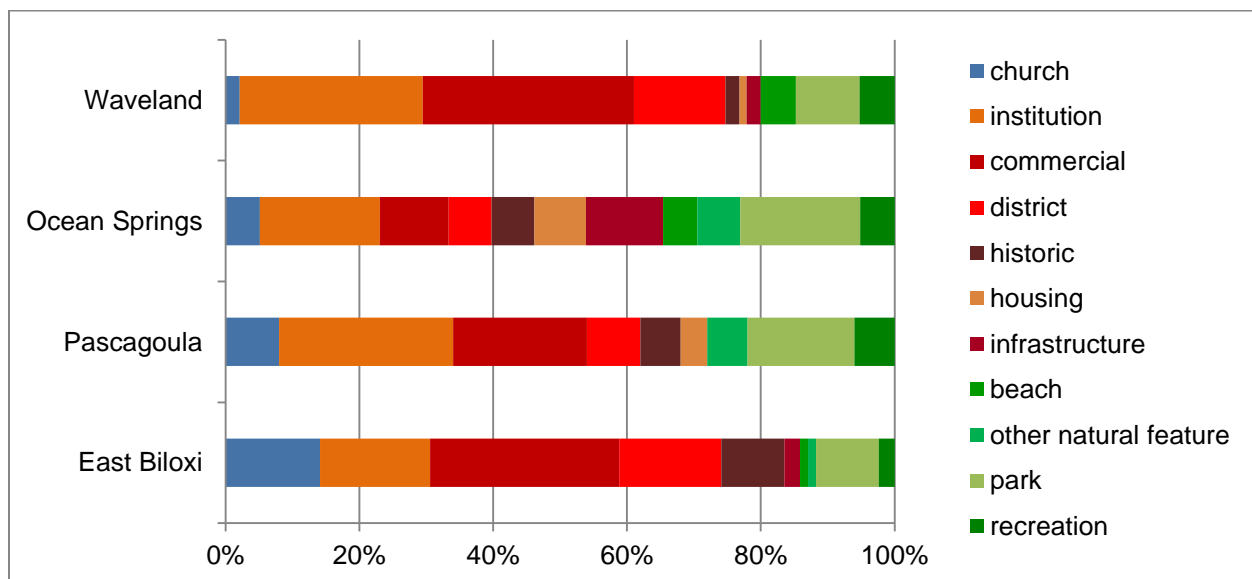


Figure 21: Types of sites and places mentioned by case study community

The spatial location of site and places mentioned for which geographic information could be determined were plotted. This included 237 (77 percent) of the total 308 sites mentioned by

subjects in interviews. Those that could not be plotted included generic categories of sites (for example “historic homes”) or nonspecific types of places that were too broad or common to pinpoint on a map. For each case study community, a convex hull geometry was created for the points that came out of interviews in that community. A convex hull is a polygon formed by the union of all possible geometries made from points in a given set. For this analysis, this included the plotted sites mentioned by case study community. As shown in Figure 22, these geometries tended to extend well beyond the boundaries of each case study community. Further, Pascagoula and Ocean Springs shared roughly the same territory from west to east, although not from north to south. In addition, a heat map was created, calculated using the point density function in the ArcInfo software extension Spatial Analyst. The point density function creates a raster grid with a magnitude per unit area from point features that fall within a given neighborhood distance around each cell of 100 meters by 100 meters. A radius, or neighborhood distance, of one kilometer was used for consistency with other spatial measures calculated at a buffer or walking distance of one kilometer. The heat map clusterings are also shown in Figure 22 and illustrate a finer-scale view of the locations of significant places around the four case study communities, as well as smaller clusters in Gulfport, Bay St Louis, and several other nodes.



Figure 22: Heat map and convex hull geometries of sites and places by case study community

Detailed views of these heat maps are shown in Figure 23. From these detailed views taken from the map above, it is clear that the subjects did indeed focus on the sites and places central to their community. Other “hot spots” arose, however. In Waveland (top left), the area around Highway 90, a shopping hub dominated by strip commercial, appeared as a smaller hub northwest of the gold and yellow district of central Waveland (another dark blue cluster of sites can be seen in neighboring Bay St Louis at the upper right corner of this figure). Similarly, in Pascagoula (bottom left), additional blue nodes appeared near the beach and along Highway 90, northeast of downtown. Sites and places mentioned by subjects in Ocean Springs and East Biloxi tended to form a radial pattern around these case study areas. The densest areas of the hot spot analysis, shown in gold and red, conform nicely to the study areas of Ocean Springs, East Biloxi, and Pascagoula. The densest areas of the hot spot analysis in Waveland were actually outside of the study area. In general, the places mentioned in interviews that could be plotted on the map indicated the importance of city centers, commercial areas, and beachfront amenities.

The Biloxi-Ocean Springs area contained the greatest density of sites, demonstrating the importance of these two communities as places for gathering.

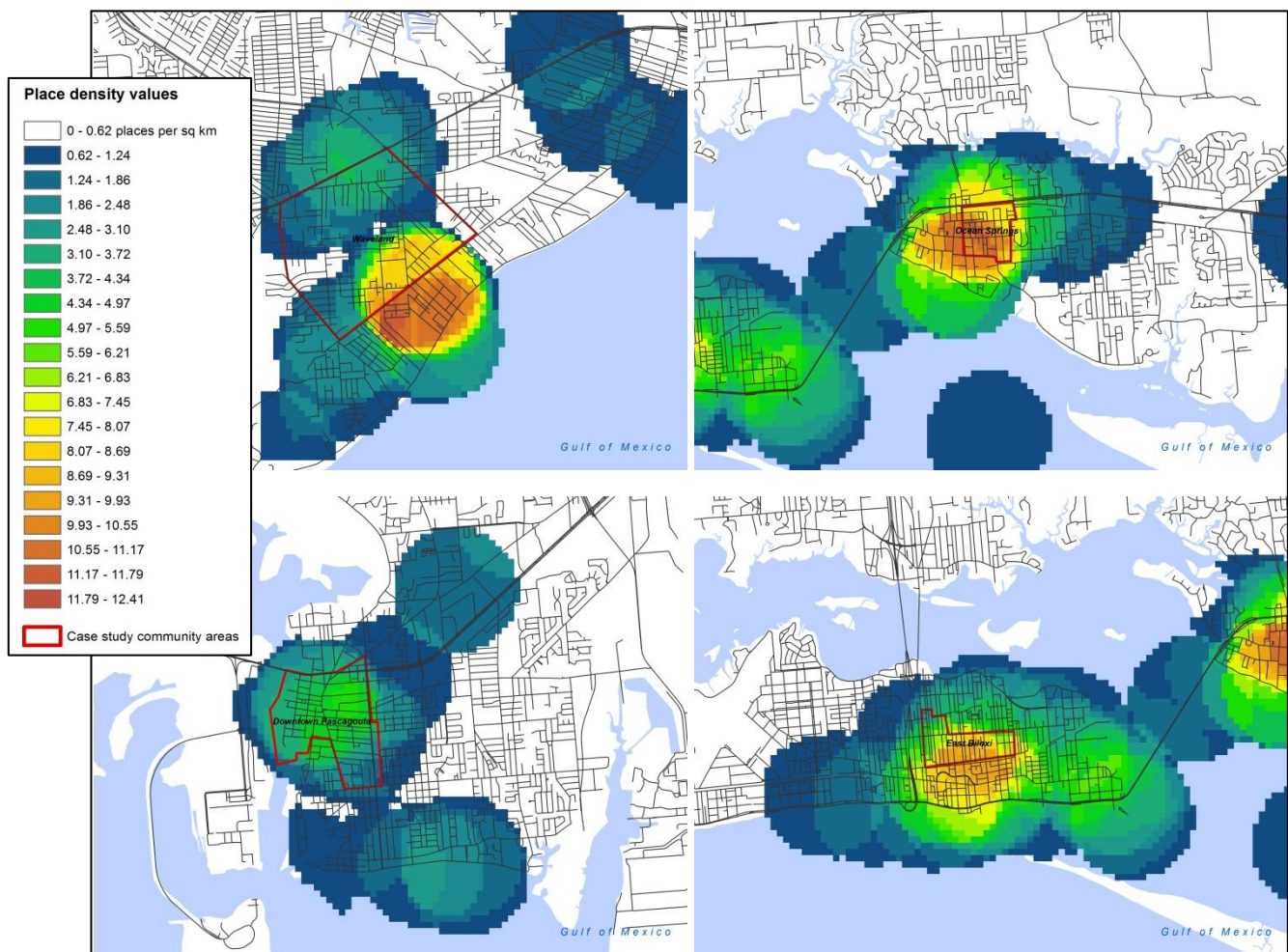


Figure 23: Detail of heat maps of site and place density by case study community

As reported previously, the number of social networks mentioned in interviews was nearly equal between low-resilience and high-resilience communities; however, the number of places mentioned was larger in high-resilience communities than in low-resilience communities (Table 23).

Table 23: Types of networks and places mentioned by resilience category

	Sum all high-resilience	Sum all low-resilience	Total, all interviews
Number of networks mentioned	149	145	294
Number of places mentioned	173	135	308

However, as in the ratings of resilience, individual responses were examined in addition to the aggregated results. When the number of networks per interview subject was plotted against the number of places per interview subject, the relationship was weak but positive (Figure 24). This points to both the tendency for certain subjects to be more thorough than others and the tendency toward highly socially connected people having a greater connection to the built environment.

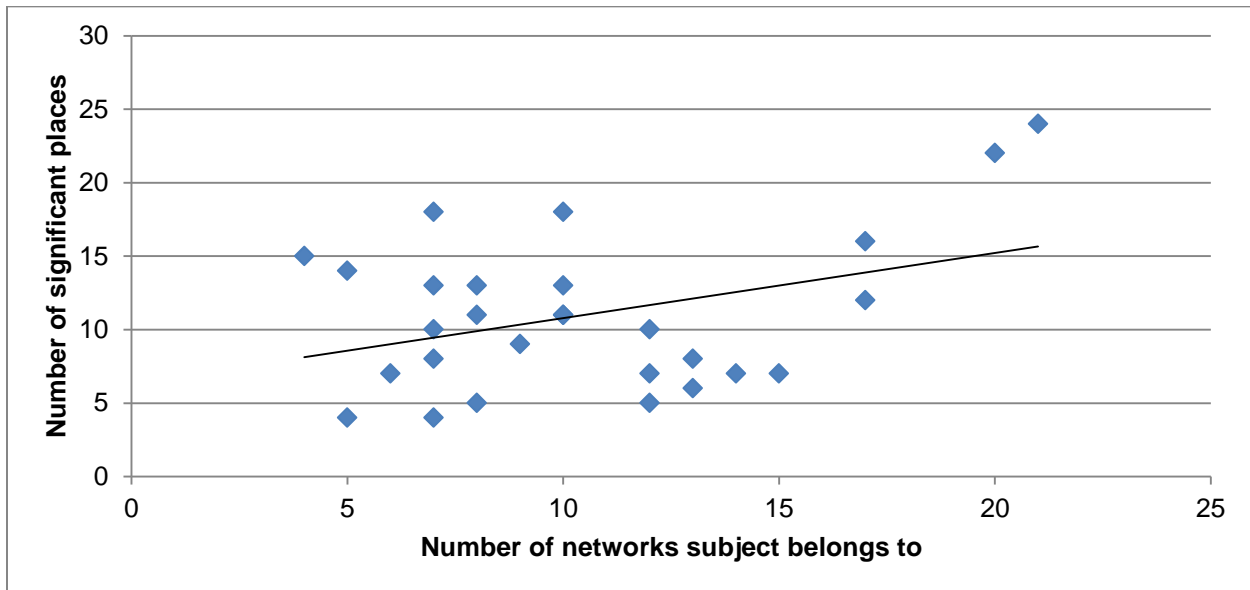


Figure 24: Relationship between number of social networks and number significant places identified in interviews

Although very few subjects had a professional background in city planning or architecture, most were quite astute about the built environment, including planning and development. Much of this knowledge has been acquired after Katrina. The subjects were able

to identify a large array of sites and also spoke in a nuanced way about complications in restoring the built environment.

As mentioned elsewhere, the most significant built environment complications post-Katrina have been the need to elevate infrastructure and structures and the loss of landmarks. A major issue for rebuilding has been the high cost of insurance and restrictions and regulations that prohibit many from rebuilding, particularly the new flood insurance rate maps. Traditional ways of building are impossible in affected areas and costs are prohibitive, therefore many lost landmarks were unable to be replaced. According to the Mississippi Department of Archives and History (MDAH) and the Mississippi Heritage Trust, 354 listed historic structures were destroyed by Katrina. Of those, 254 were destroyed during the storm and 100 were demolished within four years due to extensive and irreparable damage (Malvaney, 2009).

Many interview subjects pointed to homes as the type of buildings most missed. As a result of uneven rebuilding, particularly of homes, wayfinding is now more difficult. For example, one cannot use a once-familiar direction such as “turn left at the big blue house” in what is now a sea of empty lots. At times, post-Katrina reconstruction restricted prior customs and ways of life. For example, new parking regulations made the practice of soft shelling difficult in East Biloxi. Residents of the area would harvest crabs in their rubbery molting state by tapping the crabs with a spear known as a flounder gig and catching those that attempt to bury themselves. Along with shrimping and fishing, soft shelling was once a local ritual and an inexpensive food source. After Katrina, parking was made illegal in the area between 10 pm and 6 am; therefore residents cannot transport their gear during peak soft shelling hours.

Despite these complications, in Ocean Springs and Pascagoula, several subjects noted that the built environment is better than before, with refreshed buildings and new amenities. There were still many vacant properties to serve as reminders of Katrina, but in the four case study communities selected, trailers were not noticeably in use as primary residences. A few Katrina cottages could be found, serving their intended purpose of providing permanent modular housing. There were some derelict buildings, such as the White House Hotel in Biloxi.

Improvements continued seven years after Katrina; for example, a major wing of the badly damaged Ohr-O’Keefe Museum remained battle-scarred (Figure 25). Although parts of the Frank Gehry-designed museum reopened in 2010, these “pods” designed to house the museum’s permanent collection of George Ohr pottery were not scheduled to open until 2013.



Figure 25: Unrestored portion of the Ohr-O’Keefe Museum of Art in East Biloxi
Source: Photograph taken by author, July 2012

Results: Other Reasons for Resilience

During the interviews, residents identified many additional factors that impacted resilience in their communities other than their own formal and informal social networks. Sixty-six different factors were given by the subjects (2.4 per person on average). In order to analyze the results, the factors were coded by categories derived from Susan Cutter’s work on a Disaster

Resilience of Place (DROP) model (Cutter et al., 2008). These categories include ecological, social, economic, institutional, infrastructure, and community competence indicators (Table 24). The DROP model was developed to as a theoretically grounded and quantifiable method to assess resilience at the community level in a given place facing a given disaster.

Table 24: Community resilience indicators

Dimension	Candidate variables
Ecological	Wetlands acreage and loss
	Erosion rates
	% impervious surface
	Biodiversity
	# coastal defense structures
Social	Demographics(age, race, class, gender, occupation)
	Social networks and social embeddedness
	Community values-cohesion
	Faith-based organizations
Economic	Employment
	Value of property
	Wealth generation
	Municipal finance/revenues
Institutional	Participation in hazard reduction programs (NFIP, StormReady)
	Hazard mitigation plans
	Emergency services
	Zoning and building standards
	Emergency response plans
	Interoperable communications
	Continuity of operations plans
Infrastructure	Lifelines and critical infrastructure
	Transportation network
	Residential housing stock and age
	Commercial and manufacturing establishments
Community competence	Local understanding of risk
	Counseling services
	Absence of psychopathologies (alcohol, drug, spousal abuse)
	Health and wellness (low rates mental illness stress-related outcomes)
	Quality of life (high satisfaction)

Source: (Cutter et al., 2008)

As shown in Table 25, Cutter and others have applied the DROP model method to the Gulfport-Biloxi area in an analysis of the resilience of southeastern counties (Cutter, Burton, &

Emrich, 2010). This research found that Hancock County had low- to moderate- and Harrison County moderate- to high-resilience scores compared with other counties in the southeastern U.S. Scores were based on a minimum-maximum rescaling index of zero to one. Scores of 0.5 indicate average levels of resilience in each category. A total score of 2.5 indicates average resilience. Scores higher than the average indicate greater resilience and lower than the average indicate weaker resilience. Harrison County was above average in all categories, particularly in community capital, and stronger than Hancock County in all categories, particularly in infrastructure. Hancock County was below average in all categories.

Table 25: Community resilience scores using DROP model data for Gulfport-Biloxi Metropolitan Statistical Area (MSA)

	Resilience Type					Overall Resilience Score	
	Social	Economic	Institutional	Infrastructure	Community Capital		
Hancock County	0.498	0.409	0.499	0.203	0.499	2.108	Low to moderate
Harrison County	0.527	0.552	0.579	0.504	0.66	2.821	Moderate to high
Stone County (inland county not included in this research)	0.44	0.324	0.324	0.258	0.537	1.883	Low to moderate
Gulfport-Biloxi MSA						2.271	Moderate

Source: (Cutter et al., 2010)

Of the categories used in the DROP model, ecological and economic factors were not included in the interview responses as explicit reasons for resilience (although these types of issues did come up tangentially in a number of interviews). Two categories for this analysis were sub-categories of the above social resilience indicators – values and cohesion and faith and the faith-based community. Social networks and demographics are also included in the DROP model but are discussed elsewhere in this chapter. Other categories derived from Cutter’s model include physical infrastructure, institutional and local response, and community competence. Two items not included in the DROP model were added for this analysis – external support and

the legacy of hurricanes. External support is clearly not an endogenous factor related to resilience of place, as it is dependent on the decision of other agencies and organizations to intervene. However, it was extremely important after Katrina and differences in levels of support were perceptible to interview subjects and seen as a factor in recovery. A legacy of dealing with hurricanes or any other disaster is related to the community competence factor in the DROP model, the local understanding of risk. Hurricane experience was considered to be a distinct characteristic worthy of analysis based on interview responses. Aggregated responses by community, resilience level, and total subjects are shown in Table 26 and Figure 26.

Table 26: Interview subjects' responses, alternative reasons for resilience

	Waveland	Ocean Springs	Pascagoula	East Biloxi	High-resilience	Low-resilience	Total
Values/cohesion	5	7	8	3	12	11	23
Community competence	5	4	3	1	9	4	13
Institutional/local response	2	4	2	2	6	4	10
Physical infrastructure	1	7	1	0	8	1	9
External support	1	1	1	1	2	2	4
Faith	0	0	3	1	0	4	4
Legacy of hurricanes	0	1	1	1	1	2	3
Total	14	24	19	9	38	28	66

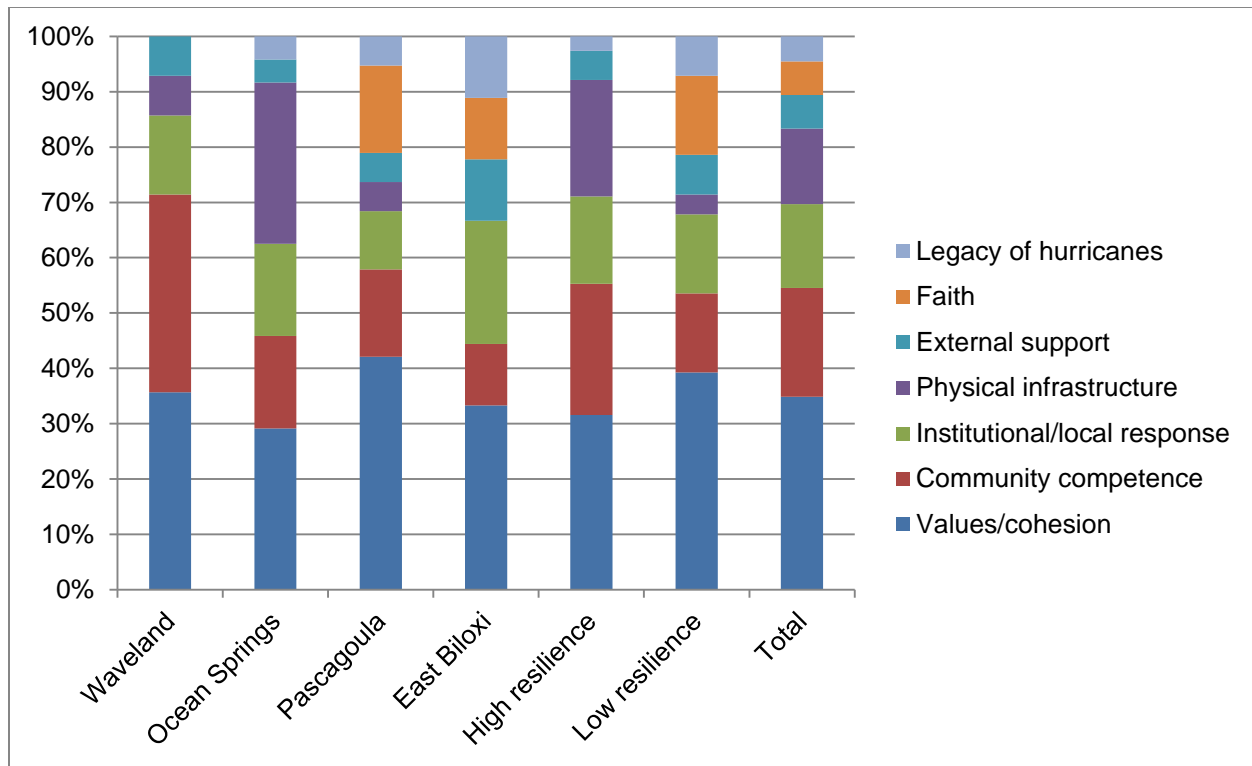


Figure 26: Interview subjects' alternative reasons for resilience

Values and social cohesion were the most oft-cited of the alternative reasons for resilience (35 percent of total responses for all communities). Although this notion is related to social networks, as social cohesion is achieved through social connections, the social resilience measures described by interview subjects tended to focus on the overall community, rather than their own networks, and the cultures and traditions of the area. Examples included families, friends, neighbors, and even strangers pitching in and helping one another, the commitment to family, the small size of the community, generosity, and multigenerational or well-established roots and family businesses in the area. In addition, greater cohesion was brought about by the hurricane, the kind of ad hoc synthetic communities noted in the literature (Tobin, 1999). Subjects also mentioned values such as the creativity, the culture, and the ambiance of their communities, intangible characteristics that also contribute to sense of place.

Community competence was the second-most cited alternative reason for resilience, comprising 20 percent of total responses for all communities. This phenomenon was more

frequently cited in high-resilience communities than low-resilience communities (24 percent versus 14 percent of all responses by respective resilience category). Examples of community competence included residents taking care of their own needs, helping to take care of others' needs, capacity issues such as the existence of partnerships and resources associated with local wealth, rebuilding instead of waiting for help, the mindset of moving forward and not quitting, and the availability of emotional support including formal mental health training and outreach.

The institutional and local response comprised 15 percent of total responses for all communities. This category included the responsiveness of local government, city leadership and political will, the efforts of major employers such as Ingalls and the Port of Pascagoula, and contingency planning by households, businesses, and nonprofits. In addition to the benefits of local government capacity in hazard mitigation (Burby & May, 1998), responsive governance has also been associated with stronger social networks (Aldrich, 2010). Specific examples of local government responses included well-attended charettes during the rebuilding phase and the Community Rating System adopted by Waveland. In another example, the Port of Pascagoula's primary responsibility was quickly restoring port activity, but it also provided the infrastructure to moor a cruise ship used as temporary housing for about 1,200 refugees.

Physical infrastructure accounted for 14 percent of total responses for all communities, although the percent differed greatly between low-resilience and high-resilience communities (4 percent versus 21 percent of all responses by respective resilience category). Of the responses categorized as physical infrastructure factors, robustness of the "core" or central business district was the most frequently cited. Lack of damage was seen as a very important reason for the strong recovery in Ocean Springs, where the downtown area is set back from the beach, versus Waveland, where the downtown area took a direct hit and was almost completely destroyed. Aside from the presence of a functioning commercial district, places to congregate were also seen as important for resilience. The rebuilding of casinos and related amenities occurred very quickly after the storm, to the amazement of residents. Several subjects noted that their respective communities are better off after Katrina, as city planning and an influx of capital have

led to a revitalized community. Features such as bridges, parks, and other recreational facilities have been created and streets, landscaping, and lighting improved.

External support comprised 6 percent of total responses for all communities. Examples of external aid included the support of outside volunteers (particularly in cleanup and rebuilding) and positive media attention, such as the efforts of former resident Robin Roberts of Good Morning America and Whoopi Goldberg on behalf of the October 2005 Mississippi Rising telethon. It should be noted that external support has been shown to be most effective when integrated with well-organized local networks and can be rendered ineffectual when lacking such local integration (Berke et al., 1993).

Responses referencing faith were found only in Pascagoula and East Biloxi, the two low-resilience case study communities, where they comprised 14 percent of all responses given for alternative reasons for resilience. With respect to the faith and presence of a strong faith-based community, residents in these communities noted the powerful presence of churches in the community, the strong Christian faith of residents, and the specific ability of the local faith-based community to avoid bureaucratic red tape in delivering aid. As discussed previously, faith-based organizations were the most common types of networks that residents belonged to in all four communities; however, with respect to describing community resilience more generally, faith was only specifically cited in Pascagoula and East Biloxi. Also, as previously discussed, subjects from Pascagoula and East Biloxi were more likely to view churches and other places of worship as symbolic and important features in the built environment.

The legacy of hurricanes was mentioned in several interviews (5 percent of total responses for all communities), as all residents had been through previous (albeit less intense) hurricanes and expected that storms would occur. Because of this, residents were familiar with protocols for securing their property, evacuating, and even with rebuilding complications such as dealings with insurance companies after a hurricane.

Interview subjects had moving personal stories of resilience such as civilians rescuing their neighbors from the deadly storm surge flooding and teachers going back to work in outdoor

classrooms with no supplies. Although these experiences were quite extraordinary, the reasons for community resilience given above were typical of those established in the literature.

Results: Reasons for Lack of Resilience

During the interviews, residents also identified many factors contributing to the lack of resilience in their communities. When asked about factors that influenced the resilience of their communities, interview subjects gave a longer list of factors that inhibited resilience versus those that enhanced resilience (71 versus 66). The factors that were most significant included construction codes, various social and economic problems, insurance, and the overall loss of population and employment (Table 27, Figure 27). Other factors included emotional and psychological damage, institutional problems and bureaucracy, location, amount of damage, and fraud.

Table 27: Interview subjects' reasons for lack of resilience

	Waveland	Ocean Springs	Pascagoula	East Biloxi	High-resilience	Low-resilience	Total
Construction requirements	3	4	2	5	7	7	14
Social and economic problems	3	1	2	5	4	7	11
Insurance	3	3	3	1	6	4	10
Loss of population and employment	5	0	1	4	5	5	10
Emotional and psychological damage	4	2	1	1	6	2	8
Institutional problems/bureaucracy	3	0	1	2	3	3	6
Location	2	0	2	0	2	2	4
Amount of damage	2	0	0	1	2	1	3
Fraud	0	0	1	1	0	2	2
Total	25	10	13	20	35	33	68

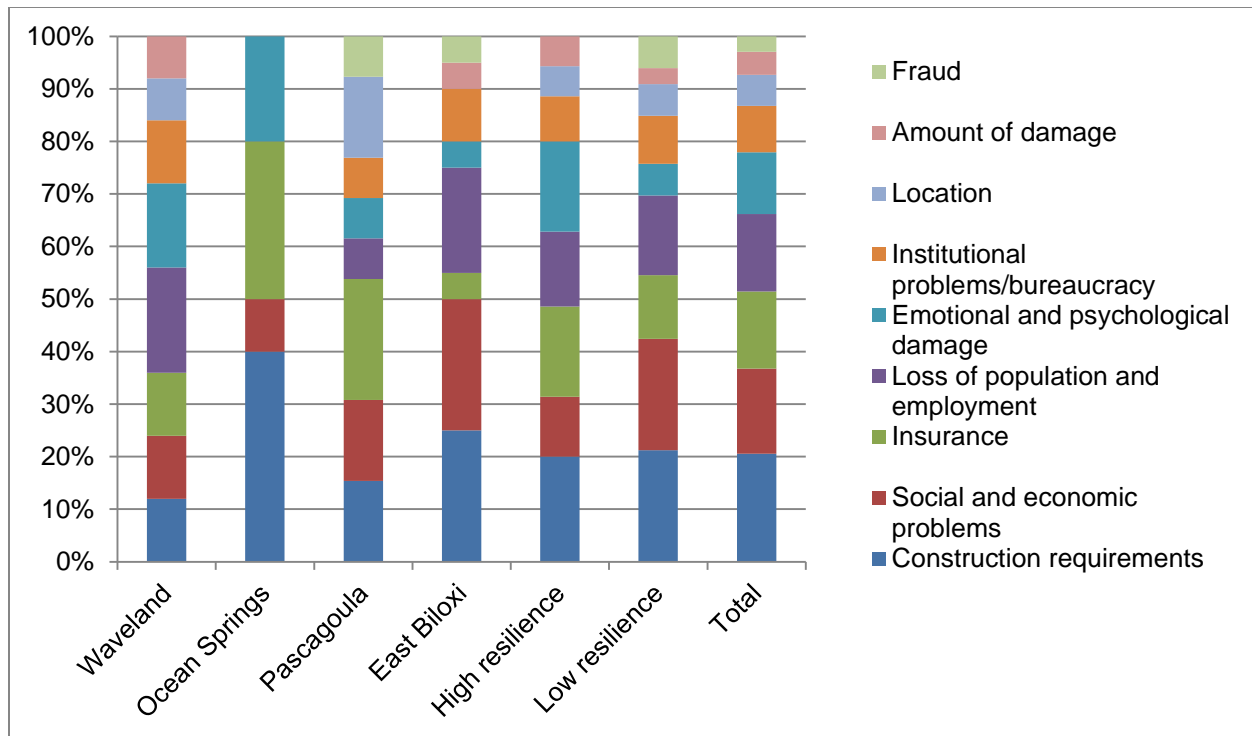


Figure 27: Interview subjects' responses for lack of resilience

Construction requirements were a very common reason for a lack of resilience (21 percent of total responses for all communities), particularly in the return of single-family housing. Since Katrina, building codes have been redrawn, as have FEMA floodplain maps. Building elevations were revised, raising 3 to 8 feet above the levels recommended in pre-Katrina Flood Insurance Rate Maps (FIRMs) in some locations. Local governments adopted the International Building Code for wind and flood requirements and many employed municipal Smart Code ordinances, based on urban design rather than traditional zoning. Although these standards were meant to protect residents, they have made rebuilding cost-prohibitive, particularly for those properties that front the Gulf of Mexico, which suffered the most damage and face the greatest restrictions. Because of this, many residents lack the resources or are overwhelmed by the technical aspects of the new standards and have not rebuilt. Homes that experienced less than 50 percent damage were exempt, and could rebuild their homes as before, generally at a lower cost.

Hurricanes have driven the repeated overhaul of building codes and insurance standards on the Gulf Coast. Hurricanes Audrey (1957) and Betsy (1965) led to modifications in coastal planning, including preservation of an open beachfront with a seawall and artificial sand beach for the public. At this time, the Southern Standard Building Code and Federal Housing Administration (FHA) standards were in use and the informal building elevation standard was 10 feet above sea level (Hearn, 2004). Hurricane-specific standards had not been formalized prior to Camille in 1969, but massive property losses prompted codification. After Camille, a 13.2 foot building elevation standard was adopted. Certain practices meant to protect residents were later ignored, such as in the risky development of casinos and recreational land uses on once-protected beachfront. Reports made after Camille called for future planning to limit exposure and take into account vulnerability of the community, particularly by adopting county- or region-wide hazard mitigation plans (Hearn, 2004). Often, seeking economic development, local governments succumb to pressure from private developers and relax building standards or enforcement in the future. Unfortunately, this type of hubris is often detrimental to disaster mitigation.

Social and economic problems were the second-most cited reason for lack of resilience (16 percent of total responses from all communities). Major problems included property value declines and foreclosures. Other problems included the lack of a social safety net, resulting in the very poor falling through the cracks. Although there were some strong nonprofits specializing in social services, including shelters and food banks, there was a lack of area capacity to meet the needs of the poor. In particular, affordable housing was seen as a weak area. Social and economic problems were more commonly noted in low-resilience communities than high-resilience communities (21 percent versus 11 percent of all responses by respective resilience category) and were highest in East Biloxi (25 percent of responses).

The increased cost of insurance after Katrina was also detrimental to resilience. Therefore, this was one of the top reasons cited for lack of resilience (15 percent of total responses in all communities). Many residents did not have coverage for flood damage, given

that these properties were beyond the pre-Katrina 100-year floodplain. According to research, regardless of risk, many households fail to insure their properties based on short-sighted economic decisions (Kunreuther, 2006). In Mississippi, poor households were improperly insured and had to rely on limited household resources, aid, grants, and loans to rebuild. Furthermore, many homes had not been flooded by Hurricane Camille, and residents were confident that Camille's high-water mark would not be breached in their lifetime. Therefore, many affected households were not insured against the significant flood damage that occurred. Aid was distributed to these properties, including funds from the state development authority. However, since flood maps were redrawn by FEMA post-Katrina, these same properties have seen dramatic increases in insurance premiums and in some cases have been refused insurance. Some residents reported paying four or eight times the pre-Katrina rates in recent interviews. Wind insurance, covered by the state, is an additional cost. The public sector can reduce the burden on residents and businesses by employing a strategy like that of Waveland, Mississippi. Under the FEMA Community Rating System (CRS), Waveland has been classified a Class 5 community, which allows a 25 percent discount on flood insurance for properties. Through the program, communities can earn credits through flood mapping, regulations, preparedness, damage reduction, and public information campaigns in order to receive up to a 45 percent discount on residents' premiums in the highest-risk flood zones. Although recent studies have found the effectiveness of CRS to be uneven (Brody et al., 2009), Waveland appears to be exceptionally committed to the approach, which bodes well for the community.

The loss of population and employment was another often cited reason for a lack of resilience (15 percent of total responses in all communities), particularly in Waveland and East Biloxi (20 percent of responses in both communities). The losses of population acted as a feedback loop wherein households and businesses in the hardest hit areas were less likely to return given the lack of amenities and the high number of vacant properties. There was also increased competition from D'Iberville and other inland communities that fared better and offered more housing options for renters. The lack of grocery stores in the area was particularly

burdensome. In Hancock County, a grocery store did not reopen until 2012. In East Biloxi, some residents remained underserved by a subpar dollar food store and an international market specializing in Vietnamese goods that did not meet the broader needs of the population. Many of the properties left vacant after these losses of population have remained under ownership of former residents unable to sell and unwilling to rebuild. There are few options other than waiting and hoping for growth and a dearth of future hurricanes.

Emotional and psychological trauma was also mentioned as a detriment to resilience in 12 percent of total responses in all communities. Interestingly, these responses were more common in high-resilience communities than low-resilience communities (17 percent versus 6 percent of all responses by respective resilience category). These responses were related to grief from losing friends and family, the fear of hurricanes and related dangers, the confusion of having so much activity going on at once, the feelings of abandonment by the outside world, the loss of property to which residents had a sentimental attachment, the loss of ways of life, and diagnosed and undiagnosed mental health issues in general. Many subjects spoke of the extreme losses experienced by their neighbors. There was a general feeling that, although the entire area experienced loss, one could always find an example of someone much less fortunate.

Institutional problems, particularly systemic bureaucracy, also slowed the recovery and reduced resilience, as cited by 9 percent of total responses in all communities. Aside from paperwork and perceived red tape, a lack of political consensus in certain communities was also cited. Similar issues were shown to be even more pervasive in New Orleans after Katrina, which hampered the collaboration and adaptability that is important in resilience (Olshansky & Johnson, 2010). In Mississippi, one interview subject responded that very few representatives from governmental agencies were on-scene after the disaster. Longer term, some residents felt that planning and recovery efforts did not involve residents. Institutional problems were notably absent in Ocean Springs, which was praised for its leadership and inclusive decision making processes.

Geographic location was cited as an issue preventing resilience in Waveland and Pascagoula, where it arose in two interviews in each community, or in 6 percent of total responses in all communities. For Waveland, the isolation and distance from major highways, which also adds to its sleepy charm, was not convenient in rebuilding and attracting households and businesses. In Pascagoula, like in other communities on the Gulf Coast, homes closest in proximity to the water were not rebuilt and thus the location near the water was a limiting factor for resilience.

Amount of damage was cited in Waveland and East Biloxi and in only 4 percent of total responses in all communities. That this response was confined to these two communities is not surprising given the relatively large amount of damage received in these areas. Specific issues raised that related to amount of damage included the damage to the city core (a counterpart to the response in the previous section, that lack of damage to downtown promoted resilience) and damage to infrastructure. This varied by community, as Ocean Springs experienced minor damage to its central business district and Waveland and East Biloxi were gravely damaged. Infrastructure issues also tended to differ among communities. For example, Waveland has restored basic infrastructure such as roads, sewer, and water, while local advocates have criticized Biloxi for failing to follow through on a water and sewage drainage project in East Biloxi (D. Walker, 2012).

Although fraud only came up in two interviews, in the low-resilience communities of Pascagoula and East Biloxi, it was an unfortunate consequence that warrants mention. Following Katrina, a contingent of criminals posing as contractors offered their services to residents who needed roofing, drywall, or other assistance. According to one interview subject, these individuals tended to prey on the distrust of outside assistance exhibited by poor, ethnic or racial minority, and elderly households. Perpetrators collected payment in advance for services that were never delivered and left town without a trace.

Finally, there were two answers given on the lack of resilience that did not fit in the above categories. First, the lack of media attention, or the bias toward coverage of New Orleans

instead of Mississippi was a source of frustration and noted by one subject as a limiting factor for resilience. Although exceptions exist, including the celebrity-filled Mississippi Rising telethon, residents were aware of the narrative in the media and were discouraged by what they felt was biased or negligent reporting. Stories and images of Mississippi that did emerge were every bit as distressing as those in New Orleans, but received a fraction of the attention. Another issue raised was that, although hurricanes are frequent in the region, there had not been a major storm in many years prior to and after Katrina. One interview subject remarked that this may have made people too comfortable or complacent, leading to a lower rate of evacuation, for example.

Subjects were also asked specifically about vulnerable populations, whether certain demographic or economic groups were less likely to recover. The literature asserts that certain populations are particularly vulnerable to disaster due to living conditions as well as a lack of resources to prepare for and recovery from a devastating event (Cutter et al., 2003; VanZandt et al., 2012). According to interview subjects in Mississippi, Hurricane Katrina was an egalitarian disaster. If anything, the storm disproportionately impacted the wealthy. The most devastated areas were closest to the waterfront, and tended to be expensive real estate. Exceptions existed, including several modest high-rise apartment buildings in East Biloxi that were destroyed. However, many poor and ethnic or racial minority households were situated on higher ground, resulting in less wind and storm surge damage. During the interviews, demographics such as income and race were not seen as major barriers to recovery.

Although other vulnerable populations fared better in Mississippi, residents did note that the disaster was difficult for the elderly. Many were isolated and unable to physically and emotionally cope with the damage to their properties. For some elderly homeowners, taking out a loan for repairs, coordinating contractors, and other necessary steps in the recovery process were unrealistic prospects. Some left to stay with family members, often in other parts of the country, and could not or chose not to return. Many subjects also spoke about elderly neighbors who were totally disconcerted by the loss of life and destruction of landmarks. These subjects

speculated that Katrina escalated existing illnesses or otherwise shortened the lives of many elderly residents.

Discussion of Stage 2 Results

The tenor of these interviews was consistent. Those living in low-resilience communities according to the resilience measure (return of households) actually tended to rate their communities high on a ten-point scale. Some qualified this by rating the residents' resilience very high and the city or city leadership much lower. Examples were given of individual struggles and difficult times, but there was an unwavering belief that the population of the Mississippi Coast had been and would continue to be resilient.

In general, residents indicated strong bonds with people and places in coastal Mississippi. However, the number and type of social networks and types of urban environments tended to differ between high and low-resilience communities. Residents indicated many are better off, having higher quality housing than before and a refreshed community due to city planning and beautification efforts. It must be noted that these improvements were not consolation for the losses incurred, and that others continue to struggle to return to their homes.

The role of the faith-based community and of individual faith in community resilience was more complex than expected. Faith-based groups were the most common social networks that interview subjects engaged with. Churches and other places of worship were also prominent features of the built environment, though more so in the two low-resilience communities. Faith in particular was singled out in these two low-resilience communities as an alternative reason for resilience. Although it is impossible to analyze the residents' levels of faith based on these responses, it would seem that the results indicate that the faith-based community is more prominent in the two low-resilience communities, which may have resulted in a greater reliance on these resources after Katrina. More than anything, this demonstrates the importance of the

faith-based community after disasters, particularly in those populations that are more vulnerable, a point which has often been made (Moore, Linnan, & Benedict, 2004; Patterson et al., 2010).

The issue of internal versus external networks of support was also recurrent in interviews. Residents of high-resilience communities tended to have greater ties to friends, schools, businesses and local nonprofits, or networks with very concentrated local ties. In contrast, residents of low-resilience communities tended to have greater ties to federal, state, university, military, and national or international nonprofits, or networks that are external by nature. This is problematic in part because of the dwindling resources of these organizations. One interview subject directing a nonprofit based in the area stated that there is greater competition for fewer dollars, which resulted in a significant decrease in the local community's ability to take care of those in need. There has also been a dramatic increase in the numbers of people in need and who cannot take care of themselves.

This research suggests that establishing and maintaining strong, redundant, interconnected local networks that interface with external and national groups will improve future resilience. The Mississippi Coast Interfaith Disaster Task Force (MCIDTF), referenced in several interviews, is an excellent example of this strategy in action. Prior to Hurricane Katrina, the MCIDTF had only been activated immediately after a storm. Since Katrina, the organization, which fosters collaboration between public, private, and nonprofit organizations, has remained active, focusing on preparedness and mental health in addition to ongoing recovery. Based on the findings, attention to the needs of elderly residents and other vulnerable populations is necessary, including outreach before and after a disaster. Finally, the results support the notion that a built environment encouraging social gathering, with many amenities and landmark areas, results in personal pride and attachment as well as greater fellowship among residents. Such spaces are already valued by city planners and should be further encouraged as effective resilience planning.

With respect to the built environment, interview subjects were most connected to institutions, commercial establishments and the unique natural features and park spaces available

in the area. Low-resilience communities tended to have greater affinity to churches and other places of worship and high-resilience communities tended to have greater affinity for a wider range of built environment components. Places of worship in Pascagoula and East Biloxi, both low-resilience communities, had a stronger presence. The location of built environment elements that were listed in interviews was concentrated near the districts described as the “heart” or “core” of each community. Although many structures were lost in Katrina, there have been efforts to rebuild in a locally and historically sensitive manner. An example is the new library in East Biloxi (Figure 28). The library was designed to recall late nineteenth and early twentieth century resort hotels from the area, which have almost completely vanished over time due to hurricane damage and economic changes. The library also houses a climate-controlled, hurricane-resistant archive and displays various local artifacts.



Figure 28: East Biloxi Library
Source: Photograph taken by author, July 2012

Interview subjects also identified alternative factors, or factors other than social networks of support, that contributed to resilience. These included

- Factors related to community values and cohesion
 - Culture and spirit of residents (including generosity, volunteerism, a strong family tradition, established roots, pride in their community, and a proactive population that helps one another)
- Factors related to community competence
 - Role of major industries and employers (shipbuilding, casinos)
 - Public participation in recovery
- Factors related to the institutional and local response
 - Political will and leadership
- Factors related to physical infrastructure
 - Relatively small damage to the central business district
- The strong faith of population and strong faith-based organizations

- The tradition of coping with hurricanes

Interview subjects also identified alternative factors that limited resilience. Factors thought to decrease resilience included

- Factors related to construction requirements
 - New building codes
- Factors related to social and economic problems
 - Depleted property values, foreclosures
- Factors related to insurance
- Factors related to loss of population and employment
- Factors related to emotional and psychological damage
 - mass confusion and fear
- Factors related to institutional problems/bureaucracy
- Factors related to location
 - Geographic isolation, proximity to coast
- Large level of damage to entire community
- Fraud

The Stage 2 analysis gave credence to many findings from the Stage 1 analysis and further identified disaster resilience factors. Many of these responses on resilience dovetail with the theories presented in Chapter 2 about disasters, social networks, place attachment, and resilience. Many others, such as tradition of coping with disasters have also been well documented in other fields (Adger et al., 2005). These dichotomous lists suggest a tension between the desire to reestablish a traditional way of life and the need to protect human life and property in advance of future hurricanes. Although Katrina was not a typical disaster and the Mississippi Coast is a small sample, the information provided by interview subjects in the area was detailed and thoughtful and can be applied to other situations.

CHAPTER 7: SYNTHESIS OF STAGE 1 AND STAGE 2 RESULTS

The Stage 1 and Stage 2 results were combined to respond to each research question: 1) does a certain type of built environment result in a more resilient community; 2) how does the effect of the built environment measure against other factors that are significant to social networks; and 3) do built environment properties make communities more conducive to social networking activity that promotes resilience? The three additional research propositions were also reexamined: a) social networks are important factors for resilience; b) social networks interact with and are influenced by the physical environment; and c) communities with the strongest resilience include both strong social networks and varied and integrated physical environments. Below are the relevant findings from both stages of the study that respond to the research questions as well as the additional research propositions.

1) Does a certain type of built environment result in a more resilient community?

With respect to the first question, communities with varied and integrated physical environments were indeed resilient. In the quantitative model, intersection density, net residential density, the density of establishments that support social networking, and the density of historic sites positively impacted resilience.

Intersection density was an important factor in the quantitative model. In interviews, subjects were asked about walkability and proximity of amenities but not specifically about the street configurations of their communities. Streets as significant places came up in ten interviews from Waveland and Pascagoula and pedestrian infrastructure came up in two interviews in Ocean Springs. The overall perception in Ocean Springs was that this area, which was by far the most resilient, is the most pedestrian friendly. According to the data, it is also the most compact in terms of intersection density, with a density of almost 80 intersections per square kilometer versus about 50 intersections per square kilometer in Pascagoula and East Biloxi and only 7 intersections per square kilometer in Waveland. Intersection density and

walkability were less important than other factors, but were significant for resilience in both the quantitative and qualitative portions of the analysis.

Net residential density was also a significant factor in the model and housing was mentioned in many interviews. In the model, net residential density positively influenced resilience along with percent renter-occupied multifamily housing. Median housing value also had a positive impact on resilience. Despite this, multifamily housing was an issue for many interviewees. In East Biloxi and Waveland in particular, the lack of affordable multifamily housing was considered an issue before and after Katrina. When calculating resilience based on occupied housing units, it was clear that the loss of a few very high-density structures skewed the results. Although some of these units have been replaced, these particular structures were not rebuilt or restored. It is typical in the area to build multifamily housing very near the shore, which would seem to create a more vulnerable situation for residents. These types of developments are more likely to be severely damaged and not rebuilt; therefore a large population is potentially displaced by each major storm. Post-Katrina comprehensive plans have begun to reconcile the need for affordable and workforce housing with the need to mitigate vulnerability. For example, Biloxi's Flood Damage Prevention Ordinance is specifically referenced in the high-density residential guidelines of its comprehensive plan (Beckman, Rouse, O'Neill, & Kim, 2009).

Historic site density positively impacted resilience in the quantitative model and historic sites were considered important for some residents in interviews. The loss of old family homes and former landmarks (such as Pascagoula's Round Island lighthouse) was upsetting to these subjects. However, the predominant attitude about historic sites was that hurricanes and other historic events (including the Civil War) have produced enormous changes to the landscape and change is part of the way of life in the area. One of the most high profile sites damaged by Katrina was Beauvoir in Biloxi, a home that the Confederate president Jefferson Davis lived in after the war until the end of his life. Using federal, state, and private funds, Beauvoir was restored and reopened as a museum and library. In Ocean Springs, the 1890 Charnley-Norwood

cottage designed by Louis Sullivan and Frank Lloyd Wright, which sat next door to Sullivan's summer cottage before Sullivan's own cottage was destroyed by Katrina, was still undergoing laborious reconstruction in 2012. The modest, late nineteenth-century home of French Creole former slave Pleasant Reed was also rebuilt and relocated to the Ohr-O'Keefe museum campus after being badly damaged by Katrina. To the population of the Mississippi Coast, there were certain landmarks worth saving, including these three historic homes and the Round Island lighthouse, which has been relocated to the mainland in Pascagoula where it will be pieced back together brick by brick. The presence of historic sites was an important factor for resilience in the Stage 1 analysis, and preserving sites that are most significant to the culture and history of the area seemed to be a priority. This is not surprising given the level of attachment to place seen in the interview process. Although each of these restored structures will be vulnerable to the next storm, residents deemed it important to dedicate funds for the preservation of high priority historic sites. Given that residents returned at a greater level in communities with a greater density of historic sites, this has the potential to increase future resilience.

Density of social networking organizations also positively influenced resilience. The establishments that support social networking included eating and drinking places, book stores, sporting and recreational camps, recreational vehicle parks and campsites, beauty shops and barbers, motion picture theaters, video tape rental, amusement and recreation services, museums, art galleries, botanical and zoological gardens, educational services, social services, membership organizations, and religious organizations. Among these categories, eating and drinking places and religious organizations were cited most often in interviews. All other categories – sporting and recreational camps, recreational vehicle parks and campsites, beauty shops and barbers, motion picture theaters, amusement and recreation services, museums, art galleries, botanical and zoological gardens, educational services, social services, and membership organizations – were also mentioned in at least one interview.

Land use mix was not a significant factor in the quantitative model but was explored in greater depth in the qualitative stage of the research. In interviews, subjects were asked about

the proximity of amenities within a short distance in their communities. The overall perception in Ocean Springs was that this area, which was by far the most resilient of the Stage 2 case study communities, had the greatest diversity of land uses within a short or walkable distance. In contrast, interview subjects stated that East Biloxi, which has been much less resilient post-Katrina, suffered from a lack of amenities such as retail and restaurants.

Although parks had a negative influence on resilience in the quantitative model, the presence of parks was clearly important to interview subjects. Parks in general were the most often cited built environment feature that was important and symbolic to residents among all total interview responses. Furthermore, parks of all kinds were used as a gathering place for social networks. Ball fields, playgrounds, and neighborhood parks were the most common types of park spaces used for gathering; however, the area has a wide variety of parks, such as neighborhood parks, state parks with camping facilities, and an historic national seashore park. The parks and open spaces in the area highlight the natural features and contribute to the livability of the area. Immediately after the storm, parks were one type of area used as a distribution point (for example, the Jackson County Fairgrounds in Pascagoula was a drop point for the National Guard).

Of course, many parks and natural features were affected by the storm. Countless trees were felled, barrier islands were inundated, and inland waterways were impacted by the storm surge. After Katrina, city government along with nonprofit groups such as KaBOOM!, the Salvation Army, and the Kroc Center made park and recreation space a priority in rebuilding. However, in 2010, the BP oil spill catastrophe further degraded the area's natural resources. Contrary to the results of the quantitative analysis, the qualitative analysis bore out the importance of parks in community resilience.

Retail services, municipal government facilities, housing, and districts such as downtown core areas were not included in the quantitative model but proved to be important for residents in interviews. Comments on retail centered on the importance of grocery stores and other staples for returning to normalcy. Municipal government facilities such as city hall and fire stations

were commonly pointed to as examples of major post-Katrina improvements. Using federal aid, many communities received new state-of-the-art facilities that greatly improved on past conditions. For example, Pascagoula gained a well-appointed county services center that unified all services in a “one-stop shop.” Significantly, in interviews, subjects spoke of downtown core areas as the “heart” of their community and as features crucial to resilience. The core districts were Coleman Avenue in Waveland, Washington and Government Streets in Ocean Springs, Pascagoula Street and Jackson Avenue in Pascagoula, and the Vieux Marche in East Biloxi. Comments were also made about the relative amount of damage to the core. Communities that sustained major damage to the core were considered less resilient by subjects. Ocean Springs was seen as more resilient and Waveland was seen as less resilient by interview subjects due to the amount of damage sustained downtown.

Residents of each low-resilience community, Pascagoula and East Biloxi, commented on changes that were made to the downtown areas of these cities in the 1970s to compete with area malls. In both cities, the core downtown shopping district was redesigned with narrowed streets and an awning or enclosure in order to emulate the mall experience. Although some of these trappings were eventually removed, the narrowed streets have remained. Both Delmas Avenue in Pascagoula and parts of Howard Avenue in East Biloxi still resemble alleys more than streets, with one lane flanked by angled parking spaces and sidewalks that are sufficiently wide but unpleasant for pedestrians due to the bulky parking areas, the vacant storefronts, and the lack of street life. Interview subjects found these urban renewal projects ill-conceived and damaging to the original character of downtown. Given the number and nature of statements made about each community’s downtown core, central business districts were certainly seen as important for resilience by interview subjects. There were no specific metrics of this in the quantitative analysis, although higher density and greater land use mix are associated with the core of an urban area.

East Biloxi has a unique built environment among the case study communities, as there are several casinos only a short distance from the study area boundaries (Figure 29). In some

ways the casinos are very separate from the community. Casino guests are encouraged to stay on the grounds, spending their money in casino shops rather than other local shops. Although casinos employ locals from the region, the relatively disadvantaged East Biloxi population is not the typical employment base. Therefore these imposing casinos flank the peninsula on which East Biloxi is situated but do not factor in the daily life of residents. Of the 12 percent in taxes casinos pay, 3.2 percent stays in the community for the city general fund and city and county public safety and school systems. In fiscal year 2012, this amounted to \$7.7 million to Harrison County and \$18.8 million to the city of Biloxi out of \$827 million in total casino revenue ("Gaming revenue," 2012).



Figure 29: Contrast between local facilities (Fleur de Lis French club, left) and casinos (Palace Casino, right)
Source: Photograph taken by author, July 2012

Some built environment factors were more significant than other variables that impact resilience, including the intervening and control variables (socio-demographic data, amount of damage). These included the same variables mentioned above – intersection density, net residential density, the presence of establishments that support social networking, and historic site density.

The intervening and control variables had varying levels of explanatory power. These results were largely validated by the interview process. For example, some lower income households, which are generally considered less resilient in studies conducted of resilience, fared better than wealthier households in many parts of the Gulf Coast because of the patterns of development in the area, thus income had almost no effect on resilience. Lower income households generally cannot afford expensive waterfront real estate, either on the Gulf of Mexico or inland waterways such as the Bay of Biloxi or Bay St Louis. These households tend to live inland and on higher ground and therefore were less vulnerable to storm surge flooding. Of course, some low-income housing was badly damaged, but interview subjects did not view the damage as more detrimental to populations that are viewed as socially vulnerable, with the exception of elderly populations. The percentage of households that are multifamily and renter-occupied had a positive impact on resilience in the Stage 1 model, although interview subjects mentioned that areas with higher proportions of renters have not rebuilt as readily.

Amount of damage and amount of aid were also included as intervening variables in the Stage 1 model and both significantly affected resilience. Both damage and aid received had a pronounced negative effect on resilience. Although amount of damage was seen as an important factor in resilience in interviews, amount of aid received by local area was not a factor. Certain interview subjects compared the amount of aid received in New Orleans to that received in Mississippi, but not among communities or households in Mississippi. The aid that was available to individual households was either dispensed door-to-door (for example, Salvation Army meal trucks), by waiting in a queue (for example, the Red Cross distribution points), or was prioritized using a door-to-door assessment process favored by many churches. Comments

were occasionally made about individuals that “hoarded” supplies, but in general residents believed that most were able to get what they needed from a variety of sources and that no subset of the population was privileged more than others in terms of external aid in the wake of the storm.

The control variables in the Stage 1 model – change in occupied housing units per acre in the previous decade of 1990 to 2000 and occupied housing units per acre in 2000 – each had a negative impact on resilience. Or, areas that were high-growth tended to reverse trajectory after Katrina and strong clusters existed in a nonrandom pattern.

In summary, four built environment variables had a significant positive impact on resilience in the model greater than the impact of many intervening variables. Aside from the two control variables, percent of damage, amount of aid, and the presence of parks had the greatest negative impact on resilience overall and percent of the population living in the area in 1995 had the greatest positive impact on resilience. The four built environment variables of intersection density, net residential density, social networking establishment density, and historic site density had a positive impact on resilience and were seen as important characteristics with respect to resilience in the interviews.

2) Do those properties of the built environment make communities more conducive to social networking activity?

With respect to the second question, the above qualities of the built environment that were associated with greater resilience (intersection density, net residential density, social networking establishment density, and historic site density) were noted by interview subjects to particularly impact social networks or to support social networks.

Subjects were asked about amenities in a short walking or driving distance in order to gauge certain properties of the built environment that are conducive to social networking, such as intersection density, land use mix, and the presence of parks. Interview subjects in Waveland, Pascagoula, and East Biloxi did feel that there were some amenities within a short distance, in

particular parks, beaches, schools. Subjects in these communities felt certain other types of amenities were lacking, in particular grocery stores in Waveland and Biloxi and restaurants in Pascagoula. Residents of Ocean Springs felt unanimously that the area has almost all the amenities within a short distance that they desire. Only a few exceptions, including the lack of a community college or other center of higher learning, were mentioned in interviews in Ocean Springs. Ocean Springs was the most resilient community in Mississippi to emerge after Katrina. This may have been in part due to the diversity and number of amenities such as parks, schools, and commercial establishments. Perhaps because of these positive aspects of the community, more households chose to return despite damage in the residential areas and particularly in beachfront properties. Whereas many of these properties remained vacant in Waveland and Pascagoula, beachfront properties in Ocean Springs were occupied at a higher rate.

The importance of those types of establishments that are conducive to social networking was a phenomenon often described in interviews. Sites mentioned by interview subjects that were used for social networking activity included restaurants, community centers, and specific kinds of commercial establishments, which were all included in the list of social networking establishments. For example, in East Biloxi, among the first businesses restored were a beauty salon and a barber shop, as these had been important spaces for gathering prior to Katrina. A local aid group set out specifically to rebuild these establishments in order to allow a sense of community and normalcy to be restored.

Various types of parks, beaches, and historic sites were also singled out as spaces for convening with social networks. The ample public amenities on the coast provided recreational opportunities for all residents, regardless of socioeconomic status. Before and after Katrina, interview subjects noted that parks and beaches were commonly used for family reunions and other social events, recreational fishing, and for both organized sports and pickup games. Furthermore, the piers, docks, and open waters were used for subsistence and commercial fishing, an important source of food or income for many households. In East Biloxi, the shrimp

boat docks on the Back Bay were noted as an important location for Vietnamese shrimp boat fisherman to socialize between hauls.

3) How does the effect of the built environment measure against other factors that are significant in forming robust social networks?

With respect to the third question, social networks noted in interviews were not tied to the built environment, but were supported by it. Over one fifth of all social networks that interview subjects relied on were faith-based organizations, which organize around a built environment element, a church or other place of worship. Many other organizations similarly exist because of an institution, such as schools, local nonprofits, municipal government, and businesses.

However, friend and family relationships are impacted less directly by the built environment. Friends and family made up 11 percent of all social networks that interview subjects relied on. Although this was a relatively small percentage, these relationships were tremendously important in providing emotional and financial support after Katrina.

In addition to the built environment, many social networks in the area are impacted by demographics. Particularly in East Biloxi, the communities of immigrants or ethnic groups such as Vietnamese, Croatian and Slavonian, and Acadian French have formed strong networks that persist even as younger generations are increasingly removed from the original culture. An established African American population is yet another demographically configured network in East Biloxi and other communities.

The Gulf Coast's diverse culture is supported by local clubs such as the Krewe of Nereids in Waveland, which is responsible for a Mardi Gras parade. This social network is tied to tradition rather than the built environment. Despite a very small Cajun population (about 650 persons in all three coastal Mississippi counties in 2000 according to the U.S. Census), Mardi Gras, Fais Do-Do, and other Cajun and Creole traditions reinforce a strong local culture, which in turn undergirds the unique sense of place and social networks in the area. The stability of the population over generations, more pronounced in residential areas like East Biloxi than in upstart

and tourist-oriented communities, also supports the Gulf Coast culture and contributes to strong local social networks as well. Population stability was also found to have a positive impact on resilience in the Stage 1 model.

Many networks in which residents belonged or that responded after Katrina originated outside the region but had local ties in the area. These national and even international social networks tended to consist of weaker ties (i.e., ties between individuals that spoke or met infrequently). However, it has been well documented that such ties are quite powerful in mobilizing resources by reaching a greater number of people (Granovetter, 1973). Weak ties are commonly formed through formal organizations and work settings, which is consistent with the types of ties mentioned in interviews. Examples from interview subjects include former classmates, military cohorts, and associates from professional organizations.

Social networks and cohesion can also be impacted by trust in leadership. In Waveland and East Biloxi, lack of trust in leadership was an issue for certain interview subjects. In contrast, interview subjects from Ocean Springs trusted and admired their local leadership. Interview subjects from Pascagoula did not discuss leadership. In Waveland in particular, the lack of reliable leadership impacted the ability of formal networks of support to mobilize and collaborate. For example, agencies and organizations that focused on affordable housing tended to work in isolation due to competition for limited resources. Few organizations met or communicated regularly, which could be changed through increased opportunities for meeting and forming coalitions, a role that city and county leadership could fill.

Additional Research Propositions

Three additional research propositions were also examined in Stage 2. First, it was determined through the Stage 2 analysis that social networks are important factors for resilience. Although questions focused on social networks in general, interview subjects invariably spoke of the social networks that were most important for surviving and recovering from Katrina without prompting. More than any other factor, social networks were found to be important for

resilience. Common and simple ways of expressing this included “neighbors helping neighbors” or “people coming together” after Katrina. Other factors given by interview subjects for resilience were strongly related to social networks, such as the qualities of community spirit and commitment to family noted in the area.

Second, social networks were found to interact with and were influenced by the physical environment. Formal social networks tended to be influenced by the physical environment through virtue of having offices or other bases of operations. These included churches, schools, and local nonprofits. Informal social networks were also influenced by the physical environment, supported by parks, schools, restaurants, and gathering places such as restaurants and community centers. Cultural institutions, such as the Ohr-O’Keefe Museum in East Biloxi and the Mary C. O’Keefe Cultural Center in Ocean Springs were important to many interview subjects, although more so with higher-income residents. Historically, the Gulf Coast has inspired many local artists, such as the potter George Ohr and the painter Walter Inglis Anderson. Galleries in Bay St Louis, Ocean Springs, and Biloxi continue to foster local artists. Institutions, galleries, and public art are features of the built environment that support a unique sense of community.

Third, communities with the strongest resilience include both strong social networks and varied and integrated physical environments. The community that was the most resilient was Ocean Springs, which indeed had both strong social networks and the most varied and integrated built environment. Of the four communities, Ocean Springs was the only one in which all interview subjects stated that a wide array of amenities such as parks, schools, shopping, and community facilities existed within a short walk or drive. The community was praised for its walkability, its sense of community, its diverse shopping and restaurant options, and the redeveloped waterfront parks. Residents in the area were very engaged in the rebuilding process, through well-attended charettes. As in the other case study communities, faith-based organizations were the most common social networks in which residents were engaged, although

various other types of formal and informal networks were also mentioned. These tended to be more locally rooted than in less resilient communities.

CHAPTER 8: EXAMINATION OF POST-KATRINA COMPREHENSIVE PLANS

During the interviews, local planning activities and processes were a common topic. Some found the process in their community inclusive and felt great pride in plans and implemented projects. These comments came primarily from residents of Ocean Springs. Others, particularly residents of East Biloxi, thought their community had excluded entire segments of the population and had focused on the wrong types of projects (such as beautification instead of social services). In order to analyze and compare the decisions communities made in rebuilding after Katrina in a more objective manner and to determine to what extent they promote resilience based on the above findings, the comprehensive plans of each case study were examined.

For some study area communities, multiple planning documents were produced after Katrina. For example, rebuilding plans were created by the governor's Mississippi Renewal Forum, the Congress for New Urbanism (CNU), the American Planning Association-American Institute of Certified Planners Planning Assistance Team, the Gulf Coast Community Design Studio (GCCDS) of Mississippi State University's College of Architecture, and other nonprofit organizations (such as community development corporations). Because these plans differed in scope and in intent, only the adopted comprehensive plans for each of the four case study communities were examined for consistency. Mississippi state statute section 17-1-1 requires that each municipality have a long range comprehensive plan adopted by the local governing body. Plans include goals over a 20 to 25 year period of development and are required to address (at a minimum) residential, commercial and industrial development; parks, open space and recreation; street and road improvements; and public schools and community facilities. In order to capture the most significant interests and values, the overarching goals of each plan were compared and analyzed. All plans included a vision statement, which were also compared.

Excerpts from each plan, including goals and vision statements in their entirety, can be found in Appendix D.

Comprehensive plans were acquired for Biloxi (Beckman et al., 2009), Pascagoula (Pascagoula Comprehensive Plan, 2010), Ocean Springs (Peshoff & Humphrey, 2010), and Hancock County (Hancock County Plan, 2010). East Biloxi fell under the Biloxi comprehensive plan, although a separate 19-page section was devoted to East Biloxi, which is one of four designated neighborhood planning areas in Biloxi along with West Biloxi, North Biloxi, and Woolmarket. Waveland also fell under the plan of the larger geographic area of Hancock County. The Pascagoula, Ocean Springs, and Hancock County plans were adopted in 2010 and the Biloxi plan was adopted in 2009. The plans were drafted by city staff and consulting firms. In Biloxi, four city departments and boards, a citizen council, and three consulting firms are listed on the credits page. Ocean Springs listed one consulting firm and five city departments and boards. Hancock County listed one consulting firm. Pascagoula's 2009 plan does not have a credits page, although a similar 2006 Pascagoula plan credits six city departments and boards, a citizen committee, and one consulting firm.

The comprehensive plans created after Katrina in the four case study communities encompass many of the resilience factors included in this analysis. These include such projects as increasing street network connections in Ocean Springs and creating a "town center" around the casinos in East Biloxi. Plans varied in robustness in certain areas, but overall each displayed a commitment to creating a varied and integrated built environment as well as a socially equitable community.

When the stated goals of each plan were compared, there were several elements that were common to more than one community (Table 28). The number of goals in each community varied, with ten in Biloxi, 52 in Pascagoula, six in Ocean Springs, and 22 in Hancock County. Those plans with fewer stated goals tended to include high-level and comprehensive goals (e.g. "Promote a Healthy, diversified, and sustainable economy that provides a strong tax base, needed goods and services, and employment opportunities for Biloxi's residents") and those plans with a

greater number of goals tended to list more specific types of activities (e.g. “A local airport with minimal off-site impacts” in Pascagoula). The full text of these goals and the vision statements can be found in Appendix D.

Table 28: Elements found in goals of plans

	Hancock County (Waveland)	Ocean Springs	Pascagoula	Biloxi (East Biloxi)
Natural resources	x	x	x	x
Diverse housing	x	x	x	x
Business development/employment	x	x	x	x
City services	x	x	x	x
Diverse transportation options	x	x	x	x
Historic and cultural resources	x	x	x	x
Protecting residents/reducing vulnerability	x	x	x	x
Design and character	x	x	x	x
Coastal and riparian resources	x	x	x	
Parks	x	x	x	
Growth management	x	x		x
Downtown		x	x	
Regionalism	x		x	
Community building			x	
Public participation			x	
Tourism	x			

Table 29 includes items found in vision statements for each case study community, including most of the categories from Table 28.

Table 29: Elements found in vision statements of plans

	Hancock County (Waveland)	Ocean Springs	Pascagoula	Biloxi (East Biloxi)
Natural resources	x	x	x	x
Diverse housing	x		x	
Business development/employment	x	x	x	x
City services			x	
Diverse transportation options		x	x	
Historic and cultural resources	x	x		x
Protecting residents/reducing vulnerability	x		x	x
Design and character		x		x
Coastal and riparian resources	x	x		
Parks			x	
Regionalism			x	
Community building	x		x	x
Public participation			x	
Tourism				x
Future generations			x	
Resilience				x
Low-income populations			x	x

In terms of the elements found in plan goals, natural resources, business development, diverse housing, diverse transportation options, and city services were included in all four plans. Protection of natural resources and business development and employment opportunities were the only elements found in all four vision statements. Diverse housing and diverse transportation options were found in two vision statements and city services in one vision statement. Given the state mandate to include open space, housing, economic development, municipal facilities, and transportation, in local comprehensive plans, the inclusion in all four communities' goals is to be expected and is a direct example of plan conformity to state-level planning (Deyle et al., 2008).

Protecting and supporting historic and cultural resources was found in the goals of all four plans and the vision statements of three communities. Historic site density had a positive impact on resilience in the Stage 1 analysis and the importance of high-priority historic and cultural sites was noteworthy in the Stage 2 interviews. The importance of historic resources to the community is adequately reflected in the comprehensive plans.

Protecting citizens and reducing vulnerability of households was found in all four communities as well as the vision statements of three communities. In Waveland, the focus was on public safety and emergency response, and in Ocean Springs, the focus was on mitigation by understanding risks. In general, the plans did not focus on disaster protection. The concept of resilience was not included in the plans of Ocean Springs and Pascagoula and only infrastructure resilience was mentioned in Waveland (as it pertained to water and wastewater systems). In contrast, the plan for Biloxi uses the term “resilient” or “resilience” in 35 places, in describing the population, the vision, and the natural and built environment of the area. Although not part of the goals section of the plan, fostering resilience was present throughout the Biloxi plan in sub-sections of the document. Given the problems associated with vulnerable populations uncovered during interviews, citizen protection is necessary; however, the plans lack rigor in identifying and supporting the most vulnerable populations, such as functional needs and elderly households.

Design and character were also included in the goals of all four communities and the vision statements of two plans. This included statements such as retaining the character, specifically the “small town character,” “historic character,” or the “distinct character” of existing spaces and promoting high-quality design. Although such elements were not quantified in the Stage 1 model, the unique character of the region was an important aspect of resilience noted in interviews, particularly in Ocean Springs. Fostering and maintaining these qualities are therefore likely to improve resilience.

Coastal and riparian protection was included in the goals of Pascagoula, Ocean Springs, and Hancock County and the vision statements of Ocean Springs and Hancock County. Although protection of natural resources was included in the goals of all communities, water resources in particular were also mentioned in these communities. Many area industries and coastal residents are reliant on these resources. The coast and inland waters are also commonly used for recreation and are an asset for the tourism industry, according to interview subjects. The area’s hydrologic features are incredibly important to the vitality of the area. Katrina and

the 2010 BP oil spill demonstrated the dramatic impact that interruptions in the seafood and tourism industries have on economic and social conditions in the area.

Parks were included in the goals of Pascagoula, Ocean Springs, and Hancock County and in the vision statement of Pascagoula. The presence of parks actually negatively impacted resilience in the Stage 1 analysis but was found to be an important factor for resilience and social networking in Stage 2. Ocean Springs and Hancock County stated in their plans the more specific goal to provide parks that meet the needs of all residents. Parks that are not functional or inclusive were found to be almost detrimental to vitality and resilience during the interview process. The goal of providing parks that specifically meet the needs of residents is beneficial for resilience.

Growth management was included in the goals of Biloxi, Ocean Springs, and Hancock County but was not included in any of the vision statements. Intersection and residential density each had a positive impact on resilience in the Stage 1 model. However, previous growth (from 1990 to 2000) had a negative impact on resilience. Based on this, it would seem that development should be of an appropriate density and sited properly. Therefore, strong growth management is likely to improve resilience. Growth management in tandem with hazard mitigation is also critical in protecting the region from the next hurricane, particularly in preventing over-development of flood-prone areas. In addition to growth management strategies, Hancock County and Ocean Springs also adopted form-based codes to develop standards for intensity and character in disparate zones.

Creating a vibrant downtown or business center was included in the goals of Pascagoula and Ocean Springs but was not included in any of the vision statements. A strong core or central business district was seen as an advantage to resilience in the interviews. The downtown area of Waveland was the most devastated of the four case study communities after Katrina. However, Hancock County's plan only briefly outlined provisions to preserve the downtown. Biloxi's downtown area has been in decline since at least the 1970s. Although not in the goals and visions, Biloxi's comprehensive plan devotes a full chapter to reestablishing downtown. Given

the importance of downtown districts for social networking and for resilience, retaining a strong business district is important to each community and, if implemented effectively, will have positive effects on resilience.

Regionalism was included in the plans of Waveland and Ocean Springs, the two communities with the smallest population, as well as Pascagoula. Regionalism was also found in the vision statement of Pascagoula. Waveland and neighboring Bay St Louis are the largest cities in Hancock County, a fairly isolated region, and after Katrina have merged some services, such as the school district. Ocean Springs recognized the need to consider a similar strategy of regional infrastructure provision and development decisions with other providers to increase efficiency and maximize investments. Ocean Springs is located near communities with more suburban patterns of growth, including Gulf Hills to the north. In its plan, Ocean Springs demonstrates the need to coordinate with Harrison County and surrounding communities to preserve the character of the community and the natural resources of the area. Regionalism was surprisingly absent from the plan of Biloxi, perhaps because it is a more established and self-sufficient population and employment center. Despite this, regional coordination should be a part of any resilience strategy in order to ensure that any one city or neighborhood is not overly vulnerable or lacking resources to recover from a disaster. Stronger formal ties between communities in the region can only improve social networks by adding redundancies. As stated by one interview subject, a community is only as resilient as its weakest link, which was apparent in communities like East Biloxi following Katrina.

Community building was found in the goals of the plan of Pascagoula. Biloxi, Ocean Springs, and Hancock County did not specifically mention community building as a goal, although other goals were related such as community viability. Community building was included in the vision statements of Biloxi, Pascagoula, and Hancock County. Community building is most evocative of creating formal and informal social networks. Comprehensive plans tend to focus on physical development; however, the plans of Pascagoula and Ocean Springs acknowledged the importance of fostering livable neighborhoods that illicit pride and

neighborliness. Sense of community was an extremely important factor for resilience based on Stage 2 interviews. The inclusion of community building in several plans is beneficial to creating future resilience through stronger social networks.

Public participation was included in the goals and vision statement of Pascagoula but not in the plans of the three other case study communities. This is unfortunate, as public participation could produce creative ideas for the community, increase trust and transparency in the planning process, improve community buy-in, and build formal and informal social networks. Participation by local interest groups increases the impact of plans and levels of commitment in elected officials (Burby & May, 1998). The most effective projects post-Katrina were the result of inclusive planning, such as the parks designed through public charettes in Ocean Springs. Less effective projects post-Katrina were often perceived to come about through a closed planning process that neglected community needs, such as elaborate boat ramps that were not useful for the many residents without boats. Given the influence of the built environment on social networks, an exclusive planning process could lead to decisions that disrupt important neighborhood ties. Improving public participation was lacking in plans (which address the built environment) and is a serious concern for future resilience.

Tourism was included in the goals of Waveland as part of its economic development strategy. The stated goals included natural resources and cultural tourism as well as gaming and “high-tech” attractions. Waveland’s tourism was particularly hard-hit, perhaps because it lacked the large-scale hotels and casinos that had the resources to quickly rebuild. The city also seemed to have a higher percentage of summer homes than other case study communities. Historically, Waveland’s summer population came via train from New Orleans. With many beachfront homes razed and properties still vacant seven years after Katrina, much of the summer population appears to have abandoned the area. Creating new tourism opportunities is important for the area economy. In Biloxi, with its numerous casinos and attractions, tourism was included in the vision statement. Ocean Springs and Pascagoula are notably short of hotel space and, although they welcome the tourists that visit, these areas have not relied as heavily on revenue from

tourists beyond day-trippers. Although the communities should move away from reliance on tourism dollars alone, many projects would also benefit local resilience, such as creation of additional recreational features, restaurants, and other built environment features that foster social networks.

Three additional categories were found in vision statements that were not featured in plan goals, but are noteworthy for resilience. First, the needs of low-income communities were included in the vision statements Pascagoula and Biloxi. Providing for future generations was found in one vision statement (Pascagoula) and future resilience was also found in one vision statement (Biloxi). These items are evincive of the need to increase resilience in the two low-resilience communities through providing future resources, particularly for socially vulnerable populations.

Based on the comprehensive planning documents produced after Katrina in the four case study communities, the region understands many of its present strengths and weaknesses with respect to disaster resilience and has outlined a strategy to mitigate damage, reduce vulnerability, and create support networks to speed up recovery for a future disaster of the scale of Katrina. Like any plan, how and to what extent these ideals are implemented is a concern. Several projects have been completed, such as the new libraries in Waveland and East Biloxi and beachfront improvements in all four communities. Other projects are in progress, such as planned mixed-use riverfront development to augment downtown Pascagoula. During the Stage 2 interviews, recurring concerns were public participation and, at the least, attention to the needs of residents in the planning process.

CHAPTER 9: SUMMARY AND PLANNING IMPLICATIONS

The results of this research provided generalizable recommendations for planning interventions in the physical and social domains that would improve disaster resilience. Based on the information gathered from the Stage 1 quantitative model and from Stage 2 interviews, specific variables measuring physical attributes of communities explained some of the difference in ability to recover among communities on the Mississippi Coast.

Intersection density, net residential density, the density of establishments that support social networking, and the density of historic sites positively impacted resilience in the Stage 1 model and were seen as important characteristics with respect to resilience by Stage 2 interview subjects. These four built environment variables had a significant positive impact on resilience in the Stage 1 model, greater than the impact of many intervening variables. The presence of parks was insignificant in the Stage 1 model but was important for social networking and resilience in the Stage 2 interviews. Control variables measuring previous growth in housing density and initial housing density, percent of damage, amount of aid, and the presence of parks had the greatest negative impact on resilience overall and percent of the population living in the area in 1995 had the greatest positive impact on resilience of the intervening variables in the Stage 1 model.

The findings of this study have important implications for disaster vulnerable communities. Communities can develop design and planning strategies to create a built environment that enhances social networks. In fact, since Katrina, the four Stage 2 case study communities have drafted comprehensive plans and implemented projects that this research suggests will strengthen social networks and improve resilience.

Conceptual Model Revisited

The results also largely validate the conceptual model used to inform the research design. Overall, the relationships between the phenomena depicted in the conceptual model were shown to align with the findings from the Stage 1 and Stage 2 analyses. Returning to the conceptual

model found in Figure 7 (a simplified version is found in Figure 30), many findings were consistent with the established and hypothesized causal relationships in the model. The link between social networks and resilience was strongly supported by the interviews, although the link between the built environment and resilience yielded slightly different results in the quantitative model (intersection density had a strong positive impact on resilience; however, the presence of parks had a weak negative impact on resilience). Taken together, Stage 1 and Stage 2 results clarified the relationships in the conceptual model. All relationships shown in the model held true, although the quantitative findings related to individual built environment and intervening socio-demographic variables were less consistent. Those specific findings in the Stage 1 quantitative analysis that were inconsistent with the model are discussed individually below.

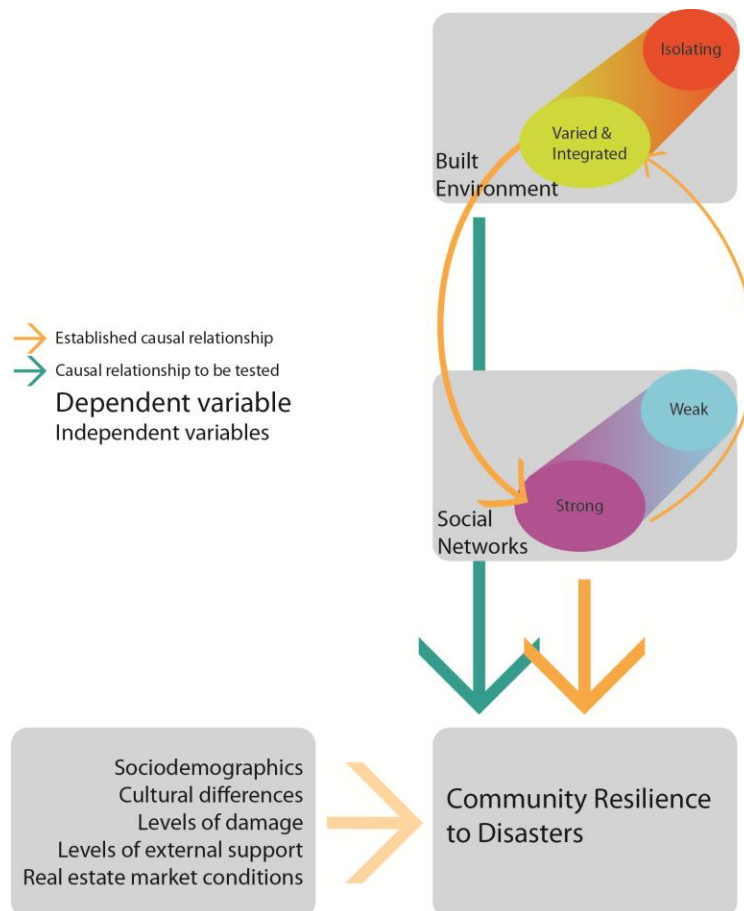


Figure 30: Simplified conceptual model

The notion that social networks support resilience was substantiated by the research. As noted previously in the literature in Chapter 2, social networks improve physical, psychological, social, and financial well-being (Aday, 1994; Ben-Porath, 1980; Berkman et al., 2000), all of which improve household or individual resilience and support after a disaster. During interviews, residents noted the same types of advantages from their own formal and informal social networks prior to and after Katrina. In addition to these benefits indirectly related to disaster resilience, social networks transfer knowledge and resources and can be directly leveraged during disaster recovery. For example, because of prior relationships, one resident welcomed her neighbors to use her functioning washer and dryer and was given other items such as paper products in gratitude rather than repayment. This type of reciprocity based on mutual needs has been well documented in the males living in a poor, inner-city African American community in Washington, D.C. (Liebow, 2003); in poor African American females in the Midwest (Stack, 1979); and in Italian-American slums in Boston (Gans, 1962). The use of social networks as an informal marketplace is a well-documented manifestation of human self-preservation, including after disasters, when supply and demand interruptions wreak havoc on the economy.

The effect of the built environment on social networks shown in the conceptual model was also demonstrated by the research. Indeed, more varied and integrated neighborhoods were shown to increase social activity in the Stage 2 interviews. These neighborhoods possessed characteristics shown to support social networks in the literature, such as varied land uses and pedestrian-oriented design (Leyden, 2003). Built environment features such as places of worship, commercial centers, historic sites, and recreational facilities were among the most common types of spaces in which social networking occurred. Many of these places were also important centers for short- and long-term disaster recovery activities. Place attachment to similar types of locations and to the natural landscape was also prevalent, constituting a direct mechanism by which the built environment influenced residents to return and rebuild after Katrina.

In the conceptual model, social networks were also hypothesized to impact the built environment, albeit to a lesser degree. This is because development patterns are influenced by politics, codes, and ideologies, although many elements of the built environment remain fixed over time and therefore the direct influence may decrease as generations pass (Rapoport, 1994). Moreover, the built environment, even after catastrophic damage, exists in a community's collective memory and is assigned a set of values by the community. To some extent, the effect of social systems on the built environment is more evident after a disaster. In Mississippi, residents attended public meetings and charettes that influenced rebuilding and prioritized certain features and land uses. Notably, waterfront park improvements have been implemented in response to resident demand, as beaches are an important social gathering point in the region. Although the effect of social networks on the built environment is weaker than the inverse effect of the built environment on social networks, it is nonetheless important, particularly during a major rebuilding effort. Shifts in urban planning values, such as use of form-based codes rather than Euclidean zoning, also affect rebuilding.

The Stage 1 and Stage 2 analysis results support the link between the built environment and social networks as well as the link between social networks and resilience. Furthermore, the quantitative model results showed a positive relationship between a more varied and integrated built environment and resilience to Hurricane Katrina. Given these combined findings and their conformance to findings from the literature, the conceptual model depiction of the impact of the built environment on resilience was validated, with only a few discrepancies within the Stage 1 dependent-independent variable relationships.

Although many social networks that intervened after Katrina were not rooted in the local built environment (for example, national professional or religious organizations), the built environment was shown to support many types of important social networks such as neighbors and local faith-based groups. Many of these local networks of support were particularly helpful in the early survival phase of the recovery. Local places of worship and other physical establishments serving social networks also served as distribution points for tangible goods as

well as volunteer labor. Without this type of infrastructure that supports social networks, communities are at a practical as well as spiritual disadvantage. In addition to the measurable impacts of the built environment on social networks, sense of place and sense of community, two related and rather ethereal qualities, are among the most important and least well understood factors in resilience. It is difficult to disentangle the two, but at the root of each is a shared set of experiences and a determination to preserve a beloved way of life.

Discussion of Built Environment Variables and Resilience

In the Stage 1 quantitative model, certain aspects of the built environment were associated with greater resilience – namely, intersection density, net residential density, community amenities where social networks gather, and historic sites. These types of features were also shown to be connected to formal and informal social networks in the interview process, as was hypothesized based on a review of the literature.

Although it would be difficult to alter the street layout of the mostly built-out Mississippi Coast region, street connectivity as measured by intersection density was shown to be important for resilience in the Stage 1 model. All four study area communities selected for the Stage 2 analysis are laid out, more or less, on an orthogonal grid. However, many areas in the most severely impacted area that are laid out along dendritic suburban street patterns have not recovered, such as the St Andrews neighborhood in Ocean Springs. This finding was consistent with the literature, as intersection density has been shown to increase pedestrian activity (Ewing & Cervero, 2010) and therefore increase the probability of chance encounters with other pedestrians. Given the difficulty of retrofitting city streets, the creation of trails and paths could improve the connectivity without altering the underlying street pattern. Planners should also be aware of the limitations of disconnected subdivisions for resilience.

The research also demonstrated the importance of housing, in particular of pre-existing multifamily housing. Net residential density had a significant influence on resilience in the Stage 1 model and related housing concerns were voiced in Stage 2 interviews. This is

consistent with the literature, in that residential density has been shown to increase the possibility for creating strategic transitory and intimate ties with neighbors, insomuch as overcrowding is prevented (Baldassare, 1977). However, renter-occupied households are most vulnerable after a disaster, as they have little control over their housing options and may be forced to move if replacement housing is unavailable (Comerio, 1997). The model and interviews indicated that an established mix of housing, diversified by age of structure, housing units per structure, and ownership will result in a more resilient community for all income groups. These housing types must be reestablished in a timely manner post-disaster.

The density of social networking establishments, or locations where groups can meet formally or informally, was also important for resilience. In the Stage 1 model, these were defined as bowling alleys, public golf courses, membership sports and recreation clubs, civic and social associations, religious organizations, labor organizations, business associations, professional organizations, political associations, eating and drinking establishments, book stores, beauty and barber shops, cultural centers, and recreational establishments. This is supported by literature linking such establishments with greater economic and social outcomes (Isserman et al., 2007; Rupasingha et al., 2000). Many such locations have been vital to the resurgence of community in Ocean Springs, and in East Biloxi, the closing of an historic African American school after Katrina was a hindrance to recovery. Overall, these types of locations are important for stimulating social activity, increasing formal and informal interactions, and facilitating organizational activity. Planning can influence the siting of these locations through zoning and ordinances and planners should be aware of the impacts of displacing long-standing establishments that support existing social networks.

The density of historic structures had a positive impact on resilience in the Stage 1 model and the protection or restoration of high priority historic sites was shown to be important to residents. With respect to historic structures, planners should identify which are most culturally significant during periods of calm and document prioritized structures thoroughly in case they are destroyed. If reconstruction is not feasible, honoring the former site may also be appropriate.

Prior to Katrina, Ocean Springs, which is the original site of Iberville's settlement of Biloxi, featured a replica of the historic Fort Maurepas. Although this structure was not replaced after Katrina, in 2009 a public park and playground situated on the site of the former fort was dedicated. The popular public space is named after the fort and features a bronze statue of Iberville and amenities such as an outdoor stage, pavilion, restrooms, a playground, and a splash pad.

In the Stage 1 quantitative model, the presence of parks had a negative impact on resilience, which was inconsistent with literature that suggests parks promote sense of place, community, and civic pride (Talen, 1999). However, interview subjects noted the importance of parks for their networks. The mixed results are likely due to the uneven distribution of neighborhood parks in the area. The beach is open along much of the Gulf Coast, particularly in Hancock County. These areas were not counted as parks in the model (as all study area geographies are within a short distance from the beach), which may have rendered parks insignificant in the model.

Discussion of Additional Resilience Factors Related to Planning

In addition to the built environment factors, this research also highlighted many factors important for resilience that should be noted due to their planning implications. First, public participation in the rebuilding process was seen as beneficial for resilience in communities that engaged the public and detrimental in those that excluded residents from the building process. In particular, participation was necessary to understand and respond to the needs of the community. This was also witnessed in New Orleans after Katrina, when participation of the public as well as communication with the public were crucial for effective recovery, and after the Kobe and Northridge earthquakes (Olshansky & Johnson, 2010; Olshansky et al., 2006). In cases where decisions were made in by technocrats, the results lacked substance and focused more on beautification, according to residents.

By increasing transparency and accountability, public participation can also improve trust in leadership, which is also important for resilience. Some Gulf Coast residents lacked trust in the government before the storm, and trust continued to erode after promised funding and aid was delayed or did not arrive. Furthermore, the initial response, particularly evacuation rates, may have been hindered by this lack of trust. According to a recent study (Brodie, Weltzien, Altman, Blendon, & Benson, 2006), households are significantly more likely to evacuate if they trust the source of evacuation information and are given clear instructions as well as options. When the information initiates from a government that the population feels is detached and apathetic, this becomes problematic. By interfacing directly with local residents through participatory planning processes, planners are uniquely able to foster transparent government.

The speed at which rebuilding occurred was also an issue for resilience. Immediate barriers were numerous and included actual roadblocks preventing evacuees from returning and issues with debris removal and insurance. Those who did not leave and those that were able to immediately begin clean-up and reconstruction tended to be most successful in rebuilding, according to interview subjects. Whenever possible, planners should be aware of and attempt to remove bureaucratic barriers, maintain communications between all responding agencies, and provide assistance before and after disasters to ensure residents understand insurance coverage and home improvement techniques that increase the capacity of the population to meet their own needs after a disaster.

Another issue raised in interviews was that of temporary housing solutions after the storm. Following Katrina, FEMA trailers meant to house victims for months remained in use for years. Interview subjects noted at the time of Katrina, there was a shortage of trailers, as many victims of 1992's Hurricane Andrew remained in trailers for more than ten years. FEMA trailers purchased after Katrina presented health problems for residents, even forcing families with members that could not tolerate formaldehyde to live separately. As an antidote to the toxic and unpleasant FEMA trailers, the Katrina Cottage was designed during the Mississippi Renewal Forum, a post-Katrina design charette. Federal funding was provided to build the structures,

which were designed to allow for expansions, and thus could be converted to permanent housing. Later, many were repurposed as shops and for other uses. Katrina cottages were an example of sturdy, healthy, and locally appropriate housing that filled the temporary housing gap and prevented disruptions in local social structures, understanding that temporary housing is likely to be semipermanent and should be accordingly sustainable. Whenever possible, planners should encourage safe temporary housing designed to encourage social networking opportunities and continuity of community functions.

Past experience with hurricanes or, conversely, lack of experience with a hurricane of Katrina's magnitude was an additional factor raised in interviews. According to the social-ecological model of disaster recovery, collective knowledge and adaptability of the population are engrained over time and over cycles of destruction and reconstruction (Adger et al., 2005). In 2005, many residents of Mississippi had not seen a hurricane as destructive as Katrina and residents will certainly leverage their experiences in future hurricanes. Although the road to recovery has been extremely arduous, few would argue that the Mississippi Gulf Coast has not learned from Katrina to become more resilient. Recently, the lessons learned in Katrina have been applied after Hurricanes Irene and Sandy on the east coast. Sharing this knowledge more broadly and systematically and using specialized skills gained from the recovery would institutionalize the expertise in the region and beyond. Furthermore, communities should consider crafting recovery plans ahead of a disaster in order to reduce the need to build consensus and conduct decision making amid post-disaster turbulence.

Several additional resilience factors related to the natural environment should also be noted, as they pertain to planning and development. For example, development of the waterfront over time has increased the vulnerability of communities on the Mississippi Gulf Coast. This includes dredging of the sound, removal of native fauna, and other interventions that altered the forests, coastal marsh, floodplain, and low terrace ecosystems. According to one interview subject, levees built across the Mississippi River Gulf Outlet Canal (MRGO) are likely to eliminate the river as an overflow for storm surge, which will protect communities along the

Mississippi River but will increase flooding of the Mississippi Gulf Coast. The dominance of human-engineered solutions for managing water resources has begun to diminish, however. Since Katrina, the stepped seawalls constructed in the 1920s to protect from erosion and flooding have been converted back to storm-buffering sandy beaches and dunes, which also provide public space. The native landscape once consisted of a narrow strip of beach dotted with marsh grasses, cypress, and oak trees (Cathcart & Melby, 2009). Similar plantings on the recreated beaches will be allowed to naturally regenerate.

Along with beaches and vegetation, the Mississippi Sound is dotted with barrier islands (Figure 31). Recent research has shown that land loss rates of between 15.6 and 29.9 acres per year were observed between 2000 and 2007 in the Mississippi barrier island chain of Cat Island, Ship Island, Horn Island, and Petit Bois Island (Morton, 2008). Total land losses between 19 and 60 percent occurred from the 1840s to 2007 due to storms and human interventions such as the dredging of deep shipping channels. Robust barrier islands are a protective buffer against both storm surge and wind and, according to interview subjects, are popular recreational areas. Barrier islands have traditionally dissipated waves and reduced storm surge risk along the coast, and dredging, levees, and channelization have increased the water volume of potential storm surges in Mississippi. Since Katrina, funding has been allocated to restore land mass and vegetation to these islands, in large part to mitigate future storm damage. Uncertain environmental factors, such as global climate change and predicted sea level rise and increased intensity of hurricanes are likely to present further challenges to the resilience of the Gulf Coast.



Figure 31: Barrier islands of Mississippi

In addition to land development and environmental planning interventions, planners may be able to participate in or facilitate partnerships that leverage and strengthen existing formal and informal networks. According to interview subjects, immediate clearing and rebuilding efforts were often undertaken by nonprofits and other volunteer organizations. Federal and state government was subject to its own often bureaucratic protocols, making it difficult to mobilize public sector resources. To fill this gap, faith-based organizations from around and from outside the area were particularly helpful in supplying skilled labor and equipment. Although these efforts were often ad hoc, such organizations were able to effectively organize to meet residents' needs. Partnerships between the public, private, and nonprofit sectors in pre-disaster planning efforts would only expand the influence and increase the available resources. Some current examples of successful partnerships exist, and philanthropy and volunteerism on the Gulf Coast are notably strong; however, institutionalizing such partnerships, particularly with the private sector, is necessary to ensure that partnerships and networks are able to effectively mobilize after a disaster. The private sector may benefit from improving the quality of life of its employees and from promoting a positive image in the community in addition to the fiscal benefits of potential

tax deductions and market expansion. Partnerships should be established at a regional level for maximum impact. Ultimately, the efforts of local, national, and even international networks of support resulted in many effective short- and long-term recovery efforts in Mississippi.

Interview subjects also noted economic factors that were important for resilience and restoration of the built environment. The lack of employment opportunities was a limiting factor for resilience in Waveland and Biloxi, and the ability of industry in Pascagoula and commercial establishments in Ocean Springs to recover boded well for those communities. In recent decades, the tax revenue supplied by casino gambling has provided capital for development, including schools and historic preservation. After Katrina, casinos and resorts lining the shores of the Gulf Coast were among the first structures rebuilt. Although casino revenues fell by 28 percent immediately after the storm, casinos turned record profits within two years (Rivlin, 2007). Unfortunately, this boom and bust cycle is likely to repeat itself with every future crisis, limiting the ability to effectively recover from a disaster. A balanced economy, including adequate employment opportunities and a supply of necessary goods and services should be taken into consideration by planners, as these are also important for ensuring the resilience of the population. Casinos and other major employers may be persuaded to engage in corporate social responsibility efforts such as providing community centers and temporary housing after a disaster. These practices may protect their labor resources and encourage greater community resilience through their own employee-based social networks

Five years after Katrina, the area was tested by another catastrophic event, the explosion at the BP offshore rig Deepwater Horizon and resulting oil spill, the worst marine oil spill in U.S. history. The original economic and property damage claims fund for Texas, Louisiana, Mississippi, and Alabama totaled \$2.3 billion, demonstrating the enormous value of the Gulf of Mexico to the region. Claims covered included loss of subsistence and other economic damage for seafood workers, damage to vessels and lost charter payments, and other property damage. The initial amount of the economic settlement has increased several times, and subsequent settlements and court decisions have allocated additional funds for criminal fines, medical

damages for clean-up workers, funds to revive tourism, funding for local nonprofits, and funding for coastal restoration such as the aforementioned barrier island restoration. Although the oil spill severely impacted the economy at a time when the region was still recovering from Katrina, careful investment of these funds is an opportunity to increase resilience.

Ideas for Further Research

This research provided a greater understanding of one aspect of resilience – the return of households – and how this is influenced by a built environment that supports social networks. Because of limitations such as the length of time that has elapsed since Katrina, the difficulty of reaching interview subjects that lack strong social networks, and other methodological shortcomings, additional research would strengthen the findings and improve validity. First, the use of path analysis would improve the validity of the findings. Given the nature of the relationships in the conceptual model, including the direct and indirect effects of social networks and the built environment on resilience, path analysis would better clarify the magnitude of each individual effect. However, inclusion of social network activity in the model would be difficult because of the effort required to quantify social networks. In addition, nonlinear statistical analysis, such as artificial neural network modeling, may also be employed, perhaps using the detailed information from the four case study communities as test cases. A neural network technique would test the ability to predict resilience from the independent variables and would be well suited for handling the complex and possibly interconnected relationships between these variables. Other next steps could include using the Stage 1 model output to select additional case study communities for interviews. The Stage 1 variables were used in selection of the Stage 2 case study communities, although final model results were not yet available to inform the selection process. Since Stage 1 regression analysis is complete, paired comparison communities framed by the Stage 1 results could be selected. In addition to advancing this research on post-Katrina Mississippi, a comparison analysis of other regions and other disasters would improve the reliability of the findings.

Conclusion

The most devastated areas of Mississippi required more than ten years to regenerate after Hurricane Camille in 1969. Based on the slow progress post-Camille, one interview subject estimated that it could take 25 to 30 years for the Gulf Coast to fully recover from Hurricane Katrina. In that time, another major hurricane will almost certainly strike, given past trends. Therefore, it is important for the region to reduce the time necessary for long-term recovery and increase the likelihood that the community will rebound.

Seven years after Hurricane Katrina, recovery is still in progress. There are many considerations that impact the built environment: physical restrictions, such as zoning, environmental impacts, and building codes; cost restrictions such as financing and insurance standards; and market demand. Rebuilding after a hurricane produces an influx of public and private money that can stimulate the local economy and spur spontaneous decision making by public and private entities. Yet, hurricanes are only one stimulus that has altered the Gulf Coast over time. For example, in the last century, dredging and development eroded barrier islands and coastal marshes, and, like many other small and mid-sized cities in the U.S., historic business districts were systematically abandoned for suburban strip and shopping malls. These activities have largely made the population more vulnerable; however, post-Katrina recovery and planning efforts appear to be reversing this trend with a focus on creating civic centers and locally appropriate design that better support social networks. Although the factors influencing resilience and recovery are complex and wide-ranging, planning and policy interventions that influence private real estate development, as well as direct public and private interventions in the built environment, can make an enormous impact on a community's ability to withstand and recover from a disaster.

As seen after Katrina, disasters have the potential to disturb every aspect of daily life. Security and stability are compromised and household resources are drained when faced with unexpected catastrophe. Recovery is clearly difficult in the face of these obstacles. It is increasingly apparent to the disaster management, psychology, sociology, public health, and city

planning professions (among others) that the strength of preexisting social networks influences the rate of recovery at the individual and community levels by leveraging a larger pool of resources and increasing access to employment. Disasters can also place a significant strain on social networks; however, stronger networks are able to endure the strain more readily and actually increase the effectiveness and rate of recovery efforts. This research shows that the effect of the built environment on social networks and resilience should not be discounted. Urban design features with the greatest capacity to increase resilience were also useful features for social networking. Although the findings differ somewhat from past work in the area of social networks and urban design, the elements of the built environment found to support social networks and resilience in coastal Mississippi overlap with many best practices in planning.

APPENDIX A: INTERVIEW PROTOCOL

BACKGROUND INFORMATION:

How long have you lived in this community? How long have you been associated with your organization [for community leaders]? Did you evacuate or stay during Katrina? If so, when did you return?

SOCIAL NETWORK QUESTIONS:

Think of organizations, networks, associations that you or any member of your household belong to. These could be formally organized groups or just groups of people who get together regularly to do an activity or talk about things. Of how many such groups are you or any one in your household a member? Please describe them.

Which of these groups or networks were you engaged in most actively before Katrina? During? After?

Which of these groups or networks disbanded or have been formed after Katrina?

RESILIENCE QUESTIONS:

Think about how your community has coped after Katrina. Resilience is the ability of a community to rebound, or to bend but not break, after a disaster. In your opinion, how resilient is your community to disasters? (1-10, 1 being not at all resilient, 10 being very resilient)

On what factors do you base your score?

By your estimation, what percent or proportion of your neighborhood has returned after Katrina? Of your city?

Have vulnerable populations returned, such as the elderly or very poor? Why or why not?

BUILT ENVIRONMENT QUESTIONS:

Think about the physical characteristics of your community – homes, buildings, open and green space, streets and sidewalks, landmarks and monuments, historic sites, businesses,

institutions, natural features. Which of these places or features are most important, memorable, or symbolic to your community in your opinion before Katrina? After?

What locations are used by your formal and informal social networks for gathering before Katrina? After?

With respect to the community pre- and post-Katrina, does your community offer amenities in walking distance to your home? What is the availability of parks and open space?

OTHER:

Do you have any additional comments about resilience and your community that you wish to mention?

RECRUITMENT:

Who else should I talk to in your neighborhood?

APPENDIX B: CONSENT FORM

CONSENT DOCUMENT FOR COMMUNITY RESILIENCE STUDY

Georgia Institute of Technology

Project Title: Resilience in the Social and Physical Realms: Lessons from the Gulf Coast

Investigator: Ann Carpenter

Protocol and Consent Title: H12079, approved 9 April 2012

You are being asked to be a volunteer in a research study.

Purpose:

- The purpose of this study is to evaluate what makes a community more or less resilient, or able to recover, after a disaster. The study uses Hurricane Katrina as an example.

Procedures:

- If you decide to be in this study, your part will involve an interview of approximately 30-45 minutes. You will be asked a series of questions about your community, including what kinds of social groups you encounter, the kinds of buildings and features in your community, and how the community survived and rebuilt after Katrina. The total amount of time should be less than 45 minutes. Remember, you may stop at any time.

Risks or Discomforts:

- The risks involved are no greater than those involved in daily activities. The questions focus on a disaster with a huge emotional impact, although they are not personal questions.

Benefits:

- You are not likely to benefit from joining this study. We hope that what we learn will someday help others.

Compensation to You:

- There is no compensation for participation.

Confidentiality:

- Your privacy will be protected to the extent allowed by law. To protect your privacy, your records will be kept under a code number rather than by name. Your records will be kept in locked files and only study staff will be allowed to look at them. Your name and any other fact that might point to you will not appear when results of this study are presented or published. We are only interested in group information. The reporting of the experimental results will only contain group mean results and will contain no personal information about individual participants including performance on the experiment. Audiotapes will be transcribed and destroyed; no link will be maintained that could connect your identity with your responses. The tapes will be accessible only to the research team and the tapes will be destroyed after data analysis is complete. To make sure that this research is being carried out in the proper way, the Georgia Institute of Technology IRB may review study records. The Office of Human Research Protections and/or the Food and Drug Administration may also look over study records during required reviews.

Participant Rights:

- Your participation in this study is voluntary. You do not have to be in this study if you don't want to be.
- You have the right to change your mind and leave the study at any time without giving any reason and without penalty.
- If you decide not to finish the study, you have the right to withdraw any data collected about you. If you withdraw, all records of your input and participation will be destroyed.
- Any new information that may make you change your mind about being in this study will be given to you.
- You will be given a copy of this consent form to keep.
- You do not waive any of your legal rights by signing this consent form.

Questions about the Study:

If you have any questions about the study, you may contact Ann Carpenter at telephone 404-407-8044 or acarpenter@gatech.edu.

Questions about Your Rights as a Research Participant:

If you have any questions about your rights as a research participant, you may contact

Ms. Melanie Clark, Georgia Institute of Technology
Office of Research Compliance, at (404) 894-6942

or

Ms. Kelly Winn, Georgia Institute of Technology
Office of Research Compliance, at (404) 385- 2175

If you sign below, it means that you have read (or have had read to you) the information given in this consent form, and you would like to be a volunteer in this study.

Participant Name (printed)

Participant Signature

Date

Signature of Person Obtaining Consent

Date

APPENDIX C: RECRUITMENT MATERIALS

Re: request for short interview

Dear coastal Mississippi resident,

A Georgia Tech research project is defining the networks of support and other features that contributed to how well Mississippi was able to withstand and recover from Hurricane Katrina. Georgia Tech is seeking the participation of residents of your community to be interviewed about the characteristics that are most important in making the area resilient.

The interview will take approximately 30 minutes. Participants can participate during one of several interview sessions in your area between July 9 and July 13, 2012. Additional dates are pending and a phone interview may also be scheduled at your convenience.

Whether or not you are willing to participate, please consider passing this notice to someone else living in your neighborhood.

Please contact Ann Carpenter at 404.407.8044 or acarpenter@gatech.edu to learn more about how to participate.

Thank you very much,

Ann Carpenter
Doctoral candidate
Georgia Institute of Technology
School of City and Regional Planning

APPENDIX D: EXERPTS FROM COMPREHENSIVE PLAN DOCUMENTS

Goals of comprehensive plans from Biloxi, Pascagoula, Ocean Springs, and Hancock County are below:

Biloxi (East Biloxi) Comprehensive Plan

Vision: The best of Biloxi’s past—its cultural heritage, natural resources, and the spirit of its people—is carried forward and enhanced in a prosperous, resilient city for the 21st century. The City’s 21st century renaissance is based on: a diverse, thriving economy that capitalizes on Biloxi’s assets: its natural and cultural resources, economic anchors, status as a premiere visitor destination, and the entrepreneurial spirit of its people; a healthy environment that supports quality of life, sustains the economy, and protects against storm damage and flooding; a welcoming community that celebrates Biloxi’s unique character and sense of place; provides opportunities for all citizens; and takes care of those in need.

Goals:

Land Use Goal: Create a resilient pattern of future land use that:

1. Retains the character of “Old Biloxi.”
2. Provides for orderly and cost-effective growth and redevelopment.
3. Maximizes positive relationships and reduces incompatibilities between different types of uses.
4. Protects sensitive environmental resources and reduces storm vulnerability.

Transportation Goal: Provide a multimodal, interconnected network that provides choices for people to move safely inside and outside Biloxi via vehicular, transit, bicycle, pedestrian, air, and waterborne transportation.

Natural, Historic, and Cultural Resources Goal: Protect and restore natural, cultural, and historic resources and maximize the benefits they provide for the economy, environment, and community.

Community Facilities and Services Goal: Provide quality, cost-effective community facilities and services that meet citizens’ needs based on objective standards, support desired future land use, and protect environmental resources.

Housing Goal: Provide safe, decent, and affordable housing that meets the needs of all residents and socioeconomic groups in Biloxi.

Economic Development Goal: Promote a healthy, diversified, and sustainable economy that provides a strong tax base, needed goods and services, and employment opportunities for Biloxi's residents.

Pascagoula Comprehensive Plan

Vision: Pascagoula will be a vital, attractive place to live, work, and visit. The elements that make Pascagoula a great community—its neighborhoods, shopping and employment centers, civic uses, open spaces, and natural resources—will be strengthened and enhanced. The diverse range of housing and work environments will be sustained and expanded to create more choices for all income levels. All Pascagoula neighborhoods will be improved, each to have public gathering spaces, essential services and pedestrian amenities, to encourage less reliance on the automobile.

Pascagoula will provide accessible, attractive, economically viable and environmentally sound transportation options that meet the needs of residents, employers, employees and visitors for safe, convenient and efficient travel by a variety of methods. Streets will be safe and attractive, and designed to enhance the quality and aesthetics of Pascagoula neighborhoods. Emphasis will be placed on alternatives to the automobile, including walking, bicycling, public transit, and car and van pooling. The adverse impacts of automobile traffic on the environment in general and residential streets in particular, will be reduced. Solutions that reduce the growth in the number of automobiles on City streets, calm or slow traffic, and save energy will be supported. It is hoped that individuals will reduce their automobile trips by 10 percent by 2020, as alternative transportation methods are implemented. The City will seek out innovative funding sources and approaches to construct and maintain needed transportation systems. Pascagoula recognizes the regional nature of our transportation system, and will be a leader in seeking regional transportation solutions through long-term planning.

Pascagoula will aggressively pursue a variety of housing opportunities that enhance the character, diversity and vitality of the City. The City is committed to increasing the development of affordable and market-rate housing. Existing housing, particularly rental units, will be conserved and rehabilitated or replaced. Pascagoula will continue its strong commitment to supporting agencies that assist households with special needs. The City will foster an environment free of discrimination and the barriers that prevent choice in housing. It will place special emphasis on family housing and housing that addresses the health care, child care, transit, recreation and social service needs of all Pascagoula residents.

Pascagoula will meet today's needs without compromising the needs of future generations. Pascagoula will respect and manage natural resources in a way that sustains the natural environment and protects our wetlands, bayous, parks, wildlife and open space legacy. Elements of the natural environment will be conserved where they remain intact and restored where they have been degraded by past development. A portion of the City will remain as open space. Even

in built-up areas, a network of parks will provide access to nature and an urban forest will provide ecological benefits and a source of beauty for residents. Pascagoula will strive for cleaner air and cleaner water. Its policies and programs will foster energy and water conservation, reduced solid waste generation, and cleanup of contaminated sites. The City will be well prepared for natural disasters and will grow and change in a way that minimizes public exposure to hazards like fire, flood, and hurricanes.

Pascagoula will provide high quality community services to its residents, businesses, and visitors. Its schools, libraries, parks, community facilities, and performing arts and cultural centers will be enhanced to serve current and future generations. Its police and fire services will be managed to provide consistently high levels of public safety. The City will continue to provide services and programs that meet the needs of special populations—including children, seniors, and people with disabilities—as well as programs in recreation, lifelong learning, and the arts that benefit all populations. Pascagoula's success in providing these services will be expressed and measured by the satisfaction of its customers, the public at large. The City will pursue new ways to deliver community services in the most efficient and cost-effective way possible. It will coordinate its efforts with other public agencies, nonprofits, and the private sector to reduce overlap and maximize the use of resources.

Pascagoula's business environment will be exciting, dynamic and vital. Businesses will have access to a wide array of support services and will enjoy positive relationships with Pascagoula residents, officials, and City staff. The competing needs of residents and businesses will be balanced so that neighborhoods are protected and enhanced while business districts are competitive and attractive. The local economy will thrive, and a diverse array of goods and services will be provided to Pascagoula consumers. Most development will occur within Pascagoula's employment areas, and will be consistent with the role and character designated for each area by this Plan.

Pascagoula will maintain a positive civic image and be a leader in the regional, state, and national policy discussions affecting the community. The City will work with neighboring communities to address common concerns and pursue common interests. The public will be actively and effectively involved in City affairs, both at the Citywide and neighborhood levels. Where appropriate, the City Council will delegate decision-making responsibilities to local boards and commissions. The Council will also assign advisory roles to these bodies as well as other community groups. Residents, businesses, and elected and appointed officials will work collaboratively to address the issues facing the City in a timely manner. This inclusive, participatory process will help build a sense of community.

Goals:

Land Use and Community Design Goals:

A well-designed, compact city, providing residents and visitors with attractive neighborhoods, work places, shopping districts, public facilities, and open spaces.

An enhanced sense of “community” with development designed to foster public life and meet citywide needs.

Safe, attractive residential neighborhoods, each with its own distinct character and within walking distance of shopping, services, schools, and/or other public gathering places.

Inviting, pedestrian-scale centers that offer a variety of retail and commercial services and provide focal points and community gathering places for the city’s residential neighborhoods and employment districts.

High quality employment districts, each with their own distinctive character and each contributing to the character of the city as a whole.

Well-designed buildings that create coherent development patterns and enhance city streets and public spaces.

Conservation and preservation of Pascagoula’s historic buildings, sites, and districts.

Attractive and safe civic and cultural facilities provided in all neighborhoods and maintained and used in ways that foster and enrich public life.

Attractive, inviting public spaces and streets that enhance the image and character of the city.

Transportation Goals:

Planning and development of transportation modes offering alternatives to single-occupant automobiles.

A convenient, efficient, public transit system that provides a viable alternative to driving.

Effective opportunities for public participation in local government facilities, services, and programs that encourage and promote walking and bicycling.

An efficient transportation system to meet the present and future mobility needs of people, goods, materials, and services.

A transportation system with minimal impacts on residential neighborhoods.

Reduction of the adverse environmental impacts of existing and future transportation systems through a combination of careful planning and mitigation techniques.

Mobility for people with special needs.

Attractive, convenient public and private parking facilities.

An influential role in shaping and implementing regional transportation decisions.

A local airport with minimal off-site impacts.

Land use planning that maximizes transportation efficiency for all modes and considers the economic development of the city.

Planned transportation system in a coordinated and cost-effective manner utilizing a fair, equitable and sufficient method of funding.

Housing Goals:

A supply of affordable and market rate housing that meets Pascagoula's share of regional housing needs.

Conservation and maintenance of Pascagoula's existing housing stock and residential neighborhoods.

Housing opportunities for a diverse population, including very low-, low- and moderate-income residents, and persons with special needs.

An end to housing discrimination on the basis of race, religion, national origin, age, sex, sexual orientation, marital status, physical handicap, or other barriers that prevent choice in housing.

Reduced housing expenses for energy.

A citywide open space system that protects and conserves Pascagoula's natural resources and provides a source of beauty and enjoyment for Pascagoula residents.

Conservation of bayous and riparian areas as open space amenities, natural habitat areas, and elements of community design.

A thriving "urban forest" that provides ecological, economic, and aesthetic benefits for Pascagoula.

Water resources that are prudently managed to sustain plant and animal life, support urban activities, and protect public health and safety.

Clean, healthful air for Pascagoula and the Mississippi gulf coast area.

An environment free of the damaging effects of biological and chemical hazardous materials.

Reduced volumes of solid waste; solid waste disposed in an environmentally safe, efficient, manner.

Natural Environment Goals:

An environment that minimizes the adverse impacts of noise.

A clean, efficient, competitively-priced energy supply that makes use of cost-effective renewable resources.

Protection of life and property from natural hazards, including hurricanes, flooding, and fire.

Community Services and Facilities Goals:

Effective and efficient delivery of community services.

A commitment to excellence and high quality customer service among Pascagoula officials and employees.

Improved quality, quantity, and affordability of social services, particularly for children, youth, seniors, and people with disabilities.

Attractive, well-maintained community facilities that serve Pascagoula residents.

Equal access to educational, recreational, and cultural services for all residents.

Business and Economics Goals:

A thriving business environment that is compatible with Pascagoula's residential character and natural environment.

A diverse mix of commercial, retail, and professional service businesses.

New businesses that provide needed local services and municipal revenues, contribute to economic vitality, and enhance the city's physical environment.

Attractive, vibrant business centers, each with a mix of uses and a distinctive character.

Thriving employment districts, such as chevron, Northrop Grumman, and the singing river medical center that complement the city's business and neighborhood centers.

Governance and Leadership Goals:

Effective opportunities for public participation in local government.

Informed and involved civic and neighborhood organizations and residents.

A leadership role on regional issues.

Active involvement of local citizens as volunteers in the delivery of community services.

New ways to encourage collaboration among the public, property owners, and the city in areas where change is desired.

More clearly defined procedures, standards, and expectations for development review.

Ocean Springs Comprehensive Plan

Vision: Ocean Springs is a community that preserves and respects its character, history and charm; maintains a pedestrian-oriented scale; protects its natural resources, environment and trees; respects its relationship with the Gulf and Bayou; promotes appropriate business development; and recognizes the importance of Bienville Boulevard and other major thoroughfares to define and connect places.

Goals:

Land Use Goal: Maintain a sustainable and compatible mix of land uses in the City of Ocean Springs through effective, coordinated growth management.

Bienville Boulevard (Hwy 90) Goal: Enhance Bienville Boulevard (Hwy 90) corridor through Ocean Springs to support economic development, multi-modal transportation and high quality community character.

Downtown/Central Business District Goal: Foster a vibrant mixed-use downtown that retains the historic character of existing commercial and residential neighborhoods, while providing increased opportunities for residents who wish to live within walking distance of neighborhood amenities and work places.

Neighborhoods and Housing Goal: To provide high quality residential neighborhoods with a variety of compatible housing types to serve the various needs of Ocean Springs residents.

Economic Development Goal: Maintain and enhance a sustainable local economy that provides employment opportunities and supports a high quality of life.

Community Design Goal: To establish Ocean Springs as a community that showcases high quality design for the benefit of its residents, businesses and visitors.

Historic Resources Goal: To preserve and enhance historic and cultural resources that reflect the heritage and character of Ocean Springs.

Natural Resources Goal: Protect and preserve natural resources including marshes and wetlands, habitat for flora and fauna, water and air quality.

Hazard Mitigation Goal: To protect life and property throughout Ocean Springs.

Facilities and Services Goal: To efficiently provide for and equitably fund high quality facilities and services to meet the needs of all businesses residents and visitors to Ocean Springs.

Parks and Leisure Goal: To provide a parks and recreation system that meets the needs of all segments of the Ocean Springs community.

Arts and Culture Goal: To maintain and enhance Ocean Springs as an “artistic” community, supporting and celebrating local arts and cultural events.

Transportation Goal: To provide safe and convenient mobility and a variety of mode choices for all of Ocean Springs residents and visitors.

Hancock County (Waveland) Comprehensive Plan

Vision: Hancock County will be a model for sustainable coastal living, respecting our unique natural setting, our heritage and communities, while providing diverse, safe housing opportunities in its thriving communities and rural areas and diverse employment opportunities for all residents.

Goals:

Character and Identity Goals:

To preserve the small town character and identity of the cities and communities in Hancock County.

To maintain or improve the quality of Hancock County's natural resources.

To protect sensitive floodplains, wetlands and wildlife habitat from inappropriate development.

To protect people, property and water quality by limiting inappropriate development in floodplains and wetlands.

Economic Goals:

To promote a healthy, sustainable, balanced economy that capitalizes on the community's natural, recreational, cultural and human resources.

To promote, recruit, and maintain a wide variety of tourism attractions, including high-tech attractions, gaming, unspoiled beaches, natural resources-based tourism and social, cultural and historic tourism.

To retain existing businesses as vibrant part of the economy.

To keep communities in Hancock County viable.

Land Use Goals:

To develop a coordinated growth management strategy in conjunction with Bay St. Louis and Waveland.

To maintain and enhance the diverse, small town charm of the County's communities as they recover, while preserving the character of rural areas and integrity of natural resources.

To promote the concept of land use compatibility with Airport operations on lands surrounding Stennis International Airport.

Housing Goals:

To have affordable housing choices that serve residents of all ages, from young working families through senior citizens.

To rebuild and grow in a manner consistent with the diverse historic forms (e.g., single family homes, garden homes, townhomes, apartments, etc.) of Hancock County.

Transportation Goals:

To maintain a transportation system that safely and efficiently meets the needs of residents, businesses and visitors.

Community Facilities Goals:

To coordinate growth decisions with the provision of infrastructure.

To provide safe drinking water for every citizen in Hancock County.

To maintain reliable, secure emergency services.

To ensure the public's safety.

To provide high quality educational opportunities for residents of all ages.

To establish and maintain a coordinated county-wide parks and recreation system which also includes native and passive recreation opportunities that serves all residents and attracts tourists.

To maintain a high quality library system that serves all ages.

To secure adequate and reliable funding for public facilities and services.

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