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Institutional Resilience Along The Mississippi Gulf Coast in The Context of Pre- And Post-Hurricane Katrina

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INSTITUTIONAL RESILIENCE ALONG THE MISSISSIPPI GULF COAST IN THE CONTEXT OF PRE- AND POST-HURRICANE KATRINA

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DEDICATION

To John and my parents. Thank you for your love and support. Without you, I would not be able to complete this process. I love you more than words can express.

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ABSTRACT

Building resilience to disasters helps reduce loss of life and property, allowing communities to recover more quickly from shocks and disruptions. Governing institutions are tasked with tremendous responsibility in terms of mitigating risks and enhancing resilience of local communities through proactive planning and policies. It is important to examine how institutional policies have changed pre- and post-disaster to determine their contribution to community resilience. Metrics and indicators can be used to quantitatively assess, establish baseline, track, and monitor resilience at the community level. Few studies have attempted to measure institutional resilience using a set of indicators and metrics, and even fewer explore the conceptual gaps between academic research on hazards and emergency management practice.

This research investigates the utility of the Baseline Resilience Indicators for Communities (BRIC) institutional resilience (IR) sub-index in a context-specific case study. This study replicates the BRIC IR sub-index, aggregated at the state scale, for eighty-two counties in Mississippi in the context of pre- and post-Hurricane Katrina. Difference of means and median tests along with evaluating of change in ranking were utilized to determine the drivers of change in institutional resilience from 2000 to 2010 for the state of Mississippi and for Hancock, Harrison, and Jackson counties. In addition, content analysis of state and local hazard mitigation plans (HMPs) provides contextual information to explain observed changes in institutional resilience metrics as well as in post-disaster mitigation practice.

Mitigation spending, flood insurance coverage, disaster aid experience, jurisdictional coordination, and crop insurance coverage are the drivers of change in institutional resilience for the state of Mississippi, while only the first three indicators along with population stability are the drivers for Hancock, Harrison and Jackson counties. Increases in mitigation spending and flood insurance coverage can be directly attributed to Hurricane Katrina. Content analysis of state and local HMPs suggests that the theoretical basis of BRIC IR indicators is reflective of mitigation practice. In addition, there are substantial improvements in the post-Hurricane Katrina HMPs in the categories of hazard identification, jurisdictional coordination, reporting of loss data, hazard modeling, participation in the National Flood Insurance Program, and social vulnerability assessment.

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CHAPTER 1: INTRODUCTION

Over the previous fifty years, total losses in the United States from weather-related events have increased tremendously (Cutter and Emrich 2005; Barthel and Neumayer 2012; Hallegatte et al. 2013; Preston 2013). Urban population growth and persistent development in or near the coastal zones contribute to greater exposure of lives and properties (Klein et al. 2003b). Inhabitants and institutions are often ill-prepared and ill-equipped as they lack the adaptive capacity and coping mechanisms to absorb the potential for loss and recover from disturbances (Cutter et al. 2008b). In recent decades, notable meteorological hazards like Post-Tropical Cyclone Sandy (2012) and Hurricane Katrina (2005) wrought havoc in U.S. coastal communities, causing losses and damage in the tens of billions of dollars (Waple 2005; Blake et al. 2013). Disruptions to local economic activities and social functions were followed by long and strenuous reconstruction periods (Cutter et al. 2006; Manuel 2013). As local communities struggle with potential devastation posed by natural hazard events and emerging climate change impacts, it is no longer sufficient for these communities to assess only the physical and social vulnerability of a particular area or population. Rather, this process of vulnerability assessment must be carried out in tandem with evaluating and enhancing a community's disaster resilience (National Preparedness Goal 2011; IPCC 2012).

Current disaster policies push for guidelines on how to incorporate resilience as a means of mitigating disaster impacts. In 2012, the National Research Council argued that it is necessary to evaluate and benchmark the baseline conditions that contribute to community resilience as well as measure the factors affecting the capacity of communities to respond to and rebound from adverse impacts of an event. This can be accomplished through the construction of resilience metrics and social indicators (Birkmann 2007; Cutter et al. 2010). Resilience metrics and indicators are useful tools in terms of measuring community resilience levels. Indicators can be employed when setting policy goals in mitigation planning or as screening tools to set baselines and assess temporal and spatial changes (Birkmann 2007; Frazier 2013). Metrics and indicators, however, provide limited and generalized representations of reality and do not capture all of the complex facets of resilience. It is necessary to carry out further research to understand resilience indicators both in terms of the approaches used to build them and their usefulness in real-world applications (Fekete 2009; Tate 2012; Frazier 2013; Singh-Peterson et al. 2015).

1.1 Research Goals and Contributions

The purpose of this thesis is evaluate and contextualize the output metrics of the Baseline Resilience Indicators for Communities (BRIC) index through replication of the institutional resilience sub-index at the state and content analysis of hazard mitigation plans. It conducts a longitudinal assessment of institutional resilience in a real-world application using the Mississippi Gulf Coast in the context of pre- and post-Hurricane Katrina as a case study. It also examines the disaster governance structure of the state of Mississippi by exploring how mitigation practices have changed in the post-Katrina period. The mixed method approach aims to acquire a better sense of institutional resilience both in academic and practical settings. It also provides a crucial opportunity for bridging conceptual gaps between researchers and practitioners in the disaster management realm.

1.2 Research Questions

The following research questions provide the focus for this thesis:

1. How has the institutional resilience for the Mississippi Gulf Coast, conceptualized as BRIC indicators, changed in the setting of pre- and post-Katrina?
2. Do state and local mitigation plans explain or indicate changes in institutional resilience metrics for the Mississippi Gulf Coast in the setting of pre- and post-Katrina?

Chapter 2 provides a literature overview of the theoretical and practical orientation of resilience, focusing on the institutional aspect. Chapter 3 focuses on the background of BRIC index, the institutional resilience indicators and the Mississippi Gulf Coast as study area. Next, Chapter 4 details the methodology and results of the BRIC institutional resilience sub-index in the context of pre- and post-Hurricane Katrina. Chapter 5 contains the examination of state and local hazard mitigation plans regarding how they have changed within the respective timeframe. Finally, Chapter 6 discusses the significances of the findings and suggests improvements for hazard mitigation plans as well as new indicators of institutional resilience.

CHAPTER 2: LITERATURE REVIEW

2.1 Conceptualizing Disaster Resilience

There are numerous ways in which resilience is conceptualized but there is "no broadly accepted single definition" between the environmental science, hazard and practitioner communities (Klein et al. 2003a; Manyena 2006; Cutter et al. 2008b, 599). Etymologically, the concept of resilience stemmed from resilio or resilire, meaning to "bounce" in Latin and has a long history rooted in the classical arts, literature, law, engineering, computer science, and social sciences (Alexander 2013). In recent years, the number of academic works relating to resilience have skyrocketed in social science research including disciplines such as geography, sociology, psychology and public health (Renschler et al. 2010; Zhou et al. 2010; Chamlee-Wright Storr 2011; Miles and Chang 2011; Cox and Perry 2011; Aldrich 2012; Berkes and Ross 2013; Morton and Lurie 2013; Plough et al. 2013; Tidball and Stedman 2013; Cutter et al. 2014b).

Holling (1973) was one of the first to describe resilience as a measure of the ability of a system to absorb change and persist after disturbances. In other words, a resilient system is one that can absorb shocks and still function. Another aspect of resilience concerns the capacity for renewal, re-organization and development (Folke 2006). Given these characteristics, two different framings of resilience emerge: ecological and engineering resilience. The global environmental change literature identifies with the ecological framing of resilience, which emphasizes the adaptive ability to cope with and learn from unpredictability (Manyena 2014). It examines resilience in relation to the long-term impacts of climate change. Adger (2000) explains the linkage between ecological resilience and social resilience in terms of human resource dependency on the natural environment, a process he observed in developing societies whose livelihoods and social order are intricately intertwined with the availability of natural resources. In later work, Adger et al. (2005) suggests that socio-ecological resilience refers to the capacity of a complex system to execute self-organization through adaptive learning and preparing for uncertainty and surprise. As such, socio-ecological resilience is directly related to adaptive capacity, or the ability of a system to adjust to change, moderate the effects and cope with a disturbance (Smit and Wandel 2006; Engle 2011).

Engineering resilience refers to resistance to disturbance, the ability to maintain an acceptable level of functioning, and speedy return to a single static equilibrium (McDaniels et al. 2008). It is closely associated with short-term coping with specific natural hazards, relating to concepts such as vulnerability, preparedness, response, and recovery (Birkmann 2006b; Paton 2006; Walsh 2007; Norris et al. 2008; Twiggs 2009; Wells et al. 2013). It can be applied at different scales to individuals, households, institutions, cities, regions or nations (Aguirre 2005; Bonnano et al. 2007; Butler 2007; Hassink 2009; Joerin and Shaw 2011; Manyena 2014). In the hazard literature, resilience can be defined as "the ability to prepare and plan for, absorb, recover from, and more successfully adapt to actual or potential adverse events" (NRC 2012, 16). It also refers to the capacity to rapidly restore system function to pre-disaster level (UNISDR 2009). Norris et al. (2008) discuss the notion of resilience as a set of capacities, which can be enhanced by economic and community resources. Others focus on engineered structures and land-use planning, which seek to minimize the impacts of disasters and quickly restore crucial services and lifelines (Bruneau et al. 2003; Rose 2007; McAllister 2013).

Berkes and Ross (2013) introduce an integrated concept of community resilience, attempting to unify the two disparate framings mentioned above. Characteristics such as adaptive capacity, flexibility, social networks and self-organization are desired traits in both ecological and engineered framing of resilience. These traits can be fostered through community development and community-based planning. Communities should strive to attain general resilience to a wide range of uncertainties and surprises while recognizing that building disaster resilience to specific hazards is also important.

2.2 Disaster Resilience at the Community Level

Many current works and research on disaster explore how to enhance resilience, ideally at the community level. This section features various definitions of community resilience and its conceptualizations at the community scale. Community is a complex and difficult concept to define because it can range from "grass-roots groups and neighborhoods to complex amalgams of formal institutions and sectors in larger geopolitical units" (Norris et al. 2008, 128).

From a hazard perspective, the spatial dimension remains crucial in terms of identifying socially and physically vulnerable populations based on geographical locations. Such spatial framing of community should acknowledge that individuals identify membership based on diverse factors such as occupation, religion, socio-economic status, gender or recreational activities, among others (Twigg 2007; Berkes and Ross 2013). As such, a community should be examined based on its spatial location as well as the socio-demographic characteristics of its population.

Community resilience is generally discussed in terms of the capacity, ability, and resources to cope with and bounce back from exposure to a disruptive event and also future events (Table 2.1). The process of building and enhancing community resilience can be achieved in the preparedness, mitigation, response and recovery phases. Two central aspects of community resilience are social learning and social capital. Resilience is associated with social learning, or the ability to self-organize, which enables communities to incorporate post-disaster lessons into planning and policies in order to be more prepared for the next disaster (Cutter et al. 2008b; Manyena 2014). Social capital is linked to the ability of a community to self-organize in the response and recovery period (Nakagawa and Shaw 2004; Aldrich 2012). Mutual assistance from social networks can benefit members of a group in terms of providing financial and social support in times of crisis.

Beyond the social components, community resilience also relates to the capability of the built environment to resist and rapidly recover from disruptive events (McAllister 2013). This means that critical facilities and lifelines need to be operational and functional during and after hazard events to support other aspects of community resilience. As such, community resilience is a multi-dimensional concept that can be applied to examine the social system and the built environment in the context of pre- and post-disaster.

Table 2.1: Selected definitions of community resilience.

Citations	Definition (direct quotes)
Timmerman 1981	A system's capacity to absorb and recover from the occurrence of a hazardous event; reflective of a society's ability to cope and to continue to cope in the future
Wildavsky 1991	The capacity to cope with unanticipated dangers after they have become manifest, learning to bounce back
Comfort et al. 1999	The capacity to adapt existing resources and skills to new systems and operating conditions
Mileti 1999	(The ability to) withstand an extreme event without suffering devastating losses, damage, diminished productivity, or quality of life without a large amount of assistance from outside the community
Paton 2000	The capability to bounce back and to use physical and economic resources effectively to aid recovery following exposure to hazards
Chenoweth and Stehlik 2001	The ability to respond to crises in ways that strengthen community bonds, resources, and the community's capacity to cope
Bruneau et al. 2003	The ability of social units to mitigate hazards, contain the effects of disasters when they occur, and carry out recovery activities in ways that minimize social disruption and mitigate the effects of future earthquakes
Ganor and Ben-Lavy 2003	The ability of individuals and communities to deal with a state of continuous long term stress; the ability to find unknown inner strengths and resources in order to cope effectively; the measure of adaptation and flexibility
Godschalk 2003	A sustainable network of physical systems and human communities, capable of managing extreme events; during disaster, both must be able to survive and function under extreme stress
Coles and Buckle 2004	A community's capacities, skills, and knowledge that allow it to participate fully in recovery from disasters
Norris et al. 2008	A process linking a set of networked adaptive capacities to a positive trajectory of functioning and adaptation in constituent populations after a disturbance
UNISDR 2009	The ability of a system, community, or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through preservation and restoration of basic structures and functions.
Magis 2010	The existence, development, and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise
Acosta et al. 2011	The ongoing and developing capacity of the community to account for its vulnerabilities and develop capabilities that aid that community in (1) preventing, withstanding, and mitigating the stress of a health incident; (2) recovering in a way that restores the community to a state of self-sufficiency and at least the same level of health and social functioning after a health incident; and (3) using knowledge from a past response to strengthen the community's ability to withstand the next health incident.
Cox and Perry 2011	A reflection of people's shared and unique capacities to manage and adaptively respond to the extraordinary demands on resources and losses associated with disasters
Berkes and Ross 2013	Communities do not control all of the conditions that affect them, but they have the ability to change many of the conditions that can increase their resilience. They can build resilience through their responses to shocks and stress, and actively develop resilience through capacity building and social learning.

2.2.1 Community Disaster Resilience Frameworks

In the last decade, there have been increased efforts to create conceptual frameworks and models to operationalize resilience. Bruneau et al. (2003) provides a seismic resilience framework for communities introducing the four R's: robustness, redundancy, rapidity and resourcefulness. These four R's have been influential in the conceptualization of many subsequent resilience frameworks. For example, Rose and Krausmann (2013) construct an economic resilience index to measure business recovery in post-disaster periods. This framework applies the four R's from Bruneau et al. (2003) as proxies for economic performance indicators. Norris et al. (2008) utilize the robustness, redundancy and rapidity concepts to generate a resilience index at the community level which defines resilience as a set of networked adaptive capacities composed of factors relating to economic development, information communication, social capital and community competence. Renschler et al. (2010a) introduce the PEOPLES Resilience Framework that highlight seven aspects of community resilience regarding to population and demographics, environmental and ecosystems, organized governmental services, physical infrastructure, lifestyle and community competence, economic development, and socio-cultural capital. Lastly, Cutter et al. (2008b) propose the Disaster Resilience of Place (DROP) model, which focuses on social resilience at the community level (Figure 2.1). The authors draw from multiple influences, defining disaster resilience as:

> The ability of a social system to respond and recover from disaster includes those inherent conditions that allow the system to absorb impacts and cope with an event, as well as post-event, adaptive processes that

facilitate the ability of the social system to re-organize, change and learn to respond to a threat (Cutter et al. 2008b, 599).

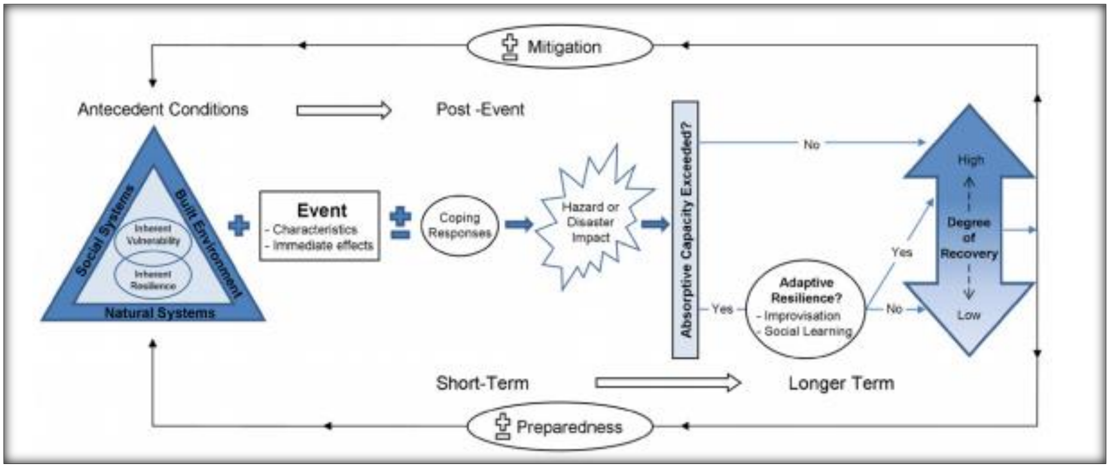

Figure 2.1: Disaster Resilience of Place (DROP) model (Cutter et al. 2008b).

Resilience in the post-disaster setting will not only allow the affected population to "bounce back" quickly, but also "bounce forward" to adapt appropriately in preparation for the next disturbance (Manyena et al. 2011). The DROP model theorized that there are sets of inherent vulnerability and resilience, which exist at the nexus of social systems, natural systems and the built environment. This conceptualization points to two qualities of resilience: inherent and adaptive. Inherent resilience refers to the system components that function well during non-crisis periods, while adaptive resilience is the flexibility of system in the post-disaster period. Adaptive resilience consists improvisation and social learning which should be incorporate back into the system as part of inherent resilience in the post-disaster period (Rose 2004). These two qualifications can be applied to infrastructure, institutions, organizations, social systems, or economic systems (Cutter et al. 2008b).

2.2.2 Resilience Indices and Applications

The Committee that produced the report, *Disaster Resilience: A National Imperative*, for the National Research Council recognized the need for resilience measurement (NRC 2012). Quantitative means of assessment allow key actors and institutions to prioritize investments and needs, monitor progress, and compare the benefits of increasing resilience with associated costs. Resilience metrics and indicators can be applied to set targets, establish goals for improvement, and provide quantitative measures for ranking and monitoring resilience factors. These can also be a way to unify disparate views of stakeholders around a consensus (Cutter et al. 2013). In addition, quantitative analysis of resilience indices can help inform local and national policymakers about changes in the socioeconomic structure of at-risk communities (Sherrieb et al. 2010).

There are various contemporary indices that have emerged from resilience conceptual frameworks (NRC 2012). Notable examples include: Rose (2004)'s economic resilience index at multiple market scales, Mayunga (2007)'s capital-based approach the Community Disaster Resilience Index, Carreno et al. (2007)'s Risk Management Index on public and institutional policies, Cutter et al. (2010)'s Baseline Resilience Indicators for Communities Index, Sherrieb et al. (2010)'s Community Resilience Index based on economic development and social capital, Orencio and Fujii (2013)'s localized disaster-resilience index to assess coastal communities, and Miles and Chang (2013)'s ResilUS for measuring hazard-related damage and recovery over time.

Some of the previously mentioned resilience indices have been put into applications (Table 2.2). These case studies are usually place-based because resilience can be better understood within a specific geographical, spatial and cultural context (Berkes and Ross 2013). Some case studies attempt to validate the resilience metrics by comparing them against social vulnerability and recovery metrics while others examine the utilities of the indicators and metrics by soliciting opinions of emergency practitioners. Sherrieb et al. (2010) apply the community resilience model by Norris et al. (2008) to examine economic development and social capital for the state of Mississippi at the county level. The authors utilize the metrics from eleven indicators from the Social Vulnerability Index (SoVI) to validate their resilience index. They find that community resilience along with community capital and economic development are negatively correlated with social vulnerability. Bergstrand et al. (2015) adopt this method by Sherrieb et al. (2010) and replicate the Social Vulnerability Index and the Community Resilience at the national level. Their findings suggest that there is a relationship between resilience and social vulnerability; however, this relationship is varied based on regional differences. On the other hand, Burton (2015) evaluates the relationship of resilience indicators (similar to those of BRIC) and disaster recovery at the block group level by comparing them in a case study of the Mississippi Gulf Coast. His findings suggest that certain indicators have the potential to be externally validated using post-disaster recovery activities.

Table 2.2: Selected framework-based resilience indices and case-study applications.

Resilience Framework	Domains	Resilience Index	Case-study Applications
Disaster Resilience of Place (DROP) Model (Cutter et al. 2008b)	Social, Economic, Institutional, Infrastructural, Community Capital, Ecological	Baseline Resilience Indicators for Communities (BRIC) Index (Cutter et al. 2014b)	FEMA Region IV, U.S. (Cutter et al. 2010) United States (Cutter et al. 2014b) Sarasota County, FL (Frazier et al. 2013) Sunshine Coast, Australia (Singh-Peterson et al. 2013) Indonesia (Kusumastuti et al. 2014) Mississippi Gulf Coast, U.S. (Burton 2015)
Capital-based strategies (Mayunga 2007)	Social Capital, Economic Capital. Human Capital, Physical Capital, Natural Capital	Community Disaster Resilience Index (Mayunga 2007)	Gulf Coast region, U.S. (Mayunga 2007)
Community Capacity (Norris et al. 2008)	Economic Development, Social Capital, Information and Communication, Community Competence	Community Resilience Index (Sherrieb et al. 2010)	State of Mississippi, U.S. (Sherrieb et al. 2010) United States (Bergstrand et al. 2015)
4 R's framework (Bruneau et al. 2003)	Robustness, Redundancy, Resourcefulness, Rapidity	Properties of Resilience (Chang and Shinozuka 2004)	Memphis, TN (Cimellaro et al. 2010) Memphis, TN (Chang and Shinozuka 2004)
Economic Resilience (Rose 2004)	Inherent Resilience	Computable General Equilibrium (CGE) Model	Portland, OR (Rose 2004)
PEOPLES (Renschler et al. 2010a)	Population and Demographics, Environmental/Ecosystems, Organized Governmental Services, Physical Infrastructure, Lifestyle & Community Competence, Economic Development, Social-Cultural Capital	PEOPLES (Renschler et al. 2010b)	San Francisco, CA (Martinelli et al. 2014)
Disaster-Resilient Coastal Community (Orencio and Fujii 2013)	Environmental and Natural Resource Management, Sustainable Livelihood, Social Protection, Planning Regimes	Coastal Community Disaster Resilience Index (Orencio 2014)	none

Frazier et al. (2013) and Singh-Peterson et al. (2014) exemplify several studies that evaluate the application of the BRIC index in a context-specific research. Frazier et al. (2013) explore the application of BRIC for Sarasota County, Florida. The authors conduct reviews of different types of current hazard mitigation plans and construct a checklist of resilience factors using the indicators of the Cutter et al. (2010)'s BRIC model as a reference. In addition, they also carry out focus groups with representatives from hazard, engineering, public safety and public work sectors, to help identify resilience indicators that are applicable to the region. Singh-Peterson et al. (2014) utilize the BRIC indicators (Cutter et al. 2010) to construct baseline resilience index for the Sunshine Coast of Australia using national data sources as well as for surveying representatives from telecommunication, energy, water, health, and emergency service sectors. This study examines the usefulness of the adapted BRIC as a top-down assessment tool. Based on survey analysis of planners, Singh-Peterson et al. (2014) conclude that BRIC is not suited to the Sunshine Coast local government area because of the omission of environmental resilience and regional and local diversity themes in Cutter et al. (2010). Similar to the Sunshine Coast study, the results from Frazier et al. (2013) suggest that there are several temporal, scalar and geographical limitations associated with quantitative resilience indicators. Both Singh-Peterson et al. (2014) and Frazier et al. (2013) stress the importance of consultations with practitioners and incorporate their suggestions into the construction of a resilience index, bridging the gap between academic research and practices.

Although applications of resilience indices are becoming increasingly common, they vary in terms of scale (e.g. local, city, national) and geographical area (e.g.

developed countries, developing countries). None of the noted examples conducted a longitudinal assessment of change in resilience metrics, including in the context of pre- and post-disaster. This is true despite the fact that the concept of disaster resilience emphasizes the ability or capacity of a community to cope and bounce back from disruption (Table 2.2). McAllister (2013) points out that it is important to track and monitor resilience metrics before and after hazard events in addition to determining the overall resilience of a community. In recognition of this research need, this thesis conducts a longitudinal assessment of institutional resilience before and after Hurricane Katrina.

2.3 Roles of Institutions in Building Resilience

Institutions are often perceived as instrumental to and responsible for the resilience of a social system through mitigation actions and reduction of vulnerability (Djalante and Thomalla 2011). Adger (2000, 354) states that "social resilience is institutionally determined, in the sense that institutions permeate all social systems and institutions fundamentally determine the economic system in terms of its structure and distribution of assets". Adaptive policies can help communities lessen the impacts from disaster and speed up the recovery periods by reinforcing institutional capacity for anticipation and learning. There are multiple factors that contribute to a society's or system's resilience against the impacts of natural hazards and other forms of disturbance. Efforts to examine how resilience can be strengthened or enhanced can be seen in the contexts of infrastructural resilience (Bruneau et al. 2003; McDaniels et al. 2008; Rogers et al. 2012; Chang et al. 2014), economic resilience (Rose 2007; Simmie and Martin 2010; Rose and Krausmann 2013), community capital (Norris et al. 2008; Chamlee-

Wright and Storr 2011; Aldrich 2012; Plough et al. 2013), social resilience (Morrow 2008; Keck and Sakdapolrak 2013), and institutional resilience (Adger 2000; Godschalk 2003; Berke and Smith 2009; Manyena 2014).

Institutions consist of “habitualized behavior and rules and norms that govern society as well as the more usual notion of formal institutions with memberships, constituencies and stakeholders” (Adger 2000, 348). They also contain “elements that measure how organizations manage or respond to disaster such as organizational structure, capacity, leadership, training, and experience” (Cutter et al. 2008b, 604). These usually take the form of governmental entities, but there have been growing collaborative partnerships between public sectors, private organizations and civil society in the decision-making process relating to disaster governance (Tierney 2012).

The capacity of an institution to effectively respond to and cope with natural hazard events reflects and contributes to the overall resilience of a system. Proactive hazard mitigation planning presumes the inevitability of change and attempts to create a system that is capable of adapting to new conditions and scenarios (Godschalk 2003). This type of action enhances system resilience by moving it beyond the status quo (Klein et al. 2003a; Manyena et al. 2011. Flexibility, vertical and horizontal integration and intra-sectorial cooperation regarding institutional management can serve to enhance system resilience as opposed to a hierarchical command and control structure (Cutter et al. 2008a; Berke and Smith 2009; Smith 2012; Berke et al. 2012).

Godschalk (2003) and Duxbury and Dickinson (2007) identify several mechanisms to bolster resilience against disaster: building code standards, land-use planning, at-risk property acquisition, and tax incentives. Other strategies include developing community mitigation capacity, network communication channels between different agencies and key actors, actively assessing hazards and risks, assisting socially vulnerable populations and spreading public awareness through educational and outreach programs. Effective hazard mitigation planning and practices are just two examples of instruments that can be executed by governmental institutions to support resilience building in communities.

At the national level, multiple federal disaster frameworks along with programs and funding from the Federal Emergency Management Agency (FEMA) are designed to proactively address risk reduction by incentivizing coordination and integration of mitigation activities at the state and local levels. In 2000, the federal government passed the Disaster Mitigation Act, providing a new set of requirements which states must comply with in order to qualify for mitigation grant assistance (Berke and Smith 2009; Smith 2012). It also required state and local governments to prepare and implement pre-disaster mitigation plans (Smith 2011; Godschalk et al. 2009). Furthermore, FEMA has different types of grants available for mitigation projects in the forms of post-disaster Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation Grant Program (PDM) and Flood Mitigation Assistance Program (FMA). These programs encourage and aid states and local governments in mitigation planning as well as implementing risk reduction projects (Rose 2007). Protective actions against hazard risks are beneficial investments that can significantly improve public safety by reducing loss of life and injuries (Rose 2007). A study by the Multi-hazard Mitigation Council demonstrates that on average, for every $1 spent by Federal Emergency Management Agency (FEMA) on hazard mitigation, society derives $4 in future benefits (MMC 2005).

2.3.1 Institutional Resilience Indicators

Few studies have attempted to examine institutional resilience as an individual characteristic of system resilience, and even fewer have attempted to measure it by using a set of indicators and metrics, particularly in a disaster context (Esnard et al. 2011; Ainuddin and Routray 2012; Cutter et al. 2014b; Yoon et al. 2015). For Esnard et al. (2011), institutional resilience functions as a component of an index measuring relative displacement risk to hurricanes. It consists of state and local disaster planning, mandated natural hazard elements and their geographic coverage in local planning, and mandated requirements for post-disaster recovery plans. The authors measure these variables as binary values, i.e. their presence or absence.

Another study produced by Ainuddin and Routray (2012) identify mitigation, municipal services and awareness as indicators of institutional resilience in their study of earthquake hazards in Baluchistan. Their indicators are associated with the percentage of population covered by hazard mitigation plan, percentage of municipal expenditures for fire and emergency management system and medical services, and percentage of people with earthquake education. Next, Yoon et al. (2015) develop an institutional resilience sub-index for their Community Disaster Resilience Index for South Korea. These institutional resilience indicators related to mitigation capacity and preparedness in terms of mitigation planning, rainwater outflow reduction planning and detention facilities planning.

Lastly, Cutter et al. (2010) originally proposed eight different BRIC institutional indicators for the examination of resilience in the Southeastern region on the U.S. They related to mitigation (e.g. population coverage by mitigation plan, Community Rating

Systems for Flood, and Storm Ready communities), flood insurance coverage, municipal services, political fragmentation, disaster experience, and social connectivity. Cutter et al. (2014b) update the BRIC institutional index and expand the list of indicators covering ten different aspects of disaster governance at the national scale. The institutional resilience score of each county in the U.S. can be calculated using data relating mitigation spending, flood insurance coverage, jurisdictional coordination, disaster aid experience, performance regime-proximity of county seat to state capital, performance regime-proximity of county seat to nearest metropolitan statistical area, population stability, nuclear accident planning and crop insurance coverage. These are further explained in the following chapter.

Despite the differences in methodological and contextual approach between these four studies, the basic logic behind selecting institutional resilience indicators is similar in each. First, institutional resilience is regarded as an individual characteristic of overall system resilience, along with social, economic, political, infrastructural, and environmental resilience. Second, the selection of the indicators is directly related to the availability of data sources depending on the temporal and spatial scale of the index. Finally, composite indicators are perceived to be useful for evaluating and benchmarking the baseline conditions that lead to community resilience as well as providing metrics to set priorities and aid in in decision-making processes (Cutter et al. 2010).

The institutional resilience section from the BRIC index (Cutter et al. 2014b) was chosen because its indicators are more likely to experience change post-disaster, especially in the mitigation funding and insurance expansion categories (Rose 2007; Michel-Kerjan 2010). As such, institutional policies relating to these categories are more actionable because mitigation planning and flood insurance coverage have been shown to be economically beneficial to individuals, communities and society (Kunreuther 2006; Rose 2007; Yoon et al 2015).

2.4 Summary

Resilience is a multi-faceted concept that has been conceptualized, operationalized and applied by various disciplines. In the hazard and disaster literature, resilience is closely related to mitigation, community resources, engineered structural protections, and land-use regulations. There have been many attempts to operationalize resilience frameworks into functional indices to benchmark resilience by employing metrics and indicators. In the case of institutional resilience, governing institutions are tasked with tremendous responsibility in terms of mitigating risks and enhancing resilience in their communities. As such, mitigation planning and policies are major parts of disaster governance that can affect the process of building and enhancing overall community resilience. Application of an institutional resilience index in a context-specific case study can help shed light on the utility of resilience metrics and indicators at varying scale. It is important to examine how institutional resilience, as well as other aspects of resilience (e.g. social, economic, infrastructural, community capital and ecological), has changed before and after hazard events in order to prioritize and allocate resources. In addition, monitoring institutional resilience metrics is crucial in determining the effectiveness and weaknesses of mitigation actions.

CHAPTER 3: BACKGROUND AND STUDY AREA

3.1 Background: Baseline Resilience Indicators for Communities (BRIC) Index

The Baseline Resilience Indicators for Communities (BRIC) is a resilience index designed to monitor and compare disaster resilience at multiple scales. The Disaster Resilience of Place (DROP) model on inherent resilience by Cutter et al. (2008b) provides the conceptual framework for BRIC. The data for BRIC mainly came from publicly available sources including census population data, FEMA data on flood coverage and mitigation planning, non-profits and private sources. BRIC used U.S. counties as the spatial unit of analysis because county boundaries are less likely to change over time as compared to other census units (e.g. census tracts, block groups). In addition, county emergency management institutions are heavily involved in emergency management planning, serving as intermediaries between state and municipal governments (Cutter et al. 2010; Cutter et al. 2014b).

The first version of BRIC contained five sub-indices, each with its own selection of indicators: social resilience, economic resilience, institutional resilience, infrastructure resilience and community capital (Cutter et al. 2010). Cutter et al (2014b) revised BRIC to expand the set of indicators for each of these listed components and included an additional environmental resilience sub-index. The authors transformed and standardized raw data values into comparable scales such as percentages, per capita and density functions. Variables were normalized using a min-max rescaling scheme that decomposed the values into an identical range between 0 and 1. This standardization process was also applied to the sub-component resilience scores. The overall sub-component score was calculated by summing the normalized value of relevant indicators. The final resilience score for each county was constructed by summing the composites of the six resilience sub-indices. The scores range from zero to six with higher scores indicating greater resilience (Cutter et al. 2014b). They represent a relative, not absolute, measurement of community resilience, which can be used to as comparative tools to understand resilience between places.

3.2 BRIC Institutional Resilience (IR) Indicators

The institutional resilience sub-index consists of ten indicators: mitigation spending, flood insurance coverage, jurisdictional coordination, disaster aid experience, local disaster training, performance regime-proximity of county seat to state capital, performance regime-proximity of county seat to the nearest metropolitan area, population stability, nuclear plant accident planning, and crop insurance coverage (see Table 3.1). Each indicator captures different aspects of institutions such as programs, policies, and governance structures that contribute to overall community resilience.

Table 3.1: Institutional resilience indicators, datasets, and temporal timeframes.

IR Indicators	Descriptions	Units	BRIC IR 2000	BRIC IR 2010	Method	Data Sources
Mitigation spending	ten-year-avg per capita spending for mitigation projects	$	1991-2000	2001-2010	(avg-10-yr) / (county pop size)	US Census & Hazard Mitigation Grant Program
Flood insurance coverage	% housing units covered by National Flood Insurance Program (NFIP)	%	2000	2010	(#s of NFIP policies) / (#s housing units)	US Census & NFIP
Jurisdictional coordination	governments and special districts per 10K person	ratio	2002	2007	(#s of govts & special districts) / (pop size/10K)**	US Census & Counties Database

IR Indicators	Descriptions	Units	BRIC IR 2000	BRIC IR 2010	Method	Data Sources
Disaster aid experience	presidential disaster declarations divided by number of loss causing events	ratio	1990-1999	2000-2009	(#s of PDD) / (#s of SHELDUS events)	PDD Database & SHELDUS*
Local disaster training	% population in communities with Citizen Corps program	%	2000	2010	(#s of CERTs) / (pop size)	US Census & Citizen Corps Council
Performance regimes-state capital	proximity of county seat to seat capital	miles	2000	2010	measures straight line distance from county seat to state capital**	Tiger/Line & National Atlas
Performance regimes-nearest metro area	proximity of county seat to nearest county seat within Metropolitan Statistical Area (MSA)	miles	2000	2010	measures straight line distance from county seat to nearest MSA**	Tiger/Line & National Atlas
Population stability	population change over previous five-year-period	%	1995-2000	2005-2010	% of population change in 5-yr period**	US Census & Current Population Estimates
Nuclear plant accident planning	% population within 10 miles of nuclear power plant	%	2000	2010	(pop within 10 mi of nuclear plant) / (county pop size)	US Census & Nuclear Power Plant Database
Crop insurance coverage	crop insurance policies per square mi	%	2000	2010	(#s of crop insurance) / (land coverage)	Tiger/Line & Farm Subsidies

*SHELDUS stands for Spatial Hazard Events and Losses Database for the United States
** The normalized values were inverted before the min-max standardization scheme can be applied

Mitigation planning and policies have demonstrable and measurable benefits to individuals and communities at large (Berke and Godschalk et al. 2009; McDaniels et al. 2015). In addition, a higher degree of integration of emergency management activities, local disaster training, and nuclear accident planning can enhance disaster preparedness in localities, allowing for a more effective deployment of resources during times of crisis (Murphy 2007; Ansell et al. 2010; Simonovich and Sharabi 2013). Flood insurance and crop insurance coverage can reduce the burden on individuals in the post-disaster period along with incentivizing communities to implement disaster risk reduction initiatives to minimize losses to property and livelihoods (Cheong 2011; Michel-Kerjan et al. 2012). Another aspect of resilience is disaster aid experience, which represents institutional knowledge in terms of accessing the bureaucratic structure to obtain aid and resources pertaining to disaster response and recovery. Finally, population stability is important to resilience because rapid population changes can affect the coping capability of a system. Unexpected population growth means that critical services might not be able to keep pace while population decline can contribute to decrease in tax base and municipal budgets, placing more pressure on existing institutions (Sherrieb et al. 2010). Analysis of how each of these indicators change over time contribute to better understanding of the process of building resilience, which can be influenced by various spatial and temporal factors.

3.3 Study Area

The utility of resilience metrics and indicators can be better understood through a place-based application (Berkes and Ross 2013). For this research, Hancock, Harrison and Jackson counties were selected for analysis (Figure 3.1). This thesis focuses on the coastal counties of Mississippi because the coastal area suffered from intense winds, storm surge and flooding from Hurricane Katrina, which displaced tens of thousands of people from their homes (Frey and Singer 2006). In general, Hurricane Katrina is by far the costliest tropical cyclones to hit the U.S., causing more than $108 billion in property damage mainly in Mississippi and Louisiana (Blake et al. 2011).

Winds of 135 mph and a storm surge of 32 feet wiped out casinos, businesses, parks, multimillion dollar homes and other physical structures along the affected Mississippi coast (Steven-Picou and Hudson 2010). In East Biloxi, housing of low-income residents was destroyed, rendering many homeless (Cutter et al. 2014a). Major critical lifelines were lost, businesses closed, and communities were displaced. In addition to the loss of life and property, coastal ecosystems were heavily impacted, experiencing saltwater intrusion in wetlands, erosion of barrier islands (Evans-Cowley and Gough 2008) and widespread damage to forest ecosystems (Kupfer et al. 2008).

Figure 3.1: Map of coastal counties in Mississippi.

At present, the Mississippi coast is home to about 13% of the state’s population and many important industries. The 2010 U.S. Census data shows that Harrison County, which includes the Biloxi-Gulfport metropolitan area, is the most populated (187,000) of the three coastal counties followed by Jackson County (140,00) and Hancock County (43,900). These counties are home to numerous industries including gambling, shrimping and fishing, tourism, oil and gas extraction, shipbuilding, defense and aerospace (NOAA 2015). In addition, the coast is host to many busy docks and ports, including the Port of Gulfport, one of the busiest ports in the U.S. Gulf region (NOAA 2015). The Mississippi coastal counties and their strategic locations play a vital role in the state's economy. Their geographical location along with active utilization and exploitation of coastal resources and ecosystems has also made this area more vulnerable to the destructive forces of natural hazards such as flooding, frequent hurricanes, and storm surges (Day et al. 2007).

3.4 Summary

The fundamental characteristic of resilience is the ability to persist and withstand shock after a disturbance as well as carry out adaptive learning to be more prepared for the next event. The coast of Mississippi is situated in a high-hazard area for hurricanes and storm surges. As such, it represents an ideal location for examining and monitoring resilience at a finer scale.

CHAPTER 4: METHODOLOGY AND RESULTS FOR QUESTION #1

4.1 Methodology

Q1: How has the institutional resilience for the Mississippi Gulf Coast, conceptualized as BRIC indicators, changed in the setting of pre- and post-Katrina contexts?

To answer research question #1, the institutional resilience (IR) sub-index was replicated for the state of Mississippi at the county level for years 2000 and 2010. The ten-year-period between 2000 and 2010 is sufficient for analysis of change resilience metrics. The data for the index were gathered, transformed, normalized, and standardized according to the methodology provided in Cutter et al (2014b). Instead of scaling the institutional resilience metrics at the national scale for 3,108 U.S. counties as seen in the work of Cutter et al. 2014b, these IR were scaled for eighty-two counties in Mississippi. This process allowed for intra-county comparison within the State of Mississippi. Theoretically, a county in Mississippi will have more in common with other counties in Mississippi than with counties in Minnesota or Virginia, given that mitigation activities devolve from the federal level to states and their local communities (FEMA 2013).

The IR composite score for each county ranges from 0 to 10, with the higher score indicating more resilience. The individual indicator values range from 0 to 1, with unity indicating the most resilient condition. In the case of four indicators, the absolute values were inverted to match theoretical orientation. They consist of jurisdictional coordination, performance regime-proximity of county seat from state capital, performance regime-proximity of county seat from the nearest metropolitan area, and population stability. For instance, the smaller the value for jurisdictional coordination, the more integrated the governance structure. Similarly, smaller distances from each county seat to the capital and the nearest metropolitan statistical area indicates increased resilience due to proximity to resources. In addition, smaller changes in population within the five-year-period contribute to resilience because the counties are less likely to experience unexpected strains on institutional resources from new arrivals.

First, the IR scores were mapped because the visualization of resilience scores can provide a comparative overview of where improvements are most needed. Next, paired difference of means tests (alpha of 0.05) was applied to determine whether the BRIC scores aggregated at the state scale have significantly changed over the ten-year-period. Further, to illustrate that scale matters, different combination of IR scores at the national scale and the state scale for 2000 and 2010 were used as pairs in the statistical analysis.

Second, given that the nonparametric distribution of each IR indicator, the Wilcoxon Signed-Rank test, an alternative to the paired different of means test, was applied to the standardized values to determine which IR indicators had significantly changed from 2000 to 2010 at Mississippi scale. Drivers of institutional resilience at the state scale refer to variables of the index that experience statistically significant change (alpha of 0.05) longitudinally. In the case of the tri-county study area, drivers of institutional resilience are determined by the significant change in rank and absolute values from 2000 and 2010. In addition, the absolute values of each indicator were utilized to explain and contextualize the changes in resilience aspects for both the state of Mississippi and the study area.

4.2 Visualization of Temporal Change in Institutional Resilience for Mississippi

The maps in Figure 4.1 illustrate that institutional resilience for Mississippi counties has changed spatially over ten years. The northern part of the Mississippi tends to have lower scores than the southern part at both times. In 2000, the most resilient counties were Quitman, Grenada, Leflore, Washington, Warren, Hinds and Harrison. In 2010, this spatial distribution shifted towards the coastal area, with Lawrence, Hancock, Harrison and Jackson and their neighboring counties having the highest resilient scores. By contrast, the spatial pattern for least resilient counties also changed. In 2000, the least resilient counties were located in northeastern part of the state including Union, Tishomingo, Itawamba and Yalobusha. By 2010, these counties were replaced by Benton, Sharkey and Choctaw. Moreover, many other counties experienced a change in ranking. For example, the resilience score for De Soto County shifted from relatively low in 2000 to relatively high in 2010. A contrasting example is Washington County, whose score of high resilience in 2000 shifted to medium resilience in 2010.

Table 4.1 and Table 4.2 show the scores of the most and least resilient counties in 2000 and 2010 from Figure 4.1. The standardized values of each indicator are also shown. For 2000, the difference between the highest and the lowest resilience score was 2.41 while for 2010, it was 3.04. The most resilient counties in 2000 had high values in the areas of jurisdiction coordination and population stability. In comparison, the most resilient counties in 2010 were also highly ranked in terms integrated government coordination as well as urbanization. The least resilient counties ranked high only in one or two aspects and very low in others. Furthermore, indicators such as disaster training and nuclear planning in general contributed little value to institutional resilience.

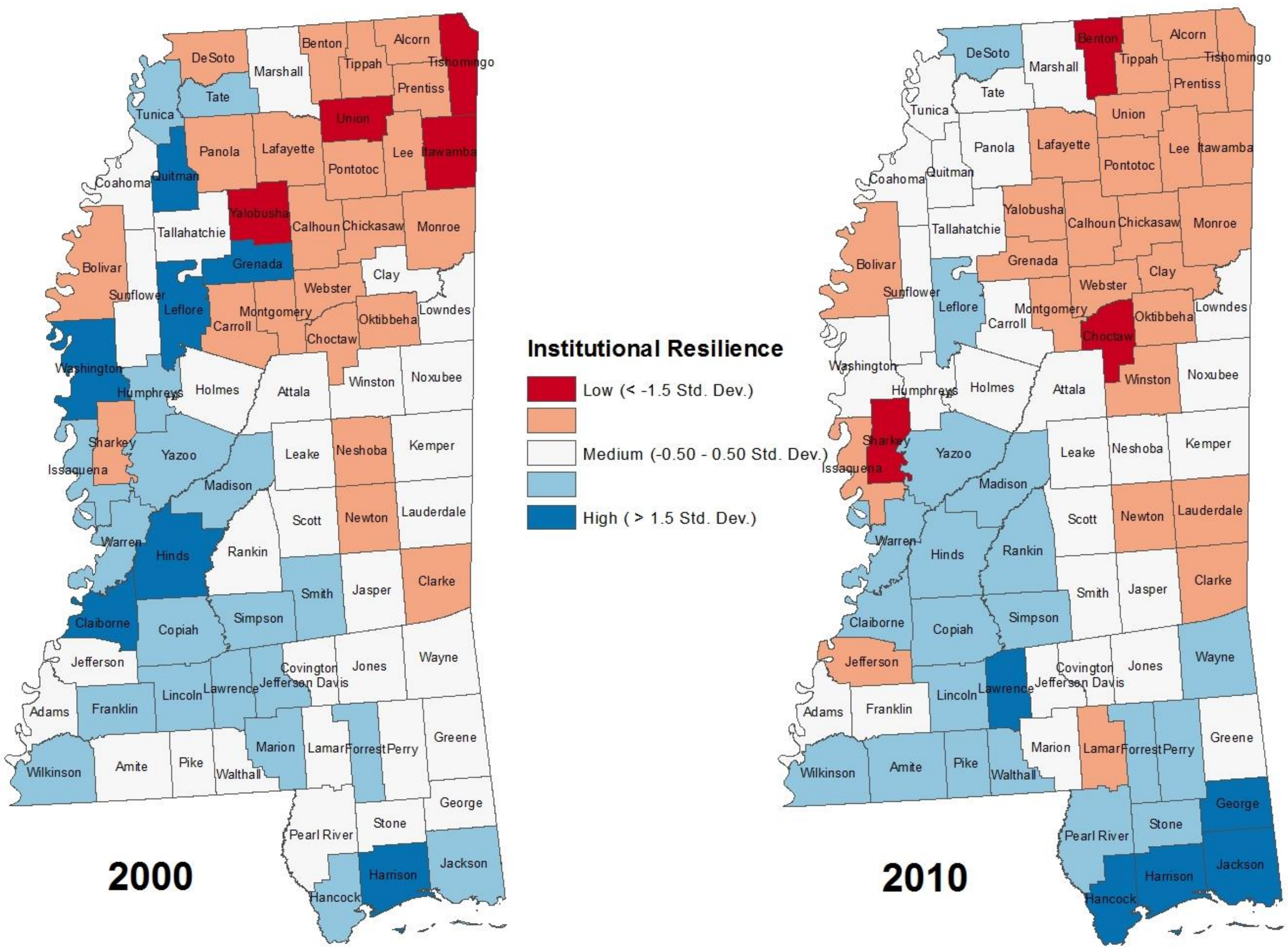

Figure 4.1: BRIC institutional resilience scores for eighty-two counties in Mississippi in 2000 and 2010 (aggregated at the state scale).

Table 4.1: Breakdowns of BRIC institutional resilience scores and metrics (standardized values) for Mississippi counties with the highest and lowest rankings in 2000, aggregated at state scale (n=82).

Rank	County	IR Score 2000	Mitigation Spending	Flood Insurance Coverage	Jurisdiction Coordination	Disaster Aid Exp	Disaster Training	Near State Capital	Near MSA	Pop Stability	Nuclear Planning	Crop Insurance Coverage
Most resilient												
1	Leflore	4.66	0.73	0.47	0.77	0.19	0.00	0.62	0.21	1.00	0.00	0.68
2	Washington	4.61	0.67	0.45	0.85	0.37	0.00	0.59	0.29	0.83	0.00	0.55
3	Claiborne	4.53	0.00	0.07	0.84	0.20	0.00	0.80	0.57	1.00	1.00	0.05
4	Harrison	4.47	0.54	0.57	0.97	0.25	0.00	0.30	1.00	0.84	0.00	0.00
5	Quitman	4.44	0.65	0.12	0.06	0.68	0.00	0.36	0.62	0.95	0.00	1.00
Least resilient												
78	Benton	2.47	0.00	0.00	0.27	0.18	0.00	0.11	0.81	0.99	0.00	0.12
79	Tishomingo	2.46	0.00	0.01	0.73	0.13	0.00	0.00	0.66	0.85	0.00	0.07
80	Itawamba	2.45	0.05	0.01	0.78	0.13	0.00	0.19	0.37	0.80	0.00	0.11
81	Union	2.43	0.00	0.00	0.71	0.07	0.00	0.21	0.62	0.65	0.00	0.18
82	Yalobusha	2.25	0.00	0.02	0.38	0.02	0.00	0.38	0.53	0.80	0.00	0.11

Table 4.2: Breakdowns of BRIC institutional resilience scores and metrics (standardized values) for Mississippi counties with the highest and lowest rankings in 2010, aggregated at state scale (n=82).

Rank	County	IR Score 2010	Mitigation Spending	Flood Insurance Coverage	Jurisdiction Coordination	Disaster Aid Exp	Disaster Training	Near State Capital	Near MSA	Pop Stability	Nuclear Planning	Crop Insurance Coverage
Most resilient												
1	Hancock	5.30	1.00	1.00	0.84	0.37	0.00	0.31	1.00	0.78	0.00	0.00
2	Jackson	4.55	0.32	0.70	0.98	0.41	0.00	0.22	1.00	0.90	0.00	0.01
3	Harrison	4.38	0.35	0.54	0.99	0.33	0.00	0.30	1.00	0.87	0.00	0.00
4	George	4.37	0.18	0.04	0.95	1.00	0.00	0.38	1.00	0.77	0.00	0.05
5	Lawrence	4.16	0.02	0.02	0.85	0.17	0.79	0.79	0.66	0.84	0.00	0.02
Least resilient												
78	Montgomery	2.41	0.00	0.01	0.69	0.03	0.00	0.62	0.21	0.71	0.00	0.13
79	Oktibbeha	2.39	0.03	0.04	0.94	0.28	0.00	0.49	0.16	0.41	0.00	0.03
80	Benton	2.35	0.01	0.00	0.50	0.20	0.00	0.11	0.81	0.58	0.00	0.14
81	Choctaw	2.31	0.02	0.00	0.71	0.23	0.00	0.60	0.14	0.59	0.00	0.02
82	Sharkey	2.26	0.00	0.16	0.00	0.12	0.00	0.76	0.36	0.33	0.00	0.52

The result from a paired difference of means test suggests that there is no statistically difference between the BRIC IR scores in 2000 and 2010 at the Mississippi scale (Table 4.3). Although the changes are not statistically significant, one must keep in mind that institutional resilience for each county is a composite score, which is calculated by summing the standardized values of all ten indicators. These values of any particular indicator have increased or decreased over the ten-year-period.

Table 4.3: Paired difference of means test result comparing BRIC IR scores (aggregated at state scale) in 2000 and 2010

Pair	t-statistic	p-value ($p < 0.05$)
State BRIC IR Scores 2000 State BRIC IR Scores 2010	-1.114	.269

4.2.1 Scaling Matters: Aggregation at the National Scale versus State Scale

The replicated BRIC IR scores for Mississippi in this study were scaled within the eighty-two counties. Paired difference of means tests (Table 4.4) suggest the scores scaled at the national scale for Mississippi are statistically different than the scores scale statewide in both 2000 and 2010. For example, in 2010, Hancock County had an IR score of 5.30 at the state scale as compared to a score of 4.48 at the national scale (see Table 4.5 and Table 4.6). At the Mississippi scale, Hancock County is being compared against eighty-one other counties in Mississippi, while at the national scale, it is compared against 3,107 other counties in the U.S. While the paired difference of means test in Table 3.2 indicates that there is no statistical significant difference between the IR scores for Mississippi from 2000 to 2010, the IR scores at the national scale are statistically different from 2000 to 2010 (Table 4.4). These statistical results illustrate that spatial scale has a considerable influence on the institutional resilience scores. It is important to consider the scaling factor and comparison units when the index is being replicated. More details regarding the significance of scaling are discussed in the case study section of Hancock, Harrison and Jackson counties.

Table 4.4: Paired difference of means test comparing Mississippi IR scores aggregated at the national scale and Mississippi IR scores aggregated at state scale in 2000 and 2010.

Pair	t-statistic	p-value ($p < 0.05$)
National BRIC IR Scores 2000 State BRIC IR Scores 2000	12.705	.000
National BRIC IR Scores 2010 State BRIC IR Scores 2010	10.226	.000
National BRIC IR Scores 2000 National BRIC IR Scores 2010	-7.501	.000

4.3 Case Study: BRIC Institutional Resilience for Hancock, Harrison and Jackson Counties

Hancock, Harrison and Jackson counties were utilized in as a case study to compare whether the drivers of institutional resilience for the Mississippi Coast were different than the drivers for the entire state. Table 4.5 contains the BRIC IR scores for the three coastal counties aggregated at the state scale, showing that that their IR scores and rankings have changed from 2000 to 2010. Hancock County ranked eighth out of eighty-two counties in 2000 and first in 2010, moving from 3.96 to 5.30. Similarly, Jackson County has the largest jump in ranking, moving from tenth place in 2000 to second place in 2010, with its score changing from 3.88 to 4.55. Harrison County moved from fourth place in 2000 to third place in 2010, although the score decreased slightly from 4.47 to 4.38.

In 2000, the three counties ranked high in terms of urbanization and flood insurance coverage. They ranked on the low end in several categories including disaster aid experience, performance regime-proximity of county seat to state capital, population stability, and crop insurance coverage. Since there was no Community Emergency

Response Team (CERT) or nuclear plant in Hancock, Harrison and Jackson, the nuclear plant accident planning and local disaster training indicators are not applicable to these counties. In 2010, Hancock, Harrison and Jackson ranked in the top three counties in terms of mitigation spending and flood insurance coverage and on the bottom for crop insurance coverage. Jackson and Hancock County, who respectively ranked eighteenth and twenty-first in mitigation spending per capita in 2000, moved to first and second place in 2010. In addition, the ranks of these three counties in the disaster aid experience and population stability have relatively improved. The two performance regime indicators are constant in values for 2000 and 2010, and as such, there was no change in rank.

At the national scale (see Table 4.6), Hancock, Harrison and Jackson counties have moved up in ranks from 2000 to 2010, and their BRIC IR scores have also increased over time. In 2000, Hancock County ranked 1109th out of 3,108 counties. In 2010, it ranked 124th of out of 3,108 counties. Similarly, Harrison County moved from 994th place in 2000 to 610th place in 2010, and Jackson County moved from 1385th place in in 2000 to 397th place in 2010. In terms of percentiles, at the national scale, Hancock and Harrison counties ranked in the 70th percentile with Jackson County in the 50th percentile in 2000. By 2010, Hancock County was in the 90th percentile while Harrison and Jackson were in the 80th percentile. By comparison, at the state scale Hancock, Harrison and Jackson counties ranked in the 90th percentile in both 2000 and 2010.

Table 4.5: Breakdowns of BRIC institutional resilience scores and metrics (standardized values) for Hancock, Harrison and Jackson counties in 2000 and 2010, with state ranking in parentheses (out of 82 counties).

Rank	County	IR State Score	Mitigation Spending	Flood Insurance Coverage	Jurisdiction Coordination	Disaster Aid Exp	Disaster Training	Near State Capital	Near MSA	Pop Stability	Nuclear Planning	Crop Insurance Coverage
BRIC IR 2000												
8	Hancock	3.96	0.01 (21)	1.00 (1)	0.76 (44)	0.38 (26)	0.00 (n/a)	0.31 (66)	1.00 (1)	0.50 (78)	0.00 (n/a)	0.00 (76)
4	Harrison	4.47	0.54 (5)	0.57 (3)	0.97 (2)	0.25 (49)	0.00 (n/a)	0.30 (67)	1.00 (1)	0.84 (44)	0.00 (n/a)	0.00 (79)
10	Jackson	3.88	0.02 (18)	0.53 (4)	0.96 (4)	0.27 (43)	0.00 (n/a)	0.22 (72)	1.00 (1)	0.86 (40)	0.00 (n/a)	0.01 (58)
BRIC IR 2010												
1	Hancock	5.30	1.00 (1)	1.00 (1)	0.84 (46)	0.37 (11)	0.00 (n/a)	0.31 (66)	1.00 (1)	0.78 (50)	0.00 (n/a)	0.00 (78)
3	Harrison	4.38	0.35 (3)	0.54 (3)	0.99 (3)	0.33 (14)	0.00 (n/a)	0.30 (67)	1.00 (1)	0.87 (34)	0.00 (n/a)	0.00 (77)
2	Jackson	4.55	0.32 (2)	0.70 (2)	0.98 (5)	0.41 (9)	0.00 (n/a)	0.22 (72)	1.00 (1)	0.90 (29)	0.00 (n/a)	0.01 (56)

Table 4.6: Breakdowns of BRIC institutional Resilience scores and metrics (standardized values) for Hancock, Harrison and Jackson counties in 2000 and 2010, with national ranking in parentheses (out of 3,108 counties).

Rank	County	IR National Score	Mitigation Spending	Flood Insurance Coverage	Jurisdiction Coordination	Disaster Aid Exp	Disaster Training	Near State Capital	Near MSA	Population Stability	Nuclear Planning	Crop Insurance Coverage
BRIC IR 2000												
1109	Hancock	4.03	0.00 (1027)	0.29 (58)	0.99 (1138)	0.22 (972)	0.00 (n/a)	0.71 (2219)	1.00 (1)	0.81 (2838)	0.00 (n/a)	0.00 (2706)
994	Harrison	4.06	0.08 (162)	0.17 (89)	1.00 (326)	0.16 (1423)	0.00 (n/a)	0.71 (2236)	1.00 (1)	0.94 (1608)	0.00 (n/a)	0.00 (2729)
1385	Jackson	3.96	0.00 (951)	0.15 (91)	1.00 (342)	0.17 (1354)	0.00 (n/a)	0.68 (2406)	1.00 (1)	0.95 (1421)	0.00 (n/a)	0.00 (2377)
BRIC IR 2010												
124	Hancock	4.48	0.23 (27)	0.54 (18)	0.99 (1243)	0.10 (1221)	0.00 (n/a)	0.71 (2219)	1.00 (1)	0.91 (2188)	0.00 (n/a)	0.00 (2764)
610	Harrison	4.11	0.08 (84)	0.29 (59)	1.00 (268)	0.09 (1330)	0.00 (n/a)	0.71 (2236)	1.00 (1)	0.95 (1540)	0.00 (n/a)	0.00 (2280)
397	Jackson	4.20	0.07 (97)	0.38 (38)	1.00 (316)	0.11 (1117)	0.00 (n/a)	0.68 (2406)	1.00 (1)	0.96 (1292)	0.00 (n/a)	0.01 (2718)

For comparison, Table 4.5 and Table 4.6 break down the state and national ranking by individual indicators in year 2000 and 2010. These rankings clarify where each county ranked statewide and nationally in terms of mitigation spending, flood insurance coverage, government coordination, disaster aid experience, local disaster training, performance regimes, population stability, crop insurance coverage and nuclear accident planning. For example, in 2000, Hancock ranked first in the state in the flood insurance coverage category with an indicator score of 1.00. At the national scale, although the absolute value for flood insurance policy per housing unit remained the same, Hancock County ranked 58th out of 3,108 counties with an indicator score of 0.29. Such discrepancies between the national and state scale demonstrate that ranking can be interpreted differently depending on the scaling. As noted earlier, the spatial scale is a crucial factor to consider in replication of an index as well in interpretation of its metrics and indicators.

4.4 Examination of Institutional Resilience Indicators and Metrics for Mississippi and Hancock, Harrison and Jackson Counties

The Wilcoxon Signed-Rank tests were performed on the all the institutional indicators to determine whether the changes in rank from 2000 to 2010 are statistically significant for the state of Mississippi. Due to the low number of cases in the tri-county study area, this test cannot be used to determine statistical significance in Hancock, Harrison and Jackson counties. The results are listed in Table 4.7, which reveal that rank changes are statistically significant for several indicators such as mitigation spending, flood insurance coverage, jurisdictional coordination, disaster aid experience, and crop insurance coverage. Meanwhile, changes in local disaster training, population stability and nuclear accident planning are not significant. In the case of the performance regimes, their values remain constant in the BRIC 2000 and 2010 and as such, no change could be measured. Moreover, there was no data for Mississippi in 2000 in the local disaster training category. As a result, the Wilcoxon Signed-Rank test was not applied for this indicator.

Table 4.7: Wilcoxon Signed-Rank Test results comparing change in values of each indicator from 2000 to 2010 for the State of Mississippi (n=82).

Indicators	Wilcoxon ($p < 0.05$)
Mitigation spending	0.000
Flood insurance coverage	0.000
Jurisdictional coordination	0.000
Disaster aid experience	0.000
Performance regimes-state capital	1.000
Performance regimes-nearest metro area	1.000
Population stability	0.076
Nuclear plant accident planning	0.655
Crop insurance coverage	0.048

4.4.1 Mitigation Spending: State of Mississippi

The Wilcoxon Signed-Rank test indicates that the mitigation spending in 2000 is statistically different from 2010 (see Table 4.7). In general, the majority of counties in Mississippi experienced significant increases in mitigation funding from 2000 to 2010. Many counties had zero in mitigation spending in 2000, with only thirty-seven counties having received mitigation funding between 1991 and 2000. By 2010, majority of counties had received post-disaster mitigation funding from the Hazard Mitigation Grant Program (HMGP). A close examination of the absolute values of counties with highest mitigation spending in 2000 and 2010 indicate some discrepancies between temporal contexts in terms of longitudinal assessment. For instance, Grenada County ranked first in hazard mitigation spending with $16.20 per capita in 2000 and Hancock County in 2010 with $85.10 per capita (Table 4.8 and Table 4.9). This difference in highest mitigation spending per capita from 2000 to 2010 reveals two important points: 1) Mitigation spending in Mississippi has increased systematically from 2000 to 2010 and 2) In order to understand the significance of the rank changes, researchers and practitioners like must examine both the absolute and standardized (ranked) data.

Table 4.8: Mississippi counties with the highest mitigation spending per capita in 2000.

Rank	County	Mitigation per capita ($)	2000 Population	Grants Received ($)	#s of Grants
1	Grenada	16.21	23,263	2,978,290	1
2	Leflore	11.75	37,947	3,521,184	5
3	Washington	10.78	62,977	5,364,533	5
4	Quitman	10.51	10,117	839,624	3
5	Harrison	8.73	189,601	13,075,743	16

Table 4.9: Mississippi counties with the highest and lowest mitigation spending per capita in 2010.

Rank	County	Mitigation per capita ($)	2010 Population	Grants Received ($)	#s of Grants
1	Hancock	85.10	43,929	37,381,916	26
2	Stone	68.28	17,786	12,145,112	9
3	Wayne	40.69	20,747	8,442,938	6
4	Harrison	30.18	187,105	56,472,159	41
5	Jackson	27.44	139,668	38,333,603	32
…					
78	Calhoun	0.27	14,962	39,815	2
79	Issaquena	0	1,406	0	0
80	Itawamba	0	23,401	0	0
81	Marshall	0	37,144	0	0
82	Sharkey	0	4,916	0	0

Given that the standardized data represents mitigation funding per capita, it does not capture the disparity between more populous counties and less populous counties. For example, in 2000, although Grenada County had the highest mitigation spending per capita, Harrison County received the most mitigation grants, taking in about $13 million for sixteen projects; Grenada only received $3 million for one project. The reason that

Harrison County ranks lower in terms of mitigation spending is because it has a much larger population (189,601) as compared to Grenada (23,263) and the values were standardized by population. Such discrepancies can also be observed in the 2010 data in which Wayne County ranked higher than Harrison County in terms of mitigation spending per capita; however, Harrison County had nine times the population of Wayne County and seven times the amount of grants received.

The shift in mitigation spending concentration can be attributed to Hurricane Katrina and the affected geographical area. In 2000, the state of Mississippi and its counties had ninety-eight projects funded by the HMGP. Funding from HMGP can only be acquired in the post-disaster context in which a disaster has been declared by the federal government. Between 1991 and 2000, Mississippi had several federally declared disasters including severe storms, ice storms, flooding, tornadoes, and hurricanes. Out of ninety-eight grants, twenty-six were linked to a severe winter event in 1994, and thirty-three to Hurricane George, which impacted many counties in 1998. In comparison, between 2001 and 2010, the state and its counties received 463 HMGP grants, about 74% (341 grants) of which were related to Hurricane Katrina in 2005.

4.4.1.1 Mitigation Spending: Hancock, Harrison and Jackson Counties

Mitigation spending dramatically increased for all three coastal counties from 2000 to 2010. This reflects the overall trend at the state scale. For example, Hancock County had only $0.31 mitigation spending per capita in BRIC IR 2000 (Table 4.10). In 2010, this value increased to $85.10 per capita. Similarly, Harrison and Jackson also experienced increase in mitigation funding, which influences the change in ranking. Hancock County came in first place in 2010, as compared its twenty-first place in 2000.

Harrison County shifted from fifth place to second place, even though contribution of mitigation spending to the overall IR score has dropped from 0.54 to 0.34. Certainly, the ranking shift in mitigation spending has an important role in the change in institutional resilience for the Mississippi Gulf Coast as well as having significant contribution to the overall BRIC IR scores in 2010. For example, change in ranking for Hancock County increases the standardized value from 0.01 in BRIC IR 2000 to 1.00 in BRIC 2010, adding 0.99 to the overall resilience score. In 2000, mitigation spending contributed to less than 0.1% of the IR score. In 2010, it made up for about 20% of the overall IR score.

Table 4.10: Mitigation spending for Hancock, Harrison and Jackson counties in 2000 and 2010.

Rank	County	BRIC IR values (standardized)	Mitigation per Capita ($)	Population Size	Grant Received ($)	#s of Grants
BRIC IR 2000						
21	Hancock	0.01	0.19	42,967	65,050	3
5	Harrison	0.54	8.73	131,420	13,075,743	16
18	Jackson	0.02	0.31	189,601	322,336	5
BRIC IR 2010						
1	Hancock	1.00	85.10	43,929	37,381,916	26
2	Harrison	0.35	30.18	187,105	56,472,159	41
3	Jackson	0.32	32.45	139,668	38,333,603	32

These increases in migration funding can be linked to Hurricane Katrina. Twenty-three out of twenty-six grants for Hancock County in BRIC IR 2010 are directly related to Katrina, thirty-four out forty-one for Harrison County, and twenty-two out of thirty-two for Jackson County. In the pre-Katrina period, the three coastal counties received around $14 million in mitigation funding. In contrast, they received about $120 million in HMGP funding in the post-Katrina period.

4.4.2 Flood Insurance Coverage: State of Mississippi

The Wilcoxon Signed-Rank Test was utilized to compare flood insurance coverage in 2000 and 2010 (see Table 4.7). This test indicates that the there is a statistically significant difference between the 2000 and 2010. A closer look at the absolute values suggests that flood coverage has generally expanded for the entire state of Mississippi, but the percentage of coverage remains relatively low. Less than ten counties have flood coverage that exceeded ten percent. Table 4.11 and Table 4.12 contain details regarding the number of flood insurance policy and housing units of top five counties with the highest and lowest coverage. Hancock, Harrison and Jackson counties are the top ranking counties in both the 2000 and 2010. These counties have to frequently deal with hazards relating to storm surge, flooding, and tropical cyclones. Benton, Franklin and Tippah County remain on the bottom in 2000 and 2010 with little to no expansion of flood coverage.

Table 4.11: Mississippi counties with highest and lowest flood insurance coverage in 2000.

Rank	County	% of Housing Units with Flood Insurance	#s of NFIP Policies in 2000	#s of Housing Units
1	Hancock	22.42	4,724	21,072
2	Issaquena	17.79	156	877
3	Harrison	12.79	10,184	79,636
4	Jackson	11.83	6,114	51,678
5	Leflore	10.46	1,475	14,097
…				
78	Tippah	0.05	5	8,868
79	Jefferson	0.03	4	5891
80	Franklin	0.24	1	4,119
81	Benton	0	0	3,456
82	Kemper	0	0	4,533

Table 4.12: Mississippi counties with highest and lowest flood insurance coverage in 2010.

Rank	County	% of Housing Units with Flood Insurance	#s of NFIP Policies in 2010	#s of Housing Units
1	Hancock	48.34	9,550	19,756
2	Jackson	34.05	19,748	57,995
3	Harrison	26.01	20,880	80,275
4	Issaquena	21.35	152	712
5	Washington	11.87	2,645	22,276
…				
78	Tippah	0.12	12	9,609
79	Pontotoc	0.11	13	12,215
80	Benton	0.10	4	4,073
81	Jefferson Davis	0.08	5	5,909
82	Franklin	0.02	1	4,170

From 2000 to 2010, the number of NFIP policies increased with little change in the number of housing units for the majority of counties in Mississippi. This dramatic expansion of flood insurance coverage for the coastal area can be linked to Hurricane Katrina. The damages caused by the storm surges from Katrina revealed the risk and vulnerability of populated settlements along the coast resulting in increased participation in the NFIP Program (Michel-Kerjan 2010).

4.4.2.1 Flood Insurance Coverage: Hancock, Harrison and Jackson Counties

Flood insurance policies double in the case of Hancock and Harrison counties while tripling for Jackson County from 2000 to 2010 (Table 4.13). This trend parallels the overall state trend in increased flood insurance expansion in the post-disaster period. Hancock, Harrison and Jackson counties are the top three counties with the highest flood insurance coverage in both BRIC IR 2000 and 2010. As mentioned earlier, the expansion in flood insurance coverage from 2000 to 2010 can be attributed to Hurricane Katrina, given the severity of the post-disaster impacts. Since the rankings for these three counties remain relatively the same from 2000 to 2010, they do not significantly influence the change in the IR scores because the tri-coastal counties remain in the top three. The change in rank (or lack thereof) due to min-max scaling, however, obscures the fact that the number of flood insurance policies has increased dramatically in the study area. Furthermore, the flood insurance coverage indicator is one of the main contributors to the BRIC IR scores for the Mississippi coast. In BRIC IR 2000 and 2010, it makes up almost 20% of the overall resilience score in Hancock County and 13% for Harrison County.

Table 4.13: Flood insurance coverage for Hancock, Harrison and Jackson counties in 2000 and 2010.

Rank	County	BRIC IR values (standardized)	% of Housing Units with Flood Insurance	#s of NFIP Policy	#s of Housing Units
BRIC IR 2000					
1	Hancock	1.00	22.41838	4,724	21,072
3	Harrison	0.57	12.78819	10,184	79,636
4	Jackson	0.53	11.83095	6,114	51,678
BRIC IR 2010					
1	Hancock	1.00	48.33974	9,550	19,756
3	Harrison	0.54	26.01059	20,880	80275
2	Jackson	0.70	34.05121	19,748	57,995

4.4.3 Jurisdictional Coordination: State of Mississippi

The results from the Wilcoxon Signed-Rank Test indicate that there is a statistically significant difference from 2000 to 2010 regarding to jurisdictional coordination (see Table 4.7). The number of government and special districts (e.g. local administrative bodies) in Mississippi counties saw an overall decline from 2000 to 2010 (Table 4.14 and Table 4.15). The data classification system from the U.S. Census might have changed over the years; some government and special districts that were counted in 2000 are not included in 2007. Another reason is that some of the governments and special districts are eliminated or consolidated over the years due to budget constraints or government reforms. For instance, Hinds County had a total of twenty government and special districts in 2000. By 2010, six of them had been eliminated or consolidated while the population size has decreased slightly. This can also be observed in the case of Bolivar County, which saw a decrease in government and special districts from a total of fifty in 2000 to forty-three in 2010.

Table 4.14: Mississippi counties with highest and lowest jurisdictional coordination in 2000.

Rank	County	Govts per 10K people	2000 Population	#s of Govts and Special Districts in 2000
1	De Soto	1.49	107,199	16
2	Jackson	1.45	131,420	19
3	Lauderdale	1.41	78,161	11
4	Harrison	1.37	189,601	26
5	Hinds	0.88	250,800	22
…				
78	Sharkey	16.72	6,580	11
79	Quitman	15.81	10,117	16
80	Benton	12.46	8,026	10
81	Bolivar	12.31	40,633	50
82	Calhoun	11.28	15,069	17

Table 4.15: Mississippi counties with highest and lowest jurisdictional coordination in 2010.

Rank	County	Govts and Special Districts per 10K people	2010 Population	#s of Govts and Special Districts in 2010
1	Hinds	0.65	245,285	16
2	Lauderdale	0.87	80261	7
3	Harrison	0.91	187,105	17
4	DeSoto	1.05	161,252	17
5	Jackson	1.07	139,668	15
…				
78	Benton	11.46	8,729	10
79	Bolivar	12.59	34,145	43
80	Issaquena	14.22	1,406	2
81	Quitman	18.24	8,223	15
82	Sharkey	22.38	4,916	11

The top five counties with the highest jurisdictional coordination in 2000 and 2010 were Hinds, Lauderdale, Harrison, De Soto and Jackson County. Their low values in the Govt. Coordination column in Table 4.14 and 4.15 indicate they have less political fragmentation as compared to their counterparts. For example, in 2000, De Soto County had sixteen government and special districts that are responsible for a population of 107,199 people. In contrast, Bolivar County had fifty government and special districts for a population of 40,633. As mentioned earlier in the background describing BRIC indicators, the fewer government and special districts that are present in a county, the higher the jurisdictional coordination. In addition, the counties that have the highest jurisdictional coordination values are also highly populous while the counties with the lowest are less populated.

4.4.3.1 Jurisdictional Coordination: Hancock, Harrison and Jackson Counties

Hancock, Harrison and Jackson counties experienced a reduction in the number of government and special districts from 2000 to 2010, although their population sizes have changed only slightly (Table 4.16). As such, this decrease indicates that there is more coordination between different agencies and less political fragmentation, contributing to overall institutional resilience. As discussed earlier, the state of Mississippi overall experiences a decline in this category. The influence of this statewide trend can be seen in the jurisdictional coordination ranking of the counties which has remained relatively the constant from 2000 to 2010. It is not a significant driver of the change in institutional resilience. A high degree of jurisdictional coordination, however, is an important contributor to overall IR scores for these three coastal counties.

Table 4.16: Jurisdictional coordination for Hancock, Harrison and Jackson counties in 2000 and 2010.

Rank	County	BRIC IR values (standardized)	Govts and Special Districts per 10K people	Population Size	#s Govts and Special Districts
BRIC IR 2000					
44	Hancock	0.76	4.65	42,967	20
2	Harrison	0.97	1.37	189,601	26
4	Jackson	0.96	1.45	131,420	19
BRIC IR 2010					
46	Hancock	0.84	4.10	43,929	18
3	Harrison	0.99	0.91	187,105	17
5	Jackson	0.98	1.07	139,668	15

4.4.4 Disaster Aid Experience: State of Mississippi

The Wilcoxon Signed-Rank Test indicates that there is a statistically significant difference from 2000 to 2010 regarding disaster aid experience (see Table 4.7). Table 4.17 and Table 4.18 illustrate that the number of PDDs has not increased over time but the loss-causing events have significantly increased. As such, there is a clear trend of decline from 2000 to 2010 in terms of the ratio of PDD per loss event. Given that the ratio speaks to the ability of counties to acquire federal funding post-disaster, counties with lower ratios are less resilient than counties with higher ratios as they either receive less federal assistance and/or experience more loss-events from hazards. One important caveat to keep in mind is that PDDs and loss-causing events are numeric counts. A billion dollar PDD for a particular county, like Hurricane Katrina, is counted exactly the same as a one hundred million dollar PDD in another county. This formula of not distinguishing the dollar amount also applies to the loss-causing events.

Table 4.17: Mississippi counties with highest and lowest disaster aid experience in 2000.

Rank	County	PDD per Loss Event in 2000	#s of PDDs	#s of loss events
1	Tate	0.50	10	20
2	Franklin	0.47	8	17
3	Wilkinson	0.47	7	15
4	Quitman	0.36	5	14
5	Tunica	0.33	5	15
	…			
78	Sharkey	0.08	2	25
79	Neshoba	0.06	3	48
80	Lee	0.06	5	86
81	Yalobusha	0.06	2	35
82	Forrest	0.05	3	62

Table 4.18 Mississippi counties with highest and lowest disaster aid experience in 2010.

Rank	County	PDD per Loss Event in 2010	#s of PDD	#s of loss event
1	George	0.24	6	25
2	Wilkinson	0.23	6	26
3	Amite	0.21	7	33
4	Green	0.14	5	36
5	Wayne	0.14	5	36
…				
78	Jones	0.02	4	173
79	Rankin	0.02	5	218
80	Leflore	0.02	2	99
81	Montgomery	0.02	1	54
82	De Soto	0.01	2	162

4.4.4.1 Disaster Aid Experience: Hancock, Harrison and Jackson Counties

The disaster aid experience ranking for Hancock, Harrison and Jackson counties has moved up from 2000 to 2010, even though these counties have had more hazard related loss-events in 2010 (Table 4.19). This ranking reflects a statewide trend of increasing loss events while the number of PDDs remains relatively constant from 2000 and 2010. The BRIC IR standardized values indicate that disaster aid experience is a driver of change in institutional resilience as well as a modest contributor to the overall BRIC IR scores.

Table 4.19: Disaster aid experience for Hancock, Harrison and Jackson counties in 2000 and 2010.

Rank	County	BRIC IR values (standardized)	PDD per Loss Event	#s of PDDs	#s of loss events
BRIC IR 2000					
26	Hancock	0.38	0.22	7	32
49	Harrison	0.25	0.16	7	43
43	Jackson	0.27	0.17	7	41
BRIC IR 2010					
11	Hancock	0.37	0.10	6	62
14	Harrison	0.33	0.09	6	69
9	Jackson	0.41	0.11	7	66

4.4.5 Local Disaster Training: State of Mississippi and Hancock, Harrison and Jackson Counties

The indicator for Local Disaster Training is characterized by the percent of population covered by Community Emergency Response Team (CERT) Program, which is part of the Citizen Corps Program created by the Department of Homeland Security to help coordinate volunteer activities in emergency situations. The CERT Program educates people about disaster preparedness for hazards that may impact the local area and trains them basic disaster response skills. These emergency response skills include fire safety, light search and rescue, team organization, and disaster medical operations (FEMA 2015c). Since it was created in the post-9/11 era, there are no data for Mississippi in 2000. In 2010, only four counties out of eighty-two Mississippi counties had CERT teams (Table 4.20). These are De Soto, Leflore, Lawrence and Panola counties. In the case of the tri-county study area, Hancock, Harrison and Jackson counties did not have any CERT in 2010.

Table 4.20: Mississippi counties with CERTs in 2010.

County	% of CERTs per capita	#s of CERTs in 2010	Population Size
De Soto	0.19	300	161,252
Leflore	0.16	52	32,317
Lawrence	0.15	19	12,929
Panola	0.00	2	34,707

4.4.6 Performance Regimes: State of Mississippi

This first performance regime indicator is calculated by measuring the distance, in miles, from the county seat to the state capital. The data was acquired from the National Atlas. The same data is applied to both 2000 and 2010 under the assumption that the county seats have not changed. Cutter et al. (2014b) utilize ArcGIS to measure the straight-line distance from the county seats to the capital. The closer the county seat is to the capital, the more resilient the county itself. The capital of Mississippi is Jackson, which is located in Hinds County. The county seat of Rankin County is closer to Jackson than that of Hinds County. Given the distance measurements in Table 4.21, Union, Lee, Benton, Itawamba and Marshall are located the farthest from Jackson.

Table 4.21: Performance regime (proximity of county seat from the state capital) for Mississippi counties.

Rank	County	Distance from County Seat to Capital (miles)
1	Rankin	11.22
2	Hinds	13.53
3	Madison	23.14
4	Simpson	29.12
5	Copiah	32.42
…		
78	Union	164.52
79	Lee	157.65
80	Benton	157.12
80	Itawamba	156.74
82	Marshall	152.98

This second performance regime indicator is represented by the distance from the county seat to the nearest metropolitan statistical area (MSA). Similar to the first performance regime, the closer the county seat is to the nearest MSA, the more resilient the county itself. The same data is applied to 2000 and 2010, under the assumption that the distance between the county seat and MSA remains the same over ten years. Rankin, Hinds, Madison, Simpson and Copiah along with twelve other counties have their county seats located within MSAs, and as such, the distance represented Table 4.22 is zero. By contrast, Oktibbeha, Sunflower, Choctaw, Monroe, and Webster are counties located in the northern central region. They are predominantly rural, and their county seats are located further away from urban centers.

Table 4.22: Performance regime (proximity of county seat from the nearest Metropolitan Statistical Area) for Mississippi counties.

Rank	County	Distance from County Seat from MSA (miles)
1	Rankin	0.00
2	Hinds	0.00
3	Madison	0.00
4	Simpson	0.00
5	Copiah	0.00
…		
78	Oktibbeha	66.28
79	Sunflower	67.09
80	Choctaw	67.71
80	Monroe	68.18
82	Webster	79.12

4.4.6.1 Performance Regimes: Hancock, Harrison and Jackson Counties

The performance regime indicators remain for the tri-county region constant in BRIC IR 2000 and 2010 (Table 4.23 and Table 4.24). As such, there is no change in ranking in these categories for Hancock, Harrison and Jackson counties. The standardized values of the second performance regime, proximity of county seat to the nearest

Metropolitan Statistical Area, however, contribute significantly to the overall IR in both 2000 and 2010.

Table 4.23: Performance regime (proximity of county seat to capital) for Hancock, Harrison and Jackson counties.

Rank	County	BRIC IR values (standardized)	Distance from County Seat to Capital (miles)
66	Hancock	0.31	145.34
67	Harrison	0.31	146.64
72	Jackson	0.22	161.82

Table 4.24: Performance regime (proximity of county seat to nearest Metropolitan Statistical Area) for Hancock, Harrison and Jackson counties.

Rank	County	BRIC IR values (standardized)	Distance from County Seat to MSA (miles)
1	Hancock	1.00	0.00
1	Harrison	1.00	0.00
1	Jackson	1.00	0.00

4.4.7 Nuclear Plant Accident Planning: State of Mississippi, Hancock, Harrison and Jackson Counties

Only one county has nuclear accident planning because there is one nuclear plant in the entire state of Mississippi. It is located in Claiborne County. As such, this indicator is not as applicable to evaluate institutional resilience for Mississippi or the tri-coastal counties study area.

4.4.8 Population Stability: State of Mississippi

The results from the Wilcoxon Signed-Rank Test suggests that the majority of counties in Mississippi have relatively stable populations in 2000 and 2010, indicating that there is not a statistically significant difference between the two sets of year (see Table 4.7). Less than twenty counties experienced significant population losses or gains, particularly in the double digits. In 2000, Calhoun, Leflore, Lauderdale, Marion and

Webster experience the least in terms of population change while Hancock, Issaquena, Rankin, Lamar and DeSoto have significant population growth (Table 4.25 and Table 4.26). In the 2010, Attala, Walthall, Itawamba, Lowndes and Forest had relatively stable population size within the five-year-period. De Soto, Stone, and Lamar experienced significant population growth while Jefferson and Issaquena counties have significant population decline.

Table 4.25: Mississippi counties with highest and lowest population stability in 2000.

Rank	County	% of Population Change 1995-2000	1995 Population	2000 Population
1	Calhoun	0.09	15,056	15,069
2	Leflore	-0.09	37,981	37,947
3	Lauderdale	0.11	78,076	78,161
4	Marion	0.12	25,565	25,595
5	Webster	-0.13	10,307	10,294
…				
78	Hancock	13.66	37,802	42,967
79	Issaquena	13.98	1,995	2,274
80	Rankin	15.96	99,451	115,327
81	Lamar	16.09	33,655	39,070
82	DeSoto	27.29	84,217	107,199

Table 4.26: Mississippi counties with highest and lowest population stability in 2010.

Rank	County	% of Population Change 2005-2010	2005 Population	2010 Population
1	Attala	0.06	19,552	19,564
2	Walthall	-0.11	15,460	15,443
3	Itawamba	0.18	23,359	23,401
4	Lowndes	-0.19	59,895	59,779
5	Forrest	-0.21	75,095	74,934
…				
78	DeSoto	17.70	137,004	161,252
79	Jefferson	-18.09	9,432	7,726
80	Stone	19.67	14,862	17,786
81	Lamar	24.75	44,616	55,658
82	Issaquena	-26.35	1,909	1,406

4.4.8.1 Population Stability: Hancock, Harrison and Jackson Counties

Hancock, Harrison and Jackson counties moved up in ranking in terms of population stability from 2000 to 2010 (Table 4.27). In 2000, Hancock County experienced significant population growth. In 2010, it has relatively small population decline. Similarly, Harrison County experienced modest population growth in 2000 and slight population decline in 2010. Meanwhile, Jackson County has a similar level of growth in both 2000 and 2010. As such, stable population size, as compared to dramatic population gain or loss, is a significant driver of change in institutional resilience and contributor to the overall BRIC IR scores for these three coastal counties.

Table 4.27: Population stability for Hancock, Harrison and Jackson counties in 2000 and 2010.

Rank	County	BRIC IR values (standardized)	% of Population Change	Population Size	
BRIC IR 2000				**1995**	**2000**
78	Hancock	0.50	13.66	37,802	42,967
44	Harrison	0.84	4.43	181,553	189,601
40	Jackson	0.86	3.79	126,626	131,420
BRIC IR 2010				**2005**	**2010**
50	Hancock	0.78	-5.96	46,711	43,929
34	Harrison	0.87	-3.46	193,810	187,105
29	Jackson	0.90	2.74	135,940	139,668

4.4.9 Crop Insurance Coverage: State of Mississippi

The Wilcoxon Signed-Rank test indicates that the level of crop insurance coverage is statistically and significantly different from 2000 to 2010 (see Table 4.7). Crop insurance policies are present in the northwestern and northern regions of Mississippi, which include Quitman, Sunflower, Leflore, Tallahatchie, Humphreys, Coahoma and Bolivar (Table 4.28 and Table 4.29). For these counties, crop insurance coverage has increased from 2000 to 2010. This expansion can be linked to increased awareness and tightened regulations regarding crop protection against adverse weather hazards, disease or pests (Glauber et al. 2002).

Table 4.28: Mississippi counties with highest and lowest crop insurance coverage in 2000.

Rank	County	% Crop Insurance Coverage in 2000	#s Crop Policies	Land Area (sq. miles)
1	Quitman	2.28	923	404.84
2	Sunflower	1.70	1182	693.79
3	Tallahatchie	1.55	998	643.92
4	Leflore	1.54	913	591.93
5	Bolivar	1.49	1305	876.28
…				
78	Newton	0.00	2	578.03
79	Harrison	0.00	2	580.98
80	Stone	0.00	1	445.37
81	Lauderdale	0.00	1	703.51
82	Jasper	0.00	0	676.00

Table 4.29: Mississippi counties with highest and lowest crop insurance coverage in 2010.

Rank	County	% Crop Insurance Coverage in 2010	#s Crop Policies	Land Area (sq. miles)
1	Quitman	2.86	1160	405.01
2	Sunflower	2.15	1500	697.75
3	Humphreys	2.13	893	418.49
4	Coahoma	2.06	1138	552.44
5	Leflore	1.79	1062	592.54
…				
78	Hancock	0.00	1	473.75
79	Neshoba	0.00	1	570.14
80	Newton	0.00	1	578.10
81	Lauderdale	0.00	1	703.63
82	Jasper	0.00	0	676.24

4.4.9.1 Crop Insurance Coverage: Hancock, Harrison and Jackson Counties

The ranking for crop insurance coverage has remained relatively the same from 2000 to 2010 for Hancock, Harrison and Jackson counties (Table 4.30). There is no significant increase in the number of crop insurance policies over the ten-year-period. As such, this indicator is not a significant driver or contributor of institutional resilience for the coastal area.

Table 4.30: Crop insurance coverage for Hancock, Harrison and Jackson counties in 2000 and 2010.

Rank	**County**	**BRIC IR values (standardized)**	**% of Crop Insurance Coverage**	**#s of Crop Insurance Policies**	**Land Area (sq. miles)**
BRIC IR 2000					
76	Hancock	0.00	0.00	2	476.88
79	Harrison	0.00	0.00	2	580.98
58	Jackson	0.01	0.03	23	726.9
BRIC IR 2010					
78	Hancock	0.00	0.00	1	473.75
77	Harrison	0.00	0.00	2	573.99
56	Jackson	0.01	0.04	28	722.75

4.5 Summary

There are five drivers of change in institutional resilience for the state of Mississippi and four for Hancock, Harrison and Jackson counties (Table 4.31). In the state of Mississippi, institutional resilience drivers include mitigation spending, flood insurance coverage, disaster aid experience, jurisdictional coordination and crop insurance coverage. The impacts of Hurricane Katrina can be observed in a statewide increase in mitigation funding, flood insurance participation and crop insurance coverage. For the three coastal counties, drivers are mitigation spending, flood insurance coverage, disaster aid experience and population stability.

Table 4.31: Drivers of temporal change in institutional resilience for the State of Mississippi and for Hancock, Harrison and Jackson counties.

Statewide	**Tri-County Coastal Counties**
1. Mitigation Spending	1. Mitigation Spending
2. Flood Insurance Coverage	2. Flood Insurance Coverage
3. Disaster Aid Experience	3. Disaster Aid Experience
4. Jurisdictional Coordination	4. Population Stability
5. Crop Insurance Coverage	

The detailed analysis of the BRIC IR scores for Hancock, Harrison and Jackson counties shows that the change in rank in each institutional resilience indicator has a direct effect on the change in resilience score over time in many cases. Consequently, when a county moves up in terms of ranking in a particular IR category, the overall IR score will usually increase. In the case of flood insurance coverage, although the number of flood policies has dramatically increased in the study area, the ranking of Hancock, Harrison and Jackson remains relatively the same from 2000 to 2010. As such, the min-max scaling can obscure significant details. Driving indicators of institutional resilience for the coastal counties are slightly different than that of the whole state because they are more context-specific and applicable to the study area. This is an important point to note for decision makers who wish to use BRIC as a tool for deciding where to invest money or allocate resources. Local needs are different from state priorities.

CHAPTER 5: METHODOLOGY AND RESULTS FOR QUESTION #2

The quantitative analysis of the BRIC institutional resilience (IR) index shows that many IR indicators are directly related to mitigation planning. These indicators include mitigation spending flood insurance coverage, disaster aid experience, local disaster training, and nuclear plant accident planning. As such, qualitative analysis of state and local hazard mitigation plans can yield useful insights in regard to contextualizing the indicators.

5.1 Hazard Mitigation Plans

The central purpose of multi-hazard mitigation planning is to reduce and manage risk and hazards in the long-term. Multi-hazard mitigation plans are required for state and local governments by the Disaster Mitigation Act of 2000 as well as serving as a condition for receiving federal funding and grants. The Act, which amended the Stafford Disaster Relief and Emergency Assistance Act of 1988, emphasizes that mitigation planning processes need to incorporate identification of hazards, risks, and vulnerabilities, prioritize mitigation actions, encourage partnership between citizens, local and state governments, and provide technical assistance for these efforts.

The Federal Emergency Management Agency (FEMA) has multiple guidelines to aid states and local government in developing mitigation plans (FEMA 2008). Over the years, these guidelines have been thoroughly incorporated into mitigation plans. As a result, mitigation planning at federal, state and local level follows the same set of steps. The first step for local and state governments is to facilitate and conduct meetings with diverse community groups. Community leaders can provide input on mitigation strategies and help evaluate the community's capacities and needs. The second step is to complete a risk assessment of the potential impacts of hazards on the people, economy, and built and natural environments of the community. The objective is to identify and prioritize risk reduction strategies (FEMA 2008).

The third step in the process is to build a mitigation strategy, which consists of mitigation goals, objectives and action items that the community will pursue. These are developed in consultation with subject matter experts, stakeholders and public surveys, as well as utilizing existing guides and resources. Collectively stakeholders identify eligible activities and projects that qualify for funding under the FEMA Hazard Mitigation Assistance (HMA). The final step is to commit to plan maintenance procedures, which are monitoring, evaluating and updating. Since mitigation plans are considered "living documents," mitigation plans need to be evaluate and modify over time. According to the old guidelines, states were required to update their plans every three years and local governments every three years. As of 2015, current FEMA guidelines require both states and local governments to update their plans every five years (FEMA 2015b).

5.2 Methodology

Q2: Do state and local mitigation plans explain or indicate changes in institutional resilience for the Mississippi Gulf Coast in the setting of pre- and post-Katrina?

Content analysis of state and local hazard mitigation plans was used to answer research question #2. The selected spatial unit of analysis is state and county-based hazard mitigation documents between the years of 2000 and 2010 to maintain the spatial and temporal consistency with the BRIC analysis. The pre-Katrina hazard mitigation plans (HMPs) for Hancock, Harrison, Jackson and the state of Mississippi were acquired from the Mississippi Emergency Management Agency via public information request. These HMPs were the first official mitigation plans, as mandated by the Disaster Mitigation Act of 2000, for Mississippi and the tri-coastal county study area. The post-Katrina HMPs were the most current mitigation plans, which were found online on county and state websites or from directly contacting the local hazard mitigation offices.

There were several updates between the first and most currents state and county HMPs (Table 5.1). The 2004 State HMP had been updated in 2007, 2010 and 2013. Hancock County updated its 2001 County HMP in 2006 and 2013. Harrison County updated its 2001 County HMP in 2005, 2008 and 2014. Lastly, Jackson County updated its 2005 County HMP in 2012. The most updated State and County HMPs were selected to represent post-Katrina HMPs because they can provide useful insights regarding the current mitigation practices and how these practices had evolved over time. In addition, these HMPs contained examples of lessons learned from Hurricane Katrina and how they had been incorporated into current planning goals and strategies.

Table 5.1: State and local mitigation plans included in this study.

	Year	Plan Title
State of Mississippi	2004	State of Mississippi Standard Mitigation Plan
	2013	Mississippi State Hazard Mitigation Plan Update
Hancock County	2001	Hancock County Hazard Mitigation Plan
	2013	Hancock County Multi-jurisdictional Hazard Mitigation Plan Update
Harrison County	2001	Harrison County Mitigation Plan
	2014	Harrison County Multi-jurisdictional Hazard Mitigation Plan
Jackson County	2005	Jackson County Multi-jurisdictional Hazard Mitigation Plan
	2012	Jackson County Multi-jurisdictional Hazard Mitigation Plan

The qualitative data acquired from the content analysis process was explored in different ways. First, the indicators in the BRIC institutional sub-index were utilized as variables to construct a checklist, using the methodology in Frazier et al. (2013). The authors utilize the BRIC framework developed by Cutter et al. (2010) as a reference to review different disaster mitigation plans including post-disaster development plan, comprehensive emergency management plan, comprehensive plan, and local mitigation strategy plan. The BRIC resilience indicators were used to determine whether certain factors were referenced or highlighted in reviewed plans.

Unlike Frazier et al. (2013), this checklist is a longitudinal assessment of hazard mitigation practices. It only included hazard mitigation plans and not emergency management plans, comprehensive plans, and post-disaster plans. The checklist was used to assess discussions in pre- and post-Katrina state and local hazard mitigation documents relating to the ten IR indicators. It recorded whether the IR indicators were present or absent in the pre- and post-Katrina HMPs. Second, an in-depth assessment of IR indicators was conducted to describe how they changed in the context of pre- and post-Katrina.

This section contains a comprehensive assessment of the institutional indicators that are found in either or both of the pre- and post-Katrina state and local HMPs. It documents the way these indicators are represented in the HMPs as well as the way their representations have changed over time. As such, documentation of any changes that were made afterward, taking the impacts of Katrina into account, provides clarifications and contextualization for the output metrics of BRIC IR indicators.

5.3 Checklist Construction and In-depth Analysis of State and Local Hazard Mitigation Plans

Table 5.2 indicates that while certain IR indicators are ubiquitously present in all HMPs, others are noticeably missing. For instance, hazard mitigation, jurisdictional coordination, disaster aid experience and flood insurance coverage are present in both state and local hazard mitigation plans in the pre- and post-Katrina contexts. By contrast, crop insurance coverage, nuclear accident planning (with exception of the pre-Katrina State HMP) and the two performance regimes are not found in any of the examined documents.

Table 5.2: Checklist for state and county HMPs using BRIC institutional indicators.

	Mississippi		Hancock		Harrison		Jackson	
Institutional Resilience	2004	2013	2001	2013	2001	2014	2005	2012
Mitigation spending	x	x	x	x	x	x	x	x
Jurisdictional coordination	x	x	-	x	-	x	x	x
Disaster aid experience	x	x	partial	x	partial	x	x	x
Flood insurance coverage	x	x	x	x	x	x	x	x
Local disaster training	x	-	-	-	-	x	-	-
Population stability	-	x	x	x	x	x	x	x
Crop insurance coverage	-	-	-	-	-	-	-	-
Performance regimes-state capital	-	-	-	-	-	-	-	-
Performance regimes-nearest metro area	-	-	-	-	-	-	-	-
Nuclear plant accident planning	x	-	-	-	-	-	-	-

(x) present and (-) absent

5.3.1 Mitigation Spending: State of Mississippi

FEMA's Hazard Mitigation Grant Program (HMGP) funds all mitigation plans and their subsequent updates. The State hazard mitigation plan is developed and maintained by the Mississippi Emergency Management Agency (MEMA). The HMGP provides grants to states and local governments to implement long-term hazard mitigation after a major disaster declaration. About 15 percent of the post-disaster assistance goes to ward mitigation programs and comes at least a year after a disaster declaration. Projects that are funded by HMGP include but not limited to retrofitting critical facilities, building saferooms and storm shelters, eliminating repetitive flood loss structures and creating warning systems.

According to the first HMP of the State of Mississippi, which was created in 2004, the comprehensive planning process involves coordination, collaboration and consultation. The mitigation plan has to be constructed in accordance with FEMA Mitigation Planning Guidance. MEMA decides to work different research and planning teams for prioritized hazards, which include earthquake, flood, hurricane, tornado, dam and levee hazards, and winter storm. In addition, state emergency management representatives are obligated to seek inputs from federal and local agencies along with community groups and business organizations. MEMA also has to make sure their mitigation strategies are integrated with local plants and initiatives. Next, it conducts multi-hazard risk and vulnerability assessment for prioritized hazards in terms of loss modeling, potential loss estimates, and exposure of critical state facilities. Moreover, the MEMA is responsible for assessment of local capacities and provides funding and technical assistance to its local districts. Finally, since the hazard mitigation plan is considered a "living document," MEMA must maintain its goals and objectives and update the plan every five years. The steps described here represent the basic outline of any mitigation frameworks for the state, county or municipal level.

The latest HMP for the State of Mississippi was updated in 2013 by MEMA. The document shows that it has been completed with a high degree with public participation.

There are observable changes between the 2004 State HMP and the 2013 updated. For instance, the 2004 State plan divides Mississippi into ten planning and development districts, which were established by grouping counties into ten geographic clusters (e.g. north, northwest, southern, etc.). By contrast, the political structure discussed in the 2013 HMP manages Mississippi counties by classifying them into nine different MEMA regions. Next, as required by FEMA, the prioritized hazards have grown to include wildfire. Meanwhile, severe weather and hurricanes and tropical storms are classified under the tropical cyclone category. Moreover, the hazard identification and risk assessment section shifts from using just probabilistic estimation to priority ranking methodology, or the Hazard Ranking Index, which takes into account multiple factors such as areas affected by hazards, health and safety consequences, property damage, environmental damage, and probability of future occurrence.

The 2004 HMP document uses historical records of different hazards to model the worst-case-scenarios. In the 2013 HMP, given the severe degree of property losses and casualties caused by Hurricane Katrina, it was used as a baseline to estimate damages, displacement and exposure in tropical cyclone scenario modelling. Lastly, the 2013 HMP also includes social vulnerability assessment, as opposed to focusing only on structural vulnerability as in previous versions. Based on the Social Vulnerability Index, or SoVI, the plan identifies different socio-demographic and built environment variables to determine the state's most socially vulnerable counties (Cutter et al. 2003). Over time, the state plan has been drastically improved in every single aspect due to increased learning experience, technological advances, and communications with its public and private partners. In addition, the disaster experience from Hurricane Katrina contributes to increased awareness about the realizable impacts of environmental hazards.

The notion of resilience can be seen throughout the 2013 state HMP. By contrast, the 2004 HMP did not have any reference mentioning resilience. Building and enhancing resilience is the central basis for the broad mission of the 2013 State Hazard Mitigation document. Most of its goals and objectives in the 2004 State HMP and 2013 HMP bear some resemblance in terms of techniques and strategies to increase public awareness, reduce risk, foster cooperation and collaboration among all levels of governments, non-profit and private sectors, and strengthen local capacities.

5.3.1.1 Mitigation Spending: Hancock County

The Federal Emergency Management Agency (FEMA) requires counties to update their HMPs every five years. The first HMP for Hancock County was created in 2001, and its latest version was updated in 2013. Moreover, unlike the 2000 version, the 2013 HMP is a multijurisdictional plan, which was jointly prepared by Hancock County, the city of Diamondhead, and the unincorporated community of Pearlington. Multijurisdictional planning allows different localities and their respective county to create comprehensive approaches that cover multiple jurisdictions; the city of Bay St. Louis and Waveland have their own local HMPs. In addition, multijurisdictional planning will aid in terms of economics of scale by leveraging individual capabilities and sharing costs and resources. One of the tradeoffs of this type of planning is localities might have less control over the process as leadership become more centralized (FEMA 2000).

When compared the 2001 and 2013 Hancock County HMPs, there are observable differences. First, the 2013 County HMP includes extensive vulnerability and capacity assessments for localities that are covered under its jurisdiction, the city of Diamondhead and the unincorporated community of Pearlington. The plan also contains different hazard profiles and mitigation strategies specially tailored to these localities. Second, in 2001 Hancock County was concerned both environmental and technological hazards, which included flooding, hurricanes, rail accident, traffic, terrorism, wildfires, tornadoes and severe heat. By 2013, most of the technological hazards were eliminated from the priority list and more natural hazards such as severe weathers, costal erosion, and climate change were added. Assessment of climate change is new and a recent federal requirement (Babcock 2013). The prioritized hazards as identified by the county are much different than that of the state.

Third, similar to the latest State HMP, the 2013 HMP incorporates the impacts of Hurricane Katrina extensively throughout the document. Since the county and its localities have not fully recovered, any recovery and mitigation activities have to be able to handle the worst-case-scenario Katrina disaster. Fourth, the 2013 County HMP has incorporated different mechanisms to assess weakness and strengths in mitigation goals and actions, as compared to the lack of assessment in the first HMP. The 2013 county plan also recorded which actions were completed and recognize barriers to the incomplete ones. Finally, in 2013, the county had also expanded its list of mitigation projects that are qualified for federal funding under HMGP. In addition to making improvements to public shelters and public warning systems, the county, as of 2013, applied for funding to establish fire breaks, retrofit individual structures to withstand hurricane force winds, and enforce land use and building code regulations.

5.3.1.2 Mitigation Spending: Harrison County

The first HMP for Harrison County was approved in 2001, and its latest version was updated in 2014. Similar to Hancock County, the most updated version is a multijurisdictional mitigation plan, which covers planning for the county and the cities of Biloxi, D'Iberville, Gulfport, and Pass Christian. Consequently, the current county plan conducts vulnerability and capability assessments on multiple hazards, taking the localities under its jurisdiction into account. The list of prioritized hazards has expanded since 2001 to include solely environmental hazards such as extreme heat, wildfires, hailstorm, hurricane and tropical storms, severe weather, earthquake, tornado, windstorm, flood, coastal erosion, storm surge, wave action, and sea-level-rise and other effects associated with climate change. It chose excludes the technological or manmade hazards that were stated in the 2001 HMP such as railroad accident, terrorism and traffic accidents because these are not high-risk hazard in Harrison County.

Second, similar to the other post-Katrina HMPs, the impacts of the Hurricane were incorporated throughout the document, particularly in the worst-case-scenario modeling and simulations. In addition, flood and storm surge maps were revised to show the extent and the magnitude of Katrina's surge. Federal funding that was received post-Katrina were used to enforce building code and land use regulations as well as increase construction of storm shelters and retrofit public structures. Third, Harrison County has adopted and applied the Hazard Ranking Index that was used to categorize and prioritize hazards for the State. Lastly, unlike the 2001 County HMP, the current version contains a comprehensive asset inventory (e.g. school, hospital, police station, fire station, etc.), which is usually lacking in many pre- and post-Katrina HMPs. Overall, the pre- and post-Katrina HMP for Harrison County are significantly different from each other in terms of management structure, prioritized hazard types, comprehensiveness of vulnerability and capability assessment, and the degrees of communication with community, non-profit and private groups.

5.3.1.3 Mitigation Spending: Jackson County

Jackson County finalized its first hazard mitigation plan following the impact of Katrina, which was approved in November 2005. Although the planning process started in early 2003, many pertinent programs and files were destroyed in Hurricane Katrina in late August 2005. Consequently, the 2005 County HMP was not as comprehensive as its counterparts, resembling the first HMPs in Hancock and Harrison counties. Over time, the current county HMP shows significant improvement as compared to the first version. First, the 2012 version is a multijurisdictional mitigation plan, which covers Jackson County and the city of Gautier. The city of Moss Point, Ocean Springs and Pascagoula participated in the planning process in 2005, but chose to create separate hazard mitigation plans for 2012. Second, the 2012 County HMP expands the list of prioritized hazards to include coastal erosion, drought, flood, hurricane and coastal storms, storm surge, severe weather, tornado, wildfires and sea-level-rise. These are ranked using probability of hazard occurrence instead of applying the State's Hazard Ranking Index. Moreover, the vulnerability and capability assessment portion of Jackson County are not as comprehensive as compared to that of Hancock and Harrison counties. There are very few applications of HAZUS-MH loss modeling, and they are exclusively applied to storm surge and hurricane.

Third, the impacts of Hurricane Katrina are not incorporated into worst-case-scenario. In addition, the current plan does not have a comprehensive list of critical facilities. A partial explanation for this deficiency in vulnerability and capability assessment is due to the fact that many important planning files were lost during the Hurricane, however, that was seven years ago. Furthermore, the plan does not contain a record of projects that were executed using funds from HMGP. Overall, the 2005 and the 2012 County HMP are somewhat different from one another, but the 2012 version is not as comprehensive as the current HMPs of Hancock and Harrison counties.

5.3.2 Jurisdictional Coordination: State of Mississippi

An indicator of jurisdictional coordination can be found in the second chapter of both the 2004 and 2013 State HMPs. This section of the documents record—as required by FEMA—every step of the planning process as well as the personnel that were involved. In 2004, the state planners coordinated with different specialized teams. The representatives came from other state governmental agencies, research universities, the Federal Emergency Management Agency, National Weather Service, U.S. Geological Survey and U.S. Army Corps of Engineers. Each team was responsible for a specific hazard type such as winter storm, earthquake or flood.

By contrast, the 2013 State HMP was produced under the guidance of a centralized entity called the Hazard Mitigation Council. The Council, formed in 2007 through an executive order by Governor Haley Barbour, is responsible for coordinating mitigation efforts between all levels of government, non-profit organizations, and the private sector. Members from cabinet level departments meet with mitigation planners, MEMA staff, FEMA program managers and specialists, local emergency managers, and university researchers to set mitigation goals and objectives along with assisting with vulnerability and capacity assessments. In addition, there are additional meetings and summits during which MEMA personnel interact with the Mississippi Civil Defense/Emergency Management Association (MCDEMA) to integrate statewide planning initiatives with local efforts. They also work closely with professionals who are involved with public health officials, Emergency Medical Service, hospital, fire and law enforcement representatives, volunteer organizations, and local governmental agencies. Given the two documents, there are significant improvements in jurisdiction coordination as time went on. This can be partially attributed to lessons learned from Hurricane Katrina and/or increased in coordination and communication experience.

5.3.2.1 Jurisdictional Coordination: Hancock County

The 2001 County HMP did not document any consultation activity between local planners and other agencies, hazard experts, non-profit, or private sectors. By contrast, evidence of jurisdictional coordination in the updated 2013 version is found in two aspects. First, the 2013 County HMP is a multijurisdictional plan which was produced jointly between the county, the city of Diamondhead, and the unincorporated community of Pearlington. This characteristic suggests that there are some elements pertaining to jurisdictional coordination when a county has a multijurisdictional hazard mitigation plan. Second, Chapter 3 of the 2013 County HMP details the planning process, which is the responsibility of the Hancock County Hazard Mitigation Committee. The Committee includes representatives from neighboring communities, local and regional agencies involved in development, business, academia, and private non-profit organizations. The Committee is also tasked with increasing public involvement through open forums and meetings. Given the current state of Hancock County, the presence of a centralized entity, which bears strong resemblance the State's Hazard Mitigation Council, indicates that there has been improvements made to jurisdictional coordination.

5.3.2.2 Jurisdictional Coordination: Harrison County

Harrison County's 2001 HMP discusses its partnership with the county Civil Defense Agency and briefly mentions its coordination with outside agency personnel. The document mentioned different local representatives as liaisons during emergencies, but did not go into details about the extent of the relationship. In addition, it also pointed out that the Civil Defense agency is responsible for providing technical support and expertise to monitor flood and disaster warnings. Given these aspects, the 2001 County HMP did not capture enough information to indicate that there was effective jurisdictional coordination at the time. In the post-Katrina period, Harrison County recognizes that all information provided in earlier plans as it relates to hazard risks and vulnerabilities, capabilities, community goals and recommended mitigation actions need to be updated due to the effects of the storm. Consequently, the 2014 version is a product of the Local Hazard Mitigation Planning Council (LHMPC) and an outside consultant team, an engineering firm called Dewberry. The LHMPC invited new members and representatives from the American Red Cross, American Medical Responses, Harrison County, city of Biloxi, D'Iberville, Gulfport, Long Beach and Pass Christian, the Gulfport-Biloxi International Airport, other cabinet departments, utility companies and casino managers. Finally, the LHMPC held open forums and webinars as part of an outreach effort for community hazard mitigation practices and providing information to the public. Over time, there are observable improvements made to jurisdictional coordination between the first mitigation plan and its current version.

5.3.2.3 Jurisdictional Coordination: Jackson County

The 2005 Jackson County HMP briefly documents the collaboration between county officials, city personnel from Gautier and Moss Point, civil defense departments, zoning and planning council and other emergency service professionals. The details of these meetings were not extensive. Moving forward to 2012, the Local Hazard Mitigation Council, which includes emergency representatives from Jackson County and the city of Gautier, sought technical assistance from state agencies (e.g. MEMA, Department of Health, Marine Resources, Transportation, etc.), business and non-profit communities, city councils, county medical communities, and utility providers. They held several meetings to identify and prioritize hazards, conduct vulnerability and capacity assessments, as well as formulate mitigation goals and actions. In addition, the Council incorporated public inputs gathered from workshops and surveys into the planning process. Overall, the elements of jurisdictional coordination are also present in all current state and local hazard mitigation plans in the form of meetings between personnel from different level of governmental agencies, non-profit organizations and private sectors.

5.3.3 Disaster Aid Experience: State of Mississippi

In the hazard assessment portion of the 2004 State HMP, it includes the data for PDDs and the number of loss-causing hazard events, which were acquired from FEMA and National Climatic Data Center (NCDC). The PDDs were reported for each hazard type as well as specified the name of the disaster declared counties. This data was also used to create a checklist to determine which counties are at the highest risk for certain types of hazards. The loss data from NCDC was used to specify the type and the number of loss-causing events along with the amount in property and crop damage. In addition, NCDC data also contains information about fatalities that occurred during hazardous events. The PDDs and loss data are present in the vulnerability assessment portion of flood, hurricane, winter storm and tornado. By 2013, there are some alterations that were made to the loss reporting approach in mitigation planning.

The 2013 State HMP uses data from the Spatial Hazard Events and Losses Database for the United States (SHELDUS) in addition to FEMA and NCDC data. SHELDUS data was only present in the tornado damage assessment and absent in other hazard assessments such as hurricane, flood and winter storm. The document cites that SHELDUS was utilized because its data can be adjusted for inflation, unlike NCDC data. Meanwhile, NDCD data was used to report property and crop damage and casualties for each MEMA region, and PDD data specified the amount of total public assistance, emergency work, and permanent work received by during each presidentially declared disaster. Moreover, NCDC data was used to report on losses during severe weather, extreme winter weather, flood, hurricane and tornado events. Losses and damages due to hazards like drought, dam and levee failure, earthquake and coastal erosion are either absent or reported by using other sources.

5.3.3.1 Disaster Aid Experience: Hancock, Harrison and Jackson Counties

By using the metric of disaster aid experience as a proxy, it can be observed that Hancock and Harrison counties have partial reporting of losses in their pre- and post-Katrina hazard mitigation plans. Only Jackson County's HMP include Presidential Disaster Declaration reporting in its profiling of hazards. As well, none of the pre- and post-Katrina county HMPs uses SHELDUS data, as they mostly rely on NCDC data for loss reporting.

For Hancock County, NCDC data was used in both the 2001 and 2013 HMPs. The most recent version, however, has a more detailed account of damages and casualties for hazards like hurricanes, severe weather, flood, and coastal storms. In addition, PDD data, which was absent in the 2001 HMP, was used to report federally declared hurricane events. For Harrison County, the way losses are reported is similar that of Hancock County. The pre-Katrina 2001 County HMP only briefly covers losses caused by different hazards while the more updated version includes more details. As such, the 2014 County HMP uses NCDC data to report the number of events and overall losses for severe weather, flood, tornado, hurricane, storm surge, and wave action. Moreover, PDD data was used to report for federally declared losses from hurricane and flood. Lastly, Jackson County has the only report that includes some information about federally declared disasters in its pre-Katrina HMP, most of which concerns hurricanes. In addition, the 2005 County HMP also contains detailed records of losses on tornado, hurricane, flood and coastal storm events. Its method of reporting losses was not altered in the updated 2012 version.

5.3.4 Flood Insurance Coverage: State of Mississippi

For the State of Mississippi, NFIP coverage is an important component of capacity assessment. The state keeps detailed records of communities that are covered by NFIP and hopes to increase participation in years to come. In the 2004 State HMP, Mississippi reported that 273 out of 310 communities included Special Flood Hazard Areas (SFHA) or flood plain members of the NFIP. In addition, 19 of these 273 communities also participate in the Community Rating System (CRS). The CRS program incentivizes communities to engage in floodplain management activities that exceed the minimum NFIP requirements. In exchange, flood insurance premium rates are discounted based on the class rating of the community. By 2013, Mississippi had 330 communities participating in the NFIP and 29 in CRS. This expansion of NFIP participation can in part be attributed to damages caused by Hurricane Katrina as well as increased outreach and education about the program itself. According to NFIP loss statistics, the Gulf Coast counties had the highest flood losses in the period of 1978 to 2013. They are also the top three counties with the most repetitive and severe repetitive loss of structures, which continue to strain NFIP resources. As observed in the pre-Katrina and post-Katrina State HMPs, the discussion about NFIP is relatively similar in the two documents.

5.3.4.1 Flood Insurance Coverage: Hancock, Harrison and Jackson Counties

Given that the Mississippi Gulf Coast area historically has the highest flood losses, it comes as no surprise that discussion regarding NFIP is present in all of the HMPs for Hancock, Harrison and Jackson counties. As of 2004, none of these counties participate in the CRS Program. The pre-Katrina HMPs for these counties did not perform detailed analysis of NFIP coverage as compared the post-Katrina County HMPs. For Hancock County 2013 HMP, NFIP is discussed in terms of flood mapping, structural elevation, floodplain ordinance and management, and CRS participation. In addition, the county tracks the repetitive and severe repetitive loss properties by mapping and record keeping, appropriately allocating resources and implementing loss-reduction strategies. With regard to CRS, Hancock County and the City of Diamondhead are not members. By contrast, the City of Bay St. Louis and Waveland both participate in the CRS with respective ratings of seven (15% discount in SFHA and 5% in non-SFHA) and five (25% discount in SFHA and 10% in non-SFHA).

In the 2001 Harrison County HMP, NFIP was mentioned in the repetitive loss properties, which the county kept detailed records, and included a recommendation section relating to retrofitting structures. The document also notes the prospect of Harrison County joining the CRS program. By 2014, Harrison County is certified as Class 8 community, which receives 10% in premium reduction in SHFA and 5% in non-SFHA. The CRS class rating for Harrison and Jackson communities fall into the average, with majority of nationwide communities attaining rating in Class 8 or 9 (Landry and Li).

Similar to the 2013 Hancock County HMP, the most updated version for Harrison County points out that NFIP participation is crucial in capability assessment as well as in floodplain management, flood mapping, reduction of repetitive and severe repetitive loss structures, and enforcement of flood ordinance. In the case of Jackson County, the 2005 County HMP only makes a brief mentioning of NFIP in regard to repetitive loss properties. In addition, one of goals of the plan was to attain better CRS rating for participating jurisdictions to indicate a lower flooding risk level. As of 2012, Jackson County, the City of Gautier, Ocean Springs and Pascagoula are participating members of the CRS system, with respective class ratings of nine, seven, seven and five. As for NFIP, the 2012 County HMP discusses flood insurance in similar terms as those of current Hancock and Harrison counties HMPs.

5.3.5 Local Disaster Training: State of Mississippi

The 2004 State HMP records that as of 2005, there are a total of 74 CERT Teams in Mississippi with 1,037 participants, many that come from school districts, community colleges, community centers, medical centers, and community emergency services. Meanwhile, the most updated 2013 HMP has no mentioning of CERT. This information can be found the State's Comprehensive Emergency Management Plan of 2012.

5.3.5.1 Local Disaster Training: Hancock, Harrison and Jackson Counties

According the 2004 State HMP, no CERT was present in the Harrison, Hancock or Jackson County. As such, the pre-Katrina HMPs of the Gulf Coast counties have no mentioning of CERT. As for the current County HMP, the only reference to CERT was found in Harrison's 2014 HMP as it discussed the need to expand CERT with little details.

5.3.6 Population Stability: State of Mississippi

The 2004 State HMP did not take population stability into consideration. It only considered the total population in 2000 of each planning and development district but did not address how population growth or decline would affect the capability to cope with different hazard types. In contrast, the 2013 State HMP takes population growth or decline into account in terms of economic activities and available housing units. For instance, from 2000 to 2010, 39 out of 82 counties gained population and 13 of these gained by ten percent. Meanwhile, 41 counties experienced a population decline between 2000 and 2012. Many of these counties are primarily located in the Mississippi Delta where the economic base has historically been heavily reliant on agriculture. Some of them experienced population loss percentages in the double digits. Population loss in rural areas can be attributed to a decrease in farming activities, high poverty, lack of job opportunities and other industries, difficult access to healthcare, education and retail services, low natural amenities and general remoteness (McGranahan and Beale 2002).

Population growth or decline can have significant influence over the availability of housing units and local economic activities. Decisions regarding mitigation planning, building codes, flood control, storm water control and protection of wetlands have to take change in population density into account.

5.3.6.1 Population Stability: Hancock, Harrison and Jackson Counties

Population stability as an indicator is present in all the pre-Katrina and post-Katrina County HMPs for Hancock, Harrison, and Jackson. Hurricane Katrina has significantly impacted the population growth trend in the Gulf Coast counties. As of 2010, Harrison, Hancock, and Jackson rebounded to their pre-Katrina population levels. The 2001 Hancock County HMP mentions the percentage change in population but did not go into detail about the impact of such change. By contrast, the 2013 updated version discusses population change in terms of available housing and effects on economic growth. Planners also map and locate dense population centers to decentralize shelters.

The 2001 Harrison HMP also mentions population changes, especially post-disaster, in terms of housing unit availability, but does not go into more detail. By 2013, planners incorporated population changes into decision making to address evacuation mapping, flood mapping, hazard awareness and sheltering. In Jackson County, a more detailed assessment about population change was found in the 2012 County HMP. Similar to Hancock and Harrison counties, the planners incorporate change in population density into risk and capability assessments along with calculating available housing units.

5.3.7 Indicators Absent from Hazard Mitigation Plans

The indicators for crop insurance damage, nuclear accident planning and performance regimes are absent in all of the state and county HMPs. Although these HMPs contain information about crop damage, they have no mention of crop insurance. As for nuclear accident planning, it was identified as a non-prioritized hazard in the 2004 State HMP, because as of present, Mississippi only has one nuclear power plant. The document did not include any reference regarding population residing nearby the nuclear plant. Lastly, the methodological approach to calculate the metrics for the performance regimes is a straight-distance measurement between county seat to the nearest Metropolitan Statistical Area or the state capital. These metrics are not observed in any of HMPs in addition function as constant values in BRIC institutional resilience in 2000 and 2010. As such, they were not included in the analysis.

5.4 Summary

The results of the content analysis in Chapter 4 illustrate that the BRIC institutional resilience sub-index contains many elements that can be found in state and local hazard mitigation (HMPs) plans. Six out of ten institutional resilience indicators are present throughout, however, the output metrics of these resilience indicators are not always found in HMPs. Mitigation spending, flood insurance coverage and disaster aid experience are found in the pre- and post-Hurricane Katrina state and local HMPs while jurisdictional coordination, local disaster training and population stability are found in some and not others. Content analysis of HMPs provides supplementary information for each of the institution resilience indicators, allowing for differentiation between a theoretical approach and institutional practices.

CHAPTER 6: DISCUSSION

This chapter contains four discussion topics. The first topic analyzes the utility of the Baseline Resilience Indicators for Communities (BRIC) institutional resilience sub-index. The second topic discusses the changes to mitigation practices at the state and local scale in post-Hurricane Katrina period. The third topic suggests improvements for BRIC institutional resilience sub-index and for state and local hazard mitigation plans. Finally, the last topic covers the future outlooks on how to bridge the gap between institutional resilience indicators and institutional practices.

6.1 Utility of the BRIC Institutional Resilience (IR) Sub-Index with regard to the State of Mississippi and Hancock, Harrison and Jackson counties

The establishment of baselines and periodic examination of reliance markers relative to that baseline is an important consideration in the development of standards (McAllister 2013). Replication of the BRIC institutional resilience sub-index at the state scale (n=82) demonstrates that it is useful for establishing a resilience baseline as well as measuring how that baseline has shifted in Mississippi post-disaster. Indicators such as mitigation spending, flood insurance coverage, crop insurance coverage, jurisdictional coordination and population stability are more likely to change from pre- to post-Katrina within a ten-year interval. By contrast, nuclear plant accident planning, local disaster training, and the two performance regimes are less likely to change. Evaluation of the absolute and standardized values of the resilience metrics illustrate that there are some discrepancies in terms of institutional drivers of change in resilience at the state and local scale. At the state scale, the Wilcoxson Signed-Rank Test is useful for determining which indicators are statistically different from 2000 to 2010. By comparison, observations of changes in rank are more appropriate in determining the indicators that drive change in institutional resilience at the local tri-county scale.

Mitigation spending, flood insurance coverage, disaster aid experience, jurisdictional coordination, and crop insurance coverage drive change in institutional resilience at the state scale while only the first three mentioned indicators along with population stability drive institutional resilience for Hancock, Harrison, and Jackson counties. The changes in indicators such as mitigation spending and flood insurance coverage can be directly linked to Hurricane Katrina while the rest have weaker linkage or no relationship with the disaster itself. Undoubtedly, the impacts of Hurricane Katrina have influenced the dramatic increase in mitigation spending and expansion of flood coverage, both at the state scale and the tri-coastal county scale.

In the case of mitigation spending, the majority of the Hazard Mitigation Grant Program (HMGP) grants received between 2001 and 2010 by the state of Mississippi, Hancock, Harrison, and Jackson counties were directly related to the Hurricane Katrina. As for flood insurance coverage, Hurricane Katrina produced a significant amount of surge and coastal flooding resulting in more than $2.6 billion in National Flood Insurance Program claims (FEMA 2015a). In the post-Katrina period, the state significantly increased the number of flood insurance policies in the post-Katrina period (FEMA 2015a). In Hancock, Harrison and Jackson counties, the number of national flood insurance policies has almost doubled or tripled from 2000 to 2010. The changes as assessed by the BRIC IR metrics in mitigation spending and flood insurance coverage are consistent with the findings within the academic literature and by FEMA (Kunreuther 2006; Rose 2007; Berke and Godschalk 2009; Nance 2009; Michel-Kerjan 2010; FEMA 2015a).

According to the BRIC IR sub-index, Hancock, Harrison and Jackson counties are the most resilient counties in Mississippi in 2010. This assessment is difficult to validate. Changes in institutional resilience for these three counties are mainly driven by the increase in mitigation spending and flood insurance coverage, which are directly linked to Katrina. However, spikes in mitigation spending and expansion of flood insurance policies are reactive policy decisions rather than proactive ones (Mitchell 2006a; Landry and Li 2011). As such, an additional temporal setting (e.g. BRIC IR 2015) is needed to examine how institutional indicators perform in periods without a major disaster or whether such institutional resilience decreases over time relative to other counties in the state.

At the state scale, changes in crop insurance coverage, jurisdictional coordination, and disaster aid experience have weaker or no linkages to Hurricane Katrina. Although the change in the level of crop insurance from 2000 to 2010 is statistically relevant, this increase could be partially be linked to the crop damage by Hurricane Katrina, or the prevalence of pests and diseases, or some combination of factors (Glauber et al. 2002). Similarly, the decrease of the number of government and special districts in Mississippi counties could be linked to Hurricane Katrina. Consolidation of governmental agencies and districts could be a result of lessons learned post-disaster in order to improve response, communication, and coordination during times of crisis (Ansell et al. 2010). As observed in the BRIC IR sub-index, the linkage between the jurisdictional coordination indicator and Hurricane Katrina is difficult to establish because decrease in political fragmentation can also be a function of governmental reform over time. Lastly, disaster aid experience has little to no association with Hurricane Katrina as measured by the numeric counts of loss events and the Presidential Disaster Declarations (PDDs). The numeric counts did not distinguish between the dollar amount of a high loss event and a low loss event. This lack of monetary distinction is also applied to PDD events. As such, Katrina would be counted the same way as less severe events.

At the tri-coastal county scale, Hancock, Harrison and Jackson counties rank significantly higher in 2010 than 2000 in terms of population stability. Between 1995 and 2000, these three counties had modest to high population growth, but in the immediate aftermath of Katrina, the Mississippi Coast experienced substantial population loss due to evacuation or permanent relocation (Hori and Shafter 2010). As a result, between 2005 and 2010, the indicator shows little to no population growth because these counties are still recovering to their pre-Katrina levels.

For future improvements, planners may want to incorporate state and county data and tailor the BRIC IR sub-index to represent local needs (Frazier 2013; Singh-Person et al. 2013). For instance, the local disaster training variable was intended to capture the degree of preparedness at the county level. Given that the value for this indicator was missing for many Mississippi counties, planners could utilize alternative proxies such as Fire Corps, Neighborhood Watch, Volunteers in Police Program and other Citizen Corps programs to measure local disaster preparedness.

The BRIC index as a whole provides a good basis for benchmarking resilience. However, it is important to understand the processes that are involved in the index construction such as theoretical and practical justification, variable selection, data availability, weighting, scalability, transformation and standardization process (Cutter et al. 2008b; Fekete 2009; Tate 2012). Without a good grasp of these processes, it may be difficult to utilize the output metrics to responsibly allocate resources.

6.2 Content Analysis of Hazard Mitigation Plans for the State of Mississippi and Hancock, Harrison and Jackson Counties

Overall findings for the second research question indicate that there are substantial differences from the pre- to post-Katrina hazard mitigation plans at the state and local level. Between the first and the most updated hazard mitigation plans, the categories of hazard prioritization, vulnerability and capability assessment, scenario modeling, reporting of losses, jurisdictional coordination, and public outreach are generally improved. Many of these observed improvements, however, are the result of changed federal requirements in order to qualify for funding from the Hazard Mitigation Grant Program along with other hazard related programs (Birkland and Waterland 2008; Berke et al. 2012). As such, the changes in pre- and post-Katrina mitigation practices can be attributed to federal top-down directives rather than local initiatives, even though state and local inputs and initiatives in mitigation planning are observed in several categories.

6.2.1 Hazard Identification in State and Local Hazard Mitigation Planning

In the post-Katrina setting, state and local governments initiated hazard mitigation councils to improve coordination and communication between representatives from different government agencies, researchers, non-profits, planners, business communities, and public health facilities. At the state level, the Hazard Mitigation Council approved a new hazard ranking process. This Hazard Ranking Methodology, adopted in the 2013 State HMP, evaluates each hazard based on risk and vulnerability characteristics such as area impacted, public health, property damage, environmental damage and economic disruption. These are used in conjunction with the usual method of estimating probability of future occurrence. As required by FEMA, this hazard ranking process also includes extensive assessment of local hazard mitigation plans to match up the hazards of concern to local communities (Berke et al. 2012). For example, the 2013 HMP established that if 45 percent or fewer of the local plans identified the hazard, it was deemed to pose no significant threat to the state.

Furthermore, the Hazard Ranking Methodology also influences how each hazard is profiled in terms of loss and scenario modeling, which consists of potential losses in lives and property, building exposure, debris generation, population displaced and emergency shelters needed. As a result, mitigation actions are prioritized based on the hazard ranking and assessment. The majority of mitigation strategies focus on tornado, dam and levee failure, tropical cyclone, flood, and wildfire because these hazards possess a high risk level. The Council excluded technological and manmade hazards because they pose less of a threat to the state than natural ones. These hazards are also not a federal requirement for an HMP. Similarly, Hancock, Harrison and Jackson counties excluded assessment of these hazards in their most recent HMPs as well.

Although elected local mitigation councils for Hancock, Harrison and Jackson counties consulted on the hazard ranking process, only Harrison County's most updated HMP incorporated the state-wide hazard ranking approach. The hazard identification and prioritization process as applied in the 2013 State HMP is not seen in the local HMPs for Hancock and Jackson Counties. These two counties rely on public surveys and probability of occurrence to prioritize and profile local hazards. The local HMPs from

Hancock and Jackson counties identify hazards based on historical records and past damages, which include casualties and property and economic damage. By contrast, Harrison County HMP incorporates findings from public surveys along with its Hazard Ranking Index, similar to that of the state, to determine how to it will address each hazard. One of the reasons Hancock and Jackson Counties have not adopted the state's Hazard Ranking Methodology is because it is too new. The state unveiled the methodology in 2013, which means that the 2013 Hancock County HMP and 2012 Jackson County HMP did not have enough time to integrate it into their local plans. It is likely that the Hazard Ranking Methodology will be incorporated in the next version of the local HMPs.

The hazard prioritization process is driven by different interests within the councils, and this affects the types of mitigation funding the state or local government may be able to acquire. There are two areas of concern in the process: (1) climate change and its related hazards (e.g. drought, sea-level-rise) and (2) public participation. The 2013 State HMP has one mentioning of climate change, with limited details, even though a discussion of climate change and its effects on local extreme weather is now federally required (Babcock 2013). By comparison, local HMPs for Hancock, Harrison and Jackson counties elaborate on climate change and related hazards such sea-level-rise, droughts, and frequent flooding. This pattern is reflective of current literature that climate change adaptation predominately planning occurs at the local and municipal level and not as a top-down directive (Measham et al. 2011).

Although the state and local hazard mitigation councils represent collaborative partnerships between government, non-profits, and business sectors, the more vulnerable citizens are often excluded from the decision making process. FEMA requires that the planning process include public participation, which is usually observed in terms of posting a draft copy to a website, forums, workshops and surveys. These techniques are not as proactive in reaching out to disadvantaged groups such as low-income and minority racial and ethnic groups, who are often underrepresented in the decision-making process (Berke et al. 2012). State and local governments should consider using different types of participatory methods to mobilize and involve communities in the planning process employing consensus-based approaches and community outreach strategies (Pearce 2003).

These observations as such relate closest to two institutional resilience indicators, mitigation spending and statewide coordination. Mitigation spending targets highly ranked hazards while statewide coordination points to increased coordination between state and local governments. One aspect to note about the relationship between the state and tri-county study area is that emergency management representatives from Hancock, Harrison and Jackson work directly within the state's Hazard Mitigation Council to update the State HMP. This is not the case for other counties in Mississippi, with the exception of DeSoto County. It bears repeating that the Mississippi Gulf Coast has enormous economic and political importance to the state. The involvement of their local representatives in the state mitigation planning process could indicate these coastal counties rank higher than others in terms of state prioritization and allocation of resources (Blaikie et al. 2004).

6.2.2 Jurisdictional Coordination at the Local Level

In the case of Hancock, Harrison and Jackson counties, one of the most significant changes from the pre- to post-Katrina period is the transition from county hazard mitigation plans to multijurisdictional mitigation plans. All of the current county HMPs for the study area cover multiple jurisdictions. Some jurisdictions within a county chose to opt out of the county's multijurisdictional plan in order to create their own HMPs due to differences in priorities. Multijurisdictional mitigation planning can be a strong indication that there are increased coordination activities between the county and its local districts (Carr 2007). This means that overlapping mitigation actions and activities can be reduced based on jointly created plans.

6.2.3 Reporting of Loss Data and Hazard Modeling

In order to meet federal guidelines, the post-Katrina state and county HMPs made substantial improvements in the reporting of losses section. The hazard modeling portion of the state and county HMPs is also substantially improved in the post-Katrina period. In the case of the state of Mississippi HMP, loss data on property damage and crop losses originated from the National Climatic Data Center (NCDC) were incorporated into the plan's risk assessment of different hazards for each MEMA region. Similarly, Hancock, Harrison and Jackson counties incorporated loss records obtained from NCDC for each hazard in their probabilistic assessment of future occurrence. NCDC records are not as spatially accurate as loss data from the SHELDUS which provides place-specific history of losses (Gall et al. 2009).

The current state plan utilizes software like Digital Elevation Model, RiskMap and Storm Surge Modeling to simulate storm surges and flooding, which were not present in the 2004 State HMP, to complement HAZUS-MH modeling. Moreover, the current state version includes worst-case-scenario assessments regarding exposure of population, infrastructure and critical facilities. The worst-case-scenario for hurricanes utilizes inundation levels and losses from Hurricane Katrina (500-Year-Event) to anticipate shelter requirements, infrastructural exposure and damages and debris generation. As well, at the county level, Hurricane Katrina exposed the vulnerability of both the social system and the physical system. In the case of Hancock, Harrison, and Jackson counties, impacts from Hurricane Katrina on critical infrastructure, buildings and vulnerable population were considered in hurricane, storm surge, and flooding HAZUS-MH scenarios.

6.2.4 Participation in the National Flood Insurance Program

In the post-Katrina period, there has been an increase in statewide participation in the NFIP program. Hancock, Harrison and Jackson Counties extended NFIP coverage to local jurisdictions and communities (Michel-Kerjan 2010). It is evident by the number of projects covered by the NFIP. This increase in NFIP participation is also captured by the flood insurance coverage metric. Furthermore, while there is some increase in the number of Community Rating System (CRS) communities, it has not risen dramatically. Only ten counties joined the CRS program in the post-Katrina period. Harrison and Jackson counties along with some of their local jurisdictions have joined CRS in 2003 and 2011 respectively while Hancock County has not, although this is part of its future action goals. This finding is consistent with current literature relating to low participation in the CRS program, in part due to the voluntary nature of the program and land-use development conflicts (Burby 2001; Landry and Li 2011)

6.2.5 Social Vulnerability Assessment

The pre-Katrina State and County HMP only contained brief mentions of vulnerable populations. Assessment of social vulnerability in the post-Katrina period has seen some improvements, particularly at the state level. The 2013 State HMP derives socio-demographic variables from the Social Vulnerability Index, or SoVI, to identify vulnerable populations and communities (Cutter et al. 2003). The results from social vulnerability assessment are incorporated into mitigation actions. As part of their mitigation goal, the state of Mississippi and Jackson County determined to conduct public outreach to vulnerable populations such as the elderly, low-income and non-native speakers. In contrast, instead of targeting certain population demographics, Hancock County and Harrison counties have some mitigation actions related to reducing risk in socially vulnerable communities. Systematic social vulnerability assessment should be carried out in tandem with community outreach and educational programs (Pearce 2003; Berke and Campanella 2008).

6.3 Suggested Improvements for BRIC Institutional Resilience Sub-Index and Hazard Mitigation Planning

It is difficult to obtain evidence to validate BRIC, because it is a generalization of certain aspect of on the ground reality. The quantitative evaluation of the BRIC IR sub-index combined with qualitative analysis of hazard mitigation practices shed light on the complexity of disaster resilience. The analysis of state and local HMPs provided supplementary information and contextualization to the resilience metrics and indicators regarding changes in institutional resilience pre- and post-Katrina.

6.3.1 Compatibility between BRIC's Institutional Resilience Indicators and Hazard Mitigation Practices

Six out of the ten institutional resilience indicators utilized in BRIC are found in hazard mitigation plans. There are certain degrees of compatibility and incompatibility between the resilience indicators and their respective presence in hazard mitigation plans. For example, increase in mitigation spending contributes to higher overall IR scores for the majority of Mississippi counties. Increased investment in mitigation activities can also be seen in the substantial improvements in the pre- and post-Katrina plans. As well, the expansion of flood insurance coverage results in an increase in the IR scores and the post-Katrina HMPs. In the case of disaster aid experience, information regarding presidential disaster declarations and loss-causing events were found in the HMPs, although the ratio does not apply. In addition, the ratio does not differentiate the difference in dollar amount between each loss event. In the future, the disaster aid experience indicator should take in consideration the loss amounts. Another example of compatibility can be found in local disaster training; however, the mentioning of CERT is only present in some pre-and post-Katrina HMPs.

By comparison, jurisdictional coordination is measured by a ratio of the number of governments and special districts per 10,000 people. This ratio is not present in the mitigation plans, but the characteristics of jurisdictional coordination, as suggested by the extant academic literature, can be found in terms of multi-jurisdictional mitigation planning. An alternative metric that can perhaps capture jurisdictional coordination is a binary variable recording presence or absence of multi-jurisdictional plan. Moreover, one could also count the number of jurisdictions covered by a multiple-jurisdictional plan.

The more jurisdictions there are participating in a jointly created plan, the more coordination between a county and its local districts.

Furthermore, in the case of the study area, the population stability indicator did not capture the immediate population loss during Hurricane Katrina because it measures the population change every five years. Since the first two years post-disaster is an important period for displaced communities to return and rebuild, this indicator fails to capture the significance of post-disaster population displacement. This observation, however, does not negate that the need for calculating population stability. Within the scope of this research, this BRIC IR indicator has limited utility. In order to improve measurement of population stability, especially for heavy impacted areas in the post-Katrina context, instead of measuring population change by a five-year increment, it could be measured every one to two years. Population stability can be calculated by using Special Population Estimates for Impacted Counties in the Gulf Coast area or the 2005 American Community Survey Special Product for the Gulf Coast Area (Frey and Singer 2006).

Finally, the performance regime indicators, based on their theoretical orientation are not applicable to the qualitative analysis. None of the HMPs mention the benefits of having its county seat near a metropolitan statistical area or close proximity to the capital. This does not mean that these indicators are useless. An alternative way to measure the advantage of being close to the capital is looking into State HMP to see which county representatives were consulted during the planning process (Blaikie et al. 2004). For example, the indicator of the first performance regime (e.g. proximity of county seat to capital) for Hancock, Harrison and Jackson Counties indicate that these counties are located relatively far from the capital. However, an in-depth assessment of the State HMP shows that the emergency representatives from only four counties were present during the planning process. These counties include Hancock, Harrison, Jackson, and DeSoto. As such, long distance between the county seat and the capital does not mean that there is less communication between county and state representatives.

6.3.2 Suggested Improvements in Hazard Mitigation Plans

In the case of State and Local HMPs, there are some areas that could be improved. First, the 2013 State of Mississippi HMP uses SHELDUS data for its inflation adjustment property only for tornadoes. As for the rest of the hazards, the loss-causing event data comes from NCDC, which is not adjusted for inflation. In the case of the tri-county study area, none of the HMPs use inflation-adjusted data. As such, using the best available and most accurate data are important to enhancing institutional resilience. Losses that occurred ten to twenty years earlier are different in terms of monetary amounts to losses experienced in the present or recent past. In the future, the state and counties should use inflation adjusted loss data (Gall et al. 2009).

Systematic and standardized social vulnerability assessment was included in the 2013 State HMP, but this has not trickled down to the counties. This form of assessment should parallel physical assessments to reduce not only losses in property but also in lives. Socially vulnerable populations, who are not only at-risk in terms of exposure but also response and recovery, should be considered in mitigation actions (Pearce 2003). Lastly, although the HMPs take population stability into consideration, they do not incorporate potential population surges or losses into worst-case-scenario planning. An unexpected surge in population can overwhelm the ability of institutions to manage crises

(Sherrieb et al. 2010). Dramatic population loss can affect tax bases and upkeep of critical facilities. These should be factored into state and county probabilistic scenarios.

6.3.3 Suggested Institutional Indicators Outside of the BRIC Institutional Resilience Sub-Index

The analysis of state and local hazard mitigation plans yield useful insights regarding additional indicators for the BRIC institutional resilience sub-index. Institutional resilience can be measured by conducting a longitudinal assessment on the reduction of repetitive loss properties. They are defined as any property for which four or more flood insurance claims of more than $1,000 have been paid within any rolling ten-year-period since Jan 1, 1978 (FEMA 2011). State and local governments track and FEMA track repetitive loss properties. Data for this indicator can be requested from FEMA's BureauNet (FEMA 2011).

Another potential measurement of institutional resilience is the number of approved Emergency Action Plans at the county level. Emergency Action Plans are designed to minimize or mitigate the impacts of potential dam or levee failures. They are also applicable in the case of nuclear power plants, coal mining, oil production plants, refineries (Binder 2002). Within the context of BRIC index, the number of EAPs should be examined for dams and levees, which are vulnerable to excessive flooding, earthquakes, and other hazards. Similar to the nuclear accident planning, this indicator, which assesses the number of EAPs per county, should incorporate nearby population centers into consideration (Walh 1997). Data can be acquired via the state Department of Environmental Quality or other departments that are in charge of regulating dam safety.

6.4 Institutional Resilience: For Whom? To What?

As presented in the literature review section, the definition of resilience is contested among scholars from various disciplines. In addition, there is no agreed upon definition for institutional resilience. Some perceive institutional resilience as an over-arching force and a causal agent that influences multiple facets of resilience (i.e. social, economic, infrastructural, and ecological) while others frame it as a component of a resilient system, paralleling economic, social, infrastructural, community capital, and ecological resilience (Adger 2000; Cutter et al. 2008b). In this study, institutional resilience is associated with the latter framing. Here I propose to define it based on the observations that were made in the research and analysis process. Institutional resilience can be defined as the ability of governance organizations, which are made up of government agencies, community groups, non-profits, private sector and other actors involved in the emergency management process, to minimize disruptions, respond, and recover from disaster through effective and proactive coordination, communication, and planning. Similar to other aspects of system resilience, it also means the ability to incorporate continuous learning from past disasters and recovery challenges such that organizations and institutions can adapt and be more prepared for future shocks and disruptions. Moreover, institutional resilience goes beyond sustaining physical structures but also involving vulnerable and at-risk populations in the planning process through outreach and educational programs.

6.5 Theoretical Contribution: Operationalizing the DROP Model

The Disaster Resilience of Place (DROP) Model in Figure 2.1 illustrates the schematic representation of disaster resilience. The BRIC indicators are selected and designed to measure inherent resilience, which are characteristics of the system that function well during non-crisis periods (Cutter et al. 2003; Cutter et al. 2014b). In examining the effect of Hurricane Katrina on the institutional resilience on the state of Mississippi and its coastal areas, it is evident that some indicators of institutional resilience sub-indexes could be classified to measure adaptive resilience. Mitigation spending and flood insurance coverage have increased significantly in the post-disaster period. The state also significantly expanded its flood insurance participation. These findings were found in the institutional resilience metrics and the state and local hazard mitigation plans.

Comparison of the pre- and post-Katrina HMPs indicate that there are characteristics of social learning in terms of social vulnerability assessment, hazard modeling, hazard classification and ranking, participation in the NFIP program, and multi-level jurisdictional coordination. Social learning "occurs when beneficial impromptu actions are formalized into institutional policy for handling future events" (Cutter et al. 2003, 603). Lessons learned from Katrina were incorporated in the updated version of both state and local HMPs to improve preparedness activities and policy decisions regarding land-use planning, building codes, zoning and structural buyouts. These post-disaster lessons are fed back into the next phase mitigation planning, and as such social learning from the previous disaster experience strengthen the inherent resilience characteristics, from which a community can become more resilient as it prepares for future disruptive events.

Identification of adaptive resilience indicators can help inform the disaster policymaking process. As observed in the BRIC IR sub-index and HMPs, indicators such as mitigation spending and flood insurance coverage are part of actionable policy decisions. These indicators are the drivers of institutional resilience in the context of Mississippi. More future work is needed to identify adaptive resilience indicators in other sub-indices such as social, economic, infrastructural, community capital, and ecological factors.

6.6 Future Research

Due to the difficulty in acquiring HMPs at different temporal settings, other types of plans such as pre-disaster, recovery, comprehensive and emergency plans were not considered in this research. Frazier et al. (2013) find elements of institutional resilience present in post-disaster redevelopment plans and comprehensive plans for Sarasota County. Moreover, the authors also observe elements of social, economic, infrastructural and community capital in these planning documents as well. This suggests that hazard mitigation plans and other planning documents are useful in terms of evaluating different aspects of resilience related to policy decision-making (Berke and Campanella 2008).

This study focuses on institutional resilience in the context of pre- and post-Hurricane Katrina. Six of the indicators of the institutional sub-index were found in local and state hazard mitigation plans. It would be useful to conduct a similar study centered on a different type of disaster such as tornadoes, earthquakes, or droughts in other states in the U.S. Alternatively, the BRIC index could be applied in the context of Hurricane Katrina but using other sub-indices such as social, economic, infrastructural, community capital, and environmental at the national and state scale. In addition, Hurricane Katrina is shown to be influential in driving change in institutional resilience. It would also be valuable to examine how institutional and other types of resilience indicators (i.e. social, economic, infrastructural, community capital, and environmental) perform during periods without a major disaster. Examination of the indicators and metrics in these sub-indices and how they change over time can contribute to a holistic understanding of disaster resilience.

Moreover, Hancock, Harrison and Jackson counties are economically and politically important to the state. Representatives from the targeted coastal counties directly participate in the hazard mitigation planning and decision-making process, as compared to other counties in Mississippi. It would be useful to examine the HMPs from the less economically developed and least populous counties and determine how they coordinate with the state with regard to mitigation planning and how their institutional resilience scores have changed before and after a disastrous event.

6.7 Conclusion

This study confirms that the BRIC institutional resilience sub-index is useful in terms of evaluating the overall resilience of a community as well as to longitudinally compare resilience before and after a disaster. Given that the overall BRIC score for each county is a composite, Hurricane Katrina is an influential factor in driving the change in both institutional resilience and overall system resilience. Application of the BRIC institutional resilience sub-index reveals the effects of scaling and standardization and how these processes can obscure significant contextual details. Replication of the sub-index demonstrates that scaling and contextualization matter in terms of explaining the utility of the resilience metrics and indicators. Scaling at the national level will yield different BRIC scores along with different metrics for each indicator. In addition, it is important to evaluate both the absolute and standardized data to holistically interpret the BRIC results.

Evaluation of the state and local HMPs adds another level of contextualization to explain the BRIC IR indicators as well provide useful insights into the disaster governance structure of the state of Mississippi. At both state and local level, the hazard mitigation plans are designed to meet the minimum federal requirements. Improvements in mitigation practice from pre- and to post-Katrina period are a function increased federal standards over time, even though there are various aspects initiated by the state and local counties. Best planning practice means that planners and representatives going beyond that what is required by the federal governments. Examples of these include the participation of socially vulnerable groups in the decision-making process, incorporation of inflation-adjusted loss data, addressing the issue of land-use in hazardous areas, and integrating climate change adaptation into planning practices.

Mitigation has tremendous value to society in terms of safety, equity and sustainability. Proactive mitigation planning helps create safer communities, reduce loss of life and property damage, and allows individuals to minimize post-disaster disruptions and recover more quickly (Godschalk 2003; Yoon et al. 2015). Resilience is a concept and a practice that will become increasingly relevant in the future. Recently, the Department of Housing and Urban Development launched a National Disaster Resilience Competition to help affected communities recover from disasters and prepare to mitigate risk. Personnel from federal agencies are partnering with universities, local governments, and non-profit institutions, notably the Rockefeller Foundation, to design mitigation strategies for different eligible communities. By using qualitative analysis to complement quantitative findings as well as focusing on one specific aspect of resilience, the methodological approach of this study can be reproduced for studying and improving other facets of resilience indicators and metrics. This mixed-method approach seeks to answer the research questions while concurrently working to bridge the conceptual understanding between hazard research and practice.

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APPENDIX A: BRIC INSITITUTIONAL RESILIENCE SCORES FOR EIGHTY-TWO COUNTIES IN MISSISSIPPI

This appendix features the composite BRIC institutional resilience (IR) scores of eighty-two counties in Mississippi, aggregated at the state scale, for 2000 and 2010. Each county is ranked based on its IR score, which ranges from 0 to 10, with each unit increased indicating more resilience. Table A.1 and A.2 contain detailed breakdown of the standardized values of the IR indicators, which range from 0 to 1, with each unit increased indicating more resilience.

Table A.1: Breakdowns of BRIC institutional resilience scores and metrics (standardized values) for eighty-two counties in Mississippi in 2000, aggregated at state scale (n=82)

Rank	County	IR Score 2000	Mitigation Spending	Flood Insurance Coverage	Jurisdiction Coord	Disaster Aid Exp	Disaster Training	Near State Capital	Near MSA	Population Stability	Nuclear Planning	Crop Insurance Coverage
43	Adams	3.26	0.01	0.01	0.91	0.40	0.00	0.62	0.33	0.94	0.00	0.04
67	Alcorn	2.72	0.03	0.01	0.80	0.27	0.00	0.01	0.55	0.88	0.00	0.16
39	Amite	3.33	0.00	0.01	0.82	0.22	0.00	0.61	0.71	0.95	0.00	0.01
53	Attala	3.09	0.02	0.01	0.67	0.23	0.00	0.74	0.50	0.89	0.00	0.03
78	Benton	2.47	0.00	0.00	0.27	0.18	0.00	0.11	0.81	0.99	0.00	0.12
62	Bolivar	2.84	0.05	0.11	0.28	0.13	0.00	0.52	0.21	0.88	0.00	0.65
69	Calhoun	2.66	0.00	0.03	0.34	0.26	0.00	0.43	0.28	1.00	0.00	0.32
58	Carroll	2.97	0.00	0.01	0.65	0.32	0.00	0.67	0.34	0.83	0.00	0.15
77	Chickasaw	2.49	0.00	0.01	0.63	0.11	0.00	0.40	0.18	0.92	0.00	0.25
73	Choctaw	2.60	0.00	0.01	0.60	0.42	0.00	0.60	0.14	0.81	0.00	0.01
3	Claiborne	4.53	0.00	0.07	0.84	0.20	0.00	0.80	0.57	1.00	1.00	0.05
61	Clarke	2.88	0.00	0.08	0.67	0.32	0.00	0.63	0.26	0.92	0.00	0.01
56	Clay	3.05	0.01	0.09	0.85	0.37	0.00	0.42	0.17	0.97	0.00	0.17
32	Coahoma	3.42	0.01	0.06	0.50	0.38	0.00	0.37	0.56	0.91	0.00	0.62
13	Copiah	3.85	0.00	0.02	0.79	0.21	0.00	0.89	1.00	0.93	0.00	0.02
30	Covington	3.54	0.00	0.03	0.86	0.54	0.00	0.76	0.66	0.66	0.00	0.03
70	DeSoto	2.65	0.00	0.04	0.96	0.35	0.00	0.16	1.00	0.00	0.00	0.13
26	Forrest	3.61	0.00	0.15	0.91	0.00	0.00	0.63	1.00	0.92	0.00	0.00
21	Franklin	3.70	0.00	0.00	0.61	0.93	0.00	0.70	0.51	0.94	0.00	0.01
42	George	3.28	0.00	0.06	0.89	0.22	0.00	0.38	1.00	0.68	0.00	0.04
49	Greene	3.19	0.00	0.05	0.82	0.48	0.00	0.43	0.80	0.59	0.00	0.01
7	Grenada	4.23	1.00	0.13	0.89	0.35	0.00	0.52	0.25	0.90	0.00	0.18
8	Hancock	3.96	0.01	1.00	0.76	0.38	0.00	0.31	1.00	0.50	0.00	0.00
4	Harrison	4.47	0.54	0.57	0.97	0.25	0.00	0.30	1.00	0.84	0.00	0.00
6	Hinds	4.41	0.01	0.24	1.00	0.15	0.00	0.99	1.00	0.98	0.00	0.05
44	Holmes	3.26	0.00	0.04	0.62	0.13	0.00	0.77	0.56	0.96	0.00	0.18
14	Humphreys	3.84	0.24	0.24	0.44	0.27	0.00	0.73	0.41	0.93	0.00	0.58

Rank	County	IR Score 2000	Mitigation Spending	Flood Insurance Coverage	Jurisdiction Coord	Disaster Aid Exp	Disaster Training	Near State Capital	Near MSA	Population Stability	Nuclear Planning	Crop Insurance Coverage
18	Issaquena	3.72	0.00	0.79	0.50	0.48	0.00	0.73	0.29	0.49	0.00	0.44
80	Itawamba	2.45	0.05	0.01	0.78	0.13	0.00	0.19	0.37	0.80	0.00	0.11
10	Jackson	3.88	0.02	0.53	0.96	0.27	0.00	0.22	1.00	0.86	0.00	0.01
38	Jasper	3.34	0.00	0.00	0.74	0.38	0.00	0.78	0.59	0.85	0.00	0.00
34	Jefferson	3.39	0.00	0.01	0.73	0.53	0.00	0.73	0.51	0.80	0.03	0.05
23	Jefferson Davis	3.65	0.00	0.00	0.69	0.53	0.00	0.79	0.68	0.94	0.00	0.01
35	Jones	3.38	0.00	0.06	0.89	0.14	0.00	0.68	0.66	0.93	0.00	0.01
51	Kemper	3.15	0.00	0.00	0.63	0.46	0.00	0.59	0.46	1.00	0.00	0.00
68	Lafayette	2.67	0.00	0.01	0.88	0.18	0.00	0.30	0.65	0.60	0.00	0.06
54	Lamar	3.08	0.02	0.04	0.85	0.16	0.00	0.59	1.00	0.41	0.00	0.01
55	Lauderdale	3.06	0.00	0.08	0.97	0.09	0.00	0.63	0.29	1.00	0.00	0.00
20	Lawrence	3.70	0.00	0.04	0.77	0.55	0.00	0.79	0.66	0.87	0.00	0.02
31	Leake	3.50	0.07	0.02	0.84	0.30	0.00	0.82	0.63	0.80	0.00	0.01
72	Lee	2.63	0.01	0.05	0.88	0.02	0.00	0.24	0.32	0.82	0.00	0.27
1	Leflore	4.66	0.73	0.47	0.77	0.19	0.00	0.62	0.21	1.00	0.00	0.68
24	Lincoln	3.64	0.00	0.01	0.87	0.36	0.00	0.79	0.75	0.85	0.00	0.00
33	Lowndes	3.41	0.07	0.28	0.90	0.28	0.00	0.40	0.35	0.99	0.00	0.14
11	Madison	3.86	0.05	0.10	0.93	0.26	0.00	0.94	1.00	0.51	0.00	0.06
17	Marion	3.72	0.00	0.15	0.88	0.34	0.00	0.67	0.68	1.00	0.00	0.01
40	Marshall	3.30	0.00	0.01	0.87	0.42	0.00	0.15	1.00	0.75	0.00	0.10
66	Monroe	2.78	0.00	0.06	0.84	0.19	0.00	0.34	0.14	0.95	0.00	0.26
60	Montgomery	2.90	0.00	0.01	0.54	0.38	0.00	0.62	0.21	0.96	0.00	0.17
64	Neshoba	2.81	0.00	0.01	0.92	0.03	0.00	0.71	0.34	0.79	0.00	0.00
63	Newton	2.81	0.00	0.01	0.65	0.15	0.00	0.74	0.37	0.89	0.00	0.00
46	Noxubee	3.22	0.00	0.02	0.70	0.42	0.00	0.51	0.48	0.98	0.00	0.11
74	Oktibbeha	2.57	0.00	0.04	0.89	0.15	0.00	0.49	0.16	0.80	0.00	0.03
57	Panola	3.00	0.00	0.03	0.63	0.09	0.00	0.34	0.73	0.77	0.00	0.41
47	Pearl River	3.21	0.07	0.14	0.91	0.30	0.00	0.51	0.72	0.56	0.00	0.01
28	Perry	3.56	0.00	0.09	0.59	0.53	0.00	0.54	1.00	0.81	0.00	0.00

Rank	County	IR Score 2000	Mitigation Spending	Flood Insurance Coverage	Jurisdiction Coord	Disaster Aid Exp	Disaster Training	Near State Capital	Near MSA	Population Stability	Nuclear Planning	Crop Insurance Coverage
37	Pike	3.37	0.00	0.02	0.80	0.27	0.00	0.64	0.69	0.94	0.00	0.01
71	Pontotoc	2.64	0.00	0.00	0.70	0.35	0.00	0.29	0.45	0.68	0.00	0.16
76	Prentiss	2.51	0.00	0.01	0.76	0.20	0.00	0.10	0.41	0.81	0.00	0.22
5	Quitman	4.44	0.65	0.12	0.06	0.68	0.00	0.36	0.62	0.95	0.00	1.00
27	Rankin	3.58	0.00	0.12	0.92	0.10	0.00	1.00	1.00	0.42	0.00	0.02
36	Scott	3.37	0.00	0.01	0.83	0.24	0.00	0.85	0.63	0.78	0.00	0.02
65	Sharkey	2.79	0.00	0.22	0.00	0.07	0.00	0.76	0.36	0.84	0.00	0.54
9	Simpson	3.90	0.01	0.04	0.87	0.29	0.00	0.91	1.00	0.77	0.00	0.01
22	Smith	3.69	0.00	0.01	0.70	0.57	0.00	0.84	0.75	0.81	0.00	0.00
50	Stone	3.15	0.00	0.02	0.78	0.26	0.00	0.46	1.00	0.63	0.00	0.00
45	Sunflower	3.25	0.09	0.06	0.67	0.16	0.00	0.63	0.15	0.74	0.00	0.75
41	Tallahatchie	3.28	0.00	0.07	0.38	0.26	0.00	0.45	0.46	0.97	0.00	0.68
12	Tate	3.85	0.00	0.01	0.76	1.00	0.00	0.23	1.00	0.62	0.00	0.23
75	Tippah	2.52	0.00	0.00	0.57	0.14	0.00	0.12	0.66	0.93	0.00	0.09
79	Tishomingo	2.46	0.00	0.01	0.73	0.13	0.00	0.00	0.66	0.85	0.00	0.07
25	Tunica	3.63	0.00	0.09	0.51	0.63	0.00	0.21	1.00	0.76	0.00	0.43
81	Union	2.43	0.00	0.00	0.71	0.07	0.00	0.21	0.62	0.65	0.00	0.18
29	Walthall	3.56	0.00	0.07	0.89	0.47	0.00	0.64	0.55	0.92	0.00	0.03
15	Warren	3.82	0.06	0.09	0.90	0.08	0.00	0.86	0.67	0.97	0.00	0.19
2	Washington	4.61	0.67	0.45	0.85	0.37	0.00	0.59	0.29	0.83	0.00	0.55
52	Wayne	3.12	0.00	0.03	0.85	0.38	0.00	0.56	0.50	0.78	0.00	0.01
59	Webster	2.96	0.00	0.01	0.63	0.58	0.00	0.52	0.00	1.00	0.00	0.22
16	Wilkinson	3.74	0.00	0.07	0.69	0.93	0.00	0.52	0.71	0.80	0.00	0.03
48	Winston	3.20	0.00	0.02	0.80	0.57	0.00	0.62	0.18	0.97	0.00	0.03
82	Yalobusha	2.25	0.00	0.02	0.38	0.02	0.00	0.38	0.53	0.80	0.00	0.11
19	Yazoo	3.71	0.00	0.19	0.72	0.29	0.00	0.85	0.67	0.69	0.00	0.30

Table A.2: Breakdowns of BRIC institutional resilience scores and metrics (standardized values) for eighty-two counties in Mississippi in 2010, aggregated at state scale (n=82)

Rank	County	IR Score 2010	Mitigation Spending	Flood Insurance Coverage	Jurisdiction Coord	Disaster Aid Exp	Disaster Training	Near State Capital	Near MSA	Population Stability	Nuclear Planning	Crop Insurance Coverage
42	Adams	3.17	0.14	0.01	0.93	0.10	0.00	0.62	0.33	0.98	0.00	0.06
77	Alcorn	2.43	0.01	0.01	0.88	0.05	0.00	0.01	0.55	0.81	0.00	0.11
8	Amite	4.03	0.01	0.00	0.89	0.88	0.00	0.61	0.71	0.92	0.00	0.01
37	Attala	3.25	0.01	0.01	0.79	0.18	0.00	0.74	0.50	1.00	0.00	0.02
80	Benton	2.35	0.01	0.00	0.50	0.20	0.00	0.11	0.81	0.58	0.00	0.14
76	Bolivar	2.52	0.02	0.09	0.45	0.08	0.00	0.52	0.21	0.56	0.00	0.59
67	Calhoun	2.65	0.00	0.02	0.54	0.23	0.00	0.43	0.28	0.92	0.00	0.24
53	Carroll	2.95	0.01	0.01	0.77	0.09	0.00	0.67	0.34	0.93	0.00	0.13
71	Chickasaw	2.57	0.01	0.00	0.79	0.25	0.00	0.40	0.18	0.65	0.00	0.29
81	Choctaw	2.31	0.02	0.00	0.71	0.23	0.00	0.60	0.14	0.59	0.00	0.02
10	Claiborne	3.94	0.02	0.03	0.89	0.22	0.00	0.80	0.57	0.38	1.00	0.02
69	Clarke	2.64	0.01	0.04	0.78	0.11	0.00	0.63	0.26	0.80	0.00	0.00
54	Clay	2.94	0.01	0.06	0.92	0.36	0.00	0.42	0.17	0.90	0.00	0.10
49	Coahoma	3.06	0.02	0.03	0.59	0.14	0.00	0.37	0.56	0.63	0.00	0.72
7	Copiah	4.05	0.15	0.01	0.87	0.14	0.00	0.89	1.00	0.97	0.00	0.01
35	Covington	3.31	0.02	0.02	0.89	0.07	0.00	0.76	0.66	0.87	0.00	0.02
20	DeSoto	3.75	0.08	0.03	0.98	0.00	1.00	0.16	1.00	0.33	0.00	0.17
19	Forrest	3.76	0.04	0.07	0.95	0.07	0.00	0.63	1.00	0.99	0.00	0.00
43	Franklin	3.16	0.02	0.00	0.75	0.31	0.00	0.70	0.51	0.87	0.00	0.01
4	George	4.37	0.18	0.04	0.95	1.00	0.00	0.38	1.00	0.77	0.00	0.05
29	Greene	3.41	0.02	0.04	0.90	0.56	0.00	0.43	0.80	0.65	0.00	0.01
59	Grenada	2.82	0.01	0.06	0.90	0.08	0.00	0.52	0.25	0.84	0.00	0.14
1	Hancock	5.30	1.00	1.00	0.84	0.37	0.00	0.31	1.00	0.78	0.00	0.00
3	Harrison	4.38	0.35	0.54	0.99	0.33	0.00	0.30	1.00	0.87	0.00	0.00
6	Hinds	4.13	0.01	0.11	1.00	0.05	0.00	0.99	1.00	0.94	0.00	0.03
41	Holmes	3.19	0.01	0.02	0.74	0.24	0.00	0.77	0.56	0.66	0.00	0.19
28	Humphreys	3.43	0.01	0.11	0.54	0.29	0.00	0.73	0.41	0.59	0.00	0.75

Rank	County	IR Score 2010	Mitigation Spending	Flood Insurance Coverage	Jurisdiction Coord	Disaster Aid Exp	Disaster Training	Near State Capital	Near MSA	Population Stability	Nuclear Planning	Crop Insurance Coverage
75	Issaquena	2.53	0.00	0.44	0.38	0.29	0.00	0.73	0.29	0.00	0.00	0.41
63	Itawamba	2.75	0.00	0.01	0.89	0.22	0.00	0.19	0.37	1.00	0.00	0.06
2	Jackson	4.55	0.32	0.70	0.98	0.41	0.00	0.22	1.00	0.90	0.00	0.01
47	Jasper	3.08	0.00	0.01	0.84	0.09	0.00	0.78	0.59	0.77	0.00	0.00
68	Jefferson	2.65	0.02	0.00	0.79	0.19	0.00	0.73	0.51	0.31	0.03	0.05
36	Jefferson Davis	3.30	0.02	0.00	0.77	0.21	0.00	0.79	0.68	0.81	0.00	0.02
34	Jones	3.33	0.06	0.03	0.93	0.05	0.00	0.68	0.66	0.91	0.00	0.01
51	Kemper	3.01	0.01	0.00	0.81	0.21	0.00	0.59	0.46	0.92	0.00	0.00
72	Lafayette	2.55	0.02	0.02	0.93	0.19	0.00	0.30	0.65	0.40	0.00	0.05
61	Lamar	2.80	0.09	0.03	0.95	0.07	0.00	0.59	1.00	0.06	0.00	0.01
55	Lauderdale	2.93	0.07	0.04	0.99	0.06	0.00	0.63	0.29	0.85	0.00	0.00
5	Lawrence	4.16	0.02	0.02	0.85	0.17	0.79	0.79	0.66	0.84	0.00	0.02
31	Leake	3.37	0.01	0.01	0.91	0.21	0.00	0.82	0.63	0.77	0.00	0.00
62	Lee	2.78	0.01	0.04	0.93	0.08	0.00	0.24	0.32	0.80	0.00	0.35
14	Leflore	3.89	0.01	0.15	0.80	0.03	0.86	0.62	0.21	0.57	0.00	0.63
22	Lincoln	3.67	0.12	0.01	0.94	0.16	0.00	0.79	0.75	0.89	0.00	0.01
48	Lowndes	3.07	0.01	0.11	0.93	0.14	0.00	0.40	0.35	0.99	0.00	0.14
23	Madison	3.64	0.02	0.06	0.97	0.07	0.00	0.94	1.00	0.51	0.00	0.07
39	Marion	3.23	0.01	0.07	0.95	0.12	0.00	0.67	0.68	0.72	0.00	0.01
45	Marshall	3.11	0.00	0.01	0.93	0.09	0.00	0.15	1.00	0.84	0.00	0.09
57	Monroe	2.88	0.02	0.04	0.91	0.24	0.00	0.34	0.14	0.93	0.00	0.27
78	Montgomery	2.41	0.00	0.01	0.69	0.03	0.00	0.62	0.21	0.71	0.00	0.13
40	Neshoba	3.20	0.02	0.01	0.97	0.18	0.00	0.71	0.34	0.97	0.00	0.00
56	Newton	2.90	0.01	0.00	0.82	0.06	0.00	0.74	0.37	0.89	0.00	0.00
52	Noxubee	2.99	0.02	0.01	0.83	0.20	0.00	0.51	0.48	0.80	0.00	0.15
79	Oktibbeha	2.39	0.03	0.04	0.94	0.28	0.00	0.49	0.16	0.41	0.00	0.03
33	Panola	3.35	0.01	0.02	0.76	0.12	0.03	0.34	0.73	0.94	0.00	0.39
25	Pearl River	3.56	0.22	0.10	0.96	0.27	0.00	0.51	0.72	0.77	0.00	0.01
18	Perry	3.77	0.01	0.05	0.77	0.41	0.00	0.54	1.00	0.97	0.00	0.01

Rank	County	IR Score 2010	Mitigation Spending	Flood Insurance Coverage	Jurisdiction Coord	Disaster Aid Exp	Disaster Training	Near State Capital	Near MSA	Population Stability	Nuclear Planning	Crop Insurance Coverage
24	Pike	3.62	0.11	0.01	0.90	0.36	0.00	0.64	0.69	0.91	0.00	0.01
65	Pontotoc	2.72	0.01	0.00	0.80	0.20	0.00	0.29	0.45	0.77	0.00	0.21
64	Prentiss	2.74	0.01	0.00	0.90	0.19	0.00	0.10	0.41	0.96	0.00	0.18
32	Quitman	3.36	0.18	0.08	0.19	0.43	0.00	0.36	0.62	0.49	0.00	1.00
15	Rankin	3.88	0.05	0.07	0.96	0.05	0.00	1.00	1.00	0.72	0.00	0.04
26	Scott	3.53	0.01	0.00	0.90	0.17	0.00	0.85	0.63	0.94	0.00	0.03
82	Sharkey	2.26	0.00	0.16	0.00	0.12	0.00	0.76	0.36	0.33	0.00	0.52
13	Simpson	3.92	0.01	0.02	0.91	0.11	0.00	0.91	1.00	0.94	0.00	0.01
30	Smith	3.40	0.01	0.01	0.81	0.08	0.00	0.84	0.75	0.90	0.00	0.00
9	Stone	3.96	0.80	0.02	0.90	0.52	0.00	0.46	1.00	0.25	0.00	0.00
46	Sunflower	3.11	0.01	0.05	0.76	0.09	0.00	0.63	0.15	0.67	0.00	0.75
50	Tallahatchie	3.04	0.07	0.03	0.58	0.17	0.00	0.45	0.46	0.68	0.00	0.59
44	Tate	3.14	0.01	0.01	0.89	0.18	0.00	0.23	1.00	0.67	0.00	0.16
70	Tippah	2.60	0.01	0.00	0.72	0.21	0.00	0.12	0.66	0.82	0.00	0.06
73	Tishomingo	2.55	0.01	0.01	0.82	0.08	0.00	0.00	0.66	0.92	0.00	0.05
27	Tunica	3.52	0.04	0.05	0.73	0.13	0.00	0.21	1.00	0.83	0.00	0.53
58	Union	2.85	0.01	0.00	0.78	0.07	0.00	0.21	0.62	0.95	0.00	0.21
21	Walthall	3.72	0.01	0.03	0.94	0.53	0.00	0.64	0.55	1.00	0.00	0.02
17	Warren	3.77	0.07	0.05	0.92	0.07	0.00	0.86	0.67	0.97	0.00	0.17
38	Washington	3.23	0.00	0.25	0.89	0.22	0.00	0.59	0.29	0.48	0.00	0.51
12	Wayne	3.92	0.48	0.02	0.90	0.56	0.00	0.56	0.50	0.91	0.00	0.01
66	Webster	2.67	0.02	0.00	0.76	0.23	0.00	0.52	0.00	0.94	0.00	0.18
11	Wilkinson	3.93	0.03	0.04	0.80	0.96	0.00	0.52	0.71	0.86	0.00	0.01
60	Winston	2.81	0.01	0.01	0.86	0.23	0.00	0.62	0.18	0.87	0.00	0.01
74	Yalobusha	2.54	0.00	0.01	0.59	0.14	0.00	0.38	0.53	0.79	0.00	0.09
16	Yazoo	3.79	0.01	0.11	0.85	0.07	0.00	0.85	0.67	0.98	0.00	0.26