MITIGATING FLOOD LOSS THROUGH LOCAL COMPREHENSIVE PLANNING IN FLORIDA

A Dissertation

by

JUNG EUN KANG

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2009

Major Subject: Urban and Regional Sciences

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ABSTRACT

Mitigating Flood Loss through Local Comprehensive Planning in Florida. (August 2009)

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Planning researchers believe that property losses from natural hazards, such as floods can be reduced if governments address this issue and adopt appropriate policies in their plans. However, little empirical research has examined the relationship between plan quality and actual property loss from floods. My research addresses this critical gap in the planning and hazard research literature by evaluating the effectiveness of current plans and policies in mitigating property damage from floods. Specifically, this study: 1) assesses the extent to which local comprehensive plans integrate flood mitigation policies in Florida; and 2) it examines the impact of the quality of flood mitigation policies on actual insured flood damages.

Study results show that fifty-three local plans in the sample received a mean score for total flood mitigation policy quality of 38.55, which represents 35.69% of the total possible points. These findings indicate that there is still considerable room for improvement by local governments on flooding issues. The scores of local plans varied widely, with coastal communities receiving significantly higher scores than non-coastal communities. While most communities adopted land use management tools, such as

permitted land use and wetland permits as primary flood mitigation tools, incentive based tools/taxing tools and acquisition tools were rarely adopted.

This study also finds that plan quality associated with flood mitigation policy had little discernible effect on reducing insured flood damage while controlling for biophysical, built environment and socio-economic variables. This result counters the assumption inherent in previous plan quality research that better plans mitigate the adverse effects associated with floods and other natural hazards. There are some possible explanations for this result in terms of plan implementation, land use management paradox and characteristics of insurance policies. The statistical analysis also suggests that insured flood loss is considerably affected by wetland alteration and a community's location on the coast. Another finding indicates that very strong leadership and dam construction are factors in mitigating flood loss.

DEDICATION

To my family

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1. INTRODUCTION

1.1. Background

Humans have suffered from floods as long as they have been on the earth. Floods cause not only severe human injury and death, but also billions of dollar losses to physical property, crops and public infrastructure. People have made continuous efforts to minimize the losses from floods with rapid technological, social and cultural progress, but flooding is still one of the greatest threats in the United States. Flood damage, which has increased continuously, causes approximately $7 billion annually (Noble, 2006). This is exacerbated by the complex interaction between intensity and frequency of flooding events and the growing vulnerability of society to floods as a result of increasing population and development in flood prone areas (Brody et al., 2007; Mileti, 1999; Noble, 2006).

The belief that "natural disasters cannot be prevented from their occurrence, but their impact on people and property can be reduced through proactive actions" (Godschalk et al., 1999) has promoted various efforts in multidisciplinary fields. While researchers in the atmospheric sciences, geophysical sciences and engineering have developed important technologies and physical tools to lower flood impacts, social science research has addressed the social, economic, political and behavior issues from flooding.

This dissertation follows the style of *Journal of the American Planning Association*.

Until the 1960s, most flood management efforts were focused on structural measures such as building levees, dams and flood walls. Some research criticized these approaches as extremely expensive with adverse impacts such as destroying ecosystems and creating a false sense of security. In the late 1960s, as a result of several flood disasters, a new flood policy emerged in the form of the National Flood Insurance Program (NFIP). Land use and relocation strategies away from hazardous areas have become emphasized and since the 1980s, much effort has gone to establishing state and local governments' roles in flood mitigation through land use planning (Godschalk et al., 1999). This tendency has led to the increasing importance of the planner's role in flood mitigation by employing proper flood mitigation policies in local comprehensive plans as well as increasing efforts to implement those policies.

In recent years, a group of researchers who examined local government efforts toward natural hazard mitigation through local comprehensive plans found there are wide variations in their results. Most previous studies have focused mainly on state mandated influence on the quality of plans associated with hazard mitigation (Berke, Crawford, Dixon, & Ericksen, 1999; Berke et al., 1997; Berke & French, 1994; Berke et al., 1996; Burby et al., 1993; Burby & Dalton, 1994; Burby & May, 1997). Continuing studies found that factors such as intergovernmental relations (Berke, 1994; Burby & May, 1998), local commitment (Norton, 2005) and citizen participation (Brody, 2003a; Burby, 2003) affect plan quality. However, comparatively little research has been done relating the impact of plan quality to actual hazard damage. Furthermore, there is no empirical research which examines variations in flood mitigation policies adopted by local governments, and the relationship between planning efforts and actual flood damage. This study develops a fully specified model for flood loss reduction by including not only planning dimensions, but also biophysical, built environmental and socio-economic factors.

1.2. Research Purpose and Objectives

This study is focused on understanding whether planning efforts toward adopting and implementing flood mitigation policies are effective in reducing the degree of losses caused by floods. This research investigates other factors affecting flood damage in Florida by using statistical analyses and GIS routines. The specific research objectives are to:

- Asses to what extent local comprehensive plans integrate flood mitigation policies.
- Examine the effects of planning factors on flood loss.
- Investigate the impact of biophysical factors on flood loss.
- Address the relative impact of built environment factors on flood loss.
- Examine whether or not socioeconomic factors influence flood loss.

In order to achieve these research objectives, this study starts by reviewing the current literature. The first sub-section of the literature review is devoted to developing a protocol to evaluate flood mitigation policies adopted in local comprehensive plans. This study evaluates the quality of adopted policies in plan documents as an important indicator of local planning efforts for flood damage reduction. The second sub-section discusses the importance of other local planning efforts such as planning capacity, planner's commitment and leadership. In addition, the third sub-section reviews literature associated with biophysical, built environment and socioeconomic factors affecting flood damage. Based on the literature review, a conceptual framework is presented leading to an assessment of how local planning efforts affect actual flood damage through a regression model.

1.3. Research Justification

The value of this research, "mitigating flood loss through local comprehensive planning in Florida", can be justified by three points of view.

1.3.1. Why Natural Hazards, Especially Floods, Need Attention

Natural disasters can have an overwhelming short-term and long-term impact on the entire society and economy of an area. They are significant threats to humans and property and, in particular, poor nations and poor people are more vulnerable to natural disasters. In the United States, though the number of deaths from natural hazards has not increased, property damage has increased enormously. Natural disasters caused damage of between $230 billion and $1 trillion (in 1994 dollars) between 1975-1994 (Mileti, 1999). In particular, the economic impact from flooding events annualizes approximately in billions of dollars (Association of State Floodplain Managers, 2007). According to data from the National Weather Service of NOAA, the annual damage estimate increased from $0.88 billion to $43.69 billion (in 2006 dollars) between 1960 and 2005. FEMA insurance claim data show that the number of policies in force increased 3.8 times from 1978 to 2006 and the average annual loss in dollars paid expanded from $147 million to $17 billion between 1978 and 2005. Even if, in part, the impact of inflation and the constant revaluation of property affect this trend (Alexander, 2000), the strongest reason is population migration and development growth in hazardous areas. The growing vulnerability of society is expected to continue because of increasing urbanization and the shortage of low cost, low risk land.

Despite these trends and expectations, natural hazards, including floods, have not had a high priority in governmental policies. Although the concerns about natural hazards have recently risen when some huge disasters inspired interest, still more research and continuous attention are needed. This study provides valuable information about the effectiveness of current flood management policies and offers suggestions for better decision making to mitigate the adverse impacts of floods in the future.

It is noteworthy why this study is focused on a single hazard – floods. First of all, flooding is the greatest threat to property in the United States. Furthermore, many communities suffer repetitive flooding over time in the same general area. This study helps to improve understanding of how communities need to respond to these repetitive floods. Finally, dealing with all natural hazards can give an overall view; however it is difficult to develop a fully specified model to explain their impacts because each hazard has different characteristics in origin and development and, thus, explanatory variables would be different. Floods are weather related hazards and comparatively site-specific.

So, biophysical and built environment factors are important variables as well as planning and socioeconomic factors. By understanding which factors influence actual flood damage, flood planners can set an appropriate priority to develop mitigation policies for their communities.

1.3.2. Why Local Comprehensive Plans Need Attention

Planning refers to "*the broad range of activities that planners undertake*" (Burby & May, 1997) and " *a process guided by a plan*" (Kaiser, Godschalk, & Chaplin, 1995). From these definitions, it is noted that planning includes not only the planning process, but also a plan document. This is the first reason why we need to evaluate the quality of a plan to examine its effectiveness.

The idea of integrating hazard mitigation and land use planning has a long history. A pioneer, Gilbert White (1936), argued that loss of lives and property from a range of natural hazards could be minimized if inappropriate development is prevented in hazardous areas. Current land use is one element of a local comprehensive plan (general plan) which guides a community's desirable future land use and development pattern based on a factual basis. In the United States, traditionally local governments are largely responsible for planning and regulating land use development (Burby & May, 1997; Hoch, Dalton, & So, 2000), and can, therefore, play an important role in hazard mitigation. Thus, my research focuses on the local comprehensive plans and local planners' commitments and capabilities.

In the past 20 years, hazard mitigation research has generated some important insights. Despite these investigations, there are still gaps between knowledge and practice that need to be addressed. My study overcomes the gaps by providing empirical evidence about the effectiveness of current planning efforts in mitigating losses from floods. This research provides meaningful information for local governments and decision makers regarding the strengths and weaknesses of current policies and how they adapt the policies to avoid repetitive flooding.

1.3.3. Why Florida Needs Attention

Florida is a peninsular state composed of 58,560 square miles and 67 counties (State of Florida, 2007b). Historically, Florida was a poor and sparsely settled region, but after World War II, its mild climate, beautiful landscapes and abundant natural resources have driven its rapid growth and economic affluence (State of Florida, 2007a). In particular, population growth is remarkable. By 1940, Florida's population was about 1.9 million but reached about 16 million in 2000 making it the 4th largest state in the United States behind California, Texas and New York. Like other states, population growth means enormous urban extension. In particular, as Florida contains vast wetlands and coastal area, population and development growth have been concentrated in low-lying areas near the coast. Over ten thousand square miles of the State are flood prone and over one million households and $46 billion in property are located in these vulnerable areas (FEMA, 1997). Due to these geographical characteristics and the rapid growth of coastal population, property damage caused by floods reached almost $2.5

billion (in 2003 dollars) from 1990 to 2003. Florida reported as the state with the highest risk from flooding (FEMA, 1997); thus, it is the ideal biogeographical setting for flood mitigation research.

The second reason is associated with planning traditions in Florida. After World War II, rapid population growth and enormous development threatened the natural ecosystem and exploited natural resources. Citizen environmental activists began to raise their voices to protect Florida's environment in the 1960s, and these activities spurred Florida to pass the Florida State Comprehensive Planning Act, the Environmental Land and Water Management Act, the Land Conservation Act and the Florida Water Resources Act in 1972 (Burby & May, 1997). However, these acts were not very useful because they were too vague and contradictory (DeGrove, 1984). Continuing concerns about urban growth increased the necessity for local land use planning, and in 1975 the Local Government Comprehensive Planning Act was passed. However, local governments did not provide enough support to local land use plans to influence local development (deHaven-Smith, 1984). By learning through trial and error, Florida passed the State and Regional Planning Act, the State Comprehensive Planning Act and the Omnibus Growth Management Act successively in 1985. The former two acts regard preparation and adoption of state and regional comprehensive plans and the other includes the Local Government Comprehensive Planning Act that mandated local comprehensive plans. This new legislation described strong state direction and regulation to achieve clearly specified goals and called attention to vertical consistency by requiring local plans to follow regional plans, and regional plans to conform to state plans. Internal and horizontal consistency was also required. Florida established minimum criteria for local government comprehensive plans through Rule 9J-5 of the Florida Administrative Code adopted by the Department of Community Affairs in 1986. The requirements provided a consistent format for local government plans and assigned important content. These requirements were not only minimum standards for local governments to prepare and submit plans, but also for the state to approve the submitted plans (Burby & May, 1997). The required contents of the plans include land use, housing, infrastructure, coastal management, conservation, intergovernmental coordination, capital improvement, and transportation. Natural hazards are mainly addressed in the coastal management element, which includes plans for hurricane evacuation and high risk area management. In addition, other components can address flood management issues. For example, floodplain management has been dealt with in future land use, infrastructure and conservation elements.

The style of Florida's mandate for local government comprehensive planning is very prescriptive and coercive because it seeks strict compliance with the requirements of the mandates. Furthermore, the State monitors local actions and applies sanctions on those that don't meet their minimum criteria. With these coercive tools, Florida uses incentives including provision of financial and technical assistance to encourage local governments (Berke et al., 1997). The State has maintained a reputation for carrying out planning mandates and helping local governments with plan development and implementation. Overall, Florida has been in the forefront of comprehensive planning and flood management policies. This historic planning background indicates that Florida is the ideal institutional setting to examine the effectiveness of integration of flood mitigation policies into local comprehensive planning. It has been over 20 years since Florida adopted local comprehensive planning; so now is a good time to empirically scrutinize the current situation and the State's success or failure.

In summary, increasing flood losses and the need to assess the effectiveness of adopted flood mitigation policies by local governments justify this research. Furthermore, comparatively little study has been done in this field. This study is closely related to the question of how governments can design programs which can work effectively. Eventually, this makes contribution to building flood resilient communities.

2. LITERATURE REVIEW

Flood mitigation is an interdisciplinary approach. Existing research about flooding occurrence and its physical impacts are related to meteorology, hydrology, geophysics and engineering, while sociology, economics, public policy and planning have focused on the socio-economic impacts. Thus, it is necessary to review a variety of disciplines to define the key components for high quality flood mitigation policies and to understand the critical factors influencing flood loss. This section serves as a foundation of the research conceptual framework and is composed of three sub-sections: defining key flood mitigation policies for plan quality evaluation, local planning efforts for flood mitigation, and other factors influencing flood loss.

2.1. Defining Key Flood Mitigation Policies for Plan Quality Evaluation

The first sub-section defines an independent variable: plan quality associated with flood mitigation policy. This study requires developing the protocol to evaluate local flood mitigation policies adopted in comprehensive plans. The evaluation protocol integrates the key components of traditional flood mitigation policies and the best elements of current plans. Figure 2.1 shows how a plan evaluation protocol was developed. The literature review focuses on understanding floods, principles of flood mitigation for sustainable and resilient communities, flood mitigation strategies including structural and non-structural approaches and mitigation through comprehensive planning. In addition, plan quality and plan evaluation research were reviewed to provide the methodological basis for this study.

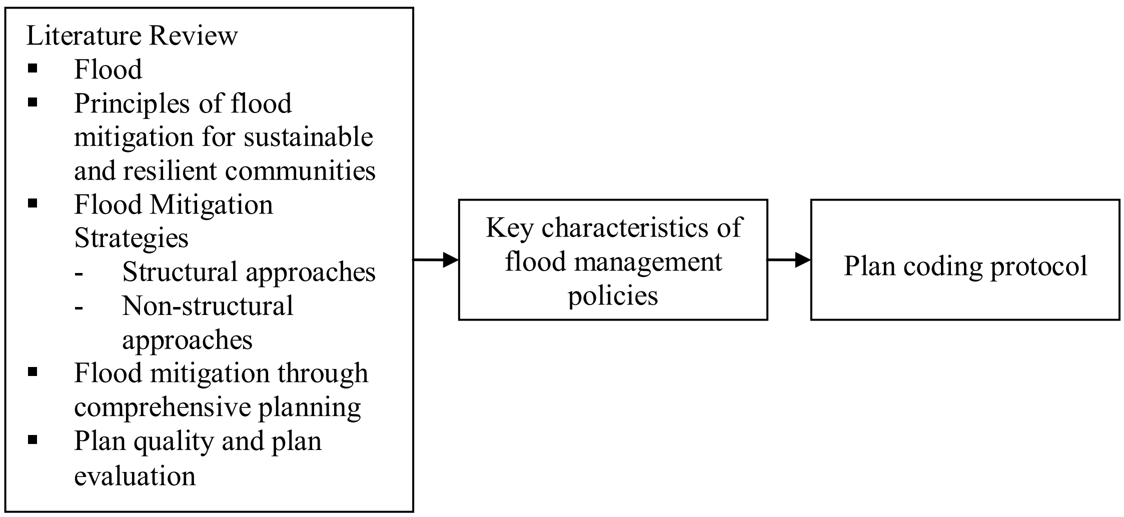

Figure 2.1. Developing Evaluation Protocol of Flood Mitigation Policies in Comprehensive Plans

2.1.1. Understanding Flooding

It is impossible to evaluate the effectiveness of flood mitigation policy without understanding and defining the phenomenon of flood, the subject of this research. A flood is an overflowing of water onto land that is normally dry (Merriam-Webster, 2007). Flooding occurs from a range of causes and conditions. The most frequent cause of flooding is heavy rain. Flooding can also be caused if snow melts rapidly or if channels have been blocked by debris, sediment or overgrown vegetation. Sometimes flooding can happen if a community drainage system is inadequate or if there is no place for water runoff to go (Floodplain Management Association, 2007). Certain types of flood hazards are associated with or triggered by earthquakes, broken dams and levees, tsunamis or hurricanes. (Burby, 1998; Floodplain Management Association, 2007).

Typical riverine flooding is the overflowing of the normal flood channels, rivers or streams, generally as a result of prolonged or heavy rainfall or intense snowmelt. This is the most common cause and results in the heaviest damage. Coastal flooding is also very common in areas close to sea level which are vulnerable during hurricanes or other large storms. Overland flooding happens outside a river or stream, such as when a levee is breached, but still can be destructive (FEMA, 2007a). Some floods develop slowly. However, flash floods can develop quickly, sometimes in just a few minutes without any warning. They can be dangerous because they can result in a large flow down small streams and often have a dangerous wall of roaring water that carries rocks, mud, and other debris (FEMA, 2007a).

A floodplain or flood-prone area is defined as any land area susceptible to being inundated by water from any source (FEMA, 2007c). As most communities contain a floodplain, flooding is one of the most common, ubiquitous and repetitive natural hazards in the United States. Regional climate and geographical characteristics affect the speed of inundation of the floodplain and its length of time. Sometimes heavy rainfall unleashes a considerable amount of rain within a very short time; and sometimes a highly prolonged rain affects larger areas for long time periods (Schwab et al., 1998).

2.1.2. Principles of Flood Mitigation in the Context of Sustainable and Resilient Community

FEMA (1996) defines hazard mitigation as “any action taken to reduce or eliminate the long-term risk to human life and property from hazards.” Floods are natural hazard events which cannot be prevented from occurring, but much of the damage can be prevented if advanced flood mitigation policies and measures are implemented.

Experience during the past several decades has shown that there is a need to shift from a shortsighted and narrow view of hazard policies to broader and more holistic approaches. The vision for a sustainable and resilient community can provide a good theoretical framework for a better flood mitigation approach. This sub-section develops important principles which flood mitigation policies should carry out based on the literature about sustainable development and hazard resilient community.

The root term of sustainable development is “sustainability.” The dictionary definition of *sustain* is to keep in existence; to maintain or prolong; or to continue or last. The original use of the term of “sustainability” can be found in biology and ecology research in the concept of ecological carrying capacity. This concept extended to other fields such as resource management and environment planning and policy. When sustainability was embraced by international organizations and governmental organizations managing development programs and projects, the term, “sustainable development” became popular (Beatley, 1998). Currently, there is no doubt that this concept is emerging as a worldwide paradigm. The most well -known definition of sustainable development was set forth by the World Commission on Environment and Development in their report "Our Common Future" which is also called the Brundtland report. It defines sustainable development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). Also, more recently, the National Commission on the Environment defined sustainable development as "a strategy for improving the quality of life while preserving the environmental potential for the future, of living off interest rather than consuming natural capital (National Commission on the Environment, 1993)." Even though they are not perfect definitions, they contain important issues of inter-generation and intra-generation equity within economic, environmental, social and institutional spheres. Sustainable development seeks to balance the conflicts among economic development, ecological preservation and intergeneration equity (Godschalk, 2004).

Rising costs from natural disasters and increased vulnerability to natural hazards have deteriorated the quality of human life and they are clearly an indication of unsustainability. When a disaster occurs in a community, there is direct physical impact including casualties (deaths and injuries) and property damage. These direct impacts can cause continuing indirect impacts such as destruction of the community's economic activities and environmental damage. Furthermore, the physical impact creates social impacts which include psychosocial, socio-demographic, socio-economic and socio-political impacts to the entire community (Lindell & Prater, 2003). Also, after the disaster, the community requires vast expenditures and effort to return to the pre-disaster condition.

However, not until recently has greater attention been paid to natural disasters. Agenda 21 adopted by the United Nations at the 1992 Rio Summit included hazard reduction and avoidance for promoting sustainable human settlement (United Nations, 1992). Increasingly, the literature about sustainability encompasses natural hazards. Sustainability in the context of natural hazards means not only to reduce losses, but also to build less vulnerable and more sustainable local communities, resilient nations and a safer world (Mileti, 1999). The concept of resiliency is extended from sustainability. A resilient community is not fragile but flexible with the ability to survive future natural disasters with minimum losses of life and property as well as the ability to create a greater sense of place among residents; more diverse economy; and a more economically integrated and diverse population (Vale & Campanella, 2005).

Based on previous literature (Beatley, 1998; Berke, 1995; Mileti, 1999), this study develops principles of sustainability that can be applied to flood mitigation. The following principles range widely from physical issues to social, economic and political issues which all affect the mitigation capacity of the community.

- *Minimize exposure of people and property to natural disasters*: One of the most important elements of sustainable hazard mitigation is to avoid exposure of people and property to natural disasters by limiting development in hazardous areas.

- *Strike a balance between hazard mitigation and economic goals*: Economic validity is a significant component of sustainability. The issues of access to jobs, income and other economic activities are closely related to poverty and social equity. Poverty is the essential root of vulnerability to natural hazards (Berke, 1995). Also, economic validity provides resources for hazard mitigation and disaster recovery. In some communities, locations along rivers, beaches or shores have economic and aesthetic potential and desirability. Or the hazardous areas were already developed and there are not many other safe places. For those communities, limitation of new development, strategic retreat, or relocation policy might not be feasible. In these cases, other sensible mitigation policies (etc. strengthening buildings or facilitating evacuation plans) need to be considered in balance with the local economy.
- *Conserve environmentally sensitive areas and integrate ecosystem management into hazard mitigation*: The recognition of ecological limits is the heart of sustainability. Especially, the practice of hazard mitigation through land use should include conserving environmentally sensitive lands such as wetlands, habitat, coastal shorelines, dune and open spaces and should respect their importance. In addition, protection of these areas and hazard mitigation approaches should be developed in the context of the entire ecosystem. Some structural action to control riverine flooding such as levees and floodwalls or some discrete land use actions like filling wetlands can result in destructive effects upstream and cause serious flooding.

- *Ensure equity in mitigating risk*: Social equity is a critical component for sustainable and resilient community. The community needs to be very concerned about equitable distribution of benefits and opportunities for disaster mitigation policies as well as fair sharing costs. Also, there are some communities where high-risk floodplains are the locations of inexpensive housing whose occupants are poor. In this case, the effort to minimize hazard risk should inevitably consider other social goals such as social equity and affordable housing.
- *Foster responsibility for disaster*: The vision of sustainability includes a spirit of responsibility and self-sufficiency. The responsibility is not limited to planners and local governments, but also includes the responsibility of residents.
- *Cooperate with others*: Natural disasters do not always correspond with administrative boundaries. So, in many cases, local governments need to collaborate with other local governments and sometimes with state and federal governments. Some researchers found that current fragmented and fractured processes of different governments are an obstacle to implementing mitigation. One important principle of sustainability is the need for planning and management at a broad level. Also, internal collaboration is critical.
- *Promote participation*: A sustainable and resilient community selects mitigation strategies which evolve from full participation of all public and private stakeholders. The participatory process itself may be as important as the outcome. According to Day (1997) and Berke (2004), citizen participation can generate a two-way flow of information between citizens having ordinary

knowledge and experts having technical knowledge and produce collective wisdom for problem solving.

- *Assure intergeneration equity*: One principle of sustainability is to consider future generations. This means a community sustainability vision has to consider the impact of land use policies on both current and future generations. For example, a gradual increase of impervious surface and loss of wetland may have little remarkable effect in the short term, but have a serious impact on flooding and run-off over an extended period. Cumulative effects of individual and community actions sometime are beyond short term estimations.

Table 2.1. Principles of Sustainable and Resilient Community for Hazard Mitigation

Dimension	Principles
Ecology	- Environmentally sensitive area conservation - Integration of ecosystem management to hazard mitigation
Society	- Minimization of exposure to natural hazards - Social equity - Intergenerational equity
Economy	- Balance between hazard mitigation and economic goals - Poverty reduction
Institution	- Citizen participation - Cooperation - Responsibility

2.1.3. Flood Mitigation Strategies

Flood hazard mitigation can be divided broadly into structural and non-structural approaches according to whether engineering or administrative methods are used (Thampapillai & Musgrave, 1985) as shown in Table 2.2. Structural approaches are based on the willingness of humans to control floods or protect human settlements. They include the building of seawalls and revetments, levees and others. Non-structural approaches are based on adjustment of human activities and human society to mitigate flood damage (Alexander, 1993). These include measures directing land use away from hazardous areas, communicating mitigation information, protecting sensitive areas or insurance. These structural and non-structural strategies have been used together to form a flood mitigation program. Depending on a community's capacity, commitment and existing conditions, each community has adopted a different combination of mitigation policies. The results for mitigating flood impact have been also varied. The following sub-section describes various mitigation approaches and their advantages and disadvantages within the history of U.S. flood mitigation policy.

Table 2.2. Structural and Non-structural Flood Mitigation Strategies

	Structural	**Non-structural**
Concept	- Flood control - Flood abatement - Protection of human settlements	- Flood mitigation - Adjustment of human activities
Measures	- Structure of dams, flood storage reservoirs, levees, dikes, pumps, channel improvements and diversions, sea wall and groins - Strengthening buildings through building codes	- Insurance - Land use management by planning tools (Comprehensive plan, zoning, ordinance, incentives) - Infrastructure policy - Awareness (Education, information dissemination) - Protect natural areas (dunes, wetland, maritime forests, vegetation etc.) - Warning, response, recovery preparedness policies

Source: Adapted from Alexander (1993) and Burby & French (1981)

2.1.3.1. Structural Approaches

Historically, in the United States, structural mitigation techniques have dominated flood management since the 1927 Mississippi River flood (Birkland et al., 2003). The federal government's Flood Control Act of 1930 supported national programs of structural flood control works.

Structures that involve modification of the built environment in order to mitigate flood damage directly include levees, floodwalls and landfills. Another structural method applies channel phase and land phase in order to control floods. Structures in channel phases include dykes, dams, reservoirs, flow retarding structures, and methods for accelerating or retarding flow, reducing bed roughness and deepening, widening or straightening channels. Other structural methods include gully control, modified cropping practices, soil conservation, revegetation and stabilization of banks and floodplains (Alexander, 1993).

These measures are focused on controlling nature rather than working with nature. There are reasons why the structural approach was dominant until recently. First of all, structural mitigation projects sometimes accomplish multiple purposes and satisfy multiple interests (Birkland et al., 2003). For example, a dam can address flood control, irrigation, power and recreational interests as well as provide a sense of security and job opportunities in the community. Thus, such projects were locally very popular. Politicians and businessmen encouraged efforts to get approval from the U.S. Army Corps of Engineers, which was assigned to prevent flood damage by the Flood Control Act of 1936 (U.S. Army Corps of Engineers, 2006). Also, the structures actually provide a great degree of protection from repetitive floods (Birkland et al., 2003). The Army Corps of Engineering stated that their flood mitigation efforts prevented more than $208 billion in damage from 1991 to 2000 (U.S. Army Corps of Engineers, 2006). Particularly, the structural approach is useful in places in or near densely developed urban areas (Birkland et al., 2003).

On the other hand, the adverse impacts of the engineering approach are considerable; despite all efforts of the structural method, flood damage has steadily increased. While smaller floods have been prevented by flood control structures, major catastrophic floods continue to grow, sometimes stemming from the structures themselves. For example, structures like channels or levees can raise the level of the river, raise the flood pulse downstream and increase the velocity of the water by constricting the waterway and the natural floodplain, thus shortening flooding time and resulting in greater downstream flooding (Birkland et al., 2003). Building codes and structures are designed to reduce the probability of loss from flooding events only up to a certain magnitude (Burby & Dalton, 1994). If natural disasters exceed such magnitude, the damage can be catastrophic. Second, structural measures are very expensive and also require enormous ongoing costs for their maintenance (Alexander, 1993). Actually, federal funds for their construction and maintenance have been decreased rapidly after the mid-1970s (Burby et al., 1988). Hurricane Katrina, which devastated communities along the Gulf Coast in the summer of 2005, was recorded as the costliest disaster. The City of New Orleans, Louisiana, one of the most catastrophic areas, was destroyed because of the failure and breaches of the levees and flood walls protecting the city due to poor maintenance and design failure. Third, structural solutions can bring a false sense of security to the public (Burby & Dalton, 1994; White, 1936). The measures rarely ever give complete security (Alexander, 1993), but people believe that the areas are protected by flood control works and the area is completely safe. This false sense of security encourages new developments in floodplains, which increase the risk of loss of life and property (Burby et al., 1985). Third, a great deal of research has found that construction of dams and other flood control structures contributes to environmental degradation and ecosystem disruption, such as the decline of fish and wildlife habitats and adverse impacts on aquatic ecosystems (Abell, 1999). Currently, many researchers suggest restoring naturally sensitive areas such as floodplains, wetlands and dunes, which can sustain natural ecosystems as well as absorb wind and wave impacts (Godschalk et al., 2000).

As a result of these considerations, complete reliance on the structural approach has encouraged a drive toward a non-structural approach or a combination of the two.

2.1.3.2. Non-structural Approaches

Non-structural approaches include insurance, land use management, awareness, environmentally sensitive area protection and other emergency and recovery policies for mitigating flood loss (Table 2.3). These techniques are critical components of flood mitigation policies in local comprehensive plans and provide the basis for developing a plan evaluation protocol.

Table 2.3. Non-structural Flood Mitigation Strategies

Strategy	Goals	Tools
National Flood Insurance Program (NFIP)	- Risk spreading - Risk reduction	- NFIP minimum elevation - Purchase insurance
Land use management	- Restriction of occupancy in hazardous zones (Location) - Design regulation (type) - Density regulation	- Planning (Comprehensive plan, land use plan) - Zoning - Infrastructure policy - Ordinances - Building code /Design standard - Special use permits - Acquisition - Relocation - Taxes /Incentives
Awareness	- Information dissemination	- Hazard, vulnerability, risk assessment and mapping - Education /Training - Mass-media campaign
Sensitive area preservation	- Preservation of ecologically important areas	- Protection of wetlands, maritime forests, estuarine ecosystems and beachfront areas
Others	- Improvement of emergency response and recovery	- Flood forecasting and warning system improvement - Emergency preparedness - Recovery plan preparation

2.1.3.2.1. National Flood Insurance Program (NFIP)

NFIP (The National Flood Insurance Program), established in 1968, provides flood insurance to floodplain residents. Conceptually, insurance allows the transfer of financial risk from an individual to a pooled group under contract (Kunreuther & Roth, 1998). Until 1968, the only way to assist flood victims in the post-disaster recovery process was federal relief which took the form of disaster loans and grants. However, the increased burden to the federal treasury caused policymakers to examine the feasibility of insurance policies against flood losses as an alternative to federal relief (Pasterick, 1998). The federal government has been managing this program; so NFIP is unique because this is the only one where the federal government plays a direct regulatory role to local governments. Through later revisions – the Flood Disaster Protection Act of 1973 and the National Flood Insurance Reform Act of 1994 – the current system has been shaped.

According to Pasterick (1998), the NFIP has three components: risk identification, hazard mitigation and insurance. Risk identification defines the areas that are vulnerable to floods[1] across the entire country. This process is necessary to effectively define risk and decide an actuarial rate. Due to the expense of risk identification, which includes hydrological research on a nationwide scope, the federal government was assigned this task. The result is the Flood Insurance Rate Map (FIRM), which serves both as the guideline to community floodplain regulation and the source of risk information for insurance companies to accurately rate policies. The second component, hazard mitigation, can be actualized by local governments' actions under the guide of the federal government. The NFIP requires the elevation of the lowest floor of a new structure above the level of the base flood (100-year flood). The federal government has provided the 100-year floodplain maps as a basis for mitigation action and as a minimum requirement for participation of local governments (Burby et al., 1988). Also, local governments have a responsibility to enforce the mitigation requirement (minimum building elevation); compliance is accomplished through building permits (Pasterick, 1998). Supporters of this legislation asserted that building elevation and insurance

[1] NFIP identified "100-year floodplain" as the standard of risk. 100-year flood is flooding which has a one percent chance of occurrence in a given year.

requirements would reduce development in flood risk areas by raising the cost of land preparation, construction and insurance (Holway & Burby, 1990).

As community participation and individual participation were completely voluntary until 1974, the rates of participation and purchase were very low. However, the Flood Disaster Protection Act in 1973 strengthened the NFIP and participation of communities in NFIP was a condition of eligibility for certain types of federal assistance. As a result of this act, about 2,200 communities participated in this program voluntarily until 1973, and in 1977, approximately 15,000 communities joined (FEMA, 2002) .

NFIP showed a number of significant achievements in floodplain management, including more widespread public identification of flood hazards as well as reduced development by raising the cost of land preparation, construction and insurance (Holway & Burby, 1990; Interagency Floodplain Management Review Committee, 1994). However, there were adverse impacts. First, the NFIP did not include any other requirements for land use management in floodplains except a construction and design tool for building elevation. Holway and Burby (1993) found that NFIP's elevation standard was indeed effective but the level of impact was limited. They suggested that this requirement must be supplemented with other land use regulations. Furthermore, current insurance and elevation requirements only apply to 100-year floodplain zones and primarily only guide new construction in those areas. It means that the NFIP does not influence the entire community and existing structures. Second, like the structural approach, insurance also can lead to greater exposure to risk. This phenomenon is called "moral hazard" which is an increase in the probability of loss when policyholders behave more carelessly than before (Kunreuther & Roth, 1998). Also, a critical problem is the large number of out-of-date NFIP rate maps which identify the flood risk zones and provide a guide for policy decision. Currently, 33% of the maps are more than 15 years old, and another 30% are 10-15 years old (Birkland et al., 2003). Beside these limitations, the NFIP has operational problems. Since FEMA started this program, expense has exceeded income and it is not self-supporting because of numerous insured properties that have repeatedly flooded. By raising insurance premiums or dropping insurance coverage, the NFIP intended to remedy this situation. FEMA borrowed money from the federal treasury to cover the deficit which was almost $1.1 billion from 1986 to 1997 (Birkland et al., 2003).

In summary, NFIP has had the most dominant non-structural flood mitigation policy in the U.S. While it has made significant achievements, it has also had the unintended effect of inducing moral hazards and new developments in floodplain. As mentioned above, improvements are suggested in many areas.

2.1.3.2.2. Flood Mitigation Through Land Use Planning

Land use is a critical issue affecting the degree to which a community is exposed to flooding as well as deciding community functions and forms in the future. Due to this importance, land use and development decisions have been very controversial (Burby & May, 1997).

Generally, land use management is carried out through land use planning. As mentioned before, planning does not mean only "process," but is " *a process guided by a plan*" (Kaiser et al., 1995). The land use plan translates the vision of a community into a specific physical pattern of neighborhoods, commercial and industrial areas and public facilities and infrastructure. This plan includes specific policies and regulation to implement it (Hoch et al., 2000; Kaiser et al., 1995).

The idea of integrating hazard mitigation and land use planning has a long history. Gilbert White (1936) and other scholars (Burby et al., 1999; Burby et al., 1985; Godschalk, Brower, & Beatley, 1989) have argued that losses in lives and property from a range of natural hazards could be minimized through local land use planning. Also, they believed that the general public and federal, state and local governments have overlooked the importance of not only hazard mitigation itself, but also mitigation through development management (Burby, 2005). Particularly, local governments which are traditionally responsible for land use decisions, have not paid much attention to these issues.

The reasons why local governments have hesitated to utilize land use planning for hazard mitigation are as follows; first, many people think that natural hazards pose a low probability of occurrence (Berke & French, 1994) and they also tend to resign the experience of disasters to fate (Berke, 1998). Thus, they tend to consider natural hazards as a minor problem so that they are more concerned about other problems such as housing, unemployment, crime, etc (Mileti, 1999). Second, costs for mitigating natural hazards are highly visible, but the benefits are difficult to measure (Wenger, 2006). It takes a long time to see the results of realized policies; so elected officials who want to show visible results to their constituents might hesitate to choose those policies (Berke & French, 1994). Natural hazards take place on various geographic scales; floods mainly follow the flow of water and do not always occur within specific jurisdictional boundary so that local governments might have difficulty cooperating with other governments if they don't prepare operational plans with other governments in advance. Fourth, there is a phenomenon called "land use management paradox (Burby & French, 1981)." Most local governments don't pay attention to hazard mitigation by utilizing land use management to restrict development in hazardous areas before they have major damage from natural hazards. If they recognize the problem and wish to employ the technique, buildings and people have already occupied the area. In this situation, land use mitigation is far less effective or is difficult to accomplish. Also, while local governments dominate land use policy decisions, most local governments are focused on economic benefits. Economic issues and environmental issues are like two sides of a coin. The desirable decision is to strike a balance between the two values, but it is very complex and difficult. Most local governments have been pressured by economic development needs and have allowed development in hazardous areas. The last reason can be found in the tradition of the U.S. on property rights. Landowners believe that their property rights are very important and their protection is almost absolute; so they use their properties as they want to and strongly resist the restriction of their property in floodplains.

Despite the above obstacles, it is true that flood mitigation through land use planning is the most promising way to minimize losses from floods. Also, the 1993 Midwest flood brought numerous changes in flood management policy with a greater emphasis on non-structural approaches especially based on land use planning (Interagency Floodplain Management Review Committee, 1994).

It is important to explore more about the power of local land use planning and the general tools which can be applied to flood mitigation strategies (See Table 2.4). According to Godschalk et al.(1998), local governments can use the following powers for land use planning: planning power, regulatory power, spending power, taxing power and acquisition power. Planning power can be used to gain the community's attention and agreement through the plan making process such as land use plans or comprehensive plans. Plan making includes the process of citizen education and persuasion, coordination and participation of various stakeholders and consensus building. The regulatory power can manage development of a community through zoning, subdivision regulations, building codes, sanitation codes, design standards, wetland and floodplain regulations, etc. These tools can regulate location, type and density of new development. Spending power restricts infrastructure and public facilities in hazardous areas by controlling public expenditures through capital improvement programs and budget management. Taxing power can levy a special tax for preservation of special districts. This method helps to equitably distribute the public cost burden to the owners of hazardous property by levying impact taxes and imposing tax breaks. Acquisition power can obtain hazardous lands by purchasing undeveloped land, purchasing development rights or transfer of development rights, accepting dedication of conservation easements and relocating vulnerable buildings or damaged buildings.

Table 2.4. Powers and Tools of Local Government for Flood Mitigation through Land Use Planning

Local Power	Benefits/Characteristics	Tools for Hazard Mitigation
Planning Power	- Involving plan making process - Including implementation tools	- Land use plan - Comprehensive plan
Regulatory Power	- Limit of location, type, and density of development	- Zoning - Subdivision regulations - Building codes - Design standards - Wetland regulations using permits
Spending Power	- Controlling public expenditures	- Capital improvement programs - Budgets
Taxing Power	- Taxing	- Impact taxes - Tax breaks
Acquisition Power	- Preserving hazardous areas	- Acquisitions - Purchase of development rights - Transfer of development rights - Dedication of conservation easements - Relocation of vulnerable buildings

Source: Adopted from Godschalk et al. (1998)

Raymond Burby and his colleagues (Burby & French, 1981; Burby et al., 1985; Olshansky & Kartez, 1998) revealed the land use tools local governments used for flood mitigation through survey studies. Zoning and subdivision ordinances were the basic tools and still most frequently used tools. Also, many communities used construction regulations including building codes and floodproofing requirements and wetland regulations. By contrast, acquisition or taxation tools were rarely used to reduce flood damage. The frequency of used tools is related to not only monetary costs but also political and organizational willingness (Olshansky & Kartez, 1998).

In reality, flood mitigation through local planning has become better at keeping pace with the increased intervention of federal and state governments. The federal government primarily provides disaster mitigation and relief funding, policy guidelines and technical assistance to state and local governments, but it does not favor direct intervention in development management. Some researchers (Nelson & French, 2002) have been concerned about its policies; often, they are fragmented and inconsistent. Sometimes, federal flood policies like disaster relief, structural approaches, or flood insurance can induce development in hazardous areas by giving a false sense of safety. State governments also supply technical and funding assistance to local governments through their constitutions and laws, but there is a wide range of variations in terms of land use policy intervention and flood mitigation policy. Some states are very active but others are not. Section 2.1.4 in detail describes the hazard mitigation policies of states and local governments in the context of comprehensive planning.

2.1.3.2.3. Awareness

Awareness of risk is the first step for preparing and implementing a policy. Also, public awareness helps people recognize the importance of flood mitigation and participate in the implementation of mitigation policies. To mitigate flood damage, a community must identify the hazard to which the community is vulnerable and assess the severity of the threat. In order to identify hazards, proper hazard maps should be prepared and update timely. This information should be disseminated to the public using various media. One of the most important principles leading to flood damage reduction is the use of education and training programs for the public and related personnel. When mitigation policy is incorporated to land use planning or comprehensive planning, the plan and process give landowners and the public information about the risks and benefits of development far from hazardous areas.

The attitudes and behavior of residents is a major factor in good land use and floodplain management policies. People who are adamant about their right to do what they want with their land do not understand how their actions impact nature and society. Sometimes their attitudes can worsen flood damages to themselves and their neighbors. Attempts to apply regulatory floodplain management measures are sometimes met with indifference, resistance and in some cases, hostility. So, developing public awareness information in common language to explain how individual actions can impact flood damage has been emphasized

2.1.3.2.4. Protection of Environmentally Sensitive Areas

The critical areas concept (e.g. environmentally sensitive areas) appeared during the environmental quality movement of the 1970s against excessive urban growth. Environmentally sensitive areas include wetlands, barrier islands, estuaries, endangered species habitats, water supply reservoir buffers, dunes, and forests. It is important to sustain natural ecosystems and mitigate hazard impacts by absorbing wind and wave impacts. Maintaining and enhancing these areas can be realized through acquiring property or development rights in floodplains, limiting development in the areas or restoring these areas. Because of used tools, sometime this issue is dealt with within land use planning, whereas sometimes separate and independent plans or acts try to solve this problem. The independent plan includes The Coastal Zone Management Act (CZMA) of 1972 which requires that states designate "area of particular concern." The 1980 amendments to CZMA encouraged "special area management planning."

The loss of wetlands is recognized as a national problem. Various acts – the 1989 North American Wetlands Conservation Act, section 404 of the Clean Water Act, the 1985 Food Security - support the policy of wetland conservation (Kaiser et al., 1995). The National Wetland Inventory of the U.S. Fish and Wildlife Service supplies general wetlands maps which have three classification schemes of systems, subsystems and classes. Section 2.3.2 explains in detail how the introduction of development in wetlands has influenced floods in terms of built environment factors.

2.1.3.2.5. Others

Other measures include flood warning and flood forecasting systems. Other plans such as emergency preparedness, recovery and relief plans can be tools for hazard mitigation if they are prepared in advance of flooding events.

2.1.4. Integrating Flood Mitigation Policies into Local Comprehensive Planning

Flood mitigation policies can be integrated in planning by using two approaches. First, flood mitigation can be undertaken through a separate stand-alone flood mitigation plan. Second, flood mitigation can be a part of a broader community plan (Burby et al., 1999). Currently, the broader and most general community plan is a local comprehensive plan, which is a long range policy document developed by expert analysis and citizen participation. This plan provides general guidance for a community's future land use by specifying an inventory and assessment of community conditions, formulating their goals and crafting policies and actions to implement them (Burby, 2005; Nelson & French, 2002).

Each type of plan has its own benefits. A stand-alone plan is easier to revise, implement and has more technical sophistication. But if this plan is focused only on areas exposed to hazards and measures to solve the problem, it is difficult to know the impact of their solutions on other areas and other people. On the contrary, when flood mitigation is integrated in a comprehensive plan, the flood issues can be considered in a broader concept of community goals involving a large number of citizens. The comprehensive plan and planning process also provide multiple planning and regulatory tools and more resources to facilitate implementation. The land use plan is one element of the overall comprehensive plan. Although the land use plan is critical in formulating community development, the comprehensive plan includes detailed transportation, community facilities, economic development, housing, and other elements. If flood mitigation is integrated with the local comprehensive plan, the scope of understanding flood impacts will be extended to other issues like land use, housing, public infrastructure and transportation. This would allow a piggybacking effect contributing to flood mitigation through other elements (Berke & Campanella, 2006; Burby et al., 1999).

Several researchers (Burby, 2005, 2006; Godschalk et al., 1998) believe that integrating flood mitigation into local comprehensive planning, both in the plan document and the planning process, would reduce flood damage. First, plans and the planning process can make it possible to consider flood issues in a systematic and comprehensive manner. Second, the first step in developing a plan is to examine factual bases to identify and assess flood risk and vulnerability. This information provides the basis for developing flood policies. Third, the plan and planning process can increase public awareness of the issues; the planning process especially can inform both landowners in hazardous areas and the public. Fourth, the planning process increases the chances of participation of citizens and various community interests, and thus reflects their concerns and opinion. Fifth, the planning process allows participants to build consensus on vision, goals and actions before the plan is implemented. Sixth, the comprehensive plan places more responsibility on floodplain residents, commercial interests and local government itself through the whole planning process. Seventh, a comprehensive plan deals with many different issues such as land use, transportation, public facilities, and other issues and can coordinate multiple issues, goals and policies from various factions of the community. This broadens the scope of mitigation plans beyond narrow safe development and emergency considerations. Eighth, by incorporating mitigation policies into comprehensive plans, the mitigation policies to some degree would be self-enforcing and enter into routine governmental activities because local planners will make decisions about public investments and development permits based on the plan. Ninth, planning is an ongoing process which is cyclical from preparation, implementation, monitoring and revision on a five or ten year cycle (Kaiser et al., 1995). Finally, the comprehensive plan is the most important means of implementing policy and the starting point of implementation.

Recently, the role of local comprehensive plans in guiding land development and integrating hazard mitigation elements has been increasingly emphasized. Many studies have explored this issue and investigated hazard mitigation elements in comprehensive plans. First of all, Burby (1997) found that hazard reduction programs were well prepared and were much stronger in communities that had adopted comprehensive plans compared to others which had not adopted comprehensive plans. More recent studies (Nelson & French, 2002; Olshansky, 2001) found that earthquake damage in communities with high quality hazard reduction programs was significantly lower than others. Also, they pointed out that the general public and federal, state and local governments have overlooked the importance of mitigation through land use planning (Burby, 2005).

A group of researchers (Berke et al., 1999; Berke et al., 1997; Berke & French, 1994; Berke et al., 1996; Burby et al., 1993; Burby & Dalton, 1994; Burby & May, 1997) brought attention to the influence of state mandates on the quality of plans related to hazard reduction. They found that state mandates actually resulted in better local plans with a high quality of hazard mitigation elements. Also, mandates have an influence not only on plan quality but also on actual natural hazard damage. Burby (2005) concludes that if local plans are mandated, 0.52% of insured property losses can be reduced. Alabama, Louisiana and Mississippi, which were devastated by Hurricane Katrina, did not have local comprehensive requirements. Burby's research (2006) shows that the dollar loss per capita from flooding was $530 in Louisiana, $337 in Alabama and $277 in Mississippi. This is much higher than $133 per capita among all coastal counties.

Recently an increasing number of states have tried to intervene in local government policy through local comprehensive plan mandates and requirements for hazard mitigation. As of December, 2006, eleven states require local governments to have comprehensive plans with hazard mitigation elements (American Planning Association, 2007). Among them, four states (Florida, California, North Carolina and Oregon) require a consistent format for local plans and specify their contents. Also, they pay attention to their compliance. Sixteen states mandate local comprehensive plans, but the hazard mitigation element is optional. The following table (Table 2.5) shows state requirements for local government plans and attention to natural hazards in their plans.

Table 2.5. State Requirements for Local Government Plans and Hazard Mitigation Elements (through December 2006)

State Requirement	States
No local government plan mandate	Alabama, Georgia, Illinois, Indiana, Iowa, Kansas, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Montana, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Texas, West Virginia, Wisconsin, Vermont
Local comprehensive plan mandate with hazard element optional	Alaska, Arkansas, Connecticut, Delaware, Hawaii, Kentucky, Massachusetts, Nebraska, Pennsylvania, Rhode Island, South Dakota, Tennessee, Utah, Virginia, Washington, Wyoming
Local comprehensive plan mandate and natural hazard element mandate	Arizona, California, Colorado, Florida, Idaho, Maine, Maryland, Nevada, North Carolina, Oregon, South Carolina

Source: American Planning Association (2007)

2.1.5. Plan Quality and Plan Evaluation

A plan is a document produced as an outcome of the planning process and an important indicator of planning effort. Developing a good plan is a starting point to accomplish goals and implement policies adopted in a plan. Most planners agree that the implementation of a plan is important, as is keeping the plan updated and its quality maintained. Then, what's a good plan? Defining the key characteristics of plan quality would serve as a criterion for the evaluation of whether a plan is good or not.

Research on plan quality and plan evaluation began in earnest not long ago because the planning profession had been more focused on the methods and process in plan making rather than questioning the components of plan quality (Berke & French, 1994). In the early stage, there were some attempts to define what constitutes high quality plans. Baer (1997) formed a list of about 60 items with eight basic classifications based on a composition of his ideas and criteria from previous research: adequacy of context, "Rational model" considerations, procedural validity, adequacy of scope, guidance for implementation, approach, data, and methodology, quality of communication and plan format. Also, Fishman (1978) who evaluated housing and land use elements in comprehensive plans, found that the best plans contained specific goals linked to local conditions and policies that are specific and stated in action-oriented language. Wenger et al. (1980) examined local emergency plans and concluded that high quality plans were composed of fact finding, frequent community-wide exchanges of information and proposals for action.

More recently, plan quality and plan evaluation research has been more conceptualized and made more systematic by a group of scholars (Berke, 1994; Berke & French, 1994; Berke et al., 1996; Burby & Dalton, 1994) who have evaluated comprehensive plans related to natural hazards. They used the concepts of Kaiser, Godschalk and Chaplin (1995), which are considered the best definition of the characteristics of plan quality. They identified three core components of plan quality: *fact basis, goals and policies*. The plan's *fact basis* specifies the existing local conditions and identifies needs related to a community's physical development. *Goals* represent general aspirations, problem alleviation, and needs that are premised on shared local values. *Policies* (or actions) serve as a general guide for decisions about the location, density, type and timing of public and private development to assure that plan goals are achieved. Policies and actions are essential components of a plan to manage development patterns. They developed a coding protocol by incorporating hazard mitigation measures into these three key characteristics and then analyzed plan contents.

Berke and French (1994), Berke et al. (1996), Deyle and Smith (1998) and Burby et al. (1997) tested whether state mandates result in high quality plans in terms of natural hazard mitigation, and found that state mandates have a positive effect on enhancing plan quality. The range of interest of the group has widened to other factors such as intergovernmental relations (Berke, 1994; Burby & May, 1998), local commitment (Norton, 2005) and citizen participation (Brody, 2003a; Burby, 2003) affecting plan quality.

Also, research topics have extended to other areas such as ecosystem plan quality. Brody (2003c) evaluated the extent to which local comprehensive plans incorporate ecosystem management principles using the plan quality evaluation concept. His research has significance in that he first conceptualized the ecosystem plan quality and expanded the three key components (factual basis, goals and objectives and policies and action) to five components. The added components are implementation and inter-organization coordination & capacities. The inter-organizational coordination and capacity refers to the ability of a local government to collaborate with other jurisdictions or organizations. The other component, implementation, includes designation of responsibility, a timeline of actions, plan updates and the monitoring of resource conditions and policy achievement (Brody, 2003b).

Three and five components and their use were summarized in Table 2.6.

Table 2.6. Plan Components

	Three Components	Five Components
Components	▪ Factual bases ▪ Goals & Objectives ▪ Policies, Tools, Strategies	▪ Factual bases ▪ Goals & Objectives ▪ Inter-organization coordination & Capabilities ▪ Policies, Tools, Strategies ▪ Implementation
Use	▪ Definition by Kaiser, Godschalk and Chaplin (1995) ▪ Used in evaluation of hazard element in comprehensive plans (Berke, 1994; Berke & French, 1994; Berke et al., 1996; Burby & Dalton, 1994; Prater, 1993)	▪ Extension of Brody (2003c) ▪ Used in evaluation of ecosystem management principles in comprehensive plans(Brody, 2003c), (Brody, 2003b)

Plan quality can be used as an independent variable as well as a dependent variable. So far, little research has chosen plan quality variable as an independent variable, whereas most studies used quality as the dependent variable to show the variation of plan quality and factors affecting the quality of plan. The former includes two studies; Burby et al. (1998) and Brody & Highfield (2005). Burby, French and Nelson (1998) investigated the impact of plan quality on seismic safety elements in comprehensive plans compared to actual earthquake damage. They concluded that local governments which had paid attention to plans and building codes experienced less damage in the Northridge Earthquake. Brody and Highfield (2005) tested the implementation of local environmental planning by examining their formality between planned design and actual development pattern. They found that development patterns deviated significantly from planned land use, but plan quality of plan implementation policies in comprehensive plans was highly correlated with actual implementation.

Table 2.7. Plan Quality and Plan Evaluation Research

Plan Quality: Topic	Plan Quality: Dependent Variable	Plan Quality: Independent Variable
Hazard mitigation elements in comprehensive plan	▪ Influence of state mandate on plan quality – Berke et al. (1999), Berke and French (1994), Berke et al. (1996), Burby and Dalton (1994), Burby and May (1997), Dalton and Burby (1994) ▪ Sustainable development concept in New Zealand plan – Berke (1994) ▪ Longitudinal analysis of plan quality - Brody(2003a)	▪ Seismic plan quality and earthquake damage – Burby et al. (1998)
Ecosystem management principles and environmental policies in comprehensive plan	▪ Comprehensive plan quality associated with ecosystem management principles – Brody (2003c) ▪ Stakeholder participation and comprehensive plan quality associated with ecosystem management – Brody (2003b), Brody (2003d)	▪ Relationship between plan quality and plan implementation – Brody & Highfield (2005)

Existing methods and concepts of plan quality and plan evaluation have provided a strong foundation for this research. First, the existing literature provides empirical evidence that plan evaluation is significantly important, since plan quality indicates both the quality of the planning process and the strength of its implementation (Dalton & Burby, 1994). It should be noted that plan quality evaluation is different from plan implementation evaluation. As mentioned above, plan quality evaluation examines a plan "document" based on evaluation criteria, whereas the evaluation of plan implementation investigates the extent to which a local plan is actually converted to action. Many studies are focused on plan quality as an important indicator of implementation. This is due to a lack of systematic evaluation of plan implementation. Brody and Highfield (2005) summarized the reasons. First, many plans are long range, making it difficult to decide when an outcome will occur and what this result should be compared to. Or, how to measure a plan's value which includes the planning process, social interaction or citizen participation, etc. Second, there is a lack of longitudinal data and conceptualized measurement methods. In addition, there is no agreement about the definition of planning success and methodology. Because of these obstacles, this study is also focused on plan quality as an indicator of planning efforts, but both evaluations are valuable and important to address the effectiveness of plan and policy.

Also, plan quality research has established a framework which captures the characteristics of plan contents based on the three or five components. Based on this framework, researchers can develop their own protocol according to their purpose by incorporating principles and measures into the components.

Third, plan quality studies improved the understanding of how to measure plan quality in a local comprehensive plan. These evaluations were substantially more systematic than early studies. They gave an ordinal scale to each item depending on the criteria for plan quality; so these quantitative scores could be identified, measured, compared and tested statistically. This methodology is employed for this study.

In summary, previous research on plan quality and plan evaluation provides a conceptual and methodological basis for determining flood mitigation policy quality. This research extends the existing literature on plan quality research. In this study, the evaluation score is used as an independent variable for assessing the impact to actual insured flood loss.

2.1.6. Evaluation Protocol for Flood Mitigation Policy

This study does not evaluate all five components of a comprehensive plan, but focuses on policy or action component. Policy is called the heart of a plan because it actualizes community goals and objectives by being implemented in the real world. As the goal of this study is to assess the impact of planning factors on ***actual*** flood loss, it is focused only on policy component that can be implemented. Based on the literature review, this sub-section has synthesized what flood mitigation policies need to be incorporated in local comprehensive plans through plan evaluation protocol. Key flood mitigation policies which are carrying out the principles of sustainable and resilient community and effective flood mitigation tools need to be captured in local comprehensive plans.

Table 2.8 represents the developed evaluation protocol which includes essential and effective flood mitigation policies. Evaluating plans against this protocol tests the central hypothesis that plans which clearly articulate policies lead to proper action that contribute to reduced flood loss.

Flood mitigation policies which can be adopted in a local comprehensive plan were categorized into twelve subcomponents: “general policy,” “land use and zoning tools,” “site design tools,” “ building standard tools,” “ acquisition tools,” “ incentive-based tool/ taxing tools,” “insurance tools,” “ structural tools,” “awareness/educational tools,” “ public facilities and infrastructure tools,” “ emergency/recovery preparedness tools,” “natural resource/sensitive area protection tools.”

Table 2.8. Flood Mitigation Policy Evaluation Protocol

Policies & Actions		
1. General Policy	1.1	Discourage development in floodplain areas
	1.2	Consistency with other regulations, laws or plans (i.e. flood ordinance)
2. Land use and zoning tool	2.1	Permitted land use
	2.2	Wetland regulation using permit
	2.3	Low density conservation
	2.4	Overlay zone with reduced density provisions
	2.5	Down zoning of floodplains
3. Site Design tool	3.1	Site plan review
	3.2	Special study/impact assessment for development in floodplains
	3.3	Setbacks/Buffers
	3.4	Cluster development to keep development away from flood zones
	3.5	Subdivision regulation
4. Building standard tool	4.1	Building standards/Building code
	4.2	Strengthening structures to meet current codes or regulations (i.e. elevation)
	4.3	Low interest loans to retrofit structures

Table 2.8. (Continued)

Policies & Actions	
5. Acquisition tool	5.1 Land and property acquisition (fee simple purchase) 5.2 Dedication of open space for hazards/Dedication of conservation easement 5.3 Transfer of development rights 5.4 Purchase of development rights 5.5 Relocation of vulnerable structures out of hazard zones
6. Incentive-based tool/ Taxing tool	6.1 Impact fees 6.2 Tax abatement for using mitigation 6.3 Density bonus
7. Insurance tool	7.1 Participation in flood insurance programs (NFIP) 7.2 Participation to Community Rating System (CRS)
8. Structural tool	8.1 Detention ponds/retention/holding 8.2 Levees 8.3 Dams 8.4 Seawalls 8.5 Riprap 8.6 Bulk heads 8.7 Channel maintenance/Channelization 8.8 Slope stabilization 8.9 Storm water management 8.10 Clearing of debris
9. Awareness/ Educational tool	9.1 Education/outreach program 9.2 Real estate hazard disclosure 9.3 Flood forecasting, warning and response program 9.4 Training/Technical assistance 9.5 Maps of areas subject to flood hazards 9.6 Computer models/evacuation systems (e.q. HEC, web-based modeling system) 9.7 Database
10. Public Facilities and Infrastructure	10.1 Capital improvements 10.2 Monitoring/retrofitting public structure 10.3 Policy not to locate public facilities in flood zones
11. Emergency /Recover preparedness	11.1 Evacuation/shelter preparedness 11.2 Emergency plan preparedness 11.3 Recovery plan preparedness
12. Natural resource/Sensitive area protection	12.1 General description of natural resource and sensitive area protection for flood mitigation 12.2 Wetlands conservation/restoration 12.3 Dune protection 12.4 Forest and vegetation management riparian areas 12.5 Sediment and erosion control regulation 12.6 Stream dumping regulations

General policy draws on hazard mitigation through land use planning and consistency with other related regulations. Land use tools guide location and density using permits and zoning. Determining acceptable land uses and density in flood prone areas may not prevent flooding, but can alleviate the risk of damage by limiting exposure in floodplain. Site design tools guide limit of design for sustainable, aesthetic and flood hazard resistant sites using setback, buffers or cluster development. The site plan review process considers the site plan, which developers submits, and includes information about the location, size and function of floodplains and conservation areas. Reviewers investigate the submitted information, and they shall not permit o practical alternatives or mitigation measures if proposed developments would destroy or degrade the function of floodplain or other environmentally sensitive areas. Also, subdivision regulation can require elevation data and proper design and lot size. Building standard tools include adoption and enforcement of building codes and a policy focusing on strengthening structures through elevation and flood-proofing for safety of individual buildings. In addition, low interest loans for retrofitting structures were included in the building standard tool.

Local government can use acquisition tools, that is, purchasing land or property, which are the most promising way to prevent development in flood prone areas.. Also, acquisition tools include transfer and purchase of development rights and dedication of conservation easement or open space for protecting environmentally significant areas from development. Transfer of development rights occurs when a community allows a developer to increase densities on another parcel that is not at risk in return for keeping floodplain areas in open space. Local jurisdictions also can purchase development rights for flood mitigation. This policy can prevent a property from being developed contrary to a community's plan by compensating an owner for partial rights – development rights.

Incentive based tools induce land use away from floodplains using taxes, fees and density bonus. Insurance is one of most commonly used policies. In addition to flood insurance, FEMA has proposed a Community Rating System (CRS) in order to help flood insurance policy holders for additional discounts and to encourage various flood mitigation measures to go beyond the minimum NFIP requirement. Communities that participate in this program can receivean additional discount based on their mitigation activities.

Structural tools include various structural methods for reducing flooding events and minimizing losses. Properly designed and constructed storm water management and drainage system can reduce the concentration of storm water runoff and flooding due to rising water in new and existing development. Retention and detention are capable of providing sufficient storage to limit peak discharge rate. Though structural measures are not recommended by some plans, they are effective in highly dense places having rare safe areas. The protocol of this study includes well known and commonly used structural measures such as levees, dams, seawalls, riprap, bulk heads, channel etc.

Educational tools help both people and experts to enhance knowledge and techniques. Education and outreach programs through the community can enhance residents' awareness and preparedness of flood hazards using workshop, meeting, media, newsletter, pamphlets etc. Also, awareness/educational tools include flood forecasting, warning and response program and technical assistance and training for staff. Maps delineating floodplains are a basis to assess flood risk in a community. Recently, with advanced computer technology, various computer models and database management skills are developed and researched in hazard studies. Thus the evaluation protocol includes these policies as best management policies.

Public facilities and infrastructures can be safe from flooding by regulating design and location. Also, capital improvement is related to infrastructure projects. Particularly, drainage facilities or storm water management facilities, which affect indirectly and directly flooding, are improved or developed through capital improvement projects.

Mitigation is closely related to emergency and recovery. The recovery process after a major disaster can provide new opportunities that can only be realized through deliberate pre-event planning efforts. Emergency and recovery plans are very important preparations. Generally, the plans should define the responsibilities of agencies and include detail procedures to institute emergency and recovery programs quickly after a disaster. Many researchers (Olson, Olson, & Gawronski, 1998; Wilson, 1991; Wu & Lindell, 2004) have asserted that preparations of shelters and evacuation and recovery and emergency plans in advance of a disaster provide local planners and officials with time to consider what procedures might more efficiently and directly affect the quality of recovery and emergency response.

The last tools indicate sensitive area and natural resource protection, which is believed to be an important factor influencing the reduction of flood damage. Environmentally sensitive areas (wetlands, dunes, forest etc.) protection is closely correlated with protecting the natural functions of the areas to ensure that the flood-carrying and flood storage capacity are maintained. In particular, wetlands maintain control of flooding and erosion, maintain habitat functions as critical areas for many animals and plant species, as well as maintain protection of coastal areas from tidal storm surges as a natural buffer. The importance of wetland protection was described in section 2.3.2 in detail. Additionally, soil erosion and sediment control assure the efficient operation of the drainage system and protect streams and bays from substantial alteration of their natural function.

The 54 items in the protocol were evaluated to measure flood mitigation policy quality and assess how well local governments employ policies. This study also investigated their impact on actual insured flood loss.

2.2. Local Planning Efforts for Flood Mitigation

Even though a plan indicates high quality policies, without the role of a planning agency and planners, it is very difficult to be implemented. Section 2.2 focuses on the importance of local governments and planners in adopting and implementing flood mitigation policies to reduce flood damage.

Local governments can play a main role in flood mitigation through planning and regulating land use. The next question then would be "How do local governments adopt and implement flood mitigation policies?" This question is closely related to the current gap between research on natural hazard mitigation and the practice of land use planning. Even though many studies have stressed the importance of land use planning to reduce exposure to natural hazards, many communities are still hesitant to accept this for a variety of reasons, mainly perceptual, political, and economic (Burby et al., 1985; Godschalk et al., 1989; Olshansky & Kartez, 1998). What factors then have influenced local planners to actually adopt and implement hazard mitigation policies?

Many studies (Berke & Beatley, 1992; Burby et al., 1985; Burby & May, 1997; Dalton & Burby, 1994; Olshansky & Kartez, 1998) have attempted to identify the key factors influencing the adoption of hazard mitigation policies. Based on the literature, I identify three factors; factors controlled by local governments (internal factors), factors uncontrolled by local government (external factors, situational factors) and factors which can be affected by both internal and external factors (Table 2.9).

The factors controlled by local governments are within the local planning process and under the control of local planners. Two can be categorized; factors controlled by the planning process; and factors associated with the capacity of planners and the planning agency. The former includes recognition of the problem; persistent and skillful advocates; interaction and communication among participants in policy development; and linkage to other issues. These factors directly influence plan-making and plan quality. The key functions of the planning process are providing awareness of hazard vulnerability and risk, communicating with stakeholders, and proposing proper policies from a broad point of view. The latter corresponds to institutional capacity: staff resources, capacity, commitment (staff and director's commitment), and budget. Limited resources in terms of both money and staff impede mitigation efforts. Even when some assistance comes from external sources, effective and efficient use of the resources depends on the ability and willingness of local governments. Numerous studies (Burby et al., 1985; Burby & May, 1997; Dalton & Burby, 1994; Godschalk et al., 1989) have emphasized the importance of the commitment of the planning staff and elected officials to work toward achieving flood mitigation. The factors controlled by local governments represent planning attention and efforts of local governments regarding hazard mitigation. These factors are important variables that influence flood mitigation policy adoption and implementation to decrease losses from flooding events.

The uncontrollable factors (external factors) are beyond the direct control of local government, but they also affect local policy adoption and implementation. These include: disasters and hazards occurrence (magnitude, seriousness and previous experience); community wealth and resources; political culture that supports regulation of private property for public ends; mandates or assistance from state and federal governments; environmental constraints (size of the hazard zone); population density; and presence of a feasible policy solution.

In addition to these factors, there are factors which can be affected by both internal and external factors: development pressure on hazardous areas and built environmental change as a result of development. Land development should be managed in accordance with an adopted local land use plan so that land use can primarily be controlled by local government. However, sometimes, external factors which the local government cannot control can create pressure on local development and land use change.

Table 2.9. Factors Affecting Adoption and Implementation of Hazard Mitigation Policy

Factors controlled by local governments (Internal factors)	**Internal & External Factors**	**Factors uncontrolled by local governments (External factors)**
✓ Factors controlled by planning process and presented in a plan: recognition of the problem, presence of advocates, interaction and communication among participants in policy development, linkage to other issues ✓ Factors associated with planners and planning agencies: staff, budget, staffs and director's commitment	✓ Development pressure ✓ Built environment change as a result of development	✓ Disaster and hazard ✓ Community wealth and resources (Social and economic condition of community) ✓ Political culture/support ✓ State planning/ hazard mitigation mandates ✓ Environmental constrains ✓ Presence of a feasible policy solution

While it is not the goal of this study to investigate policy implementation mechanisms by examining conformity, it is important to note that plan quality is not always correlated with the extent of plan implementation. However, high quality plans and a well developed planning process can encourage community greater commitment to the plan and produce a strong impact on mitigating actual flood damage.

2.3. Factors Influencing Flood Loss

A *hazard* is an event that has the potential to cause loss of lives or property, and a *disaster* is a major detrimental impact of a hazard upon the population and economy, society and built environment of an affected area (Schwab et al., 1998). Thus, a natural disaster results from the impact of a natural hazard on the built environment and human society of an affected area. The magnitude of a disaster depends not only on the intensity of the natural hazard event, but also the number of people and structures exposed and the effectiveness of mitigation actions to protect people and property.

This section 2.3 reviews the literature about other important factors affecting flood damage: biophysical and built environmental factors. Besides these factors, the research model controls socioeconomic factors such as population and community wealth variables.

2.3.1. Biophysical Factors

Precipitation is a beginning point which causes flooding and makes discharge[2] based on existing hydrologic conditions. In particular, the amount of flood discharge mainly depends on biophysical factors such as the duration and intensity of the rainfall, and the conditions of floodplains and streams.

The intensity and duration of rainfall in the transient climate affects the speed of the inundation of the floodplain and the period of inundation (Alexander, 1993). The NOAA has stated that "as the global climate continues to warm, extreme flooding is expected to become more frequent (NOAA, 1997)."

Also, Pielke and Downton (2000) said that "This has led decision makers to accept as conventional wisdom that climate factors underlie the growth in flood damage in the United States." We intuitively recognize that more precipitation and longer flood periods would cause more flood losses.

Flood damage is affected by a community's permanent natural and topographical factors such as characteristics of streams and the size of floodplains. The following Figure 2.2 depicts a general concept of floodplains and streams. A waterway is usually

[2] Discharge is generally defined that the volume of water passing a point per unit time.

an area which will be inundated regularly and there is real and frequent danger to life and property within this area. An area outside of the floodway which could be flooded less frequently is referred to as the flood fringe. 100-year floodplains which can be inundated with one percent annual chance include the flood fringe and floodway. Even though flood hazard can be a disaster based on various conditions in the watershed, larger floodplains and larger stream areas are closely related to the physical vulnerability of flood damage.

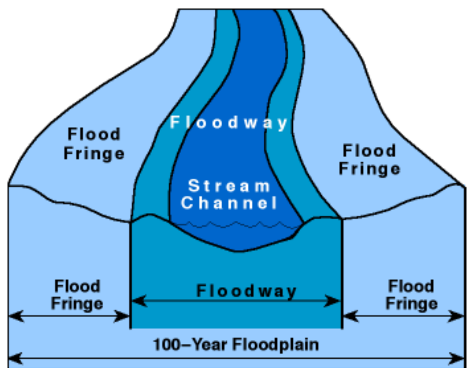

Figure 2.2. Floodplain
Source: Ohio State Department of Natural Resources (2009)

Recently, sequential studies conducted by Brody and his colleagues (Brody, Zahran, Maghelal, Grover, & Highfield, 2007; Highfield & Brody, 2006) found that these biophysical factors create significant impacts on increased property damage from flooding events even though these variables were used as important control variables.

Coastal flooding occurs in coastal communities when storms, hurricanes or strong winds drive ocean water inland. The water pushed ashore is called storm surge. Currently, storm surge risk zone maps are developed using coastal surge/flooding tools including SLOSH (Sea, Lake and Overland Surges from Hurricanes) model. Because much of the United States' densely populated communities are located in the Atlantic and Gulf coastlines, which lie less than 10 feet above mean sea level, the danger from coastal floods is remarkable (National Hurricane Center, 2009).

2.3.2. Built Environments and Floods

Besides the above natural settings, human development activities are closely associated with the amount of loss of lives and property from floods. Changes in land use and the built environment incurred by human activities are neither necessarily transient nor necessarily permanent phenomena (Alexander, 1993). Potential features indicating change in the built environment and contributing to an escalation of flooding loss include the amount of impervious surface, the number and value of structures and the change in the hydrological system through development of ecologically critical areas such as wetlands (Brody, Zahran, Maghelal et al., 2007).

The United States has experienced rapid urbanization. As shown in Table 2.12, the urban population has increased over 150% and the urban land area expanded almost 300% from 1945 to 2000. Impervious surfaces such as rooftops, roads, parking lots, driveways and sideways have long been characteristics of urban development. From the 1990s, many researchers have used the percentage of impervious surface as an indicator of urbanization and a predictor of environmental impact of urban development (Arnold & Gibbons, 1996). An impervious surface is defined as a human-produced surface that prevents the infiltration of water into the soil (Moglen & Kim, 2007). The increase of impervious surfaces causes the alteration of the hydrological cycle which is also closely related to flooding.

Table 2.10. Urbanization in the United States from 1945 to 2000

	1945	1950	1960	1970	1980	1990	2000	Change (1945-2000)
Urban Land Area (Sq. mile)	23,456	30,048	40,238	54,103	73,930	87,376	92,505	294.4%
Urban Population	86,513	86,513	96,468	125,269	149,647	167,051	187,053	157.0%

Data: US Census

The logical mechanism of the relationship between impervious surfaces and floods is as follows: development in urban or agricultural and forest lands means that land is converted from fields to impervious surfaces such as roads, buildings or parking lots. Generally, undeveloped areas such as forests and agricultural lands, rainfall and snowmelt are stored on vegetation, in surface depressions or in the soil column. However, construction activities remove vegetation, soil and depressions from the land. In addition, increasing impervious surfaces reduces infiltration of water into the ground, which loses the ability to absorb and store rainfall (Figure 2.3). This causes a change in the natural hydrologic system of a basin and accelerates runoff to streams. With less storage capacity for water and more rapid runoff along relatively smooth pavement, streams rise more quickly and have a higher flood peak discharge rate which often results in flooding. The combination of high volume and rapid runoff can increase erosion of structures in floodplains, downstream areas and stream bank. Also, when the runoff carries debris from construction sites and developed areas it affects the severity of flooding damage. Overall, development activities may be important factors contributing not only to environmental degradation, but also the amount of flood loss.

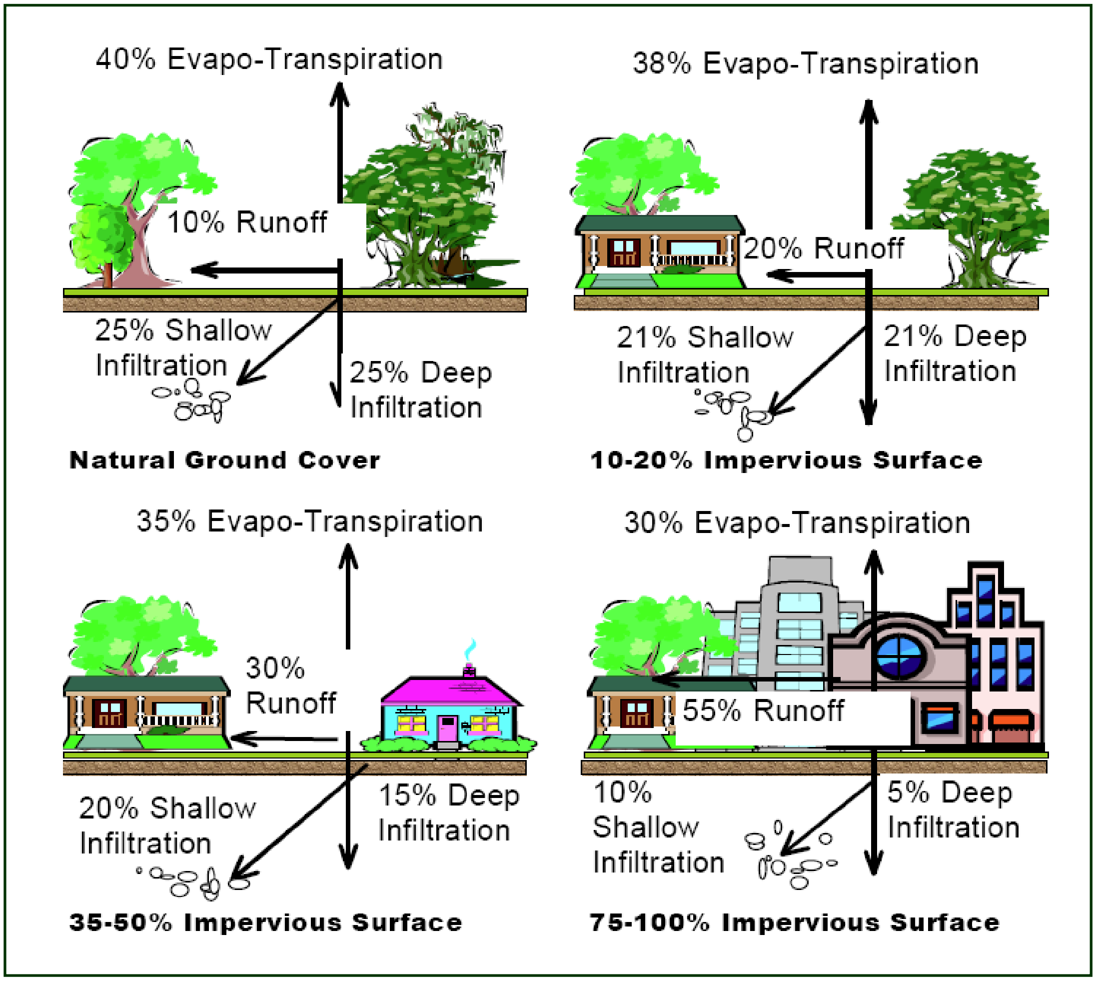

Figure 2.3. Water Cycle Changes Associated with Urbanization
Source: California Water & Land Use Partnership (2008)

It is well known that wetlands have a significant impact on the hydrological cycle and have a value and role in ecosystem function. On the contrary, the alteration or development of wetlands has impacted the intensity and frequency of flooding through both the increase of impervious surfaces and decrease in the capability of natural water retention within watershed units (Highfield & Brody, 2006).

Generally, wetlands are areas saturated with water. As a regulatory definition, the Clean Water Act defines wetlands as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (Environmental Protection Agency, 2007)."

From the 1960s and 70s, wetland protection received increasing environmental interest in the United States. However, with rapid urbanization, wetlands are one of the most threatened environmental resources. In the beginning stage, the greatest loss occurred as a result of agricultural conversion, but recently various urban activities are increasingly altering wetlands. The values of wetlands include not only ecological functions such as water quality, food chain support, wildlife habit, fisheries and heritage, but also natural flood mitigation by sustaining the hydrological cycle such as groundwater recharge and discharge, floodflow alteration and sediment stabilization (Brody et al., 2007; Maltby, 1991).

Currently, wetlands are managed through a permit process. The Clean Water Act Section 404 requires a wetland permit in order to alter a wetland. This program is the responsibility of the U.S. Army Corps of Engineers.

Some studies have empirically examined the influence of the built environment on flood loss directly or indirectly through statistical methods, simulation and observation. Recently, Highfield and Brody (2006) examined the cumulative wetland development impact on economic damage from floods using statistical analysis and found that individual permits within the floodplain have significant impact on flood losses. Another study of Brody and his colleagues (Brody, Zahran, Highfield et al., 2007; Brody, Zahran, Maghelal et al., 2007) confirmed increased wetland alteration on increased property damage caused by flooding events. Furthermore, the authors found that an increased number of impervious surfaces also significantly increased property damage. Ogawa and Male (1986) used a simulation methodology to evaluate the role of wetlands on flood mitigation and found that increased wetland encroachment resulted in a considerable increase in peak flow. Bullock and Acreman (2003) comprehensively reviewed existing studies on the function of wetlands on downstream river flows, floods and groundwater. They confirmed that wetlands have a significant influence on the hydrological cycle. Most studies (23 of 28) found evidence that "floodplain wetlands reduce or delay floods."

2.3.3. Socio-economic Factors and Flood Loss

Socio-economic factors such as population growth and increasing concentration of property in high flood risk areas increase the possibility of flood loss. It is well known that the impacts of natural hazards such as floods are not only a function of biophysical and geographical factors, but also of human society and built environments. Therefore, it is vital to include social and economic factors which help explain the degree of flood damage.

The impacts of socio-economic factors on flood loss are closely associated with the intensity of flood event as well as number of people and structures exposed to the event. Namely, communities with a large population and wealth exposed to high flood risk would suffer more loss from the flooding event. On the contrary, communities with a large population and high level of wealth also tend to adopt and implement various flood mitigation measures. Depending on the effectiveness of mitigation policies to protect property and people, the overall losses would be decided. This study includes population and median household income as critical demographic variables in socio-economic factors.

Studies found that public participation influences the plan quality associated with natural hazards mitigation. Public participation is closely related to public awareness and implies more effective stakeholder contributions to the decision making in flood mitigation measures which cause reduction of loss. Public participation also reflects the social atmosphere of a community, which this study includes as a variable within socio-economic factors.

As mentioned earlier, insurance is a dominant non-structural flood mitigation measure. Communities establish a prerequisite for community-wide insurance participation. However, individual participation is voluntary, but sometimes residents living in 100-year floodplains are required to have insurance by lending companies or mortgage institutions. The rate of residents' participation in NFIP is also a critical indicator of public interests in flood mitigation. The level of insurance purchase of residents would be varied with public perception and awareness of flood risk. Generally, people buy flood insurance policies because they consider the insurance as an importance resource for recovery and repair for damaged properties. Thus, it is intuitive that insured flood loss in a community would parallel the residents' participation in insurance policy. When flooding happens across multiple communities, communities with a large number of insurance policies would receive more payments from NFIP, which results in more insured losses.

3. CONCEPTUAL FRAMEWORK AND RESEARCH HYPOTHESES

Based on the literature review, I constructed a conceptual framework to provide the theoretical basis for a statistical model that describes the influence of plan quality on flood damage. This study identified other key factors influencing flood damage. Based on this conceptual framework, research hypotheses were specifically stated to test the research questions.

3.1. Conceptual Framework

The following figure 3.1 illustrates how each variable is conceptually related to the dependent variable, flood loss. The main independent variable of the conceptual framework is planning factors which include the quality of flood mitigation policies adopted in local comprehensive plans and other planning efforts. Also, I postulate that biophysical, built-environmental, and socio-economic variables have effects on the flood damage.

The following sub-section of this section provides a conceptual definition for each variable and describes the rationale and research hypotheses for each variable.

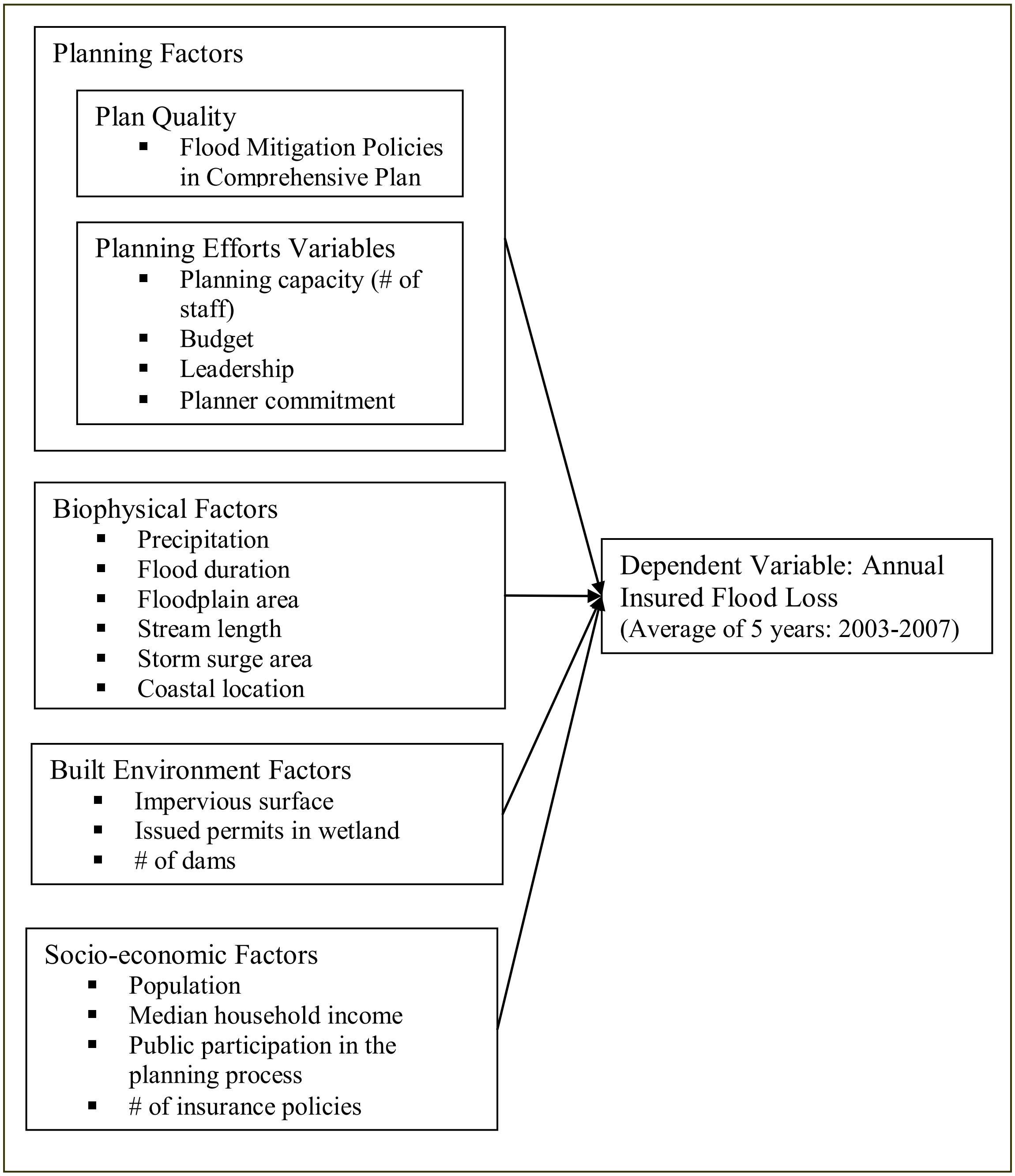

Figure 3.1. Conceptual Framework

3.2. Dependent Variable: Flood Loss

In this study, the dependent variable is actual loss to property from floods. Reducing losses to life and property from floods is one of the ultimate goals of various flood mitigation plans and policies. The U.S. has steadily reduced the loss of lives in flooding events in this century, but the property damage has increased. Even if, in part the impact of inflation and the constant revaluation of property affect this trend, rising damage stems from population migration and development growth in hazardous areas (Alexander, 2000). Climate change and planning efforts for flood mitigation can mediate the increase or decrease of flood losses.

It is critical to understand the definition of flood loss/damage and how to measure it. The general concept of this term is something that is lost as a result of floods. However, currently, there is no accurate and official definition of this term and guidelines to estimate this because there is no agency in the United States with responsibility for collecting and evaluating detailed and accurate flood information (Pielke, Downton, & Miller, 2002). Therefore, accurate and official nationwide data on flood loss at the local level does not exist. Even if it requires substantial resources, it is essential that a comprehensive, accurate and nationwide database should be established to help researchers and policy makers (Association of State Floodplain Managers, 2007).

However, there are four available data sources for flood loss/damage even though each has deficiencies. The National Weather Service (NWS) provides flood loss data at the national, state and drainage basin levels, not at the local level. The NWS collects data through its numerous field offices and provides loss estimates for significant flooding events. However, Pielke and Downton et al.(2002) said "The NWS damage estimates do not represent an accurate accounting of actual costs, nor do they include all of the losses that might be attributable to flooding." Also, the data quality may be not consistent depending on other operational constraints at their field offices (Hydrologic Information Center, 2000). Pielke and Downton et al.(2002) reevaluated the NWS damage information after compiling publications and reports of other federal and state agencies and then provided this data through their website (http://www.flooddamagedata.org/national.html).

Another available database is the Spatial Hazard Events and Losses Database for the United States (SHELDUS 2006) developed by the Hazard Research Lab at the University of South Carolina. This database contains county-level hazard data derived from several existing data sources. According to the SHELDUS webpage, flooding data is obtained from the National Climate Data Center, "Storm Data and Unusual Weather Phenomena." Only flooding events with more than $50,000 in losses was manually entered into this data. This data might have a problem similar to the NWS data with the possibility of underestimating actual losses. However, this data is nationwide at the county level, free to the public and easily accessed.

The other available flood loss data source is flood insurance claim payment data. The insurance claim data is comparatively accurate and nationwide at the community level. However, it is limited to losses of insured properties and does not reflect all flood losses.

Considering the shortcomings and advantages of each database, this study uses insured property damage that are claim payments made by the National Flood Insurance Program (NFIP). Total payment is the total amount paid on flood losses based on insurance claims. First, this data is accurate, not an estimate. Also, the data are nationwide including Florida at the community level. While the SHELDUS data have some benefits, this database presents a problem to the validity of the study. The data are aggregated geographically to the county level, which includes all losses in jurisdictions embedded in the county boundary. Local comprehensive plans and flood mitigation policies are generally developed and implemented at the jurisdiction level; so their authority boundary is not the same with the county geographical boundary. Disaggregating the county data to the local jurisdiction level would threaten validity. Section 5 investigated four data source and trends of flood loss focusing on NFIP insured loss data.

3.3. Independent Variables

In this study, there are four groups of independent variables: planning factors, biophysical factors, built environmental factors and socio-economic factors.

3.3.1. Planning Factors

Planners have faith that vulnerability from floods and actual flood loss can be mitigated through planning activities. This study uses five indicators to represent a local jurisdiction's planning effort: quality of flood mitigation policy, number of staff, budget, leadership, and planner commitment.

3.3.1.1. Plan Quality: Flood Mitigation Policy

A plan document is the most tangible and important indicator of planning effort made by communities because a plan is not only a reflection of the planning process but also a starting point for implementation (Baer, 1997). This study assumes that the quality of flood mitigation policies adopted in local comprehensive plans indicates how well local governments attempt to implement flood mitigation policies.

The quality of flood mitigation policy is measured by evaluating local comprehensive plans against the developed protocol (Table 2.8). The protocol was established by incorporating sustainable and resilient principles and important flood mitigation measures to the existing plan quality evaluation concept. Flood mitigation policies which can be adopted in a local comprehensive plan were categorized in twelve subcomponents. Each component has several items and a total of 54 items was evaluated. These items were used to measure flood mitigation policy quality.

The central hypothesis of this study is that plans which articulate the policies will lead to action that contributes to reduced flood property losses. By including more specific and detailed flood mitigation policy recommendations, planners are able to know which policies are most appropriate for their community and can develop proper policies for mitigating flood damage. Also, the planning process for developing a high quality plan would provide an opportunity for planners to have intimate flood mitigation knowledge, hazard related information and learn public needs.

Hypothesis 1: Higher quality of flood mitigation policy will result in lower amounts of property loss from floods.

3.3.1.2. Planning Efforts

The efforts of local governments in adopting and implementing flood mitigation policies can be represented by the following indicators: planning capacity, planner's commitment, budget and leadership.

3.3.1.2.1. Planning Capacity

In this study, planning capacity means the number of planners who are involved in the development of the comprehensive plan and the implementation of flood mitigation policies. The more planners working on planning and flood mitigation, the more personnel and technical expertise can be devoted to implementing flood mitigation activities.

Hypothesis 2: Jurisdictions with more planners will have lower amounts of flood property loss.

3.3.1.2.2. Budget

Annual budgets dedicated to flood planning and activities represent the community's financial capability for flood mitigation. The budget can be applied to a wide range of activities from staff's salary to policy implementation activities. Assuming that the budget is efficiently spent for planned activities, a larger budget will contribute to decreased flood property losses.

Hypothesis 3: Jurisdictions with larger budgets will have a lower amount of flood property losses.

3.3.1.2.3. Leadership

Leadership reflects the confidence and interests of local leaders to adopt and implement flood mitigation policies. Community leaders who have greater commitment and strong willingness can make effective decisions for flood mitigation.

Hypothesis 4: Communities with stronger leadership will lead to lower flood losses.

3.3.1.2.4. Planner Commitment

Commitment is the willingness of local planners to recognize the importance of local flood mitigation and preparedness and to implement proper policies. It is widely known that planners with greater commitment and understanding of problems and policies will undertake more suitable and varied programs to minimize flood losses. Higher planner commitment is a critical factor for local government actions.

Hypothesis 5: Jurisdictions with greater planner commitment will lead to lower amounts of flood losses to property.

3.3.2. Biophysical Factors

In this study, natural settings affecting physical vulnerability of flood and flood damage include precipitation, flood duration, area of floodplain, stream length, storm surge zone and coastal location.

3.3.2.1. Precipitation

The intensity and frequency of flooding outcome are conditioned on the amount of rainfall. The soil is able to hold and store some degree of precipitation. Yet, if heavy rainfall exceeds the capability of the soil, it results in flooding which can causes losses of life or property. Communities experiencing frequent and heavy rainfall will have much more flooding losses than other communities.

Hypothesis 6: A larger amount of precipitation will result in increased amounts of property loss.

3.3.2.2. Flood Duration

Flood duration is also a weather phenomenon and refers to the length of the period of inundation. It is one of the flood parameters which affect flood loss in the flood loss estimation model. Sometimes heavy rainfall unleashes huge amounts of rain within a very short time causing floods in local areas, and sometimes prolonged rain affects larger areas for a long time. Generally, with longer flood duration, larger areas are inundated causing more flood damage in the inundated zones.

Hypothesis 7: Longer flood duration will result in more flood damage to property.

3.3.2.3. Floodplain

Floodplains are areas more physically vulnerable to flooding hazards than other areas. The 100-year floodplain refers to an area which has a one percent flooding occurrence in a given year. The higher percentage of floodplains in the entire community, the greater possibility of floods with more vulnerable people and property in the areas. So, larger floodplains can correspond to more flood property damage.

Hypothesis 8: Jurisdictions with larger floodplain areas will have more property damage from floods.

3.3.2.4. Stream Length

Typical flooding occurs from the overflowing of flood channels, rivers or streams as a result of heavy rainfall or snowmelt. Longer stream length indicates the higher possibility of flooding and in turn, communities having large stream density would include larger floodplains. These factors can increase vulnerability and actual loss to property from flooding events.

Hypothesis 9: Jurisdictions with longer stream length will have more flood property loss.

3.3.2.5. Storm Surge Area

Storm surge is caused by high winds that raise the water level higher than the ordinary sea level. Usually this is associated with storms or hurricanes and is the most common cause of coastal flooding. Thus, communities including larger storm surge area are exposed to higher risk in coastal flooding.

Hypothesis 10: Jurisdictions with larger storm surge area will have more property damage from floods.

3.3.2.6. Coastal Location

Coastal communities are closely associated with coastal hazards and coastal flood risk. Communities that are located on Florida coastlines are more likely to have a history of frequent storms and repetitive floods and include larger risk zones.

Hypothesis 11: Coastal communities will experience more flood damage to property.

3.3.3. Built Environment Factors

Flood loss to property can be influenced by built environment factors: impervious surface, wetland alteration and the number of dams.

3.3.3.1. Impervious Surface

Impervious surfaces such as roads, buildings or parking lots reduce the infiltration of water into soil and compromise its ability to store and absorb water. It causes high volume and rapid runoff, which has a higher flood peak discharge rate and results in flooding. Currently, the percentage of impervious surface in a community is an important indicator of the impact of development on the ecosystem and flooding events. A higher degree of urban development and higher percentage of impervious surface will contribute to the higher possibility of flooding and the amount of flood loss.

*Hypothesis 12***:** Communities with a higher percentage of impervious surface will have more property loss from flooding.

3.3.3.2. Issued Permits in Wetlands

It is widely accepted that wetland alteration impacts the hydrological cycle. This phenomenon can result in increased flooding due to reduced natural water retention in watersheds. Currently, the United States controls the development and alteration of wetlands through a permit process. There are four types of permits for wetlands: individual permits, letters of permission, general permits and nationwide permits. Jurisdictions with higher numbers of issued wetland permits are likely to have altered a larger amount of naturally occurring wetlands in their community. This development pattern can result in a higher possibility of floods and increased vulnerability of population and property.

Hypothesis 13: Jurisdictions with higher numbers of issued wetland permits will have more property damage from floods.

3.3.3.3. Number of Dams

Construction of dams has been used for a long time as traditional structural measure for flood control. Even though there are many arguments regarding the effectiveness of the structural measures, evidence has shown that these techniques provide a considerable degree of protection from repetitive floods (Birkland et al., 2003; U.S. Army Corps of Engineers, 2006). In particular, this approach is useful in urban areas that have already been developed.

Hypothesis 14: communities with a higher number of dams will have lower amounts of property loss from floods.

3.3.4. Socio-economic Factors

Socio-economic variables are the important contextual variables in predicting flood damage. Based on the literature review, this model includes population, wealth of community, public participation and number of insurance policies.

3.3.4.1. Population

Usually, a community with a large population has more complex problems including more development in floodplains that result in higher exposure to flood hazards.

Hypothesis 15: Jurisdictions with larger populations will have more flood property damage.

3.3.4.2. Wealth

A wealthy community will be more likely to have the financial resources to implement flood mitigation measures. In this study, median household income of each jurisdiction is measured for this variable. The higher the median household income, the wealthier the community, and the more financial resources and incentives it can devote to adopting and implementing policies for flood damage mitigation.

Hypothesis 16: A wealthier community will have lower amounts of flood property loss.

3.3.4.3. Public Participation

It is well known that public participation is a critical process of exchanging information and generating trust and commitment toward the adoption and implementation of flood mitigation policies. In particular, civil participation in the planning process creates a chance to be involved in the decision-making process for flood mitigation. Public participation in this study refers to the degree of public participation or involvement in the planning process. If more people participate in plan development, they will learn more about flood risk and vulnerable areas. In addition, they would prefer to live far from areas exposed to floods and recognize the need to take flood mitigation action, in turn pressing local government to employ and implement mitigation.

Hypothesis 17: Communities with a higher degree of public participation in the planning process will have lower amounts of flood property loss.

3.3.4.4. Number of Insurance Policies

As residents purchase more insurance policies due to flood risk and political or policy pressure, the entire community's insurance claim payment is likely to become larger.

Hypothesis 18: Communities with more insurance policies will have more insured flood damage.

4. RESEARCH METHODS

4.1. Study Design

This study is based on 1) a survey that measures local jurisdiction planning efforts associated with flood mitigation planning and policies, 2) local comprehensive plan evaluation which indicates to what degree local governments integrate flood mitigation policies in their plans, 3) statistical data that measure flood damage and other socio-economic variables, and 4) GIS data that measure spatial characteristics. This study is cross-sectional, since data on the dependent variable and independent variables are based on observations representing a "single point" in time.

4.2. Unit of Analysis, Study Population and Sampling Method

The target population is local jurisdictions in the United States with comprehensive plans. The study population, which is the collective study units, is based on all jurisdictions in Florida. Thus, the unit of analysis is the single jurisdiction within the state of Florida. This study took a random sampling of local jurisdictions in Florida based on the following strategy; 1) the sample was limited to jurisdictions within 100 miles of the Florida coastlines with a population of 5,000 or more so not to skew toward small communities; and 2) large cities were excluded in order to prevent a biased impact on the model.

Based on these criteria, 264 jurisdictions were sampled and an internet survey was sent to flood planners in those communities. 93 jurisdictions responded with a response rate of 35.2 %. Among those responses, 34 planners (jurisdictions) answered that there was no flood in their jurisdictions during the last five years. Thus, 59 Jurisdictions reported flood experience during the last five years. For the statistical model, comprehensive plans would be adopted and implemented before the period of insured flood damage (2003-2007). Thus, of 59 jurisdictions, six plans developed and adopted after 2004 were excluded in the analysis. Overall, this study analyzed 53 local comprehensive plans as shown on Table 4.1. Figure 4.1 depicts the locations of the study jurisdictions.

Table 4.1. Study Jurisdictions

Bartow, Boynton Beach, Brooksville, Callaway, Clermont, Cocoa beach, Daytona Beach, De Bary, Deltona, Destin, Dixie County, Fort Walton Beach, Franklin County, Gainesville, Gilchrist County, Glades County, Gulf County, Gulfport, Hallandale, Hernando County, Highlands County, Jackson County, Jacksonville Beach, Lake Wales, Largo, Live Oak, Manatee County, Marion County, Miami Lakes, Miami Springs, Miramar, Monroe County, Neptune Beach, New Smyrna Beach, North Port, Ocoee, Oldsmar, Palm Beach Gardens, Parkland, Pasco County, Pensacola, Pinellas Park, Plant City, Pompano Beach, St. Johns County, St. Petersburg, Sumter County, Sweetwater, Tampa, Temple Terrace, Valparaiso, Washington County, Winter Garden

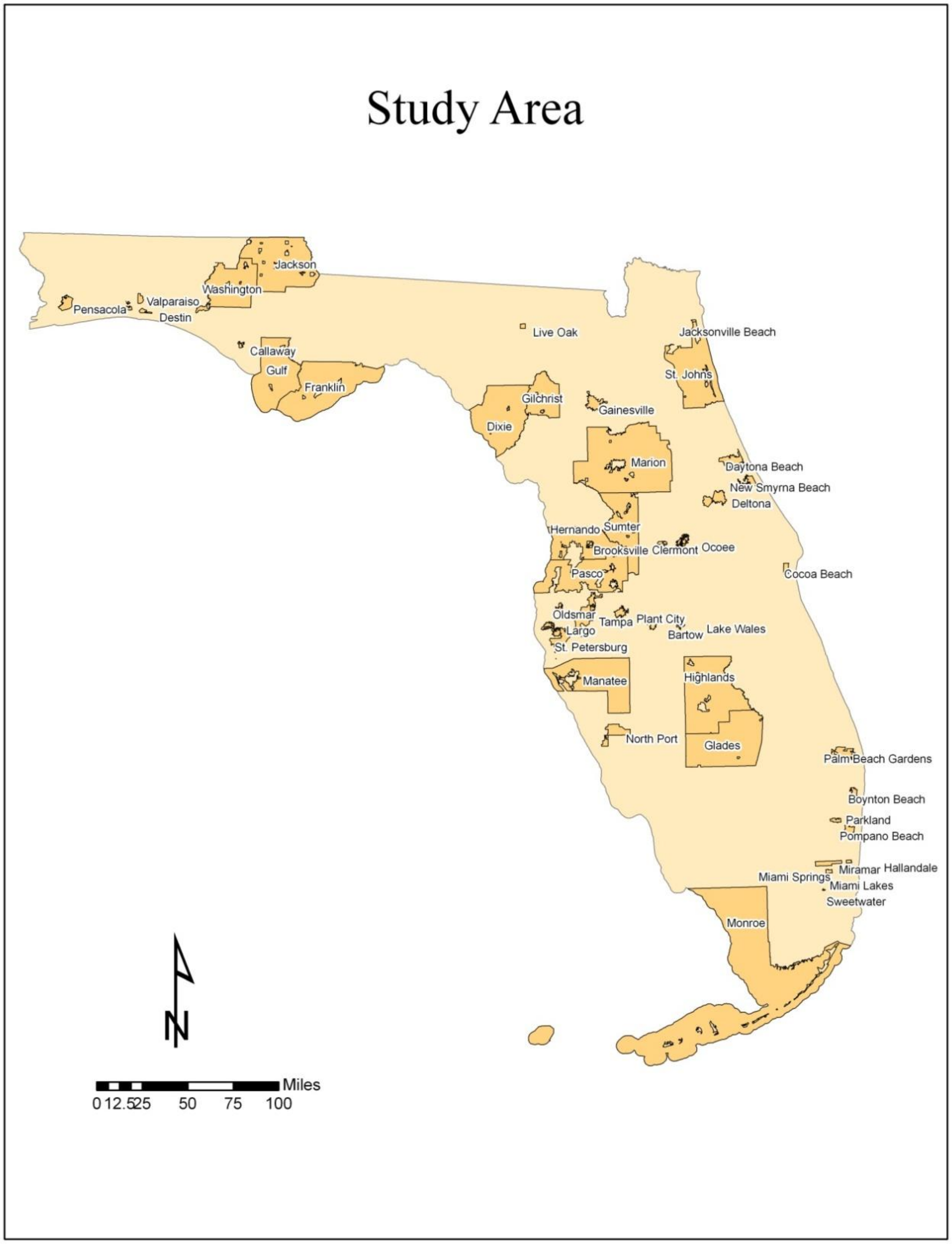

Figure 4.1. Study Area

4.3. Data Collection

Data were obtained from existing data and an internet survey for this research. For flood loss data, flood insurance claim payment data were collected from FEMA. Most of the local jurisdictions comprehensive plans were collected from "Florida Papers Process Automation & Paperless Electronic Routing System (http://dcaenterprise.eoconline.org/)" and local jurisdictions' websites. Some plans were gathered through direct contact with local planners.

GIS based data were downloaded from the Florida Departmental Protection web site (http://www.dep.state.fl.us/gis/datadir.asp). Floodplains GIS maps were obtained from FEMA. Precipitation data were gathered from the National Climate Data Center (NCDC). The U.S Army Corps of Engineer provided the location and other information (type, size, construction or issued date etc.) of dams and issued wetland permits. This information was transformed to GIS data using geocoding. NOAA coastal service center created the Coastal Change Analysis Program (C-CAP) database (http://www.csc.noaa.gov/crs/lca/ccap.html) which provides land cover and change data. The impervious surface was calculated in the Arc GIS using land cover data acquired from the NOAA database. NOAA also provided storm surge zone maps for entire Florida. 2000 Census data were utilized for socio-economic variables such as population and median household income.

In this study, the survey of key local flood planners was a critical data collection technique. This survey was conducted through the internet in 2007 as part of a National Science Foundation (NSF) research project on flood mitigation policy. The data obtained from the survey include planning efforts such as planning capacity, planner's commitment, budget, leadership and public participation.

4.4. Concept Measurement

Measurement is a critical process of assigning a value to a variable. The table on page 87 shows the constructs, variables, measurements and data sources.

4.4.1. Dependent Variable: Flood Loss

The dependent variable, flood property loss, was measured as the annual average loss using insurance data. Namely, flood property loss is insured annual average property damage. This variable was skewed; so it was necessary to approximate a normal distribution using log-transformation. These data were collected from FEMA NFIP claim database. The flood loss data are nationwide and at a jurisdiction level.

4.4.2. Independent Variables

4.4.2.1. Planning Factors

Plan Quality (Flood Mitigation Policy): This variable was measured by scoring plans against the evaluation protocol. The coding procedure followed the existing methodology of plan quality evaluation research. The measurement has an ordinal coding scheme. Individual policies were evaluated as 0 = not mentioned in plan; 1 = mentioned but no detail; and 2 = mentioned in detail. Based on this basic scheme, a plan evaluation guideline was developed for each policy. If a policy item in the protocol was not considered in a plan, it got a score of "0." If a plan uses the words "should", "may", "encourage", "prefer", "suggest", it received a score of "1." Even if a policy is mentioned but specific information is not known about implementation "when," "where," "what," and "how," then it got a score of "1." If a plan mentions "when," "where," "what," and "how" a policy will be realized, it received a score of "2." Also, when a description of a specific policy used strong mandatory words such as "mandate," "shall," "must" or "will," it received a score of "2." Because the protocol included 54 items, the total possible score ranges from 0 – 108. The score shows the quality of the flood mitigation policies adopted in the local comprehensive plans. A higher score reflects a higher quality of flood mitigation policy.

In the statistical model, this total score was used as an independent variable to assess the impact of plan quality on flood loss. Furthermore, an evaluated score was utilized for further analysis by calculating the policy's breadth and depth score. Table 4.2 describes the measurement technique of the policy scores and based on previous studies (Brody, 2003b; Godschalk et al., 1999; Peacock et al., 2009).

Table 4.2. Policy Breath and Depth Scores

Score Name	Equation	Scale
Policy breadth score	Breadth score of an item = (number of plans that address a specific policy) / (number of plans in the study)	0 -1
Policy depth score	• Depth 1 = (sum of policy scores of plans that address a specific policy) / (number of plans in the study) • Depth 2 = (sum of policy scores of plans that address a specific policy) / (number of plans that address a specific policy)	0-2

The breadth score of a specific policy measures the proportion of the plans that includes the policy among all plans. This measurement is very useful to evaluate to what degree local governments in Florida integrate a specific policy in their plans. The policy depth score can measure the detail or degree of strength with which local governments mention the specific policy. Depth score is measured by two methodologies. The first method is to calculate the average score a policy received across all plans and the second depth score assesses the average score for plans which address the policy. This study calls the former *depth1* and the latter *depth 2*. Most existing research uses *depth 2* for assessing the depth but recent research conducted by Peacock et al.(2009) added *depth 1* to assess the quality of the policy across all study plans. These breadth and depth measures provide an overall assessment of quality of flood mitigation policies in detail. The depth scores have a range of 0 to 2 like the policy evaluation scheme. While a score of 0 is not addressed in the plans, a score of 2 indicates that a policy is mentioned with detailed coverage in the plans. A score of 1 suggests that a policy is just mentioned without detailed information. It might be reasonable to assume that a depth score of around 1.5 would reflect a reasonable or acceptable level of quality (Peacock et al., 2009). Again, *depth 1* indicates how well policies are being mentioned across all 53 plans, while *depth 2* suggests how well flood mitigation policies are addressed among the plans which address specific policies.

Planning Efforts (Planning Capacity, Budget, Leadership, and Planner Commitment): Planning capacity measures the number of full time staff members. A full time staff member was considered as 1 and a part time staff person was measured as 0.5.

If a full time staff member has 4 different equal roles and one of them is planning and flood mitigation, it is considered as 0.25. Planner commitment and leadership were measured with 6 ordinal scales. 0 means no commitment; 1 means very weak; 2 is weak; 3 is neither weak nor strong, 4 means strong commitment; and 5 indicates very strong commitment. Budget refers to the annual budget for flood planning.

4.4.2.2. Biophysical Factors

In this study, six predictors are measured: precipitation, flood duration, area of the 100-year floodplain, stream length, storm surge area and coastal location.

Precipitation was measured as the average annual surface precipitation during 2003 - 2007 recorded by a weather station that is the nearest from a jurisdiction. These data were obtained from the National Oceanic and Atmospheric Administration (NOAA)'s National Climate Data Center Online. Flood duration refers to the number of days of floods, hurricanes, storms and coastal hazards. In addition to flood duration, the days of hurricanes, storms and coastal hazards were included since hurricanes, storms and coastal hazards can produce coastal flooding. It was measured based on the start and end dates of each event obtained from SHELDUS. This database is at county level. Because of this data limitation, it was assumed that communities located in the same county have the same flood duration. Stream length was calculated using GIS data collected from the National Hydrology Dataset (NHD). Also, FEMA provides a 100-year floodplain digital map and NOAA created a storm surge zone map to easily calculate the areas of floodplain and storm surge zone in GIS. Costal location is decided based on whether the community is located on coastline and this dummy variable is also related to the "coastal management component" in comprehensive plans because the state requires the coastal component for all coastal jurisdictions.

4.4.2.3. Built Environment Factors

Built environment variables influencing flood property loss include impervious surface, number of issued wetland permits and number of dams.

Impervious surface was calculated based on land cover data from the NOAA Coastal Change Analysis Program. In the classification of land cover, impervious surface included the following land cover types: pavement/roadside, urban, urban/residential, and urban open/others.

Wetland alteration was measured as the cumulative number of issued permits from 1991 to 2003 within a community boundary. There data were collected from the US Army Corps. of Engineers through a Freedom of Information Act request. The original record included the permit type, issued date and location (latitude and longitude) which was geocoded in GIS to provide insights to their spatial impact. In addition, this study calculated the number of dams located in each community from data obtained from the US Army Corps. of Engineers.

Table 4.3. Constructs, Variables, Operational Measures, and Their Source

Concept	Variable Name	Variable Operation	Scale	Type/Sign	Data Source
Dependent variable	Insured Flood damage	Average annual insured damage (2003-2007)	Ratio	Dependent	FEMA NFIP
Planning variables I : Plan Quality	Flood Mitigation Policy	Score of plan quality evaluation	Interval	Independent	Collected local comprehensive plans
Planning variables II: Planning Effort	Planning capacity	Number of full time staff members	Ratio	Independent	Survey
	Budget	Annual budget for flood planning	Ratio	Independent	Survey
	Leadership	Leadership to flood planning and hazard mitigation	Ordinal	Independent	Survey
	Planner commitment	Commitment to planning for a flood resilient community	Ordinal	Independent	Survey
Biophysical Variables	Precipitation	Average annual precipitation (inches) at a nearest weather station from a jurisdiction	Ratio	Independent	National Climate Data Center, 2003-2007
	Flood duration	Number of days for flood, hurricane, storms and coastal hazards	Ratio	Independent	Spatial Hazard Events and Losses Database for the United States
	Floodplain area	100 year floodplains in each community	Ratio	Independent	FEMA Digital Q3 Flood Data, 1999
	Stream length	Stream length	Ratio	Independent	National Hydrology Dataset (NHD)
	Storm surge area	Strom surge area in each community	Ratio	Independent	NOAA
	Coastal location	Coastal community or not	Dummy	Independent	Comprehensive Plan
Built Environment Variable	Impervious surface	Area covered by impervious surfaces.	Ratio	Independent	NOAA Coastal Change Analysis Program
	Issued permit in wetland	Cumulative total of issued wetland permits (1991-2003)	Ratio	Independent	U.S. Army Corps of Engineers, 2004
	# of dams	The total number of dams in a jurisdiction area.	Ratio	Independent	U.S. Army Corps of Engineers, 2004
Socio-economic Variable	Population	Jurisdiction population	Ratio	Independent	State of Florida, The Office of Economic & Demographic Research
	Median household income	Median household income	Ratio	Independent	U.S Census, 2000
	Citizen participation	Degree of the public participation in the planning process	Interval	Independent	Survey
	# of Insurance policies	Number of insurance policies purchased by a community	Ratio	Independent	NFIP, FEMA

4.4.2.4. Socio-economic Factors

Socio-economic variables reflect socio-economic conditions of a community affecting flood damage. Population of study jurisdictions are collected from the Office of Economics & Demographic Research of Florida State and median household income is provided by the U.S. Census. Citizen participation was collected from the survey and measured with 6 ordinal scales such as planner commitment and leadership. FEMA provides the data of the number of insurance policies purchased by a community through their website.

4.5. Reliability and Validity of Variables

There are two principal issues of concern when it comes to measurement: validity and reliability. Validity deals with the accuracy of the measurement as it is reflected from theoretical concepts. Reliability is the consistency or stability of the measurement. This part discusses status and threats to this research design.

4.5.1. Validity

Validity types were categorized into statistical conclusion validity, internal validity, construct validity and external validity (Shadish et al., 2002).

First, statistical conclusion validity is associated with the appropriate use of statistics to infer the correlation between the dependent variable and independent variables. The increase of the probability of errors (Type 1 and Type II error) in the regression model can threaten statistical conclusion validity. The comparatively small sample size (n = 53) of this study causes a low statistical power, and it is possible that the relationship between the dependent variable and independent variables would be incorrectly insignificant. Also, the number of independent variables is relatively large compared to the sample size. For this reason, this study analyzed the independent variables by blocks (planning factors, biophysical factors, built environment factors, and socio-economic factors). Significant variables in block test were selected for the final model. This method can keep the number of independent variables quite low in a final regression model.

Second, the threat to internal validity is caused by the fact that it is very difficult to include all related variables influencing the dependent variable, flood loss. Flooding is a natural phenomenon with impacts that can be controlled by proactive mitigation action. Not only planning efforts, but also political issues have made a big difference in adopting and implementing flood mitigation policies. However, this study did not consider political variables. Also, a flooding event is an interactive process with various natural settings. Even if this research tried to develop a fully specified model, it is not possible to construct a perfect model to explain all these processes. However, this study increased internal validity through various considerations. First of all, only jurisdictions that had experienced floods over the last 5 years were chosen for the study. Also, one of the important factors which influenced adoption of hazard mitigation policy, plan mandate, was controlled by selecting only Florida, which mandates local comprehensive plans.

Another threat to internal validity is study period. To show causal relationships between the dependent variable and independent variables, the evaluated plans should be developed before the flood damage period. This study selected 53 plans that were developed before 2004. Most plans were developed and revised before the time of flood damage (2003-2007), but some overlap this time period by one year.

Third, construct validity is related to the agreement between a theoretical framework and a specific measurement. This includes two points of view. First, the theoretical relationships should be adequately specified in the research model based on the literature. Second, the measurement instrument of the concept should correspond to what is to be measured. The threat to construct validity on the dependent variable stems from the limitation of flood insurance claim data. As mentioned before, there exists no perfect flood damage data. Even if flood insurance payment data is accurate at the community, it does not represent all property damage from floods.

The construct validity of the plan quality depends on how well the coding protocol reflects the quality of the plan and how accurately the coder grades the plan. For this issue, the plan evaluation protocol and evaluation guidelines were developed very carefully based on existing research and were pre-tested before being applied to the actual plans.

Finally, this research shows a limitation in external validity, which involves how well this study would predict similar findings in other populations at other times. Study areas are limited to Florida since Florida has a comparatively long and strict hazard planning tradition and a high level of flood risk. It means that it is difficult to generalize the findings of this research to other areas even though the methodology can be applied to others.

4.5.2. Reliability

Reliability is the consistency or stability of the measurement when a measurement is performed in the same manner. In this study, reliability is associated with plan quality evaluation. To increase reliability, the plan coding and coding guidelines were well prepared and pretested. It is necessary that it is pretested and revised several times before it is applied to the actual evaluation. The detailed coding guidelines for coding helped maintain reliability and prevent confusion. To assess the reliability of the plan evaluation, a Cronbach's Alpha[3] was tested. In this study, the Crombach's Alpha was 0.874 which is widely acceptable to be reliable.

4.6. Data Analysis and Multiple Regression Model

4.6.1. Data Analysis

Data analysis is composed of two steps. The first step is descriptive statistics to assess overall trend of flood property loss across the State and overall qualities of local comprehensive plans associated with flood mitigation policies. The quality of flood mitigation policies was discussed to show the overall quality of flood mitigation efforts and what kind of mitigation policy is often used. Plan quality scores were examined in

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[3] Cronbach's Alpha measures consistency among individual items by measuring how well each item in a scale is correlated with the sum of the remaining items. If Cronbach's Alpha is greater than 0.70, it is widely acceptable to be reliable.

the context of policy breadth and depth scores. The second step explained the influence of various factors on insured flood loss using an ordinary least squares (OLS) regression analysis.

4.6.2. Multiple Regression Model

This study employed a multivariate regression method based on Ordinary Least Squares (OLS) to test the hypothesis that the variance of flood loss will be affected by planning factors, biophysical attributes, built environment factor and socioeconomic factors.

Because there are a large number of independent variables compared to the sample size, it would be better to conduct the analysis on the block groups. This approach would present a more thorough investigation of factors as well as keep the number of independent variables in the regression model at their proper level (Brody, 2001). This study groups the variables in four blocks: planning, biophysical, built environment and socio-economic factors. At the beginning, the block group of planning factors was entered into the model and then, biophysical, built environment, and socio-economic factors were added separately into the planning factor by block. The final model included significant variables from each analysis.

This study uses the following model equation. The coefficients such as $\beta_1, \beta_2, \beta_3$ and β_4 are partial regression coefficients and represent unique effects of the specific independent variables on the dependent variable (FL) controlling for the other independent variables. For instance, β_1 is an independent influence of flood planning factors on flood property loss when we assume the other variables are controlled.

$$FL = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$$

Where, FL: Insured flood loss to property in a jurisdiction

α : Regression intercept
X_1: Planning factors
X_2: Biophysical factors
X_3: Built environment factors
X_4: Socio-economic factors

The regression models were analyzed through the following steps. First, a correlation analysis was conducted among the dependent variable and the independent variables to assess the preliminarily relationships. Second, to decide if the model is significant (in other words, if the model has accounted for a significant proportion of the variance), F-statistics were analyzed. To measure the proportion of the variance accounted for, the multiple coefficient of determination (Adjusted R square) was examined. Finally, a regression analysis was conducted to assess the influences of the independent variables on the dependents variable. In this step, we can assess the relative importance of each variable.

This study tested normality, multicollinearity, heteroskedasticity, independence and model specification to ensure that there were no violations of the OLS regression assumptions Also, as the study areas were randomly sampled and are not neighboring each other, spatial autocorrelation was not considered in this study. Some variables, particularly those selected from the survey, include a comparatively large number of missing cases; so missing value treatment is needed for the statistical models. This study employed mean substitution as a missing value treatment to prevent a substantial decrease in the sample size available for the analysis.

The regression models tested the impacts of planning, biophysical, built environment and socioeconomic factors on the log transformed annual average insured flood damage. Also, this study considered both the unstandardized coefficients and standardized coefficients (Beta). The unstandarized coefficients are useful to compare coefficients across equations and the standardized coefficients help to compare the explanatory power (relative importance) among different variables and help to seek the best predictor of flood damage.

5. TRENDS AND SPATIAL DISTRIBUTION OF FLOOD LOSS

The dependent variable in this study is losses caused by flooding events, thus requiring a clear understanding about flood loss statistics. As mentioned earlier, currently there are four major flood damage datasets with varied techniques, accuracy, accessible timeline and spatial scales. To better understand, flood loss, this section summarizes the flood loss datasets. Specially, I investigate the magnitude and trends of flood losses in the Unites States using four different data sources, and then I narrow down the examination of the trend of insured flood losses in Florida at county and community using National Flood Insurance Program data. This trend analysis helps to understand the impact of losses caused by floods and provides a base to develop strategies to effectively cope with flood problems in the future.

5.1. Historical Flood Loss Data

Currently, there are four flood loss[4] data sources which are easily accessible on the Internet: National Weather Service (NWS), reanalysis of NWS damage, SHELDUS and NFIP. The basic information of the four data sources is summarized in Table 5.1.

[4] Losses caused by natural hazards include both direct and indirect costs. Direct costs are related to immediate physical damage and repair costs caused by flooding events. Indirect costs include loss of business and personal income, reduction of property values, loss of tax revenue, psychological impact and ecosystem disturbance in an extended time period after a flood (Heinz Center, 2000). Many researchers suggest the need for data of both direct and indirect impacts. However, because indirect loss is very difficult for measure, current available flood loss estimates focus on direct losses such as property loss, crop loss and fatality. This study is focused only on direct costs.

Table 5.1. Flood Damage Data Sources

Source	Spatial Scale	Available Time Period (by Dec.2008)	Author/Available Info
National Weather Service (NWS) flood damage dataset	- National - State	1995-2007	- National Weather Service (NWS), Office of Climate, Water and Weather Services
Reanalysis of National Weather Service (NWS) flood damage dataset	- National - State - Basin	1926-2003	- Pielke, Roger A., Downtown, Mary W., Miller, Zoe Barnard (2002)
Spatial Hazard Events and Losses Database for the United States (SHELDUS) dataset	- National - State - County	1995-2007	- Hazard Research Lab at the University of South Carolina - Database of 18 natural hazards including floods. - Date, location, property and crop losses, injuries and fatalities.
National Flood Insurance Program (NFIP) dataset	- National - State - Jurisdiction (Community)	1969-2007 (1978-2007 data available on the internet)	- FEMA - Loss dollars paid, number of claims paid, policies in force, premium and coverage

Although each source provides a different level of data, all of them show flood damage at the national level, which indicates the longitudinal trend across the US. The NWS collects loss data through field offices, but the quality of flood loss estimate does depend on conditions of each field office. In addition, the goal of this agency is not to assess damage accurately, but to predict flood events which lead to loss (National Weather Service, 2004). The NWS provides flood loss estimate data at national, state and basin levels. The NWS and its predecessor, the U.S. Weather Bureau, have collected data from 1925 to the present. However, it is possible to access data on national and state levels only between 1995 and 2007 on the Natural Hazard Statistics website (http://www.weather.gov/os/hazstats.shtml). It is noteworthy that NWS loss estimates include only direct damage due to flooding that is caused by rainfall and/or snowmelt. It excludes flooding due to winds such as hurricane storm surges, tsunami activity and coastal flooding because "although they cause water inundation, they are not hydrometeorological events (National Weather Service, 2004; Pielke et al., 2002 p.2)."

Pielke, Downton and Miller reanalyzed the NWS flood damage estimates in 2002 through a project sponsored by National Science Foundation (NSF) and National Oceanic and Atmospheric Administration (NOAA). They tried to make the NWS data as complete and consistent as possible and the result was published on the website (http://www.flooddamagedata.org/national.html), and in several reports and journal articles. The data are available at national, state and basin levels from 1926 to 2003.

The Hazard Research Lab at the University of South Carolina offers the Spatial Hazard Events and Losses Database for the United States (SHELDUS) covering 1995 to 2007 (http://webra.cas.sc.edu/hvri/products/sheldus.aspx). This database includes 18 different natural hazards types and county level datasets. Also, it contains the beginning date, location (name of county and state), property and crop losses, injuries and fatalities. In particular, flood loss is derived from monthly storm data publications, which are prepared by the National Climatic Data Center (NCDC), the National Environmental Data and Information Service (NESDIS), NOAA and NWS (Hazards Research Lab, 2006). The "Storm Data" published by the NCDC lists flash flood and river flood events which are associated with heavy rainfall and/or snowmelts. This includes floods occurring near streams as well as urban flooding. River flooding occurs along major rivers or tributaries. Floods in SHELDUS data also did not include coastal flooding caused by winds. These data are quite similar to NWS flood damage data (see in Figure 5.1). Hurricanes/storms and coastal hazards which can cause coastal flooding are separately classified in SHELDUS. This database is beneficial in that county level data are available and include diverse information about various natural hazards.

Since 1968, NFIP has provided flood insurance to residents and FEMA has publicized the statistics for insured loss, policies in force and premiums by year. These data are composed of accurate and precise figures, not estimates. Due to the characteristics of "insurance," these data only represent *insured* losses. NFIP flood insurance includes its own requirement that the community's voluntary participation conditioned on a resident's individual purchase. The community needs to enforce mitigation requirements in order to be accepted in the program. Because of these attributes, NFIP data do not reflect all flood losses and its representative degree depends on individual and community participation rates. In the beginning stage of this program, participation rates were very low, but they have steadily increased. Nearly 20,000 communities across the United States and its territories are voluntarily participating in this program (FEMA, 2007b). Also, these data are both accurate and reliable and the statistics are available at national, state and community levels between 1978 and 2007.

In this program, "flood" is defined as:

"A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties (at least one of which is your property) from overflow of inland or tidal waters, from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow (FEMA, 2002 p.23)."

This definition shows that insured losses paid by NFIP cover the inundation from tidal water as well as rainfall and this is distinguishable from other data.

Overall, each data source counts losses in different ways, using different time spans and different spatial scales. However, they all include nationwide flood losses. In an attempt to understand the seriousness of losses caused by floods, the following section 5.2 examines the historical trend in flood losses across the United States using the above mentioned data.

5.2. Trends of Flood Loss in the United States

Examining historical trends in flood loss provides a snapshot for addressing longitudinal status and provides insights for anticipating future trends. Figure 5.1 depicts the overall tendency of flood losses (focusing on property damage) in actual dollars between 1960 and 2007 using four available databases. The annual flood losses fluctuate, but the historical trend from 1960s to 2000s indicates an apparent damage increase between $86 million per year and $16 billion per year with occasional catastrophic experiences. FEMA insurance claim data show that the number of policies in force increased 3.8 times from 1978 to 2006 and average annual losses expanded from $147 million to $17 billion between 1978 and 2006. Insured losses are mostly lower than flood losses from other data sources as I expected, but NFIP reported over $17 billion payments for policy holders in 2005. This is a much higher value than other data sources for that year. The main reason stems from the different definitions of losses from floods. NFIP insurance includes coastal flooding caused by storm surges while other data sources do not. When hurricane, Katrina hit the U.S. coastal areas in 2005, NFIP counted the property damage from coastal flooding incurred by the huge hurricane while other agencies had a different category for hurricanes/storms. These two different definitions caused a large variation between NFIP insured property damage and damages from other data sources in 2005. Also, it influenced the accounting of losses throughout the entire time period examined.

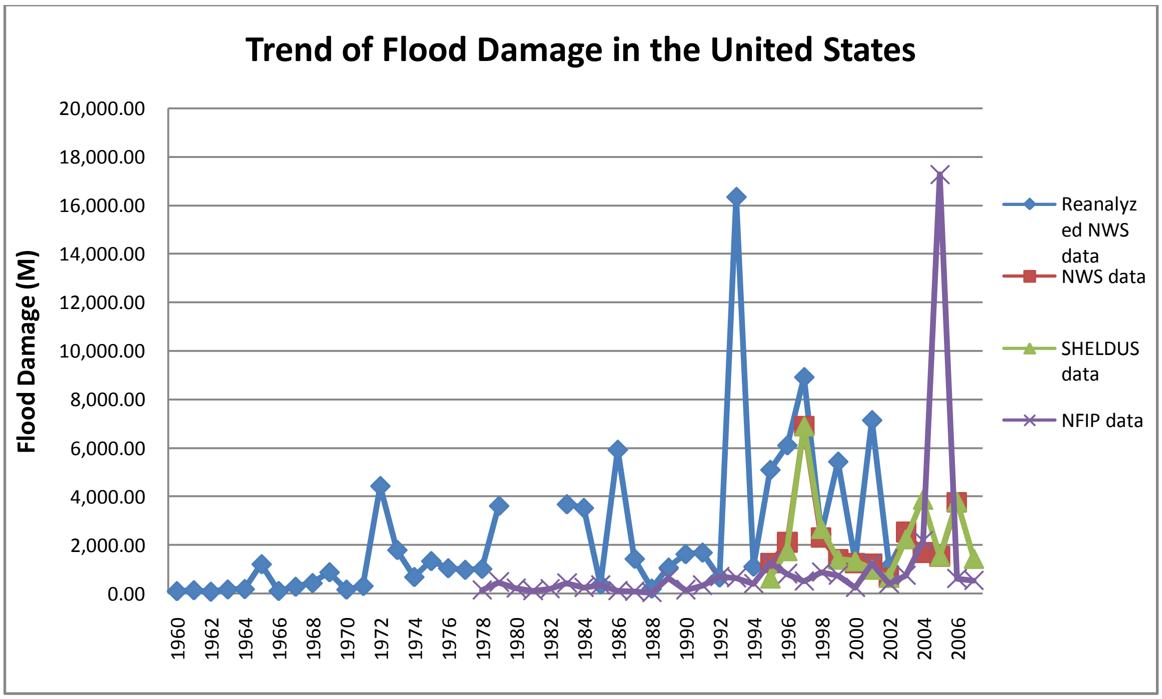


Figure 5.1. Trends of Flood Damage in the United States

Due to the inconsistency among the four databases stemming from different methodologies of data collection, definition of flood loss, time span and reliability, it is difficult to identify the trend of flood damage in one sentence. However, it is fairly obvious that in the long term, flood damage has increased with catastrophic flooding events such as the 1993 Midwest flood and 2005 Hurricane Katrina. When strong floods occur in highly populated and developed areas, they tend to become catastrophic and cause huge losses. In addition, where the community is not well prepared for disasters, the impacts are magnified.

Here, I repeat some researchers' (Mileti, 1999; Pielke et al., 2002) arguments that the techniques and models currently in hand are insufficient; thus further and accurate loss estimation is demanded. Also, they proposed the need for an agency which is able to collect, manage and release reliable and official flood damage datasets. Accurate and reliable data can have a huge influence on research to provide a basis for improving the current status and supporting better decision making. Furthermore, considering that flood is a weather-related and comparatively site-specific natural hazard, data are needed on regional and local scales to directly influence local policy makers and planners responsible for developing effective policies for their community.

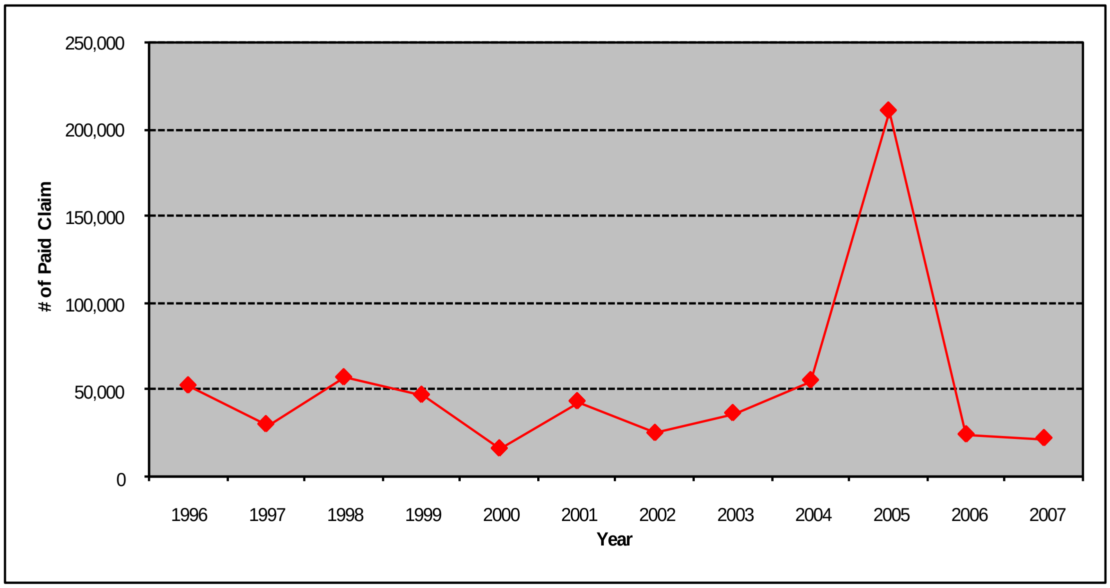
This study investigates the relationship between local flood mitigation policies and flood damage; thus the flood data should be reliable and precise at the jurisdiction level. To satisfy these conditions, I chose the insured loss data collected from FEMA through NFIP as a main database for the dependent variable. This database is most proper in terms of data validity and spatial scale (jurisdiction level). The following section 5.3 provides a chance to be familiar with the insurance data and investigate NFIP insured losses at national and state levels during 1996-2007. The spatial distribution of flood loss in the study area, Florida, is then examined in the following step.

5.3. Trends of Insured Flood Loss at National and State Levels

As has been noted, this study employs claim payments made by the National Flood Insurance Program (NFIP) because of data accuracy and data feasibility at the jurisdictional level.

During the twelve years (1996-2007), NFIP has paid 623,220 claims with total claim payments of $26,335,640,019. NFIP average annual loss is approximately $2 billion ($2,194,636,668.25) with an average claim payment of $42,257.

As shown in Figure 5.2, particularly in 2005, NFIP paid 211,019 claims with loss payments of over $17 billion ($17,283,465,887.48) because of continuing significant flooding events (Hurricane Dennis, Hurricane Katrina, Hurricane Rita, Tropical Storm Tammy, and Hurricane Wilma). Flood loss for 2005 was over 66% of the total insured losses during 1996-2007. Hurricane Katrina, which was the most devastating disaster in United States history, created 165,618 claims with total payments of $16,016,992,444 and an average claim payment of $95,813.



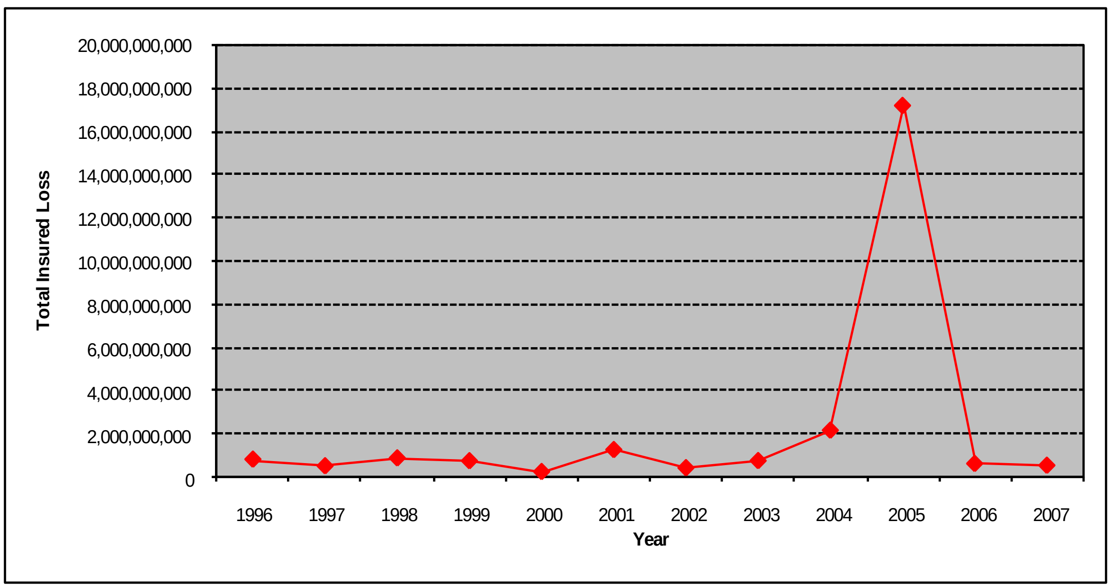


Figure 5.2. Number of Claims and Insured Losses by Year, 1996-2007

Under NFIP, insurance provides coverage for three parts: *Building*, its *Contents* and *Increased Cost of Compliance (ICC)*. ICC coverage applies to a building which has been declared substantially damaged or repetitively damaged, where there are increased costs to comply with state or community floodplain management laws or ordinances after a flood. Generally, ICC helps pay for the cost of building elevation, relocation, demolition or floodproofing. This coverage can be provided in addition to building or contents coverage for actual physical damages but it cannot exceed $20,000 (FEMA, 2002). Total insured loss is the sum of the three payments.

The following investigates US insured flood damage by state between 1996 and 2007. GIS maps help to describe the changes in longitudinal flood loss trends. Flood losses paid by NFIP varied widely across states. Tables 5.2 and 5.3 show the top ten states and lowest ten states in accumulated property losses paid by NFIP from 1996 to 2007. Due to the impact of Hurricane Katrina in 2005, Louisiana reported the largest amount of loss (over $13 billion) in the United State with Mississippi (over $2 billion), Florida (over $2 billion), Texas (over $1.8 billion) and Alabama following. The states with the highest flood damages are clustered on the Gulf Coast (Figure 5.3). Also, some states located on the Atlantic coast (North Carolina and Pennsylvania) also reported a comparatively high level of loss. States with lower damage were found in the central and north/or west regions. Insured losses were less than $1 million in Wyoming and Utah; Wyoming had only $323,699 of insured property damage during 1996-2007 and Utah reported only $489,820 of insured damage. Total insured loss for Louisiana was over five times the second damaged state, Mississippi, and approximately 43,000 times the lowest amount of loss in Wyoming.

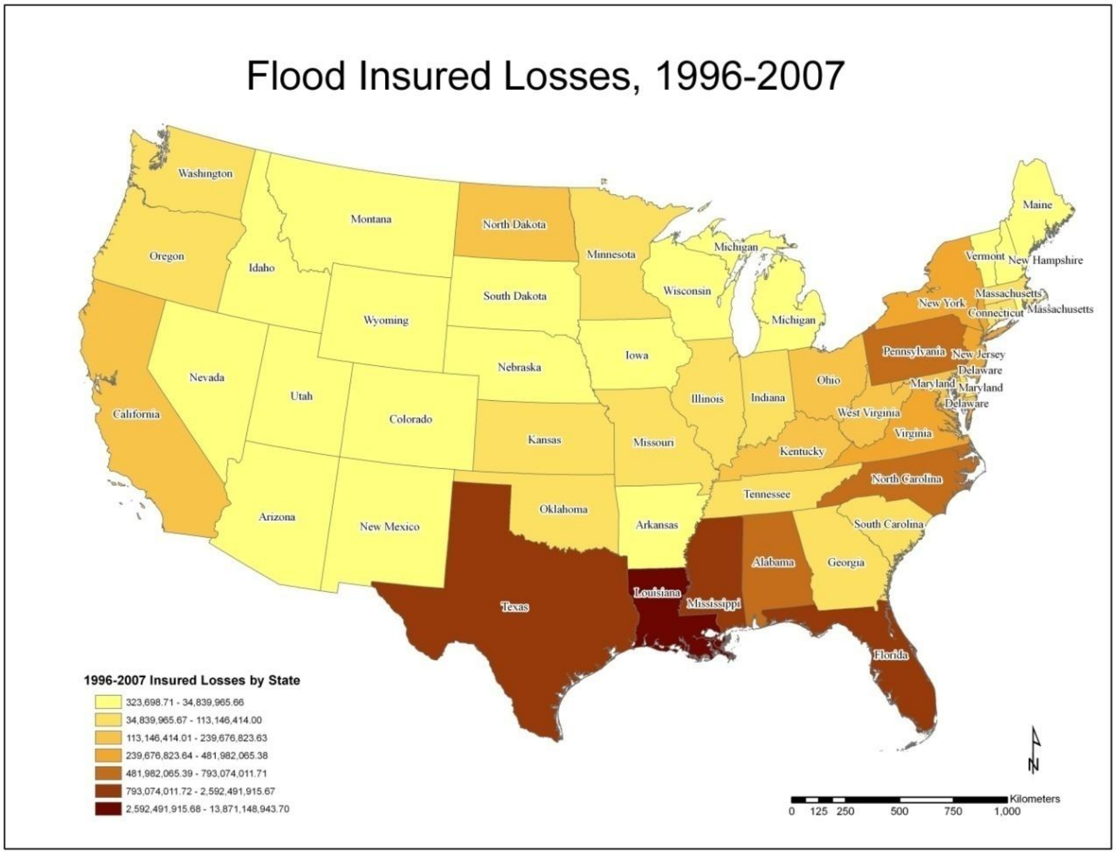


Figure 5.3. Flood Insured Losses by State, 1996-2007

Table 5.2 . Top 10 States in Accumulated Insured Flood Losses, 1996-2007

Rank	State	Number of Claims	Pay_BLDG	Pay_CONT	Pay_ICC	Total Insured Losses
1	Louisiana	178,330	10,908,375,062	2,866,401,834	96,372,048	13,871,148,944
2	Mississippi	26,169	1,988,274,911	584,913,214	19,303,790	2,592,491,916
3	Florida	90,292	1,940,391,403	492,264,970	17,649,393	2,450,305,765
4	Texas	63,665	1,431,653,839	451,898,482	8,587,609	1,892,139,931
5	Alabama	18,906	651,389,126	133,031,707	8,653,179	793,074,012
6	North Carolina	35,056	556,420,522	96,200,694	10,066,026	662,687,242
7	Pennsylvania	28,778	499,760,362	140,541,990	5,792,382	646,094,734
8	New Jersey	24,085	372,688,284	107,962,810	1,330,972	481,982,065
9	Virginia	18,204	293,045,906	51,527,900	14,535,561	359,109,367
10	New York	16,114	241,483,879	53,200,937	924,696	295,609,512

Table 5.3. Lowest 10 States in Accumulated Insured Flood Losses, 1996-2007

Rank	State	Number of Claims	Pay_BLDG	Pay_CONT	Pay_ICC	Total Insured Losses
45	Colorado	487	4,445,135	568,528	55,802	5,069,465
46	Nebraska	415	3,851,948	761,607	0	4,613,555
47	Idaho	286	3,514,591	640,324	0	4,154,916
48	Vermont	264	3,033,284	518,491	0	3,551,775
49	Montana	433	2,915,458	285,624	0	3,201,082
50	Alaska	107	1,572,111	136,827	20,000	1,728,938
51	Guam	90	1,148,600	342,856	0	1,491,456
52	District of Columbia	42	1,252,816	92,371	0	1,345,187
53	Utah	62	441,732	48,088	0	489,820
54	Wyoming	39	322,212	1,486	0	323,699

Figure 5.3 illustrates the annual insured losses by state during 1996-2007. The top five states in insured loss by year and significant flooding events by year are presented in Appendix A and B. In 1996, North Carolina, Pennsylvania and Florida incurred the most insured flood damage caused by Hurricane Fran, Josephine and northwest and northeast floodings. The 1997 insured loss map shows that the midwest states of North Dakota, Kentucky and Minnesota experienced the highest level of damage caused by upper midwest and south central floods. In 2000, Florida suffered from flooding events and reported the highest damage of $167 million while comparative overall losses across the United States were much smaller. As mentioned above, 2005 was the year with the largest NFIP payments in U.S. history because of several hurricane events, including Hurricane Katrina on the Gulf Coast. States located along the Gulf Coast (Louisiana, Mississippi, Florida and Alabama) had a huge amount of property damage, and they all ranked among the top five states in insured damage. In particular, Louisiana reported over $13 billion of insured property damage, which is the

largest payment in US history. This year's (2005) damage was almost 97% of the entire damage for twelve years (1996-2007) in Louisiana.

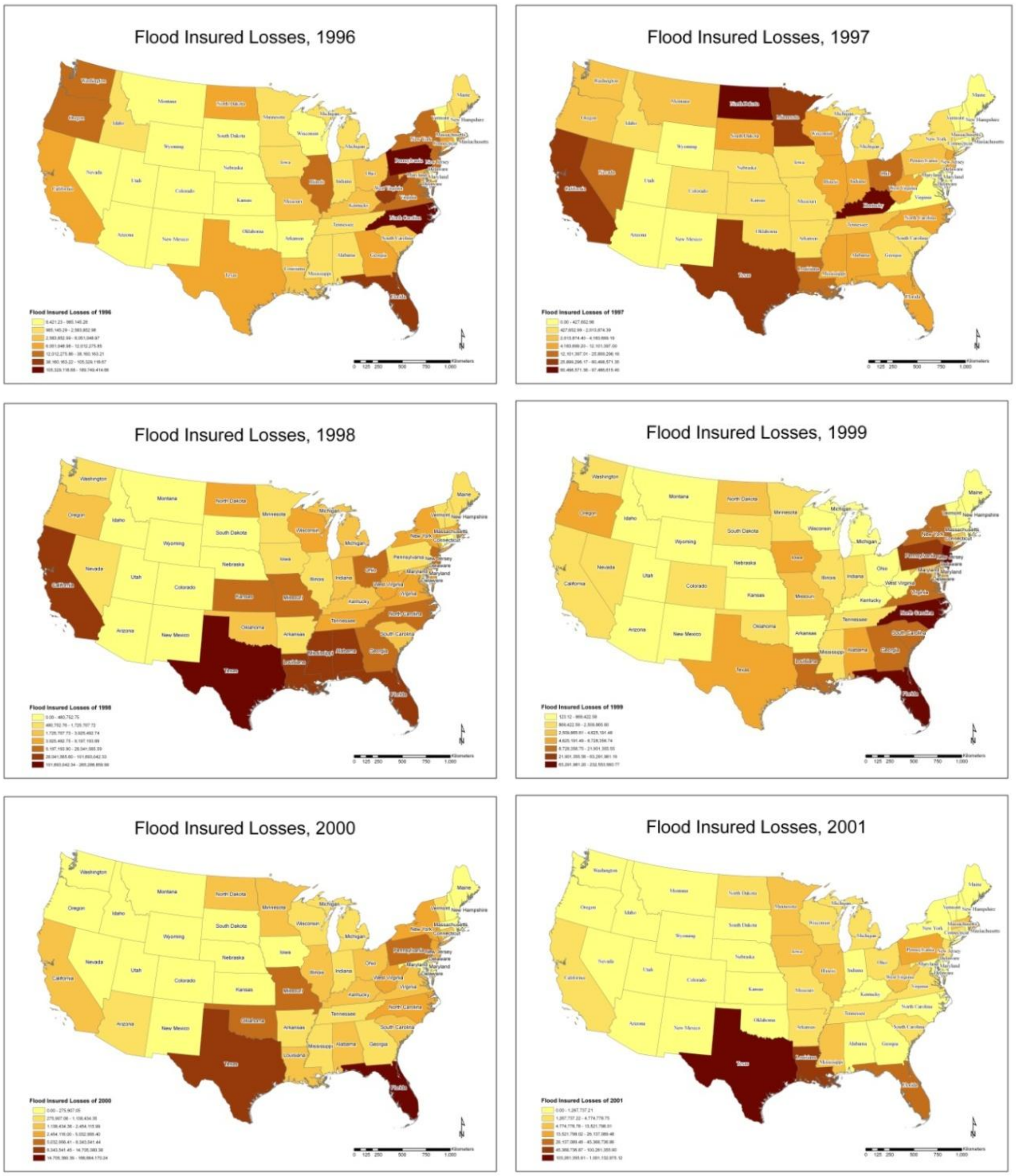


Figure 5.4. Flood Insured Loss Trends by State

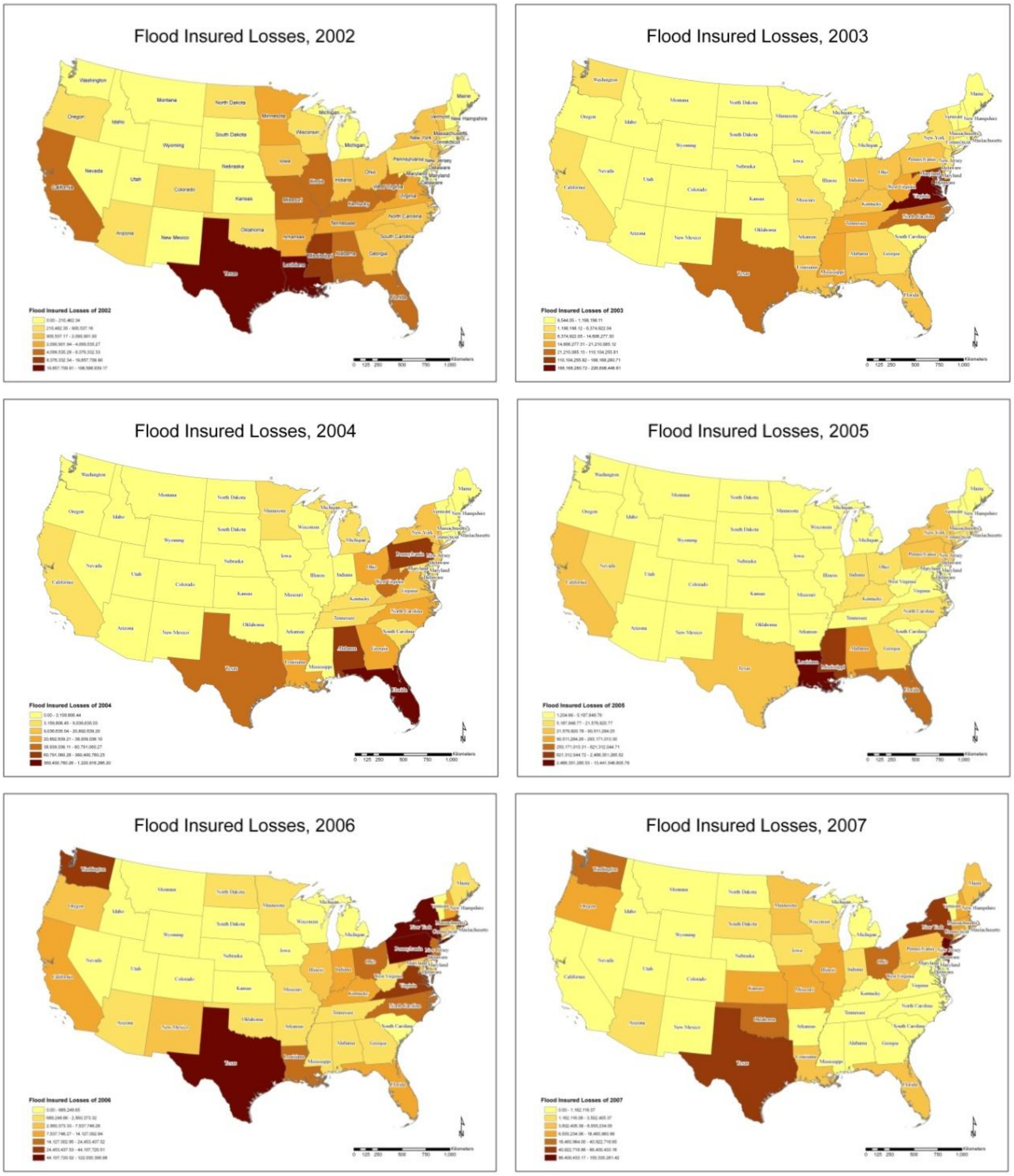


Figure 5.4. Continued

Overall, insured flood losses varied widely from over $13 billion in Louisiana to about $0.3 million in Wyoming between 1996 and 2007. With Louisiana and

Mississippi, which experienced catastrophic damages in 2005, coastal states such as Texas and Florida have encountered repeated losses from floods; so they often ranked among the higher states with flood damage by year. The US coastal zone has experienced increasing concentrations of population and infrastructure (Crossett et al., 2004) and this trend has accelerated increased insured damage in these areas. Considering that the impacts of natural hazards can be reduced if proper mitigation policies are implemented, these coastal states should consider more effective mitigation policies. For example, Florida, the fourth in insured flood losses, contains large low lying coastal zones and high population within these zones. Also, the state of Florida has become known as a leader in hazard mitigation policies and comprehensive planning efforts. Thus, this state is ideal for my study which examines the status of current flood mitigation policies and their effectiveness. The next sub-section, focusing on the state of Florida, investigates the spatial distribution and pattern of insured property losses caused by flooding through both descriptive and hotspot analysis.

5.4. Trends of Insured Flood Loss in Florida

5.4.1. Insured Loss and Per Capita Insured Loss

Florida has over 18 million residents and 80 percent of them live or work on or near coastlines or rivers or in floodplains (Florida Division of Emergency Management, 2008). In addition, this state has experienced a rapid increase in coastal population and frequent coastal storm events. These circumstances induced 95 percent of all Florida communities to participate in the National Flood Insurance Program. As of April 30, 2007, over 2,181,930 policies were issued in Florida - almost 41% of the total policies in the United States (Florida Division of Emergency Management, 2008). This statistic indicates that Florida is a leader among states that actively participate in both the NFIP and flood mitigation efforts.

Table 5.4 presents the insured flood losses in Florida and compares them with the US average. The number of claims between 1996 and 2007 in Florida was more than 14% of the entire US claims. Insured flood losses were over 9% (over $2 billion) of $26 billion in US total losses. Florida incurred a comparatively large proportion of annual US losses in 2000 and 2004. In 2000, Florida suffered damage of $166 million in continuing floods which was almost 67% of US damage in that year. In 2004, the insured flood loss in Florida was over $1 billion due to several hurricanes - Hurricane Charley, Frances, Ivan and Jeanne – and was more than 56 % of the entire US losses. Between 1996 and 2007, average annual insured flood loss in Florida was about $200 million.

Based on NFIP insurance data between 1996 and 2007, a resident living in Florida suffered almost $153.31 in loss - 1.6 times that of the US insured flood loss per capita ($93.58 per capita) during the same time period (Table 5.5). This result indicates that Florida experienced significantly higher annual property loss from floods than other states. Particularly, Florida reported significantly higher insured property damage per capita ($76.39) in 2004, paralleling total insured losses and the number of claims.

Table 5.4. Trends of Insured Flood Loss in Florida and U.S.

Year	#of Claims, Florida (%)	# of Claim, US (%)	Insured Loss, Florida, $ (%)	Insured Loss, U.S., $ (%)
1996	6,813 (12.93%)	52,679 (100%)	105,329,118.67 (12.72%)	827,790,157.25 (100%)
1997	1,478 (4.87%)	30,338 (100%)	12,101,397.00 (2.33%)	519,505,659.47 (100%)
1998	7,918 (13.81%)	57,350 (100%)	101,693,042.33 (11.48%)	886,112,489.15 (100%)
1999	15,637 (33.10%)	47,245 (100%)	137,909,784.11 (18.27%)	754,763,257.36 (100%)
2000	10,157 (62.08%)	16,361 (100%)	166,664,170.24 (66.21%)	251,711,107.99 (100%)
2001	3,330 (7.64%)	43,560 (100%)	45,368,736.86 (3.56%)	1,273,664,923.02 (100%)
2002	759 (3.00%)	25,287 (100%)	8,376,332.33 (1.94%)	430,750,921.70 (100%)
2003	1,125 (3.06%)	36,716 (100%)	14,005,229.38 (1.84%)	760,686,136.99 (100%)
2004	22,075 (39.65%)	55,668 (100%)	1,220,916,286.20 (56.10%)	2,176,325,247.19 (100%)
2005	20,076 (9.51%)	211,019 (100%)	621,312,044.71 (3.59%)	17,283,465,887.48 (100%)
2006	524 (2.14%)	24,458 (100%)	10,295,708.93 (1.64%)	627,074,582.73 (100%)
2007	400 (1.79%)	22,305 (100%)	6,333,914.68 (1.16%)	543,789,648.63 (100%)
Total	90,292 (14.49%)	623,220 (100%)	2,450,305,765.44 (9.30%)	26,335,640,018.96 (100%)

Table 5.5. Insured Flood Loss per Capita in Florida and U.S.

Year	Insured Loss per capita (Florida, $ per capita)	Insured Loss per capita (U.S., $ per capita)
1996	6.59	2.94
1997	0.76	1.85
1998	6.36	3.15
1999	8.63	2.68
2000	10.43	0.89
2001	2.84	4.53
2002	0.52	1.53
2003	0.88	2.70
2004	76.39	7.73
2005	38.87	61.41
2006	0.64	2.23
2007	0.40	1.93
Total	153.31	93.58

*2000 census population was used.

Community and individual participation in NFIP are voluntary, but community participation is a condition of individual purchase by community residents. From 1996 to 2007, Florida experienced insured damage of $2,450,305,765 as shown in Table 5.4. Of a total of 368 participating communities in Florida, Santa Rosa County received the largest amount of insured damage of $358,756,314.25 and Escambia County, the second largest damaged community, suffered damage of over $300 million (Table 5.6). The summed damage of the top 20 communities was 77 % of the total damages in Florida.

Table 5.6. Top 20 Communities of Insured Flood Loss, 1996-2007

Order	Name of Community	Total Insured Damage (1996-2007), $
1	Santa Rosa County	358,756,314.25
2	Escambia County	308,462,517.61
3	Miami-Dade County	242,016,493.76
4	City Of Key West	169,768,976.56
5	Monroe County	168,555,134.48
6	Pensacola Beach-Santa Rosa Island Authority	137,639,644.95
7	Okaloosa County	86,111,111.80
8	City Of Miami	54,391,475.53
9	Lee County	50,569,846.33
10	City Of Destin	33,862,328.56
11	City Of Marathon	33,799,119.08
12	St. Lucie County	31,516,653.01
13	Walton County	30,031,646.60
14	City Of St. Petersburg	29,827,920.66
15	City Of Pensacola	28,819,799.57
16	City Of Vero Beach	27,043,237.71
17	City Of Fort Pierce	25,406,630.96
18	City Of Gulf Breeze	24,530,956.25
19	Indian River County	23,691,461.87
20	Martin County	22,679,676.34
Mean		94,374,047.29

Generally, communities with a larger population[5] will have a larger amount of insured damage. This hypothesis is likely to apply to the top 20 communities. The average population of the top 20 communities was 156,966 when excluding Pensacola Beach-Santa Rosa Island authority; meanwhile the average population of all 368 communities was 42,990. However, population is not in the only factor explaining insured damage. The following sections investigate this issue in detail.

As shown in Tables 5.6 and 5.7, only two counties (Monroe County and Santa Rosa County) in the top communities for total insured damage also rank among the top 20 communities in per capita insured losses. The mean of the 20 top communities in per capita insured losses is $3,141.89 - 20 times the average per capital damage of Florida. A majority of communities among the 20 top communities in per capita insured losses are located on the coasts or on islands. For example, the City of Key West experienced the highest per capita insured damage of $6,663. The Cities of Key Colony Beach, Layton, Marathon and Monroe County are clustered on the southern Florida peninsula; these areas are well known to be vulnerable and susceptible to storms and flooding. Another noteworthy coastal cluster of per capita loss communities is near Pensacola Bay and Choctawhatchee Bay northwest of the Florida peninsula. This cluster includes the cities of Gulf Breeze, Destin, Shalimar and Santa Rosa County.

[5] The population of a county as a jurisdiction is not the entire county population including all populations of municipalities, but only includes residents living in unincorporated areas within the county boundary. The Office of Economic & Demographic Research provides Florida population numbers for counties and municipalities and this study employed their population data which was estimated based on the 2000 census population.

Table 5.7. Top 20 Communities of Insured Flood Loss per Capita, 1996-2007

Order	Name of Community	Total Insured Damage, $	Population	Insured Damage per capita (1996-2007), $
1	City of Key West	169,768,976.56	25,478	6,663.36
2	Monroe County	168,555,134.48	36,036	4,677.41
3	City of Key Colony Beach	3,645,295.92	788	4,626.01
4	Town of St. Marks	1,191,773.62	272	4,381.52
5	City of Gulf Breeze	24,530,956.25	5,665	4,330.27
6	Town of St. Lucie Village	2,299,578.74	604	3,807.25
7	Santa Rosa County	358,756,314.25	104,454	3,434.59
8	City of Marathon	33,799,119.08	10,255	3,295.87
9	Franklin County	19,517,259.32	6,192	3,152.01
10	City of Destin	33,862,328.56	11,119	3,045.45
11	Town of Horseshoe Beach	618,015.93	206	3,000.08
12	Town of Shalimar	2,152,044.16	718	2,997.28
13	Town of Medley	3,154,337.65	1,098	2,872.80
14	Town of Yankeetown	1,427,689.88	629	2,269.78
15	Town of Redington Beach	3,454,464.80	1,539	2,244.62
16	City of Cedar Key	1,566,952.37	790	1,983.48
17	Everglades City	778,692.71	479	1,625.66
18	City of Vero Beach	27,043,237.71	17,705	1,527.44
19	City of Layton	270,458.12	186	1,454.08
20	Town of Sewalls Point	2,819,376.44	1,946	1,448.81
Mean		42,960,600.33	11,308	3,141.89

5.4.2. Spatial Distribution of Insured Losses

The descriptive analysis of total insured losses and per capita losses provide a general understanding about Florida's insured damage distribution. This section 5.4.2 examines the spatial distribution of insured losses at the county level[6]. Particularly, I employ hotspot analysis using GeoDa software. Hotspot analysis shows a quick snapshot of overall spatial patterns and hotspot areas where there are high levels of flood damage in comparison to surrounding areas. Figure 5.5 depicts distribution of the insured losses at the county level. It is very clear that coastal counties have experienced much higher levels of flood damage than inland counties. The spatial distribution indicates that inland communities with lower levels of damage are surrounded by coastal counties with high levels of damage. Escambia County and Santa Rosa County of northwest Florida and Monroe County and Miami-Dade County of southern Florida have the highest levels of insured flood losses - over $370 million from 1996-2007. These two clusters are consistent with the above community analysis results. Many top twenty communities for insured damage or per capita insured damage are located within these counties' boundaries. Again, local flood planners and decision makers in these areas should give more attention to floods in their development and policy decisions. Furthermore, state government has to support and encourage local governments in these vulnerable zones to develop and implement flood mitigation policies.

[6] The insurance claim dataset acquired from NFIP includes the number of insurance claims and insured damage. This data is collected at the jurisdiction level which is the participating unit. In addition, this data includes county name and zip code of specific claims. For spatial analysis, insured losses were mapped at the county level.

Okaloosa County, Lee County, Pinellas County, St. Lucie County, Broward County and Indian River County are the second largest group of jurisdictions which experienced over $50 million in losses. On the contrary, inland counties such as Glades, Gadsden and Jefferson Counties reported receiving less than $1 million in insurance payments from 1996-2007.

In addition, this study asks if there are statistically significant hotspots and if there is spatial autocorrelation with insured flood damage using GeoDa (Version 9.5, Spatial Analysis Laboratory, 2008) which has functions to measure Moran's I and Local Index of Spatial Association (LISA). The calculated Moran's I spatial autocorrelation statistic for insured flood damage using Rook Contiguity spatial weights was 0.6490 indicating a strong positive spatial autocorrelation. This result provides evidence that spatial autocorrelation may impact the analysis of insured damage in Florida if research is focused on the entire state. But, the study jurisdictions of this research were randomly sampled and were not adjacent to each other; so this study was not affected by spatial autocorrelation.

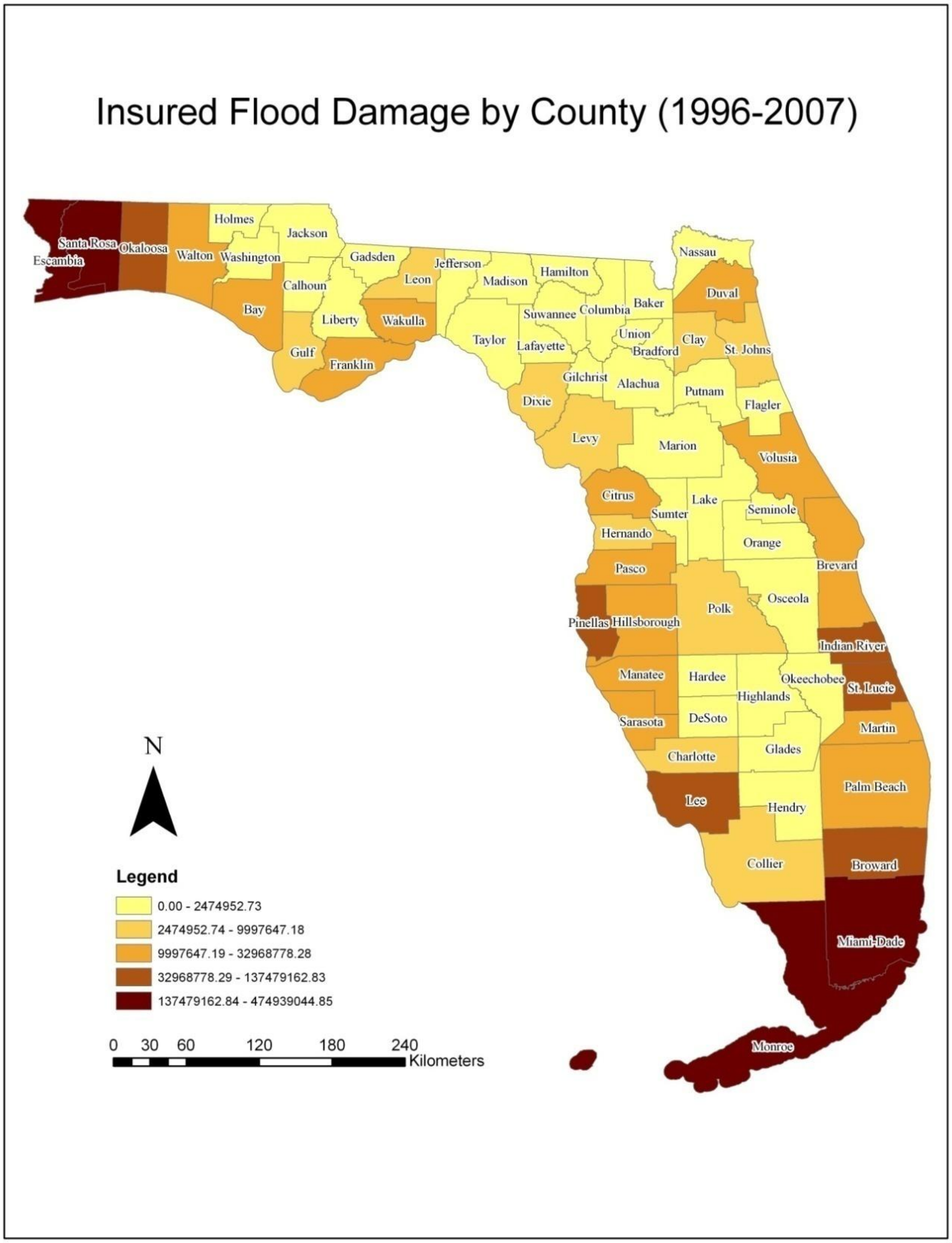


Figure 5.5. Insured Flood Losses by County, 1996-2007

Local spatial patterns of autocorrelation can be described by a LISA map which shows those locations with a significant Local Moran statistic classified by type of spatial correlation as shown in Figure 5.6. The high-high and low-low scores suggest clustering of similar values, whereas the high-low and low-high locations indicate spatial outliers. “Cool spots” of low-low clusters (low flood damage in a low damage neighborhood) are located in inland areas. A cool spot cluster consists of Madison, Suwannee, Columbia, Union, Bradford and Alachua Counties. Highlands County is another cool spot surrounded by low damage neighbors. In contrast, there exist two “hotspots” of high-high clusters (high flood damage in a high damage neighborhood from floods) on the Florida peninsula. The first cluster of hotspots includes Escambia, Santa Rosa and Okaloosa Counties in northwest Florida. These counties have experienced high flood damage; they are also surrounded by comparatively high flood damage neighborhood counties. The other hotspot cluster is the southern Florida cluster including Miami-Dade County and Monroe County. These counties mostly include low lying lands and islands with numerous vacation homes built on the beaches. A spatial outlier of low-high was significant in the LISA analysis. Collier County had a comparatively lower amount of flood damage but its neighborhood counties suffered high property damage from flooding.

The descriptive spatial distribution analysis showed an overall snapshot regarding flood damage in Florida. The next section details specific flood mitigation policies incorporated in local planning.

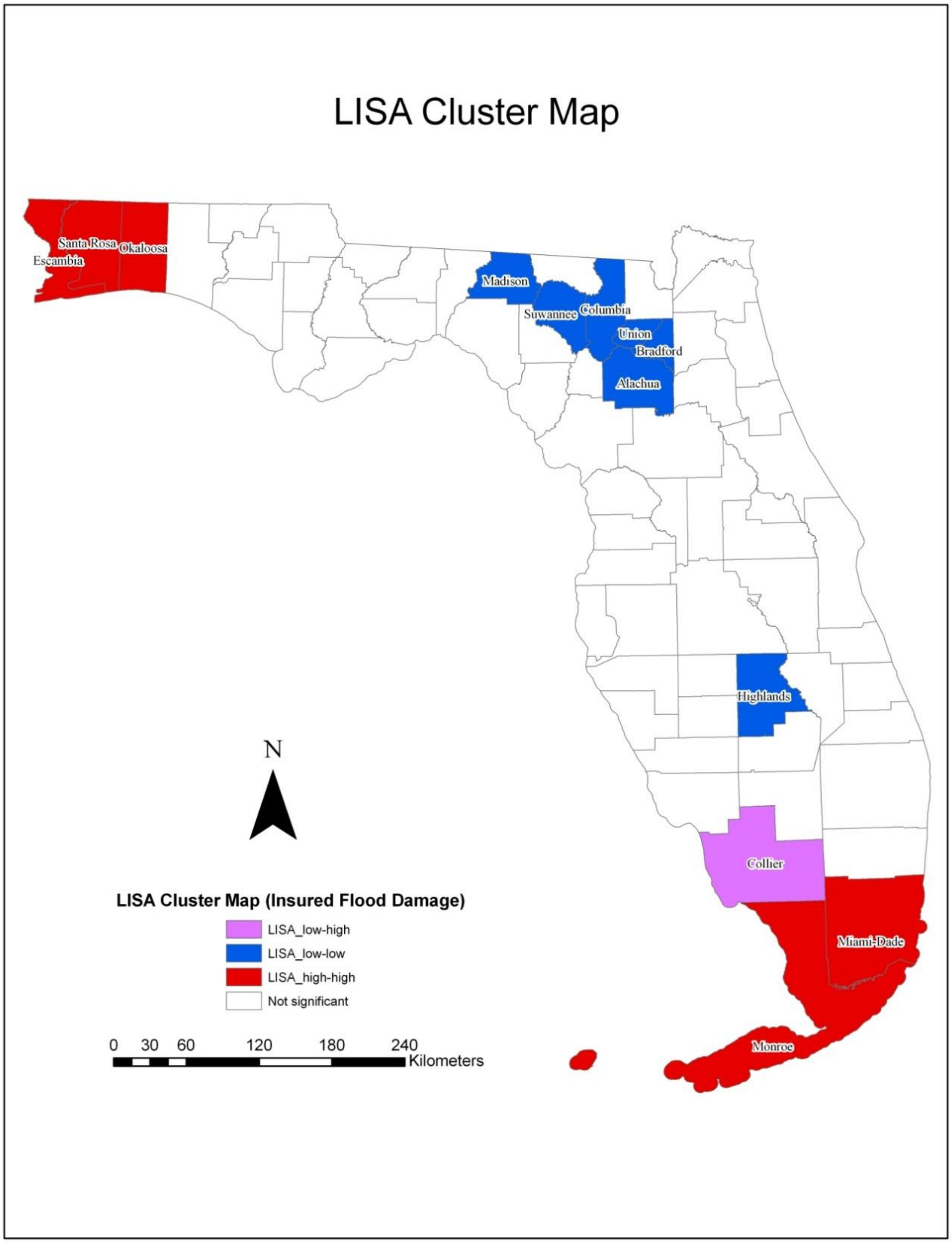


Figure 5.6. Hotspot Analysis in Insured Flood Damage

6. QUALITY OF FLOOD MITIGATION POLICIES IN LOCAL COMPREHENSIVE PLANS

Losses caused by natural disasters such as floods are greatly influenced by past and currently implemented hazard mitigation polices. This section evaluates a sample of plans, examines flood mitigation policies and analyzes the strengths and weaknesses of jurisdictions in incorporating flood mitigation policies in their plans. In addition to assessing overall plan quality, this section reveals the degree to which flood policies are addressed by calculating policy-based descriptive statistics (policy breadth, policy depth 1 and 2).

As mentioned earlier, the sample of plans was selected based on survey results for 59 jurisdictions in Florida reported flood experience during the last five years. To satisfy the conditions of the statistical model, comprehensive plans should be adopted and implemented before the period of insured flood damage (2003-2007). Thus, of 59 jurisdictions, six plans developed and adopted after 2004 were excluded in the analysis. Overall, this study analyzed 53 local comprehensive plans.

The following sub-section presents a detailed analysis of flood mitigation policies adopted in local comprehensive plans. The sub-section is broadly divided into three parts. The first part presents the overall assessment of all plans as well as a comparison of coastal and non-coastal communities' comprehensive plans. The detailed policy quality is then examined through both breadth and depth analysis. The third part assesses the degree to which each local community adopted flood mitigation policies in the comprehensive plan. As mentioned earlier, the scale for evaluation ranges from 0 to 2; this coding explains how much detail is mentioned in the plan of a specific policy. Greater detail and specific information or strong terms are generally associated with higher quality.

6.1. Flood Mitigation Policies in Local Comprehensive Plans

Generally, a local comprehensive plan is composed of two parts; 1) data and analysis, and 2) goals, objectives and policies. "Data and analysis" provides a foundation and basis for the formulation of goals, objectives and policies by indicating current status and problems of the local community. This study focuses only on policies of the second part, "goal, objectives and policies." Plan evaluation was conducted against the protocol which was developed based on the literature review.

Florida mandates local comprehensive plans, which contain elements of future land use, housing, transportation, infrastructure, conservation, recreation and open space, intergovernmental coordination, and capital improvement. In addition, Florida requires coastal jurisdictions to include a coastal management element in their plans. Flood mitigation policies are mainly incorporated in coastal management, land use, conservation and infrastructures (storm water management) elements. Sometimes, recreation and open space and capital improvement elements include some flood related policies.

6.1.1. Flood Mitigation Policy Quality

The developed evaluation protocol is categorized into 12 components which have been broken into 54 specific flood policies. The number of policies associated with each component varies from two to ten policies. Some components such as “general policy” and “insurance tool” have two specific flood mitigation policies, while “structural tool” includes ten detailed structural flood management policies.

Table 6.1 displays the scores of each policy component and the overall quality of the sampled plans. The mean score for total flood mitigation policy quality is 38.55 points, which represent 35.69% of possible points. This mean score is not very high and it can be inferred that sample jurisdictions have not been able to effectively incorporate flood mitigation policies into their local comprehensive plans. Also, the qualities of flood policy varied considerably across the 53 jurisdictions (Standard Deviation = 12. 58, Min. = 6 and Max. = 66). In addition to the overall quality, the mean scores of the components have wide variations. For example, “general policy” component earned 3.30 points which represent 82.55% of the points possible for this component. This result indicates that local jurisdictions have made relatively strong efforts to include “discourage development in floodplain areas” and “consistency with other regulation, laws and plans related to flood management.” In contrast, the average score for “incentive-based tool/taxing tool” was only 0.42 points which yields only 6.92% of the possible maximum score of 6 points. This fairly low score demonstrates a lack of attention to incentive-based or tax-based flood mitigation tools by local governments. “Public facilities/infrastructure,” “emergency/recovery preparedness” and “natural resource/sensitive area protection" received over 50% of possible points. "Land use and zoning tool," "site design tool," and "building standard tool" received less than 50% of their possible maximum scores. On the other hand, "insurance tool" received 29.72% and "structural tool" earned 22.64% of possible scores. Even though "awareness/education tool" is known as an inexpensivebut effective measure, this component did not receive enough attention - less than 20% of the possible score. Furthermore, "acquisition tool" received relatively less attention as well as "incentive-based/taxing tool," which earned only 17.55% of the possible maximum score.

Table 6.1. Flood Mitigation Quality Assessment

Component	# of Policies	Mean Score (%)	Min.	Max.	Standard Deviation	Possible Max. Score (%)
General policy	2	3.30 (82.55%)	0	4	1.14	4 (100%)
Land use and zoning tool	5	4.34 (43.40%)	0	8	1.92	10 (100%)
Site design tool	5	4.25 (42.45%)	0	9	2.28	10 (100%)
Building standard tool	3	2.75 (45.91%)	0	4	1.24	6 (100%)
Acquisition tool	5	1.75 (17.55%)	0	7	1.63	10 (100%)
Incentive-based tool/taxing tool	3	0.42 (6.92%)	0	2	0.66	6 (100%)
Insurance tool	2	1.19 (29.72%)	0	4	1.18	4 (100%)
Structural tool	10	4.53 (22.64%)	2	9	1.74	20 (100%)
Awareness/ Educational tool	7	2.74 (19.54%)	0	13	2.24	14 (100%)
Public facilities and infrastructure	3	3.25 (54.09%)	0	6	1.69	6 (100%)
Emergency/ Recovery preparedness	3	3.08 (51.26%)	0	6	2.46	6 (100%)
Natural resource/ Sensitive area protection	6	6.96 (58.02%)	0	11	2.24	12 (100%)
Total Flood Policy Quality	54	38.55 (35.69%)	6.00	66.00	12.58	108 (100%)

Histograms showing the shape of the distributions of scores help to explain the characteristics of the components. Total flood mitigation policy quality scores show roughly a bell-shaped distribution with a minimum score of 6 points and maximum of 66 points with substantial variance (Figure 6.1). Highest frequency is around 40 points in the histogram. The histogram of each component score can be found in Appendix C. Distribution of the scores for “general policy” and “building standard” are left-skewed (negatively skewed); thus a larger number of communities received comparatively high scores. In contrast, “acquisition” and “incentive-based tool/taxing tool” show a considerable right-skewed distribution which indicates that a dominant number of jurisdictions earned lower scores for these components. Also, a majority of jurisdictions received comparatively low scores in “awareness/education tool,” indicating a slightly right-skewed distribution. “Public facilities/infrastructure” has a plateau-like distribution with a similar frequency between 1-5 points. “Emergency/recovery preparedness” shows a double-peaked distribution which means the data actually reflect two distinct peaks at 0 and 5 points. Coastal and non-coastal communities show a significant difference in this component which creates the double-peaked distribution. More detailed discussions of comparison between coastal and non-coastal communities for all components and overall quality follow.

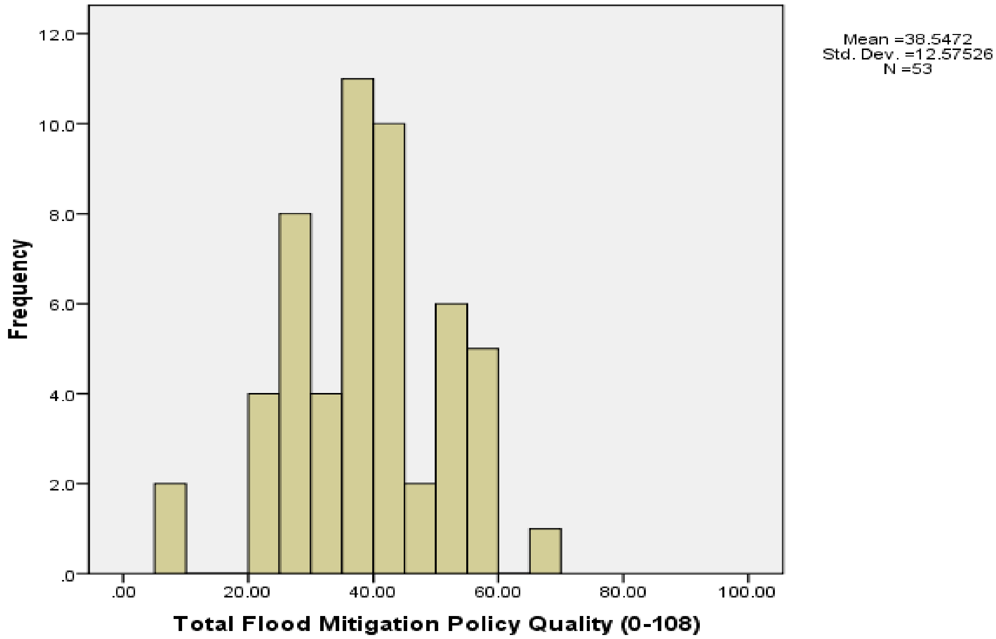


Figure 6.1 Total Flood Mitigation Policy Quality

6.1.2. Flood Mitigation Policies of Coastal and Non-coastal Communities

The United States has experienced a rapid increase in population and property along its coastline and Florida has paralleled this trend. As of 2007, over 12 million people, which is about two thirds of the total Florida population, live in coastal areas. In addition to this demographic trend, Florida has experienced repetitive and sometimes catastrophic natural hazards such as hurricanes and flooding. As shown by insured loss analysis, Florida is ranked as one of the highest damaged states from natural hazards. We cannot remove this natural physical vulnerability. However, to decrease the impact caused by natural hazards on the basis of existing vulnerability, the state of Florida, which is one of the few states that recognize the importance of planning for natural hazard mitigation, has required local comprehensive plans for all local jurisdictions. The state mandates the 35 counties and 164 municipalities located in coastal zones to prepare separate coastal management elements in their local comprehensive plans to protect humans and property from the impacts of natural disasters. According to rule 9J-5, communities can accomplish this purpose by restricting development in high hazard coastal areas, by planning for evacuations and recovery and by preserving coastal resources. Due to the requirements of the coastal management element, many natural hazard policies, including flood management policies, are incorporated in this element. The combination of "coastal location" and planning requirement of "coastal management element" in plan documents substantially affect the quality of flood mitigation policies.

In this study, 27 jurisdictions are coastal communities which require coastal element in their plans and 26 are non-coastal communities. To test whether there is a difference in the quality of flood mitigation policies, I conducted a t-test to compare the means of two groups.

As shown in Table 6.2, while the mean total policy quality of coastal jurisdictions is 45.74 points with a range of 0-108, the mean score of flood policy quality adopted in non-coastal communities is 31.08 points, which is much lower than plan scores for coastal jurisdictons. The distributions of scores of the two groups are quite similar with standard deviations of 10.11 and 10.43 (Figure 6.2). The t-test result indicates that there is a significant difference in means of total policy quality between coastal and non-coastal communities at the 0.01 level of significance. It can be concluded that the comprehensive plans of coastal communities that include a coastal management element received scores as much as 14.66 points higher than non-coastal plans.

Table 6.2. Comparison of Mean Policy Quality Scores between Coastal and Non-coastal Communities

	N	Mean	Std. Deviation	T	Sig.	Mean difference
Total Policy Quality of Coastal Communities	27	45.74	10.11	5.20	.000	14.66
Total Policy Quality of Inland Communities	26	31.08	10.43			

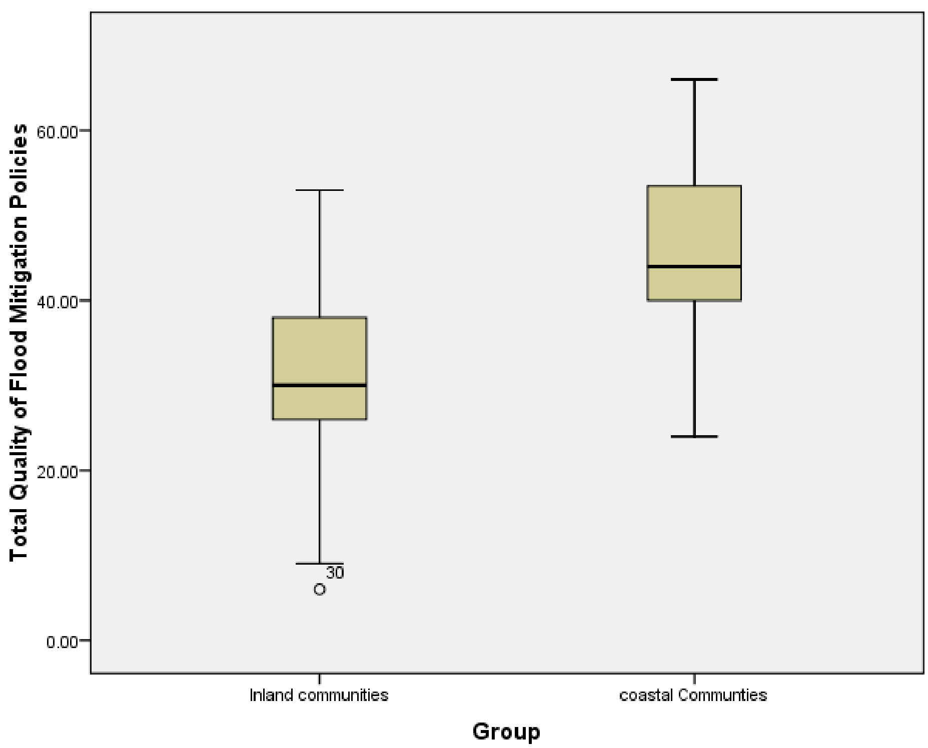


Figure 6.2. Boxplot of Policy Quality Scores of Coastal and Inland Communities

Total quality is composed of twelve components. It is noteworthy to test whether there are differences in the qualities of components between the two groups to get a more comprehensive and detailed understanding. Table 6.3 shows the descriptive statistics and t-test results of each component between coastal and inland community groups.

Table 6.3. Comparison of Mean Policy Component Scores between Coastal and Non-coastal Communities

Component	Group	N	Mean	SD	T	Sig.
General policy	Coastal Communities	27	3.56	0.80	1.67	0.10
	Inland Communities	26	3.04	1.37		
Land use and zoning tool	Coastal Communities	27	4.44	1.91	0.40	0.69
	Inland Communities	26	4.23	1.97		
Site design tool	Coastal Communities	27	3.44	2.39	0.40	0.69
	Inland Communities	26	2.04	2.20		
Building standard tool	Coastal Communities	27	3.44	0.85	4.99	0.00
	Inland Communities	26	2.04	1.18		
Acquisition tool	Coastal Communities	27	2.22	1.76	2.21	0.03
	Inland Communities	26	1.27	1.34		
Incentive-based tool/taxing tool	Coastal Communities	27	0.59	0.80	2.07	0.04
	Inland Communities	26	0.23	0.43		
Insurance tool	Coastal Communities	27	1.56	1.15	2.42	0.02
	Inland Communities	26	0.81	1.10		
Structural tool	Coastal Communities	27	5.07	1.59	2.44	0.02
	Inland Communities	26	3.96	1.73		
Awareness/ Educational tool	Coastal Communities	27	3.26	1.83	1.77	0.08
	Inland Communities	26	2.19	2.51		
Public facilities and infrastructure	Coastal Communities	27	4.26	1.16	5.63	0.00
	Inland Communities	26	2.19	1.50		
Emergency/ Recovery preparedness	Coastal Communities	27	5.11	1.01	11.57	0.00
	Inland Communities	26	0.96	1.54		
Natural resource/ Sensitive area protection	Coastal Communities	27	7.85	1.99	3.20	0.00
	Inland Communities	26	6.04	2.13		

Similar to overall quality, the mean flood policy scores of coastal communities across all components are higher than those of inland communities. While mean quality scores for "building standard tool," " public facilities and infrastructure," "emergency/recovery preparedness" and "natural resource/sensitive area protection" are substantially higher in coastal communities ($p < 0.01$), mean scores for "general policy," "land use and zoning tool" and "site design tool" did not show significant differences between coastal and inland communities. It can be inferred that policies categorized in the "general policy," "land use and zoning tool" and "site design tool" are commonly used land use management instruments for all communities and did not result in critical differences between coastal and non-coastal jurisdictions. However, flood mitigation policies associated with "public facilities and infrastructure," "emergency/recovery preparedness" and "natural resource/sensitive area protection" are the principal concerns of *the coastal management element* of local comprehensive plans to provide better plan quality for coastal jurisdictions. Also, coastal communities tend to pay more attention to coastal construction regulations; so they have clearer and more detailed use of building standard tools. Furthermore, the mean quality scores of "acquisition tool," "incentive based tool/taxing tool," "insurance tool," and "structural tool" are significantly higher in coastal communities at the 0.05 significant level, demonstrating that coastal communities also have incorporated more flood policies associated with these components into their plans than other communities. On the whole, the analysis shows that coastal communities have made a greater effort to develop flood mitigation policies than inland communities.

A series of studies (Berke et al., 1999; Berke et al., 1997; Berke & French, 1994; Berke et al., 1996; Burby et al., 1993; Burby & Dalton, 1994; Burby & May, 1997) concluded that strong state mandates contribute to higher quality plans related to natural hazards. This study found that, under the comparatively strong mandate of Florida, there are substantial variations among policies adopted by local jurisdictions. In particular, the specific mandate for "coastal management" and requirements can explain the significantly higher flood mitigation quality. The coastal management element reflects both location vulnerability and institutional pressure. Coastal communities of Florida have been affected by various coastal hazards such as hurricanes and coastal flooding and they are constantly susceptible to these hazards. Due to past experiences and physical vulnerability, local jurisdictions must pay more attention to hazard issues. Also, the state mandate and requirement for coastal element for coastal jurisdictions contribute to the quality of flood mitigation policies adopted in their local plans. Overall, local conditions and the state mandate for coastal communities have made a significant impact on the quality of flood mitigation policies incorporated in local comprehensive plans.

6.2. Flood Mitigation Policy Performance Analysis

Flood management policies are assessed in terms of the *breadth* and *depth* of coverage. Breadth measures how broadly a policy is addressed across all plans by determining the proportion of plans mentioned the policy. Depth assesses how well a policy is addressed by the plans; this is measured by two methodologies. The first method is to calculate the average score a policy received across all plans and the second depth score assesses the average score for plans which address the policy. This study calls the former *depth 1* and the latter *depth 2*. Most existing research uses *depth 2* for assessing the depth, but recent research conducted by Peacock et al.(2009) added *depth 1* to assess the quality of the policy across all study plans. These breadth and depth measures provide an overall assessment of quality of flood mitigation policies in detail. The depth scores have a range of 0 to 2 like the policy evaluation scheme. While a score of 0 is not addressed in the plans, a score of 2 indicates that a policy is mentioned with detailed coverage in the plans. A score of 1 suggests that a policy is just mentioned without detailed information. It might be reasonable to assume that a depth score of around 1.5 would reflect a reasonable or acceptable level of quality (Peacock et al., 2009). Again, *depth 1* indicates how well policies are being mentioned across all 53 plans, while *depth 2* suggests how well flood mitigation policies are addressed among the plans which address specific policies.

The first component, "general policy," which is composed of two flood policies, was mentioned by a relatively high percentage of plans. As listed in Tables 6.4, a majority of local comprehensive plans included traditional and basic flood mitigation ideas through land use planning. Eighty-nine percent of plans addressed flood mitigation policy through land use by discouraging development in floodplain areas. Also, there is wide spread mention regarding consistency with other regulations, laws or plans (81%). The depth scores are also quite high. Most local comprehensive plans discussed basic ideas of flood mitigation through land use and consistency with other regulations or plans with strong terms. They are likely to recognize the importance of these policies for flood mitigation. However, these policies are declaratory or normative. Because of these characteristics, jurisdictions might mention them in strong terms such as “shall,” “must” or “will.”

Policies for “land use and zoning tool” are related to the following ideas: 1) regulation of land development in floodplains prevents exposing people and property to flooding; 2) and conservation of floodplains and wetlands maintains the flood-carrying and flood- storage capacities of floodplains. To regulate development, permits and zoning are commonly used tools. While land use permits in floodplains (81%) and permit regulations in wetlands (85%) were frequently used tools in local comprehensive plans, only 17% of jurisdictions used an overlay zone with reduced density provisions. In addition, over half of the plans (58%) mentioned low density conservation of flood risk areas. Low density conservation and overlay zones with reduced density provisions did not receive high *depth1* scores; however their *depth 2* scores (over 1.6) are comparatively high. This result suggests these policies are ignored by many jurisdictions, but if they are mentioned, the qualities of detail coverage area are usually good. It is noteworthy that down zoning of floodplains was not presented in any local comprehensive plans. Where allowable, density has already been decided in a local comprehensive plan, down zoning to lower densities is likely to face strong opposition from property owners and cause legal challenges. Since local governments are hesitant to face legal obstacles, this seems to explain why no plan mentioned this policy.

With respect to “site design tool,” 87% of sampled plans mentioned setback/buffers from floodplains and environmental sensitive areas and 74% of plans discussed site plan reviews related to flood mitigation and management. It is interesting that over half the plans (58%) mentioned cluster development to keep development away from floodplains, but this policy's depth scores are comparatively low in both *depth 1* of 0.70 and *depth 2* of 1.19. This result indicates that most plans did not offer detailed information or did not use strong terms even if they addressed the cluster development policy. On the other hand, 40% of plans mentioned a policy regarding special study or impact assessment for development in floodplains, often times providing a good detail (*depth 2* of 1.52) but this was not across all plans (*depth 1* of 0.6). Twenty-three percent of plans which mentioned subdivision regulation for flood mitigation, tended to give a comparatively a detail information (*depth 2* of 1.5), but this was not across the all evaluated plans (*depth 1* of 0.34).

Table 6.4. General Policy, Land Use and Zoning and Site Design Tools

Policies & Actions		**Breadth (0-1)**	**Depth 1(0-2)**	**Depth 2(0-2)**
1. General Policy	1.1. Discourage development in floodplain areas	0.89	1.72	1.94
	1.2. Consistency with other regulations, laws or plans (i.e. flood ordinance)	0.81	1.58	1.95
2. Land use and zoning tool	2.1. Permitted land use	0.81	1.45	1.79
	2.2. Wetland regulation using permit	0.85	1.64	1.93
	2.3. Low density conservation	0.58	0.96	1.65
	2.4. Overlay zone with reduced density provisions	0.17	0.28	1.67
	2.5. Down zoning of floodplains	0.00	0.00	0.00
3. Site Design tool	3.1. Site plan review	0.74	1.21	1.64
	3.2. Special study/impact assessment for development in floodplains	0.40	0.60	1.52
	3.3. Setbacks/Buffers	0.87	1.40	1.61
	3.4. Cluster development to keep development away from flood zones	0.58	0.70	1.19
	3.5. Subdivision regulation	0.23	0.34	1.50

Table 6.5 presents the components of "building standard tool", "acquisition tool" and "incentive based tool/taxing tool" which together include 11 flood mitigation

policies. Regarding building standards/building code, 75% of jurisdictions have the policies for building codes or building standards in their plan and 79% of communities mentioned retrofitting or strengthening structures to meet current codes or regulations. On the other hand, no plan included a flood mitigation policy to use low interest loans to retrofit structures. Building codes are a regulatory effort to protect the public from hazards through structural requirements, such as building materials and construction techniques (Burby et al., 2000). The state of Florida has a single statewide unified code (Florida Building Code) developed by the Florida Building Commission which local jurisdictions can administer and enforce. While a majority of communities mentioned their building codes (75%), their detailed coverage was not across all plans (*depth 1* of 1.23). However, most plans provided good detail about strengthening of structures to meet current codes or regulations (*depth 1* of 1.53 and *depth 2* of 1.93). In particular, most plans that mentioned this policy focused on minimum elevation and building design standards which are required by FEMA. As mentioned previously, coastal communities have paid more attention to the" building standard" component, which reflects both state and local efforts through the Shore and Beach Preservation Act and building codes including specific coastal construction building designs.

Acquisition tools have had very limited use by local governments. Half of the plans (51%) in the study sample mentioned land and property acquisition such as fee simple purchase for flood management with less detailed information (*depth 1* of 0.68 and *depth 2* of 1.33). 40 % of community plans discussed transfer of development rights (TDR) of floodplains or environmentally sensitive areas and only 6% of plans mentioned purchase of development rights (PDR). 23% of plans mentioned dedication of open space or easement for flood mitigation and relocation of vulnerable structures away from flood prone areas. No policy among the five acquisition tools received over 1.5 in depth scores. This result indicates that plans did not address them in good detail or these policies are used more optionally than required.

Table 6.5. Building Standard Tool, Acquisition Tool and Incentive-based Tool/Taxing Tool

Policies & Actions		Breadth (0-1)	Depth 1(0-2)	Depth 2(0-2)
4. Building standard tool	4.1. Building standards/Building code	0.75	1.23	1.63
	4.2. Strengthening of structures to meet current codes or regulations (i.e. elevation)	0.79	1.53	1.93
	4.3. Low interest loans to retrofit structures	0.00	0.00	0.00
5. Acquisition tool	5.1. Land and property acquisition (fee simple purchase)	0.51	0.68	1.33
	5.2. Dedication of open space for hazards/Dedication of conservation easement	0.23	0.28	1.25
	5.3. Transfer of development rights	0.40	0.42	1.05
	5.4. Purchase of development rights	0.06	0.08	1.33
	5.5. Relocation of vulnerable structures out of hazard zones	0.23	0.30	1.33
6. Incentive-based tool/ Taxing tool	6.1. Impact fees	0.09	0.09	1.00
	6.2. Tax abatement for using mitigation	0.04	0.04	1.00
	6.3. Density bonus	0.25	0.28	1.15

The three policies for "incentive-based tool/taxing tool" were also rarely adopted by local governments as shown in Table 6.5. Among the three incentive and tax based flood mitigation policies, a density bonus policy was mentioned in 25% of plans and only 9% of plans addressed a policy of impact fees for flood mitigation. Plans rarely discussed tax abatement for mitigation (4%). Given the very small percentage of plans mentioning those policies, it is not surprising that the depth scores are very low with most substantially less than 1 of *depth 1* score and around 1 of *depth 2* score. Even if some plans addressed those policies, they did not give specific information and just mentioned the policies with modifying terms such as "prefer," "encourage" or "suggest." Nevertheless, it is true that incentive tools are useful to encourage stakeholders to think about and implement flood mitigation policies rather than force them.

With regard to the insurance tool (Table 6.6), over half of the plans (58%) discussed the communities' participation in flood insurance programs, but a few plans (8%) mentioned participation in the Community Rating System (CRS) in their plans. These policies received comparatively high *depth 2* scores of 1.77 and 2.00 suggesting good coverage by plans addressing these policies. While a very small number of jurisdictions paid attention to CRS, they offered detailed information using strong terms. CRS was introduced to encourage communities to move beyond NFIP minimum standards. As CRS has a comparatively short history – it was adopted in the early 1990s – and it is an incentive-based program based on the result of community policy implementation, CRS is likely to receive attention from a very limited number of local governments. However, this program was supported by recent research (Brody, Zahran, Maghelal et al., 2007) as an inexpensive means of reducing property damage directly through a quantitative model.

The overall scores regarding specific structural tools are not good except for detention/retention and storm water management measures. All plans (100%) provided excellent details using strong terms regarding storm water management, particularly in the infrastructure elements of plan documents (*depth 1* and *2* of 2). A large number of plans discussed detention/retention/holding methods (72%), often providing good detail (*depth 2* of 1.79) in plans which included this policy. Interestingly, no plans in the 53 study samples addressed construction and maintenance of dams and levees and only around 10% of plans discussed policies regarding seawalls (11%), riprap (17%), bulk heads (9%), channelization (11%) and slope stabilization (4%) with limited detail coverage. The low scores associated with structural tools might stem from two causes. First, comprehensive plans are naturally more focused on non-structural policies such as zoning and land use management. Also, the Florida planning tradition has emphasized non-structural approaches for flood mitigation (Brody, Kang, & Bernhardt, 2009). Clearing of debris policies addressed by 49% of plans was discussed through association with disaster emergency management and recovery.

Although education and outreach programs for flood mitigation have been recognized as inexpensive but effective tool, these received little attention by local jurisdictions with a 30% *breadth score* in this study. Only 4 % of plans addressed real estate hazard disclosure but when addressed, plans offered detailed information (*depth 2* of 2). Similarly, flood forecasting, warning and response policies were suggested by only 4% of plans and 15% of plans discussed training/technical assistant policy for flood mitigation, often times providing an acceptable detail (both *depth 2* of 1.50) but this was not across all plans (*depth 1* of 0.6 and 0.23). As shown in Table 6.6, a comparatively large number of communities (74%) mentioned that they have used and maintained floodplain maps indicating that NFIP effort are widely used at the local level. Computer modeling or evacuation systems are still unknown policies by local governments (9%).

38% of jurisdictions mentioned developing, and maintaining databases regarding flood plains and environmentally sensitive areas with less depth scores (*depth 1* of 0.51 and *depth 2* of 1.35).

Table 6.6. Insurance Tool, Structural Tool and Awareness/Educational Tool

Policies & Actions		Breadth (0-1)	Depth 1(0-2)	Depth 2(0-2)
7. Insurance tool	7.1. Participation in flood insurance programs (NFIP)	0.58	1.04	1.77
	7.2. Participation to Community Rating System (CRS)	0.08	0.15	2.00
8. Structural tool	8.1. Detention ponds/retention/holding	0.72	1.28	1.79
	8.2. Levees	0.00	0.00	0.00
	8.3. Dams	0.00	0.00	0.00
	8.4. Seawalls	0.11	0.13	1.17
	8.5. Riprap	0.17	0.17	1.00
	8.6. Bulk heads	0.09	0.09	1.00
	8.7. Channel maintenance/Channelization	0.11	0.15	1.33
	8.8. Slope stabilization	0.04	0.04	1.00
	8.9. Storm water management	1.00	2.00	2.00
	8.10. Clearing of debris	0.49	0.66	1.35
9. Awareness/ Educational tool	9.1. Education/outreach program	0.30	0.43	1.44
	9.2. Real Estate Hazard Disclosure	0.04	0.08	2.00
	9.3. Flood forecasting, warning and response program	0.04	0.06	1.50
	9.4. Training/Technical assistance	0.15	0.23	1.50
	9.5. Maps of areas subject to flood hazards	0.74	1.32	1.79
	9.6. Computer models/evacuation systems (e.q. HEC, web-based modeling system)	0.09	0.11	1.20
	9.7. Database	0.38	0.51	1.35

The remaining policies are related to public facilities and infrastructure, emergency/recovery preparedness and natural resource/sensitive area protection (see Table 6.7). In regard to “public facilities and infrastructure,” capital improvement policy was adopted by most jurisdictions (94%) to improve or develop drainage facilities or storm water management facilities which affect flooding indirectly and directly. Compared to high breadth score, the depth scores associated with capital improvement are not high and show very a small difference between *depth 1* and *depth 2* scores[7]. This result means that this policy is widely adopted for infrastructure such as drainage and storm water management (*breadth score* of 0.94) but specific capital improvement for other flood mitigation facilities is rare causing *depth scores* of less than 1.2 at a level of "just mentioning."

45% of communities among the 53 study areas adopted a policy for monitoring/retrofitting public structures for flood mitigation, often with good detail (*depth 2* of 1.55), but this did not occur across all plans (*depth 1* of 0.7). A relatively high percentage (75%) included a policy for not locating public facilities in flood risk zones with a good detail (*depth 2* of 1.88). This policy is mainly discussed in the coastal management and capital improvement elements in the comprehensive plans and is related to limiting public expenditures in risk areas which would subsidize development in high hazard areas.

As discussed before, "emergency/recovery preparedness" component is critical for coastal management element. About 60% of local plans addressed evacuation/shelter preparedness, emergency plan preparedness and recovery plan preparedness, often times with good detail (*depth 2* range between 1.64 and 1.90), but this did not apply to all areas (*depth 1* range between 1.02 and 1.04). Particularly, the separate coastal management element of comprehensive plans had a significant influence on these

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[7] The result of depth scores is closely related to the policy quality evaluation. I offered a score of 1 for plans which discuss capital improvement policy associated with drainage facilities or storm water management. Only when plans include a specific capital improvement policy for specific and detailed flood management facilities, they can receive a score of 2.

policies qualities, thus coastal communities received significantly higher scores than non-coastal communities.

Not surprisingly, most plans (94%) encompass the general idea of the importance of natural resources and sensitive area protection for preserving natural drainage functions and mitigating floods through the "conservation element," "land use element" or "open space element." Also, wetland conservation and restoration from physical and hydrological alteration was adopted by most plans (94%) with good detail and comparatively strong terms (*depth1* of 1.72 and *depth 2* of 1.82). Similarly, a majority of local jurisdictions (94%) mentioned a sediment and erosion regulation policy relatively well (*depth 1* of 1.77 and *depth 2* of 1.88), indicating that they recognized the importance of erosion control for protecting streams and drainage systems from substantial alteration of their natural functions. Forest and vegetation provide many aesthetic and biologic functions including storm and flood buffering and supporting wildlife. About 70% of plans mentioned this policy, often in good detail (*depth 2* of 1.54), but it was not mentioned across all plans (*depth 1* of 1.08). The remaining two policies of dune protection and stream dumping regulations did not get attention across most communities. 34% of plans discussed dune protection and only 11 % of study jurisdictions suggested stream dumping regulations. But, communities which recognized the need for these measures provided relatively detailed information about them. So, dune protection policy received a *depth 2* score of 1.72 and stream dumping regulation received a *depth 2* score of 1.83.

Table 6.7. Public Facilities and Infrastructure, Emergency/Recovery Preparedness and Natural Resource/Sensitive Area Protection

Policies & Actions		Breadth (0-1)	Depth 1(0-2)	Depth 2(0-2)
10. Public Facilities and infrastructure	10.1. Capital improvements	0.94	1.13	1.20
	10.2. Monitoring/retrofitting public structure	0.45	0.70	1.54
	10.3. Policy not to locate public facilities in flood zones	0.75	1.42	1.88
11. Emergency/ Recovery Preparedness	11.1. Evacuation/shelter preparedness	0.62	1.02	1.64
	11.2. Emergency plan preparedness	0.60	1.02	1.69
	11.3. Recovery plan preparedness	0.55	1.04	1.90
12. Natural resource/ sensitive area protection	12.1. General description of natural resource and sensitive area protection for flood mitigation	0.94	1.60	1.70
	12.2. Wetlands conservation/restoration	0.94	1.72	1.82
	12.3. Dune protection	0.34	0.58	1.72
	12.4. Forest and vegetation management riparian areas	0.70	1.08	1.54
	12.5. Sediment and erosion control regulation	0.94	1.77	1.88
	12.6. Stream dumping regulations	0.11	0.21	1.83

6.3. Flood Mitigation Policies by Jurisdiction

The above analyses show that there are substantial variations in the extent to which local jurisdictions incorporate flood mitigation policies in their comprehensive plans. Examining the plan quality score of each jurisdiction can better indicate which specific communities have high or low flood mitigation policy quality. As listed in Table 6.8, the quality scores vary widely from a minimum of 6 to 66 on a 0-108 range.

Overall, Pasco County received the highest score (66 of 108 points) in the total quality of flood mitigation policy which represents 61.11% of possible scores. Franklin County, City of New Smyrna Beach and Hernando County follow with the highest quality plans. In contrast, the City of Sweetwater (9 of 108 points) and City of Miami Springs (6 of 108 points) are among the lowest scoring plans in the study sample. It is notable that three sampled jurisdictions (Sweetwater, Miami Springs and Miami Lakes) of Miami-Dade County all earned very low scores. Considering that Miami-Dade

County stands out as the third largest insured damage county shown on Figure 5.5 and Table 5.6 and is one of the hotspots, it may be reasonable to assume that these jurisdictions have considerable weakness in incorporating flood mitigation policies into their plans compared to the degree of their vulnerability and risk to flooding. The City of Valparaiso in Okaloosa County, one of hotspots in flood damage, also has substantial room to improve its quality of flood mitigation policies for flood damage and risk. Nine of ten of the highest scoring plans are in coastal communities which include coastal management element in their plans. This result is consistent with the findings of previous sub-section.

Table 6.8. Flood Mitigation Policies by Community

Jurisdictions	Coastal Management Element	Total Quality Score (0-108)	Percentage (0-100, %)
Pasco County	Yes	66	61.11
Franklin County	Yes	58	53.70
New Smyrna Beach	Yes	58	53.70
Hernando County	Yes	57	52.78
Jacksonville Beach	Yes	56	51.85
St. Johns County	Yes	55	50.93
Tampa	Yes	54	50.00
Manatee County	Yes	53	49.07
Pinellas Park	No	53	49.07
Monroe County	Yes	51	47.22
Oldsmar	Yes	51	47.22
North Port	Yes	51	47.22
Boynton Beach	Yes	48	44.44
Destin	Yes	47	43.52
Pensacola	Yes	44	40.74
Gulfport	Yes	44	40.74

Table 6.8. Continued.

Jurisdictions	Coastal Management Element	Total Quality Score (0-108)	Percentage (0-100, %)
Largo	No	44	40.74
St. Petersburg	Yes	44	40.74
Callaway	Yes	43	39.81
Dixie County	Yes	43	39.81
Marion County	No	43	39.81
Gulf County	Yes	41	37.96
Fort Walton Beach	Yes	41	37.96
Highlands County	No	40	37.04
Cocoa Beach	Yes	39	36.11
Jackson County	No	39	36.11
Bartow	No	39	36.11
Pompano Beach	Yes	38	35.19
Deltona	No	38	35.19
Winter Garden	No	37	34.26
Sumter County	No	37	34.26
Daytona Beach	Yes	37	34.26
Gilchrist County	No	36	33.33
Temple Terrace	No	36	33.33
Ocoee	No	36	33.33
Palm Beach Gardens	Yes	33	30.56
Hallandale	Yes	31	28.70
Gainesville	No	30	27.78
Plant City	No	30	27.78
Clermont	No	29	26.85
Washington County	No	29	26.85
Miramar	No	28	25.93
Valparaiso	Yes	28	25.93
Lake Wales	No	28	25.93
Brooksville	No	27	25.00
Miami Lakes	No	26	24.07
De Bary	No	25	23.15
Neptune Beach	Yes	24	22.22
Live Oak	No	22	20.37
Glades County	No	21	19.44
Parkland	No	20	18.52
Sweetwater	No	9	8.33
Miami Springs	No	6	5.56

An interesting result from the t-test shows that the mean flood mitigation policy qualities of fifteen counties are significantly higher than those of thirty eight cities ($t = -2.29$, $p < 0.05$). As shown on Figure 6.3, counties containing relatively large areas have more green color (higher flood mitigation quality) than cities. This result suggests that counties have given more attention to integrating flood policies into their comprehensive plans or have more resources, land area, etc.

Total plan quality and flood mitigation component scores by jurisdiction were detailed in the graph of Appendix D. There is no obvious consistency in flood mitigation component composition where one or two components stand out from the others in terms of affecting the overall quality. Generally, lowest scoring communities not only have fewer policies, but also focus on a limited number of components. For example, City of Miami Springs, the lowest scoring community, employed policies from only three policy components among the twelve components; it also earned the lowest scores overall.

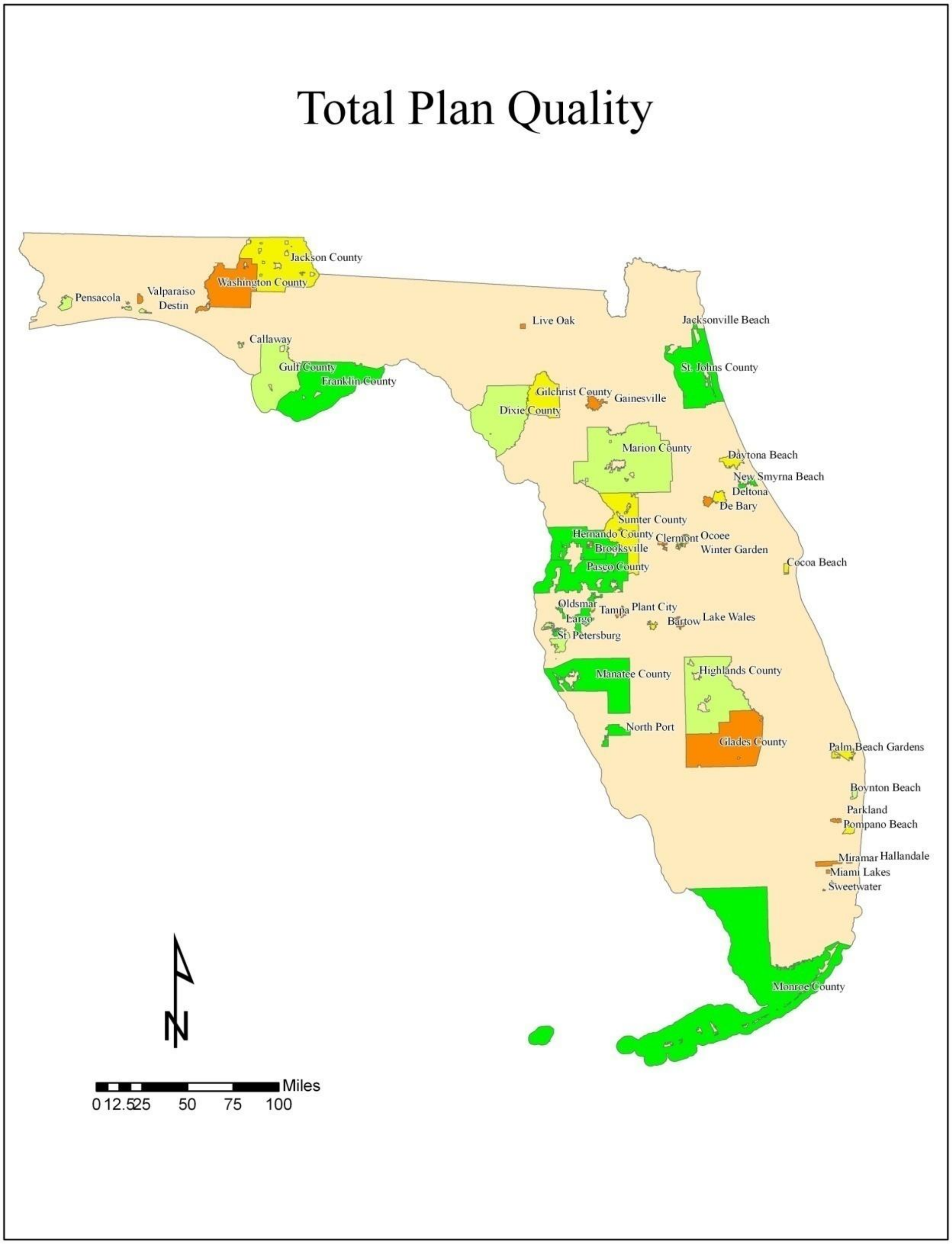

Figure 6.3. Total Plan Quality of Flood Mitigation Policy by Community

6.4. A Brief Summary of Flood Mitigation Policy Analysis

This analysis highlights the relative strengths and weaknesses of local governments to effectively integrate flood mitigation policies in their plan documents. The above findings are summarized as follows:

First, there is considerable variance in the quality of flood mitigation policies adopted in local comprehensive plans even though they are subject to the same Florida state mandate. There continues to be wide disparity between coastal and non-coastal jurisdictions. Coastal jurisdictions that are highly vulnerable to coastal hazards and required to include a coastal management element have significantly higher quality of flood mitigation policies in their plans. Furthermore, counties received higher scores than cities in the sample.

In addition, the 53 plans in the sample received a mean score of 38.55 points on a scale of 0-108 indicating relatively weak efforts. This result shows that there is still considerable room for improvement by local governments on flooding issues. Local plans most often adopt general descriptions about restricting development in floodplains and consistency with other flood related regulations, as well as some regulatory tools such as land use permits and wetland permits. Also, some site design tools such as setbacks, site plan review and building standard tools are commonly used measures by local governments. However, there is a lack of attention to incentive-based tools/taxing tools and acquisition tools. Also, most plans neglect to suggest structural tools except detention/retention structures and storm water management tools. As mentioned earlier, while inland communities have not been concerned about incorporating flood policies into their plans, it appears that coastal communities have been more concerned about flooding issues, particularly mitigation tools for public facilities and infrastructure, emergency/recovery preparedness, natural resource/sensitive area protection and building design tools.

This section has examined the degree to which local jurisdictions have incorporated flood mitigation policies into their comprehensive plans and found that there is considerable variation among communities. The next section investigates the influence of this variation on actual flood damage and further this study develops a fully specified model to examine factors influencing flood damage.

7. FACTORS INFLUENCING FLOOD LOSS

This section examines the extent to which quality of the adopted flood mitigation policies influence actual flood damage. In addition, other factors such as planning capacity, leadership and commitment, biophysical, built environment, and socio-economic variables are hypothesized as the driving factors affecting flood damage based on the literature review. The dependent variable, flood damage, is measured by insured flood loss. This study employed correlation analysis and ordinary least squares (OLS) regression models to accomplish the research objectives. Understanding the strength and direction of these impacts provides important insights and indicates how planners and floodplain managers can improve current policies.

The first sub-section summarizes the descriptive statistics of variables employed in the study model. The next sub-section presents the result of correlation analysis and the following sub-section examines the impacts of independent variables on insured flood damage through regression models.

7.1. Descriptive Statistics of Variables

Table 7.1 presents the descriptive statistics for each variable. This analysis briefly sketches characteristics of the variables. Flood damage was measured as average annual insured loss acquired from NFIP insurance data. As mentioned in the methods section, the NFIP insurance database provided the most precise and accurate data which was collected at the jurisdiction level. Average annual insured loss from 53 valid jurisdictions was $963,388 with a huge standard deviation of $3,645,985. This property loss data is skewed to the right, so was log transformation to derive a normal distribution. The following correlation and regression analyses were conducted with the log transformed dependent variable.

As examined in Section 6, the mean of plan qualities with regard to flood mitigation was 38.55 with a standard deviation of 12.58 on a 1-108 range. The distribution of this variable was approximately normal shape.

Table 7.1. Descriptive Statistics of Variables

Variable	Mean	Standard Deviation	Min.	Max.	N
Dependent Variable					
Annual average insured Flood damage	963,388.58	3,645,985.51	0	25,390,941.99	53
Planning Factors					
Plan quality	38.55	12.58	6.00	66.00	53
# of staff	1.25	1.36	.00	5.00	36
Budget	3.03	2.22	1.00	7.00	40
(Money)	(78312.50)	(138641.98)	(2500.00)	(450000.00)	(40)
leadership	3.72	1.03	0	5	46
Commitment	3.67	1.10	0	5	46
Biophysical Factors					
Precipitation (Annual average, inch)	54.77	6.51	38.72	70.17	53
Flood duration (Annual average)	3.83	2.25	0	8.80	53
Floodplain area (sq mile)	94.07	192.15	0	991.26	51
Stream length (mile)	83.78	159.39	0	672.16	53
Storm surge area (sq mile)	33.26	91.43	0	428.42	53
Coastal location(Dummy variable)	0.51	0.50	0	1	53
Built Environment Factors					
Impervious surface (sq mile)	18.93	24.98	0.79	133.43	53
# of issued wetland permit	73.26	113.10	0	689	53
# of dams	1.30	3.06	0.00	14.00	53
Socio-economic Factors					
Population(2000)	52486.77	71949.92	6192	307335	53
Median household income	39004.46	12650.74	24380.00	102624.00	53
Public participation	3.07	1.06	0	5	46
# of Insurance policy	6287.15	9577.47	51.00	38258.00	53

Five variables with regard to number of staff, budget, leadership, commitment, and public participation were selected through the survey. Appendix F provides the survey questionnaires describing the five variables.

The average number of staff members dedicated to planning and flood mitigation was 1.22 persons per jurisdiction in the sampled communities which annually spent an average of $78,312.50 for flood planning[8]. One third of communities (18 of 40 = 45%) reported that their organization had only a $0-$5,000 budget for flood mitigation and planning; thus the distribution curve was skewed to the right. Therefore, the median value of this variable (budget) is $7,500 which is much smaller than the mean ($78,312.50). The levels of leadership, commitment and public participation regarding a jurisdictions' flood planning and hazard mitigation were measured with 6 point Likert scales with 0 indicating "not present", 1 meaning "very weak", 2 meaning "weak", 3 meaning "neither weak nor strong", 4 meaning "strong" and 5 meaning "very strong." Over 65 percent of respondents reported generally strong and very strong levels of commitment and leadership, where about 35 percent of jurisdictions lacked commitment and leadership. In addition, the degree of public participation is comparatively low; over 65 percent of respondents answered this question as not present, very weak, weak, or neither weak nor strong. This result indicates that public participation in the process of flood planning has not received appropriate attention.

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[8] Annual budget of each jurisdiction was measured with seven scales: $0-$5,000; $5,001-$10,000; $10,001-$20,000; $20,001-$50,000; $50,001-$100,000; $100,001-$300,000; $300,001 or greater. The average annual budget was estimated by recoding a response in a given category to the midpoint of the range. Specially, $0-$5000 was recoded to $25,00, $5,001-$10,000 was recoded to $7,500, $10,000-$20,000 was recoded to $15,000, $20,001-$50,000 was recoded to $35,000, $50,001-$100,000 was recoded to $75,000, $100,001-$300,000 was recoded to $200,000, and $300,001 or greater was recoded to $450,000.

Table 7.2. Frequency of Budget

	Frequency	Percent
$0-$5,000	18	45.0
$5,001-$10,000	3	7.5
$10,001-$20,000	2	5.0
$20,001-$50,000	6	15.0
$50,001-$100,000	3	7.5
$100,001-$300,000	4	10.0
$300,001 or greater	4	10.0
n	40	
missing	13	

Table 7.3. Frequencies of Leadership, Commitment and Public Participation

	Leadership	Commitment	Public Participation
0: not present	1 (2.2%)	1 (2.2%)	2 (4.3%)
1: very weak	1 (2.2%)	2 (4.3%)	1 (2.2%)
2: weak	1 (2.2%)	1 (2.2%)	7 (15.2%)
3: neither weak nor strong	13 (28.3%)	12 (26.1%)	20 (43.5%)
4: strong	21 (45.7%)	21(45.7%)	14 (30.4%)
5: very strong	9 (19.6%)	9 (19.6%)	2 (4.3%)
n	46	46	46
missing	7	7	7

As mentioned earlier, this study includes 27 coastal communities and 26 inland communities. The degree of development in the study communities shows considerable variation. For example, impervious surface including high, medium, low and open space developed areas shows a standard deviation of 24.98 with a mean of 18.93 mi^2. Marion County has the largest impervious surface (133.43 mi^2) and the City of Sweetwater contains the smallest developed areas. Wetland permits, which were geocoded into a GIS, show that an average of 73 permits were issued by jurisdictions during 1991and 2003. Monroe County issued the highest number of wetland permits during study period. In the study jurisdictions, an average of 1.30 dams was built and Washington County has the highest number of dams (14 dams). Jurisdictions with more than 5000 residents were included in this research and the mean size of population was 52,487 persons. Pasco County is the most highly populated jurisdiction (307,335) and Franklin County is the least populated area in the study samples.

7.2. Correlation Analysis

Correlation analysis and multi-regression models were used to identify the variables affecting actual flood damage. Particularly, the Pearson correlation coefficient (r) was used to identify the relationships between variables. The correlation analysis matrix is included in the Table 7.4 on page 159 and indicates several significant findings.

First, log transformed annual average insured loss is correlated with four independent variables at the significance level of 0.01 and five independent variables at the 0.05 level of significance. With regard to planning variables, it is noteworthy that flood mitigation quality is positively correlated with insured loss with a coefficient of 0.58 ($p < 0.01$). This result suggests that communities which developed higher quality plans reported a larger amount of annual average insured flood damage. This result contradicts the research hypothesis and suggests the need to consider alternate explanations. In addition, communities with very strong leadership are negatively correlated with insured flood damage ($r = -0.285$, $p<0.05$)[9]. Communities with very

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[9] As explained in the previous section, leadership was measured in an interval scales which can be coded in the dummy variable depending on the study interests. This study examined the impacts of levels of leadership on flood damage using dummy variables. As a result of trials, this study found that particularly

strong leadership regarding flood mitigation were likely to have a lower amount of insured property damage from flooding. Other planning efforts such as budget, number of staff, planner commitment are not significantly correlated with insured flood damage and their associations did not show consistent directions.

With regard to biophysical factors, flood duration ($r = 0.307$), flood plain area ($r = .365$) and storm surge area ($r = 0.362$) of each community had significantly positive correlations with insured flood damage at a significance level of 0.05. As expected, the significant correlation between flood duration and insured damage indicates that longer lasting floods, storms and coastal hazards were significantly correlated with the property damage. Also, the positive correlations between floodplain area and insured damage and another significant correlation between storm surge area and insured damage support the expectation that communities with risk areas exposed to flooding would have more damage caused by flooding events. In addition, coastal communities requiring a coastal management element in their plans experienced substantially larger insured property damage with a coefficient of 0.66 ($p<0.01$).

Among built environment variables, wetland alteration had a significantly strong positive correlation with annual insured flood damage ($r = 0.663$, $p<0.01$) suggesting that the issued development permits in wetlands are likely to degrade the hydrological function of wetlands and cause floods. It is noteworthy that the magnitude of this correlation is largest among significant relations. With regard to socio-economic factors,

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very strong leadership makes significantly negative impact on the insured damage and other levels of leadership did not provide any impact. So, this dummy variable of "very strong leadership" was included in the correlation and regression models.

the numbers of insurance policies of communities ($r = 0.470$, $p<0.01$) are positively correlated with insured flood damage suggesting that if residents purchase more insurance policies due to flood risk and political or policy pressure, the entire community's insurance claim payment is likely to become larger. Moreover, population size ($r = 0.345$, $p<0.05$) also has a positive correlation with insured damage since local jurisdictions with larger populations have more people and more insured properties exposed to flooding.

With the above correlation relationships, there are other inter-variable correlation relationships among variables. The quality of flood mitigation policies is another critical issue which many previous studies have focused on. As shown in Table 7.4, seven variables have correlations with policy quality at $p<0.01$ and two variables are correlated with it at $p<0.05$. For planning efforts, the number of staff has a significant correlation ($r = 0.451$, $p<0.01$) with plan quality, suggesting that having more staff members result in the development of high quality flood plans. In addition, with regard to biophysical environments, the quality of adopted flood mitigation policies in local comprehensive plans has a significant positive correlation with stream length ($r = 0.278$, $p<0.05$) indicating that communities with more streams and rivers were likely to pay more attention to flood policies. Moreover, the positive correlation between the quality of flood mitigation policy and coastal location ($r = 0.589$, $p<0.01$) and the positive correlation between flood mitigation quality and storm surge area ($r = 0.331$, $p<0.05$) suggest that coastal communities highly vulnerable to storm surge were more likely to develop comprehensive plans including various and articulate flood mitigation policies.

The level of development is also significantly correlated to the plan quality. Thus, impervious surface ($r = 0.357$, $p<0.01$) and the number of wetland permits ($r = 0.472$, $p<0.01$) have considerable positive correlations with flood mitigation plan quality indicating that communities experiencing more development activities, both in the entire areas and environmentally sensitive areas, are likely to develop higher quality plans as responsive actions. This result confirms what is well known. Planners and policy makers tend to be reactionary in their efforts, so development activities are likely to motivate the adoption of more flood mitigation activities (Burby & French, 1981). Plan quality also shows a positive correlation with population ($r = 0.448$, $p<0.01$) and the number of insurance policies ($r = 0.415$, $p<0.01$). When community populations are bigger, residents purchase more insurance policies, and tend to make more effort to adopt flood mitigation policies in their comprehensive plans.

Flood duration has positive correlations with storm surge area and coastal location as well as insured property damage. These relationships suggest that coastal communities with large storm surge zones reported longer flood duration. Floodplain area is significantly correlated with stream length ($r = 0.726$, $p<0.01$) and storm surge area ($r = 0.476$, $p<0.01$). Also, communities containing large floodplains tend to issue more wetland permits ($r = 0.681$, $p<0.01$) and are more likely to build dams ($r=0.276$, $p<0.05$). Stream length is correlated with storm surge area, impervious surface, wetland alteration and dam construction as well as floodplain area. It is notable that the coastal location variable has various significant correlations. First, as mentioned earlier, coastal communities not only develop better plans than non-coastal communities, but they have also experienced large insured flood losses ($r = 0.66$, $p<0.01$) with significantly long-lasting flooding events ($r = 0.306$, $p<0.05$). Also, they have positive correlations with storm surge area ($r = 0.353$, $p<0.05$), wetland alteration ($r = 0.422$, $p<0.01$) and the number of insurance policy ($r = 0.459$, $p<0.01$). This result suggests that coastal communities tend to contain larger storm surge areas and they transform wetlands by issuing more development permits. At the same time, residents in coastal communities are likely to buy flood insurance due to high flood risk.

The degree of development (impervious surface area and wetland permits) is significantly correlated with population size in a positive direction. Impervious surface area is closely correlated with population size with a coefficient of 0.830 ($p<0.01$) (This correlation indicates the risk of multicollinearity. However, the regression models do not include both independent variables in the same equation). This correlation results suggests that large cities tend to be under pressure to increase development both in entire areas and environmentally sensitively areas. Furthermore, the level of development measured by impervious surface area and wetland permit has a positive correlation with the number of insurance policies. Thus, people living in communities experiencing higher development pressure tend to seek safety and adjust risk by purchasing insurance policies. Additionally, impervious surface areas have a positive correlation with plan quality ($r = 0.375$, $p<0.01$). The number of planning and flood management staff ($r = 0.366$, $p<0.01$) suggests that communities with large developed areas also have better plans and more staff. It is notable that wetland alteration is not only correlated with social variables (population and number of insurance policy), but also with biophysical variables and planning variables. First of all, the number of issued wetland permits is positively correlated with floodplain area ($r = 0.681$, $p<0.01$), stream length ($r = 0.650$, $p<0.01$), storm surge area ($r = 0.309$, $p<0.05$) and coastal locations ($r = 0.422$, $p<0.01$) indicating that communities that include larger surge area and floodplains, longer streams and rivers and located along the coast tend to issue more wetland permits. In addition, the degree of wetland alteration has a significant correlation with plan quality, number of staff and insured damage.

The construction of dams is correlated with floodplain size ($r = 0.276$, $p<0.05$) and stream length ($r = 0.543$, $p<0.01$). Communities with large populations not only experience a high degree of development (wetland permit and impervious surface) causing larger insured damage ($r = 0.345$, $p<0.05$), but also provide better plans ($r = 0.448$, $p<0.01$) and more staff ($r = 0.500$, $p<0.01$). Median household income of a community is correlated with very strong leadership in a positive direction ($r = 0.468$, $p<0.01$) and public participation has a significant correlation with community budget ($r = 0.304$, $p<0.05$).

The number of insurance policies in a community measures the degree of participation in NFIP and is noticeably correlated with various variables. Table 7.4 shows that this variable is strongly correlated with population ($r = 0.717$, $p<0.01$). As mentioned before, people living in coastal communities tend to buy more insurance policies ($r = 0.459$, $p<0.01$). Furthermore, the number of insurance policies has a positive correlation with development degree as measured by impervious surface ($r = 0.412$, $p<0.01$) and the number of issued wetland permit ($r = 0.538$, $p<0.01$). This result parallels some researchers' worries that flood insurance can induce new development, causing an increase of wetland alteration and area of impervious surface. Also, communities having more NFIP policies have better plans ($r = 0.415$, $p<0.01$) and larger staffs ($r = 0.468$, $p<0.01$), as well as a greater amount of insured damage ($r = 0.470$, $p<0.01$).

On the whole, the intercorrelations reveal the relationship between the independent variables and insured flood loss. The magnitude of intercorrelation coefficient and the direction of the relationships suggest that multiple variables affect flood damage. .The above correlation of each independent variable with the dependent variable contains indirect effects as well as direct effects – making it difficult to assess the unique contribution of each predictor. Thus, the following employs regression models to isolate the impact of each independent variable.

Table 7.4. Intercorrelations of Study Variables

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Annual Insured Flood loss (log)																		
2	Flood policy quality	.581**																	
3	Number of Staff	.314	.451**																
4	Budget	-.190	-.109	.412*															
5	Very Strong Leadership	-.285*	-.214	.019	.103														
6	Commitment	.130	.177	.134	.291	.098													
7	Precipitation	-.189	-.391**	-.199	-.065	-.013	-.349*												
8	Flood duration	.307*	.148	.012	.042	.007	.058	.190											
9	Floodplain area	.365*	.218	-.010	-.292	-.158	.089	-.273	.015										
10	Stream length	.229	.278*	.493**	-.214	-.132	.047	-.187	-.055	.726**									
11	Storm surge area	.362*	.331*	.100	-.134	-.069	.030	-.150	.322*	.476**	.328*								
12	Coastal location	.660**	.589**	.233	-.310	-.059	-.021	-.073	.306*	.069	.085	.353**							
13	Impervious surface	.239	.375**	.374*	.119	-.102	-.003	-.129	-.120	.220	.366**	.017	.066						
14	# of issued wetland permit	.663**	.472**	.581**	-.150	-.072	.146	-.311*	.115	.681**	.650**	.309*	.422**	.248					
15	# of dams	-.235	-.009	.221	.093	-.128	-.003	.055	-.223	.276*	.543**	-.072	-.201	.275*	.000				
16	Population	.345*	.448**	.500**	.277	-.118	.046	-.146	.013	.084	.212	-.013	.225	.830**	.352**	.092			
17	Median household income	-.111	-.148	.046	.137	.468**	-.153	.214	.046	-.148	-.113	-.163	.003	-.135	.018	-.172	-.085		
18	Public participation	.092	.155	.302	.304*	.074	.305*	-.236	.094	-.005	-.023	-.053	.054	.020	.104	-.139	.031	.159	
19	# of Insurance policy	.470**	.415**	.468**	.007	-.060	.041	-.144	.150	.136	.217	.038	.459**	.412**	.538**	-.101	.717**	.047	.152

(*significant at p<0.05, ** significant at p<0.01)

7.3. Examination of the Factors Influencing Flood Loss

This section 7.3 addresses the research question, “What factors influence flood damage?” Specifically, I use multiple regression analysis to test whether the quality of flood mitigation policies incorporated in local comprehensive plans mitigate flood damage, while taking into account other variables. With the dependent variable, insured flood loss is regressed against the four independent variable blocks (planning factors, biophysical factors, built environment factors and socio-economic factors) as identified in the conceptual framework presented in Section 3.

As previously mentioned, this study conducts sequential multiple regressions by blocks of variables to examine the unique impact of each variable block on the variance of flood damage. First, planning factors were entered into the model, followed sequentially by biophysical, built environment, and socio economic blocks. The final model includes the significant variables in each analysis.

I tested normality, multicollinearity, heteroskedasticity, independence and model specification to ensure the OLS regression assumptions were met. Because jurisdictions were randomly sampled and not adjacent, spatial autocorrelation was not considered in this study. Some variables, particularly those from the survey, include a comparatively large number of missing cases, so missing value treatment was needed for the statistical models. I employed mean substitution as a missing value treatment to prevent a substantial decrease in the sample size available for the analysis.

The regression models test the impacts of planning, biophysical, built environment and socioeconomic factors on the log transformed annual average insured flood damage. Table 7.5 presents the results and unstandardized coefficients of five models which are separated by entering factors.

With regard to planning factors, my expectation was that jurisdictions with higher quality of flood mitigation policies, larger number of planners, more commitment, stronger leadership and larger budgets would have a lower amount of flood damage. Planning factors tested in Model 1 explained 29 percent of the variance in the insured flood damage. Among the variables in this block, plan quality had a statistically significant positive impact on insured flood damage at the 0.01 level. This result contradicts Hypothesis 1 that higher quality of flood mitigation policies will result in a lower amount of property loss caused by floods. This result is consistent with the correlation analysis result showing positive correlation between the quality of flood mitigation policy and insured flood damage (Table 7.4). As shown in the correlation analysis, communities which have experienced a rapid increase in population and development with physical vulnerability to large storm surge areas and floodplains, or are located on coasts, tend to develop higher quality plans. And communities which have small populations and do not contain large risk areas, are not likely to pay attention to flood mitigation policies as well as they haven't incurred large insured damage. The positive relationship between plan quality and insured flood damage suggests that simply having a high quality plan does not statistically contribute to mitigating flood damage. A possible interpretation can stem from the following reasons. First, without implementation of adopted policies, the goals of policies cannot be achieved; also it is impossible to mitigate the risk of flooding in communities. Another interpretation is that if a higher quality plan is developed as a reactionary action to the community rapid development, it is not easy to stop continuing development in floodplains which requires purchase of insurance. Sometimes communities introduce new development into risk areas by using the excuse of high quality of plan or insurance. In Model 1, despite theoretical justification, the number of staff devoted to planning and flood mitigation, budget, degree of leadership, and commitment had no significant impact on insured flood damage and their directions of relationship are not consistent and mixed. These inconsistencies and insignificant power of the above planning efforts may reflect the complex context in flood mitigation planning process. It is true that most local governments tend to overlook natural hazards issues which can be demonstrated by comparatively small number of staff and low budget. In addition to this tendency, even though staffs and planners have a strong interest in natural hazard mitigation, there are still controversies over flood mitigation policies. When some planners with high commitment focus on flood mitigation only through purchasing insurance policies and ignore flood mitigation by permitting development in flood prone areas, the damage, particularly insured damage, will continue to increase.

Model 2 increases the ability to explain the variance of insured flood damage from 29 percent to 50 percent by adding biophysical factors to planning factors. In this model, plan quality does not have a significant influence on insured flood loss when controlling the biophysical factors (however, the direction of the coefficient is still positive). Noticeably, the dummy variable of “very strong leadership” has a significantly negative impact on the insured loss at the 0.1 level. This result partially supports

Hypothesis 4 that jurisdictions with stronger leadership will lead to less flood damage by encouraging implementation of flood mitigation policies. Surprisingly, the precipitation and flood duration are not statistically significant in regard to insured flood damage. This result suggests that insured flood damage tend to be affected by location and built environment factors rather than climatological factors. Namely, this indicates that as shown in the book "Disasters by Design (Mileti, 1999)," the impact of natural disasters can be mitigated by where and how we "design" our community. This study is a starting point to understand the current status and problems in order to design more resilient communities. Among biophysical factors, floodplain area is statistically significant indicating that communities with larger floodplain areas had more insured property damage at the 0.01 level. In larger floodplain areas, the higher probability of flooding plus more residents who are likely to purchase insurance policies results in greater amounts of insured flood damage. In addition, location of communities is a critical influence on insured flood damage at the 0.01 level. Jurisdictions located on the coast have more insured property damage from flooding (Hypothesis 11) because they are susceptible to coastal hazards (longer flood duration, larger storm surge area) as well as having residents who purchase more insurance policies.

Model 3 addes built environment factors to planning factors to explain annual average insured flood losses. This model accounts for 53 percent of the variance of the insured property damage from flooding events. In this model, flood mitigation plan quality significantly influences the increase of insured flood damage at the 0.1 level; very strong leadership considerably contributes to the decrease in insured flood damage, which is significant at $p<0.05$. With regard to built environment factors, this model does not statistically support Hypothesis 12 that communities with larger areas of impervious surface will have more insured property loss. However, this model revealed that wetland alteration substantially impacts insured property damage (Hypothesis 13). This result indicates that jurisdictions which had issued a higher number of wetland permits were more likely to have a larger amount of insured property damage from floods. In other words, increased development permits in wetlands impacts the hydrological cycle, causing increased flooding and flood damage to property. Despite the importance of wetland conservation, both in ecosystem management and flood mitigation, the number of issued wetland development permits has increased significantly in Florida (Brody, Zahran, Maghelal et al., 2007). While 2,487 permits were issued in 1993, 4,766 wetland permits were granted in 2003 suggesting an increase of over 90% during 10 years. In addition, this model found that the number of dams had a statistically significant negative impact on insured damage at the 0.01 level. This result supports Hypothesis 14 that construction of dams can decrease flood damage.

To test the effect of socio-economic factors on insured flood damage, Model 4 incorporated four variables including population, median household income, level of public participation in the flood planning process and the level of participation in the NFIP, while controlling for planning factors. This model explains 31 percent of the variance in the dependent variable.

Table 7.5. Explaining the Insured Flood Damage (Unstandardized Coefficients)

Dependent Log (Insured flood damage)	Model 1	Model 2	Model 3	Model 4	Model 5
Planning Factors					
Plan quality	.078***	.018	.041*	.066**	.018
# of staff	.198	.359	-.035	.024	
Budget	-.180	.004	-.056	-.148	
Very strong leadership	-.958	-1.096*	-1.190**	-1.146	-1.221**
Commitment	.196	.153	.092	.238	
Biophysical Factors					
Precipitation		.000			
Flood duration		.107			
Floodplain area		.005***			.001
Stream length		-.003			
Storm surge area		-.000			
Coastal location		2.079***			1.475***
Built Environment Factors					
Impervious surface			.000		
# of issued wetland permit			.010***		.007**
# of dams			-.196***		-.149**
Socio-economic Factors					
Population(2000)				-.000	
Median household income				.000	
Public participation				-.027	
# of Insurance policy				7.525E-5*	.000
(Constant coefficient)	8.054***	8.068***	9.221***	7.847***	9.626***
	N = 53	N = 53	N = 53	N = 53	N = 53
	$F(5,47) = 5.25$	$F(11,41) = 5.752$	$F(8, 44) = 8.524$	$F(9,43) = 3.577$	$F(7,45) = 12.865$
	Prob.>F =.001	Prob.>F =.000	Prob.>F =.000	Prob.>F =.002	Prob.>F =.000
	$R^2 = .358$	$R^2 = .607$	$R^2 = .608$	$R^2 = .428$	$R^2 = .667$
	Adj. $R^2 = .290$	Adj. $R^2 = .501$	Adj. $R^2 = .537$	Adj. $R^2 = .308$	Adj. $R^2 = .615$

*<0.1 level, **<0.05 level, and ***<0.01 level

Contrary to expectations, population, median household income and public participation did not significantly impact insured flood damage. Previous studies provided inconsistent results regarding the impact of population and community wealth on adoption of hazard mitigation policies. This study supports the literature, which states that these variables have no effect on flood damage. Contrary to theoretical justification that public participation in the planning process will improve flood mitigation, flood mitigation in the planning process has not been given proper attention by the public, thus less attention has diluted the effectiveness of public participation in mitigating flood damage. Only the degree of a community's participation in a flood insurance program has a meaningful influence on insured damage suggesting that if residents have a high number of insurance policies, communities would have more insured property damage.

Model 5 is a fully specified model incorporating significant variables from the other models including plan quality, dummy variable of very strong leadership, floodplain area, coastal location, number of issued wetland permits, number of dams and number of insurance policies. This model accounts for a significant proportion (62%) of the dependent variable, insured flood damage.

Controlling for the above variables, plan quality regarding flood mitigation policy does not have a statistically significant effect on insured flood damage. However, it is noteworthy that the directions of influence of the plan quality on the insured flood damage were all positive even if it is a non-significant predictor when controlling biophysical factors – particularly the coastal location variable. Overall, this finding does not support the main research hypothesis (Hypothesis 1) that high quality will lead to action that contributes to reducing insured property damage caused by floods. This result does not repeat findings of Nelson and French (2002)'s research. They evaluated the relationship between seismic safety elements of comprehensive plans and damage caused by Northridge Earthquake and found that locally prepared plans could be effective in reducing damage associated with seismic events. As previously mentioned, the first possible interpretation with regard to rejection of Hypothesis 1 can stem from the failure of implementation of adopted policies in the comprehensive plans. Policies described in plan documents can be realized through the implementation process. If this connection is eliminated, we may never see the impact of the adopted policies on the final outcome such as flood damage; so it is doubtful whether or not currently adopted flood mitigation policies have been effectively implemented. Further study is needed regarding the implementation of adopted policies and their impacts. Another possible interpretation is that the adverse impacts of other land development policies and their implementation – such as wetland alteration and development in flood prone areas - may outweigh flood mitigation policies. In regard to this interpretation, my models show that the robust and significant impact of wetland permits on increased insured damage is consistent with previous research (Brody & Highfield, 2005). It is noteworthy that even if many plans in the study sample include wetland regulation and land development regulation in floodplain areas, actual implementation of the policies did not support their written and documented policies. Recent research conducted by Deyle et al (2008) supports this phenomena by comparing residential development intensity inside coastal hazard areas with pre- and after- local comprehensive plan approval. They found that residential development in coastal hazard risk areas increased in the study communities in Florida even though they had approved comprehensive plans including development management and hazard mitigation policies to direct population and development away from coastal hazard areas. The other possible interpretation regarding the positive relationship between flood mitigation plan quality and "*insured*" flood damage stems from the characteristics of "insurance" policies for flood mitigation. Some communities, which paid considerable attention to flooding and developed high quality plans, encourage residents to purchase flood insurance to aid rapid recovery and mitigation from floods. In this case, it is possible that even if the overall flood damage decreases, the proportion of insured damage will increase. Otherwise, some communities, particularly those with rapid development and not enough land safe from floods, would introduce new development in flood prone areas. Residents living in floodplains must buy insurance policies required by mortgage companies or other institutions. Overall, these communities would not only increase participation in the NFIP program and insured damage, but also new development in the flood prone areas leading to greater exposure to flood risk. The overall relationships among insurance, other flood policies and plans, development, and flood loss need to be examined in further study to provide a comprehensive picture for flood mitigation mechanisms.

Among planning effort variables, the dummy variable of "very strong leadership" is the only significant variable in Model 5. Whether or not the jurisdictions have very strong leadership significantly affects insured flood damage with a partial coefficient of -1.22 at the significant level of 0.05. This result indicates that communities with very strong leadership in developing and implementing flood mitigation policies have much less insured flood damage. It is noticeable that other levels of leadership such as "strong," "neither weak nor strong," and "weak" did not significantly impact insured damage. As mentioned before, one obstacle for natural hazard mitigation is that community leaders lack confidence and willingness in regard to this issue and are hesitant to apply leadership to hazard mitigation. This research found that even if a community has leadership in flood mitigation, the leadership should be "very strong" to adopt and actually realize policies to reduce flood loss.

Floodplain area has no significant effect on insured damage in the fully-specified model, although the direction is positive. The decrease in significance of the floodplain variable may be associated with the inclusion of wetland permits in Model 5 compared to Model 2. While the area of floodplain is a very critical factor for explaining flood damage, wetland alteration dilutes the effect by significantly being correlated with floodplain. It is also apparent that coastal location is a very powerful predictor in explaining the variance of insured flood damage at the 0.01 level. Coastal communities exposed to various coastal hazards have much higher insured property damage, even if they made considerable efforts in their comprehensive plans and employed various flood mitigation policies.

Two variables among the built environment factors – wetland permit and dam construction - are all very significant predictors for insured flood loss. Consistent with Model 3, wetland alteration is a driving factor in generating insured flood damage indicating that communities which issued more development permits in wetlands have notably higher insured damage caused by floods. As mentioned above, this result can be interpreted in two possible ways. First, wetland alteration causes flooding events and flood damage by changing hydrological capability as discovered in existing studies. Also, development pressure in naturally sensitive areas such as wetlands mobilizes residents to purchase insurance policies (either a required or voluntary) which causes an increase in insurance payments. Like Model 3, the construction of dams significantly influenced insured damage in a negative direction at a 0.05 level in the fully specified Model 5. Dam is one of the traditional structure measures for flood control and can bring a sense of safety to residents. Planners and floodplain managers should identify the right combination of structural and non-structural policies and techniques by considering local conditions.

The number of insurance policies in the final model still has a positive impact, but is no longer significant in explaining the variance in insured flood damage. A decrease in the statistical significance may be associated with more statistically powerful variables loaded in the model. The impact of this variable tends to be more subtle compared to other powerful variables such as wetland permits and coastal location.

Table 7.6 represents the standardized beta coefficient showing relative importance in terms of explanatory power. Overall, wetland permits is the most powerful predictor and coastal location is the second most important variable explaining the variance in insured flood damage, followed by the number of dams and very strong leadership.

Table 7.6. Explaining the Insured Flood Damage (Standardized Coefficients)

Dependent Log (Insured flood damage)	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
	(Beta)	(Beta)	(Beta)	(Beta)	(Beta)
Planning Factors					
Plan quality	.452***	.106	.238*	.383**	.105
# of staff	.102	.184	-.018	.012	
Budget	-.160	.004	-.050	-.132	
Very strong leadership	-.168	-.192*	-.208**	-.201	-.214**
Commitment	.092	.072	.043	.112	
Biophysical Factors					
Precipitation		.002			
Flood duration		.111			
Floodplain area		.455***			.073
Stream length		-.256			
Storm surge area		-.003			
Coastal location		.484***			.344***
Built Environment Factors					
Impervious surface			.090		
# of issued wetland permit			.497***		.388**
# of dams			-.277***		-.210**
Socio-economic Factors					
Population(2000)				-.070	
Median household income				.058	
Public participation				-.012	
# of Insurance policy				.333*	.008
(Constant coefficient)					
	N = 53	N = 53	N = 53	N = 53	N = 53
	$F(5,47) = 5.25$	$F(11,41) = 5.752$	$F(8, 44) = 8.524$	$F(9,43) = 3.577$	$F(7,45) = 12.865$
	Prob.>F =.001	Prob.>F =.000	Prob.>F =.000	Prob.>F =.002	Prob.>F =.000
	$R^2 = .358$	$R^2 = .607$	$R^2 = .608$	$R^2 = .428$	$R^2 = .667$
	Adj. $R^2 = .290$	Adj. $R^2 = .501$	Adj. $R^2 = .537$	Adj. $R^2 = .308$	Adj. $R^2 = .615$

*<0.1 level, **<0.05 level, and ***<0.01 level

7.4. Summary

This section presented the analyses findings which identify the driving factors and their impacts on the variance of insured flood damage based on the study hypotheses and objectives. To better understand the effects of the four dependent variable groups on insured flood loss and maintain proper number of variables, biophysical, built environment, and socio economic factors were added into planning factors using four regression models (Model 1- Model 4). The fully specified Model 5 includes the significant variables from the preceding four models.

Based on the regression analyses above, the following summary is made. Table 7.7 presents the summary of significant variables. The rank was determined based on the standardized coefficient (Beta) of independent variables. Influence size was separately calculated since the dependent variable was log transformed.

First, the degree of plan quality regarding flood mitigation policy had little discernible effect on reducing insured flood damage while controlling other biophysical, built environment and socio-economic variables. This finding runs counter to Hypothesis 1 that higher policy quality will cause a decrease in flood property loss. It is apparent that communities with large risk areas, communities with frequent disasters, and communities with rapid development tend to develop better plans, in reaction to disasters. Even though it is critical that these communities develop long-term plans and incorporate various hazard mitigation policies, these policies also stimulate encroachment on flood risk areas (Deyle et al., 2008), which in turn limit the implementation of the adopted policies and their effectiveness after implementation. This study confirms the "land use management paradox" suggested by Burby and French (1981). Furthermore, highly developed and populated jurisdictions with better plans tend to focus on flood insurance policy as an important non-structural measure which causes a positive relationship between plan quality and insured damage. The next section discusses policy implications based on the findings of this research.

Among other planning variables, the number of staff, budget and planner commitment did not have any significant effect on insured flood damage, contrary to expectations. However, the dummy variable of very strong leadership contributed to reduce insured flood damage. When communities have very strong leadership in developing flood mitigation policies and implementing them, insurance damage can be mitigated by 70.51%[10]. However, considering that the overall leadership level is low, considerable additional effort is needed by community leaders and planners. This study found that these efforts deserve attention.

With regard to biophysical variables, two meteorological variables (precipitation and flood duration) did not have statistically significant impacts on insured flood damage in the regression model, while flood duration was positively correlated with insured damage at the 0.05 level. Floodplain area and coastal location significantly influenced insured property damage in Model 2 which includes planning and biophysical factors. But, in the fully specified model, the dummy variable of coastal location made a significant impact on insured flood damage with a positive direction. When communities are located in coastal areas, they will experience 337.10%[11] more insured flood damage than inland communities.

Among built environment factors, the number of wetland permits had the most significant impact on insured property damage caused by flood. Wetland alteration not only influences the hydrological cycle, but also increases flooding resulting in increased

[10] Because this is dummy variable and the dependent variable was log transformation, the percentage change is $100(e^{-1.221} - 1) = -70.51\%$

[11] The percentage change of this dummy variable was calculated with the following formula: $100(e^{1.475} - 1) = 337.10\%$.

damage. Thus, if a community issues a permit for development in a wetland, this would cause a 0.7% increase in insured property damage in the community. Despite this result, the wetland permits have been continuously increased in Florida and this tendency demands more careful use of permits through stronger regulations. On the contrary, the construction of dams can play a significant role in reducing insured flood damage. Dams built as flood management measures can decrease insured property losses by 14.9%.

Among socio-economic variables, the number of insurance policies was significant in Model 4 containing planning factors and socio-economic factors, but this significance disappeared in the fully-specified model. Thus, there was no significant socio-economic variable anlayzed in Model 5.

Table 7.7. Significant Variables on Insured Flood Loss and Influence Size

Rank	Sign	Partial coefficient	Influence size	Variables
1	+	0.007	0.7%	Number of wetland permit
2	+	1.475	337.10%	Coastal location
3	-	-1.221	70.51%	Very strong leadership
4	-	-0.149	14.9%	Number of dam

The results described above provide important insights to understand factors influencing flood damage as well as the impacts of planning efforts and plan quality. Based on the results, the following section discusses the policy implications, which contribute to reducing actual flood loss and accelerating implementation of adopted flood mitigation policies. However, conclusions should be made with caution due to the small sample and limitations of the data. This analysis should be considered as the first step for building a comprehensive and overarching model of flood mitigation.

8. CONCLUSIONS AND DISCUSSIONS

Planning researchers (Burby, 2005, 2006; Godschalk et al., 1998) believe that property losses from natural hazards such as floods can be reduced if governments address this issue and adopt appropriate policies in their plans. However, little empirical research has examined the relationship between plan quality and actual property loss from natural hazards. This research addresses this critical gap in the planning and hazard research literature by evaluating the effectiveness of current plans and policies. A trend analysis, descriptive statistics, correlation analysis and multivariate regression were applied to assess not only the effectiveness of current flood mitigation policies incorporated in local comprehensive plans, but also the factors affecting actual property damage caused by floods in Florida.

8.1. Summary of Key Findings and Conclusions

This study started with a trend analysis of flood losses. Even though annual losses have fluctuated, the overall historical trend from the 1960s to 2000s indicates an apparent increase in damage from catastrophic disasters. During 1996-2007, the NFIP paid 623,220 claims with total payments of over $26 billion, an 800% increase in damage between 1978 and 1989 ($3.2 billion). In particular, Florida has encountered repetitive losses from floods with average annual insured losses reaching about $200 million. Insured flood loss in Florida between 1996 and 2007 was $153.31 per capita - 1.6 times the US average insured flood loss per capita ($ 93.58). Flooding remains one of the greatest hazard threats in Florida. 53 study jurisdictions had large variations in insured flood damage with an average annual loss of $963,388 during 2003 and 2007.

In addition, to understanding the current status of flood mitigation policies, this study assessed the ability of local governments to incorporate flood mitigation policies in their local comprehensive plans. This analysis provides suggestions to help planners and floodplain managers improve current policies and plans to mitigate actual flood damage. The key findings regarding the research objective, which was to assess the extent to which local comprehensive plans integrate flood mitigation policies, are as follows:

First, the descriptive analysis of plan evaluation shows that the mean score for total plan qualities with regard to flood mitigation is 38.55 points which represent 35.69% of the possible points. This result indicates that local governments have not effectively incorporated flood mitigation policies into their local comprehensive plans. The scores of local plans varied widely from one community to another. While many studies revealed that stronger plan mandates can produce higher quality plans, this study shows that there are wide variations even under the umbrella of Florida's mandate. This result has a thread of connection with findings of Deyle and Smith (1998)'s research which examined the degree of local government compliance with Florid state mandates. They concluded that although some other studies found that the prescriptive mandate in Florida produced higher plan quality, local governments in Florida selectively implemented state mandates with highly varied results. They also found that the level of compliance with state planning mandates was influenced by both state administrative agencies and local conditions such as hazard experience. Even if this study does not consider state agency's capabilities, the correlation analysis shown in Table 7.4 suggests that local planning capacity, coastal location, stream length, degree of development (impervious surface, number of wetland permits), population size and degree of participation in NFIP have significant correlations with the quality of plans associated with flood mitigation.

Second, the plan quality analysis indicates that coastal communities received significantly higher scores than non-coastal communities. This finding can be explained in two ways. First, Florida mandates all coastal jurisdictions to prepare a "coastal management element" which some researchers call a "hazard element." The state outlines the goals and policies which the element needs to mention. So, state mandates cause coastal communities to pay more attention to natural hazards and this influences the extent to which local plans address flood mitigation policies. Second, it is intuitive that coastal locations are closely associated with flood risk. When a community is located in a risky place near the coast or has a history of frequent storms and repetitive floods, both planners and residents would have high flood risk perception which results in high plan quality incorporating more flood mitigation policies.

Third, the evaluation protocol is divided into 12 components which include 54 specific flood mitigation policies. This study found substantial variations in the scores of each component. While most communities adopted land use management tools such as permitted land use and wetland permits as primary flood mitigation tools, incentive-based tools/taxing tools and acquisition tools such as impact fees and tax abatement were rarely adopted by local jurisdictions. Natural resource/sensitive area protection tools, such as wetland conservation and sediment and erosion control regulation were more often found to be adopted in comparison to awareness/education tools such as real estate hazard disclosure, flood warning programs and computer modeling. Plan quality breadth and depth analysis assess how broadly and how well each policy is addressed. The analyses found that communities tend to focus on a narrow set of policies at the expense of other tools which could be more effective in flood mitigation. These results suggest that there is still considerable room for flood mitigation measures in local communities.

Fourth, gaps of policy quality between coastal communities and non-coastal communities appeared not only in the overall quality, but also the mean scores of twelve components. While mean scores for “general policy,” “land use and zoning tool” and “site design tool” did not show statistically significant differences between coastal and inland communities, other component scores were all substantially higher in coastal communities. The attention coastal communities paid to flood mitigation measures may be due in part to the state mandate which requires a coastal management element and due in part to geographical risk.

This study then examined the impact of the quality of flood mitigation policies on actual insured flood damage using regression models and further identified other factors influencing insured property loss. Other factors include planning efforts such as planning capacity, leadership and commitment, biophysical factors, built environment factors and socio-economic factors. With regard to which factors influence insured flood loss (Section 6), this study found some valuable results which provide critical insights about how property losses caused by floods can be managed and mitigated in the long term.

First, the main hypothesis of this study (Hypothesis 1) was rejected. In other words, communities incorporating higher quality flood mitigation policies in their comprehensive plans did not show a lower amount of insured flood damage. On the contrary, plan quality and insured damage showed a positive relationship although it was not statistically significant in the fully specified regression model. This result counters the assumption of plan quality research that better plans are associated with better outcomes. As previously mentioned, there are some possible explanations for this result in terms of plan implementation, land use management paradox and characteristics of insurance policies.

One possible interpretation is failure of implementation. The failure can stem from possible points in the implementation process; policies in plans can be shelved without any action. It is also possible that programs or actions can be sidetracked, or even though some policies are implemented, they cannot be connected with impacts on output. Policy and plan implementation are influenced by a variety of political, economical, social and environmental factors. Due to these complexities and the difficulties of measurement and data collection, there few implementation studies have been conducted. However, further study is needed to investigate implementation processes of flood mitigation policies. Another possible reason for unsuccessful implementation may stem from conflicts between flood mitigation policies and other development policies. The main policies for flood mitigation limit development in hazardous areas and direct people away from risk zones. However, in Florida, continuing and rapid development in hazard risk areas has been occurred and researchers (Brody & Highfield, 2005; Deyle et al., 2008) have provided evidence that these development trends did not conform with local land use plans for growth management.

Communities having higher quality flood mitigation policies tend to experience pressure to develop and are susceptible to floods. As mentioned earlier, plan and policy development is reactionary in hazard mitigation; policies do not easily suspend encroachment in risk zones, which in turn limits the implementation and effectiveness of adopted policies. This finding repeats the “land use management paradox” suggested by Burby and French (1981). Furthermore, communities under rapid development pressure with high plan quality are more likely to encourage residents to buy insurance policies. Actually, when development occurs in risk areas, insured property is better than non-insured, but insurance policies can bring “moral hazards” which justify new development and population encroachment in floodplain areas. To that end, high quality flood mitigation plans did not guarantee a reduction in insured flood damage and, on the contrary, sometimes they allowed development in flood hazard areas causing a high level of flood insurance participation and larger insured property damage.

Second, contrary to expectations and other studies’ endorsements, planning capacity (number of staff and budget) and commitment do not significantly impact reduction of flood damage. However, the presence of very strong leadership does in fact significantly contribute to decreased insured flood damage. Considering the relatively low interest and confidence of community leaders in flood mitigation, only very strong leadership can cross the threshold to effective flood mitigation while other levels of leadership did not have a significant influence. This finding is critical because it demonstrates that while communities' leaders tend to be hesitant to accept flood mitigation policies due to conflicts with economic issues, strong leadership can be a valuable influence on flood damage mitigation.

Another major finding from the regression analysis shows that a community's location on the coast is a critical and driving factor determining insured property damage from floods while meteorological factors such as precipitation and flood duration did not show significance. This finding is important because if a community must be located on the coast or in a high risk area, community design and development pattern would be more important than unpreventable natural phenomena. Thus, coastal communities should receive more attention from planners and residents. Correlation and plan quality analyses show that even when coastal communities in Florida have developed higher quality flood mitigation policies in their plans, they have incurred a larger amount of insured damage from floods as well as experienced high pressure for development in both environmentally sensitive areas and general lands. On the whole, coastal jurisdictions not only have to facilitate implementation of flood mitigation, but also manage the entire development related to flood mitigation through stronger regulations and active monitoring.

This study also found that insured flood loss was considerably affected by wetland alteration which was the most powerful predictor in the explanatory model. This result supports the literature about the importance of wetland conservation as a non-structural flood mitigation measure (Brody & Highfield, 2005). Development in wetlands involves serious ecological losses which both compromise ecosystems and limit the natural function of containing water capacity. Florida has issued a considerable number of wetland permits with continuing annual increases for the last decade, particularly in the southern portion of the state and along the coastline (Brody & Highfield, 2005). Wetland alteration shows a critical connection between natural systems and development patterns; in other words, wetland permits which are the outcome of local planning decision can critically impact the local built environmental landscape as well as alter the hydrological system. Regarding economic loss, one wetland permit increases 0.7% of insured property damage caused by flooding events - $674/permit in flood damage.

Another finding indicates that construction of dams is a factor in mitigating flood loss independent of expensive construction and management costs. Thus, planners and decision makers should identify the proper combination of non-structural and structural flood mitigation techniques by considering their communities' physical and socio-economic conditions.

On the whole, the above findings not only provide valuable information about current flood mitigation policies adopted by local jurisdictions, but more importantly, they can provide the ideal direction for flood damage mitigation both at a broader spatial range and a temporal scale. The following extends the findings to policy implications to provide insights for strategic improvement of flood mitigation for sustainable and resilient community development.

8.2. Theoretical Contributions

This study makes some important theoretical contributions to the scholarly literature on planning, plan evaluation and hazard mitigation research.

First, this study is the first to examine the extent to which local governments in Florida have incorporated flood mitigation policies in their plans using plan evaluation methodology. While most existing studies have focused on overall natural hazards or mixed hazards, this study focuses on a single hazard, flooding, to provide a clear understanding of current flood mitigation policies which are the basis for developing a fully specified flood mitigation model. The developed protocol, which is a set of existing and best flood management policies, can serve both as an evaluation criteria and guidance for local jurisdictions to include a wide range of policies.

This study is also meaningful in that it adds to studies focused on state mandates and plan quality. This research found that while all Florida local jurisdictions are under the same state mandate for local comprehensive plans, requirement for a specific element such as "coastal management" for on coastal communities significantly influenced overall plan quality and the degree of incorporated specific policies. Thus, coastal communities which included "coastal management" in their plans appeared significantly better across most plan components.

In addition, this research calls into question the effectiveness of flood loss mitigation through local planning activities. Even if some previous studies investigated plan quality associated with natural hazards, there is limited empirical research to connect plan quality with outcome. My research fills this gap and adds to the scholarly literature which found that better plans are not necessarily associated with implementation of adopted policies and better outcomes. Considering that planning is an adaptive and learning process, this study provides a critical opportunity to improve current flood mitigation through local planning. This study leaves open the question of how to promote implementation of flood mitigation policies which tend to receive low priority among practitioners compared to other policies.

While this research did not support the hypothesis that better plans in flood mitigation policies result in better outcome – less property damage – it should be noted that this result does not mean that local comprehensive plans cannot be effective in flood mitigation. The fact that issued wetland permits are a significant driving factor on insured flood damage confirms that decisions for community development seriously impact flood loss which is a basic idea of flood mitigation through land use planning. Thus, local comprehensive plans which guide community development are still very important, but current local comprehensive plans tend to parallel the "land use management paradox." Namely, plans are likely to be developed in reaction to high development pressure and high exposure to hazard risk, and the policies do not easily stop encroachment in risk areas which in turn limits the implementation and effectiveness of adopted flood mitigation policies.

With the selected sample, this study did not find that planning capacity, budget and planner commitment guarantee reduction of property loss caused by floods.

However, it confirms that very strong community leadership is important to mitigate insured flood damage.

Also, this study confirms necessity for coastal area management of coastal communities which are under rapid development pressure and exposed to coastal hazards. This study further adds to the theoretical assumptions that coastal location was an important determinant in flood damage. It suggests that coastal communities need to pay more attention to flood mitigation policy implementation.

One of the major contributions of this study is to extend previous flood mitigation studies to include all possible factors and create a comprehensive conceptual model of flood mitigation through planning based on identified significant factors on insured flood loss. This study confirms that properly locating communities and adopting and implementing flood mitigation policies are critical issues in mitigating flood loss.

The following section 8.3 offers suggestions for promoting the adoption and implementation of flood mitigation policies based on findings.

8.3. Policy Implications and Recommendations

Planners have faith that developed plans will be implemented and achieve their goals resulting in positive impacts. However, real-world plans experience various degrees of success and failure affected by social, economic, political, and environmental factors. Thus, evaluating plans and examining their effectiveness becomes a critical learning process.

This study developed a conceptual and measurable flood mitigation model which identified the driving factors of flood damage. Based on the findings in the research model, this section sets forth several policy implications and recommendations to show practitioners how to effectively promote flood mitigation policies, implement them through the planning process and mitigate flood damage.

Recommendations can be applied to locations in other states as well as Florida because floods are ubiquitous and floodplains are common across the United States. This study offers the following implications and recommendations to facilitate flood loss mitigation:

8.3.1. Need for Reliable and Correct Flood Loss Data

Before proposing planning implications designed to incorporate mitigation policies, the first recommendation focuses on flood loss data. As previously described in Section 5, to evaluate a certain issue, it is necessary to prepare precise data to measure it. Though some flood loss datasets exist, there is no perfect one at the moment. While this study employed insurance data because it is most precise and is collected at the community level, it did not cover all damages, but represented only insured property damage from flooding. Thus, this study suggests the need for an organization which can collect, manage and release reliable and official flood damage data from the community level to the US level. Furthermore, if the area of the flood damage is mapped using GIS, the maps can be analyzed in combination with existing floodplain maps. Planners and floodplain managers who can effectively identify and understand flood problems in their communities using reliable data can enhance their ability to manage them toward resilient and sustainable communities.

8.3.2. Improving Plan Quality Associated with Flood Mitigation

Since the "Growth Management Act" of 1985, Florida has established a state mandate for local comprehensive planning. But, the adoption of flood mitigation policies has largely been left to the discretion of local governments. As reported in Section 6, comparatively low plan quality scores and wide variations from one community to another show that local governments have different philosophies about the importance of flood mitigation independent from state mandates. Also, communities tend to focus on a narrow range of measures, such as land use permits and wetland permits, setbacks and building codes. While these are necessary approaches, communities need to find a proper combination of policies that are effective for local conditions by including other measures such as acquisition tools and incentive/tax-based tools. In addition, education and awareness tools, which have generally been ignored, are comparatively economical but effective in informing the public and helping planners. Practitioners can use many available sources about natural hazards and best planning practices. If these data are incorporated into a GIS framework, it will help planners and residents to understand their risk and vulnerability. Examples of GIS data providers in Florida include Florida Geographic Data Library (http://www.fgdl.org/) and Florida Department of Environmental Protection (http://www.dep.state.fl.us/gis/portal.asp). Also, some researchers are developing web-based GIS systems to help local jurisdictions understand development decisions and their impacts on communities. The Texas Coastal Atlas (http://coastalatlas.tamu.edu/), developed by the Hazard Reduction & Recovery Center at Texas A&M University, is a good example even though from a different state. By conducting various studies and providing training opportunities, states can play an important role in building data and providing information to local governments about floods and mitigation measures. Continuing encouragement by states will ensure that local governments not only include various hazard mitigation approaches in their plans, but also implement them.

8.3.3. Facilitating Implementation of Flood Mitigation Policies

This study's most significant finding is that plan quality did not contribute to mitigation of insured flood damage. Namely, policy development in local comprehensive plans was not connected to policy implementation. Then, how can adopted flood mitigation policies be implemented to achieve better outcomes? This has been a traditional issue in the field of planning research: plan vs. implementation.

The first lever for improving implementation of flood mitigation policies is to use the FEMA Community Rating System (CRS) which was developed to encourage community flood risk mitigation activities to go beyond minimum NFIP standards. A community which voluntarily participates in this program receives a rating score based on the CRS system; the rating scores are divided into 10 classes which correspond to premium discount rates from 5 to 45 percent. For example, a Class 1 community would receive a 45 percent premium discount, while a Class 9 community would receive only a

5 percent discount. A Class 10 is not a participating community and receives no discount. The CRS classes for local communities are based on 18 activities which are organized under four categories - public information, mapping and regulations, flood damage reduction, and flood preparedness (FEMA, 2008). A unique characteristic of CRS is that jurisdictions can receive credit by verifying their activities to ensure implementation (Brody et al., 2009). The evaluation is conducted by external reviewers (Insurance Service Office, Inc.) and the process is ongoing and dynamic. So, if a community has made more effort and implemented a greater number of flood mitigation measures, the community can receive a higher score which provides a higher discount rate for flood insurance. This study recommends the active application of the CRS program to guarantee the implementation of policies. However, there is still room to actively apply CRS to local jurisdictions. As previously shown in Table 6.8, only 8 % of sampled jurisdictions mentioned this program in their plans, indicating very low attention. FEMA needs to identify ways to encourage local communities to participate in this program and implement flood mitigation activities. In order to assure the success of this program, joint responsibility of federal and local government is required. For successful use of CRS, I propose the following suggestions: First, the 10 classes are so broad that there are gaps in flood mitigation activities among communities in the same class. Thus, the 10 classes need to be more diversified with different incentives between participants and non-participants or between active participants and inactive participants. Also, the incentives should be attractive to encourage local communities to participate in

this program. FEMA should research the effectiveness and revision of this program and advertise the benefits to encourage local communities' participation.

Second, in order to implement adopted policies, it is imperative to have a regular monitoring process. Implementation is a complex and diverse process; in particular, flood mitigation policies have more complexities due to the reluctance of local officials and conflicts with economic interests. Due to these potential conflicts, monitoring and evaluation of plans and policies are critical to facilitate policy implementation and provide an adaptive process. Monitoring and evaluation can be applied to both plan documents and the planning process. Plan documents should include provision for monitoring the implementation process, assessing the effectiveness of policies, and updating schedules and responsibilities. Brody and Highfield (2005) found that the quality of "implementation component" in local comprehensive plans had a significant effect on the degree of implementation of environmental management policies while plans including better policies were not associated with better plan implementation. Thus, local planners should enhance the implementation component in their plans as well as polices and factual bases. In addition, all jurisdictions in Florida are required to update their plans by preparing an Evaluation and Appraisal Report every seven years. This can be a good opportunity to evaluate current approaches and policy implementation as well as revising current plans. However, in many cases, this has more likely been a procedural rather than a substantive evaluation. This study recommends that the State develop a systematic and scientific implementation evaluation methodology which can assess implementation more precisely and comparably across jurisdictions. Laurian et al.(2004) suggested a conformance-based plan implementation evaluation (PIE) which focused on the land development permitting process and its development policy. Many researchers (Brody & Highfield, 2005; Deyle et al., 2008) have employed conformity research to measure whether plan outcome conforms to goals and policies in the plans. Though this study does not show how or what adopted mitigation policies have been implemented and why or what policies have been shelved, further study will examine these issues. Particularly, further research on the topic is needed to develop a theoretical framework of plan implementation mechanisms and practical and systematic plan implementation methodologies at both the state and local level.

Third, this study found that “very strong leadership” is a key to flood loss reduction. Implementation of appropriate flood mitigation policies cannot take place without strong leadership; a few jurisdictions with extraordinary local leadership can actually reduce property damage caused by floods. Lack of strong leadership or political willingness is not only the current problem, but community leaders must have strong willingness and confidence in flood mitigation efforts. First, a skillful and credible advocate group is very important to enhance leadership. Particularly, planning scholars and researchers can provide valuable support by researching the importance, strengths and weaknesses of mitigation policies. This dissertation is also one of several critical studies which have investigated factors influencing actual flood damage and the relationship between plan quality and outcome. Researchers should not only study these issues, but also disseminate their research findings through various communications, presentations and workshops with community leaders and planners. Second, public concerns and participation are closely related to a community leader's interests. Although the regression models in this study did not reveal a significant relationship between public participation and flood damage reduction, this study found that relatively low public participation in the communities' flood planning and hazard mitigation may have influenced the weak effect of this variable in the model. Residents living in communities which suffer chronic losses from flooding or are located on coastlines, have particularly high risk perception and concern about floods. However, if they don't have an opportunity to participate in the planning process, this will result in low policy priority by local leaders. Therefore, professional groups, civic organization and planning staff should inform residents about the importance of mitigation policies and extend opportunities for them to participate in plan development and hazard mitigation activities. A higher degree of public participation results in higher commitment and stronger leadership in staff and elected officers. In general, the success of flood mitigation plans requires cooperation between citizens and community leaders in the planning process and commitment to the plan implementation.

8.3.4. Mitigating Flood Damage through Development Management

The findings of this research reveal both the importance and difficulty of flood mitigation through local development management.

In terms of importance of development management in flood mitigation, this study provides critical evidence that limiting flood risk exposure through regulation of wetland development affects flood loss. In other words, an increase in issued wetland permits significantly contributes to more flood damage. Therefore, the U.S. Army Corps of Engineers, which is responsible for federal wetland permitting, and local governments must review the process and possible impact and give careful consideration to issuing wetland alteration permits.

Difficulty of flood mitigation through land use management clearly showed that higher plan quality which incorporated articulated flood mitigation policies did not influence insured damage reduction. This result is related to the failure to implement adopted policies, which stems from the conflict between policies that promote development and policies that limit development. This dissertation learned that in the study areas, the former policies tend to prevail over the latter policies. So, the trend of new development in risk areas has continued; meanwhile developed flood mitigation policies are not likely to be effectively implemented. In addition, communities with high risk areas which are under strong development pressure are more likely to develop better plans but are not effective in preventing encroachment in environmentally sensitive areas and floodplains. Furthermore, flood insurance, one of the most commonly used non-structural methods (all study jurisdictions are participating in NFIP) can not only lead to new development in floodplains although the buildings are elevated, but also higher insured damage. These overall situations indicate that flood mitigation policies did not achieve an actual decline in insured flood loss. Conflict between policies occurs often in communities with high development pressure and large developed areas at risk. In communities where land use restriction policies are likely to be less effective, planners and leaders need a stronger commitment to implement policies and incorporate other flood mitigation measures, such as incentive-based policies, public awareness and education measures into land use regulations. Future research should be encouraged to help communities choose appropriate flood mitigation practices that best reflect local conditions.

8.4. Study Limitations and Further Study

8.4.1. Study Limitations

Although this study provides a greater understanding of the effectiveness of current flood mitigation policies, it has some limitations. First, the study is focused only on Florida and a relatively small sample size may lack enough statistical power to generalize the conclusions to other jurisdictions or other states. Also, this study used insured damage data as a measurement of the dependent variable, flood loss. As previously mentioned, insured damage has its limitations since it cannot represent all damage, but mainly focuses on residential and commercial properties. Therefore, these data do not cover damage of uninsured properties and public infrastructures. Considering all possible data and validity issues, this study chose the precise insurance data collected by jurisdictions paralleling the study unit. However, reliable flood data are required for better measurement of flood damage in the future.

The third limitation is related to plan evaluation. The policy evaluation protocol contains existing flood mitigation policies. However, the protocol did not include any specific ideal criteria such as the best density in floodplains - it only evaluated the existence of a policy and the degree of detail. For example, the protocol included density regulation in coastal high hazard areas. However, allowable density in these areas is varied from 8 units per acre to 15 units per acre depending on community conditions such as available land area and development speed. Even if density regulation policies are strongly mentioned and graded to the same score, the outcome might be different depending on the specific density degree. However, the protocol of this study did not measure this specific issue which could affect development management. Thus, in addition to simple plan evaluation, evaluation of policy propriety needs to be addressed in further study.

While this study meaningfully provides empirical evidence about the relationship of plan quality to flood damage, it did not investigate plan and policy implementation process. Namely, this study omitted the intermediate process and steps of policy implementation and directly examined the links between plan quality and flood damage. Further research is needed to examine policy implementation process and its intermediate linkage to outcome.

8.4.2. Further Study

This study has attempted to evaluate current conditions and provide a greater understanding regarding flood mitigation policies and factors influencing flood loss. However, it is an only starting point for understanding overall flood mitigation mechanisms and improving current efforts. Further research is needed to extend study areas, develop better data and examine the implementation process to more thoroughly understand the mechanism and provide more applicable policy implications.

First , to overcome the current limitations and generalize the results, the study area need to be extended to other communities facing serious flooding problems. The plan evaluation protocol developed in this study can be applied to other communities and serve as both a guideline for new policies and an evaluation criteria for already adopted and implemented policies. More importantly, further research is needed to investigate other states with different planning histories and biophysical and built environments. This will provide a comparison study and resulting generalizations. Also, increasing the sample size is an effective way to extend understanding and improve statistical power. Different data for measuring flood damage such as SHELDUS could be used to supplement insurance damage data. It is possible that insurance loss data and other loss data show different interactions with planning efforts due to the characteristics of flood insurance. As exiting data, such as SHELDUS, did not provide jurisdiction level data, further research will need to employ a disaggregation process of loss data.

Another direction for further research is plan implementation. While this study concluded that higher quality flood mitigation policies adopted in plan documents was not associated with lower insured property damage caused by floods, this dissertation did not specifically examine the implementation process. Thus, it is important that further research thoroughly investigates ways to implement the policies adopted in plans at the local level. In addition, further research could determine which policies are more likely to be transformed into action and are more likely to be shelved without action. Also, further research can raise questions to determine which factors influence the degree of implementation and process of implementation. As previously mentioned, due to a lack of systematic implementation evaluation methodology and a lack of data, there are limited studies regarding plan implementation. Further study needs to measure the degree of plan and policy implementation using appropriate evaluation frameworks. Further implementation study would bring a better understanding of effective flood mitigation mechanism by revealing the associations among plan quality, policy implementation and flood damage. In addition to implementation research, further research is needed on the efficacy of Community Rating Systems which this study proposed as a policy recommendation for facilitating implementation of flood mitigation policies.

My study categorized 54 flood mitigation policies in an evaluation protocol. While the study focused on the aggregated overall quality score, each policy needed to be assessed on its own impact on flood damage. By more thoroughly investigating the influence of individual components or individual policies, the research would provide insights into the strengths and weaknesses of individual components or policies in flood mitigation. From a practical standpoint, this research would develop clear strategies for selecting appropriate combination of flood mitigation policies.

Finally, further study needs to involve supplemental case studies of communities with best management practices for flood mitigation as well as communities with highly problematic cases. Case studies provide supplemental information for quantitative research, and an opportunity to illustrate stories of successful or failed flood mitigation policies. Interviews with community leaders, planning staff and residents would help understand their respective roles in the planning process and barriers which they experience in implementing flood mitigation planning. This research would not only support statistical results, but also explore the theoretical connections between planning and policy implementation.

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APPENDIX A

Top Five States by Year

Year	Rank	Name of State	# of Claims	Total Insured Losses ($)
1996	1	North Carolina	9,555	189,749,414.66
	2	Pennsylvania	9,366	138,415,527.63
	3	Florida	6,813	105,329,118.67
	4	West Virginia	3,744	63,070,723.78
	5	New York	2,974	38,160,163.21
1997	1	North Dakota	4197	97,486,615.40
	2	Kentucky	3608	79,844,670.13
	3	Minnesota	2983	60,498,571.35
	4	California	2291	44,123,883.51
	5	Texas	2677	36,837,177.53
1998	1	Texas	10,275	265,288,859.99
	2	Florida	7,918	101,693,042.33
	3	Alabama	4,184	94,541,098.00
	4	Louisiana	7,801	78,187,103.92
	5	California	4,504	60,715,232.16
1999	1	North Carolina	11,990	232,553,560.77
	2	New Jersey	6,353	148,450,301.99
	3	Florida	15,637	137,909,784.11
	4	Pennsylvania	2,104	63,291,981.19
	5	South Carolina	1,074	21,901,355.55
2000	1	Florida	10,157	166,664,170.24
	2	Texas	979	14,705,380.38
	3	Oklahoma	404	8,343,541.44
	4	Pennsylvania	464	6,972,836.58
	5	Missouri	195	5,924,558.83
2001	1	Texas	25,507	1,001,132,975.12
	2	Louisiana	6,724	103,261,355.90
	3	Florida	3,330	45,368,736.86
	4	Pennsylvania	552	26,137,089.48
	5	West Virginia	802	13,521,798.01
2002	1	Texas	7,780	198,588,939.17
	2	Louisiana	9,175	130,978,686.36
	3	Mississippi	1,752	19,857,709.90
	4	Florida	759	8,376,332.33
	5	California	283	7,819,129.04
2003	1	Virginia	10,071	226,698,446.81
	2	Maryland	5,338	168,168,280.71
	3	North Carolina	5,546	110,104,255.81
	4	Texas	3,005	53,142,829.26
	5	West Virginia	1,556	21,210,085.12

Top Five States by Year (Continued)

Year	Rank	Name of State	# of Claims	Total Insured Losses ($)
2004	1	Florida	22,075	1,220,916,286.20
	2	Alabama	6,182	360,400,760.25
	3	Pennsylvania	8,930	209,275,738.19
	4	Texas	2,372	60,791,060.27
	5	West Virginia	2,551	49,321,848.08
2005	1	Louisiana	145,942	13,441,548,605.78
	2	Mississippi	17,797	2,466,351,285.52
	3	Florida	20,076	621,312,044.71
	4	Alabama	5,566	293,171,013.30
	5	California	2,408	90,511,284.25
2006	1	Pennsylvania	3,880	122,030,306.98
	2	Texas	3,986	99,088,638.00
	3	New York	2,444	91,529,396.20
	4	Virginia	2,272	44,107,720.51
	5	Massachusetts	1,274	35,761,785.24
2007	1	New Jersey	6,114	155,335,281.42
	2	Texas	3,351	86,400,433.16
	3	New York	2,587	61,043,039.16
	4	Ohio	1,318	40,922,718.65
	5	Washington	717	28,754,265.64

APPENDIX B

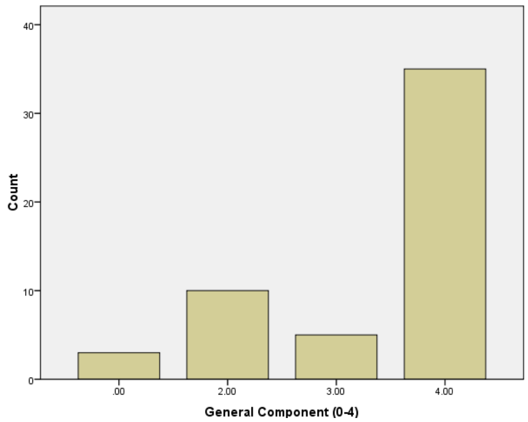
Significant Flooding in the United States (1996-2007)

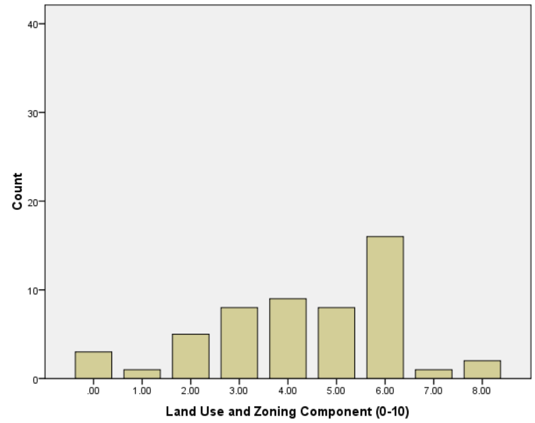
Year	Name of Event	Date	# of Paid Policy	Amount of losses	Average paid loss
1996	Northwest Flood	Feb-96	2,329	$61,903,974	$26,580
	Bertha	Jul-96	1,166	$10,388,364	$8,909
	Fran	Sep-96	10,315	$217,844,647	$21,119
	Hortense	Sep-96	1,381	$20,215,202	$14,638
	Josephine	Oct-96	6,512	$102,604,272	$15,756
	Northeast Flood	Oct-96	3,480	$40,837,392	$11,735
	California Flood	Dec-96	1,858	$39,697,267	$21,366
1997	South Central Flood	Feb-97	4,529	$100,436,961	$22,176
	Upper Midwest Flood	Apr-97	7,398	$160,102,096	$21,641
1998	Pineapple Express	Jan-98	4,228	$57,677,068	$13,642
	Nor'Easter	Feb-98	3,212	$28,011,723	$8,721
	Hurricane Bonnie	Aug-98	2,675	$23,073,621	$8,626
	Texas Flood	Sep-98	4,876	$78,402,450	$16,079
	Louisiana Flood	Sep-98	5,174	$50,987,804	$9,855
	Hurricane Georges (Keys)	Sep-98	3,436	$43,134,378	$12,554
	Hurricane Georges-Ms,Pr,La	Sep-98	848	$14,150,532	$16,687
	Hurricane Georges (Panhandle)	Sep-98	1,680	$23,250,392	$13,840
	Texas Flood	Oct-98	3,190	$143,580,854	$45,010
1999	Hurricane Floyd	Sep-99	20,439	$462,270,253	$22,617
	Hurricane Irene	Oct-99	13,682	$117,922,109	$8,619
2000	Florida Flood	Oct-00	9,276	$158,283,182	$17,064
2001	Tropical Storm Allison	Jun-01	30,662	$1,103,765,221	$35,998
	Tropical Storm Gabrielle	Sep-01	2,418	$34,836,088	$14,407
2002	Texas Flood	Jul-02	1,896	$70,634,069	$37,254
	Tropical Storm Isadore	Sep-02	8,442	$113,691,962	$13,467
	Hurricane Lili	Oct-02	2,563	$36,900,365	$14,397
	Texas Flood	Oct-02	3,250	$88,984,769	$27,380
2003	Hurricane Isabel	Sep-03	19,852	$491,649,350	$24,766
2004	Hurricane Charley	Aug-04	2,608	$50,607,681	$19,405
	Hurricane Frances	Sep-04	4,952	$151,454,257	$30,584
	Hurricane Ivan	Sep-04	27,574	$1,571,160,291	$56,980
	Hurricane Jeanne	Sep-04	5,373	$127,303,899	$23,693
2005	Hurricane Dennis	Jul-05	3,795	$118,898,101	$31,330
	Hurricane Katrina	Aug-05	166,464	$16,016,992,444	$96,219
	Hurricane Rita	Sep-05	9,463	$462,565,949	$48,882
	Tropical Storm Tammy	Oct-05	4,116	$44,728,148	$10,867
	Hurricane Wilma	Oct-05	9,597	$362,866,548	$37,810
2006	Pa, Nj, Ny Floods	Jun-06	6,403	$226,150,757	$35,319
	Hurricane Paul	Oct-06	1,507	$37,233,617	$24,707
2007	Nor'Easter	Apr-07	8,623	$224,651,554	$26,053

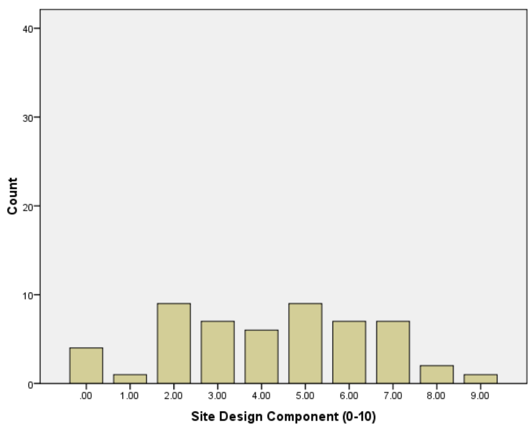
Source: FEMA (http://www.fema.gov/business/nfip/statistics/sign1000.shtm)

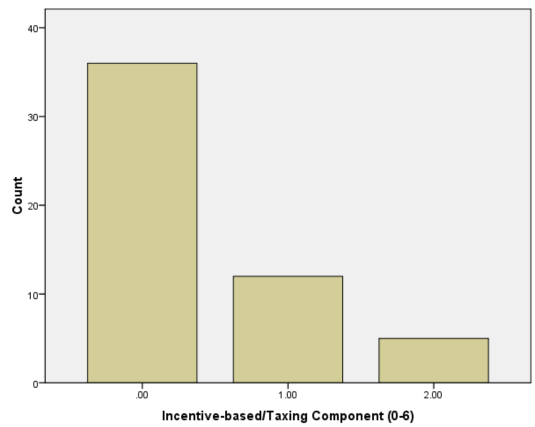
APPENDIX C

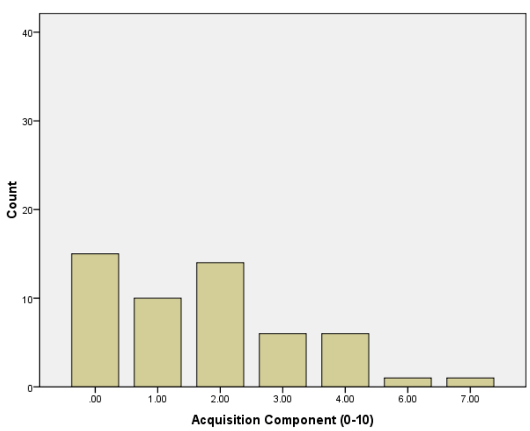
Histogram of Flood Mitigation Policy Components

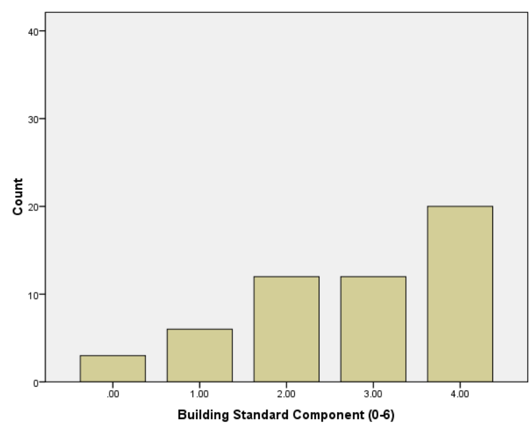


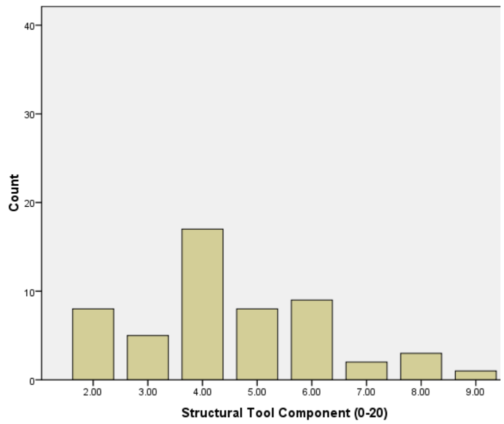








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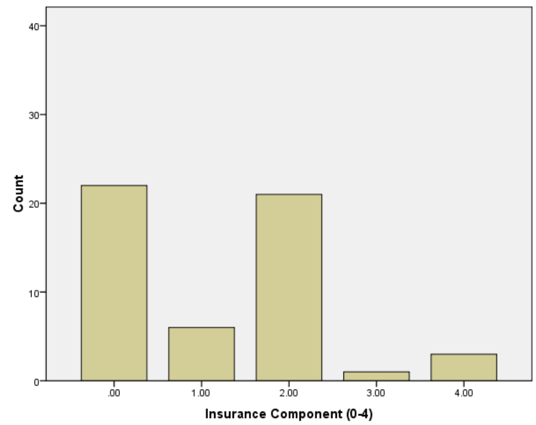
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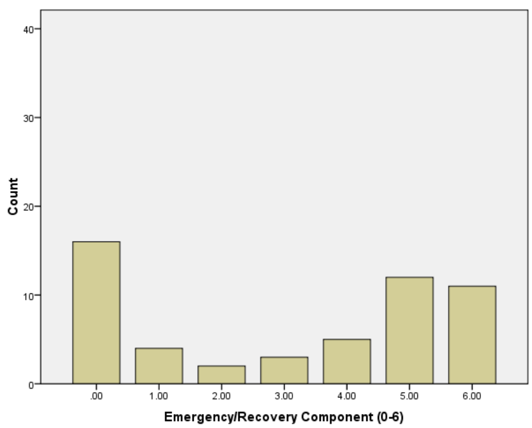
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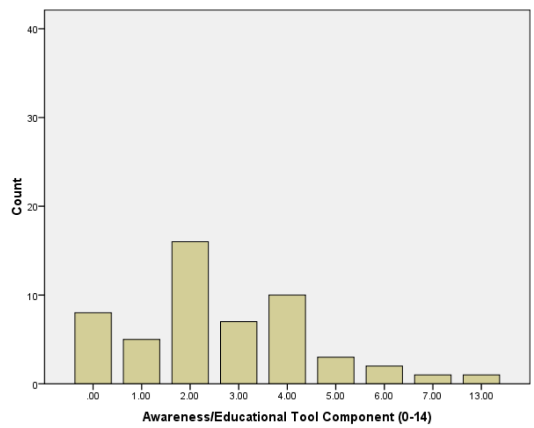
Emergency/Recovery Component (0-6)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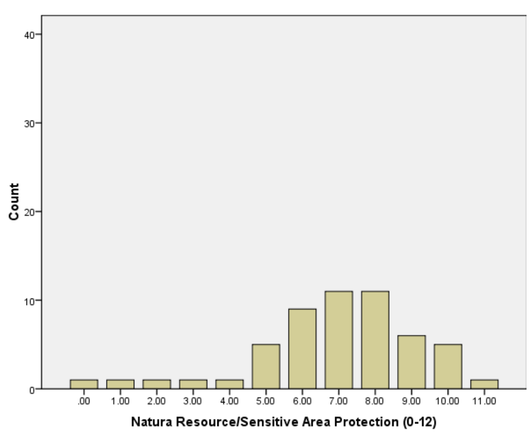
Awareness/Educational Tool Component (0-14)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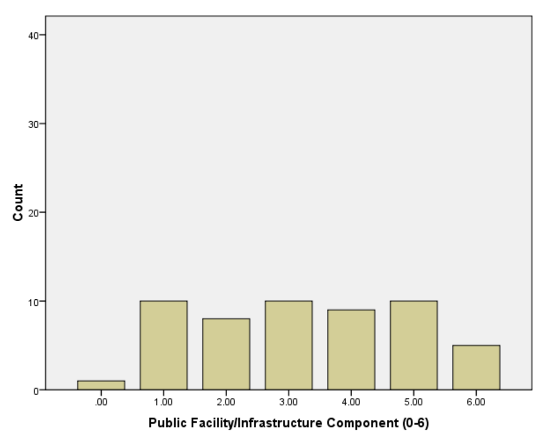
Natura Resource/Sensitive Area Protection (0-12)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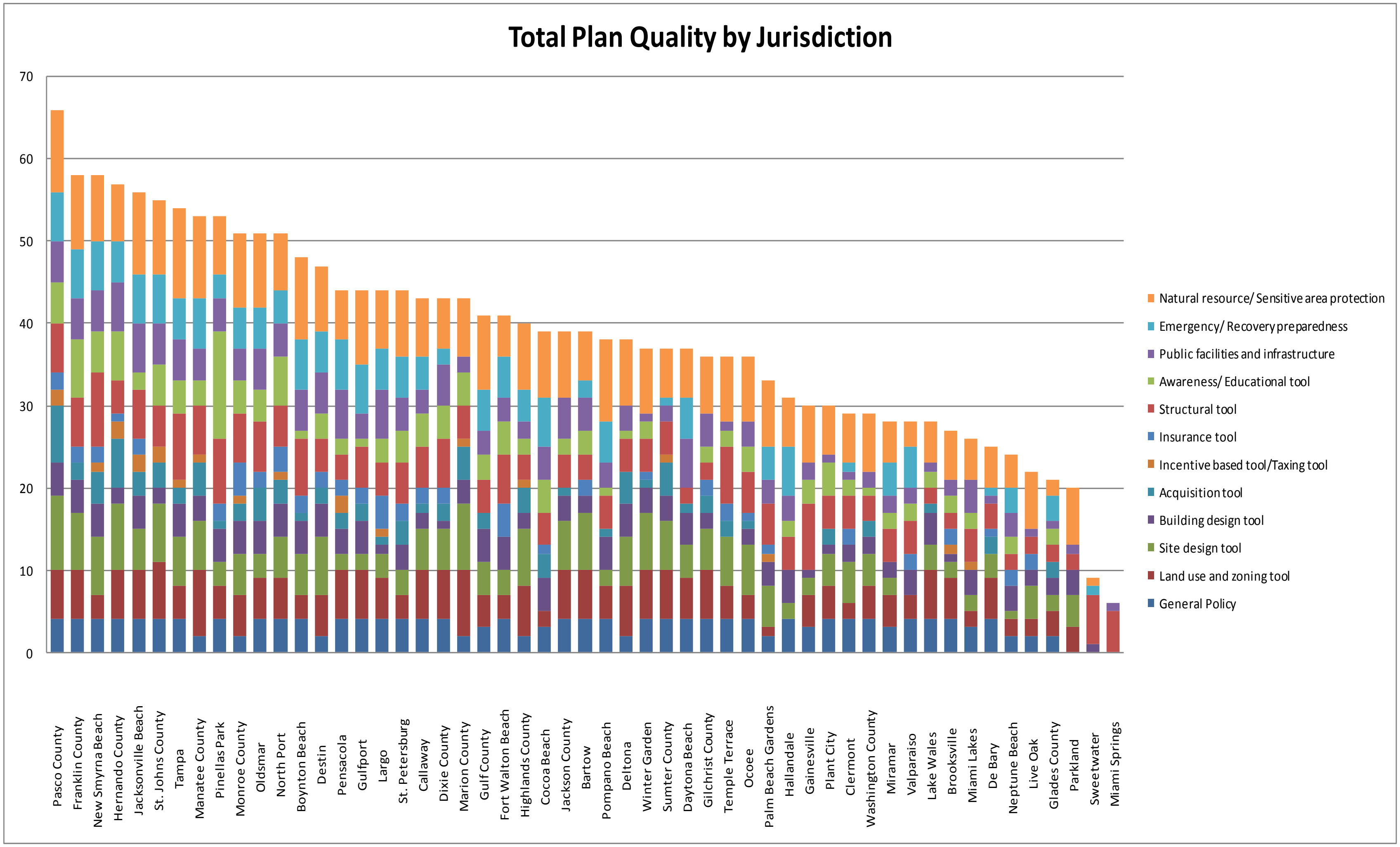
Public Facility/Infrastructure Component (0-6)

APPENDIX D

Total Plan Quality and Flood Mitigation Component Scores by Jurisdiction



APPENDIX F

Flood Policy Response and Planning Capacity Survey

Definitions:

- Repetitive flooding occurs when the same physical location floods regularly or at a minimum of once per five years.
- Repetitive flooding can include, but is not limited to structural damage.
- Flooding does not need to occur only as a result of major storms, but can take place even in response to relatively low amounts of precipitation.
- This type of flooding occurs chronically over time in the same general area.
- Flooding can result in structural damage, roadway damage, and disruption of hydrologic definition.

Purpose:

- This survey seeks to understand how and why communities vary in their responses to localized repetitive flooding.

Instructions:

- Please answer the questions to the best of your ability.
- You may need to consult with co-workers regarding some of these questions.

1. Over the last 5 years, how many floods have occurred in your jurisdiction? Circle the best response.

0 1 2-5 6-10 10 or more

If you responded 0, or no floods in the past 5 years, please skip to question 4

The next questions are about your jurisdiction's use of various techniques *in response to a flood or floods.*

2. Over the last 5 years, how often did your jurisdiction use the following *structural approaches* when responding to repetitive flooding? *For this survey, repetitive flooding occurs when the same physical location floods regularly or at a minimum of once per five years. Repetitive flooding can include, but is not limited to structural damage.*

	Please indicate the extent to which your jurisdiction used a response strategy by using the following scale:	**Never used**	**Used occasionally**	**Used extensively**	**Not within this jurisdiction's authority**
a.	retention/detention/holding	⓪	①	②	③
b.	levees	⓪	①	②	③
c.	channelization	⓪	①	②	③
d.	dams	⓪	①	②	③
e.	clearing of debris	⓪	①	②	③
f.	Other (Please explain): ____________________	⓪	①	②	③

3. Over the last 5 years, how often did your jurisdiction use the following *nonstructural or policy-related approaches* when responding to repetitive flooding?

	Please indicate the extent to which your jurisdiction used a response strategy by using the following scale where:	**Never used**	**Used occasionally**	**Used extensively**	**Not within this jurisdiction's authority**
a.	Stand alone flood plan	⓪	①	②	③
b.	Zoning	⓪	①	②	③
c.	Setbacks or buffers	⓪	①	②	③
d.	Protected areas or conservation overlays	⓪	①	②	③
e.	Land acquisition (e.g. fee simple purchase, purchase of development rights, conservation easements, etc.)	⓪	①	②	③
f.	Education/outreach programs	⓪	①	②	③
g.	Training/technical assistance	⓪	①	②	③
h.	Intergovernmental Agreements	⓪	①	②	③
i.	Referendum (tax)	⓪	①	②	③
j.	Computer models/evaluation systems (e.g. HEC)	⓪	①	②	③
k.	Use of Community Development Block Grants (CDBG) to mitigate flooding problems	⓪	①	②	③
l.	Construction codes	⓪	①	②	③

m.	Specific policies in the local comprehensive plan	⓪	①	②	③
n.	Land Development Code regulation	⓪	①	②	③
o.	Other (please explain): ………………………	⓪	①	②	③

The next set of questions is about your jurisdiction's *ability to respond* to repetitive flooding events. There are many characteristics that help organizations adapt and effectively respond to repetitive flooding.

4. Over the last 5 years, how strong would you say the following characteristics have been in your jurisdiction's flood planning and/or hazard mitigation organization?

Please indicate the strength of each characteristic in your organization by using the following scale:	**Not present**	**Very weak**	**Weak**	**Neither weak nor strong**	**Strong**	**Very strong**
	⓪	①	②	③	④	⑤

a. commitment to planning for a flood resilient community	⓪	①	②	③	④	⑤
b. interest from elected public officials in planning for a flood resilient community	⓪	①	②	③	④	⑤
c. sharing of information among staff members (in the same organization or in other organizations within the jurisdiction)	⓪	①	②	③	④	⑤
d. verbal communication among staff members (in the same organization and in other organizations within the jurisdiction)	⓪	①	②	③	④	⑤
e. sharing financial and personnel resources among staff members (in the same organization and in other organizations within the jurisdiction)	⓪	①	②	③	④	⑤
f. establishment of informal or personal networks among staff members (in the same organization and in other organizations within the jurisdiction)	⓪	①	②	③	④	⑤
g. degree of leadership in the organization's administration	⓪	①	②	③	④	⑤
h. available financial resources to plan effectively for a flood resilient community	⓪	①	②	③	④	⑤
i. available staff members and other personnel to plan effectively for a flood resilient community	⓪	①	②	③	④	⑤
j. quality of data (e.g. flood vulnerability, natural resources, GIS data layers, etc.) with which to plan effectively for a flood resilient community	⓪	①	②	③	④	⑤
k. degree of public participation/involvement in the planning process	⓪	①	②	③	④	⑤
l. ability to adjust policies in response to a flood related problem (i.e. be flexible and adaptive in planning approaches)	⓪	①	②	③	④	⑤
m. ability to think and plan long range (20+ years)	⓪	①	②	③	④	⑤
n. ability to make policies that recognize an interaction between human and ecological systems	⓪	①	②	③	④	⑤
o. ability to hire retain key staff members over the long term (i.e. personnel turnover rate)	⓪	①	②	③	④	⑤
p. ability to adjust local policy in response to declining downstream water quality	⓪	①	②	③	④	⑤

The following questions will provide us with background information on your jurisdiction.

5. **How many full time professional staff members are dedicated to planning and flood mitigation in your jurisdiction?** *(e.g. If you are the only person and split your time between 4 different roles evenly, put 0.25. If there are two full time staff and one part time staff persons, put 2.5).*
   ____________ Full Time Employees

6. **Give an example of a recent flood you consider to be repetitive:**
   a. Date: Month: _____ Day: _____ Year: ____ b. Location (be as precise as possible):______________

7. **Estimate your organization's annual budget dedicated to flood planning**: $0 - $5,000; $5,001 - $10,000; $10,000 - $20,000; $20,001 - $50,000; $50,001 - $100,000; $100,001 - $300,000; $300,001 or greater

8. **How many years experience do you have as a floodplain administrator?** 0-1, 2-5, 6-10, 10 or greater years

9. **How long have you worked for this organization?** 0-1, 2-5, 6-10, 10 or greater years

10. **Name of your jurisdiction (City or County name & State):**
    ____

11. **Your job title (eg. "Floodplain Administrator" or "City planner"):**
    ____

12. **How many events with property damage have occurred in your local jurisdiction in the past 5 years?** 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 or more

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Edwards, J., Kang, J. E., & Silenas, R. (2008). Promoting regional disaster preparedness among rural hospitals. *The Journal of Rural Health*, *24*(3), 321-325

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