Toward a Comprehensive Natural Hazard Mitigation Framework -- The Consideration of Land Use Planning in Coastal Communities

by

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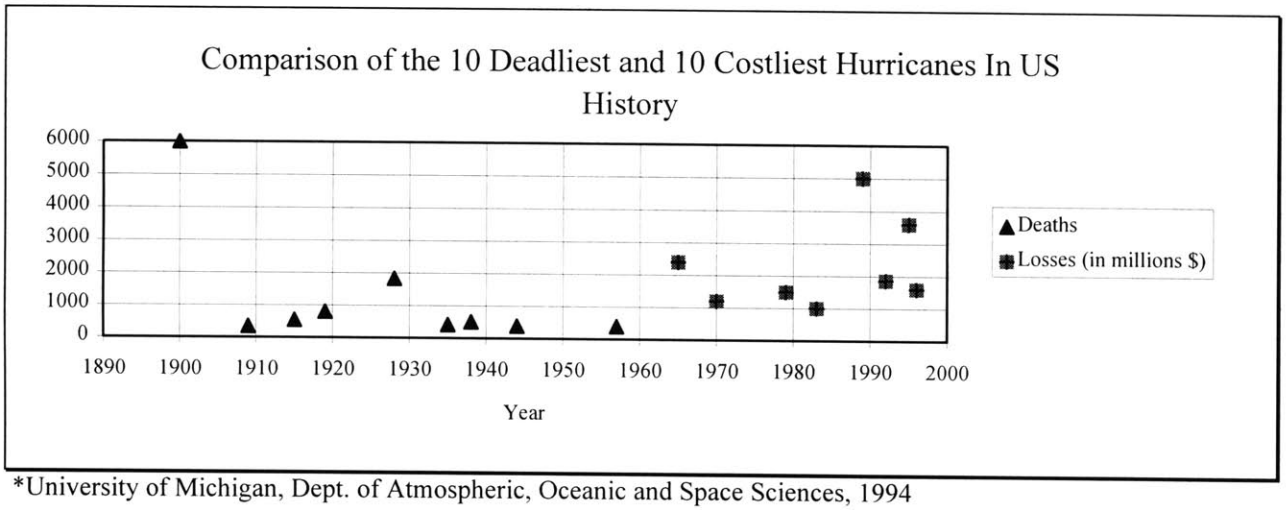
INTRODUCTION

America's Atlantic and Gulf coasts are priceless, delicate treasures. Like all national treasures, our shores attract the attention and interest of millions. For some the coast is a home and a way of life. For others it is a seasonal destination or a favorite place for a short respite. Over the past three decades the population within 5 miles of the coast has grown at three times the rate of the nation as a whole.[1] Unfortunately, this place, from time to time, exhibits destructive energy in the form of gale winds, damaging waves, storm surge, and flooding. A hurricane is a furry bent on having its way.

The 1900 hurricane which struck Galveston, Texas lasted only a matter of hours. Six thousand people were killed, five thousand were injured, and ten thousand left homeless. Despite the glaring of a red morning sky, a foretelling of stormy weather, most of the salty Texans did not bother to prepare. The port city of 40,000, whose numerous wharves served 1,000 ships a year, stood on a barrier island partitioning Galveston Bay from the Gulf of Mexico. After a local weatherman saw his barometer drop he raced his horse cart along the shore shouting about the coming storm. It was too late.[2]

Nearly a century has passed since the Galveston tragedy and little knowledge has been amassed concerning the extent to which coastal localities are addressing hurricanes and severe coastal storm hazards.[3] What is known, however, is that we still experience hurricanes with the same frequency and relative intensity, but the social and economic consequences of living in harm's way have changed. For example, modern technology affords us better weather forecasting and storm tracking provides earlier warning. Improvements in building technology have led to stronger construction materials and improved building techniques. Enhanced disaster management services have expedited the evacuation process and yielded shorter response and recovery periods. The result is a laudable one -- a reduction in hurricane death tolls. At the same time, however, property losses are rising. These divergent trends can be seen in a comparison of the 10 deadliest and 10 costliest US hurricanes in history. (Figure 1.1)

Figure 1.1



*University of Michigan, Dept. of Atmospheric, Oceanic and Space Sciences, 1994

One simple explanation which accounts for the rising costs of hurricanes is that more people "live in harm's way." In other words, the rapid growth on the Gulf and Atlantic coasts has put more property in the path of destruction. More than 36 million people live in hurricane-prone counties with the population expected to grow to more than 73 million by 2010.[4] Concurrent with the coastal population boom development has increased and property values have risen. The property/casualty insurance industry provides one indicator of this via the value of insured property. Between 1980 and 1993, the value of insured coastal property increased 166% and 193% for residential and commercial property respectively. Today, the total insured exposure is estimated at $3.15 trillion just on the Gulf and Atlantic coasts.[5]

Alone, these statistics are daunting and appear to leave little hope for reversing the trend of rising storm costs. However, they do not tell the whole story. Many forces underlie these growth and population trends, all of which affect land use and development along the coast. For example, there are public policies (at all levels of government), market incentives, and technologies which promote development of hazardous areas. Our understanding of these forces, their interaction with each other, and our ability to plan for certain events and mitigate their impact has been far outpaced by this tremendous growth. While the problem may be subtle, it is exceedingly complex and ultimately challenges planners to confront tough choices about economic growth and sustainable development.

This study is about making those tough choices and the impediments to achieving meaningful natural hazard mitigation. This requires an in-depth consideration of this

entanglement which includes politics, policy, economics, and human nature. To date, natural hazard mitigation policy has lacked this sensibility, exhibiting a disproportionate reliance on constructing stronger buildings, coastal engineering (e.g. seawalls, jetties, groins, bulkheads, etc.) and technological advancements in weather forecasting. It has also been reactionary (i.e., consideration of mitigation only surfaces after a severe event) and ad hoc.

The solution is a comprehensive framework (CMF) that emphasizes land use planning, as well as coastal preservation, enhancing the structural integrity of built environment, and market incentives. By stressing land use and local action, the assumption is that localities will be forced to gather and analyze information about the suitability of land for development and enumerate the limitations and risks of developing hazard-prone areas.[6] It is through this systematic process that localities can generate alternatives, inform stakeholders, and make rational decisions regarding the public's health, safety, and general welfare.

WHAT IS HARM'S WAY

This research pertains to the effects hurricanes have on people and property. The following diagrams depict a scenario that is typical of the impact hurricanes have on barrier islands and provides a context for discussing policy alternatives throughout this study.

Diagram 1: Prototypical Undeveloped Barrier Island

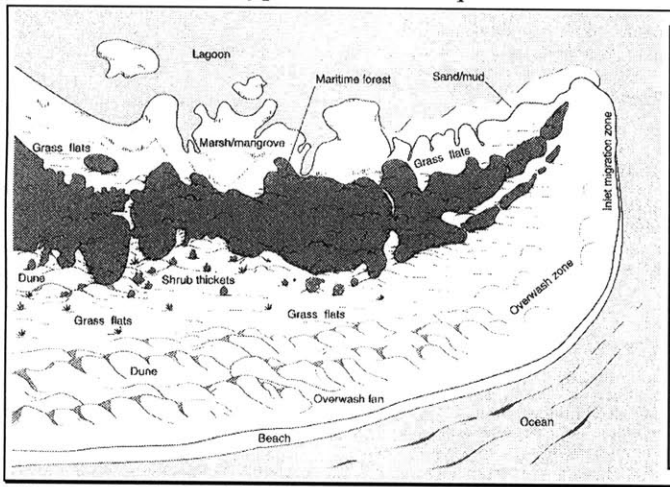


Diagram 1 represents an undeveloped barrier island characterized by beaches, dunes, grass flats, maritime forest, and a lagoon (intercoastal waterway). The most dynamic of coastal land features, these islands constantly change shape from the forces of the ocean and wind.

(Source: Bush, David, Pilkey, Orrin R. and Neal, William J. 1996. *Living by The Rules of The Sea*. Duke University Press. pp. 10-20.)

Diagram 2: Typical Development Pattern on Barrier Island

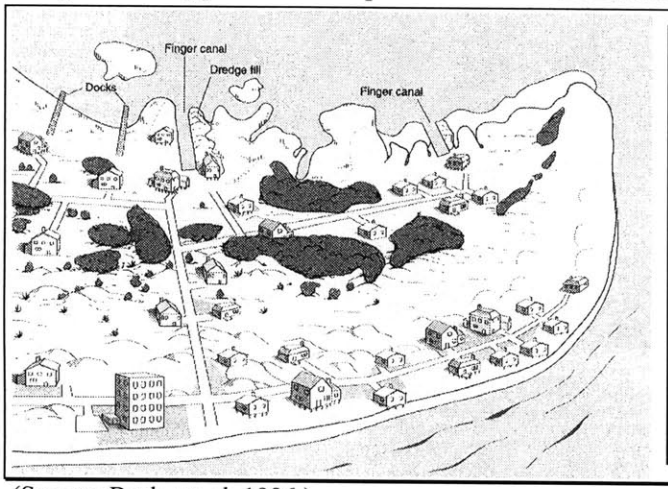


Diagram 2 is an illustration of typical development patterns on a barrier island. Canals are cut on the lagoon side, flat, straight roads carve dunes, and residential and commercial buildings flatten dunes.

(Source: Bush, et. al. 1996.)

Diagram 3: Areas Likely Affected From Hurricane

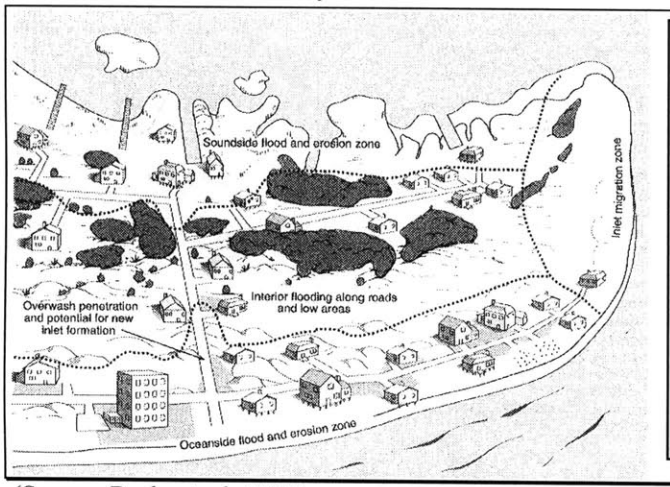


Diagram 3 outlines areas likely to be altered from hurricanes. Although each island is different, this gives a general sense of where and how property is at risk.

(Source: Bush, et. al. 1996)

Diagram 4: Typical Hurricane Impact

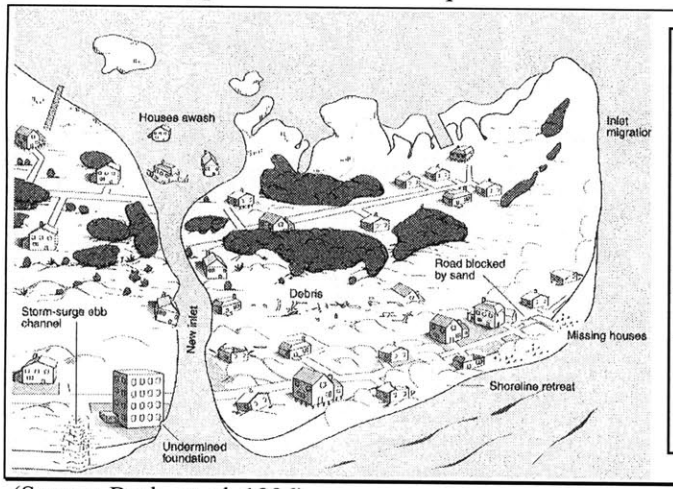


Diagram 4 shows a common hurricane scenario. Notice the new inlet and the path it took over the canal and the roadway. The shore has retreated, roads have been blocked, and homes have been lost in the wash-over channel.

(Source: Bush, et. al. 1996)

TEXAS: A CASE STUDY

Texas provides a fertile case study due to is 367 miles of coast in the hurricane-prone Gulf of Mexico. Texas is also a state where there is very little intervention in the affairs of local government by state government. The implication is that localities engage in planning, or not, on their own accord – a more or less voluntary approach. At opposite ends of the Texas shoreline lie two communities, each on a similar long, narrow strip of sand that parallels the mainland shore. In the north-eastern quadrant of the Texas shore is Galveston, a very old town with a rich history and equally rich experience with hurricanes. After the 1900 storm, Galvestonians had a choice, retreat from the forces of nature, or stay. The city is still there today, 60,000 strong. Along the way, however, a great deal of effort has gone into protecting the people, their property, and the shore from storms. But the tides of development are threatening to put Galveston in the same precarious and vulnerable position it occupied at the turn of the century. Pro-growth sentiments are strong as the city strives to expand its tax base by encouraging development on the west end of the island. Land use planning is not only an afterthought, but perceived as an impediment to the city's prosperity.

Along the south-eastern edge of the state is South Padre Island, a young resort town. Habitation of the island didn't begin in earnest until the late 1920s and early 1930s when wooden causeways spanning Laguna Madre connected North and South Padre Islands with the mainland. However, the town didn't incorporate until 1973 with its first big building boom not far behind. Peaking in the early 1980s, development occurred without much guidance or consideration of natural hazards. This assessment is based on the fact that high-rise condominiums line the beach, unprotected by the natural dunes which once existed but were removed for their construction. Numerous resorts lie in washover channels carved by previous hurricanes, a pattern of development dictated solely by land value. Today, the small town of 3,500 permanent residents continues to see land values rise as plots with beachfrontage grow scarce and vacationers continue to arrive by the thousands. This has led to great pressure to begin developing north of town on a 7 mile stretch of privately owned beach. The prospect for effective hazard mitigation in both instances seems unlikely given local economic conditions, a political climate with limited tolerance for government intervention and a lack of pressure from the state and federal

government to change the status quo. To be sure, the tools exist at the local level to get the job done and the CMF is a promising vehicle for hazard mitigation.

MODE OF ANALYSIS

Before hazard mitigation policies can be property evaluated, it is necessary to explore the elements that influence development and land use in the coastal zone. Chapter 1 looks at the conditions that dominated coastal development very early in this country's history and those which permeate land use today. Chapter 2 and 3 analyze the contemporary forces (i.e. public policy, insurance markets, and technology) that lead to the development of hazardous coastal areas. Consideration is also given to human psychology as a factor. Chapter 4 takes a closer look at the role local governments have in land use and hazard mitigation and proposes a Comprehensive Mitigation Framework (CMF) as a response to the challenges posed by the complexity of the problem. Emphasis is placed on integrating mitigation into community-based land use planning processes. Chapter 6 is a case study on Texas and two of its coastal barrier island communities. Recognizing that each community possess a unique history, economy, culture, and character, not to mention distinct politics and mode of governing, the objective is to assess the chances of each community implementing a CMF.

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[1] NOAA. 1997. Office of Ocean Resources conservation and Assessment. Phone interview.

[2] Lipkin, Richard. 1994. *Nature on The Rampage*. Chapter entitled *Weather's Fury*. Smithsonian Institution, Washington, D.C.

[3] Hurricanes are cyclonic storms formed by the release of latent heat from ocean water condensation. US hurricanes are characterized by counterclockwise, circular winds ranging up to 100 miles around a calm eye. Low barometric pressure generates a localized sea level rise called storm surge. Hurricanes are rated on the Saffir/Simpson Hurricane Scale according to wind speeds ranging from 74 mph to 95 mph (Category 1) to 155+ mph (Category 5).

[4] National Planning Data Corporation, US Census; NPDC is a company specializing in census updates between the decennial residential census.

[5] AIR, Inc. 1995. AIR is a research firm that has focused on developing a database of personal and commercial insured property liabilities by county to estimate insurer exposure to natural hazards. The databases are used with computer models that simulate the physical characteristics of hurricanes and damaging effects on exposed properties.

[6] Burby, Raymond, et. al. 1997. Draft: *Overwhelming Hazards – Land-use Planning for Safer Communities*. College of Urban and Public Affairs. University of New Orleans. October. p. 2.

CHAPTER ONE

INHABITING THE COAST -- AT-RISK FROM THE BEGINNING

Daniel Boorstin, former Librarian of Congress, said the Massachusetts Puritans' "City upon a Hill" prospered because it was really a City on the Sea, referring to the sea as the great opener of colonial markets and minds.[1] To be sure, the very first settlements in America prospered because of their proximity to the sea, but the people were also mindful of its inherent dangers. Perhaps it was this reverence for the sea which led the Puritans to build their city upon a hill, away from storm surge, erosion, high winds, and coastal flooding. And perchance, that initial City on the Sea prospered because it was the City upon a Hill.

The prudence demonstrated by the Puritans, positioning their settlement out of harm's way, was rare. Driven by trade, agriculture, and pragmatism, early settlements found economic growth through trade rooting America's largest cities along the eastern seaboard. There were other reasons for settling the coast; it was the first area encountered by settlers making it a practical and natural place to start. Others found settlement to be more a function of culture, ideals about desirable ways to live, the relation between population and economic centers, and political organization. Assuming there is truth in each explanation, collectively these theories point to one important fact: there have always been numerous forces effecting land-use and development patterns in America. This section will make a brief account of the forces which historically have dominated coastal land use.

The Dutch Set the Tone

The Netherlands has a rich history of coastal engineering dating back to 1220 when the first dikes were built to keep the North Sea from continually inundating much of the territory's below sea-level land. Built both inland and on the coast itself, these first dikes were purely defensive, but later they took on an offensive character, wresting substantial areas of land from the sea.[2] Imposed by its geography, a pervasive need for

solidarity, a coming together to fight against the sea, ultimately dictated the social and economic structures of the country.

Dutch records indicate that severe floods led people to build their homes on artificial hills throughout much of the 14th,15th, and 16th centuries. But with an existing, well established population that was clearly threatened, and with no place to go, the Dutch began building more dikes. For the Dutch, these massive coastal engineering projects served two purposes: (1) to protect villages and towns against the water and sea; and (2) to permit agricultural and urban expansion. Yet many view the Dutch as proof that the sea and nature can be conquered. American engineering journals are full of the details of the Dutch dike system. And from the pages of the glossy magazines and countless school books Holland emerges as a modern industrial nation, all made possible by engineering feats. At this juncture, a serious question must be posed: with a geological history continually working to inundate the 2/5ths of the country that is below sea level, did the engineers construct a false sense of security along with the coastal dikes? Furthermore, do millions in other areas now inhabit hazardous, unstable, risky areas because of coastal engineering? Perhaps in a small crowded nation there is little room to pick and choose the method or scene for development. The engineering of Holland's coastline protects a large population,

*Scientific American, March 1997: Sea dikes protect low-lying areas of the Netherlands from the ocean, which rises above the land in many places. The Dutch government must maintain hundreds of kilometers of dikes and other flood-control structures on the coast and along riverbanks.

considerable agriculture, and valuable industry leading many to the conclusion that the Dutch found themselves, therefore, with no choice but to build dikes.

Colonial Times: Our Own Confrontation With the Sea

The attitudes and approaches that prevailed in the Netherlands were manifest, to a degree, relatively early-on in the United States. Our reliance on engineering solutions to problems presented by nature emerged in the early 1900s, but not before other mitigation policies were contemplated. The thought of destructive storms was never far from the minds of those on the shore as Atlantic and Gulf Coast hurricanes made their mark in the 1800s and early 1900s. In all, there were 14 severe hurricanes from 1796 to 1919. A brief chronology follows:

Chronology of Atlantic and Gulf Hurricanes 1796 - 1919

YEAR	EVENT
1796	Storm surge inundates much of the Florida Keys.
1815	Fall hurricane tops all dunes on Long Island's western shore.
1831	Louisiana fishing village destroyed. 150 dead.
1842	20-foot storm surge with hurricane at Cedar Key, Florida.
1844	Port St. Joe, Florida, devastated from Hurricane.
1846	Key West destroyed after hurricane floods Main Street w/ 5 ft. of water.
1848	15-foot storm surge and hurricane hits Tampa.
1886	Texas seaport of Indianola destroyed by hurricane.
1893	Hurricane w/ 20-foot storm surge inundates Hilton Head, South Carolina.
	2,000 killed in Savannah, Georgia.
1893	1,150 killed in Cheniere Caminada, Louisiana hurricane.
1900	City of Galveston leveled and 6,000 killed in hurricane
1909	350 die in Mississippi-Louisiana hurricane with 15-foot tides.
1919	300 killed at Key West from hurricane and 500 at Corpus Christi in 16-foot tides.

*Source: Pilkey, Orrin H. Jr. and Wallace Kaufman, *The Beaches Are Moving*. 1983. pp. 149-150.

In the early to mid-18th century, most seacoast towns had a relatively small wealthy class, mostly merchants, who lived in good houses on the shore. However, it wasn't until we gained our independence that we actively sought out the beaches for

recreation and a means of escape from one another. After the colonists defeated the British, Philadelphia's new elite began to sail their boats down the Delaware Bay to Cape May, the southernmost tip of New Jersey. It was there that these dignitaries would set anchor, swim in the ocean, and lounge on Cape May's broad, sandy beaches and conceive of the nation's first resort and the undisputed queen of beach cities for almost a century.[3] Following an advertisement written by the postmaster which appeared in Philadelphia's *Daily Aurora* in 1801, Ellis Hughes opened the Hughes Atlantic Hotel. By 1830 six others had opened boarding houses along Cape May and within twenty years it was the nation's most popular resort.[4] Cape May signified a different kind of coastal land use and development that carried forward throughout the nineteenth century. It was centered less on trade and agriculture and more on recreation and tourism.

In the absence of formal hazard mitigation policies, these early settlers practiced mitigation in one way: using natural means of staying out of harm's way such as living on higher ground or behind sand dunes. But these lessons appear never to have been fully inculcated in our society. In fact, the notion of mitigation even appeared in news papers as far back as 1870. The August 20, 1870 edition of the Raleigh *Observer* read:

> "Men cannot build houses upon sand and expect them to stand now any more than they could in olden times...Summer seaside resorts must be built far enough above the tide line to insure safety as well as patronage. People are wary of making hairbreadth escapes in seeking health and rest."[5]

Cape May and other towns like it crafted their own mitigation efforts out of a respect for the power of the sea. Most hotels and other buildings were built behind dunes, and the piers were designed so that they could be taken down in the fall and reassembled in the spring. The first boardwalks at Cape May were merely boards laid on the sand and picked up before storms. Perhaps this behavior was inspired by the fact that two lighthouses fell into the sea due to storm induced erosion at Cape May before 1859.[6]

In 1888, the immense Brighton Beach Hotel on Coney Island, New York, was moved back 2,000 ft. from the shoreline using steam locomotives, an engineering feat that seemed to foreshadow a trend toward a more deliberate means of hazard mitigation that relied on engineering.[7] In 1938 a Federal Writer's Project report said of that year's major hurricane: "There are earnest proposals that seaside resorts pass zoning laws. The

New England Council hopes to persuade owners to build cottages further inland instead of at the shore's edge...Errors of centuries of haphazard building may now be rectified."

While almost totally unique, the Coney Island experience has been followed by mitigation efforts centered on engineering, not the zoning alluded to in the Federal Writer's Project. But along with more sophisticated and wide-spread use of engineering, a host of other mitigation techniques emerged in the 20th century which are discussed in the following chapter. As the traditional influences on coastal land use (e.g. economics, trade, and tourism to name a few) discussed in this section have grown stronger, drawing millions more to the coasts, new forces have arisen promoting more extensive development of hurricane prone regions and entrenching detrimental perceptions about the interface between humans and nature.

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[1] Boorstin, Daniel J. 1965, *The Americans: The National Experience*, Vintage Books, New York, NY.
[2] Herbert H. Rowen. "Netherlands." The New Encyclopaedia Brittanica: Macropaedia. 15th ed. 1994, p.877.
[3] Pilkey, Orrin H. Jr., and Wallace Kaufman, 1983. *The Beaches Are Moving*, Duke University Press, Durham, NC. pp. 164-173.
[4] Pilkey and Kaufman. 1983. p. 165.
[5] Pilkey and Kaufman. 1983. p. 164.
[6] Pilkey and Kaufman. 1983. p. 170.
[7] Bush, David M., Pilkey, Orrin, H. Jr., and Neal, William J., 1996. *Living by the Rules of the Sea.* Durham, NC.

CHAPTER TWO

PUTTING LAND USE IN A CONTEMPORARY CONTEXT: PUBLIC POLICY AT THE FEDERAL AND STATE LEVEL

In a seminal piece on the state of the environment that appeared in *New Yorker* in 1987, Barry Commoner quipped,

> *"...the environment is governed by stubborn, largely unalterable natural forces, while the system of production is subject to human choice. Logically, therefore, the decisions that determine the choice of production [technology] ought to be governed by the constraints inherent in nature. But in fact, the actual direction of governance is reversed."*

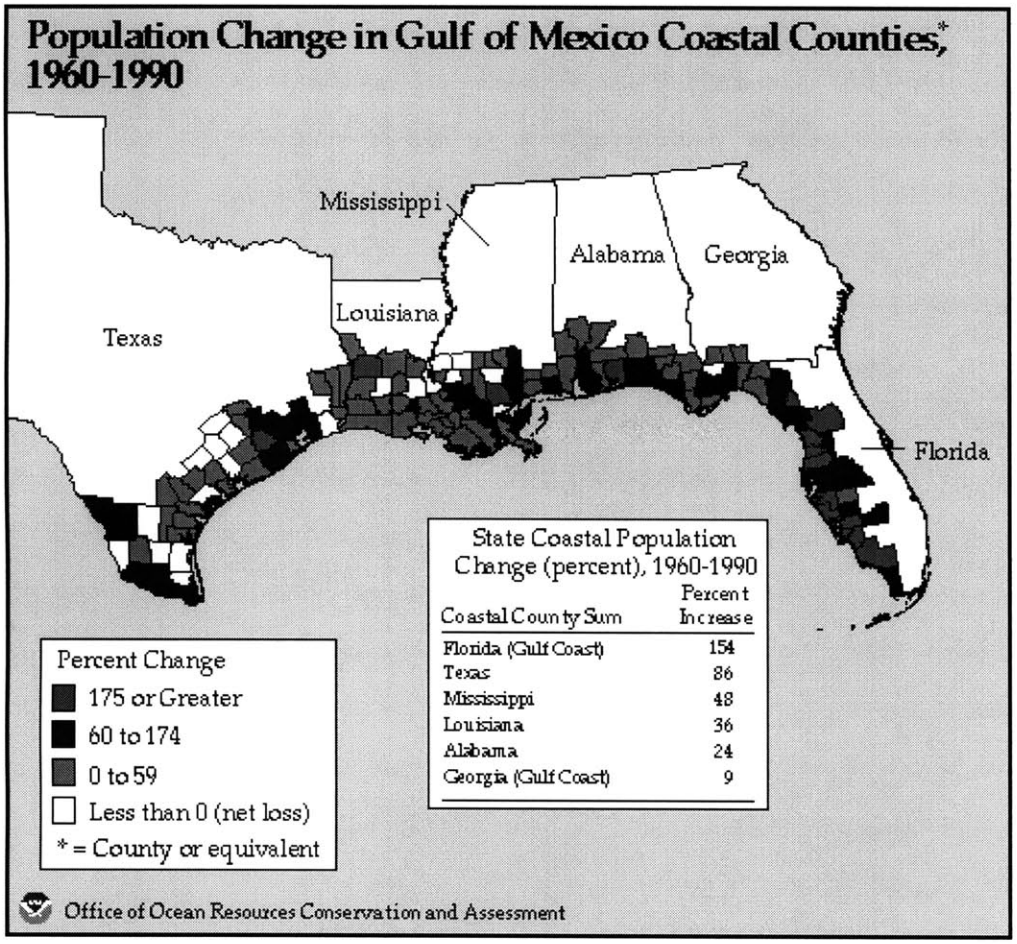
Substituting the word planning for production in this quotation gives it a great deal of relevance. Throughout history, hurricanes, coastal flooding, erosion, and other forms of severe weather have posed a significant threat to people and property along the coast. Judging by the sheer number of people living along the coast today, it is clear that these destructive natural phenomena do not profoundly influence where we live. Instead, through our governance (i.e. planning), we have sought either to control the stubborn, largely unalterable forces inherent in nature or we have disregarded them.

Demographic trends are a testimony to this fact. Undaunted, people continue to move to the Gulf and Atlantic coasts at a rate that far outpaces the growth of the nation as a whole. (see Figure 2.1) Already, nearly half of the country's population resides along this narrow fringe, comprising less than one-fifth of the contiguous United States land area.[1] There are no signs that this trend is slowing. Going forward, of the 20 states expected to have the greatest growth over the next 30 years, 17 are coastal.[2] Looking at the nation as a whole, over 36 million live in the most hurricane-prone counties, a figure that is expected to reach almost 75 million by 2010.[3]

By themselves, these numbers convey no sense of urgency or need for action. However, recent catastrophic events have drawn our attention to the exorbitant costs, both economic and social, attendant with the demographic trends. In 1992, Hurricane Andrew scoured southern Florida, leaving behind $15.5 billion in insured losses and over $25

billion in total economic loss.[4] This event and a rash of other billion dollar losses have led planners, insurers, and economists to examine the constellation of forces that *do* profoundly influence where we live and how we plan. Such forces include, but are not limited to, public policy, the market place, and technological innovation. Noticeably absent from this list are the forces inherent in nature that Commoner referred to in his essay. This section will examine public policy in general, then at the federal and state level, explaining how it shapes the coastal landscape. In addition, I will discuss such policies within the context of natural hazard mitigation.

Figure 2.1



PUBLIC POLICY AND LAND USE

Land use regulation in the United States falls mostly within the domain of local governments. This traditional view of land use being a local prerogative is in many cases

a suitable one, since the function of regulation is necessarily site-specific. However, due to the nature of the coast and the coastal ecosystem, local governments may not have the capacity in terms of financial resources, technical ability, or political willpower to fulfill the role of official protector and conservator of the coastal zone. Further, many of the pressures on the coast originate on a national or regional level, transcending political jurisdictions. Some take the view that local powers are in large part insufficient to effectively manage the coastal region, and state and federal intervention is necessary. Hence, we have somewhat of a patchwork of land use policies in this country.

Within this patchwork, it is clear that many decisions affecting the public are made by public agencies. However, the greater number of the critical choices are the work of private persons on private property influenced heavily, albeit indirectly, by their governments.[5] Many public policies tend to exacerbate the pressures on the coastal zone. To illustrate this point, public policies can be broken down into four broad categories according to the type of impact they have on development and land use in the coastal zone. In general, public policies either promote development or they resist it. This end is achieved either actively or passively (see Figure 2.2). In other words, many policies have an incidental impact on land use where the express purpose of the policy is toward some other goal. Therefore, some policies only passively play a role.

Figure 2.2 Examples of Public Policies According to Impact on Land Use and Development

	Actively	**Passively**
Promotes Dev.	- Directed public investment in infrastructure	- Availability of federal flood insurance (NFIP)
	- Tax incentives	- Federal disaster assistance
Inhibits Dev.	- Sec. 404 Clean Water Act	- Coastal Zone Management Act
	- Endangered Species Act	- Coastal Barrier Resources Act

The first category includes those policies that, without detrimental intent, actively encourage development in high risk areas.[6] This is achieved, for example, through directed investment in infrastructure (bridges, roads, sewers, sidewalks, etc.) and the use of tax incentives, as well as other financial inducements. In these cases, the intention is

clearly stated in the policy itself, that is, to attract development to a specified area. Traditionally, these policies are pursued at the local level, and to a lesser extent, at the state and federal level.

The second category promotes development as well, but only passively. The availability of federally backed flood insurance, in a sense, subsidizes hazardous coastal development in some areas. For example, property owners rebuild in the same locale because no regulation prevents it and because they are able to purchase flood insurance underwritten by the federal government. The result is a damage-rebuild-damage cycle.[7]

The third type of policy, actively inhibits development in sensitive areas. Such policies designate certain areas as unsuitable for development because of the potential adverse impacts on the environment. Policies in this area include Section 404 of the Clean Water Act pertaining to wetlands protection and the Endangered Species Act.

The fourth category pertains to those policies that do not actively inhibit development, but do so through passive means. In these instances, the policy does not expressly preclude development, rather it renders disincentives for development in hazardous and sensitive coastal environs. One example is the Coastal Barrier Resource Act (CBRA) where flood insurance is denied to those living in designated areas. Another policy that falls into this group is the Coastal Zone Management Act (CZMA). The CZMA is somewhat different, however, in that it is a voluntary state-run policy through which guidelines for development along the coast are recommended. Nonetheless, both are passive means for directing land use.

FEDERAL POLICY

Throughout the 1800s and early 1900s, the federal government was not involved in land management, nor did it shoulder any of the risk borne by those who chose to live in hazard-prone areas.[8] Beginning in the 1930s, this policy of noninvolvement began to change with the development and use of the land in flood plains. The value of this land was in agriculture, in the plains states, and in development in coastal areas. What followed was a natural progression into river flood plain control, navigation, and hydroelectric power development.[9]

The federal government took its first step in this direction with the Flood Control Act of 1936 in which it took over water resource development, flood control, and disaster relief associated with floods. At the time, emphasis was solely on structural protection from floods leading to a massive effort to construct dams, levees, and reservoirs. Since then, direct federal regulation of land use has been limited primarily to the protection of wetlands and endangered species. Even more limited has been the effort to address poor land management and consequent increases in risk in the coastal zone. In some cases, the federal government has employed regulatory mandates and incentives to prod localities and states to initiate controls over development, or at least to analyze the hazards present. This activity has come under two policies, the National Flood Insurance Program (NFIP) and the Coastal Zone Management Act (CZMA) and two agencies, the Federal Emergency Management Agency, and the National Oceanic and Atmospheric Administration. (See APPENDIX A for a list of key federal policies affecting the coastal zone) Other policies include federal disaster assistance and the Coastal Barrier Resources Act (CBRA).

The National Flood Insurance Program (NFIP)

The National Flood Insurance Program (NFIP) was created nearly thirty years ago by a sequence of two laws, the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. The NFIP made low cost, federally-backed flood insurance widely available. It was the vehicle Congress hoped would reduce private financial losses caused by flooding, lessen the risks of flood loss through certain land use control measures, and reduce the tax burden from federal disaster relief and reconstruction. Today, in order for a given community to be eligible for flood insurance it must first meet minimum land use requirements. More specifically, the program requires that flood zones be identified (mapped) and minimum elevation requirements be set above an established flood level. In addition, stipulations are imposed for specific flood-proofing techniques for all structures. (See APPENDIX B for details on how communities participate in the NFIP.)

The legislation accompanying the NFIP has tough language for those owning property in a designated flood zone who do not choose to purchase flood insurance. The law says that in the event of a flood, a property owner can not receive certain forms of federal financial assistance such as FHA and VA home mortgages, direct loans, and aid from the SBA. In addition, aid from the U.S. Department of Agriculture is only available to those communities participating in the NFIP and the property owner must have flood insurance. Communities not participating in the program may also find it difficult to obtain permits from the EPA and the Army Corps of Engineers when it comes to water treatment systems, waste disposal, landfills, dredging, and shoreline engineering within the flood zone.

The NFIP has more stringent requirements in the coastal zone because of the greater flood risk. The program differentiates between an inland flood risk and coastal flood risk with the V-zone designation which refers to areas where combined storm surge, wind-driven waves, scouring or erosion, plus the battering action of debris pose a significant risk.[10] The differentiation also involves higher insurance rates, as well as tougher elevation requirements for structures within the V-zone. The applied insurance rates for structures in the V-zone is a function of the structure's elevation in relation to a certain flood elevation, taking into account wave height. Historically, about two-thirds of claims paid by the NFIP are for flood damage in V-zones.[11]

In order to receive flood insurance in these hazardous areas, the following construction requirements must be met:

- The elevation of structures on adequately anchored pilings or columns with the lowest portion of the building above base flood elevation plus wave height;

- The space below this floor must be free of obstructions (fill may not be used to support), or enclosed by break-away walls;

- Structures must be landward of the mean high-tide line, and alteration of sand dunes or mangrove stands that will increase flood damage is prohibited.

These federal requirements are intended to be a minimum, a point of departure for state and local statutes.

The NFIP in Perspective

Historically, the NFIP has fallen short of its espoused goal of reducing exposure in high-hazard areas and shifting the onus to those that create risks. With tremendous development pressures in coastal areas, the stipulations imposed by the NFIP have done little to deter development in flood prone zones. Estimates are that 3,000 new structures a year will be built in V-Zones, thus adding to the tens of thousands of existing structures.[12] The reason is that flood insurance itself is a countervailing force that encourages coastal and barrier island development.[13] The result of providing federally underwritten insurance in high risk areas is a "double dipping" on the part of residents. Not only do tax dollars go toward rebuilding structures in the same high risk areas, but the beach and coastal engineering projects are also remade at exorbitant taxpayer expense.

Another significant problem is that lenders have not required that flood insurance be purchased in the past. A 1990 GAO report estimates that there are close to 11 million properties in Special Flood Hazard Areas (SFHAs 100 - year floodplain), but only 1.4 million are actually have flood insurance. In the state of Texas, compliance with the program ran a paltry 22%, meaning 78% did not have flood insurance. The study showed that many properties are not required by law to have flood insurance because they either have no mortgage, or have a mortgage from an unregulated lender.[14] In recognition of the poor compliance levels, Congress passed the NFIP Reform Act in 1994 which penalizes lenders which do not force homeowners in flood-prone areas to purchase flood insurance. Because it is so new, it is not clear what impact this will have.

Finally, the program has been criticized for not being actuarially sound.[15] In other words, many question whether the rates are commensurate with the risk because for much of the life of the program, it has not paid for itself. While there is considerable debate on the this topic, the federal government provides relief to those who do not use the system by allowing a deduction for uninsured losses in excess of 10% of adjusted gross income. Well short of an insurance policy intended to make a victim whole in the event of a disaster, this tax break may not only dampen participation in the program, but further impede acquiescence on other hazard mitigation efforts.

Improvements to the NFIP -- The Community Rating System

Criticisms of the NFIP have not fallen on deaf ears at FEMA as they continue to make efforts to improve the program. One such effort is called the community rating system (CRS). The program is designed to reward communities for pursuing an exceptional course of action, i.e., going beyond the minimum requirements of NFIP. In all, there are 18 different actions for which CRS gives credit. (See APPENDIX C) The carrot in this case is a reduced insurance premium for property owners within the community based on the community's rating, Class 1 - 10, Class 1 being the best (See APPENDIX C). Discounts range from 5% up to 45% based on this sliding point scale. Local governments carry the responsibility of submitting the appropriate documentation, and demonstrating implementation of different creditable activities. Properties in communities with a Class 1 rating are entitled to a 45% reduction in their flood premiums. To date no community has received a rating of 4 or better, only 2 communities have a rating of 5, and only 10 communities have received a 6.[16] Participation, which is voluntary, has been modest among those communities in the NFIP, representing 64% (928) of the current flood policy holder base. The vast majority of these communities, (96%) maintain a rating of only 8 or 9.

Aside from the meager participation and poor community ratings, the CRS still leaves many questions unanswered. Perhaps the most significant issue is whether some of the activities for which localities receive credit actually reduce damage. Also of concern is whether offering discounts, thus further reducing the premiums paid, in fact further subsidizes development coastal areas.

Coastal Zone Management Act (CZMA)

The federal government asserts an indirect influence on land use along the coast through a number of policies. The Coastal Zone Management Act (CZMA) of 1972 is a prime example. The impetus for the CZMA was a dire need for better management of coastal land and water resources and protection of critical habitat. By the early 1970s, development had begun to take its toll on the shore. The act authorizes all coastal states to

prepare and implement management plans for their shorelines. While the program offers incentives to states for developing coastal zone management plans, including federal funding and technical assistance, it is only voluntary. There are no federal regulatory powers or financial sanctions. Key states such as Virginia, Georgia, and Texas opted out of the program initially, citing the undue burden it would put on development and economic growth. Only recently did Texas join in with final approval of its plan in early 1997.

The CZMA is administered by the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce, which provides funding for state planning and implementation of the program. The key requirements include coastal land-use planning based on land classification, and the identification and protection of critical areas. The designation of areas of critical environmental concern, or areas of particular concern, is the heart of the planing classification. Other important land and water use designations include the categories of permissible uses, areas of preservation, or vital areas, and priority uses. Several states have completed the mapping of critical areas and areas of concern. Many also require permits to build in or alter environments of the coastal zone. The U.S. Army Corps of Engineers may also come into the picture if the development or alteration affects wetlands. In some states, the two permitting processes have been merged into a single application.

Federal Disaster Assistance

The federal government has been in the business of providing financial assistance to states and localities in response to natural hazards for many years. Perceived as another method of subsidizing, or passively promoting potentially hazardous development in coastal areas, disaster assistance is administered by FEMA. There are two major classifications for this assistance: 1) individual and family assistance and 2) public. The former is a grant in aid up to $10,040 through the Individual and Family Grant (IFG) program. This is intended to cover disaster-related expenses such as home repairs not covered by homeowners policies or replacement of personal belongings. FEMA's public assistance is a cost-sharing program between FEMA and the state or locality in which the

disaster has occurred. Designed to cover damages to public facilities, the grants are based on a 75/25 federal-state cost share. Common projects include repair and replacement of bridges, sewers, roads, and artificial public beaches. Only those communities that participate in the NFIP are eligible for public assistance funds. However, those applying for IFG grants need not have federal flood insurance, but must agree to purchase it upon receiving the grant.[17]

FEMA records show that between 1978 and 1988, approximately $88.5 million was dispensed each year as a result of hurricanes and coastal storm events. In more recent disasters, Hurricanes Hugo and Andrew, FEMA has agreed to cover 100% of the cost of the public damages where traditionally a 25% contribution from the affected state government has been required. It is still unclear the extent to which this has promoted development. To be sure, FEMA public assistance funds provide a substantial subsidy to coastal communities, in essence underwriting risk for a variety of coastal public investments.[18] Furthermore, there are virtually no incentives for hurricane-prone coastal localities to locate public facilities out of harm's way. The same is true with regard to designing disaster-resistant buildings. The FEMA reconstruction subsidy generally comes on top of the original federal subsidy used to construct the facility. For example, the Army Corps heavily subsidizes beach renourishment. Once sand is lost or eroded in a storm event it becomes an eligible cost under the public assistance program, a prime example of double-dipping.

A Change in Direction?

The most significant policy shift in federal disaster relief came in 1988 with the passage of the Stafford Disaster Relief and Emergency Assistance Act. It was at this point that the federal government began to stress the notion of disaster mitigation. The Stafford Act created a Hazard Mitigation Grants Program which provides matching funds for state and local mitigation projects. The grants are limited to 10% of the federal share of the public assistance and are thus tied to disaster declarations. In the six years between passage of the Act and 1992, FEMA obligated $43 million to floodproof sewage treatment facilities, drainage projects, equipment purchases, planning programs, training,

and relocation of structures. Approximately 60% of the funds have been used to improve public/private facilities, with relatively little going toward relocation/acquisition and planning programs (i.e., beach management plans, development of hazard mitigation plans, and development of zoning and building code ordinances).[19] Noticeably absent from their agenda has been a land use planning requirement as a condition for receiving such funds.

Another important change that came under the Stafford Act was that mitigation became an eligible expense under the FEMA Public Assistance Program, which allows for portions of the 75% federal contribution to go toward mitigation. FEMA may also stipulate that states and localities take actions to mitigate hazards in order to receive funds. This includes instituting safe land use and construction practices. In addition, states receiving assistance must prepare state-wide hazard mitigation plans with the intention that these plans will force states and their localities to account for their vulnerability to natural hazards and identify projects which can reduce it in the long run. At their discretion, FEMA can completely withhold assistance based on whether the programs and policies in the state plan have been implemented. The bad news is that it would be a politically unpalatable and even unethical to withhold assistance in emergency situations. The good news is that most states that have been required to prepare plans have done so. These efforts and other by FEMA are well-intended and constitute a step in the right direction but it remains to be seen whether they translate into real action and a reduction in losses.

Coastal Barrier Resources Act (CBRA)

Another means by which the federal government indirectly influences land use along the coast, specifically barrier islands, is the Coastal Barrier Resources Act (CBRA). The CBRA was enacted with the specific purpose of restricting federally subsidized development of undeveloped coastal barriers along the Atlantic and Gulf of coasts. The CBRA withdraws all federal incentives for new development from the undeveloped coastal barriers included in the Coastal Barrier Resources System (CBRS) by prohibiting federal expenditures that directly or indirectly promote development (e.g., federal flood

insurance, U.S. Army Corps of Engineers structural development projects, and federal assistance for construction of roads, bridges, water supply systems, etc.). The objective is to place the risks inherent to coastal development on those who choose to live on or invest in coastal barriers.

Does the CBRA work?

While CBRA has accomplished the objective of reducing federal assistance and federal exposure, it has not deterred development.[20] Development has continued on some coastal barrier islands with private financing for high-valued projects such as multi-story condominiums.[21] A number of studies have been conducted to document CBRA's effectiveness. With the use of case studies, David Godshalk found that at least initially, the loss of subsidies did serve to slow development. The caveat, however, was that for larger forms of development (e.g. condominiums and multi-family projects), developers were able to find replacement insurance and were also able to replace other subsidies and sources of funding.[22] One community that served as a case for the Godshalk study, Topsail Island, NC, a small community on North Carolina's outer banks, was recently leveled by Hurricane Fran.

The most recent study of CBRA conducted by the U.S. General Accounting Office (GAO) in 1992 analyzed 34 CBRS units. Using aerial photography (over time), building permit data, and field visits, the inquiry revealed that 9 of the 34 units had experienced development since 1982.[23] In total, 1,200 new residential units had been erected on these units, with further development slated for the future. The GAO report also found that nearly 10% of property owners in the CBRS were able to get flood insurance.

Conclusions on Federal Policy

While general in nature, this survey of coastal federal land use policies leads to some important conclusions. First, land use policy in the US tends to be disjointed, spread over numerous different agencies and departments, and devoid of a single, comprehensive direction. The second conclusion, a direct result of the first, is that the

federal government not only sends mixed messages to its citizens about land use in coastal areas, but actually pursues conflicting policies. As indicated, there are several federal policies that can, and do, influence the coast and its development. On the one hand, the federal government provides a number of different subsidies to coastal development, including making available federally subsidized flood insurance through the NFIP, disaster assistance funds, income tax code provisions (e.g., casualty loss deductions), and a host of infrastructure subsidies (e.g., funding of roads and highways, sewage treatment plants, etc.). At the same time, the federal government pursues conservation and coastal resource protection through CBRA and the CZMA, in addition to acquiring coastal areas for national seashores and wildlife refuges. In sum, the federal government has done more to confuse the issue than to advance land use planning to manage losses from natural disasters.

STATE POLICY

Aside from actions prompted by the Coastal Zone Management Act, the National Flood Insurance Program, Section 404 of the Clean Water Act, and the Endangered Species Act, each state pursues only that which it deems necessary in the way of land use regulation. In a sense, all fifty states have their own land use policies and requirements, only a few specifically directed toward mitigating risks from natural hazards. States generally follow one of three general approaches. The first approach is for the states to directly intervene, in which case they exercise regulatory powers over local decision making. Second, states may establish a planning processes that requires (or encourages) localities to do what the state asks.[24] And third, states may opt out all together and let local governments do what they see fit.

States most often use the power to regulate as a means of influencing development along the coast. These rules are often imposed on new development in wetland areas, sand dunes, and high erosion areas. Some states, thirteen to be exact, use setback requirements as a means of moving new development farther back from the shore. For example, North Carolina's Coastal Area Management Act directly regulates shorefront development through an erosion-based setback standard and development in

other sensitive coastal lands (e.g., coastal marshes). In Texas, the Dune Protection Act and the Open Beaches Act require certain local governments to adopt and implement programs for the preservation of sand dunes.

The second approach, setting up planning processes, is more rare. These process oriented efforts consist of state mandates requiring local governments to develop comprehensive plans whereby localities are given broad policy objectives by the state and left to fill in the details. The hope, or intention, in many of these cases is that the locality will take an integrated approach and integrate natural hazard concerns in the development of their comprehensive plan.

The oldest standing comprehensive land use mandate is California's – sixty years old. The law requires each planning agency and legislative body of each county and city to adopt a comprehensive long-term plan for the physical development of the county or city. Pertaining to land use and hazard mitigation, each plan must include a land use and conservation element. In 1972, the law took a dramatic step by integrating hazard vulnerability into its list of requirements with a safety element. The safety element was added for the protection of the community from any unreasonable risks associated with earthquakes, tsunami, flooding, wild land and urban fires. Under the law, each community must map known seismic and other geologic hazards to be used in the overall planning process.

States have also experimented with using a blend of incentives and disincentives to influence land use decisions. Florida, for example, restricts future public investment in infrastructure in hurricane prone areas. Other states use the provision of low interest loans for funding mitigation programs undertaken by local governments. In this regard, the Texas Water Control Revolving Fund dispenses money for structural and non-structural controls for floods. Most states will, at a minimum, make maps available to localities to facilitate their planning exercises.

Conclusions on State Land Use and Development Management

State land use and hazard mitigation policies are similar to those for federal policy in that they are generally devoid of any clear direction. Where states do well is in the

regulation of development in environmentally sensitive areas such as wetlands where efforts to enact state regulations or mandates addressing development within areas subject to natural hazards is virtually non-existent. To the extent that the two overlap, the consequent reduction of development in these regions serves to limit risk and exposure, thus reducing the likelihood of losses to future hurricanes.

An assessment conducted by Raymond Burby indicates that there is a small correlation between local governments' success in managing development in hazard prone areas and state comprehensive planning requirements. Not only are localities more inclined to do comprehensive planning as a result of such mandates, but the plans are more likely to be factually substantiated with well articulated goals, and possess stronger overall guidance for development. In this regard, state-mandated comprehensive planning makes sense. However, compliance with such mandates is erratic and local attention to hazards under such mandates is not guaranteed.[25] Another concern is the degree of variation among plans in terms of quality and implementation (i.e., impact on development).

The relative impact state planning mandates have on hazard reduction is yet unclear. To pursue land use planing policies and hazard mitigation from the state level may not be the most effective strategy. To date, less than one third of the states subscribe to this particular method, namely comprehensive planning.[26] Furthermore, among those that do, there have not been any major shifts in land use and development management and the outcomes vary considerably among states depending on policy design and political will at the state level. Perhaps more important than a commitment at the state level is a commitment at the local level to bring about this type of change.

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CHAPTER THREE

TECHNOLOGY, PRIVATE MARKETS, AND THE HUMAN PSYCHOLOGICAL FACTOR

Public policy's role in shaping land use and hazard mitigation policy is accompanied by at least three other factors: implementations of various technologies, private insurance markets, and human psychological responses. Each exert a degree of influence on land use with concrete implications for reducing losses from hurricanes.

TECHNOLOGY

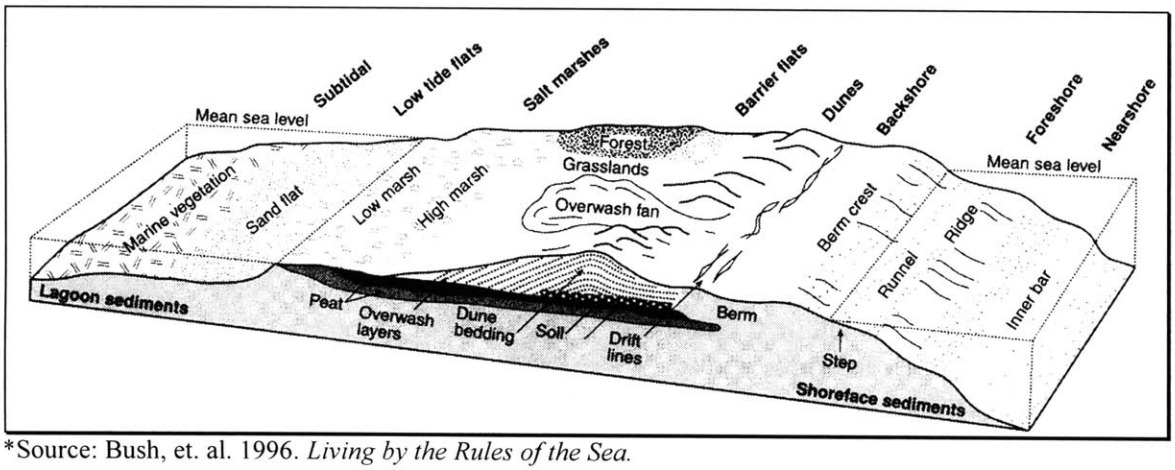
Modern technology has served to facilitate coastal inhabitancy from the advent of the air conditioner to the proliferation of the automobile. Perhaps of greater significance has been the widespread use of coastal engineering, advanced construction techniques, the use of building codes, and the emergence of satellites to predict and track hurricanes. Together, the implementation of these technologies on coastal development has been substantial.

COASTAL ENGINEERING

Coastal engineering faces an seemingly insurmountable task as a line of defense from nature's elements. Consideration must be given to the make up of barrier islands and the extent of the forces present there in order to understand the technical benefits and shortcomings of coastal engineering. Barrier islands, where some of our most dense coastal development resides, act as the interface between the ocean and land, bearing the full impact of atmospherics and oceanographic energy.[1] In other words, they are nature's line of defense between the mainland and the sea. They are but an unconsolidated mass of gravel, sand, and mud, surrounded by ocean and sound waters. Some common attributes are their low elevation, narrow width, and meager vegetation cover. Because of their make-up and precarious local, they are susceptible to wave erosion, over-wash, longshore drift, flooding, flood scour, wind and dramatic sand movement during storms. Figures 3.1

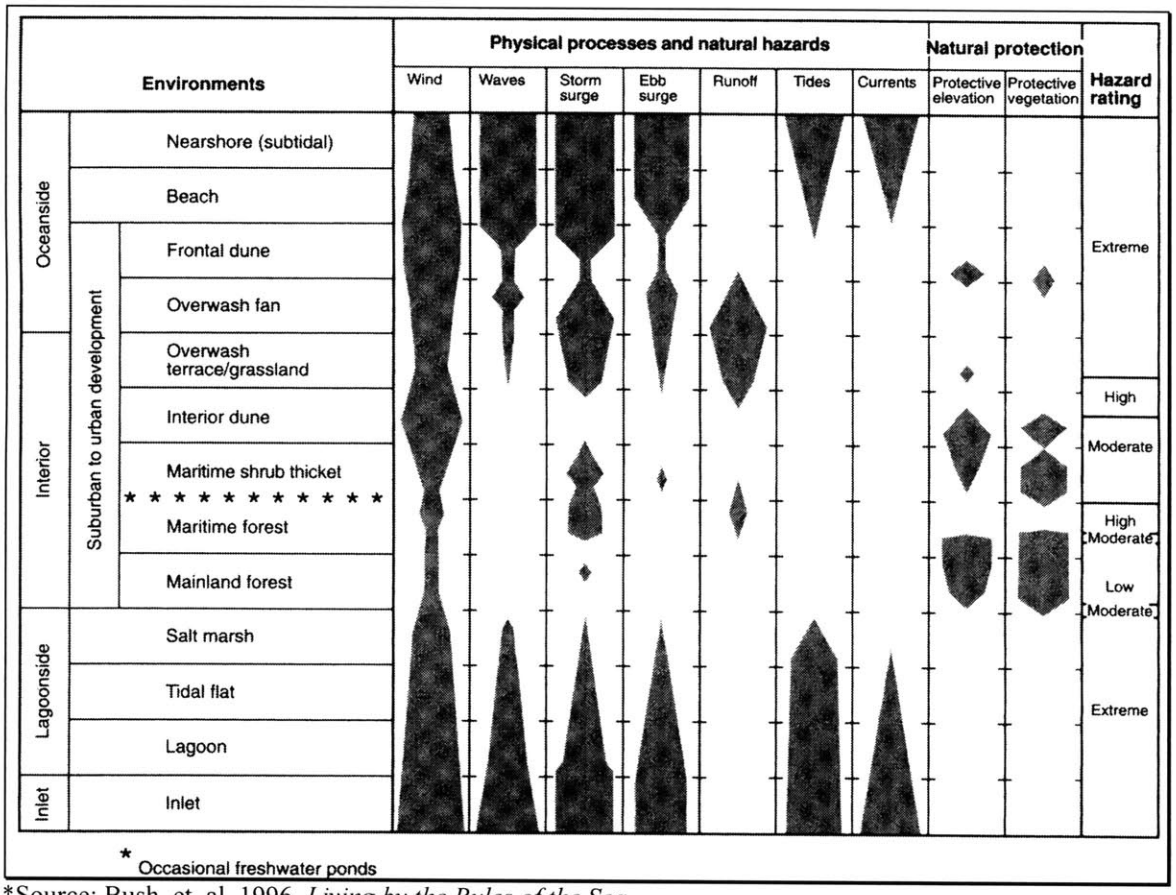
shows the various coastal environments and Figure 3.2 outlines typical impacts. The wider bars in Figure 3.2 indicate greater frequency and/or intensity of the action. The most important aspect of this chart is that the environments subject to development all experience intense processes and generally have limited natural protection.

Figure 3.1



*Source: Bush, et. al. 1996. *Living by the Rules of the Sea.*

Figure 3.2



*Source: Bush, et. al. 1996. *Living by the Rules of the Sea.*

Coastal Engineering in Practice

Less than one year after the tragic 1900 Galveston Hurricane, a board of engineers was appointed to devise a means of protecting the city from another event of such magnitude. The engineers proposed that a solid concrete wall be built along the shore. The top of the seawall was to be 17 feet above mean low tide and it was to span 3 miles. The initial phase was completed in 1904 and today, the wall extends over 10 miles of the Galveston shoreline. The Galveston seawall is illustrative of our propensity to "engineer" protection from coastal forces such and hurricanes. What is lost in this tactic is that erosion, flooding, and high winds have only become hazardous with our occupation of the coastal zone. Today, some element of coastal engineering is present in nearly every coastal community as bulkheads, rip-rap, jetties, groins, revetments, breakers, and other hard structures. This investment in engineering hard structures along the coast has come at substantial cost, both financially and environmentally.

Coastal engineering consists of both hard and soft stabilization of the shore. Hard stabilization refers to the construction of structures to hold the shore in place and keep the waves out. Soft engineering implies shoreline maintenance through the addition of new sand to replenish an eroding beach, or planting vegetation to hold sediment in place. The objective of both hard and soft engineering is the same, to protect property along the shore.

Hard Stabilization

There are three types of hard stabilization: 1) land-based shore-parallel; 2) offshore shore-parallel; and 3) shore-perpendicular. The first category consists of seawalls (wood, steel, rock, or concrete structures designed to halt the retreat of the shoreline into a line buildings), bulkheads (similar to seawalls), and revetments (consist of an armor of rock facing on a dune or beach slope designed to act as a buffer to the waves).[2] Seawalls, and the other land-based shore-parallel structures, fail as a means of protection in one very important respect: they facilitate shoreline and beach erosion. A seawall does not absorb all of a wave's energy, rather it displaces that energy by reflecting, scouring, and eroding sediment in front of and down current from the seawall.

In essence, they deprive the area of the resource that gives it all its value, namely the beach.

Offshore shore-parallel structures, called breakwaters, are specifically used to dampen wave energy as a means of protecting the shore. The result of breaking wave energy offshore is an accumulation of sand behind the structure, thus widening beaches. The problem is that as sand accrues in one area, it is taken from another, starving downdrift beaches of sand.[3] The third type of structure, shore-perpendicular, is designed to block the along-shore flow of sand, trapping it in strategic areas for beach creation. Groins, which run perpendicular to the shore, are made of rock, wood, concrete, and steel, and are the most common implementation of this technique. Jetties differ only in that they are used to stabilize navigational entrances and inlets. The problem with groins is that they cause intense erosion on the downdrift side of the structure, depending on the net littoral drift. Jetties suffer from the same problem, only it is more pronounced because the interruption of longshore sediment transport is more complete.[4] It should be noted that none of these structures and/or techniques serves to protect property from high winds, storm surge, flooding, and the host of other perils that accompany hurricanes. Yet, many coastal residents have great faith in these structures, not only as protection from nature's day-to-day routine, but its anomalous events as well.

Soft Stabilization

Soft stabilization is pursued through beach replenishment, dune building, and the planting of beach vegetation. Beach replenishment involves moving large amounts of sand from some offshore or offsite source, to a beach area suffering from erosion. This method is perceived as a means of protection for buildings and enhancement of recreational resources. Replenishment is often carried out by dredging a nearby shipping channel and pumping the sand along a pipe to the desired location. There are strong regional differences in the lifespan of replenished beaches. Along the U.S. East Coast, in the barrier islands from Cape Canaveral to the south, replenished typically beaches last nine years; from Cape Canaveral north to the Florida state line, the typical lifespan is five

years; between Florida and New Jersey, two to four years; and along southern New Jersey, two years.[5]

There are several deficiencies with this approach beginning with cost. Pumping sand from offshore costs $1 million per beach-mile, or alternatively, between $2 - $12 per cubic yard for dredging. The average sized project involves one million cubic yards of sand per mile. Based on these figures, it will cost the state of New Jersey $3 billion over the next fifty years to replenish a 36-mile strip of beaches.[6] And this is only for treatment of a symptom of a larger problem – the beaches move naturally.

Finally, many of these projects come at significant cost to the environment. In Boca Raton for instance, it is believed that coral heads were destroyed as the result of a replenishment project that extracted sand from an offshore source. On the other hand, replenishment has done well by meeting one of its objectives, bringing people to the shore. Development has increased in density where large replenishment projects have been completed in Carolina Beach, North Carolina, and Jacksonville Beach, Florida.[7]

The greatest protection afforded coastal buildings are beach dunes. Often overlooked in the past, dunes have for years been excavated for ocean views, building sites, or notched at road terminals for beach access.[8] Wherever dune removal or notching has occurred for development, the possibility of inlet formation, overwash channel formation, and wind damage has increased. Consequently, the augmentation of existing dunes and artificial construction of new dunes has become an important and useful form of coastal engineering. Although the best dune is a natural one, artificial dunes can be constructed over time using sand fencing, planting suitable vegetation (e.g. beach grasses), and imposing appropriate land use restrictions where dunes exist.

The soft stabilization methods are generally considered to have less of an environmental impact, but still present problems over the long-term. Beach replenishment is a costly and ephemeral treatment for a much larger problem that we have no control over. Dune building offers a more sensible approach but it is a lengthy and difficult process that is never as good as what was there to begin with.

Conclusions on Coastal Engineering

In most cases, coastal engineering is expensive where the financial cost has been borne by the federal government (i.e. the American taxpayer) and the environment. But the reality is that these areas, which are susceptible to natural hazards, often possess attributes that make them attractive for economic use.[9] At a very early stage, huge investments were made in such areas leading engineers to look for ways to reduce risk while continuing to reap the rewards of vulnerable locals. Poor development siting and inappropriate island alterations have been the necessary evil of development in these areas.

Researchers have concluded that, to date, it is unclear whether the benefits gained from such efforts outweigh the costs and shortcomings of this approach, where complete protection has been elusive.[10] A report prepared for the U.S. government indicates that fully two-thirds of national losses in flooding result from catastrophic events that exceed the design limitations of engineering works that are relied on to provide safety.[11] These findings suggest that despite the fact many people and business tend to view the structures as affording complete protection, all they do is induce development in hazardous areas. The incidence is one of increasing, not decreasing exposure to, and likelihood of catastrophic losses. Localities have contributed to this loss scenario by waiving requirements for building elevation because they overestimate the degree of protection of structures behind seawalls.

Along the coast, hundreds of miles of shoreline have been engineered to protect property from hurricanes and coastal storms so that in cases such as southern New Jersey solid walls of concrete and rip-rap now line the shore rather than dunes and dry-sand beach, which have all but disappeared. The key is to preserve, not engineer, the coastal environment by disturbing it to the least extent possible. Where feasible, attempts should also be made to augment natural dunes, and/or restore them when they have been damaged.[12] Coastal preservation one essential element of natural hazard mitigation.

BUILDING CODES

Today's residential structures have come a long way since the days of log cabins. Current structures have the benefit of better construction techniques and materials that have been developed throughout this century. Better materials such as impact resistant windows, engineered trusses, and composite roof shingles have increased the standard of building construction. Improved construction techniques such as minimum spacing requirements for wood framing and minimum fastening requirements have also added to building quality. Unfortunately, many commit a leap of faith when they assume that simply because of better construction materials and techniques, current structures are necessarily safer. The truth is that standards (codes) and workmanship are just a component of safety.[13]

Typically, local governments have resided over the enactment and enforcement of building codes. However, there are three national model building codes providing states and local governments with the option of enacting all or part of the recommended code provisions. These codes establish minimum standards for new or proposed construction, and contain provisions applicable to existing construction as well. According to a survey conducted by the Federal Trade Commission, 97% of the building codes used in the country are based on the model building codes, indicative of a heavy reliance on these standards.[14]

Although building codes have been important in mitigation of damage from several natural hazards, they have been effective as a means of preventing wind damage, even hurricane winds. Each code specifies minimum wind loads for design. For example, the SBCCI uses a wind speed map, developed for each locality, to determine the appropriate wind load pressures at various wind speeds for proposed structures. In addition, localities subject to severe wind levels have taken these provisions further and adopted building requirements to meet their needs. For example, Galveston, Texas has adopted a wind load at 140 mph.

Shortcomings: Enforcement

Despite steady progress in our knowledge of how to build better structures, at an affordable price, Hurricane Andrew left the impression that this know-how is simply not enough. Investigations following Andrew showed evidence of major deficiencies in code enforcement and construction techniques.[15] Armed with one of the strongest codes in the country, Dade County suffered a disproportionate amount of inland damage because of inadequate inspection and enforcement procedures. Poor code enforcement was attributed to limited staffing and a general lack of expertise among inspectors. Even prior to Andrew, various surveys and damage evaluations in coastal areas concluded that the lack of code compliance and enforcement – not the particular standards written into the codes – resulted in wind damage.[16]

The onus, however, should not lie completely with the inspector. Contractors must also be held accountable for poor construction. It is clear that builders are racing against the clock because time is money. For example, pneumatic nail guns allow a single worker to shoot hundreds of nails in a day. But the fact is that unless that worker has pride of workmanship and self inspects for quality, a number of those nails could be missing their intended targets. Is it the role of the inspector to inspect every nail on each of the 20,000 new buildings constructed in Dade County each year? Moreover, is it efficient?

Conclusions on Building Codes and Development Patterns

As with each of the previous subjects, it is important to consider how, if at all, building codes affect development patterns. At this point, it cannot be said that codes influence the location of development. The best that can be said is that competent enforcement of sound codes tends to raise the general standard of the built environment, affording more safety to the occupants, the property itself and adjoining property than would exist without the codes. But the codes and code enforcement give many a false sense of security.[17] Many homeowners in hazard prone coastal areas tend to vest an excessive amount of faith in not only the safety of their homes, but their ability to endure the elements without sustaining significant damage. Therefore, codes make people feel

better about building and living in high-hazard areas. Yet no building code is intended to leave a house standing after a category 4 or 5 hurricane passes through.

Building codes are an integral piece of the mitigation framework. They the only piece that directly addresses the risk of damages from wind. As such, efforts to develop stronger codes, train building officials to improve code enforcement, educate those doing the construction, and transfer new building materials from the research lab to the market are a must. In order to allow technical innovation and progressive improvement in building construction, the model codes are moving in the direction of performance oriented requirements.

WEATHER DETECTION SYSTEMS AND EARLY WARNING SYSTEMS

Early warning systems are perhaps the oldest method of hazard mitigation and are still prevalent today. Some systems focus on reducing losses immediately preceding the onset of a hazardous event such as home phones that ring automatically to signal rising flood waters. The best methods, however, have been established by the federal government and are more technologically sophisticated. With a long history of involvement in the forecasting and weather research, the National Weather Service and its National Hurricane Center in Miami are our primary source of information concerning hurricane and storm tracking, and local evacuation and preparedness. Today, a variety of satellite imagery technologies including infra-red (IR) and color IR, are used to identify and track hurricanes from their earliest signs of development. (see Figures 3.3 and 3.4).

While the NWS has historically provided dependable and state-of-the-art information concerning hurricane location and movement, experts in 1983 were in general agreement that advances in hurricane prediction and forecasting that would radically increase the amount of warning time were not likely. The Hurricane Center stated that for the average hurricane it can usually only provide between twelve and sixteen hours of warning before hurricane landfall occurs. But technology has advanced to where computer modeling may eclipse satellite imagery as the preeminent tool for hurricane detection and tracking.

NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) has developed a Hurricane Prediction System that is the result of more than a decade of R&D by a small group of GFDL scientists. During the last two hurricane seasons scientists at GFDL and at NOAA's National Meteorological Center (NMC) in Camp Springs, MD, have been comparing this new system with their operational hurricane forecast models.

Figure 3.3

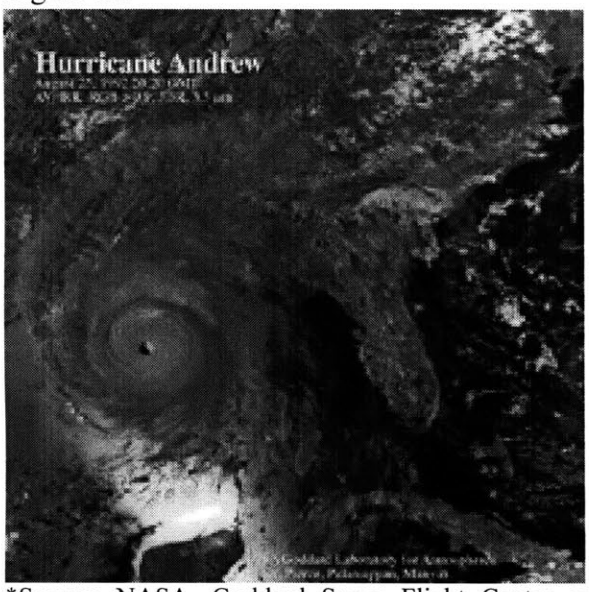
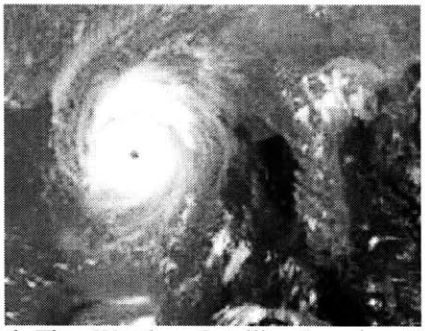


Figure 3.4



*Source: NASA, Goddard Space Flight Center and The Weather Satellite Imaging Page at http:// users.vnet.net/syzygy/homepage.html.

Because of its success in forecasting in Hurricane Emily (1993) and other tropical storms during the 1993 hurricane season, NMC decided to run the GFDL system as part of its operational hurricane forecast suite in a parallel test mode during the 1994 season. The redesigned model exhibited a ten-fold improvement. It forecasted 60 cases for the Atlantic, 148 cases for the eastern Pacific, and a few experimental cases for typhoons in the western Pacific. Comparisons of the GFDL model's storm track forecasts with those from current NMC hurricane models for 1994 tropical storms in the Atlantic indicate that the GFDL system is in the top performance group for forecasts out to 36 hours and is superior to all other forecast models at 48 and 72 hours.

Conclusions for Forecasting Technology

Research by Gilbert White and others has suggested that the decrease in catastrophic death tolls is likely attributable to such technological improvements yielding longer warning and evacuation periods.[18] Although White and others stop short of claiming that these technologies have facilitated the dramatic growth and development along more vulnerable areas of the US coast, but they have certainly made those who choose to live there more comfortable. More to the point, simply knowing that the technology exists, capable of keeping us informed up to the minute, through three different media (radio, TV, and the internet), as to the location, speed, and direction travel of an approaching hurricane does not result in a high-rise condominium being developed on the beach. Nor does it do anything to protect property per se (i.e. the satellites do not move buildings upon locating an oncoming storm). In this regard, it does little to mitigate property damage. It does, however, fulfill a very important function which is to give people ample time to move out of the way.

PRIVATE INSURANCE MARKETS: And Other Economic Considerations

Said to be the hand-maiden of economies, private insurance markets constitute yet another variable in this complex equation. At first glance, the availability of insurance appears to be one of the few absolute preconditions for development. For example, it is difficult, if not impossible, to obtain financing for either a new residential or commercial structure without insurance. In this regard, it would seem that if insurance were simply unavailable, development would not occur. To date, no studies have been able to isolate the cause and effect between insurance availability and development along the coast.[19] However, it is clear that pricing distortions in insurance markets send inaccurate economic and psychological signals to consumers and understate the true cost of living in harm's way. In turn, this leaves those in non-hazardous areas to subsidize hazardous coastal development and threatens the stability of private property/casualty insurance markets.

Andrew's Legacy

Property/casualty insurance companies comprise the single largest private market most disrupted by catastrophic natural disasters. In 1992, Hurricane Andrew yielded 680,000 insurance claims totaling $15.5 billion, destroyed or damaged 82,000 business and 135,000 homes, and a total of nine property/casualty insurance companies became insolvent as a result.[20] The fall-out from Hurricane Andrew and other large hurricanes is emblematic of the shortcomings that exist in this private, albeit regulated and imperfect, market. Having raised questions about the ability of the market to absorb mega-catastrophic losses, Andrew also led some to rethink whether the mere availability of insurance in coastal regions was a good idea, including insurers. Immediately following Andrew property insurance was difficult to get as many insurers began to withdraw from certain coastal areas. The same is true today. And in South Carolina, where Hurricane Hugo left its mark in 1989, many coastal residents still cannot afford property insurance because of the increases in premiums and deductibles. Likewise, some property/casualty insurance companies have fled the state after taking on huge losses.[21]

Property/Casualty Insurance Basics

The first, and most important point regarding property/casualty insurance is that its usual policies do not cover flood. Rather, wind is a standard peril covered in this market, whereas flood insurance is written exclusively by the federal government through the NFIP (with the exception of WYOs).[22] Therefore, the storm surge that brings as much as 15 feet of water over barrier islands, flooding homes and businesses, is of little concern to private insurers. However, the 120 mph winds that often tear the roof from the walls, break glass, and propel flying debris during hurricanes are of great concern.

The second important point about private insurance markets is the notion of actuarial rates and the regulator. Much like the utility industry, most states have an insurance commissioner whose role it is to oversee the rate setting process. In this case the commissioner's duty is to ensure the availability and affordability of insurance and the solvency of insurers. Through this process, rates and rate increases are scrutinized and

ultimately approved by the commissioner who is an elected public official. Thus, actuarial rates, or rates which are supposed to reflect actual risk, are in fact negotiated.

The resulting political dynamic creates a downward pressure on rates where the politician, seeking to remain in good stead with the people will strive to keep rates low, reducing costs for home-buyers. The insurance companies, on the other hand, are unable to charge the rate which they believe is commensurate with the risk, leaving them with artificially low rates. To be sure, competition among insurers also creates downward pressure on rates as well. Ultimately, there are important implications for these pricing distortions, as well as other failures in the market.

The Primary (Voluntary) Insurance Market

Individuals may get wind coverage on their home in two ways. The first way is through the voluntary market where an insurance company will provide coverage in return for a premium. All premiums, in essence, become a large pool available to discharge policyholder claims whereby any one policyholder may end up being a net contributor, or a net beneficiary.[23] The rate setting process is a complicated and closely guarded art-form practiced by insurance companies and their actuaries. While relevant, a detailed explanation for rate setting is not within the scope of this inquiry. Nonetheless, it is useful to keep in mind that because of the potential for catastrophic losses, insurance providers must have the ability to spread losses widely over a broad area, draw on reinsurance (secondary) markets, and have a high surplus-to-premium ratio to ensure solvency. For instance, an insurance company's surplus, or equity capital, is there to provide a safety net. As a practical matter and a regulatory requirement, insurers cannot operate without it. In other words, there must be a dollar of surplus for every three dollars of coverage written, an axiom called the Kenney Rule.[24]

A common, and advised practice is for primary insurers to sell their risks in a secondary reinsurance market, thereby reducing the surplus requirement and further diffusing the risk. This surplus requirement is of little or no consequence to insurers when it comes to non-catastrophic events (e.g. fires), those which they can routinely handle. It does, however, come into play in catastrophic events such as Hurricane Andrew when

surplus is depleted resulting in an inability of primary insurers to write coverage after the event at levels written prior to the event. Scenarios similar to this, resulting in shortages, gave rise to the second way coverage is provided for wind peril.

The In-Voluntary (Residual) Insurance Market

The second means by which coverage is written for wind is through the in-voluntary, or residual markets. Known originally as FAIR plans, meaning fair access to insurance requirements, they were set up in the 1960s following an unprecedented number of riots causing insurers to cease writing coverage in inner-city areas they considered riot-prone. As a matter of public policy, and at the urging of the federal governments, 27 states and the District of Columbia, instituted statutory FAIR plans under which, in general, any property is eligible for insurance regardless of the environment in which it is located and regardless the exposure surrounding it if not within the property owner's control.

At the same time, however, some coastal states were experiencing a similar problem as a result of actual and potential catastrophic losses from hurricanes. Seven states stepped forward with beach plans offering coverage to those in areas where private insurers were not voluntarily writing because the risk was too great. These plans operate much the same way the FAIR plans do in that insurers within the state participate based on market share. Every insurer that writes in the state is required by law to participate in the plan. Today, these in-voluntary markets, referred to as beach plans continue to operate in seven states offering windstorm coverage in limited, coastal areas of their state.

Pricing Distortions and Other Shortcomings in Insurance Markets

As indicated, the private insurance market is far from perfect. Beginning with the pricing distortions resulting from government regulation of insurance rates, there are a number of other imperfections in the market. Rade T. Musulin, Vice President and Chief Actuary for Florida Farm Bureau, described these flaws as follows:

1) One lesson learned in Hurricane Andrew was that limitations in actuarial databases and loss estimation techniques led to gross errors in pricing and measurement of catastrophe exposures in the primary insurance market. This led to inaccurate forecasts of long-term loss costs, little or no consideration of risk in pricing, classification systems insensitive to catastrophe exposure, and serious underestimation of probable maximum loss (PML).[25] Up until Andrew in 1992, it was believed that the PML from a hurricane was in the $6 - $8 billion range when in fact, insured losses from Andrew were twice the upper end of that range.
2) The discounting of true risk in most primary property insurance pricing models and regulatory standards led to an ignorance of the risk inherent in the insured book of business. Therefore, the models were almost guaranteed to yield economically distorted prices. In order for the system to function properly, prices should reflect the volatility of the line of business and the covariance of risks within the insured population, not what is deemed a "fair" rate.[26] APPENDIX D (figure 1) illustrates how catastrophic events are not properly priced according to the risk load. The result is a gap in the system whereby the primary insurance market is precariously positioned, ill-equipped to absorb mega-losses.
3) A basic assumption in the insurance market model is that the insurer must have freedom to choose among risks whereby the economically correct price is one that makes an underwriter indifferent between various risks. Viewing the process as one of pricing capital, the capital market that underwrites such decisions comes from capital reserves held by primary insurers and/or reinsurance companies where there is freedom to choose from a variety of investment opportunities. The risk load for such investments is the compensating factor that makes various portfolios of policies equally attractive.[27] In the case of beach and wind plans, where insurers are forced to share risks that are ordinarily uninsurable, this assumption about the freedom to choose among risks no longer holds.

4) A corollary to the above point is that price volatility is a natural consequence of high variation in mean loss and insurers' tendency to fund losses internally through retained earnings. Given a relatively constant demand for coverage, the supply of capital will ebb and flow with trends in hurricane activity. In low catastrophe periods, supply will increase and price will drop. When capital is depleted, the price must rise sharply, as companies turn to capital markets to replace internally generated capital.

Among other things, these issues suggest a tension free market realities and the regulatory process. Natural disasters are not uninsurable in the private market, but are not insurable under current conditions.[28] For example, APPENDIX D (figure 2) shows the relative increase in cost to a typical homeowner in Florida using a true economic cost model to determine the premium. Notice the difference in cost is $80 per month, or almost $1,000 per year. Assuming a capitalization rate of 8 per cent, the value of the home is artificially inflated $12,500 for each year the insurance rate is $1,000 below market prices. In essence, it is like writing a check to each beachfront homeowner who tend to be more well-off resulting in not only a subsidy for hazardous development, but a subsidy for the rich. APPENDIX D (figure 3) demonstrates a direct relationship between household income and proximity to the coast. Given what has been demonstrated regarding premium affordability, a premium determined solely by the market would only exacerbate the existing arrangement where only the wealthy can afford to live on the coast.

Implications for Land Use and Hazard Mitigation

From this study, it is not clear that shortages in primary insurance coverage have substantially deterred coastal development or mitigated damage from hurricanes. Despite the fact that several severe ($1 billion plus) hurricanes have occurred since Hugo (1989), causing insurers to raise rates as much as politics will allow and in some cases, leave certain areas altogether, growth is still occurring at a robust rate. Furthermore, statistics show that even with rising market penetration, beach plans are not filling a very large gap. For example, in Florida and South Carolina, the residual market only writes between

.5% and 1.5% of the states wind coverage, both of which offer coverage in very limited coastal areas. (see APPENDIX E) Such evidence suggests that the involuntary markets cannot be accountable for development that occurred in high-risk areas.

It is more clear, however, that the political/regulatory process yields artificially low, distorted prices that send inaccurate economic and psychological signals to consumers. Insurance priced at below-market levels (less than the full cost of expected losses and appropriate risk loads) leads to over-consumption in the same sense a subsidy yields over-consumption of a good. As a consequence, land is over-consumed in the form of development of high hazard areas. In theory, as risk and premium rates go up, some people and firms will decide that the benefits of locating in, or continuing to occupy a hazardous area are not worth the added insurance costs and they will locate elsewhere. Unfortunately, rates are not commensurate with risk and the pressure on regulators to maintain affordability and availability in hazardous areas will continue to yield poor public policy with economically inefficient outcomes.

There have been some other side-effects of the enormous insurance losses in recent years that relate to public policy. In general, the industry has tried to limit catastrophic losses of reserves by shifting risk to government. When insurance companies began canceling policies in Florida following Hurricane Andrew, for example, the State of Florida instituted a surcharge on property insurance policies to create the Hurricane Catastrophe Fund, or a residual insurance market. Efforts are made almost annually to shift more hazard insurance risk to the federal government as well. These bills, which surface in almost every session of Congress, try to establish a public corporation to provide all-hazards insurance, with the federal treasury providing reinsurance for catastrophic losses that exceed loss reserves. Such efforts have yet to succeed.

Insurance may be a powerful tool in reducing overall economic loss from disasters. Properly designed and executed, insurance can spread the risk equitably, send accurate economic signals, and result in reduction of economic loss potential. But, a financially stable policy may still exacerbate the situation it is intended to remedy unless it is accompanied by premium rates proportionate to the hazard, and a strong link to land use planning.

THE HUMAN PSYCHOLOGICAL FACTOR

Orrin Pilkey, a renowned coastal researcher from Duke University, uses a colorful metaphor to describe the relationship between humans and nature on the coast. He recounts the classic silent films where the heroine is fastened to the railroad tracks as the steam locomotive bears down on her. Luckily, she escapes death every time. The unfortunate reality is that this scene is played out by real people, whose numbers continue to grow every year, the Gulf and Atlantic Coasts are the railroad tracks, and the steam locomotives are hurricanes. In these cases, the people are tied to their property and precious belongings.[29]

Up to this point, the critical issue has been how people have come to find themselves in this untenable position (i.e., what influences land use and development). To respond to this issue solely by reference to influences such as public policy, private markets, and technology, without mention of individuals' behavior and their perception of risk would be shortsighted. It is therefore meaningful to examine common perceptions of risk and how they are influenced by these outside forces.

Behavioral Taxonomy

Among coastal dwellers today, there is a variety of perceptions regarding the threat of natural disasters that perpetuate a false sense of security, propagate inaction or an ambivalence toward mitigation, and lead to the development of some very hazardous areas. This can, in part, be explained using a basic behavioral taxonomy developed by Gilbert White, founder of the Natural Hazards Research Center at the University Colorado, Boulder.

In general, there are four attitudes/perceptions exhibited in areas subject to natural hazards, all of which can be characterized as psychological barriers to mitigation. The first behavior is found in coastal areas where the majority of citizens either deny the risk exists or dismiss the probable effects as insignificant.[30] This may also be referred to as cognitive dissonance, a lack of acknowledgment for very real, every-day risks. In fact, people living along the coast are more than likely to be cognizant of such risks as one

study points out. A survey conducted by researchers from Clark and Toronto Universities showed that two thirds of the residents present in the Ash Wednesday storm of 1962 knew of the history of destructive storms along the coast when they bought their property.[31] At the time, 90 percent said they had experienced storms in the past and intended to stay in the area.

The second behavior occurs in people who are aware of the risks and regard the effects as significant, but assert that little can be done to mitigate the impacts. Thus, the prospect of loss is tolerated without undertaking mitigating measures. The third, most prevalent behavior, is seen in people who believe that something can be done to mitigate losses from natural hazards and further understand that damage can be catastrophic, but they are not aware of steps that can be taken. The fourth pattern is seen where the majority of people are prepared to consider dramatic changes in location and livelihood as a result of a previous natural disaster, and the probability of future events.[32] This is mostly exhibited in developing countries where, for example, droughts force people to pick up look for more fertile land.

In part, these behaviors can be attributed to the nature of extreme events themselves (i.e., the fact they are completely random and rare) and the consequent uneasy relationship between people and uncertainty. Hurricanes are stochastic processes, recurring and irregular, making the prediction of any single event uncertain. And for all of us, uncertainty is experienced in a wide range of everyday events whether waiting for a train, stepping off the sidewalk to cross the street, or thinking of future career prospects. At first glance, the only thing common among these day-to-day uncertainties is their futurity. However, they are all associated with probabilities of occurrence, and hold certain consequences. Unfortunately, there is no single explanation for why individuals accept certain risks over others.

The question of how the components of the risk - loss and probability - are connected in people's perception is relevant to acceptance. On the one hand, this process of acceptance may be impaired by a general inability to accurately understand perceive probabilities of loss. As a result, they tend to discount heavily any benefits from avoiding a hazard or taking action to reduce vulnerability. Alternatively, time horizons, public

policy, and technology enter the process and affect perceptions of risk. The result is millions of people accepting the risk of hurricanes along the coast.

The Time-Horizon Factor

As pointed out by White et. al., people possess different time-horizons, or the length of time they look forward, which in turn, affects their perception of risk.[33] A developer, for example, may wittingly build a condominium along a beach where, in the year before, 120 mph winds and a seven foot storm surge left the adjacent building in ruins. If the developer was asked whether he felt there was any risk in building in that area, the response would likely be, no. Even when confronted with the incontrovertible evidence of the damaged adjacent structure, he would say there is still no risk because by the time the next extreme event hits, he expects to have sold the building and made his money. One explanation for this behavior is that he does not think over the long-term. Of course there are other reasons the developer perceives no risk, not the least of which is the fact he possesses insurance. The situation, however, is quite different for the series of property owners who follow, or FEMA (and the American Taxpayers) when they fund relief efforts, and the scientist who has mapped hurricanes and erosion rates for the past 40 years. Insofar as people operate on short time-horizons, their appraisal of a future event may be drastically different from the scientists taking a long view or a property owner with a 30 year mortgage.

A related perception is called the gambler's fallacy. This theory notes the propensity in people who have experienced a serious disaster to assume it will not happen again, at least not for some time.[34] Of course this notion is not true due to the fact hurricanes are more or less random events. These individuals, as well as others, appear to have substantial tolerance to stress created by the risk or by the uncertain timing of natural events. In making adaptations over long periods of time they are not willing to pay heavily to eliminate the hazard. In the short run they do not seem to seek risk for risk's sake. Neither do they place a high negative value on stress.

Public Policy's Influence on Human Psychology

It is true that many of our public policies perpetuate a perception of risk that leads individuals into hazardous situations. White was the first, in 1957, to question why, after all the Government measures implemented in the 1930s under FDR's New Deal (the Tennessee Valley Authority program) and the $5 billion spent since 1936 Federal Flood Control Act, damage from flooding catastrophes had continued to increase. The deceptive security afforded by the protection of the new flood barriers had led to an increase in investment. More people than before lived in the river valleys at risk from floods. Such research was subsequently extended to human behavior in the face of hurricanes and a host of other natural hazards with significant "additional costs" imposed on society as a result of inhabiting areas at risk.[35]

More recently, federal disaster assistance has come under attack as breeding complacency, inaction, and being largely responsible for recurring disaster losses. Over the years, it has been common for individuals, localities, and states to view federal disaster assistance as an entitlement, something deserved regardless of the cause of damage. Recall that federal assistance is only available upon issuance of a presidential disaster declaration which are to only be issued in cases where the resources of affected states and local governments are clearly exceeded. But in practice, presidential declarations have been carried out in a perfunctory fashion, evolving out of cases where damages are modest and where state and local governments could have covered the tab.[36]

Not surprisingly, FEMA's efforts to change the way it does business have been heavily criticized by state and local governments, as well as property owners in high risk areas. One proposal which was floated in the late 1980s would have shifted the cost share ratio between the state and the federal government to 50/50 (from 25/75), and instituted an ability-to-pay measure. Due to the intense political opposition from sates and localities, the proposals were tabled. Because relief and insurance subsidize people and firms occupying hazardous areas, relief can produce complacency. If it is known that someone else will pick up the tab, individuals, as well as communities, are not likely to pursue a course of action to reduce vulnerability. This argument is voiced by economists and holds for cases where such steps are feasible and cost effective.[37]

Technology's Influence on Human Psychology

A prediction of hurricanes tackles uncertainty and insecurity by announcing that an undesirable event will possibly, or even definitely, take place within a specific time window, even if the exact date and time cannot be pinpointed. Nevertheless, weather forecasts have long been part of our daily lives. The probability of hurricanes and land fall on the Gulf and Atlantic coasts can already be reliably predicted by means of weather satellites, radar, and high-flying weather aircraft. The problem consists in warning fatigue, as well as in the inexperience of the population, as is evident from the fluctuating number of evacuees. In light of such evidence, the question arises whether the very different social systems are equally capable of coping with the discoveries of natural science which lead to catastrophe prediction.

Conclusions on Human Psychology and Perceptions of Risk

The constellation of forces that influence land use (where people live) and hazard mitigation policy can lead to misperceptions of the true risks attendant with living on the beach. In theory, people engage in behavior that combines adaptation to extreme events with both purposeful and incidental adjustments.[38] Accordingly, adapting to hurricanes would lead one from a state of awareness of the risk, to action, and finally to intolerance. But the mix of adjustments, or lack thereof, reflects a bounded rationality – a continuum of perceptions – that is influenced by public policy and technology and in some cases leads to mounting vulnerability to catastrophe. The human psychological factor plays another important role in that we are a compassionate animal. The result is that once a disaster has occurred, there is an unwillingness to force people to live with its consequences, even when they have voluntarily assumed the risk.

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CHAPTER FOUR

LOCAL LAND USE PLANNING AND HAZARD MITIGATION: TOWARD A COMPREHENSIVE MITIGATION FRAMEWORK

In America, municipalities and other forms of local government have long been the principal sources of land use control. Today several states impose comprehensive planning requirements, a trend that began in the late 1960s, but most do not. At the same time, mitigation planning is also realized at the local level, where hurricanes strike and where people and property are exposed. According to the 1995 FEMA mitigation strategy, "All mitigation is local." There is a high degree of logic to the emphasis on local control given the diversity of conditions and communities along the Atlantic and Gulf coasts. Local governments subscribe to many different views on how to mitigate coastal storm damage based on these differences – from devising their own innovative solutions to simple compliance with state and federal regulations.

The notion of preventing development in hazardous areas is not new. Three decades ago the first empirical studies were conducted on the effectiveness of land use and development management in mitigating losses from natural hazards.[1] Still, polices that integrate land use tools with mitigation are rare at the local level. This section will continue to examine the nexus between land use/development management and mitigation at the local level and the basic tools and authority that make it possible. After all, this is where the rubber meets the road.

The impetus for suggesting a more deliberate union between mitigation and land use planning is twofold. One, there is a need to move emergency management concerns from an isolated public safety position within local government to actively integrating it with community planning and development management in order to improve the effectiveness of both.[2] This acknowledgment leads to what I will advocate at the end of this chapter – a comprehensive mitigation framework (CMF). Two, a more integrated

approach can be an effective means of meeting the call for more sustainable communities – avoiding poor development decisions so as not to compromise the rights, privileges, and experiences of future generations.

THEORY BEHIND LAND USE AND HAZARD MITIGATION

The underlying theory behind using land use planning as a mitigation tool is straightforward: where hazards can be clearly delineated, the most appropriate land use management tools would be those that prevent substantial development in high hazard areas. Such tools include, but are not limited to, setback regulations, infrastructure and capital improvement policies, special tax treatment, and acquisition and/or relocation of property in hazardous areas. Within the context of mitigation, the land use planning process is perceived to yield at least four benefits:

1) By providing information about the location and nature of various hazards, plans alert individuals and community policy makers to the liabilities of building in hazardous areas.
2) By indicating the most appropriate uses of land in a community (showing that in many cases hazardous areas do not have to be used more intensively for communities to realize economic and other development objectives), plans make it possible for communities to consider and, where economically efficient, actually adopt restrictions on building in hazardous areas.
3) By linking natural hazards to other public policy issues, such as environmental protection, plans lead to increased priority for hazard mitigation.
4) By working with all affected stakeholders, it is more likely that mutually beneficial solutions will emerge.

The Tools: Development Management, Taxation and Fiscal Policies, Land Acquisition, and Others

The most prevalent land use and development management tools are those which regulate the location, amount, density, and type or development in coastal localities.[3]

Zoning and subdivision ordinances are prime examples of these standard regulations. Typical zoning ordinances may be used to control the type (e.g. residential, commercial, recreational, etc.), intensity (e.g. bulk, height, floor area ratio, set back, etc.) and density of development which occurs in high hazard areas. The south shore of Long Island, New York has put these tools to use by reducing permissible densities along its vulnerable shore.[4] Another approach is the set back requirement whereby new construction must set back a certain distance from the shore. This type of restriction may be found at the state level as well, but is always implemented at the local level. A variation on the set back is used on Sullivan's Island, South Carolina where the delineation of a recreation and conservation easement in which development is prohibited amounts to a *de facto* set back. The Open Beaches Act in Texas is similar in that no structures are allowed to impede lateral movement along the beach seaward of the vegetation line.

Subdivision ordinances, on the other hand, control the transformation of empty land to a developed site. These controls may also govern density, configuration, layout and design of development. For example, subdivision ordinances may impose minimum lot size requirements to reduce the amount of new development exposed to storm hazards. Further, development plan reviews and other processes of subdivision approval afford additional opportunities to dictate the orientation of development. One strategy is to make subdivision approval contingent upon mitigative actions, such as the protection of dunes, wetlands, and natural vegetation where all structures must be a sufficient distance from protective dunes (e.g. they must be landward of dunes). An alternative is to build in the flexibility necessary for moving a structure back upon the shoreline eroding by requiring lots which are sufficiently deep. It should be noted that such requirements are just as valuable, perhaps more so, in post-storm situations when there is tremendous pressure to rapidly redevelop.

Concerns and Limitations with Development Management

There are numerous concerns with development management that give pause to coastal localities wanting to mitigate hazards. Chief among them is whether the regulation amounts to a taking of property under the Fifth Amendment of the U.S.

Constitution. From an administrative standpoint, these regulations often fit into an existing regulatory framework (as it is likely they already have zoning ordinances in place and a process for generating and approving them) and may be relatively low cost. In some states, the process is augmented, or supplanted by environmental impact assessments used to assess site-specific hazards and recommend ways to mitigate their impact. Of greater concern, however, is not the administrative burden, rather the secondary economic effects. Beginning with the individual property owner, such restrictions may result in a dimunition of value based on the fact the owner can no longer use the land for its highest economic use. On the other hand, it is debatable whether such restrictions serve to dampen overall levels of development given the availability and substitutability of non-hazardous or less-hazardous land. For a more detailed discussion on the takings issue, see APPENDIX F: Understanding the Takings Issue. A related determinant is availability of similar development sites in neighboring jurisdictions which do not have hazard zone regulations.

The effectiveness of such regulations is a function of the stringency of the measures themselves and the political will to enforce them. In other words, these tools can be circumvented through variances, special use permits, amendments, and other special exceptions if the elected public officials deem it necessary. Perhaps the most important aspect of development regulations as they pertain to mitigating hurricane hazards is their influence on the location of buildings relative to the hazard zones, not reductions in the amount of overall development.

Taxation and Other Fiscal Policies

Taxation and fiscal policies may be used to achieve a more desirable allocation of the costs imposed on the public by development in hazardous areas. The intention of using taxation is twofold: 1) to shift more of the cost burden directly onto the owners of such property; and 2) to influence patterns of development. In regard to inducing certain development patterns, the economic theory is that through the use of differential assessment on certain types of land, it is possible to reduce the property tax burden on undeveloped parcels, thus decreasing holding costs. This in turn will potentially extend

the period of time for which they are devoted to undeveloped uses.[5] Most states provide for a differential assessment and make forest-land, open space and recreational land eligible for such reductions. Leaving parcels undeveloped or open in coastal areas will reduce the amount of property and people exposed to the threat of a hurricane.

Another tax mechanism involves the use of special assessments, impact fees, and exactions. The premise is that building in hazardous areas increases the cost imposed on the public relative to development in non-hazardous areas. The costs are manifest in the emergency response that is needed for such an area in the event of a hurricane. Also, there are costs related to evacuation, search and rescue, temporary housing, and the reconstruction of public infrastructure that must be accounted for as well. An assessment of this kind may be applied where property owners are determined to receive a distinct and substantial benefit in excess of the general benefits received by the public at large. Applying this concept to storm hazard management, a locality would be required to delineate an area in which special storm services are provided and in which residents would be subject to the special assessment.[6] A similar approach to the special assessments is the impact fee. While a special assessment may be used to cover the short-term costs associated with the floodproofing of utilities, an impact fee would be applied to pay for mitigation of the larger impacts increased demands on evacuation services that are the result of development.

Concerns and Limitations of Taxation and Fiscal Policy

The use of differential assessments is fairly widespread but its effectiveness at retaining land in undeveloped uses is minimal where land is in high demand, which is nearly everywhere along the coast.[7] This suggests that differential assessment will not be an appropriate tool for managing development in oceanfront and barrier island areas where demand is very high, although it should not be discounted altogether for this reason alone. Coupling differential assessments with the development management tools and public acquisition programs will make them a more effective tool. Reducing the permissible development density in a hazard location together with preferential

assessment may reduce the opportunity costs to the land-owner, enough such that there is a reduction in the amount of land converted to developed uses in hazardous areas.

Differential assessments, much like zoning, come with costs. For example, if a reduced or preferential assessment for hazard parcels is granted, local tax rates may have to be increased to compensate for loss in revenue. Commonly referred to as a tax shift, this phenomenon will be greatest in instances where the value of undeveloped preferentially treated land is highest.

Impact fees are most effective in recouping the area-wide costs associated with development. Research has shown that they will not prevent growth in high hazard areas, although they may indirectly discourage development.[8] The extent of their success is a function of the availability of substitute parcels of land not subject to fees, in addition to the elasticity of demand for hazard area development (i.e. the sensitivity of demand to changes in price). The greater the elasticity of demand for oceanfront or hazard zone development, the greater the will be the relocation or displacement effect. One economic side effect of this may be a reduction in the local tax base if development chooses to locate in other jurisdictions that do no have such fees or assessments. This would not be the outcome if these additional charges applied to only hazard area development while displaced development could be accommodated in other less hazardous sites within the same jurisdiction.[9]

There is also a problem with generating a defensible fee structure, one that is based on empirical data, not what is merely deemed necessary or thought to be fair. It is almost certain that the mere proposition of fees of this nature will bring opposition from developers and homeowners alike and may even lead to court. (See Understanding the Takings Issue). It is therefore advisable for the local government to find a fee that can be demonstrated as being commensurate with or proportional to the action being sought by the builder. This leads to the concern that it is difficult to predict how impact fees, exactions, and assessments will affect change. It is likely that these costs will be passed along to the homeowners making it more difficult for first-time home buyers, an unacceptable result for many communities.

Land Acquisition

A policy that provides an absolute surety that no development will occur in hazard areas is public acquisition. One is acquiring fee simple title, which means obtaining the full "bundle of rights" associated with a parcel. Another is the transfer of development rights. The crux is that undeveloped lands could remain open space for public recreational uses and preclude risky development. An alternative to fee-simple title acquisition is a public purchase of only the development rights. This means that the public entity (e.g. Parks District) would pay the owner the fair market value of the right to develop the land in return for leaving the land undeveloped for some specified period of time or perpetuity. This can be accomplished with the use of a restrictive covenant which accompanies the deed.

Another method involves transferring development rights to other, less hazardous sites. Under this scenario, a locality would zone the storm hazard areas to lower density such that fewer units are allowed. In return, developers of the land would be permitted to transfer all or some of this "unused development right" to parcels in designated low hazard areas. Alternatively, they can sell these rights on the open market to others who own land in areas designated for development. The local government must allow for increased densities elsewhere in order for the market to work properly.

Also included in this category of mitigation at the local level are relocation programs where a threatened structure is moved to another site. Relocation of families and their belongings received a great deal of attention in the aftermath of the Great Midwest Floods in 1993. In an unprecedented move, FEMA, with the assistance of the Department of Energy's sustainable development group, moved entire towns including Valdemyer, Illinois. Prior to 1993, there were few instances of large scale relocation with the exception of one that took place in Baytown, Texas in 1983. In this case properties were purchased in the Brownwood subdivision, an area hit hard by Hurricane Alicia in 1983 with the help of federal funds. Ultimately, the entire subdivision of destroyed or heavily damaged homes, which had been subjected to repeated hazards, was prevented from being rebuilt in this extremely hazardous location.

Limitations and Concerns of Land Acquisition Policies

To make certain that no development will occur in hazardous areas, public acquisition is the best mitigation vehicle. However, the use of this method posses a problem of cost and impracticality in many instances. Cost may be the predominant obstacle in areas where hazardous parcels carry a very high market value, making it cost prohibitive for a locality to purchase. For example, using a fee-simple strategy in areas that are experiencing high growth, as many coastal areas are, will be very expensive. Moreover, the purchase of land that has already been developed will be even more expensive. The exception may be cases where property is acquired in the aftermath of a storm where the structures are substantially damaged and greatly reduced in cost.

One means of making acquisition more feasible is for a public entity to obtain preemption or rights of first refusal where it is legally possible.[10] Right of first refusal would put the local government in the position of property buyer, ideally in local land transaction involving hazardous areas. This oversight would enable them to spend their limited resources available for land acquisition on only those parcels likely to be developed, meaning those that are actually in the process of being bought or sold for development uses. Yet another approach to reduce cost is to resell a fee-simple position with certain deed restrictions (e.g. limitations on future development). This strategy would enable the local government to fund additional procurements with the proceeds from fee-simple transactions. A locality may also be able to more efficiently use its resources by coordinating acquisition decisions with non-profit environmental organizations such as the Nature Conservancy, Audobon Society, and the Trust for Public Land. Although their acquisition decisions are not based on hazard criteria, a community may be able to influence decisions based on a cost sharing arrangement.[11]

Infrastructure Investment and Capital Improvement Policy

In the movie *Field of Dreams,* Kevin Costner's character was moved to build a baseball diamond in the middle of a cornfield because of a simple mantra: If you build it, they will come. Local governments know this mantra well, except that they tend to concentrate on building roads, sewers, drinking water treatment plans, waste water

facilities, schools, firehouses and a host of other public facilities. In the case of local governments, it isn't a fantasy baseball team that they are luring, but economic growth and new development. Dubbed growth shapers, these investments are driven by two determinants, location and timing, both of which have implications for hazard mitigation at the local level. In terms of the former, a locality may pursue a policy such that investments in infrastructure are in low hazard areas in order to direct development away from high hazard areas. Such investments imply a certain long-term perspective on growth in the area, thus bringing in a temporal dimension. The area selected for improvement would, for example, include sufficient land to accommodate further growth and account for certain assumptions regarding evacuation capacity.

Taking a holistic approach, the notion of guiding development through capital investment should be closely linked other socially beneficial objectives. In this case, it makes sense to reducing the public costs of such facilities and the extent of public investment at risk in high-hazard areas. This leads to a second, often overlooked point regarding the protection of public facilities: they are often uninsured. While it may be assumed that public facilities are insured taxpayers have found, much to their dismay, that the public officials did not find it economically cost efficient to pay a premium.

Concerns and Limitations on Infrastructure Policy

To be sure, the reduction and redirection of public investment can be very effective at alleviating future damage to public facilities and infrastructure. However, it is less certain that such a policy will influence private development. Depending on local conditions, limiting public investment will only be an effective deterrent if development in high-hazard areas is dependent upon these investments in infrastructure and facilities. For example, if a development on a barrier island is able to obtain water through individual site wells and dispose of wastewater through septic tanks, it is not likely that provisions of public sewer and water facilities by the locality will impede growth in hazard zones. Furthermore, localities will often look to the developer to finance the infrastructure themselves, in which case the locality has little sway. It may be possible for the locality to assert greater control by restricting the issuance of septic tank permits,

but if they cannot cite health problems as the reason then the legality of such a tactic is questionable.

Overlap with Other Public Policy Issues: Environmental Protection

Ordinarily, loss of natural resources would be lost in a discussion about hazard mitigation, but it actually can play a very important role in the pursuit of land use planning as an effective mitigation tool. Beaches, dunes, bluffs, and wetlands have been lost to poorly planned economic growth and unintended harm has been done as the result of coastal engineering efforts (e.g. seawalls, groins, jetties, etc.) to protect people and property. Professor Orinn Pilkey, Jr., has documented the impact of construction in coastal areas, finding such activity to interfere with the natural geological processes that protect the coast.[12] Environmental/habitat protection laws provide one nexus between coastal land management and hazard mitigation. Coastal management plans have been put forth as a means to protect sensitive coastal environments through restrictions on coastal engineering and shorefront building. But they have an important and favorable side effect: they further the cause of hazard mitigation. The state of North Carolina, one of the most progressive in the area of coastal zone management, has setback regulations that require all major structures in areas vulnerable to ocean erosion to be setback sixty times the annual erosion rate. The purpose was not hazard mitigation, but coastal resource preservation. However, mitigation is certainly an effect.

But these junctions in public policy are not identified as such, and opportunities to "piggyback" hazard mitigation on other policy issues are often overlooked or understated. At the same time environmental laws strive to protect habitat, land use planning can serve to preserve, augment, and restore existing features of the natural environment that possess mitigative features. For example, the dunes which once lined the shorelines of barrier islands bordering the Gulf and Atlantic provided natural protection against hurricane winds and storm surge. Land use regulations that target dune protection can ensure dunes are not destroyed, or severely compromised, due to development. Thus placing structures, both residential and commercial, behind dunes affords a line of protection to people and their property. Likewise, wetlands which are a common feature in coastal environments

can serve as natural sponges during flooding and therefore constitute a valuable natural mitigation opportunity. Preserving them serves environmental and mitigation purposes. This makes wetland protection ordinances an effective tool through which such areas are not filled in to create more upland for development. To destroy these areas, even when it is in compliance with federal policies (i.e. where in lieu of not building, other areas are set aside for wetland preservation) would push flood risk onto other areas and increase the extent of property and the number of people at risk.[13]

CONCLUSIONS ON LOCAL POLICY

This chapter reviewed an array of land use planning mechanisms, the authority from which they are derived, and how they may be used in hazard mitigation. In addition, this chapter discussed the shortcomings of the policies themselves (as deterrents of development and effective mitigation tools) and the consequent concerns local governments may have in employing them. The wealth of policy alternatives and their relative promise for effective hazard mitigation at the local level reinforce the notion that if all mitigation isn't local, it should be. Moreover, it is not enough to recognize the richness of this setting, rather steps must be taken to anchor land use planning and mitigation in community-based planning processes. As indicated, the coast is a confluence of pressures that originate at the national and regional level. In addition, it is a constantly changing land mass, ebbing and flowing with each passing tide (and hurricane). Factor in practical limitations on civic financial resources, meager technical capacity, and nonexistent political will and it is questionable whether local governments can fulfill the goal of hazard mitigation through land use planning. In this regard, the integration of mitigation with land use planning is an absolutely necessary, but not sufficient, means of pursuing a comprehensive mitigation framework.

Unfortunately, this will not be easy. As alluded to earlier, many coastal localities are predisposed toward development (growth) for the simple reason that it builds tax base. For example, it is common for localities to have public policies that encourage development in high hazard areas in much the same fashion that state and federal policies do. It is the revenue from property taxes, assessed at the local level on each property, that

make the town viable. And although it was not explicitly stated above, there is a tremendous tension between the need for economic growth (i.e. building a tax base through additional development) and land use and mitigation planning at the local level. There are no easy answers to this dilemma.

Where land is in limited supply and the entire land mass represents a hazardous area, as is the case on most barrier islands, effective mitigation through land use planning means using less land for less development. Hence, coastal towns are reticent to pursue an aggressive mitigation strategy through land use planning because of the effect it may have on long-term economic growth. Moreover, they are also aware that in general, such policies are politically unpopular for many private property owners and are leery of the takings issue. The general distaste for government regulation can at times, and in certain regions of the country, boil over into a distrust of government motives and intentions and result in an antagonistic constituent – government relationship. In other instances, it may lead to a takings lawsuit. While no specific case has gone to the Supreme Court on claims that a hazard mitigation policy is an unconstitutional taking, local governments have seen the lines drawn on other, similar land use regulations. But much has been learned from these takings cases and the Supreme Court has delineated four rules to guide future use of police powers and regulation so as to avoid an unconstitutional takings.

It is easy to turn to the notion of sustainable development for the answers and it is entirely true that good hazard mitigation policy is a sub-tenet of sustainable development. However, to pursue sustainable development within the context of local government and hazard mitigation implies that there is an ample supply of non-hazardous land to which development can be directed. As stated, this is not a luxury afforded barrier islands. Furthermore, there is little land along the coast that remains undeveloped. This is not to say that in the context of mitigation and wind damage along the coast, land use planning and sustainable development are bankrupt policies. Rather, mitigation at the local level challenges us to find the right amalgam of means (policy tools) to achieve the same end (sustainable development). It must also be recognized that this mixture may vary from town to town.

In sum, planners and mitigation officials must remain mindful that while the endpoint of mitigation is local action, this action typically occurs in an intergovernmental framework. Because localities have not place a high priority on hazard reduction, state and federal mandates and incentives have provided a push in some instances. But plans must still be implemented through specific mechanisms that are adopted and actually carried out locally. In the end, however, land use plans can be viewed as a decision support tool with which rational community decisions are made. In this case, decisions regarding the development of high-risk landscapes.

TOWARD A COMPREHENSIVE MITIGATION FRAMEWORK

Having more people in harm's way presents a serious problem, but the risks posed by hurricanes grow in large part because the dangers are understated in development policy and land use planning. To date, mitigation has been disproportionately reliant on building codes, weather forecasting technologies, and adjustments in insurance markets. The result has been an ad hoc and disjointed implementation of hazard mitigation that has done little to stem the spiraling social and economic costs of hurricanes. Further, I argue that land use planning, although overlooked in the past, must come to the forefront as a legitimate means of mitigation. Any of these approaches, in and of themselves, are sub-optimal if used as the sole means of averting losses in natural disasters.

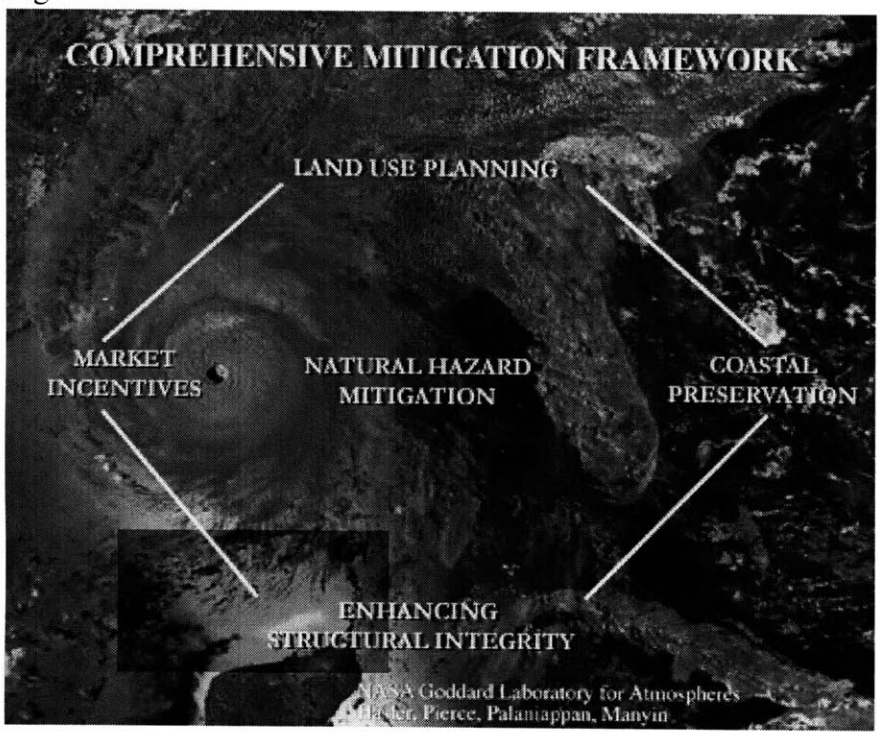
I am calling for the establishment of a comprehensive approach in the form of an enhanced coordination of the relevant tools and techniques that affect the location, rate, type, amount, quality, public cost, and quality of development in hazardous areas. Within a planning context, the comprehensive mitigation framework can be conceptualized as a diamond consisting of four interdependent parts as seen in Figure 4.1.

The Plan

There are various types of local plans capable of realizing mitigation. For example, most communities have emergency management or response/recovery plans which endeavor to reduce vulnerability of people to damage, injury, and loss of life and property resulting from natural or man-made catastrophes, riots, or hostile military or

paramilitary action. They are broad and seldom, if ever, integrated into any community planning process, such as a comprehensive plan. There is usually a chapter in each emergency management plan on mitigation but rarely does it discuss land use. Moreover, content on mitigation is not a required. In other cases, communities have prepared comprehensive plans that articulate a vision for growth in which there is a section on mitigation. Mitigation is also pursued through reactionary plans or reconstruction plans that can serve either as general guidelines for making decisions about redevelopment following a storm or as detailed instructions about which uses and site-specific areas and parcels will be permitted to be rebuilt and in what ways. Ideally, such reconstruction plans call for preventing rebuilding, reducing the density of redevelopment, or otherwise protecting development in the most hazardous locations.

Figure 4.1



Regardless the model pursued, the goal should be consistent: reduce deaths, injuries, and property loss from natural hazards. One model is to bring a CMF into the comprehensive plan by developing a separate chapter used to describe the threat to property and safety posed by hurricanes, map the location of storm hazards, and estimate the dollar amount of property at risk. The plan may focus on future development or on existing development, or both. Pursuing the first option would work best in situations where there is still a significant amount of undeveloped land. Local land use policies in this context must impose limitations on new private and public development,

aggressively pursue the acquisition of open space, and require more stringent disaster-resistant construction. In addition, the plan must suggest the types and densities of uses allowed in the hazard area and highlight the spatial variation of risk. A strategy that centers on existing development would require consideration of financial stimuli for retrofit, relocation, and plans for re-building and re-use of land in the event of a disaster.[14]

The comprehensive mitigation framework (CMF) represents not only a departure from the traditional mitigation plan, but a departure from the way in which mitigation is thought about. It is proactive, encompassing, and rooted in community planning. It is also threat-driven as opposed to disaster-driven. Perhaps more importantly, the CMF helps to develop a political constituency for land use planning and natural hazard mitigation by forcing communities to identify hazards, risks, and recognize those that bear the costs of disasters. Engaging in a CMF also requires that organizations and individuals (both private and public) with mitigation responsibilities be identified and included. In order to institutionalize a CMF, experts in the disciplines of land use, coastal preservation, economics, property insurance, building codes, must be involved in addition to residents, local business owners, and developers.

The CMF is a tool box, not necessarily a plan in and of itself. In other words, the act of blending market solutions, with land use planning, enhanced structural integrity, and coastal preservation can be left to take place within a broader planning process, such as the development of a comprehensive plan. In fact, that may be ideal because there is a need to ground mitigation in community planning. Alternatively, where communities are not required to have comprehensive plans or are not engaged in a similar long-term planning processes, the CMF can become the basis for a stand alone plan.

In the next chapter, I look at two coastal communities that confront the risk of hurricanes with each passing year. The intent is to examine the manner in which hazard mitigation is pursued and more specifically, the extent to which land use planning is used. Finally, I will explore the feasibility of using a CMF in each community based interviews conducted with local planning officials, developers, academics, and private citizens.

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[3] Godshalk, et. al. 1989. p. 167.
[4] Long Island Regional Planning Board, 1984. From Godshalk, et. al. 1989.
[5] Godshalk, et al. 1989. p. 173.
[6] Godshalk, et al. 1989. p. 175.
[7] Godshalk, et al. 1989. p. 176.
[8] Godshalk, et al. 1989. p. 177.
[9] Godshalk, et al. 1989. p. 176.
[10] Godshalk, et al. 1989. p. 172.
[11] Godshalk, et al. 1989. p. 173.
[12] Morton, Robert A., Pilkey, Orrin H. Jr., Pilkey, Orrin H. Sr., and Neal, William J. 1983. *Living with the Texas Shore*. Duke University Press. Durham, NC.
[13] Godshalk, et al. 1989. p. 164.
[14] Burby, et. al. 1997. By Berke, Pillip, Godshalk, David, and Kaiser, Edward. *Integrating Hazard Mitigation and Local Land Use Planning*. p. 137.

CHAPTER FIVE

A CASE STUDY:
HAZARD MITIGATION ALONG THE TEXAS COAST

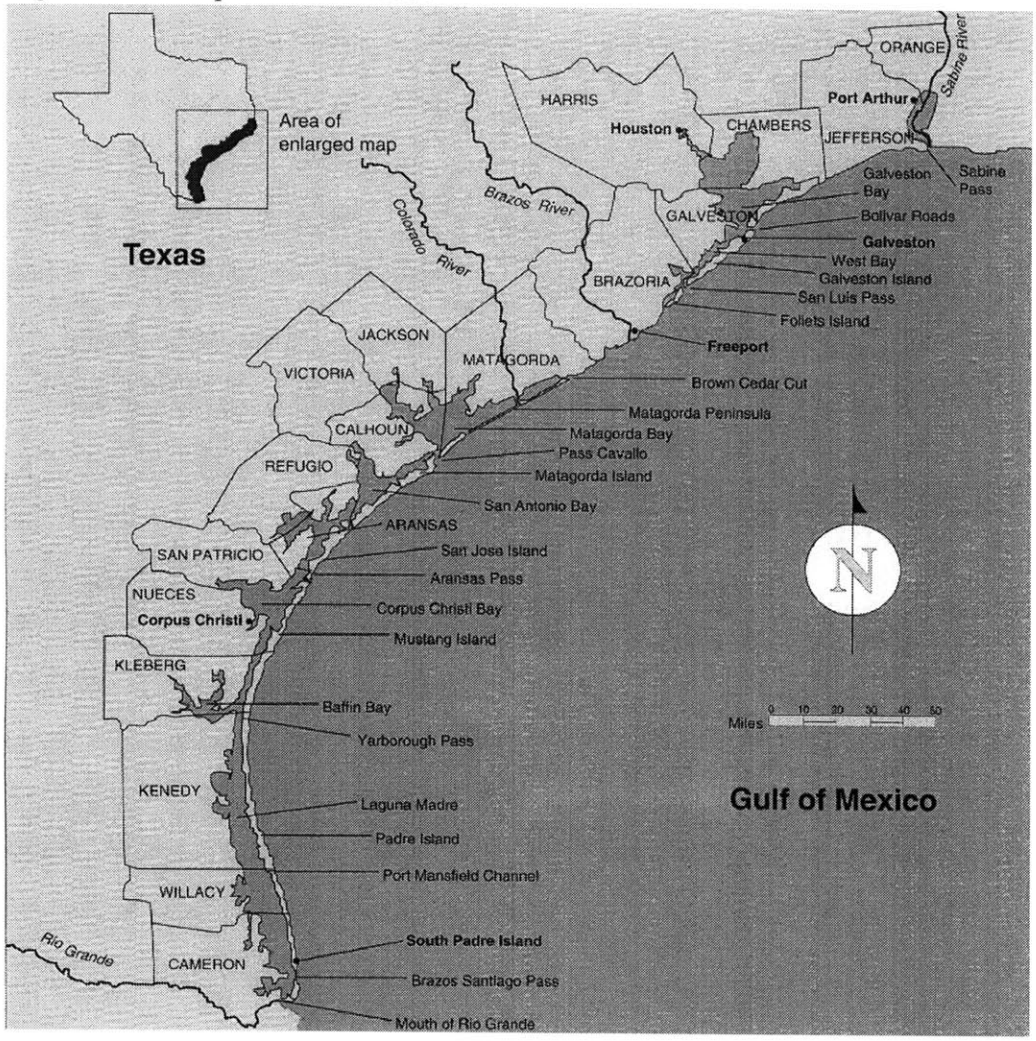
From Palm Grove to Sabine Pass, the Texas coast is 367 miles of barrier islands, spits, and deltaic shorelines. This stretch of coast in the Gulf of Mexico once had a wide spectrum of land uses including oil production, heavy industry, shipping, agriculture, cattle ranching, fisheries, and tourism. With no state-wide planning requirements, the state government had little say in how any of these uses came about. Instead, land uses were (and still are today) determined locally by the nearly 1,500, virtually autonomous cities and counties in Texas. This structure, or lack thereof, of governance is rooted in a bold sense of independence and a strong anti-government sentiment. The result is a largely voluntary approach to land use planning and mitigation.

Despite this independence, communities along the coast have shared a similar experience with respect to land use over the past two decades. Attributable to the high demand for housing from a burgeoning coastal population and a penchant for economic growth, this period has been marked by rapid development on many barrier islands. While this trend slowly homogenizes the coastal landscape to one of condominiums, resorts, bungalows, hotels, and vacation homes, it also greatly increases the number of people and amount of property exposed to hurricanes. From the availability of insurance (flood and wind) and disaster relief to development subsidies and the low-cost of raw land relative to nearby Florida, a number of factors send economic and psychological signals that have led to a trend toward development in hazardous areas and reduced the financial risk of owning property on the beach. Today, there are 4.5 million living along the Texas coast, a population that swells to as much as 6 million during vacation months.[1]

This chapter consists of three sections. The first section will provide a general background on Texas including a brief account of its bout with hurricanes followed by a review of state laws that influence land use along the coast. This information will facilitate a better understanding for how hazard mitigation can be practiced at the local

level. Each of the next two sections will look more closely at two communities along the coast, Galveston and South Padre Island. Both communities share similar exposure to

Figure 5.1 Map of Texas Coast



hurricanes but each has pursued their own means of protecting the people and property that stand in harm's way. In conducting this research I spent ten days on the Texas coast, five each in South Padre Island and Galveston, interviewing city planners, emergency managers, developers, and local residents. In addition, I gathered historical information as a basis for understanding how each community developed economically. This in turn lends insight into their differing approach to hazard mitigation.

History of the Texas Coast: a History of Hurricanes and Missed Opportunities

The history of the Texas coast is replete with severe weather events. The early storms were generally not well documented because so few people lived on the islands and although storm records vary in detail, at least ninety one tropical storms have hit the coast since 1900. Within that span, a storm of hurricane strength has made landfall about once every 7 years. On at least five occasions as many as three storms have struck the coast in a single year.[2] (see APPENDIX G)

The first half of the century was characterized by a lot of hurricane activity along the Texas coast beginning with the 1900 storm in Galveston. After a relatively slow decade in the 1950s, the 1960s brought three big storms: Carla (1961), Beulah (1967), and Celia (1970). What was important about these storms was not the amount of damage that they caused (which totaled over $1 billion), or that the 1960s were unusually active, rather that each storm was unique in how it caused damage. Carla was characterized by its immense size and storm surge. Beulah, on the other hand, brought hard rains and flooding. Finally, Celia caused extensive wind damage from extremely high wind speeds. It would have been logical, therefore, if hazard mitigation policy went the direction of comprehensive/multi-peril (wind and flood) following the 1960s. However, communities along the coast failed to respond with well articulated hazard mitigation policies and as memories faded of a tumultuous decade, aggressive development of barrier islands ensued.

The last thirty years have been characterized by a lull in hurricane activity with only two storms of note, Allen (1981) and Alicia (1983). Each storm caused considerable damage along the northeastern shore, yet this time, a more deliberate effort was made to craft comprehensive mitigation policies in the aftermath of Hurricane Alicia. Again, mitigation policies failed to stem development in hazardous areas and barrier islands continued to be governed under aggressive pro-growth policies.

Review of State Legislation and Programs Affecting Coastal Land-use

In Texas, there are few rules and regulations imposed at the state level on local government. There is not a statewide land-use plan, with the exception of scattered

elements of wetland, beach and dune protection, erosion control, and a new coastal zone management plan. Further, the state does not require that localities have a land use plan either. The governing body of a municipality may regulate the location, height, size, and density of buildings and the amount of open space reserved for recreational and other uses on its own terms. In order to exercise zoning powers, the governing body may appoint a zoning commission and may adopt ordinances to enforce zoning regulations. If a local zoning regulation imposes higher standards than those required under another statute or regulation, then the local zoning regulation controls.

Beyond granting the authority to regulate land use to local governments, the state does have a small number of regulations and programs that permeate local governance along the coast. Below is a description of each along with an indication as to how they relate to hazard mitigation.

Texas Open Beaches Act

Passed in 1959, the Texas Open Beach Act (Act; TN RC 61.001) was the first major piece of coastal legislation in the state. The Act states:

> "...that the Public, individually and collectively, shall have the free and unrestricted right of ingress and egress to and from the State-owned beaches bordering on the seaward shore of the Gulf of Mexico...the larger area extending from the line of mean low tide to the line of vegetation bordering on the Gulf of Mexico."

Initially a declaration of the public's right to unimpeded use of the State's beaches, the Act has become a fairly strong management tool. This strength is exercised through the states right to acquire private beach-front property either by formal dedication of title (or commonly accepted public usage with the consent of the owner), or by prescription which implies that the public may take the land from the private owner. The issue of State acquisition of private land becomes particularly relevant after storm-induced shoreline retreat that leaves buildings standing on the public beach, i.e., seaward of the vegetation line.

The Open Beach Act does not address hazard mitigation explicitly, rather its ability to alleviate cases of extreme exposure is incidental to its stated purpose – open, unrestricted public access. A short case history draws out the significance of this Act. Shortly after passage of the Act, the State's right to such land was confirmed in a case concerning barriers erected by a private company on Galveston Island that limited access to a section of existing beach. The court found that because the beach had been used unrestrictedly by the public for more than 100 years, that use, in effect, constituted an implied dedication of an easement to the public. The manmade barriers were found to be in violation of this principle.

Another important rule was established in a case following Hurricane Alicia (1983) in which the beach on the western half of Galveston Island eroded 130 feet. One year after the storm, most of the sand had returned to the western beaches, yet the vegetation line had remained, in a sense, retreated. Two lawsuits were filed as a result of this hurricane. In the first case, the State attorney general filed a suit against those homeowners on Galveston beach whose property was more than 50 percent destroyed and was located between the water and the vegetation line after the hurricane. The State argued that structures in this zone were in violation of the Texas Open Beaches Act and should not be rebuilt. The State won the case in 1984. The homeowners appealed this decision, filing a countersuit in a Galveston court. In this litigation, the plaintiffs (homeowners) argued that the Open Beaches Act does not imply a rolling easement; when the public beach erodes, so do the public rights. The homeowners lost this case.

This short case history illustrates the scope of the law, the state's willingness to enforce it, and the small contribution it makes to limiting development in hazardous areas. Proven and powerful, the Act must not be relied on as the sole means of development management in high hazard areas where heavy exposure to storm surge, flooding, and high winds carry well beyond the vegetation line.

Sand Dune Protection Act

The Sand Dune Protection Act (1973) represents another significant law on the Texas coast. In 1970, the State passed a requirement that each county commission issue

permits for the removal of sand, marl, gravel, and shell within 1,500 feet of any public beach with later became the Sand Dune Protection Act. The Act authorizes those counties with jurisdiction over coastal barriers to establish a dune protection line and to require developers to obtain a permit from the county commission to disturb a dune or vegetation seaward of the line.

Adoption of this Act by the individual counties is optional. Both Cameron (location of South Padre Island) and Galveston county have adopted dune protection lines and each local government has a formal process for permit approval. If a dune area under consideration is deemed critical to the protection of State-owned lands, then the General Land Office must approve proposed activities. There is no required State permit, however, nor can the Land Office comment if the county has not adopted a dune protection line. [3] In 1993, the General Land Office adopted rules under which local governments further developed local plans for permitting development. The rules require that development be planned so that public access is preserved, destruction of dunes is avoided, and erosion, storm, and flood hazards are minimized. All 18 local jurisdictions have receive approval from the GLO for their plans, yet it remains to be seen how effective they are.

Mention is made of this law and its implementation because of its incidental effect on hazard mitigation. Dunes are a natural protective feature on most barrier islands, deflecting high winds and quelling storm surge in hurricane-like conditions. Efforts to preserve, augment, and/or repair dunes are essential to an effective mitigation strategy. Where it is possible to locate structures behind dunes as a matter of compliance with the Act, and as a land use planning strategy, there is a greater likelihood losses and damage will be minimized.

A unique approach was used to protect dunes in Port Aransas, Texas, where the builders together with the city government, the county, and the local water district agreed on deed restrictions placed on development in the first row of un-stabilized dunes. The agreement also stipulated that no seawalls, bulkheads, or rip-wrap be constructed on individual properties. Small parcels of land owned by private conservation organizations exist all along the Texas coast. One example is Bird Island in West Bay (Galveston Bay)

behind the town of Jamaica Beach. This property is leased from the GLO and managed by the National Audubon Society.[4]

Texas Coastal Zone Management Program (TCMP)

The TCMP represents a continuation of the discussion in the previous section, but addresses a much broader range of coastal concerns. In recognition of the pressures on coastal ecosystems brought by recent population growth, economic opportunity, and development, the state of Texas adopted the Texas Coastal Management Program (TCMP) in 1995. Final federal approval was given to the Texas program in January, 1997, bringing the state into a voluntary, state-federal partnership under the Coastal Zone Management Act. For this, Texas is eligible to receive federal funds to advance the objectives of the program.[5] The TCMP not only identifies loss and degradation of dunes, coastal wetlands, and other critical aquatic ecosystems as a concern, but references the growing number of persons and structures vulnerable to coastal erosion, coastal flooding, storm surge and wind damage. The program is based largely on existing statutes, primarily the Texas Coastal Coordination Act (1991).

The program is noteworthy because of its intent to directly regulate Coastal Natural Resource Areas (CNRAs) which include, but are not limited to, coastal barrier islands, gulf beaches, critical dunes areas, special hazard areas, and critical erosion areas. The TCMP will adopt performance standards intended to avoid, minimize and where possible, compensate for adverse impacts to the CNRAs from development activity. The standards will provide for the management of coastal development on beaches, in dunes, and in areas of high hazard and will serve to coordinate the activities of eight state agencies and 18 local governments, under the Coastal Coordination Council. It will rely on state control of land and water uses, although local governments will implement State guidelines related to beach and dune management.

The section on barrier islands pertains to shore access, dune protection and hazard mitigation. Each city and county government with jurisdiction over a barrier island will implement the TCMP policies related to the above issues. The program requires that each locality develop a Beach Access and Dune Protection Plan, per the Open Beach Act and

the Dune Protection Act, that must address development adjacent to public beaches and within critical dune areas. The plan must also address impacts to dunes, construction practices to minimize damage from flooding and storm surge, and use and placement of erosion control structures. The plans must be certified by the General Land Office and the Attorney General's Office. Local governments may issue beachfront construction certificates and dune protection permits to implement their plan.

The adoption of this program is significant for two reasons. One, it signals a trend away from the fragmented governmental framework of the past, which has been an impediment to the development of comprehensive coastal management policy, toward a more collaborative approach. As indicated before, even though all mitigation is local, it takes place within an intergovernmental framework. Moreover, it is important that the framework cultivates the use land use planning and development management. Two, the TCMP has the potential to become the focal point for a comprehensive mitigation framework (CMF), a context within which hazard mitigation policies can be identified, analyzed, and implemented at the local level. The caveat, however, is that TCMP is untested and there are likely to be a number of disputes as the state begins to assert more control over local governments.

Texas Catastrophe Property Insurance Association (CATPOOL) Program

The Catastrophe Property Insurance Pool Act (CATPOOL) is an involuntary insurance market that was created by the Texas Legislature in 1971 after Hurricanes Carla, Celia, and Beulah hit coastal development on the upper, central, and lower Texas coast. The CATPOOL is a significant piece of legislation for a number of reasons. The first reason pertains to the pretense under which it was created. The second reason is that the CATPOOL, with the assistance of the Texas Department of Insurance, has its own guidelines for wind resistant construction. These standards are imposed as a precondition to receiving insurance in the pool. After the storms of the 1960s the legislature made two findings: 1) homeowners and developers along the coast would find it difficult to secure insurance in the voluntary market; and 2) the availability of insurance was a necessary

precondition for economic development. In the words of the legislature (Article 21.49 of the authorizing legislation):

> "...an adequate market for windstorm...insurance is necessary to the economic welfare of the State of Texas and that without such insurance...growth and development of the State of Texas would be severely impeded. It is therefore the purpose of this Act to provide a method whereby adequate windstorm...insurance may be obtained in certain designated portions (the entirety of first tier coastal counties) of the State of Texas."

The CATPOOL provides coverage for losses due to wind, not flood. It requires all insurance companies licensed to write property insurance in Texas to share the risk of major natural catastrophes based on a market-share formula. Hence, the involuntary nature of the market.[6] Today, the CATPOOL has a total exposure of $10 billion[7] and writes approx. 10-15% of the policies on South Padre Island, and between 30-40% on Galveston.[8] The remainder of insurance coverage is written by the voluntary market (private insurers). These figures are important because they seem to question the urgency of the shortage and suggest that development would have occurred absent an involuntary insurance market. Nevertheless, those beachfront properties insured in the CATPOOL are subsidized: (1) other property owners subsidize high-hazard coastal development through escalated premiums across the state; and (2) the taxpayers of the State subsidize the program through the premium tax credit for catastrophic losses.

The second important aspect of the CATPOOL is that it enforces its own wind resistant building standard (developed and enforced by the Texas Department of Insurance engineers). In the state of Texas, most incorporated municipalities adopt the Standard Building Code while in un-incorporated areas (i.e. counties) there is no authority to enforce a code -- compliance is voluntary. Regardless of what jurisdiction a structure lies in, to be insured in the CATPOOL it must meet their standard.

In the 1980s, poor construction practices took over as the preeminent issue after a study revealed that damage from Hurricane Alicia (1983) at West Beach in Galveston was disproportionately high compared to Hurricane Diana (1984) which struck Kure Beach, North Carolina. By comparison, both storms had sustained winds of 80 - 90 mph,[9]

and both communities possessed similar terrain and the same number of homes with similar construction. The Texas Tech report found that 70% of the houses at West Beach were destroyed beyond repair, while only 3% of the homes on Kure Beach needed structural repairs. The report concluded that the difference was attributable to the quality of the building codes and how well they were enforced. The Galveston code was simply not as rigorous and/or as well enforced as the North Carolina code.[10] As a result of this study, a move was made to strengthen this code by adopting a Building Code Effectiveness Grading Schedule (BCEGS). This is a method for evaluating a community's building code enforcement program. Today, the CATPOOL is in the process of updating its code.

Despite this effort to enforce a consistent wind resistant building standard across the state's coastal regions, the CATPOOL claims not to be proactive on mitigation. Yet, in addition to code enforcement in un-incorporated areas, the program distributes educational material to 3rd and 4th grade teachers teaching the children about hurricane safety and building codes.[11] Nonetheless, the costly impact of the state's most recent hurricane, Alicia (1983), led many to reassess the program. For example, some argue that the State should follow the Federal example set by CBRA and reduce state subsidies for insurance on coastal barriers by eliminating the program altogether. Others are diametrically opposed and argue that the State should step in to provide the insurance coverage being withdrawn through the passage of CBRA. In its current state, the program makes a significant contribution to hazard mitigation through the enforcement of wind resistant codes despite the pretenses under which it was created.

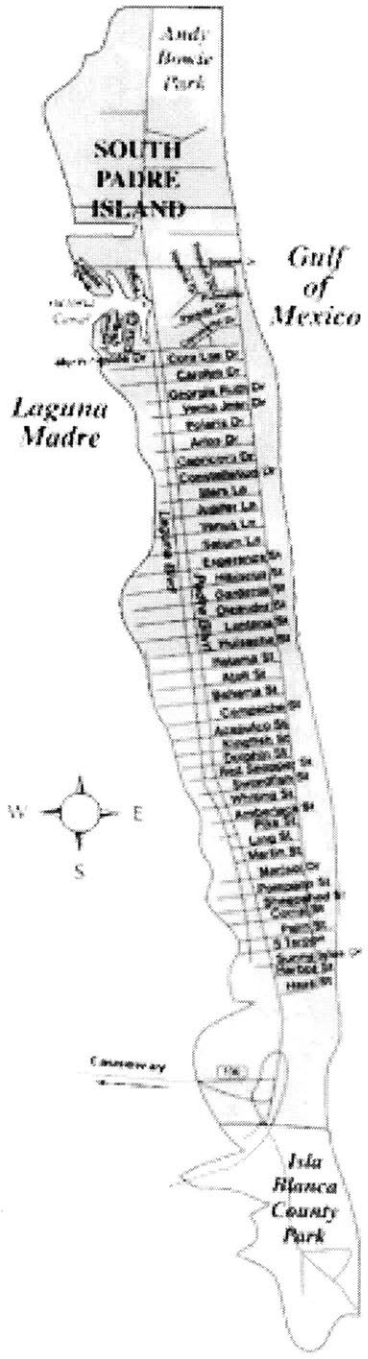
SOUTH PADRE ISLAND

Upon arriving on South Padre Island, I found a brochure with advertisements of popular eateries and night spots on one side, and their location on a map on the other. What caught my attention was the description .

> "The City of South Padre Island, incorporated in 1973, is a four mile strip of high-rise condominiums and resort hotels, cottages, bungalows, restaurants and bars.

...never wider than three miles, South Padre island offers an endless variety of things to do - sun-bathing, shelling, and surf fishing."

Figure 5.2



Not to be outdone, some of the advertisements left quite an impression as well. Wells Real Estate Inc., boasts a slogan says, "WE SELL THE ISLAND." On the reverse side, Sunny Isle Rental Services declares, "WE RENT THE ISLAND."

These opening narrations are indicative of the fact that the only industry in this small island community is tourism. The town is situated on the southernmost 6 miles (Figure 5.2) of the 110 mile long Padre Island and is connected to the mainland by the 2.5 mile long Queen Isabella Causeway. The town's vehicular traffic is accommodated primarily by Park Road 100 which is a four lane road that runs north-south. It is served by a council-manager form of government. The estimated year-round population is 2,000, a number that swells to as many as 200,000 during spring break in March. A smaller number inhabit the island seasonally, "whitebirds" that flock down from Canada and the upper Midwest in the cooler months, and Texans in the summer. The area is just finding its value as an eco-tourism market giving birders much to see during migration season on the 30 miles of undeveloped beach north of town.

To understand hazard mitigation and land use on South Padre, it is necessary to examine how it came

to be the only developed resort in South Texas, in addition to its geological character, experience with erosion, hurricanes and other natural processes.

The Island

I was told that the difference between the forces which acted on land use and development on South Padre and those in other parts of the state (i.e. Galveston), is that there were no rules except those imposed by nature itself. Nearly 2,000 years ago, nature enforced its rules by creating the island with the retreat of the Rio Grande.[12] Throughout most of its history, the island has had a wide, sandy beach with a discontinuous line of 15 to 20 ft high dunes. The lagoon side of the island has sand flats which slope toward the lagoon into mud flats. Wetlands are rare along the back side of the island and the few that exist today were artificially created.[13]

There have been numerous tropical storms and hurricanes that helped change the shape of the Island, 22 since the turn of the century. (APPENDIX H) At the same time, shoreline erosion averages between 10 and 15 feet of per year with localized variations on the southernmost and northernmost portions of the island. Jetties at the Brazos Santiago Pass have caused a shoreline accretion along the southern end of the island since 1933, and erosion at the north end near Andy Bowie Park.[14] In response shoreline retreat on the northern portion of the island, the town just completed a $1 million beach replenishment project.

Development and Hurricane History

For an island with such a hurricane-riddled past, there is a subtle irony to how is was said to be first inhabited – by a mixture of hurricane-wrecked slaves and Coahuiltecan Indians.[15] Followed by ranchers who introduced cattle and horses in the late 18th century, the Lower Rio Grand Valley grew as a military transshipment (rail to water) point until the area was devastated by a hurricane in 1867. Soon thereafter, weekend and summer excursions carried bathers from Brownsville to South Padre to spend the day on the beach, only to return at night. In the 1920s, the island was sold to a developer whose aim was to make Padre Island into another Miami Beach. Early efforts to establish the

island as a tourism mecca failed in part due to the disturbance of hurricanes. In 1933, the Texas Highway Department conducted its first survey on the island only to have a category 3 hurricane destroy all the existing structures on the island along with the only causeway, leaving little doubt that a beach highway was unfeasible. [16]

The island was infrequently visited by campers and day-sailors for the next two decades until a developer from Corpus Christi bought a five mile segment and enticed the county to build a causeway to the island by deeding the southernmost tip (150 acres) and a section to the north (225 acres) to the county as public parks (Isla Blanca and Andy Bowie Parks, respectively). In 1954 the Queen Isabella Causeway as opened but development was still slow due to a concern over hurricanes, a lack of insurance, and a poor water supply. The island was hit by another hurricane (Carla) in 1961, a category 4, and again in 1967 (Beulah), a less sever storm that caused much washover activity on the northern portion of the island. Yet, by some accounts Hurricane Carla stimulated a development boom because by 1964 there were fifteen resort hotels on the island. Development activity also increased following Beulah, in part due to how recently introduced condominiums held up to a category 3 and in part due to the emergency of insurance markets [the NFIP (1968) and the Texas CATPOOL (1971)].[17]

Development on the island did not truly begin until the 1970s and peaked in the early 1980s. A comparison of the island's development can be seen in Exhibits 5.3-5.5. (all aerial photos are courtesy of Richard Stockton, South Padre Island).

Figure 5.3

Figure 5.3 is an aerial view looking south on South Padre Island, taken in 1970. Notice that there is little development.

Figure 5.4

Figure 5.4 is the same view, looking south, taken circa 1993.

Figure 5.5

Figure 5.5 was taken in 1996 looking to the north.

The island was the site of yet another hurricane land-fall in 1980 (Allen) which caused considerable property damage, erosion and revived washover channels along the northern portion of the island. Undeterred, the building cycle continued up through 1982 and was in fact invigorated by Allen. A local developer recalls the influx of insurance monies and disaster assistance, a cash infusion, which elevated land values triggering a mini-development boom. His view was that Hurricane Allen turned out to be a boon for the South Padre economy. The cycle came to a close with the devaluation of the Mexican

peso and a downturn in the Texas oil boom in 1982. Since then development has been predominately residential with a trend toward filling the inner portions of the island.

Politics, Land Value, Land Use and Mitigation Planning

The pattern of development that exists today, high-rise condos on the beach and single-family residential units inland, is the result of land values and politics dictating land use. Although there was ample vacant land within the interior of the island, the demand for beachfront property led to the displacement of single-family along the beach by high-rise condos between 1960 and 1985. At the time of the building boom the town of South Padre was in its infancy and there was no vision for how development was to be managed or directed. There was no land use plan, at least one that was adhered to, and still isn't today. A long-time resident of the island recalled a design charrette that was held circa 1973, about the time the town incorporated, in which a "spine development" plan was put forth. According to the design, all high-rise buildings were to run north to south down the center of the island, while shorter residential buildings would inhabit the fringes. This plan never materialized for political reasons. The board of aldermen were intent on letting developers reap the most form their investments by allowing high-rise condos to go in right on the beach.

Another concern with the pattern of development is that it serves little attention to past geomorphologic changes brought about by hurricanes.[18] The highest concentration of development spans at least three major washover channels with grid street pattern that only facilitates the flow of water over the island. For example, one of the islands upscale developments, Fiesta Isles, resides in the center of one of the island's largest washover channel. Appropriately, the widest washover area just north of the town was deeded to the county and is now a park, Andy Bowie Park.

In the late 1950s, an attempt was made to fortify and protect an exclusive residential area along the beach with the construction of a seawall. Hurricane Carla toppled the project and the developer's beachfront home with it. Another, similar coastal fortification was constructed soon after, this one a number of feet inland and substantially larger than the previous one. This stood for nearly five years until Hurricane Beulah

removed it in 1967. While no further attempts have been made to construct localized seawalls, every commercial structure along the beach has a substantial concrete bulkhead as seen in Figure 5.6.

Today there are essentially three policies that relate to mitigation at the local level (aside from compliance with NFIP requirements, wetlands protection, and enforcement of the CBRA which only impacts a section of Padre northof any development). The first is a beach and dune protection framework that struggled early-on to assert any control over construction on the beach which has recently been reinvigorated by the TCMP. The second is the South Padre Island building code. Third, South Padre has an emergency management plan that addresses mitigation. Also, as previously indicated, the town has undertaken isolated, ad hoc projects to slow erosion such as the recent beach replenishment. These mitigation projects, however, are not pursued in a systematic way or as part of a larger framework.

Figure 5.6 High-rise condo with bulkhead.

Beach and Dune Protection

Texas passed the Dune Protection Act in 1973, the same year the Town of South Padre Island incorporated. Politics intervened at the same time when powerful real estate lobby won an exemption to the Act from the state legislature for South Padre. As a result, a number of dunes were "notched" to clear the way for large multi unit, commercial

structures along the beach. (see Figure 5.7) As one developer noted, "only now are we beginning to realize the value of natural dunes as wave buffers...but at the time land values were such that it was advantageous to be right on the beach."[19]

Efforts are now being made to protect sand dunes through the South Padre Beach and Dune Tack Force, an artifact of the Texas Coastal Zone Management Program. The town's policy states that no buildings may be built east of Gulf Boulevard (the road nearest the shore that runs north-south) without first obtaining a Dune Protection and Beachfront Construction Permit which is granted by the Town of South Padre, another process tainted by political whims.

Figure 5.7 Shoreline development in natural sand dune area.

After the Task Force reviews an application for a permit, a recommendation is made to the Board of Aldermen (an elected, 5-member board) which grants final approval. The guidelines stipulate that the town shall strive to balance the objective of dune protection and preservation while recognizing a property owner's right to reasonable development of private property. Notwithstanding the activities and/or recommendations of the Task Force, only the Board of Aldermen can deny or grant a permit.

Within this context, the Board of Aldermen can essentially do anything they want. In the past, seats on the Board were dominated by developers, realtors, and members of

the chamber of commerce, all predisposed toward economic growth. In other words, the beach and dune protection framework is not guarantee for hazard mitigation. This dynamic brings to light that there must be political support for mitigation at the local level even when there are good policies and procedures in place.

South Padre Building Code

Building codes in most coastal towns are intended to ensure the quality construction of structures such as homes and commercial buildings. The Town of South Padre uses the Standard Building Code and two building inspectors to achieve this goal, yet they carve out an exemption for one and two-family homes. Instead, construction of one and two family dwellings are subject to a less stringent, prescriptive code which does not meet engineered specifications, but tends to keep the costs of the home down. With regard to natural hazard mitigation, both codes tend to make such structures resistant to wind peril. Hurricane winds have historically caused extensive damage along the Gulf coast and South Padre is no exception. For a long time, the cause for this damage was believed to be the result of inadequate building codes; specifically inadequate wind velocity requirements in the codes. In reality, non-engineered residential and small commercial buildings were incurring wind damage as the result of improper connection of various structural elements such as rafters to studs, studs to beams, beams to piling, etc. Thus, the lack of code compliance and enforcement – not the standards themselves – has been the primary cause of wind damage.

A study completed four years ago by the National Committee on Property Insurance found that inspectors, plan reviewers, and builders along the Gulf coast (including South Padre) had little or no training in wind resistant construction, in part because such training is relatively new. The study also found a general lack of enforcement of adequate connections of windows, doors, and mechanical equipment to the building framing system. Hurricane clips, which connect the roof to the walls (top plates) of a house, were used in every jurisdiction but no consideration had been given to the capacity of such clips. Finally, in jurisdictions where roof framing was supported by

interior walls, beams, etc., the connection was toe nailed providing little or no resistance to uplift wind forces.[20]

The South Padre building code possesses all the necessary tools to ensure residential and commercial structures are built well and are resistant to wind (up to a point), thus minimizing property damage in hurricanes. But, as the study points out, having a code is only half the game. Another caveat is that it has been almost twenty years since a hurricane "tested the code" and its construction on the island. Nonetheless, the building code is an integral part of mitigation.

Emergency Management Plan

South Padre's emergency management plan endeavors to meet four objectives: mitigation, preparedness, response, and recovery. The emergency management director who carries the responsibility of developing and implementing the plan is the mayor. All emergency policy decisions (i.e. declaring a state of emergency) are made by the mayor and the Board of Aldermen. The city manager on the other hand is responsible for the operational aspects of the plan. Maintaining the hazard mitigation element of the plan is the role of the Public Works Director who must survey potential hazardous situations in town and develop specific plans to lessen the hazard. Mitigation activities under the plan do not address issues of land use (i.e. location of new development and/or relocation of structures that are in hazardous areas). The plan does not provide an appropriate forum in which alternative land uses can be analyzed, discussed, and implemented. It is, as the name indicates, designed to deal with emergency situations, not day-to-day governance.

GALVESTON

In sharp contrast to the relative youth of South Padre, Galveston has a long, rich history as one of the oldest cities in the state of Texas. Dubbed the "Manhattan of the South" at the turn of the century, Galveston's population has fluctuated between 40,000 and 60,000 for nearly one hundred years. Also unlike its southwestern counterpart, Galveston's growth was stunted because of its location on the Gulf and its exposure to hurricanes. Despite tremendous coastal engineering feats (e.g. the 15 mile-long seawall

and a massive grade raising project), the availability of insurance for flood and wind, a well-built building stock and solid building code, improvements in hurricane tracking technology, local pro-growth policies, and natural assets capable of supporting a much larger population, Galveston seems to have gone against convention. The legacy of past hurricanes, however, appears to be fading. In the last 10 years new subdivisions with expensive homes have begun to fill-in the western portion of the island beyond the protection of the seawall, land values along the beachfront are beginning to climb, and significant reinvestment has taken place in the downtown historic district, The Strand.

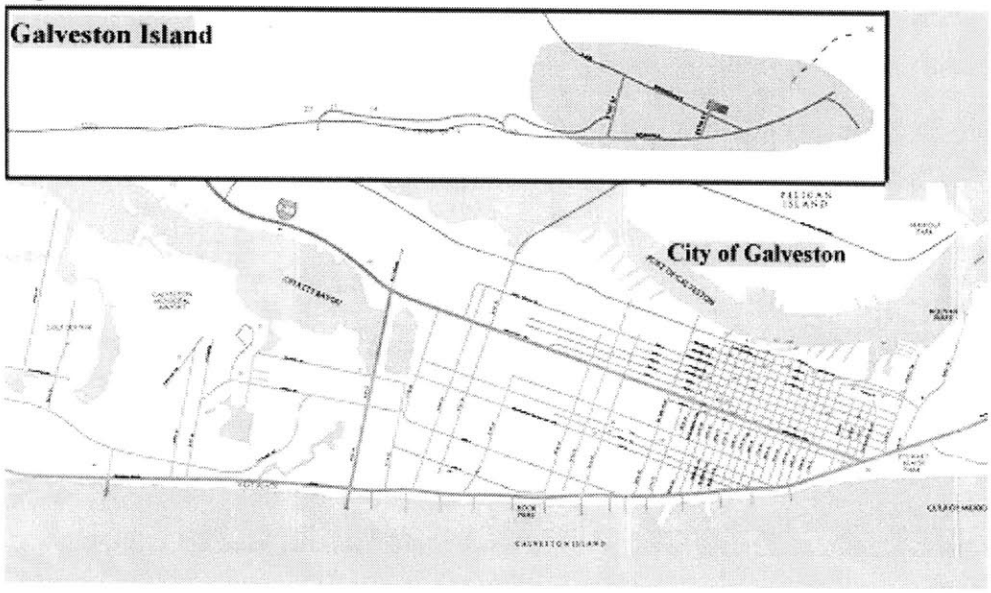
In order to provide a complete picture of hazard mitigation in Galveston and draw meaningful conclusions, it is necessary to assemble some basic facts. First, I will look at the general geologic character of the island followed by an account of its development and hurricane history. There are two hurricanes in particular, the 1900 storm and Hurricane Alicia (1983), that lend insight into contemporary land use practices and mitigation policy. Within the discussion of Hurricane Alicia, I will look at emerging land use and development trends and Galveston's modern mitigation policies. Finally, I will discuss the prospects for a comprehensive mitigation strategy.

The Island

Galveston Island is a 28 mile-long narrow barrier ranging between 1/2 and 3 miles in width, lining and protecting the Texas coast. (Figure 5.8) The 12 to 15 ft. sand dunes that once bordered the island were removed in the development boom of the late nineteenth century leaving the island without any natural protection from the sea. Since then significant alterations have been made to fortify and protect the island. The eastern end of Galveston, called East Beach, has been altered by jetties used to protect and improve the harbor entrance. Most of East Beach is accreting due to such alterations, from 200 to 7,000 feet in slightly less than 100 years, producing a broad sand flat.[21] Although there are a few high-rise condominiums, most of East Beach is used for recreational purposes.

Moving southwest down the island, the next 10+ miles of shore is dominated by the seawall. Along the seawall, beach/sand is found only in pockets on the north side of the several, short groins protruding into the Gulf and in most areas riprap protects the

Figure 5.8



base of the seawall. Shoreline erosion does not exist, or is not a factor simply because no beach remains.[22] The shoreline west of the seawall has a low profile making it susceptible to flooding and overwash, and is generally wet, muddy and marshy with hundreds of localized ponds. In addition, erosion has led to a steady retreat of the beach. The most severe erosion rates 11.6 ft./yr. are immediately west of the seawall and 2.5 ft./yr. further down the island. The only stable vegetation along West Beach is roughly a one mile stretch called Indian Beach.[23]

Development and Hurricane History

The city of Galveston was born in 1836, the same year Texas gained independence from Mexico. With a natural deep water port, the shipping industry quickly moved Galveston into a position of prominence. In 1885, it was the largest and richest city in the state with The Strand, a business district, known throughout the country as the "Wall Street of the Southwest." Galveston was the first in the state to have a post office,

navy base, hospital, grocery store, gas lights, telephone, opera house, medical college, golf course, public library and the first Chamber of Commerce.[24]

Thought to be due to a poor water supply and a heavy reliance on agriculture, manufacturing and the industrial revolution with its large institutional investors never came to Galveston. In an attempt to rectify the problem, the town installed a new water system in 1890, but even wealthy Galvestonians invested elsewhere. The reality was that Galveston lay in harm's way and investors knew it, thus questioning the prudence of placing expensive capital, or even a city, in such a place. O.P. Hurford, explained in a letter to the editor of the *Galveston Daily News* in 1876 that he had heard in the commercial circles of Chicago, Cincinnati, Philadelphia, and New York that Galveston was unsafe for investment because of flooding and high wind. He wrote:

> "There are to-day untold millions of Northern capital looking southward for investment, of which Galveston would receive her legitimate proportion if we could offer a reasonable argument that the island will not one day be washed away."[25]

About the same time, Houston built its own shipping channel and began taking business from Galveston's port and luring the industrialists to locate there, boasting its location 50 miles inland from potential hurricane threats. Even when oil exploration brought industrialization to most of Texas in the early twentieth century, the pipelines led to Houston, Port Arthur, Beaumont, and Orange – but not to Galveston (which was still recovering from the 1900 storm).[26]

Although railroads, harbor activities, and cotton trade constituted the main thrust in the Galveston economy throughout much of the nineteenth century, an important minor current of tourism also evolved, with the beach being the primary commodity. Beginning in the 1950s, vacation communities began to appear on the west end of the island beginning with Jamaica Beach and Sea Isle. But at the time, development on West Beach was rare and made difficult by an unwillingness of local lending institutions to finance development in "unprotected" areas (i.e. areas not behind the seawall). However, many other projects both and in front of the seawall. One project of note is Pleasure Pier. After

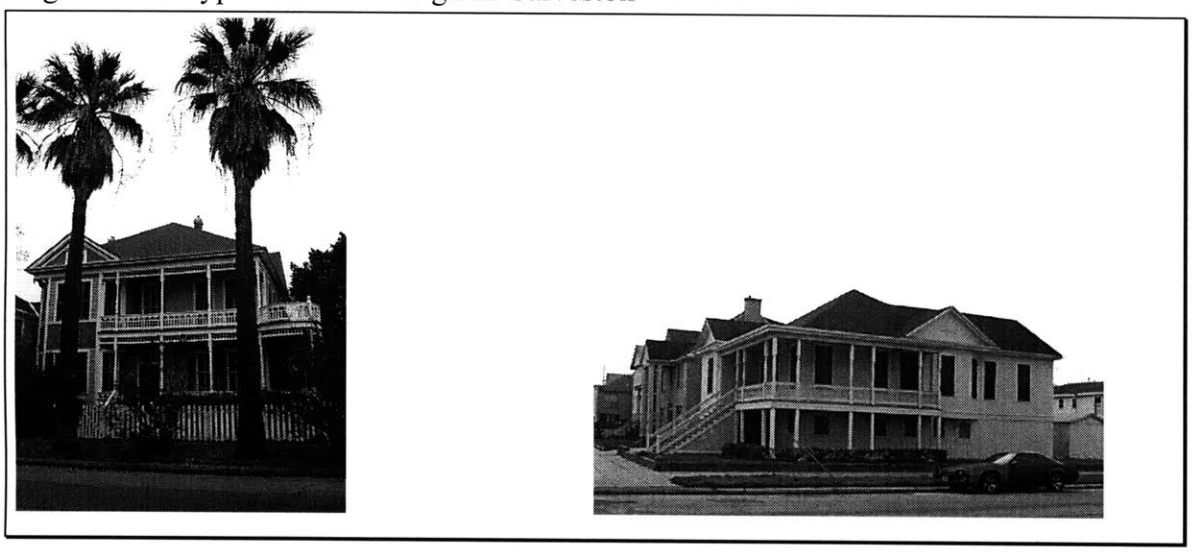
a failed attempt to make this four-block long wooden pier into an entertainment and social center, the pier was reinvented in 1965 with the construction of a 250 room hotel (the Flagship) that the city of Galveston now owns. (Figure 5.9) A boondoggle from the beginning, the investment in the pier and hotel seem unmindful of the frequency with which hurricanes make land-fall in the area. Condominiums also began appearing along the seawall in the mid-1970s despite their precarious position. For one condo, engineers went to great lengths to acknowledge hurricane threats in their design sending concrete pilings 120 feet into the sand and building the first floor 24 feet above mean high tide, all designed to withstand 240 mph winds.[27]

Figure 5.9

Today, Galveston has a hearty residential building stock, the vast majority of which is located behind the seawall. The older homes appear to have been built with storms in mind donning designs that indicate an expectation of floods and high wind. Many homes have full wrap around porches and kitchens on the second floor, with permanent louvered shutters and stair cases leading to an entrance 10 ft. off the ground. (Figure 5.10) This design enabled citizens to conduct daily life above flood waters and insulated from high winds if necessary.

To be sure, Galveston has been battered by a number of tropical storms and hurricanes (see APPENDIX I). There are simply too many to chronicle each one and its impact on the island. Therefore, I will discuss two, the 1900 storm because of its magnitude and Hurricane Alicia (1983) because it was the most recent.

Figure 5.10 Typical Home Design in Galveston



The 1900 Storm and the Engineering Response

In 1900, Galveston was hit by a major hurricane that claimed 6,000 lives, 3,600 homes, and 300 feet of shoreline. Records show that little preparation had been made for hurricanes despite almost half a century of experience with them. The rapid development of the city in the late 1800s led to the removal of sand dunes along the beach front. Left unprotected from the sea, many in the city recognized the risks and a number of plans for storm protection had been developed; however, because of financing difficulties and general public apathy, none of these plans was realized. What little that was done involved planting a line of salt cedars on top of the few sand dunes left in order to stabilize them in addition to hauling sand into the city to elevate it and promote drainage. Still, the highest point in the city was barely seven feet above sea level.[28]

Technology had come to Galveston early, boasting one of the county's first weather stations 1871. Even with what was considered adequate warning time, the city had been through storms before and many failed to heed evacuation warnings. In this

case, it was the magnitude of the storm that took the town by surprise. The combination of wind and rising water was enough to leave the entire area looking like a pile of rubbish. (Figure 5.11)

To be sure, people moved from Galveston never to return, but many stayed resolved to defy nature. Those that did stay, at the advice of a specially appointed group of engineers, constructed a seawall intended to break storm waves, stem storm surge, and keep the town from flooding. In addition, the grade of the island was raised as much as 12 feet in places, creating a slope from the sea to the bay in order to facilitate drainage.

Figure 5.11 Sacred Heart church, 1900.

Source: Rosenberg Library. Galveston, TX.

A total of 25 million cubic yards was pumped in and all structures including offices, homes and churches were carefully raised.[1] The seawall and the grade raising are prime examples of the attitude that solutions to problems in nature can be solved simply through engineering. It is also indicative of the tenacity and spirit of people when faced with adversity.

The legacy of this event is important not only from a structural perspective, but from an economic and psychological point of view as well. The town's response to the storm was indicative of the Dutch in their effort to hold back the sea and led many to stay under the false impression that a seawall would prevent something like that from ever happening again. The mitigation response also led to a concentration of almost all the economic growth behind the seawall over the

next seventy years, thus dictating a long-term pattern of land use and economic growth. Aside from building a false sense of security and a disproportionate reliance on coastal engineering for natural hazard mitigation, the seawall also eventually began to take away one of Galveston's most precious commodities, its beach. This is not to say that a wholly rational approach would have been to abandon the island altogether. In reality, however, many did by never leaving the island's economy to stagnate over the next half century.

Hurricane Alicia (1983),Hazard Mitigation, and Emerging Trends

By tracking tropical storms and hurricanes by decade (see APPENDIX G), it is easy to see that the period between 1970 and the present represents a relative lull in storm activity for the Texas coast. Yet, on August 18, 1983, a category 3 hurricane crossed the western end of Galveston reminding many that it is a matter of when, not if, another storm will make land-fall in Texas. Hurricane Alicia is an important study because it speaks to numerous contemporary mitigation issues in Galveston including emerging land use and development trends and their general approach to hazard mitigation. Much has been written about the attitudes and policies of Galvestonians both before and after Alicia, giving an indication of the effectiveness of certain mitigation practices.

The first severe storm since Hurricane Carla (1961), Alicia was the most costly storm in Texas history up to that point in time. There was substantial landward retreat of both the shore- and vegetation line. The shoreline retreated between 10 and 250 feet, eroding more than 2 million cubic yards of sand from the area extending west of the seawall called West Beach.[29] Wind damage was extensive and rain and storm surges flooded most of the western portion of the island.[30] At the time, there was $400 million in residential development in progress in the twenty-plus miles of beachfront from the end of the seawall to the western tip of the island.

Pre-Alicia Context

There were various home- and dune-protection efforts found in each area of development ranging from sand traps to concrete or wooden bulkheads hundreds of feet

long. Most were destroyed in the storm affording little protection to the properties which had them and causing severe, localized erosion on adjacent properties.

The pre-Alicia mitigation policy was well-intentioned but limited in success. Beginning in 1980, after Hurricane Allen swept well south of Galveston, the city enacted some development regulations aimed at hazard mitigation. A sand dune ordinance was adopted prohibiting construction in the dune area west of the seawall within 500 feet landward of mean high tide without a building permit. In 1983, Galveston incorporated the most recent FEMA flood elevation requirements into the previously adopted Standard Building Code. Finally, just two weeks before the storm the city enacted stronger building code specifications for all construction seaward or west of the seawall.[31]

At the same time, through the use of tax increment financing, the city enticed developers to build infrastructure (roads, sewers, etc.), followed by development, by agreeing to freeze tax assessments in new development areas at predevelopment levels. This, along with the newly available flood insurance, facilitated an upswing in the building cycle and overburdened their planning capacity. Galveston had annexed the west end of the island in 1977 and zoned it for development, but never developed a comprehensive plan or development criteria, despite its hazard exposure. The city was, and still is, interested in expanding its tax base which meant responding to individual private development requests as they were made.[32]

Post-Alicia Context

As a condition to receiving disaster funds under the Disaster Relief Act, Texas had agreed to evaluate losses from the storm and their mitigation practices. At the same time, FEMA found that urban development along the coast had largely occurred without consideration of land use and without regard to natural hazards. FEMA recommended that Galveston prepare a development management plan for the west end of the island calling for the city to take a more proactive approach. It was recommended that a carrying capacity study be done to asses alternative uses of the land to reduce risk and limit the amount of property and people vulnerable to hurricanes.

Galveston's mitigation plan post-Alicia, developed with help from the state, makes no mention of the possibility of using development controls to prevent future growth. Nevertheless, immediately following the storm there was a moratorium on construction and despite the threat of fines for violations, a number of infractions took place. What emerged, and in fact what is facing most coastal communities today, is an impasse between limiting development in hazardous areas and the desire to expand the local economy (i.e. the tax base) through development. In this case, the confrontation is taking place on Galveston's West Beach where development pressures are greatest.[33]

In a discussion with the local planner, he cited the fact that the city takes very little risk in allowing such development and that there were few direct costs borne by the locality itself. The planner noted the continued willingness of the federal government to provide disaster assistance, the fact developers are willing to put up the costs to build the infrastructure, and that people, of their own free will, keep moving in. This becomes a very difficult situation for a planner to say no, particularly when between 30-40% of Galveston's land is occupied by public, non-taxpaying entities. Finally, he pointed out that much of the land on West Beach is still occupied by a hand-full of very large ranches.[34]

In light of pro-growth policies in Galveston, it is interesting to see how perceptions of risk differ among those building on West Beach. The differences are clearly seen in Spanish Grant, a subdivision on West Beach, where two adjacent homes build to flood elevations that differ by 8 ft. (Figure 5.12)

Figure 5.12 Built in recent years on West Beach

There are also a host of homes on West Beach that are in serious danger of falling into the Gulf. Last year an unnamed tropical storm of moderate strength, took a number of homes to the brink of collapse. (Figure 5.13-5.15) Recent pictures illustrate the relative imminent danger of many properties on the West Beach. Reducing storm hazards is featured prominently in their current mitigation policy for the west end. The focus, however, is on performance standards dealing with structural designs and elevation requirements. In reality, the post-storm investigation, along with the recommendations, did nothing to deter development in the hazardous west end.

Expedient politics continue call on tax increment financing, encouraging higher density development. The assumption in Galveston appears to be that strengthening the building code will be the step needed to protect against future hurricanes. Unfortunately, as pointed out in the National Committee on Property Insurance, code enforcement has been meager along the Texas coast, in addition to the myriad problems with relying on building codes. There are some local success stories involving the use of conservation easements where limitations are imposed to retain/protect natural, scenic, or open space values of real property or assure its availability for agricultural, forest, recreation, or open space use.

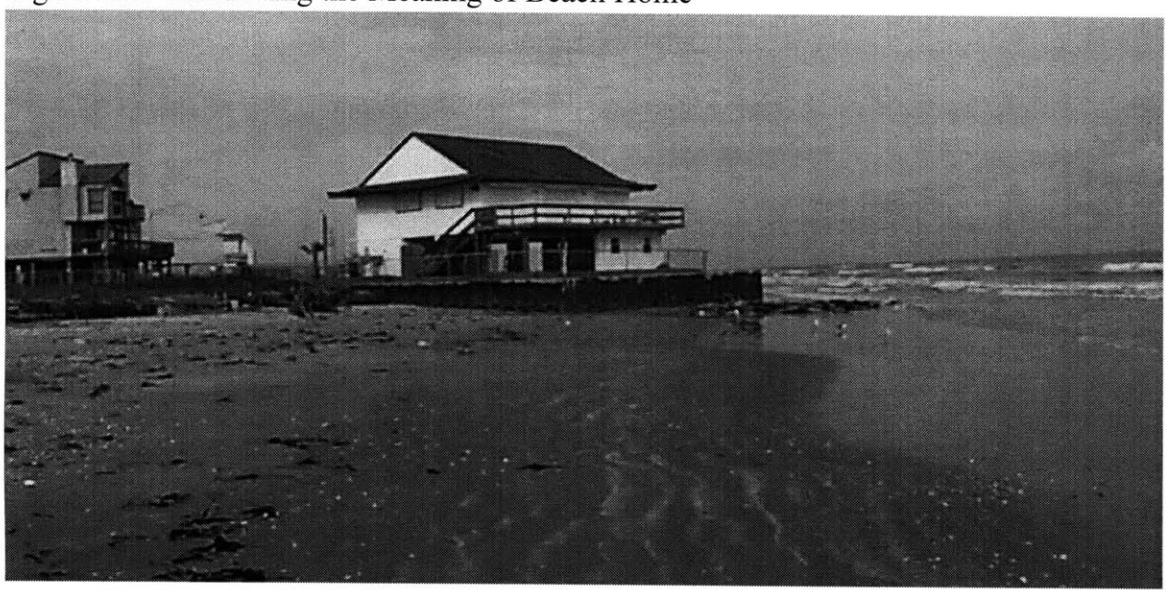
Figure 5.13

Figure 5.14

History clearly shows that Galveston beachfront property will receive minor storm damage every few years and extreme storm damage about every 20 yrs.[35] Frequent storms and long-term beach erosion

lend credence to the consideration of land use planning and a comprehensive mitigation approach on Galveston.

Figure 5.15 Redefining the Meaning of Beach Home



CLOSING THOUGHTS ON TEXAS, GALVESTON, and SOUTH PADRE

In closing, there a number of key observations from the Texas study. While not all Texas communities are as strongly anti-planning as Houston, where there are no zoning laws, there is a distinct absence of land use planning and development management. It follows that this posture is the result of not only a policy process, but a political process as well. Public policy in the two coastal communities highlighted in this study tend to emphasize economic development and place little value in land use planning. Galveston and South Padre Island are both riding a relatively recent surge in development activity and do not intend to jeopardize economic growth. Both areas possess a conservative attitude toward the regulation of private property and with no movement toward stronger penalties for unwise coastal development in hazard areas within a state or federal framework, the trend will continue.

It is apparent that memories are short. Hurricanes have not caused substantial damage in Texas in nearly fifteen years, a period characterized by high growth in spite of the fact the legacy of destruction brought by hurricanes is incontrovertible. Still,

hurricanes do not change the essential character of a locality. Attitudes toward the use of public policy as an intervention tool in the private development market are strong. The carrots available today make a difference, but only to a degree. As long as people continue to move to the coast, the federal government is willing to bail out local government and the residents of hazard-prone areas following a hurricane, insurance is universally available and offered at below market rates, and the costs/benefits to land use and natural hazard mitigation planning are not enumerated, existing political attitudes will prevail. Thus, the communities seeking development will continue to be unimpressed with the need to limit growth in high risk areas. This constitutes a seemingly insurmountable hurdle for the implementation of a CMF in Galveston and South Padre, but to say it is easy would suggest it is a trivial matter and this is not a trivial matter.

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[1] Texas General Land Office, 1997.
[2] Morton, Robert A., Pilkey, Orrin H. Jr., Pilkey, Orrin H. Sr., and Neal, William, J. 1983. *Living with the Texas Shore*. Duke University Press. p. 11.
[3] The US Department of the Interior. 1988. *Report to Congress: Coastal Barrier Resources System*. Volume 20. pp. 2-7.
[4] The US Department of the Interior. 1988. *Report to Congress: Coastal Barrier Resources System*. Volume 20. pp. 2-7.
[5] Monies will be used to help enhance local government capacity to respond to coastal hazards. TCMP, 1997. Texas General Land Office.
[6] The maximum coverage on residential homes $288,000 (includes contents) and commercial properties the policies may go up to $1.1 million.
[7] A full 100% of the CATPOOL liability is on the coast.
[8] This coverage is mostly for high-rise condominiums, not residential buildings. Information obtained in phone interview with Charles McCullough, Director of the Texas "CATPOOL," 4/25/97; and Ron Demerjian, President, Property Insurance Plans Service Office (PIPSO) 4/48/97.
[9] These wind speed were below the designed levels specified by the local codes. Texas Department of Insurance. 1997.
[10] Rogers, Spencer M. Jr., Sparks, Peter R., and Sparks, Katherine, M. 1985. *A study of the Effectiveness of Building Legislation in Improving the Wind Resistance of Residential Structures.* Texas Tech University, Lubbock, Texas.
[11] This program is conducted in concert with the Insurance Information Institute. There is also a take-home packet the kids bring home to their parents to do a hurricane preparedness assessment on the home.
[12] Morton, R.A. and J.H. McGowen, 1980. *Modern Depositional Environments of the Texas coast.* Guidebook 20, bureau of Economic Geology, Austin, Texas.
[13] Meyer-Arendt, Klaus J. 1987. *Resort Evolution along the Gulf of Mexico Littoral: Historical, Morphological, and Environmental Aspects.* Ph.D. dissertation in Geography, Louisiana State University, Baton Rouge, LA.
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[15] Meyer-Arendt, 1987. From Writers' Round Table (WRT) 1950. Padre Island. The Naylor Co., San Antonio.
[16] Meyer-Arendt, 1987. From Garza, R. 1980. *An Island in Geographic Transition: A Study of the Changing Lan Use Patterns of Padre Island, Texas*. Ph.D. dissertation in Geography, University of Colorado, Boulder, CO. and the WRT.
[17] Meyer-Arendt. 1987.
[18] Meyer-Arendt. 1987.
[19] Interview with local developer, Denis Franke, local developer. March 6, 1997.
[20]Southern Building Code Congress International, Inc. 1992. *Coastal building Department Survey.* National Committee on Property Insurance. Boston, MA.
[21] Morton, Robert A., Pilkey, Orrin H. Jr., Pilkey, Orrin H. Sr., and Neal, William J. 1983. *Living with the Texas shore*. Duke University Press. Durham, NC. p. 62-69.
[22] Ibid.
[23] Morton, Robert A., and Paine, Jeffrey G. 1989. *Shoreline and Vegetation-Line Movement, Texas Gulf Coast*. Bureau of Economic Geography. University of Texas. Austin. pp. 17-19.
[24] Galveston Chamber of Commerce. 1997.
[25] McComb, David. 1986. *Galveston, A History*. University of Texas Press. Austin. p. 48.
[26] McComb, David. 1986. p. 48.
[27] McComb, David. 1986. p. 190.
[28] McComb, David. 1986. p. 123.
[29] Morton, Robert A., and Paine, Jeffrey G. 1985. *Beach and Vegetation-Line Changes at Galveston Island, Texas: Erosion, Deposition, and Recovery from Hurricane Alicia*. Bureau of Economic Geography. University of Texas, Austin. pp. 10.
[30] Godshalk, David R., Brower, David J., and Beatley, Timothy. 1989. *Catastrophic Coastal Storms*. Duke University Press. pp. 75-76.
[31] Godshalk, et al. 1989. p. 81.
[32] Godshalk, et al. 1989. p. 82.
[33] A typical 75 ft.(wide) x 220 ft. (deep) beachfront lot averages $150,000, representing a significant investment.
[34] Interview with the head planner from Galveston.
[35] Morton, Robert A., and Paine, Jeffrey G. 1985. pp. 1-4.

CHAPTER SIX

CONCLUSION

Fundamentally, this study is about where we live, how we build, what we perceive our relationship with nature to be, to whom we hold ourselves accountable, why we have been unsuccessful in mitigating property damage from hurricanes, and what is to be done to stem the tide. It is also about sustainability.

Impediments to natural hazard mitigation along the coast abound. Such obstacles are rooted in public policy and institutional organization where land use polices at the federal, state, and local level lack coherence, coordination, and a clear path for hazard mitigation. Many public policies indeed promote development of hazardous areas while responsibility for mitigation is diffuse among countless public and private sector actors.

Other barriers to mitigation are found in economics and the difficulty of internalizing the full cost of living on the coast because of the way in which insurance is priced (at under market prices) and made universally available. Basic economics show that subsidies result in over-consumption as is the case with insurance. As a consequence, land is over-consumed resulting in unsuitable development of high risk, hurricane-prone areas. Without internalizing the full costs, the wrong economic and psychological signals are transmitted to consumers encouraging risky, irresponsible behavior.

We also find challenges to pursuing mitigation in human psychology and our propensity to engineer solutions to problems presented by nature. Perhaps to a fault, we are compassionate beings and find ourselves coming to the aid of the few (that make poor decisions) at the expense of the many. Hurricanes and other natural disasters not only appeal to our benevolent sensibilities, but they also serve as an organizing force, galvanizing people in the face of adversity to defy nature. Furthermore, the mixture of forces that dictate land use leave many to misperceive the true risk (financial and environmental) of living on the beach.

Mitigation and land use planning also suffers from diffuse, nearly non-existent political support. Unlike the disbursement of disaster assistance which is met with wide-spread endorsement, the demand for better natural hazard mitigation hankers for a strong political constituency. As with any political issue, constituencies are defined and motivated according to who stands to gain from a particular action and/or who bears the cost. In this case, the costs of natural disasters are hidden too far beneath the surface, too diluted for any single group to coalesce, suggesting that everyone pays for disasters. For example, there are no explicit costs imposed on localities for making unwise land use decisions. Nor have the benefits to natural hazard mitigation and land use planning been enumerated and codified under a single framework executable at the local level. It is also true that the linkages between hazard mitigation and other public policies have not been made clear and persuasive enough to generate demand for coordinated action.[1] As a consequence, there is a growing concentration of people and property along the coast that in turn, increases our vulnerability to natural hazards. These themes are clearly seen in Galveston and South Padre.

Stemming the Rising Tide: The Comprehensive Mitigation Framework and the Invocation of Local Action

Effective natural hazard mitigation may be achieved through a comprehensive mitigation framework that emphasizes land use planning, yet incorporates market incentives, coastal preservation, and enhancing the structural integrity of the built environment. Starting with land use planning at the local level, additional pressure must be applied to local governments to partake in a land use planning process that takes into account the threat of hurricanes, flooding, and shoreline erosion. This will only be done by incentivizing land use planning through the imposition of direct costs and/or the provision of real benefits. In this regard, the federal government and states have an important role. Currently, the Federal Emergency Management Agency requires that each town prepare an emergency management plan as a condition for receiving federal disaster funds. To date, most plans lack a strong land use planning element. Therefore, FEMA should also require those plans to include one of the model land use planning

elements/requirements recently developed by the American Planning Association as a condition for receiving disaster assistance.

In addition, monies earmarked for state hazard mitigation grants under the under the FEMA's 404 program should require that localities have an existing land use plan, or commit to developing and implementing one if one does not already exist. This goal can be accomplished, in part, by making hazard assessment information more accessible to state and local planners using Geographic Information Systems (GIS) to improve hazard mapping. Concurrently, the states' role is to encourage comprehensive mitigation planning through state-wide planning mandates. Mandates would serve to level the playing field among the communities in a coastal region where development decisions are influenced by the same guiding principles.

It is also imperative that the government stop subsidizing risk. There are a number of policies including the National Flood Insurance Program, disaster relief, tax deductions for losses, and Army Corps of Engineer shoreline engineering projects that deserve reconsideration. For instance, the NFIP must be actuarially sound and be run more like a profit-making entity. Many contend that it is a break-even business but at present, the program is $1 billion in debt and with a ceiling of $1.5 billion, FEMA is looking to expand it borrowing capacity to $2 billion. Without Uncle Sam as a backstop, the program would either have to raise insurance rates to remain solvent or go out of business. Since the later is less viable politically, greater emphasis must be placed on making the program more actuarially sound in order to shift the onus to those who take the risks which translates into raising rates.

In addition, just as private insurance policies require a deductible, so to should federal disaster assistance to state and local governments (e.g., $5 per capita).[2] This represents a departure from the existing 25% (state) -- 75% (federal) cost sharing mechanism and would directly impose disaster costs on state and local governments. In turn, efforts to reduce liability through mitigation would be more likely to occur at the local level where it belongs.

We must also address current tax law which allows for a deduction for losses exceeding 10% of adjusted gross income but places no requirements on property owners

or local governments to reduce their exposure to the hazard. This should be changed by stipulating that a piece of property must be built to the model code and comply with all NFIP provisions, as well as local land use laws, in order to receive the deduction.

Meanwhile, Congress is studying shoreline erosion rates and the effects of ending flood insurance coverage of damage due to erosion. Not only should erosion coverage be dropped, which disproportionately benefits the most wealthy, but Army Corps of Engineer coastal engineering projects be avoided.[3] Emphasis must also be placed on coastal preservation rather than coastal engineering. This may be done through the adoption of local ordinances that call for the preservation, augmentation, and restoration (PAR) of critical environments and natural mitigation features such as sand dunes, maritime forests, beach vegetation, and wetlands.[4] Localities must also identify areas of overlap with environmental policies at the state and federal level that achieve the same end. It is important that these policies be recognized for their contribution to mitigation in order to reduce its isolation from more widely accepted public policies and garner broader support.

The establishment of market incentives and engaging the insurance community are critical. Initially espoused as a way to share losses without subsidizing risk, insurance (both federal and private) in application has departed from that principle. In the case of private insurance, through in-voluntary beach plans chartered by the states. However, there are a number of paths that can be pursued by insurers within a CMF. For instance, residential insurance rates are essentially administered as one-size-fits-all standards. With some exceptions, they do not take into account individual mitigation features of each home (i.e., set back exceeding the minimum requirement, the presence of storm shutters, hurricane clips, disaster resistant glass, etc.). With the help of local building officials, a more detailed inventory of the building stock and its attributes can be used to adjust rates to accurately reflect the mitigation features of each home. As a quid-pro-quo, insurance companies may offer additional training for building inspectors and local contractors to improve the integrity of the built environment.

At the same time, discounts may be given to entire communities that agree to develop a comprehensive mitigation framework and land use plan. Engagement by

insurance and other financial sectors not only has a high symbolic value in terms of elevating the importance of comprehensive planning and natural hazard mitigation, but they also bring additional know-how and assistance to community-based planning processes. Ultimately, insurance market incentives and public policy must endeavor to internalize the full cost of living on the beach by rewarding prudent behavior and penalizing improvident acts.

Finally, consideration should be given to abolishing in-voluntary markets altogether, letting free market competition settle insurance rates and availability as a means of sending more accurate economic signals. The only reason we have not done this to date is because people on the coast complain to their legislators about insurance availability and affordability, a thinly veiled attempt to absolve themselves of the responsibility of living on the coast. Together, these changes will: 1) reduce the subsidization of risk along the coast; 2) reduce financial incentives to locate and develop in harms way; 3) bring the full cost of living on the coast closer to the surface; and 4) invoke local action as the costs and benefits become more explicit to local governments.

Because of nature's tendencies, many of the beaches and barrier islands lining the Gulf and Atlantic coast are not suitable for our inhabitation. Conversely, it is naive to believe that the 36 million people who live in harm's way will pack up and move inland. Rather the vision is for local planning and land use decisions to consider, and where appropriate, make adjustments for, the risks imposed by hurricanes and other natural hazards along the coast.

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[1] Godshalk, David R., and Baxter, Stephen. 1997. *Making Mitigation Work: Final Report to the National Science Foundation.* Chapter 16. p. 13.
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[3] Burby, et. al. 1997. p. 354.
[4] Bush, David M., Pilkey, Orrin H. Jr., and Neal, William J. 1996. *Living By the Rules of the Sea.* Duke University Press. Durham, NC. p. 15.

APPENDIX A

Key Federal Involvement in Land Use in the Coastal Zone

Agency	Primary Activity	Key Legislation
Office of Ocean and Coastal Resource Management (OCRM w/in NOAA)	Implements coastal zone management program; works with states in developing and implementing their programs.	Coastal Zone Management Act (CZMA)
Federal Emergency Management Agency (FEMA)	Implemets the National Flood Insurance Program (NFIP); providesdisaster assistance to coastal states and local governments.	National Flood Insurance Act; Flood Disaster Protection Act
U.S. Army Corps of Engineers (COE)	Technical assistance and funding of shoreline protection, beachrenourishment; implements Sec. 404 wetlands permit program.	Federal Flood Control Acts (or 1917, 1936, 1945, 1955, 1968...); Clean Water Act
Environmental Protection Agency	Oversees Section 404 wetland permit program	Clean Water Act
National Park Service (NPS w/in DOI)	Maintains and manages national seashores and national parksystem units; oversees Coastal Barrier Resources System (CBRS)	Coastal Barriers Resources Act (CoBRA)
U.S. Fish and Wildlife Service (USFWSw/in DOI)	Enforces federal wildlife and endangered species laws; preparesand implements species recovery plans; establishes and maintains system of national wildlife refuges.	Endangered Species Act (ESA)
National Marine Fisheris Service (NMFS w/in DOI)	Fisheries management; protection of marine mammals.	Marine Mammal Protection Act

*Source: Beately, Timothy J., David J. Brower, and Anna K. Schwab. 1994. *An Introduction to Coastal Zone Management.* Island Press, Washington, DC. p. 56.

APPENDIX B

Identifying Flood Zones: The First Step

The first step in the flood insurance process is to establish preliminary flood hazard areas that approximate the area inundated by a flood with a recurrence rate of one in one hundred years, or one-percent chance of occurrence in any given year. These maps, called Flood Hazard Boundary Maps, are provided to each participating community by FEMA. Those communities with development or developable areas in the flood zone can participate by applying to a special "emergency program." Under the program, the community (incorporated town or village, county, or other governing unit) must adopt minimal flood plain management and construction regulations to ensure that the location and design of future buildings serve to minimize vulnerability. All structures are eligible for limited insurance under the initial emergency program stage, no matter how precarious their location or how poorly constructed.[1] Thus, the owners of existing structures can purchase flood insurance coverage at an affordable rate.

The next stage of the process includes a detailed survey of the community's flood risks, but only after they are in compliance with the requirements of the emergency program. The 100-year floodplain maps, or base flood maps, form the basis for carving out zones used to determine insurance rates. The resulting Flood Insurance Rate Map (FIRM) is published by FEMA for insurance underwriters, banks and lending institutions, community officials, and individuals. Once the FIRMs are put out, and rates have been determined, a community may transition from the emergency program to the regular flood insurance program.

Progressing to the next stages means that every new structure must comply with local ordinances that meet or exceed the minimum requirements set by the NFIP. Existing structures that are remodeled, added on to, or altered in a major way must also abide by the same terms. Additional requirements are imposed in coastal high-hazard areas, called V-zones. The most significant difference is that the lowest portion of the lowest floor beam must be above the base flood elevation (BFE), as shown on the FIRM.[2]

The zones, or classifications, are indicated on the map with shading where darker shading corresponds higher flood risk. The zones are labeled from A, a 100-year flood zone, to C, the lowest flood hazard. Every FIRM shows areas within the 100-year flood boundary, which are termed "Special Flood Hazard Areas (SFHAs)." A "100-year flood" does not refer to a flood that occurs once every 100 years, but refers to a flood level with a 1 percent or greater chance of being equaled or exceeded in any given year. The SFHAs may be further subdivided into insurance risk rate zones. (See APPENDIX B) Areas between the 100-year and 500-year flood boundaries are termed "moderate flood hazard areas." The remaining areas are above the 500-year flood level and are termed "minimal flood hazard areas." The SFHAs are subdivided into flood hazard zones, or insurance risk rate zones. It is from these maps that actuarial, or non-subsidized, insurance rates are established.

NFIP Special Flood Hazard Areas

Zone V: SFHAs along coasts subject to inundation by the 100-year flood with the additional hazards associated with storm waves. Because detailed hydraulic analyses have not been performed, no base flood elevations or depths are shown. Mandatory flood insurance purchase requirements apply.

Zones VE and V1-30: SFHAs along coasts subject to inundation by the 100-year flood with additional hazards due to velocity (wave action). Base flood elevations derived from detailed hydraulic analyses are shown within these zones. Mandatory flood insurance purchase requirements apply. (Zone VE is used on new and revised maps in place of Zones V1-30.)

Zone A: SFHAs subject to inundation by the 100-year flood. Because detailed hydraulic analyses have not been performed, no base flood elevation or depths are shown. Mandatory flood insurance purchase requirements apply.

Zones AE and A1-30: SFHAs subject to inundation by the 100-year flood determined in a Flood Insurance Study by detailed methods. Base flood elevations are shown within these zones. Mandatory flood insurance purchase requirements apply. (Zone AE is used on new and revised maps in place of Zones A1-30.)

Zone AH: SFHAs subject to inundation by 100-year shallow flooding (usually areas of ponding) where average depths are between one and three feet. Base flood elevations

derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements apply.

Zone AO: SFHAs subject to inundation by 100-year shallow flooding(usually sheet flow on sloping terrain) where average depths are between one and three feet. Average flood depths derived from detailed hydraulic analyses are shown within this zone. Mandatory flood insurance purchase requirements apply.

Zone A99: SFHAs subject to inundation by the 100-year flood which will be protected by a federal flood protection system when construction has reached specified statutory progress toward completion. No base flood elevations or depths are shown. Mandatory flood insurance purchase requirements apply.

Zones B, C, and X: These areas have been identified in the community flood insurance study as areas of moderate or minimal hazard from the principal source of flood in the area. However, buildings in these zones could be flooded by severe, concentrated rainfall coupled with inadequate local creates areas of high flood risk within these rate zones. Flood insurance is available in participating communities but is not required by regulation in these zones. (Zone X is used on new and revised maps in place of Zones B and C.)

Zone D: Unstudied areas where flood hazards are undetermined but flooding is possible. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

*Source: FEMA

[1] Pilkey, et. al. 1983.
[2] Pilkey, et. al. 1983.

APPENDIX C

Approved Mitigation Activities Under CRS

Activity	Maximum Points	Average Points	Applicants (%)
300 Public information activities			
310 Elevation Certificates	137	73	100
320 Map determinations	140	140	92
330 Outreach Projects	175	59	53
340 Hazard disclosure	81	39	40
350 Flood protection library	25	20	77
360 Flood protection assistance	66	51	45
400 Mapping and regulatory activities			
410 additional flood data	360	60	20
420 Open space preservation	450	115	42
430 Higher regulatory standards	785	101	59
440 Flood data maintenance	120	41	41
450 Stormwater management	380	121	37
500 Flood damage reduction activities			
510 Repetitive loss projects	441	41	11
520 Acquisition and relocation	1600	97	13
530 Retrofitting	1400	23	3
540 Drainage system maintenance	330	226	82
600 Flood preparedness activities			
610 Flood warning program	200	173	5
620 Levee safety	900	0	0
630 Dam safety	120	64	45

Source: FEMA, 1992.

Discounts Based on CRS Rating

Community's total points	Class	SFHA Credit (%)
4500 +	1	45
4000-4499	2	40
3500-3999	3	35
3000-3499	4	30
2500-2999	5	25
2000-2499	6	20
1500-1999	7	15
1000-1499	8	10
500-999	9	5
0-499	10	0

Source: FEMA, 1992.

APPENDIX D

ILLUSTRATIONS OF PRICING DISTORTIONS IN PROPERTY/CASUALTY INSURANCE MARKETS

FIGURE 1

Pricing Risk

Characteristic	Earthquake	Fire
Frequency	1:100 yrs	100:1 yrs
Severity	$100 M	$10,000
Average Annual (mean) Loss	$1 M	$1 M
PML	$100 M	$1.2 M
Needed Capital	$99 M	$0.2 M
Economic Price @ 5% ROC	$5.95 M	$1.01 M
Reinsurance Analogy	$99 xs $1M	$0.2M xs $1M
Traditional Pricing Expense Load	$0.40 M	$0.40 M
Traditional Pricing P&c Load	$0.05 M	$0.05 M
Traditional Premium	$1.45 M	$1.45 M
Economic Premium	$6.35 M	$1.41 M

Source: Rade T. Musulin, Florida Farm Bureau. 1997

FIGURE 2

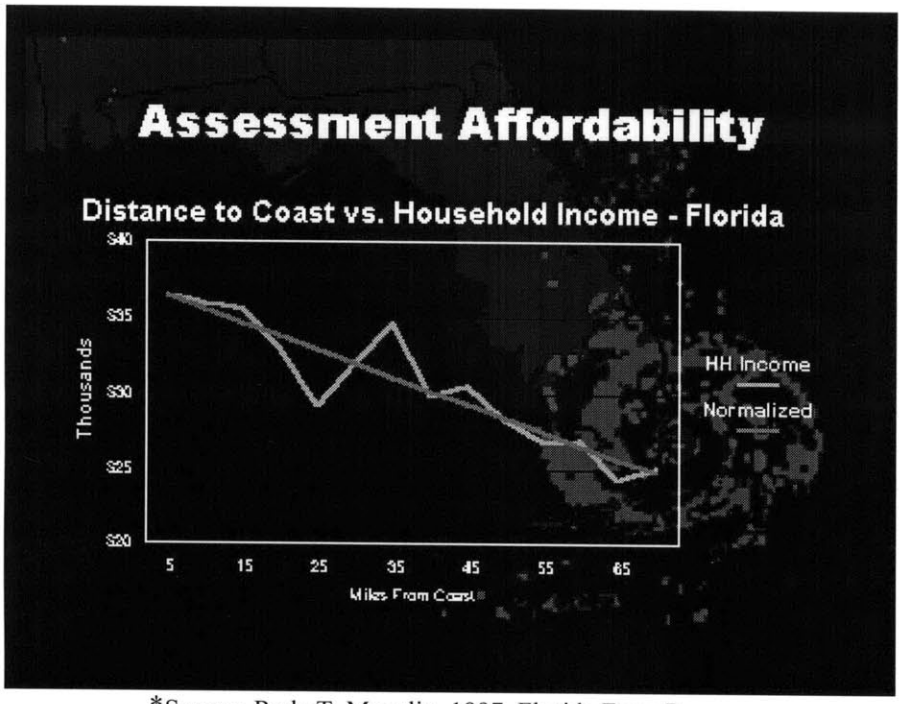
Example of Premium Price Differential
from Florida Windstorm Underwriting Association

Monthly Cost for:	Current	Modeled	% Change	$ Change
FWUA Premium	$ 15.00	$ 95.00	515%	$ 80.00
Non-Wind HO Premium	$ 71.00	$ 71.00	0%	$ -
Total HO Premium	$ 86.00	$ 166.00	92%	$ 80.00
Mortgage & Taxes	$ 1,050.00	$ 1,050.00	0%	$ -
Total Payment	$ 1,136.00	$ 1,216.00	7%	$ 80.00

*Source: Rade T. Musulin, 1997. Florida Farm Bureau.

**Rates reflect expected loss and expense, but not risk load, for $113,000 of coverage on a $135,000 property (including land) in coastal Dade County, Florida. Rates at these levels were not implemented.

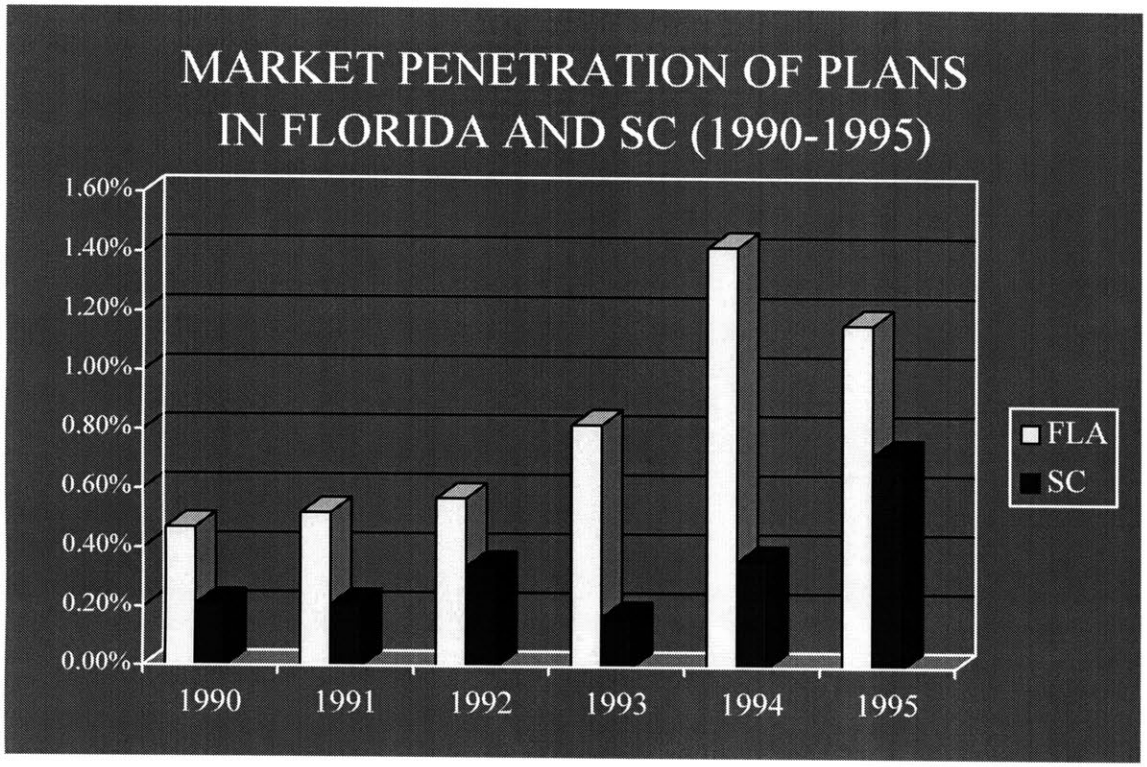
FIGURE 3



*Source: Rade T. Musulin. 1997. Florida Farm Bureau.

APPENDIX E

IN-VOLUNTARY INSURANCE MARKET PENETRATION



*Source: Property Insurance Plans Service. 1997.

APPENDIX F

Understanding the Takings Issue

In today's planning environment, local officials find themselves walking a fine line between affording protection to their constituents utilizing the police powers bestowed upon them and a resurgent property rights movement that looks with suspicion at any governmentally imposed limitation on the use of their land. But the issue of takings has been around for some time, in fact since the passage of our Constitution. The takings issue comes from the Fifth Amendment to the U.S. Constitution which states, "...nor shall private property be taken for public use, without just compensation." At the time, this language was directed toward the actual use or seizure of private property for public use. Approximately seventy years ago, the U.S. Supreme Court extended that principle beyond the physical seizure of property, asserting that while property may be regulated to a certain extent, if regulation goes too far, it will be recognized as a taking. The Court was referring to instances where the net result for the property owner, as the result of a regulation, was essentially the same as if the government had physically taken the property. And for sixty years, in instances where this was the case, the court would hold that such a regulation amounted to an unconstitutional taking and simply invalidate the regulation. This left the property owner free to do as they could have done before the regulation was instituted. Seen as a reasonable and fair remedy for local governments, they would then proceed to adopt a new regulation, presumably one that would respond to the court's adverse findings in the previous case.

Over time this became less acceptable to property owners and cases. Cases emerged where property owners would submit that the local government must purchase the regulated land. It was not until 1981 that the Court arrived at a compromise between these positions, ultimately leaving local governments with two choices: buy the land as it would under an eminent domain proceeding, or repeal the unconstitutional regulation and compensate the landowner for the loss of use of the property while the regulation was in effect. That is how the law is implemented today.

The Takings Rules

Up to this point, the Supreme Court has established four clear rules to identify a taking:

1. where the landowner has been denied "all economically viable use" of the land (an issue of fundamental fairness);
2. where the regulation forced the landowner to allow someone to enter onto the property (such as a cable company which wants to install a cables on an apartment building enforcing);
3. where the regulation imposes burdens or costs on the landowner that do not bear a "rational nexus" or reasonable relationship to the impacts of the project, and that there be "rough proportionality" between the taking and the benefit of the project to the community; and
4. where government can accomplish a valid public purpose either through regulation or through a requirement of dedicating property, government should use the less intrusive regulation, for example, prohibiting development in a floodplain property (a matter of common sense).

The Police Powers

At the same time takings law was evolving, so to was the concept of police power, an essential function of government. The policy power is the right of the government to interfere with private activity (or the use of private property) for the protection of public health, safety, and general welfare. Zoning is one of the most prevalent forms of police power; so too are building codes and subdivision ordinances. The power of local governments to exercise their police power in the context of urban planning was validated by the Court in the 1920s in a holding that said zoning in principle did not constitute a taking. In *Village of Euclid v. Ambler* (1926), the Supreme Court gave its approval to an early zoning ordinance in a Cleveland suburb despite an argument by the plaintiff landowner that the government should have to pay for prohibiting industrial development on his land, which reduced its value by 75 percent--from $10,000 to $2,500 per acre.

To clarify, the police power and regulatory takings law are not fundamentally in conflict. To the contrary, they are complementary bodies of law that have evolved together. The takings decisions of the U.S. Supreme Court simply set limits on the extent of police power regulation.

How Local Governments Can Avoid Potential Takings Issues

(Christopher J. Duerksen and Richard J. Roddewig, Takings Law in Plain English, 2nd ed. (Clarion Associates, Inc., 1994), pp. 41-43.)

There are a number of different ways in which communities concerned about fairness and balance for all citizens in addressing the takings issue can protect themselves against potential takings claims. These include the following:

1. Establish a sound basis for land use and environmental regulations through comprehensive planning and background studies. A thoughtful comprehensive plan or program that sets forth overall community goals and objectives and which establishes a rational basis for land use regulations helps lay the foundation for a strong defense against any takings claim. Likewise, background studies of development and pollution impacts can build a strong foundation for environmental protection measures.

2. Institute an administrative process that gives decision-makers adequate information to apply the takings balancing test by requiring property owners to produce evidence of undue economic impact on the subject property prior to filing a legal action. Much of the guesswork and risk for both the public official and the private landowner can be eliminated from the takings arena by establishing administrative procedures for handling "takings" claims and other landowner concerns before they go to court. These administrative procedures should require property owners to support claims by producing relevant information, including an explanation of the property owner's interest in the property, price paid or option price, terms of purchase or sale, all appraisals of the

property, assessed value, tax on the property, offers to purchase, rent, income and expense statements for income-producing property, and the like.

3. Establish an economic hardship variance and similar administrative relief provision that allow the possibility of some legitimate economically beneficial use of the property in situations where regulations may have an extreme result. These procedures help to avoid conflicts in the first place by allowing for early consideration of all alternatives that may be satisfactory to all concerned. However, relief should be granted only upon a positive showing by the owner or applicant that there is no reasonable economic use of the property as witnessed by evidence produced as outlined in No. 2 above. Remember that the landowner generally has the burden of proof on hardship and takings issues.

4. Take steps to prevent the subdivision of land in a way that may create economically unusable substandard or un-buildable parcels. Subdivision controls and zoning ordinances should be carefully reviewed, and should be revised if they permit division of land into small parcels or districts that make development very difficult or impossible--for example by severing sensitive environmental areas or partial property rights (such as mineral rights) from an otherwise usable parcel. Such self-created hardships should not be permitted to develop into a takings claim.

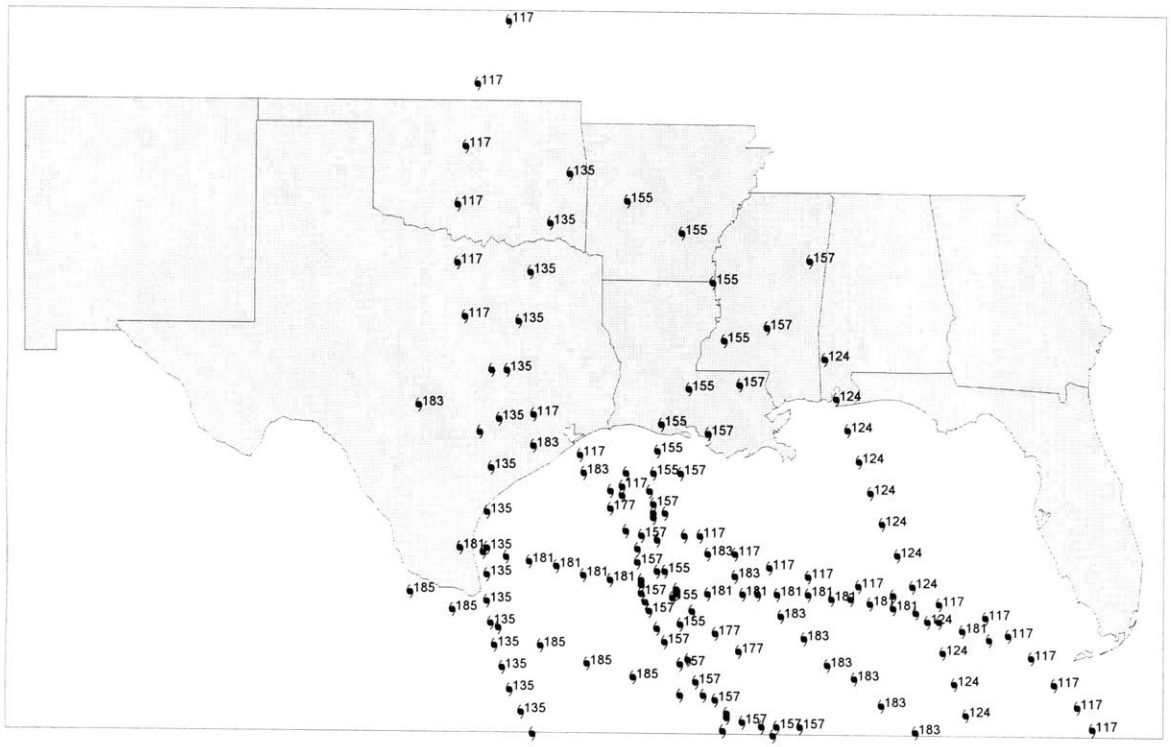
5. Make development pay its fair share, but establish a rational, equitable basis for calculating the type of exaction, or the amount of any impact fee. The U.S. Supreme Court has expressly approved the use of development conditions and exactions, so long as they are tied to specific needs created by a proposed development. The use of nationally accepted standards or studies of actual local government costs attributable to a project, supplemented by a determination of the actual impact of a project in certain circumstances, may help to establish the need for and appropriateness of such exactions.

6. Avoid any government incentives, subsidies, or insurance programs that encourage development in sensitive areas such as steep slopes, floodplains, and other high-hazard areas. Nothing in the Fifth Amendment requires a government entity to promote the maximum development of a site at the expense of the public purse or to the detriment of the public interest. Taxpayers need not subsidize unwise development. At the same time, consider complements to regulation such as incentive programs that encourage good development, when regulatory approaches cannot alone achieve necessary objective without severe economic deprivation. While not a legal requirement, such programs can help take the sting out of tough, but necessary, environmental land use controls.

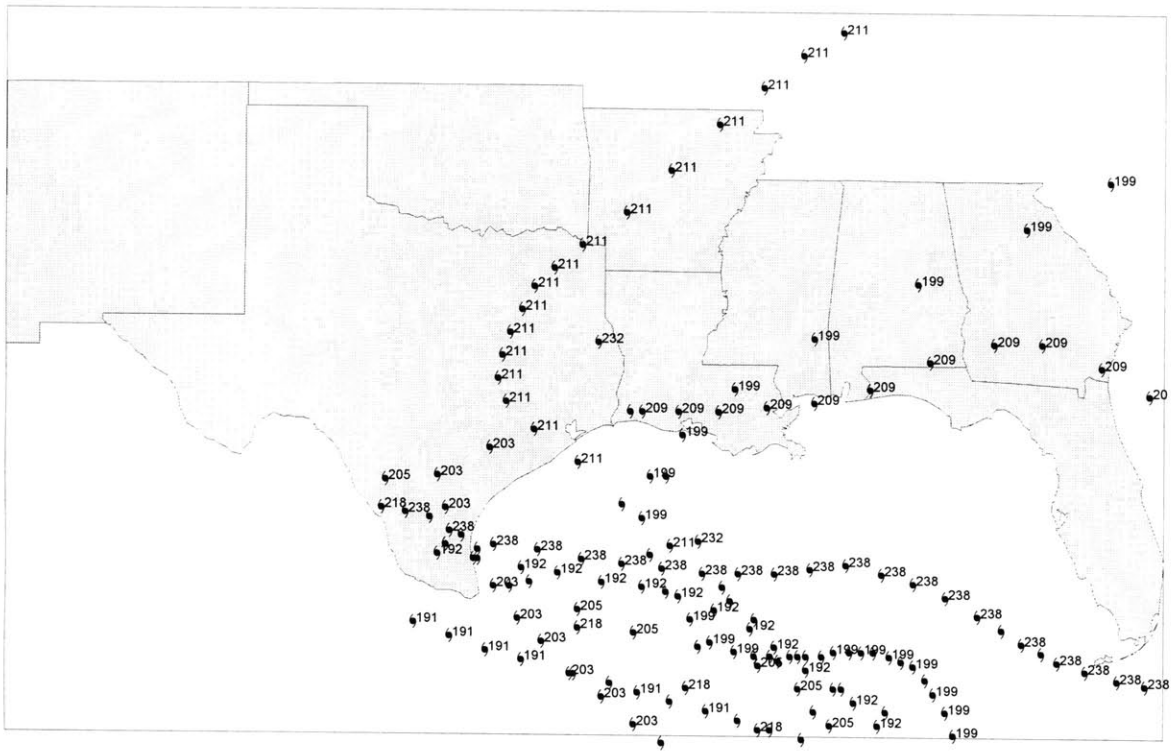
APPENDIX G

TEXAS STORM TRACKS BY DECADE

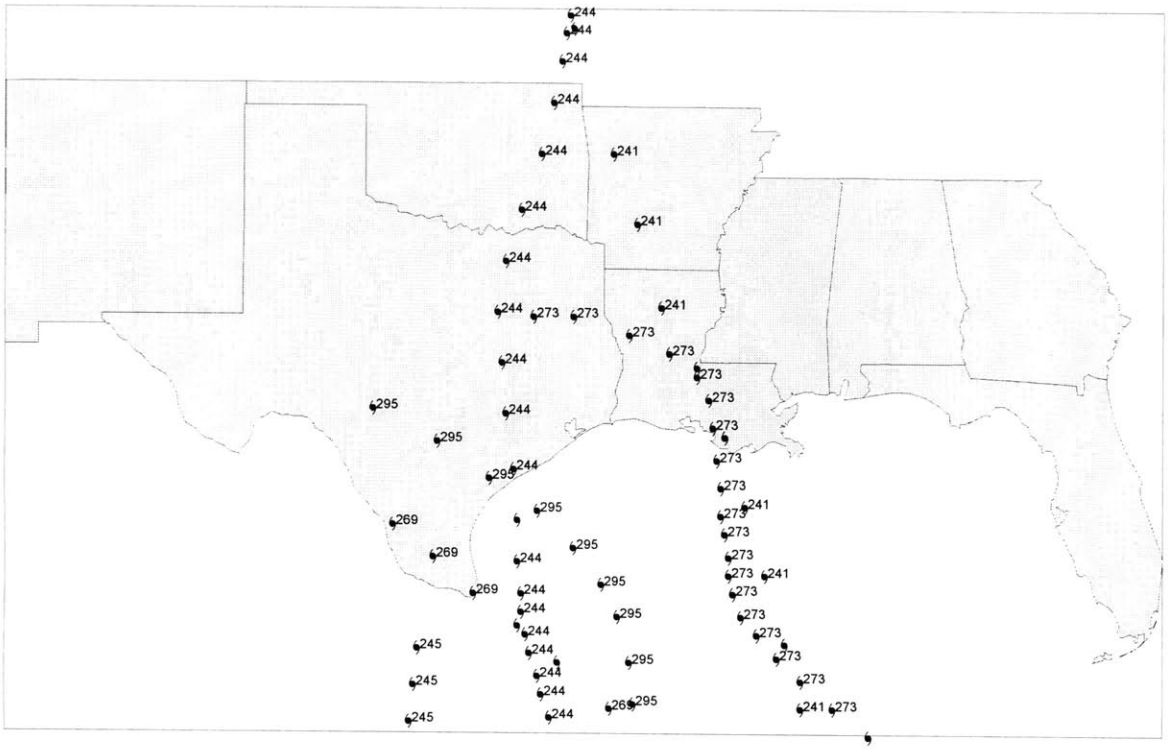
*Maps Produced by Kristin M. Berry. Insurance Institute for Property Loss Reduction. 1997.



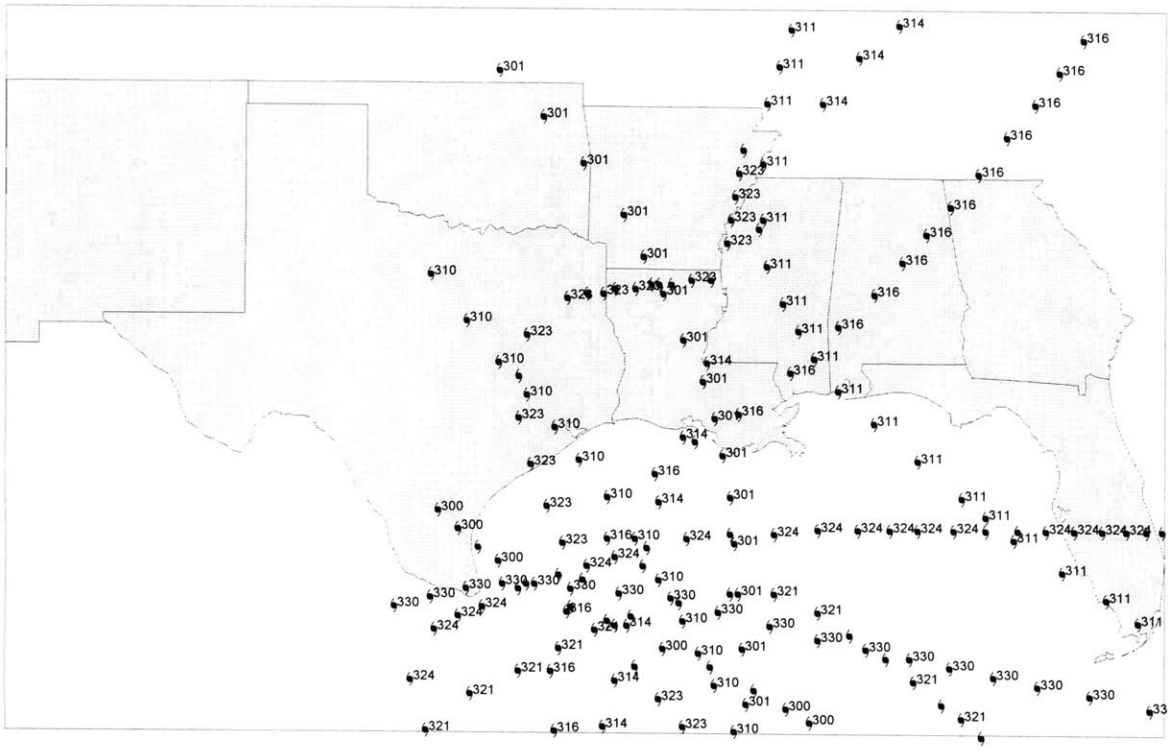
Name	Type	Start Date	End Date	Year
117	HR	08/27	09/15	1900
118	HR	09/09	09/23	1900
124	TS	06/10	06/14	1901
135	TS	06/19	06/28	1902
155	TS	09/24	09/30	1905
157	HR	10/05	10/10	1905
177	HR	09/16	09/18	1908
181	TS	06/25	06/30	1909
183	TS	07/13	07/22	1909
184	HR	07/27	08/11	1909
185	TS	08/20	08/28	1909



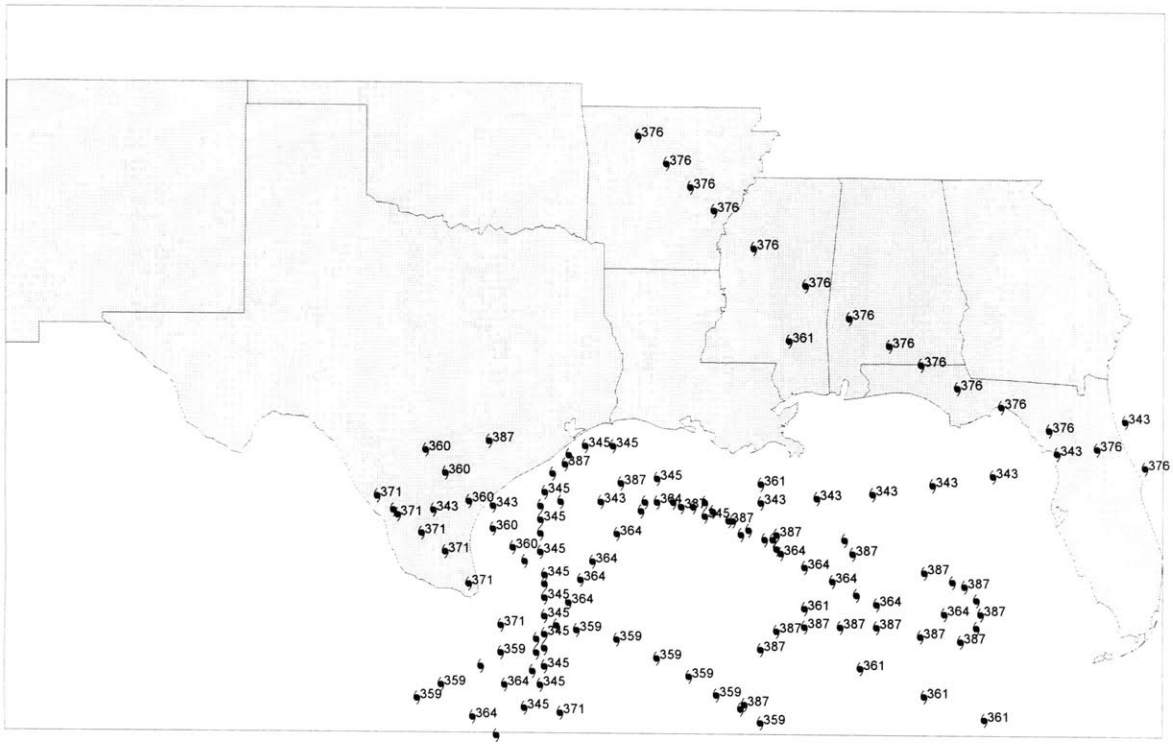
Name	Type	Start Date	End Date	Year
191	TS	08/20	08/31	1910
192	TS	09/05	09/15	1910
199	TS	06/07	06/16	1912
203	HR	10/11	10/17	1912
205	HR	06/22	06/28	1913
209	TS	09/14	09/19	1914
211	TS	08/05	08/23	1915
218	HR	08/12	08/19	1916
232	HR	08/01	08/07	1918
238	TS	09/02	09/15	1919



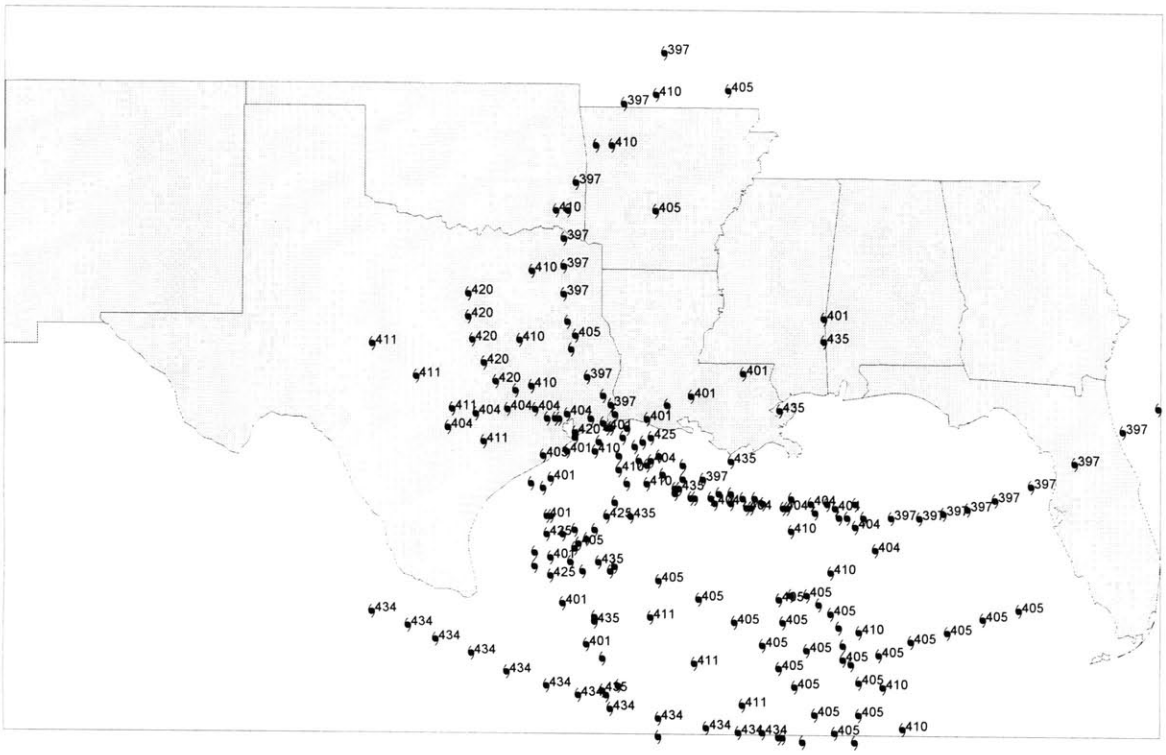
Name	Type	Start Date	End Date	Year
241	HR	09/16	09/23	1920
244	HR	06/15	06/26	1921
245	HR	09/06	09/08	1921
269	HR	09/06	09/07	1925
273	HR	08/22	08/27	1926
295	HR	06/27	06/29	1929



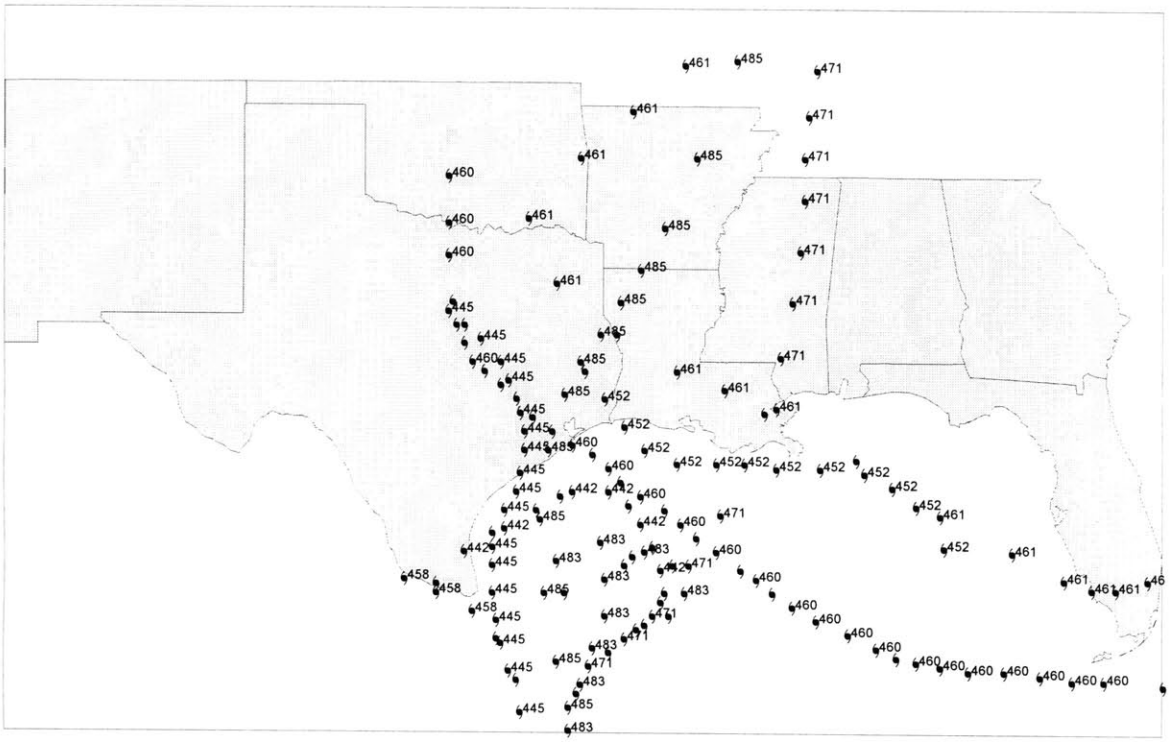
Name	Type	Start Date	End Date	Year
300	HR	06/25	06/28	1931
301	TS	07/11	07/17	1931
310	TS	08/12	08/15	1932
311	HR	08/26	09/04	1932
314	TS	09/18	09/21	1932
316	HR	10/07	10/18	1932
321	TS	06/27	07/07	1933
323	TS	07/21	07/27	1933
324	TS	07/25	08/05	1933
330	TS	08/28	09/05	1933



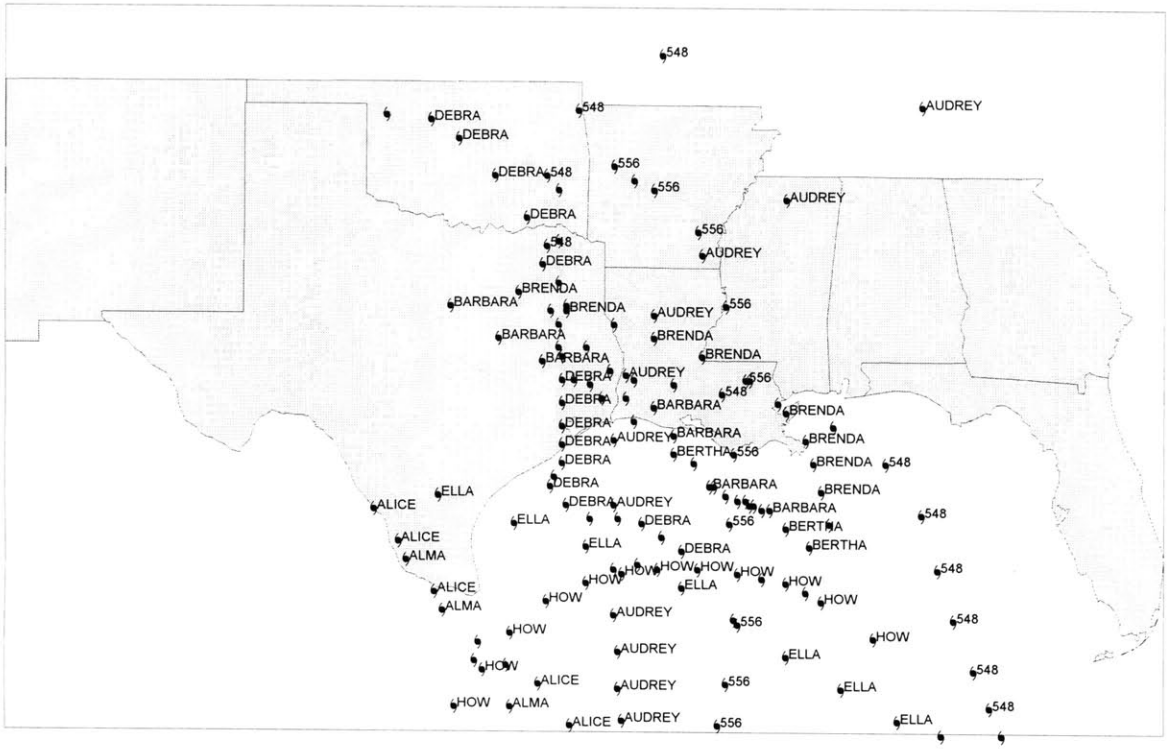
Name	Type	Start Date	End Date	Year
343	HR	07/21	07/26	1934
345	TS	08/26	09/01	1934
359	TS	06/19	06/22	1936
360	TS	06/26	06/28	1936
361	HR	07/26	07/27	1936
364	TS	08/07	08/12	1936
371	HR	09/10	09/14	1936
376	TS	08/24	09/02	1937
384	TS	08/10	08/15	1938
387	HR	10/11	10/17	1938



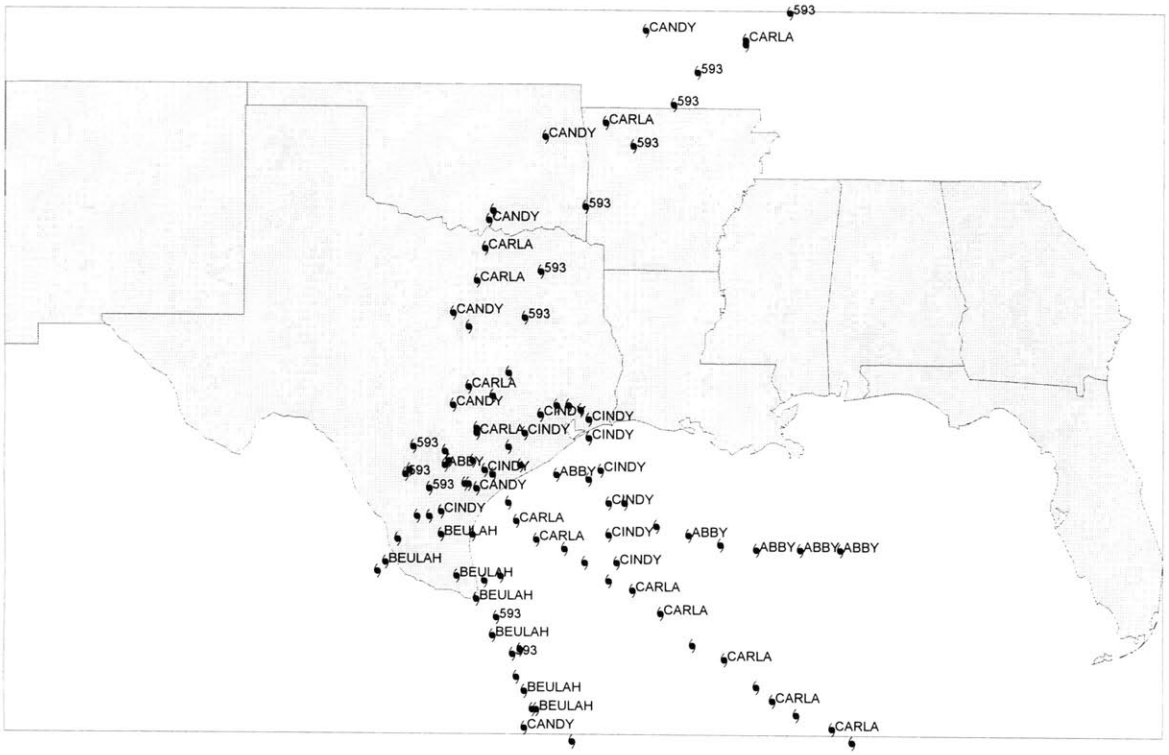
Name	Type	Start Date	End Date	Year
397	TS	08/02	08/11	1940
401	HR	09/19	09/25	1940
404	TS	09/1	09/16	1941
405	TS	09/16	09/25	1941
410	TS	08/17	08/23	1942
411	HR	08/21	08/31	1942
420	HR	07/25	07/29	1943
425	TS	09/15	09/20	1943
434	HR	08/19	08/23	1944
435	TS	09/09	09/11	1944



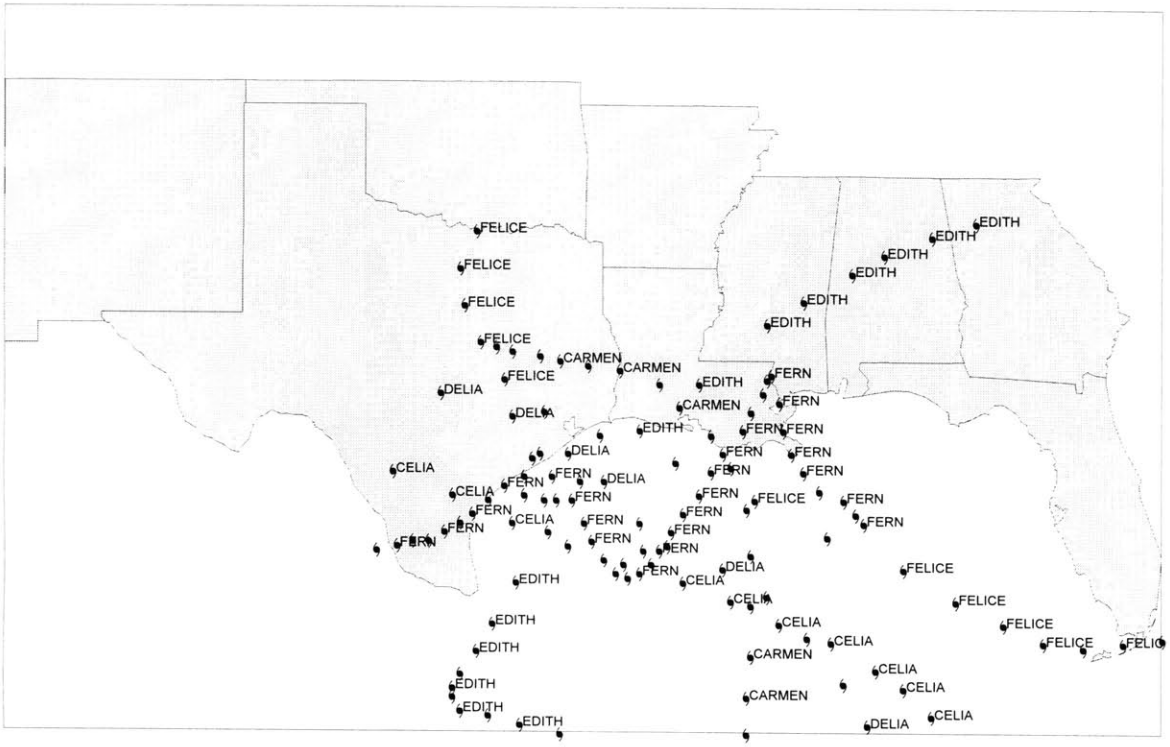
Name	Type	Start Date	End Date	Year
442	HR	07/19	07/22	1945
445	TS	08/24	08/29	1945
452	HR	06/13	06/16	1946
458	TS	07/31	08/02	1947
460	HR	08/18	08/27	1947
461	HR	09/04	09/21	1947
471	TS	09/01	09/07	1948
483	TS	09/20	09/26	1949
485	HR	09/27	10/06	1949



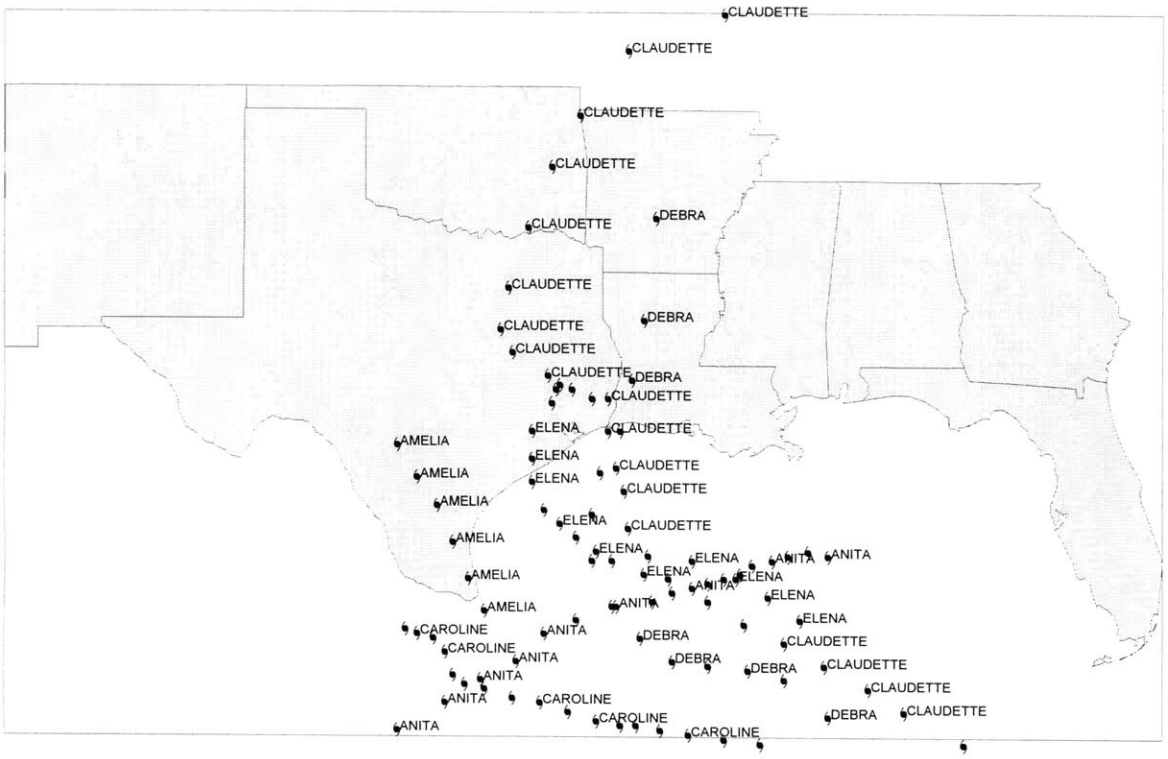
Name	Type	Start Date	End Date	Year
HOW	HR	10/01	10/04	1950
ALICE	TS	06/24	06/26	1954
BARBARA	HR	07/27	07/30	1954
BRENDA	HR	07/31	08/03	1955
548	HR	08/23	08/30	1955
556	HR	06/12	06/15	1956
AUDREY	TS	06/25	06/29	1957
BERTHA	TS	08/08	08/11	1957
ALMA	TS	06/14	06/16	1958
ELLA	HR	08/30	09/06	1958
DEBRA	HR	07/23	07/28	1959



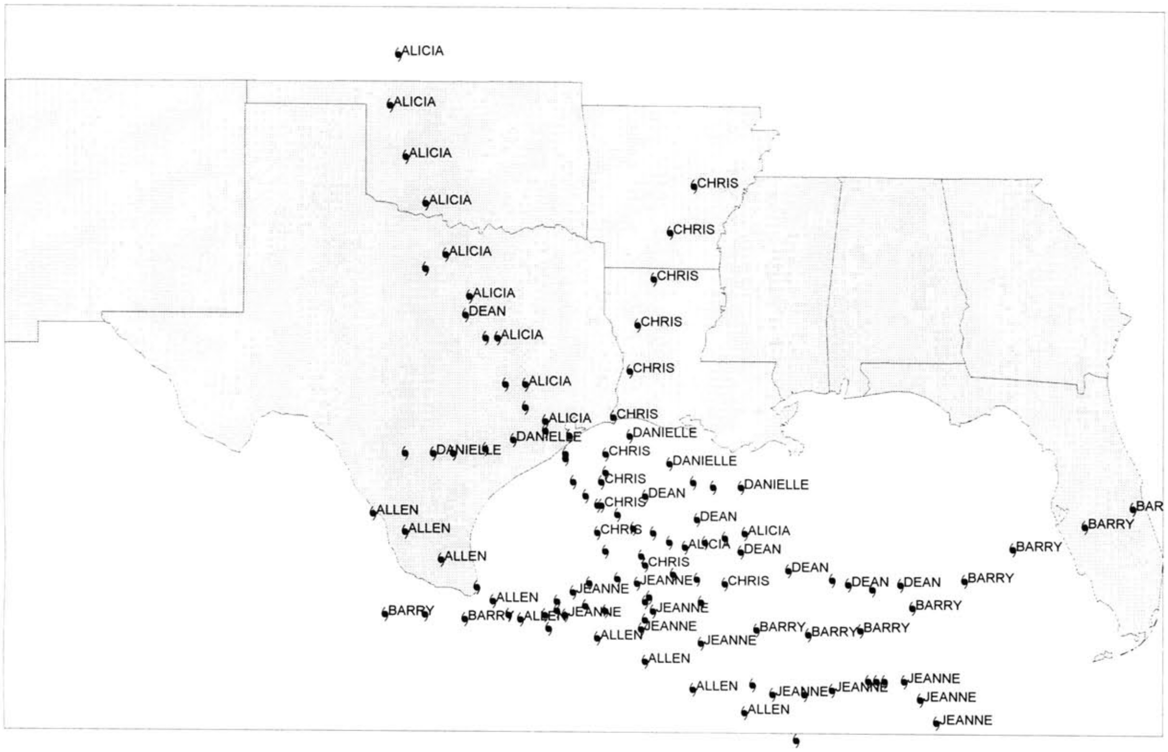
Name	Type	Start Date	End Date	Year
593	HR	06/22	06/29	1960
CARLA	HR	09/03	09/16	1961
CINDY	TS	09/16	09/20	1963
ABBY	TS	08/05	08/08	1964
BEULAH	HR	09/05	09/22	1967
CANDY	HR	06/22	06/26	1968



Name	Type	Start Date	End Date	Year
CELIA	TS	07/31	08/05	1970
FELICE	HR	09/12	09/17	1970
EDITH	TS	09/05	09/18	1971
FERN	HR	09/03	09/13	1971
DELIA	TS	09/01	09/07	1973
CARMEN	HR	08/29	09/10	1974



Name	Type	Start Date	End Date	Year
CAROLINE	HR	08/24	09/01	1975
ANITA	HR	08/29	09/03	1977
AMELIA	SS	07/30	08/01	1978
DEBRA	HR	08/26	08/29	1978
CLAUDETTE	HR	07/15	07/29	1979
ELENA	HR	08/30	09/02	1979



Name	Type	Start Date	End Date	Year
ALLEN	SS	07/31	08/11	1980
DANIELLE	HR	09/04	09/07	1980
JEANNE	HR	11/07	11/16	1980
CHRIS	TS	09/09	09/12	1982
ALICIA	TS	08/15	08/21	1983
BARRY	HR	08/23	08/29	1983
DEAN	TS	07/28	08/02	1995

APPENDIX H

Tropical Storms and Hurricanes Affecting South Padre Island since 1900

	Name	Type	Start Date	End Date	Year
1	135	TS	06/19	06/28	1902
2	181	TS	06/25	06/30	1909
3	185	TS	08/20	08/28	1909
4	192	TS	09/05	09/15	1910
5	203	HR	10/11	10/17	1912
6	205	HR	06/22	06/28	1913
7	218	HR	08/12	08/19	1916
8	244	HR	06/15	06/26	1921
9	269	HR	09/06	09/07	1925
10	300	HR	06/25	06/28	1931
11	324	TS	07/25	08/05	1933
12	330	TS	08/28	09/05	1933
13	371	HR	09/10	09/14	1936
14	442	HR	07/19	07/22	1945
15	445	TS	08/24	08/29	1945
16	458	TS	07/31	08/02	1947
17	593	HR	06/22	06/29	1960
18	BEULAH	HR	09/05	09/22	1967
19	CANDY	HR	06/22	06/26	1968
20	EDITH	TS	09/05	09/18	1971
21	AMELIA	SS	07/30	08/01	1978
22	ALLEN	SS	07/31	08/11	1980

APPENDIX I

Tropical Storms and Hurricane Affecting Galveston since 1900

	Name	Type	Start Date	End Date	Year
1	117	HR	08/27	09/15	1900
2	155	TS	09/24	09/30	1905
3	157	HR	10/05	10/10	1905
4	177	HR	09/16	09/18	1908
5	183	TS	07/13	07/22	1909
6	199	TS	06/07	06/16	1912
7	209	TS	09/14	09/19	1914
8	211	TS	08/05	08/23	1915
9	232	HR	08/01	08/07	1918
10	310	TS	08/12	08/15	1932
11	316	HR	10/07	10/18	1932
12	345	TS	08/26	09/01	1934
13	387	HR	10/11	10/17	1938
14	397	TS	08/02	08/11	1940
15	401	HR	09/19	09/25	1940
16	404	TS	09/1	09/16	1941
17	405	TS	09/16	09/25	1941
18	410	TS	08/17	08/23	1942
19	420	HR	07/25	07/29	1943
20	425	TS	09/15	09/20	1943
21	452	HR	06/13	06/16	1946
22	460	HR	08/18	08/27	1947
23	485	HR	09/27	10/06	1949
24	AUDREY	TS	06/25	06/29	1957
25	DEBRA	HR	07/23	07/28	1959
26	CINDY	TS	09/16	09/20	1963
27	ABBY	TS	08/05	08/08	1964
28	FELICE	HR	09/12	09/17	1970
29	DELIA	TS	09/01	09/07	1973
30	DEBRA	HR	08/26	08/29	1978
31	CLAUDETTE	HR	07/15	07/29	1979
32	DANIELLE	HR	09/04	09/07	1980
33	CHRIS	TS	09/09	09/12	1982
34	ALICIA	TS	08/15	08/21	1983
35	DEAN	TS	07/28	08/02	1995