

Coastal Storm Vulnerability of the Treasure Coast Barrier Islands



Living on the Edge: Coastal Storm Vulnerability of the Treasure Coast Barrier Islands

A report by Florida Atlantic University's
Center for Urban and Environmental Solutions

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We are pleased to release *Living on the Edge: Treasure Coast Barrier Island Vulnerability Study*, published by Florida Atlantic University's Center for Urban and Environmental Solutions (CUES). In the aftermath of the 2004 hurricane season, CUES' unique research capacity in coastal and environmental issues was brought to bear on the growing costs and threat of natural hazards faced by Florida's coastal communities. The importance of fostering resilient coastal communities has risen to the forefront of public policy as Florida and other coastal states face the immediate challenges of post-storm recovery and long-term issues of climate variability and global economic competitiveness.

The *Living on the Edge* report complements the regional visioning initiative of the Committee for a Sustainable Treasure Coast (CSTC), which in late 2005 published its recommendations for prosperity and balanced growth of the Treasure Coast region. FAU developed this research to assist the newly established Institute for a Sustainable Treasure Coast, which is charged with tracking and advancing implementation of CSTC's goals and objectives. *Living on the Edge* aims to inspire regional cooperation and informed policy choices among local planning staff, emergency management professionals, elected officials and citizens concerned with promoting sustainable development patterns.

Research for this project was funded by the Florida Hurricane Alliance, a multidisciplinary cooperative research initiative of nine Florida universities supported by a grant from the National Oceanic and Atmospheric Administration. FAU strongly supports institutional partnerships that enhance the state's research capacity and expand its economy. This publication, CUES' work with the CSTC and the university's relationship with the Harbor Branch Oceanographic Institution are representative of FAU's investment in the Treasure Coast region and its commitment to addressing community needs through relevant scholarship and outreach.

A handwritten signature in black ink that reads "Frank T. Brogan".

Frank Brogan
President
Florida Atlantic University

A handwritten signature in black ink that reads "Jim Murley".

James Murley
Director
Center for Urban & Environmental Solutions

PREFACE

The *Living on the Edge: Treasure Coast Barrier Island Coastal Vulnerability Study* was prepared by Florida Atlantic University's Center for Urban and Environmental Solutions (CUES) for the Florida Hurricane Alliance, a consortium of ten state universities contracted by the National Oceanic and Atmospheric Administration to research pathways toward coastal hazard resiliency. Based on CUES' 30 years of expertise in applied land-use policy and environmental research, we approached the issue of coastal hazards from an interdisciplinary perspective aimed at informing policymakers and the public about the vulnerabilities of our communities and the costs associated with natural disasters. We aspire to understand the natural processes and development practices that contribute to the growing cost of coastal storm events and suggest policies to best mitigate the impacts.

September 2004's "double slam," the landfall of Hurricanes Frances and Jeanne on Florida's Treasure Coast, resulted in an estimated \$14 billion in property damage. It highlighted the need to improve our understanding of the dimensions of community vulnerability and mitigation practices. The Treasure Coast region was selected for our initial research to support the Committee for a Sustainable Treasure Coast (CSTC). That regional planning group, established by Governor Bush's Executive Order 04-61 and organized by State Senator Pruitt and CUES, was charged with developing policy recommendations for sustainable regional growth. In focusing the Florida Hurricane Alliance research on the barrier islands of the Treasure Coast, CUES saw the opportunity to translate coastal vulnerability research into sustainable regional planning practices.

Since the project's inception, more attention has turned to the relationship between land use policy and hazard vulnerability. At the state level, Governor Bush's Executive Order 05-116 convened a task force to examine the effectiveness of the Coastal High Hazard Area regulations. In the aftermath of Hurricane Dennis, the Department of Environmental Protection began considering a re-evaluation of its coastal set-back regula-

tions. The Florida Oceans and Coastal Resources Council will be addressing coastal hazards in its annual research and policy priorities, and the recent establishment of the Florida Century Commission for Sustainable Development creates an opportunity to incorporate hazards resiliency into statewide 20-year and 50-year strategic growth plans. At the local level, Treasure Coast counties and municipalities are involved in the Local Comprehensive Plan Evaluation Assessment Review, or have recently completed their Local Mitigation Strategy and seek to incorporate resiliency strategies into their policy making. CUES believes that its research will inform those planning processes and promote regulations and public investment that enhance community resiliency.

The research undertaken with NOAA Phase I funding sought a better understanding of the barrier islands' relationship to the region, their development trend, and number and types of assets that are directly exposed to hurricane and erosion hazards. The Interim Report produced in August 2005 described the types of data collected, the data sources, and the methods and rationale employed in preparing the analysis. An appendix and CD contain some of the key geo-referenced data and maps developed to illustrate the research program. The Interim Report was intended to serve as a model for hazards mitigation research that can be adopted by other Florida communities on the Atlantic and Gulf coasts seeking a comprehensive regional-level assessment of coastal vulnerability.

This report presents the research findings and analysis for the Treasure Coast study area. Through the lens of people, place, and economy, it highlights the resiliency or vulnerability characteristics of barrier island communities and examines how current federal, state, and local policies, especially the Local Comprehensive Plans, address hazard vulnerability. It also offers over 60 recommendations for new research and policy initiatives. It is our hope that a detailed understanding of the barrier islands' unique resources and vulnerabilities provides a context for the development of innovative and sound planning policies. The final *Living on the Edge* report is intended to inspire regional cooperation in making sustainable and hazard-resilient choices in future economic and land development policy.

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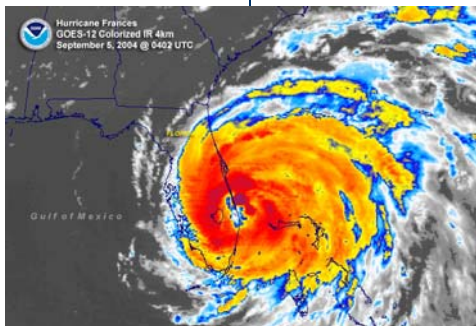
GLOSSARY OF ACRONYMS

ASCE -7 – American Society of Civil Engineers’ building standards
BI – Barrier Island
CCCL – Coastal Construction Control Line
CHHA – Coastal High Hazard Area
CSTC – Committee for a Sustainable Treasure Coast
CEMP – Comprehensive Emergency Management Plan prepared by counties
COBRA – Coastal Barrier Resource Act
CRS – Community Rating System of the National Flood Insurance Program
CVA – Community Vulnerability Assessment
EAR – Evaluation and Appraisal Report of the LCP required by DCA
DCA – Florida Department of Community Affairs
DEP – Florida Department of Environmental Protection
FEMA – Federal Emergency Management Agency
FIRM – Flood Insurance Rate Map
FPL – Florida Power and Light
IA – Individual Assistance Grants (furnished by FEMA to private citizens)
LCP – Local Comprehensive Plan
LMS – Local Mitigation Strategy documents prepared by counties
LOS – Level of Service
PA – Public Assistance Grants (furnished by FEMA to local governments)
Pre-Firm & Post-Firm – Before or after adoption of the Flood Insurance Rate Maps
NFIP – National Flood Insurance Program
TCRPC – Treasure Coast Regional Planning Council
USACE – United States Army Core of Engineers

CHAPTER 1

INTRODUCTION

Land economics and public policies that support economic growth and property rights foster urban development in areas vulnerable to coastal storms and other natural hazards. Whether for transportation, recreation, or aesthetics, economic assets and population tend to concentrate along coastlines and waterways with little or no regard for the destruction and the economic and social consequences associated with a disaster. Historically, America's public policy response to natural hazards has been framed by a "loss reduction" paradigm that accepts development of vulnerable land and attempts to reduce the impacts of hazard events, primarily through engineered solutions, emergency preparedness and response, and a combination of market and government-subsidized insurance.



The tendency toward increasing asset exposure along the coasts is particularly severe in Florida, a state with over 1,200 miles of coastline and one of the fastest growing populations in the nation. Since 1950, Florida's population has increased fivefold, and now 80% of the state's residents live within 20 miles of salt water.¹ From 1980 to 2003, Florida led the nation with a 75% increase in coastal population: an estimated 7.1 million people. In 2000, Florida was among the top three states in the nation in terms of the number of housing units in coastal counties. The state ranked number one from 1999 through 2003 in the number of residential construction permits issued in coastal counties; approximately 607,000 single-family and 264,000 multi-family dwelling units were initiated.² While urbanized South Florida has the greatest concentration of assets (an estimated \$434.4 billion in taxable property), the rapidly developing Treasure Coast, with a property assessed value of approximately \$76.6 billion, is not far behind.

Although Florida's growth management and hazard mitigation practices strive to reduce the impacts of coastal storm and other hazard events, the vulnerability engendered in the current coastal development pattern is increasingly evident. In 2004, within a six-week period, Hurricanes Charley, Frances, Ivan, and Jeanne crisscrossed the state, causing 117 deaths and over \$42 billion in property damage. It is estimated that one in five homes in Florida was damaged by one of the storms, and the two that impacted the Treasure Coast directly (Hurricanes France and Jeanne) caused \$14 billion in damage.³ In 2005, Hurricanes Dennis, Katrina, and Wilma resulted in \$10.5 billion in insured losses in Florida, not to mention the devastation in other coastal states. According to experts in catastrophic modeling, if a Category 5 storm similar to Hurricane Andrew were to hit South Florida in the coming years, damage could easily exceed \$100 billion.

Permitting development in hazard prone areas, however, is both increasingly expensive and a recipe for disaster. Although late 20th Century improvements in forecasting, emergency preparedness, and response have dramatically reduced the number of storm-related fatalities, both the costs of planning for a hurricane's landfall and recovering from coastal hazard events (including both monetary and intangible impacts) are rising.⁴ For example, the economic cost of raising a hurricane warning, in terms of lost productivity, safeguarding of homes and industry, evacuation of aircraft and vessels, and canceled beachfront vacations, is estimated to be between \$0.5- \$1.0 million per mile, depending upon the amount of coastal development.⁵ Multiplying that figure by the large impact zone meteorologists include in the 72 to 48 hours prior to landfall, one can easily understand that simply raising several hurricane warnings in one season can have significant impacts on the regional economy. As the intensity and expansiveness of coastal development increase, the impacts grow.

The costs of natural disasters are most apparent in the aftermath. Expenditures associated with clean-up and recovery, both physical and economic rebuilding and the psychological toll, are hefty. Many of the costs are borne by the private sector, businesses and individuals who suffer property damage, financial hardship, stress, depression, and even death. But the impact on the public sector should not be underestimated. The costs of emergency preparedness, clean-up, security, and restoration of services are public liabilities. Indirect costs, such as a reduction of public tax revenue resulting from damaged homes that depreciate in value and financially encumbered businesses, are also of concern.

At different levels of government, the public sector also pays for ongoing mitigation. Engineered solutions, such as "hardening" the built environment through infrastructure investment, beach nourishment, and sound building codes, protect and improve the resiliency of physical property. Strategic preparedness and emergency response,

such as the construction of public shelters and the training of first responders, minimize the loss of life. Government sponsored and regulated insurance prevents industry market failure and fills some of the loss gap. All of those mechanisms are employed to varying degrees to perpetuate a development pattern that is assumed to maximize the economic value of assets and protect private property rights.

Appropriate land use strategies and regulation, recognized as the most powerful but often most controversial hazard mitigation tool, have not been fully exploited. The primary impediment to employing land use regulation for mitigation is that it is perceived as impinging on private property rights, making it politically contentious to promote and implement. That is particularly true of waterfront properties, whose scarcity and desirability significantly drive up values despite the risks associated with coastal storm events. Developers vigorously oppose restrictions on density or building setbacks, as they perceive those regulations to adversely impact the development values of prized and expensive land. In addition, it has been argued that restricting development of a community's most attractive and highly valued real estate adversely impacts its economic vitality. Coastal communities thrive on their marine recreation and beach-related tourism, resulting in the development of housing and hotel units in close proximity to beaches and waterways. Those high-value developments also generate the lion's share of municipal property tax revenue, and, because many of those units are occupied seasonally, they do not consume a proportionate share of public services.



Appropriate setback regulations protect buildings and the integrity of the dune field.

The combination of hazard mitigation tools dictated by public policy and the degree and timing of their implementation engender complex issues of social justice, as the costs of those efforts are carried among taxpayers regionally and the benefits are reaped differentially. Moreover, the greater the value and number of assets at risk, the more adaptive mitigation measures are needed to reduce the loss. Thus it is becoming increasingly clear that the pervasive "loss reduction" paradigm results in substantial asset exposure, increased community vulnerability, and rising economic and social costs. Unabated, the mounting costs will threaten the region's economic vitality and undermine the quality of life enjoyed by its residents.

Building sustainable communities is the charge of the new century, and hazard resilience is a component of sustainability. Scholars in hazard and mitigation planning rec-

ognize that replacing the “loss reduction” paradigm with one of “sustainable development” offers a new and constructive strategy for analyzing coastal development and hazard mitigation options.⁶ The concept of resiliency--the ability to withstand hazard impact and recover or adjust without adversities--advances sustainability by lowering the costs of storm impacts and minimizing the resources that must be committed to preparedness and recovery. Resiliency also suggests Darwinist characteristics of social and economic adaptability, traits that are important during disruptive periods. At the crux of sustainability are principles that balance land development, ecological integrity, economic vitality, and social and intergenerational equity to create vibrant communities that can be maintained over time. Sustainability moves away from mitigation through short-term engineered solutions and promotes ecologically compatible long-term strategies such as strategic retreat and appropriate land uses that balance economic vitality and a respect for property rights.

Implementing a sustainable hazard policy begins with clearly understanding the characteristics of vulnerability and resiliency in communities: taking stock of their strengths and weakness. It requires a thorough understanding of the socio-economic and built environments, the market forces that bear upon it, and the policy framework that shapes development and attempts to control hazards risk exposure. Assessing vulnerability is complex, because it involves attempting to identify and quantify risk and assets. Actuarial science revolves around risk estimations, but for our purposes it can be briefly described as the sum of the probabilities of each specific type of hazard event occurring. Assessing the assets exposed to risk begins with a comprehensive definition of those assets. While in the past the assets were defined in terms of the features of the built environment, today we embrace a comprehensive approach, including people, the natural and built environments, and the economy.

Assets have characteristics of value and resiliency that are variable and subjective. Property and economy can be valued monetarily, but human assets and features of the natural environment, such as turtle habitat or aesthetic views, are difficult to quantify. However, that information is critical. As communities and state government struggle to craft policy that balances economic development pressures, environmental concerns, and exposure to coastal hazards risk, they must base their choices on a full-cost accounting of the costs and benefits of different levels and types of asset exposure. To achieve that, all possible aspects of asset exposure and hurricane impacts must be considered. Assessing asset exposure also identifies where and how much change is needed to create greater resiliency and what type of policy tools are best suited for reaching the objectives in a sustainable manner. The following analysis focuses on assessing barrier island asset exposure to coastal storm events. It does not delve deeply into measuring event risk but rather quantifies and characterizes the various assets at stake. It is based on a triad structure of community: People, Place, and Economy.

RESEARCH APPROACH AND CASE STUDY LOCATION

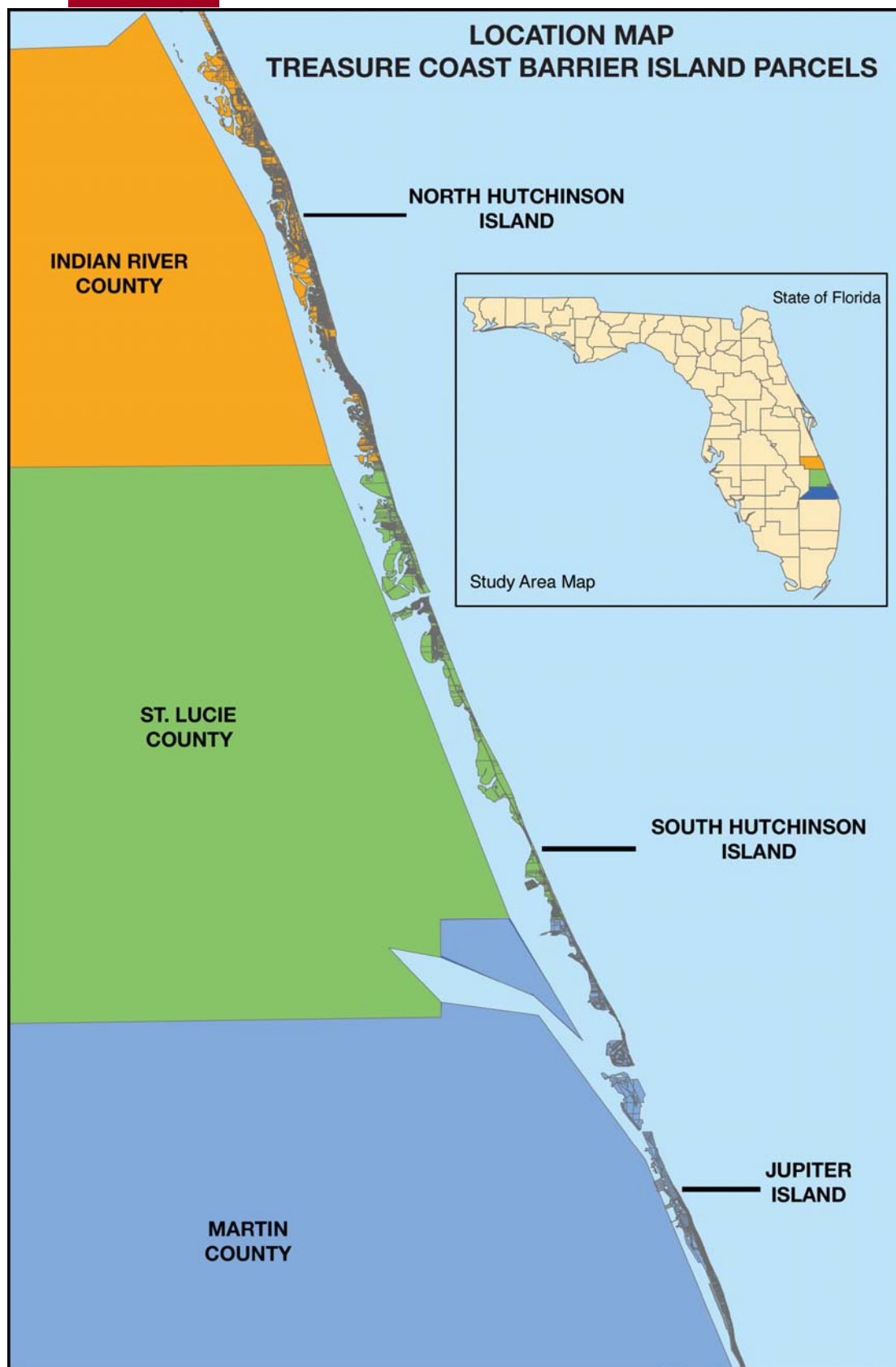
Florida's barrier islands, the narrow beach-lined islands that parallel the peninsula's coast, are a regional environmental system of critical ecological and economic importance. Those dynamic land masses buffer the mainland from the impacts of violent coastal storms and shelter coastal estuaries, enabling them to sustain ecosystems of great biodiversity. Their shorelines, inlets, and proximate waterways support vital commercial businesses and the recreational activities upon which coastal tourism thrives, and the uplands contain the most expensive and desirable real estate. The value and fragility of barrier islands, in terms of the environmental resources, the assets placed on the land, and their function as nature's fortification for storms, make decisions regarding coastal hazards mitigation politically and fiscally complex.

A web of local, state, and federal regulations was developed over the past two decades to balance oceanfront real estate development with the protection of environmentally sensitive land and greater hazard resiliency. Many of those policies are focused on the coastal edge, thus the barrier island presents an excellent opportunity to study how numerous layers of policy, implemented by several government agencies, come together to create community resiliency. For those reasons, and because barrier islands are geomorphically, demographically, and economically distinct from the mainland, they were selected for this in-depth study.

The project's study area was defined as North and South Hutchinson Island and Jupiter Island, a 60-mile long barrier island chain that runs along the Atlantic Coast in Indian River, St. Lucie, and Martin counties, Florida.⁷ The counties are part of the Treasure Coast, a region north of West Palm Beach and south of NASA's Cape Canaveral. South Hutchinson Island was ground zero for both Hurricanes Frances and Jeanne that struck September 5 and September 26, 2004, respectively. That was the first time in history that two storms made landfall within a couple of miles of each other in a three-week period. The category three storms struck in the early morning hours with winds over 100 mph.

The study area islands include unincorporated portions of the three aforementioned counties, the towns of Orchid, Indian River Shores and Jupiter Island, and parts of the cities of Vero Beach and Fort Pierce ([see Appendix maps](#)). Thus the study area is subject to eight Local Comprehensive Plans (LCP), three Comprehensive Emergency Management Plans (CEMP), and three Local Mitigation Strategies (LMS). Each locality is unique, and each must be responsive to local political constituencies, circumstances, and historical development.

Figure 1



The research methodology used a mixed-method case study approach that integrates quantitative as well as qualitative data. Case study research is emergent rather than tightly prefigured. Since the hurricane events on the Treasure Coast occurred recently and the data are still emerging, that research approach allowed data and issues that surfaced over time to be incorporated. The qualitative nature of case study research also allows the interpretive researcher to develop a socio-economic lens of power, place, and precedent. It focuses broader themes onto local circumstances and highlights how specificities of location and actors impact the achievement of desired policy goals. It provides a narrative voice to a sequence of events regarding coastal development and hurricane hazards that document how previous land use policy and development regulations performed in the wake of a destructive event.

The study's broad scope, which included an assessment of vulnerability characteristics, policy analysis, and hurricane impacts, required the use of multiple data sources and several types of analysis. Thus, the relevant research method and data are described in conjunction with the narrative of the findings in each chapter. The report is divided into three broad themes: People, Place, and Economy. The Place section has multiple components, including Natural Environment, Regulatory Context, Built Environment Exposure Analysis, and Concluding Summary. In addition, the report includes a chapter of Recommendations for creating resilient communities. Supporting materials that were developed but not integrated into the text are included in the Appendix.

A Community Vulnerability Assessment (CVA) begins with gaining an in-depth understanding of the assets at risk. A community's assets, however, are not simply the physical infrastructure, residential and commercial construction, and property. They also include the social components of the community, its residents, workforce, and institutions--components integral to the quality of life, the vibrancy of the economy, and the resiliency of the community during and after a coastal storm event. For those reasons, the Community Vulnerability Assessment begins with an understanding



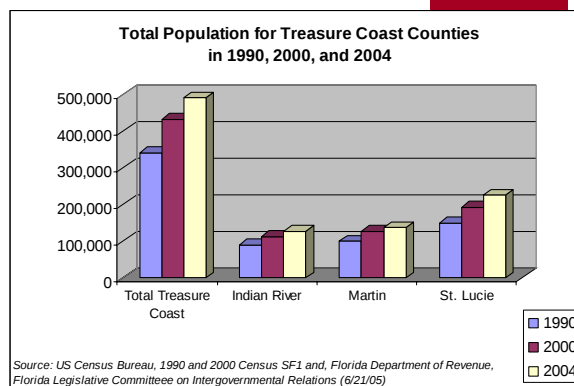
of the region's demographic composition and trends. By comparing the data for the barrier island communities to the surrounding mainland, one can determine if demographic characteristics contribute additional vulnerability to the barrier islands or make them more resilient. The CVA also helps emergency managers plan more effectively for hazard events and more efficiently distribute scarce resources during recovery.

Quantification of the resident population, population growth rate, and population distribution is critical for preparing evacuation plans and other emergency response activities, such as search and rescue, shelter designation, and distribution of relief supplies. It also allows policy makers to better understand the degree of risk to human life present on the barrier island, if that risk is growing, if current emergency provisions or mitigation efforts will adequately meet future demand, and how the barrier islands compare to the surrounding mainland which also requires emergency services. Fully understanding the nature and speed of the region's growth is important. For example, newly arriving residents would most likely have little or no experience with preparing for coastal storm events, whereas those migrating from southern counties are apt to be familiar with hurricane preparation procedures and emergency options.

THE REGION'S POPULATION AND GROWTH

As Figure 2 shows, the population of Martin, St. Lucie, and Indian River counties at the time of the 2000 census was estimated at 432,400, up an astounding 26.7% from 1990. Of the three counties, St. Lucie had the most residents, approximately 192,700, and was growing the fastest, an estimated 2.8% per year. By comparison, Martin and Indian River counties, with populations of approximately 126,700 and 113,000, respectively, were growing at a rate of 2.6% and 2.5% annually.⁸ Population projections for the region estimated that in 2004 there were approximately 490,700 people in the three counties.⁹ The greatest increase in population occurred in St. Lucie County, which was projected to have 226,200 persons, a 17.4% increase over the 2000 Census figure. Martin and Indian River counties were estimated to have grown 8.6% and 12.3%, respectively, and presently have 137,600 and 127,000 people.

Figure 2



By 2010, the region's population could reach 581,400.¹⁰ The rapid growth rate suggests that the opportunity to pro-actively plan for sustainable and resilient development is ripe today and must be addressed. Most of the growth has occurred (and will continue to take place) on the mainland portion of the counties where there are large tracts of undeveloped land. Yet, the barrier islands and other coastal areas, with their prime real estate, continue to experience strong development pressure.

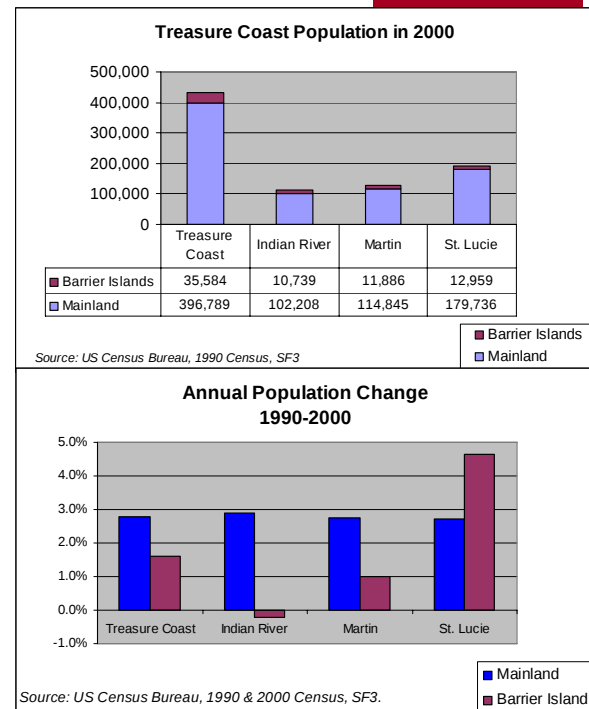
Population growth in the region is driven by both interstate relocations and a northern migration of residents from South Florida counties. The 2000 census revealed that approximately half the residents in the three-county region had changed homes in the previous five years. Among those who had relocated, 25% had moved from a different Florida county and 28% from another state.¹¹ Newly arrived residents, both young and old, contribute to social vulnerability. Residents who move from other parts of the U.S. have little or no experience with coastal storm events and have not learned "hurricane preparedness" techniques. They also have more limited social networks to rely on during the recovery period and might be unfamiliar with the resources available from public and non-profit entities. [Click to view appendix data.](#)

Barrier Islands Demographics

The population of the study area's barrier islands is approximately 35,584, according to the 2000 Census. This is relatively small in comparison to the mainland, accounting for only 9% of the region's residents. Figure 3a indicates that the barrier island population is rather evenly distributed by county, although within St. Lucie it is somewhat clustered in one census tract at the center of Hutchinson Island.¹² That cluster results from some high-density residential development and the fact that surrounding census tracts contain acres of conservation land belonging to Florida Power and Light.

From 1990 to 2000, the population of the study area grew by approximately 5,000 residents, or 1.6% annually. That is significantly slower than the rest of the Treasure Coast. The difference can be attributed to the fact that the barrier islands were largely built-out, and land on most of the barrier islands is zoned for low density residential development. Figure 3b shows that 80% of the population growth on the barrier islands occurred in the St. Lucie County portion, which gained 4,100 residents; the remainder occurred in the Martin County portion of the study area. The population change in the Indian River County portion was flat.

Figures 3 a & b



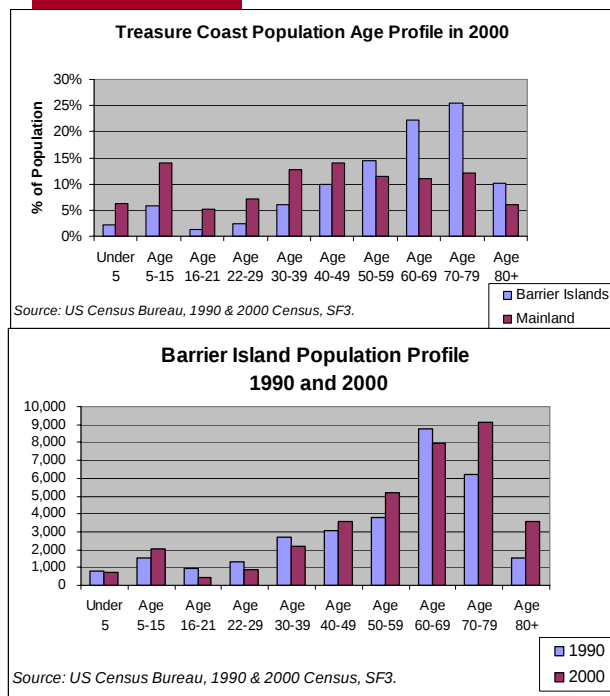
CHARACTERISTICS OF POTENTIAL SOCIAL VULNERABILITY

Age and Disability

The age and income of residents influence vulnerability to hazard events. Generally speaking, the very young and the very old are more vulnerable to hazard impacts due to physical strength, limited mobility, and dependency on others for execution of daily living tasks. Conversely, young and middle age adults have greater independence and access to resources.

Figures 4 a & b

The age profile of barrier island residents is significantly older than that of the mainland residents, suggesting a higher level of social vulnerability on the barrier islands during storm events. Figures 4a and 4b show that, whereas persons over 60 years of age comprise 29% of the population on the region's mainland, they represent 58% of the residents on the barrier islands. The barrier islands have an especially high concentration of residents 70 to 79 years of age; approximately 9,100, or 38%, of the study area's residents are in that age group. Conversely, the islands have a much smaller percentage of children, only 8% compared to 20% for the region.¹³



The distribution of seniors along the barrier islands is uniform, with no one area containing a concentration of any age group. Based on past trends, one might expect that the number of very elderly residents will increase as the population bulge shifts from residents in their 60s to residents in their 70s. That trend may be slightly tempered if frail elderly residents relocate to institutional facilities or with family members, but the number of older seniors will continue to rise.

Factors which make the old and young vulnerable to hazard events also apply to persons with disabilities. In the 2000 Census, 6,034 study area residents were identified as disabled (approximately 17% of the study area population). That is lower than the region, which identified 23% of the population as disabled.¹⁴ As can be expected, people over the age of 65 comprise more than half of the barrier islands' disabled residents. On the mainland, there are a greater number of disabled adults between 21 and 64 years of age. [Click to view Appendix data.](#)

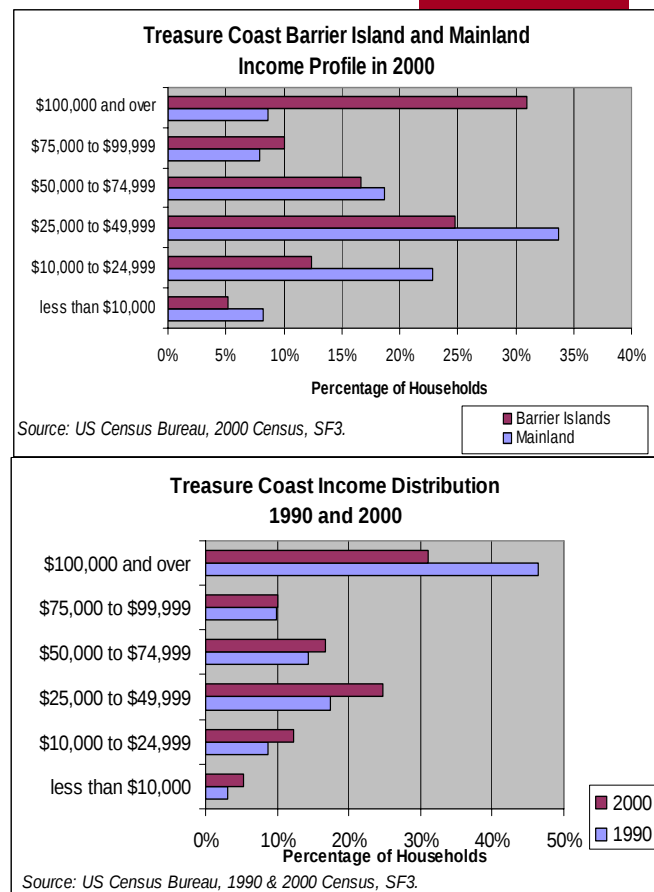
Household Income

Household income is one of the most important parameters of household vulnerability. High income households are typically better able to recover from hazard events than their poorer counterparts. Middle and upper-income households are more likely to have insurance coverage for major assets. They typically have greater monetary re-

sources to prepare for hurricane events, as well as savings for expenses related to rebuilding and extended periods of economic recovery, including lack of employment. As one University of South Alabama professor noted, “Many poor families don’t even have insurance; if they have renters’ insurance, that only covers the property inside and doesn’t help them deal with demolished housing, destroyed cars or lost jobs.”¹⁵ For example, in Indiantown, which has a median income of \$28,997 compared to \$44,370 for Martin County, families are still living in emergency trailers provided by FEMA. Conversely, affluent residents of the barrier islands may experience the “Jacuzzi effect,” where insurance coverage for damage repair actually ends up enhancing their asset’s value.

Not surprisingly, as seen in Figures 5a and 5b the study area, with its ocean and Intracoastal properties, contains a high percentage of affluent households. Approximately 5,350 barrier island households, or 30%, report incomes over \$100,000 per year, and another 10% earn between \$75,000 and \$99,999. That compares favorably to the mainland in the region, where only 9% of households report incomes of over \$100,000 and 8% of households earn between \$75,000 and \$99,999. The income profile of the study area shows that there are significantly fewer lower and moderate income households--those earning less than \$25,000 per year or earning between \$25,000 and \$50,000--on the barrier islands than the mainland. The ratio of households earning \$50,000 to \$75,000 is similar between the study area and the mainland.¹⁶ [Click to view Appendix data.](#)

Figures 5 a & b



Within the barrier islands, the wealth is concentrated in the northern segment in Indian River County, which includes the City of Vero Beach and the John’s Island community. The Indian River portion of the study area contains more than 3,200 households earning over \$100,000 annually, compared to 1,600 and 817 in the study areas included in Martin and St. Lucie counties, respectively. The barrier island in St. Lucie County, which

includes a portion of the City of Fort Pierce, contains the greatest number of moderate income residents, with approximately 2,000 households reporting incomes of between \$25,000 and \$49,000.

Housing Occupancy

The affluence of the barrier islands also translates into greater levels of resident homeownership and investment real estate. The 2000 Census counted 27,600 housing units in the study area: nearly 11,900, or 43%, in St. Lucie; 9,800, or 35%, in Indian River; and approximately 6,000, or 22%, in Martin County. A high level of vacancies--over 30% in the northern and southern parts of the barrier islands and 46% in the St. Lucie section, compared to an average of 12% for the region's mainland--suggests that the property is occupied intermittently. Among the occupied units, approximately 90% are owner-occupied, compared to 77% for the mainland.¹⁷ [Click view appendix data.](#)

Numerous factors can contribute to social vulnerability, including family status, ethnicity, and race. Social vulnerability and characteristics are determinants of access to resources and influence the level of knowledge about hazard risks and needs and attitudes about recovery assistance. Single person households, for example, are perceived to be more vulnerable, since they must cope with the physiological and economic impact of storm preparation, damage, and rebuilding alone or amongst a looser network of extended family and friends. Areas with a concentration of single-parent, female-headed households, or single elderly residents are thus considered to increase community vulnerability.

Seasonal Residents and Newcomers

The "snowbird" population, which typically spends four to six months in the region (arriving in November and departing by May), is not likely to be residing in Florida during the hurricane season. Thus, they are not perceived as contributing to community vulnerability because they do not require evacuation or shelter. In many cases, it is assumed that, since their Florida home is a second residence, they would not be critically impacted by the costs of recovering from storm events.

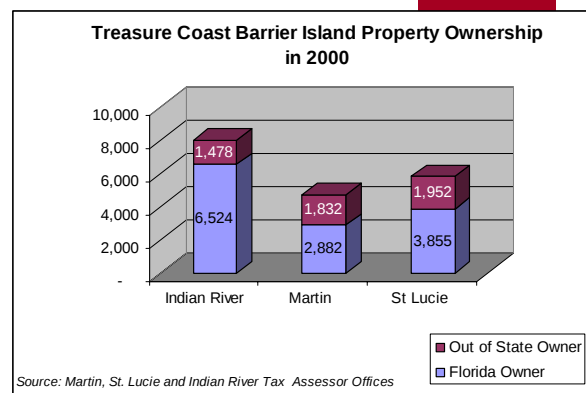
While seasonal residents may not need shelter and aid, they must not be dismissed in terms of their emergency needs and impact on the regional recovery. As these residents are often away during the storm event, they are not easily able to properly secure their property, including installing storm shutters, tending to outdoor equipment, or remov-

ing valuables. After the storm, they are often unable to address damage issues effectively, resulting in secondary losses. Most important, once their homes are damaged, they may not vacation in the region during the following “season,” while the area is in a period of recovery and their homes are repaired. That has repercussions for the local businesses dependent on seasonal tourism.

Determining the number of seasonal residents in the region and on the barrier islands is difficult. A 2004 study by the Bureau of Economic and Business Research at the University of Florida estimated that seasonal residents account for 1.23% of Martin County’s residents and 1.58% of St. Lucie residents (approximately 5,267 people). Their survey results for Indian River County yielded no seasonal residents, suggesting that the sample size was inadequate.¹⁸ The 2000 Census estimated that the three counties contained 21,000 seasonal housing units. Based on an average household size of 2.3 people, one might estimate the number of seasonal residents to be 48,200.

We have attempted to estimate the number of seasonal residents within the study area using both the 2000 Census and tax roll information showing the primary mailing address of a property owner. Based on the 2000 Census, there were 10,100 vacant housing units in the study area, an average vacancy rate of over 37%. That is more than three times the regional vacancy rate of 12%, indicating a concentration of seasonally-occupied housing. Based on an average household size of 2.03 residents per unit for the area, we can estimate that there are approximately 18,000 seasonal residents. Our tally of out-of-state property owners, depicted in Figure 6, indicates that of the 18,523 units, approximately 28% are owned by out-of-state residents. Out-of-state owners are more heavily represented in the Martin and St. Lucie portion of the study area, where between 35% and 39% of the units are owned by out-of-state interests. By contrast, only 18% of the Indian River County barrier island properties are owned by people from out of state.

Figure 6



DISCUSSION

The recent hurricane experiences exposed a gap in planning for the most vulnerable populations. Economically disadvantaged households and some seniors do not have access to automobile transportation for evacuation or the means to purchase pre-storm supplies needed for the post-storm recovery period. Moreover, when the electric power stopped, elderly residents were trapped in condominium towers, sometimes for days. Others had no access to life-dependent medical supplies or treatment.

The overall demographic characteristics of the barrier islands do not represent a greater social vulnerability compared to the region as a whole. Although the concentration of older adults is a significant factor, that is offset by characteristics of resiliency such as affluence, homeownership, and mobility. There are few households with young children, and fewer female heads of households with children under 18. Nearly all residents speak English.

It is important to consider, however, that as seasonal residents age, they are more likely to extend their stay in Florida, arriving earlier in the autumn or not returning to the north every year. If more active hurricane seasons result in a higher number of late season storms, the seasonal residents might find themselves arriving during storm warnings and advisories or experiencing the storms. Conversely, seasonal residents might delay their arrival in Florida, resulting in a negative economic impact on the community. Additional research on visiting patterns of seasonal residents would be valuable to understanding the potential vulnerability presented by that population.

Census data do not capture the shift in seasonal patterns, but one must speculate that the number of elderly living on the barrier islands is greater than the estimate generated from a simple census population pyramid. The tendency for the number of very elderly to grow is noteworthy. Zoning restrictions prohibiting the location of institutional residences and favoring single-family homes will discourage additional concentration of vulnerable populations, but due to the particular difficulties elderly residents face in a hurricane crisis, their numbers and locations must be understood as a characteristic of vulnerability.

Presently, however, the primarily social vulnerability is associated with population pockets on the mainland. Emergency managers on the Treasure Coast have created programs to evacuate and provide services for special needs households. Citizens can pre-register for transportation to shelter facilities, and the counties established special needs shelters for frail populations. The 2004 hurricanes made clear that the Treasure Coast region needs to retrofit existing shelter facilities and build new ones. Some of the comprehensive plans explicitly require that new public buildings meet shelter requirements; others prioritize the retrofitting and hardening of existing buildings.

New programs are also being developed in conjunction with the local school boards and Community Transit to improve public transportation for non-driving or economically disadvantaged households during coastal hazard emergencies. St. Lucie County developed a bus program for the barrier islands in 2004, and Martin County is creating one after seeing images of damages caused in New Orleans by Hurricane Katrina.¹⁹ All of those approaches are important, and funding must be obtained for the projects.

In addition not-for-profit organizations, such as the Salvation Army, the Red Cross, and faith-based groups, reach out to citizens, providing relief supplies and services, but all those efforts need effective coordination and additional resources. In the wake of last year's hurricanes, social service agencies and not-for-profit groups were overwhelmed with additional service requests for displaced and financially-impacted households. Their ability to meet those needs was compromised by damage to their facilities, inadequate communication systems that hampered inter-agency cooperation, absent personnel, and, more important, limited financial resources. Not-for-profit organizations noted that the hurricane season impacted their fund-raising activities, as fall and pre-Christmas events were cancelled. Affluent households also cut back on their charitable contributions as they incurred their own storm-related expenses.

To reduce social vulnerability, intensive public education about coastal hazards and emergency response is needed. All citizens must be better informed of proper evacuation procedures, including when to leave, what to take, where to go, and alternative ways to get there. Disseminating that information is challenging, especially to vulnerable populations that may not properly interpret the message, or whose circumstances limit their

ability to act on hurricane information. According to the Director of the Red Cross for the Greater Palm Beach Area Chapter, citizens must learn the skills and have the ability to acquire the resources to be more self-reliant in the post-disaster recovery period.²⁰ The increasing number of households with generators is evidence of that new trend, but with it comes additional complications, such as access to fuel and accidental injuries and death.

In the future, public policy aimed at issues of social and economic vulnerability must be expanded from excellent emergency preparedness to initiatives that facilitate more rapid and comprehensive recovery. Along with assuring adequate shelter facilities, the shelters must provide the services that allow residents to resume their lives with fewer disruptions. For example transportation must be available from the shelter to key facilities, especially for long-term shelter victims. Childcare and other social services must be better coordinated and associated personnel trained to mitigate the residents' adverse circumstances. Finally, institutions that aid in the process must be supported, both with training and financial means.

The concept of “place” refers to both the natural environment and the constructed features society introduces to the landscape of a specific location. In hazard vulnerability assessment and mitigation planning it has been customary to count the people and list and value the infrastructure, buildings, and personal property assets at risk of damage or loss due to episodic severe natural events. Thus, this report begins with an analysis of demographics and the built environment. To that base we added a review of the impacts on the natural environment and economy. Tallying the environmental impact is relatively new. It has emerged as an important aspect of hazards planning, because it illustrates how human development has profoundly altered nature’s

ability to weather and recover from severe coastal storms. Incorporating the impacts on the natural environment, and the cost of protecting and restoring it, informs a “full-cost accounting” of the trade off between development that places assets at risk and land conservation and retreat strategies that reduce asset exposure.



To address the vulnerabilities of “Place,” this research looked critically at the building stock, the natural assets we strive to protect, and the public policies that regulate and shape our communities. A summary of the key regulatory agencies and corresponding plans and regulations is presented at the onset to establish the context for development. That is followed by an analysis of asset exposure and resiliency characteristics and a discussion of the links between current vulnerabilities and public policies. Finally, there is a description of the natural environmental features of the barrier islands, the impacts of the 2004 hurricanes on those assets, and the policy response.

THE BUILT ENVIRONMENT

SUMMARY OF REGULATORY CONTEXT

To address the issue of coastal development and hazards vulnerability, it is important to understand the regulatory context that governs land development, coastal environmental resources, and emergency management in Florida and, specifically, in the Treasure Coast region. Coastal areas are managed by a complex network of local, state, and federal agencies that monitor, maintain, and improve both the natural and built environment of the barrier islands. This section will describe the role of only the key regulatory entities and policy mechanisms that regulate development, maintain and preserve the fragile barrier island ecosystem, and mitigate the impact of natural hazard events.

FEDERAL POLICY

FEDERAL EMERGENCY MANAGEMENT AGENCY

Disaster Relief and Pre-Disaster Mitigation Funds

The Robert Stafford Act of 1968 designated the Federal Emergency Management Agency (FEMA) as the lead federal agency in addressing natural disasters and hazard mitigation. FEMA provides states with Public Assistance grants to help localities recover the additional costs associated with emergency response. Public Assistance grants are offered for debris removal and emergency stabilization projects (Categories A & B), as well as for longer term structural reconstruction of public facilities and infrastructure (Categories C-G). FEMA offers two additional programs for preventive mitigation projects. A state will typically receive 7.5% of the total recovery cost for those preventive projects. When the Stafford Act (42 U.S.C.) was amended by the Disaster Mitigation Act of 2000, states and localities were directed to prepare comprehensive mitigation strategies in order to receive Pre-Disaster Mitigation Funds. Only projects detailed in those plans would be eligible to receive federal funding.

FEMA also offers individuals and businesses Individual Assistance grants and low interest-rate loans for recovery from catastrophic events. Individuals, especially those without insurance coverage or with low incomes, are eligible to receive up to \$15,000 to

cover emergency lodgings and repairs. Citizens with insurance can also receive assistance for expenses not covered by insurance, excluding the deductible, or can apply for a low interest loan through the Small Business Administration.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) is the country's most sweeping hazard mitigation policy. Created in 1968, it is made up of three components: identification of risk, mitigation through local regulation and private investment, and re-distribution of risk through a government-backed insurance program that is implemented by the private sector. The federal government has undertaken the responsibility and cost of developing Flood Insurance Rate Maps (FIRM) that identify the 100-year flood plains throughout the country. That has become the "science" behind the actuarial calculations that underwrite the insurance program. The mitigation component is embodied in a code of development regulations that increases resiliency of structures in flood and storm surge zones. NFIP has stringent regulations that increase resiliency of structures in flood zones. Those measures include specifications for building materials and design standards for construction that elevate living space above the projected flood levels.

Early on it became apparent that the NFIP, rather than reducing vulnerability through updating of existing development and better construction standards, served to encourage development on land that would otherwise prove too risky. That was particularly true of coastal properties and previously deserted barrier islands, where the requirement to elevate the first floor served to create pylon-construction with superior views of the ocean. On valuable land, the cost of the structural mitigation and insurance premiums is small in comparison to the economically viable return on development. Thus, in 1982, Congress passed the Coastal Barrier Resource Act (COBRA) that removed all federal support, both insurance and infrastructure investment, *on substantially underdeveloped coastal barriers*. COBRA was expanded in 1994 to include support for development on environmentally protected areas, but it did not comprehensively deal with construction and mitigation initiatives in developed coastal communities.

Community Rating System

The Community Rating System (CRS) was created in 1990 to encourage communities in flood-prone areas to adopt flood management practices that exceeded the NFIP standards. Under CRS, the flood insurance premiums a community pays are adjusted to reflect additional resiliency created by activities that reduce flood loss, facilitate accurate

insurance rates, and promote public awareness of flood issues. Communities can receive a rating of 1 through 10, with 1 providing the greatest reduction in insurance premium rates. Participation in CRS is voluntary. In the Treasure Coast study area, all of the localities participate, with the exception of the Town of Orchid, and maintain a rating of 7 or 8, which provides residents with a discount of between 10% and 15%.²¹

United States Army Corps of Engineers

The U.S. Army Corps of Engineers (USACE) provides vital engineering services and capabilities across a spectrum of federal operations, including water resources, environment, infrastructure, homeland security, and warfighting. One of the nation's oldest government agencies, the USACE's involvement in various kinds of water resources projects, such flood plain management, inlet and riverine navigation, and beach erosion control, has defined the nation's, and particularly Florida's, coastal areas and wetlands. Through its numerous divisions and programs, the Corps has built and still maintains hundreds of locks and dams, flood reduction structures and reservoirs, piers, jetties, and bridges that facilitate transportation vital to commercial activity, provide recreation and, most important, prevent flooding disasters.

The Corps' infrastructure, flood management, and beach erosion control programs are an important component of the federal hazard mitigation framework. In Florida, the USACE works cooperatively with the regional water management districts on numerous canal and levy projects, including the 39-mile long St. Lucie Canal that manages water flow and provides shipping access from Lake Okeechobee to the Indian River Lagoon. The USACE has also participated in the Vero Beach, 1.3-mile Fort Pierce Beach and the 3.7-mile Hutchinson Island restoration projects and created the pier structures of the Fort Pierce Inlet. Under the Federal Response Plan, the USACE is designated as the lead agency for Public Works and Engineering. During disaster declarations, the Corps can be authorized to provide emergency services, including supplying potable water, removing debris, conducting urban search and rescue, and providing emergency electrical power and ice. Its engineering expertise is used to provide technical advice and structural evaluations to localities regarding emergency repair of public infrastructure and facilities.

THE STATE OF FLORIDA

DEPARTMENT OF COMMUNITY AFFAIRS

Local Comprehensive Planning

In Florida, the Department of Community Affairs (DCA) is entrusted with implementing the state's activities related to comprehensive planning and emergency management. Florida Statute 163.3164 requires localities, either municipal or county, to create Local Comprehensive Plans for community development. Administrative regulations adopted by DCA (Chapter 9J-5, Florida Administrative Code) further detail specific issues within eight broad categories that localities must address with goals, objectives, and policies. The synthesis of the policy is manifest in the Future Land Use Map, and that is further set forth in zoning and development regulations that detail construction, activity use, and the setback requirements for each parcel within the jurisdiction.

From 1988 to 1991, localities prepared and submitted draft comprehensive plans to DCA for review and comment. DCA staff teams reviewed plans carefully, sending back suggestions for revision prior to local adoption. The adopted plans were then reviewed for compliance, but the plans remain dynamic documents that are revisited through the Evaluation and Appraisal Report (EAR) process every 7 years. That provides an opportunity to update the plans based on analyses that monitor the course of development.

According to F.S. 163.3178, "a component which outlines principles for hazard mitigation and protection of human life against the effects of natural disaster, including population evacuation, which take into consideration the capability to safely evacuate the density of coastal population proposed in the future land use plan element in the event of an impending natural disaster."

In recognition of the unique and delicate environmental characteristics of the state's coastal shoreline, Statute 163.3178 also specifies that coastal communities must develop a Coastal Management Element within their comprehensive plan. Local governments are directed to inventory ecological assets, socio-economic characteristics, and hazard mitigation issues and plan for coastal development in such a way that activities will not damage or destroy coastal resources; would protect human life in the event of natural hazards; and would limit public expenditures that encourage additional development or place public assets at risk. The statute specifies that the plan include a "component which outlines principles for hazard mitigation and protection of human life against the effects of natural disaster, including population evacuation, which take into consideration the capability to safely evacuate the density of coastal population proposed in the

future land use plan element in the event of an impending natural disaster.” That effectively places a development ceiling subject to the evacuation capabilities of existing bridges and infrastructure in place prior to October 1985 (Florida Statutes 380.27).

In the late 1980s, each county developed a Hurricane Evacuation Plan that identified shelter demand and clearance times needed to evacuate the Coastal High Hazard Area (CHHA). Those studies, which modeled evacuation scenarios for storms of different intensities, during peak and non-peak periods based on the existing road infrastructure, established guidelines for maximum population densities on the barrier islands. Based on that analysis and preexisting conditions, planners developed the new Future Land Use Maps and zoning regulations that would limit development to ensure public safety. The build-out scenario also determined the maximum Level of Service (LOS) for which infrastructure would be provided.

F.S. 163.31 also established the Coastal High Hazard Area for uniformity and planning purposes, defining it as the area requiring evacuation from a Category 1 hurricane. The CHHA in the study area covers the entire barrier island and stretches westward onto the mainland. The western boundary of the CHHA varies, depending on elevations and flooding potential, but is generally limited to the area east of Federal Highway/US1. The CHHA designation is significant, as the county comprehensive plans limit public investment in infrastructure and public facilities in that area. The level of restriction varies slightly but is geared to maintaining the Level of Service (LOS) for development existing or development sanctioned in the comprehensive plan’s Future Land Use Element. Exceptions are made for projects that increase public access, restore environmental resources, or are water dependent.

Review of Administrative Code 9J-5 provides details of how localities are to comply with the FL 163 requirements. Under 9J-5.012, the administrative law specifies the content of the Coastal Element, which includes review of land use, beach and dune systems, and development policies. It directs localities to prepare post-disaster redevelopment plans (PDRP) and identifies hazard mitigation issues that need to be addressed in the Conservation, Capital Improvement, and Transportation Elements of the LCP. The extent to which localities comply with the specifics of 9J-5 varies significantly.

Comprehensive Emergency Management Plan

The Department of Community Affairs is also charged with overseeing emergency management planning. In the aftermath of Hurricane Andrew, DCA instructed each county (not each locality) to develop a Comprehensive Emergency Management Plan (CEMP) to address preparedness, response, recovery, and mitigation of hazard events. The plans identify all types of hazards, both natural events such as hurricanes, flooding, and wildfires and man-induced technological or terrorism situations. In coastal counties, the CEMP addresses coastal storm vulnerabilities by identifying areas prone to flood and storm surge and assessing the ability to evacuate and shelter the potentially affected population. It also identifies the priority actions and responsibilities of each government agency in the recovery process.

Although the plans identify the need for mitigative actions, the emphasis of those documents is on re-establishing vital services to return a community to normal or pre-storm conditions. References to mitigative actions pertain primarily to assessment and documentation of damage that can then be analyzed and incorporated into future mitigation planning. The CEMPs commonly direct governments to establish post-disaster task forces and charge them with developing mitigation strategies, or subordinates mitigation planning initiatives to actions or plans that are identified in the comprehensive plan's Post-Disaster Mitigation section or the Local Mitigation Strategy document.

Unified Local Mitigation Strategy

The aforementioned federal Disaster Act of 2000 requires all local governments to prepare a Local Mitigation Strategy document. In Florida, that initiative was organized by DCA in cooperation with the Regional Planning Councils. Each Treasure Coast county contracted with Continental Shelf Associates, a planning firm with hazard expertise, to develop the Unified Local Mitigation Strategy (LMS) documents. The LMS plans, like CEMP documents, identify the community's vulnerability to multiple hazard risks, including hurricane, storm surge, flooding, erosion, wildfires, technological failure events, and hazard material contamination. The LMS objective, however, is to identify projects and actions that would either prevent or reduce the impact of the hazard event. Because only projects identified in those plans are eligible for FEMA post-disaster mitigation funding, the LMS recommendations emphasize "bricks and mortar" projects that are also eligible for funding through several state sources. Projects with multiple sources of grant and matching fund opportunities stand a better chance of being implemented and are thus prioritized.

To be effectively implemented, the LMS recommendations must be integrated into the policies and goals of each element of the Local Comprehensive Plan (LCP). Currently, the LCPs include language that directs governments to amend the comprehensive plans if post-disaster reports or the Treasure Coast Regional Planning Council's (TCRPC) mitigation plans identify land use conflicts; but the status of the LMS report and prioritization of projects it sets forth are not clearly identified. The initiatives identified in the LMS may be adopted into the comprehensive plan at the time of the EAR, with an LCP amendment, or not at all. DCA is now actively promoting plan integration through a series of local workshops, publications, and several model pilot projects. Proper integration and cross-reference among the plans are important because that will facilitate funding allocation for mitigation work, prevent projects that increase vulnerability from materializing, and avoid conflict in selecting and prioritizing post-disaster redevelopment initiatives. It also promotes coordination among localities in addressing mitigation projects.

Florida Building Code

Florida adopted a state minimum building code in 1974 that required all local governments to adopt and enforce a minimum building code to protect the health and life safety of the public. The system provided three separate model codes (fire, electrical, and structural) that local governments could adopt, amend, and enforce as they saw fit. Hurricane Andrew demonstrated that the system of local codes did not provide a sufficient level of public protection.

After Andrew, Miami-Dade County conducted an exhaustive review of its building code and made significant changes to both the code and support systems for code enforcement, resulting in the Miami-Dade Code standards. In other areas of the state, the Board of Building Codes and Standards (predecessor to the Commission described below) adopted significant upgrades to the wind resistance standards of the model that was used by the majority of other local governments. Nonetheless, they were still less stringent than the Miami-Dade ordinances. In 1996 the Florida Building Commission was appointed to review the disparate system of local codes and make recommendations for modernizing and standardizing them. The 2000 Legislature authorized implementation of the 2001 Florida Building Code and the first edition replaced all local codes on March 1, 2002.



Older manufactured homes are particularly vulnerable to hurricane damage and unfit shelter during the storm event. In the storm aftermath, residents of mobile home parks often require extended temporary housing.

The new 2001 Florida Building Code integrated separate fire, structural, and general engineering codes into one document that superseded all local regulations. It raised construction standards for all types of structures, but in terms of hurricane protection, it specifically raised the wind resistance standards for roofing and cladding in inland areas to wind speeds of 120 mph and created a standard for projectile debris applicable to roofing materials, wall cladding, outside doors, skylights, glazing, glass block, shutters, and other external protection devices.²² The new code also required homebuilders to furnish hurricane shutters with all new residential construction.

The Building Code does not focus on flood prevention. Article 1403.6 regarding flood resistance states, “This code specifically defers to the authority granted to local government by Title 44 CFR, Sections 59 and 60. This code is not intended to supplant or supersede local ordinances adopted pursuant to that authority, nor are local floodplain management ordinances to be deemed amendments to the code.” Deference to local authority gives localities responsibility over the level of resiliency adopted. Localities in turn tend to use the standards identified by the NFIP.

The Florida Building Code requires the Florida Building Commission to update the code every three years in order to incorporate new national standards of health, safety, and welfare of the public. As the 2004 update would be the first since the establishment of the 2001 Code, the Commission was careful to review the track record of the previous statute and make revisions based on lessons learned over the past few years, especially the impacts observed from the 2004 season.

The 2004 Florida Building Code is, in many respects, a simple update of the 2001 Code but incorporates important aspects of the International Building Code and adds changes to code enforcement practices and code design procedures. The 2001 code established the primary wind resistance design standard used in the code as the American Society of Civil Engineers’ (ASCE) Standard 7. In the 2004 update, the commission sought an easier way to allow the state to adopt updates to the ASCE’s 7. Thus they recommended that ASCE amendments be adopted by administrative rule rather than legislatively. By removing the process from elected representatives, it should be easier to adopt the higher standards proposed by engineering professionals at ASCE. In addition, the 2004 code clarifies the procedures by which owners can have plans and construction inspected by private providers, and it specifies the qualifications, ongoing training, and insurance requirements that those private entities must have. It also outlines a more streamlined procedure for the use of building materials and new technologies to be approved by the state. The new regulations were implemented in October of 2005.

DEPARTMENT OF ENVIRONMENTAL PROTECTION***Coastal Construction Control Line Program***

Development along the ocean shoreline has additional regulatory requirements set out in the Florida Beach and Shore Preservation Act, administered by the Department of Environmental Protection (DEP). Florida Statutes 161.053 created the Coastal Construction Control Line (CCCL), whose westward boundary is designated as approximately 500 feet landward of the mean high water line. Development eastward of that line requires a permit from the state's Bureau of Beaches and Coastal Systems. The Coastal Construction Control Line is not a setback requirement determined by localities. Rather, it designates a zone landward of the mean high water line, which is environmentally sensitive and within which development must not adversely impact the beach and dune eco-systems. Thus, engineers examine all building plans to assess the impact of development on the dune system, beach, and wildlife, such as sea turtles, to prevent deterioration of the natural environment.

Implementation of CCCL regulations mitigates the risk posed by erosion and storm surge, as the law requires buildings to be set back landward on the property. The CCCL regulations require construction to be set landward of the 30-year erosion line projection at the time of permitting. The 30-year erosion line is the projected position of the seasonal high water line (SHWL) 30 years after permitting based on historical fluctuation and is determined on a parcel-by-parcel basis, depending on site specific features that influence these parameters.²³ However, the CCCL regulations include notable exemptions from those requirements that comprise its ability to position structures away from the oceanfront. Exemptions include structures deemed to be minor, such as a pool, or even a single family home which is constructed amongst pre-existing construction in a reasonably continuous and uniform line of construction (Statute 62B-33.005 (9)).

Construction seaward of the CCCL is subject to design guidelines aimed at reducing the structure's vulnerability to erosion and inundation from coastal storms. The design guidelines establish a minimum elevation for the lowest horizontal structural member of a habitable structure. They also provide guidelines for foundation pilings that are subject to beach erosion. Because geomorphic features of beaches vary, the estimated storm surge height of a combined one-percent return period storm is calculated for each beach monument location throughout the state to establish site specific base elevation standards.²⁴ Throughout the study area, construction must be elevated 15 to 18 feet above the ground, depending on the specific lot location.

In 1985, Florida enacted the Coastal Protection Act to minimize damage to the natural environment, private property, and life through the imposition of strict construction standards near the coasts. The act covers land from the seasonal high water line to 1,500 feet landward of the CCCL. The Coastal Building Zone on a barrier island covers land from the seasonal high water line (SHWL) to 5,000 feet landward of the established CCCL or the entire island, whichever is less. Thus, in the study region, it covers the width of the entire island in nearly every instance. Within that zone, all construction must meet NFIP construction standards and is subject to retrofitting guidelines similar to those outlined for NFIP²⁵.

REGIONAL

TREASURE COAST REGIONAL PLANNING COUNCIL (TCRPC)

The Treasure Coast Regional Planning Council is one of 12 regional not-for-profit organizations established by FS 186.502 (4) devoted to providing technical planning expertise to localities from a multi-county perspective. Composed of elected officials from Indian River, St. Lucie, Martin and Palm Beach counties, the TCRPC serves to create a regional vision and insure that growth patterns and initiatives are synergistic across political jurisdictions.

SRPP coastal development policy states "...to limit future development on barrier islands to land uses which are resource dependent or compatible with the physical and environmental characteristics of barrier islands, or those uses which can occur without degradation of important environmental resources or interference with public access to beaches."

The Treasure Coast Strategic Regional Policy Plan (SRPP) is the guiding planning document for the region. The advisory nature of the regional planning councils makes the document a "manual" that local governments can use to ensure that their comprehensive plans are in line with regional objectives. The SRPP does not contain a coastal element like the Local Comprehensive Plans but does include a chapter on Natural Resources of Regional Significance. That section identifies primary coastal habitats and conservation issues and, in Strategy 6.4.1, prohibits activities that result in beach erosion or damage to the primary dune system.

The SRPP also sets forth Policy 6.4.1.3 to "limit future development on barrier islands to land uses which are resource dependent or compatible with the physical and environmental characteristics of barrier islands, or those uses which can occur without degradation of important environmental resources or interference with public access to beaches." The TCRPC's regional role sets the context within which each county and municipality's Future Land Use Plans or ordinances must comply.

Similarly, the TCRPC is developing a regional multi-hazard mitigation plan. That document seeks to ensure that the Local Mitigation Strategies developed by localities in accordance with FEMA's mandate are synergistic. By outlining a regional approach, they seek to coordinate local priorities and maximize the impact of funded initiatives. In the wake of 2004, the TCRPC has highlighted the need to update the Hurricane Evacuation Study models integrating counties to the south into a multi-county evacuation and shelter plan. They also identified the need to find funding for various shelter projects and improve communications with FEMA to gain a clearer understanding of its reimbursement policies.

THE SOUTH FLORIDA AND THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICTS

Florida's five water management districts, enabled under Section 373.069, F.S., were created primarily to mitigate the impacts of flooding. Over the years, however, the districts' role has been expanded considerably to include water supply, water quality, and environmental protection. The Treasure Coast region is managed by two districts, the St. John's River Water Management District, which includes Indian River County and 17 other counties in the watershed of the St. Johns River, and the South Florida Water Management District (SFWMD), which serves St. Lucie and Martin counties and the other 14 counties south of Lake Okeechobee from coast to coast.



Florida's regional water management districts are involved in acquisition of public lands, which manage water retention, water quality and contribute to ecosystem preservation and restoration.

The water management districts' flood prevention goals and policies are an integral part of regional hurricane mitigation, as flooding is a hurricane-related peril. To meet those responsibilities, the districts operate and maintain a regional drainage system of land and canals throughout their jurisdictional areas. The SFWMD "Canal Conveyance Capacity" program, for example, ensures that the canals are dredged and otherwise maintained so that water can be channeled and stored to prevent inundation.

The canal and levy system was established early in the last century as a highly engineered approach to hazard mitigation. As advances in environmental science demonstrated that casual manipulation of drainage basins adversely impacts the ecology, the region's water management districts have become increasingly sophisticated environmental stewards. Planning policy in the SFWMD explicitly states that the "District will

encourage non-structural methods, including acquisition, regulation and application of appropriate land use and water management policies to address and prevent water resource problems” (SFWMD Strategy 2.2.1).

The districts also administer the Save Our Rivers and Florida Forever programs for the purpose of protecting environmentally sensitive land. The acquisition program, which has purchased land within the CHHA, has helped reduce hazards vulnerability by eliminating development of coastal parcels and increasing the numbers of preserved wetland acres. In 2003, for example, the SFWMD acquired nearly 600 acres of valuable conservation land surrounding the Indian River Lagoon.

LOCAL COMPREHENSIVE PLAN ANALYSIS PERTAINING TO THE TREASURE COAST BARRIER ISLANDS

The study area contains the towns of Indian River Shores, Orchid, and Jupiter Island, a portion of the cities of Vero Beach and Fort Pierce, and the unincorporated lands in Martin, St. Lucie, and Indian River counties. Thus, the Treasure Coast barrier islands are covered by eight comprehensive plans that were adopted between 1988 and 1992. For the purposes of this analysis, primary attention was given to the counties’ Local Comprehensive Plans (LCP) and then to their Comprehensive Emergency Management Plans (CEMP) and Local Mitigation Strategies (LMS). The municipalities’ comprehensive plans were reviewed but not analyzed in detail.



Inadequate setback regulations subject homes to destructive storm surge despite base floor elevation requirements.

The counties’ comprehensive plans are the principal policy documents that set out development goals and objectives. The Future Land Use Plan dictates policy that drives and regulates both public and private development activities throughout the jurisdiction, meaning unincorporated portions of the county. In addition, the Coastal Element details land use policy that is specifically relevant to the coastal areas, including the barrier islands, and contains nearly all of the language pertaining to hazard mitigation and post-disaster redevelopment. For that reason, the Coastal Element was given particular attention in our research.

To comply with the state planning mandate, the Coastal Element must consider:

- restriction of development activities that would damage or destroy coastal resources;
- land use and development density in relation to the ability to safely evacuate and shelter the population;
- preservation of water-related or water-dependant activities;
- limitations on public expenditures in areas that are subject to destruction by natural disasters;
- a redevelopment component that outlines principles which shall be used to eliminate inappropriate and unsafe development when the opportunity arises.

Yet, how each jurisdiction fulfills the requirements is largely left to local discretion, resulting in LCPs that vary in scope, specificity, and the content of the mitigation approaches.

A direct comparison of the plans and their mitigation policies is difficult because the definition of the coastal area is not consistent. The coastal zone in Martin and St. Lucie counties' plans refers to the barrier islands and the river and lagoon system within the 100-year flood plain. Indian River makes reference to the entire drainage basin related to the Indian River Lagoon, an area that includes over half the county. Discrepancy in the size of the geography impacts the specificity of the land use policy statements. The challenge is compounded by the varying degree of cross-reference between the Coastal Element of the plans and other sections.

The counties' coastal plans are tailored to the specific barrier island land under county jurisdiction and are responsive to locally specific conditions such as development policies of internally contained local jurisdictions. The counties have sovereign municipalities of different size and economic characteristics controlling varying amounts of ocean-front land. The extent to which the county plans shape the city plans or vice versa is not clear. Nonetheless, the plans were analyzed to determine if variations or conflicting policies undermine optimal mitigation and how synergies can be maximized.

To analyze variation among the counties' Local Comprehensive Plans, the policies, goals, and strategies related to hazard mitigation were categorized based on whether the initiative used a land use, engineered hardening, or emergency management approach. Land use initiatives include regulations or policy related to permitted use, density, setback, land acquisition, and public investment in infrastructure or facilities that would facilitate additional intensity of development. Engineered hardening refers to policy advocating construction standards or enhanced infrastructure to overcome storm

impacts. Emergency management refers to initiatives focused on hurricane evacuation, support and coordination of first responders, and enhancements to the public and private shelter system. Commitment to mitigation through engineered hardening was also evaluated by examining the prioritization of projects identified in the Infrastructure Element of the LCP and the LMS documents. Issues related to emergency management were cross-referenced with the CEMP, which summarize the Hurricane Evacuation Studies of the mid-1980s. In addition, all three documents for each county were reviewed to extract the counties' policies related to post-disaster reconstruction.

As part of the content analysis, the policy mechanism and policy language were examined with respect to the restrictiveness of the ordinance, the applicability in terms of spatial geography, the protective level of the standard established, and the timeframe given for implementation. Figure 13 is a distilled summary of the policies. Finally, local officials were interviewed to obtain an historical perspective on policy evolution. Clearly, localities employ a combination of all these mitigation approaches to different degrees. The purpose of the analysis was to understand if the ensemble of policy goals and objectives promote a preferred approach, and if a particular approach yields more resilient communities.

LAND USE APPROACHES

Review of the Future Land Use maps indicates that in Martin and Indian River counties, planners down-zoned development, limiting use to low intensity uses--primarily low density residential. Martin County created a specific Hutchinson Island Development Ordinance that zoned the barrier island for residential use at two units per acre. That can drop to one unit per acre if level of service (LOS) standards for transportation are exceeded. Indian River County permits between two and four units per acre on the barrier island. Those counties' plans expressly state that counties "will use all applicable regulations to restrict development" in the CHHA.

Figure 7

Summary of Coastal Hazard Mitigation Policy Embodied in Comprehensive Plan

	INDIAN RIVER COUNTY 1991 *	ST. LUCIE COUNTY Jan-90 *	MARTIN COUNTY Feb-90 *
Hazard Policy Statement	Through 2020, Indian River County will maintain an estimated evacuation time of 12 hours or less for a Category III hurricane. The county will solicit funding for shelter retrofits and assess vulnerable public assets	St. Lucie Shall strive to protect the people and property in St. Lucie County from the effects of hurricane storm damage. It shall weigh future development as to the impact it would have on the county's ability to protect the people and property in St. Lucie from the effects of hurricane storm damage.	The Protection of human life and capital facilities form the destructive effects of hurricanes and natural disasters by limiting public expenditures and development activities in identified coastal high Hazard areas, providing for safe and effective emergency evacuation and establishing procedures for post-disaster redevelopment.
Land Use Policy Statement	1) During 1995 through 2020 there will be no increase in land-use designation density or use within the Coastal High Hazard area. 2) The County will support purchase of land on the barrier island 3) Shall limit densities to ensure timely evacuation, shall prohibit congregate care facilities.	All Development proposed in the Future Land Use Element in the Coastal Areas shall occur in a manner which protects, conserves and enhances the Natural resources of the Coastal area and the Environmental, social and economic benefits attributed to them	1) Barrier Island development regulation shall address at a minimum: Maximum residential density, wet-land preservation, shoreline protection, flood damage prevention, endanger species habitat, potable and wastewater, site design, recreation and open space, transportation standards, public safety, storm water quality. 2) The major purpose of the development regulations will be to limit public expenditures and direct population concentrations away from the coastal high hazard area. 3) The County shall protect the coastline and avoid loss of life in the CHHA by minimizing land development and public facilities, and providing safe and effective emergency evacuation.
Land Use Objectives	1) Lands acquired by the county under its environmental land program shall include property within the HVZ. 2) Within the CHHA the county will not make infrastructure improvements, or use public funds to accommodate development more intense than allowed by the comprehensive plan 3) The County shall utilize all applicable state and federal regulation, and the appropriate objectives and policies in the comprehensive plan to limit public and private development in the CHHA	1) The County shall address development and redevelopment in the coastal area in the County's Hurricane Evacuation Plan 2) The County shall promote the construction of publicly owned buildings that can be safely utilized as public hurricane shelters, 3) The County shall maintain the worst case 22.5 hour hurricane evacuation time 4) The county shall provide immediate response to post hurricane situation through the implementation of post-disaster response and redevelopment plans as set forth in the Treasure Coast Hurricane Evacuation Plan.	1) To limit public expenditures in the designated coastal high hazard area to necessary public services in order not to subsidize new development. 2) Direct population away from coast. Encourage low-density land uses within the coastal high hazard area. 3) To provide for public safety during emergency evacuation by maintain or reducing emergency evacuation clearance time and maintain adequate road system. 4) The establishment of post-disaster procedures for immediate and long term response to disaster including clean-up and redevelopment

Figure 7

Summary of Coastal Hazard Mitigation Policy Embodied in Comprehensive Plan

	INDIAN RIVER COUNTY 1991 *	ST. LUCIE COUNTY Jan-90 *	MARTIN COUNTY Feb-90 *
Special Land Use Designations	Adopted a Coastal Construction Code which is applicable to all buildings in the coastal building zone, an area 5000 feet landward of the state CCCL, or the entire barrier island	Shall not grant a permit in CHHA unless it is approved by FDEP.	1) Establishment of a "Barrier Islands Ordinance". 2) Establishment of a Beach and Dune Preservation Zone 3) Establishment of Shoreline Zone
Density and Use	1) Residential and TDR ranging from 3 to 10 p/acre 2) Restriction on congregate care facilities	Residential Medium and High at 9 to 15 units per acre.	Only detached single-family residential, not to exceed 2 units per upland acre, no taller than 4 stories or 40 feet.
Property Line setbacks	It recognizes the CCCL of 6/81 as the Dune Stabilization Line and prohibits development seaward.	Defers to the CCCL regulations	No new development will be permitted eastward of the CCCL line established in 6/1985.
Land Acquisition Policy	1) The conservation element identifies a priority to purchase lands in the HVA. 2) There is also a priority to purchase land on the Barrier Island	Conservation Plan states that conservation land should be available for multiple uses.	Acquire and develop public access site to the water. Identify funding for acquisition of land within the Category 1, 2, 3 hurricane surge area
Infrastructure	1) Through 2004 there shall be no expansion of infrastructure within the CHHA other than that which is deemed necessary to maintain existing levels of service. 2) The county shall maintain a rating of 7 according to NFIP's Community Rating System. 3) Single family units must pay full cost of infrastructure in the CHHA	Public funds shall not be used for infrastructure or service expansion or improvements to areas designated as coastal high hazard areas unless such funds are necessary to: 1) provide services to existing subdivisions approved for development prior to adoption of this policy 2) provide adequate evacuation in an emergency 3) Provide recreational needs and other appropriate water dependent or water related use	Public funds shall not be used for infrastructure or service expansion or improvements to areas designated as coastal high hazard areas unless such funds are necessary to: 1) provide services to existing subdivisions approved for development prior to adoption of this policy 2) provide adequate evacuation in an emergency 3) Provide recreational needs and other appropriate water dependent or water related use 4) provide support to public and private land development specifically designed to minimize storm hazards. Consider relocation of Infrastructure out of CHHA.

Figure 7

Summary of Coastal Hazard Mitigation Policy Embodied in Comprehensive Plan

	INDIAN RIVER COUNTY 1991 *	ST. LUCIE COUNTY Jan-90 *	MARTIN COUNTY Feb-90 *
Sewer and Water	The county shall not allow new underground storage tanks or septic facilities to be located ocean ward of the Dune Stabilization Setback Line 2) The county will decommission all remain wastewater package plants in the HVZ	Flood Proofing of all sewer pump stations in the HVA	1) Infrastructure investment is permitted to correct deficiencies that impact lagoon. 2) Septic is only permitted on 1/3 acre or larger and shall be fitted with back flow. 3) New sewer in HVA shall be flood proofed.
Roads and Bridges	Maintain a Hurricane Evacuation of less than 12 hours for a Cat III. All major bridges shall be designed to withstand a 100-year/3day storm event. By 2010 existing roadways must meet storm event standards.	1) The County shall maintain the worst case 22.5 hour hurricane evacuations time. 2) Turning lanes should be constructed at key intersections on the BI to facilitate access to bridges and causeways.	1) Maintain Hurricane Evacuation to 17 3/4 hours for Cat V. 2) New developments shall develop evacuation plans. 3) The County will pursue removal of Australian Pines from rights of way.
Public Facilities	The County shall not fund facilities which increase development in the CHHA and shall not subsidize public facilities unless to meet LOS or its related to public access or resource management.	The County is prohibited from using public money for facilities in the CHHA unless: 1) provide services to existing development, 2) provide adequate evacuation 3) water dependent uses, restoration and enhancement of natural resources	Minimize public facilities in CHHA, cannot construct, finance, acquire, accept contribution, repair or replace public facilities in CHHA unless they are items that are approved in the Coastal Element.
Hurricane Shelters	The county sees to retrofit public facilities for shelters.	Policy is in place that all new public facilities include design standards for shelters	New Development must provide shelter for 25% of population

Source: Local Comprehensive Plans of Indian River 2001, St. Lucie 2004 and Martin County 2002.

* Year of adoption

Adherence to that principle is evident in several recent land use decisions. In December 2004, Indian River County denied an LCP change to a Canadian developer seeking to develop 24 condominium units on a four-acre parcel south of Seaview Drive and west of A1A. Seven months later, the developer received approval for only 10 homes on the site.²⁶ The trade-off means that density will remain low, but the value of the assets built on the barrier island will still be large. Each home is projected to cost between \$3 and \$5 million, supporting the trend that makes residing on barrier islands a privilege of only the very rich.

St. Lucie County's plan does not put forth an asset reduction strategy. In St. Lucie County, high rise residential development at a density of 9 to 15 units per acre is per-

mitted on the barrier island. The coastal land use policy language used in the LCP states, “All development proposed in the Future Land Use Element in the coastal areas shall occur in a manner which protects, conserves and *enhances* the natural resources of the coastal area and the environmental, *social and economic benefits* attributed to them” (emphasis added). According to planning officials, in the 1980s St. Lucie made a conscious choice to permit high density development east of A1A in order to conserve environmentally sensitive land on the west side of the road.²⁷ By treating parcels divided by A1A as contiguous, planners permitted the transfer of development density from the west parcel to the ocean-side, which was more valuable due to beach adjacency and views available from upper floors. Once the development rights of the western parcel were exhausted, the value of the land was reduced significantly. Developers often deeded the land to the public in order to reduce the property tax obligation or the land was purchased by the public at moderate prices.

Local officials also point out that high-rise construction results in a smaller footprint, leaving more land in a natural condition.²⁸ Established side-yard setbacks of 69 feet on portions of the barrier island are intended to prevent the feeling of towering concrete ‘streetwalls’ typical of urbanized areas of A1A in southern counties. It appears that in St. Lucie there is a preference for a modernist aesthetic of ‘tower-in-the-park’ or the ‘tower-along-the-beach’ development, which balances density stacked vertically with open space at the ground level. In July 2005, the Board of County Commissioners turned down the proposed 8-story Windward Grande condominium project slated for the site of the former Hutchinson Inn because the developers requested a variance to place the buildings too close together.²⁹

With regard to the population densities generated by that type of land use strategy, county officials point out that the presence of the Florida Power and Light facility, which includes over 1,000 acres of adjacent land for recreational use, helps ensure that the overall population density is manageable for emergency evacuations. The geopolitical boundaries of St. Lucie include two barrier island causeways and extend south to within one mile of the Jensen Beach Causeway in Martin County, keeping evacuation clearance times down despite development density.

Sentiments regarding development density may slowly be changing in the wake of the recent hurricane experience. Development approvals have been withheld from a Michigan developer seeking to construct a mixed-use project on the southwest corner of St. Lucie Court and South Ocean Drive. Although the developer has reduced the massing of the building from 8,000 to 3,500 square feet, residents complain that the proposed density of 13.7 units per acre does not conform to the density limitations outlined in a 1981 referendum. Commissioner Coke of St. Lucie County commented that, “We talked

about raising the bar after the hurricanes and building better and following the city's comprehensive plan. Seven units on a half acre is not raising the bar and is not what the community on South Hutchinson Island supported."³⁰

Non-Conforming Land Use

Since development of the barrier island predates adoption of the Local Comprehensive Plans, portions of the study area still contain a small number of uses that were deemed undesirable or vulnerable for the barrier island location. Some of those commercial parcels were codified in the creation of the Future Land Use Maps; others, it is believed, will eventually be replaced. The number and type of non-conforming uses are important to document as such parcels might contribute additional vulnerability, such as environmental contamination or concentrations of fragile populations. Some non-conforming uses remain on the barrier island, but they are mostly related to higher density development, and none poses a significant environmental risk.³¹

The counties' responses to vulnerable uses vary. In Indian River County, for example, the LCP specifies that congregate care facilities for the elderly are not permitted in the CHHA. By contrast, St. Lucie County, whose barrier island geography includes three mobile home parks, did not choose to remove those uses. Instead, they have gradually changed the building codes to permit the mobile homes to acquire characteristics of permanent home structures.

Land Acquisition

For all three counties' LCPs, both the Conservation Element and the Coastal Element address identification, planning, and acquisition of environmentally sensitive land. To finance the desired acquisitions or conservation easements, localities typically turn to bond referendums or sales tax surcharges. In 1992, Indian River County passed a \$26 million Land Acquisition referendum that has funded significant coastal acquisitions around the lagoon since 1995. Martin County's Lands for You Program, which ran from approximately 1992 to 2000, used a one-half cent sales tax to purchase nearly 1,000 acres of sensitive oceanfront and recreational land. In 1994, St. Lucie County passed its first bond referendum, raising \$10 million for land acquisition. The 1998 referendum that followed has generated \$20 million, used to leverage an additional \$60 million from secondary sources.

The criteria for parcel acquisition are focused on environmental value rather than hazard mitigation. Land acquisition is not identified as a key hazard mitigation policy except during the post-disaster recovery period, when storm damage may create an opportunity for strategic acquisition. Nonetheless, local governments have been able to reduce development of vulnerable land through strategic acquisition because coastal parcels often fit both the environmental and mitigation criteria. The Martin County and Indian River County LCPs reference CHHA as an area to consider for acquisition of public land, but none of the plans specifically outlines the priority level of CHHA parcels. St. Lucie County targets property within the Hazard Vulnerability Area but refers specifically to the CHHA only regarding post-disaster reconstruction.

In 2004, new referendums were on the ballot in Martin and Indian River counties, as money from 1990s initiatives had been expended. Indian River County passed a bond referendum of \$50 million for land acquisition that also included preservation of agricultural lands. Inclusion of agricultural land as needed open space and to curtail sprawling land development for sustainable communities was a milestone. Such properties, like some parcels needed only for hazard mitigation, do not fit a strict definition of environmentally sensitive land. Inclusion of those properties in the public acquisition strategy may establish a stronger precedent for acquisition of land for hazard mitigation.

In contrast, the 1 cent sales tax surcharge proposed to fund land acquisition in Martin County failed 48% to 52% in the November 2004 vote. The defeat disappointed planners in a county that prides itself on environmental stewardship. Local officials believe the hurricanes' impact was an overriding concern for citizens, as they were unwilling to burden themselves with additional tax while households and businesses were recovering from hurricane losses.³² The defeat may have also resulted from a shift in the focus of land to be acquired. While Martin County still seeks two barrier island parcels, much of the conservation attention has been shifted to acquisitions of large western county parcels related to the Comprehensive Everglades Restoration Project. Those acquisitions have clear environmental benefits but might be less attractive to the voting public.

INFRASTRUCTURE AND PUBLIC FACILITIES

Concurrency between development and the provision of public infrastructure is a primary component of the LCP's Future Land Use and Infrastructure Elements. In the Coastal Element, however, the issues related to infrastructure and public facilities are addressed in two specific ways. First, the Coastal Element identifies weaknesses in specific existing public infrastructure systems that require remediation. For example, the

LCPs in Indian River and St. Lucie specifically direct county government to address relocation or upgrading of sanitation facilities. (As of 2004, the Indian River County water treatment facility had been moved off the barrier island and the St. Lucie package treatment stations were remediated.) Second, investment in infrastructure is used as a tool to constrain development of vulnerable coastal areas to predetermined densities.

While narrow objectives such as waterproofing sanitation pumping stations or relocating water treatment facilities cannot be viewed as shaping an overall mitigation approach, the relative uniformity among the plans in restricting public investment in infrastructure or public facilities within the CHHA can be viewed as a land-use mitigation strategy. The wording of the plans varies but generally states that public funding of infrastructure or infrastructure repair is limited to “maintaining existing levels of service” for the existing residents or anticipated development as sanctioned by the Future Land Use plan.” Martin County’s language is the strongest, detailing the public investment restriction to include not subsidizing or accepting possession of facilities in the CHHA.

Some exemptions to the CHHA public investment restrictions are found in all the LCPs, but it is the differences in policy that reveal how hazard mitigation policy is slanted toward land use, engineered hardening, or emergency management. Policies restricting public investment in the CHHA uniformly exempt initiatives that restore or enhance natural resources or provide more public access. Exemptions are also made for water-dependent and water-related uses, as state policy encourages localities to undertake those activities. However, St. Lucie County exempts investments in infrastructure needed for evacuation, as they offset high density residential development with better access to evacuation routes. The other parts of the St. Lucie LPC establish road widening objectives at key intersections needed to evacuate the barrier islands.

Martin and Indian River do not have similar objectives in their LCPs. Indian River County’s Coastal Element identifies potential road constraints on segments of A1A that fall within the federal COBRA zone, but no solution is incorporated in the plan’s policy objectives. Consistent with policy language that directs development away from the barrier islands, the plan’s Transportation Element specifically restricts transportation infrastructure investment that might contribute to development in the CHHA. Martin County’s plan raises issues regarding the capacity of the Jensen Beach Causeway and related intersections. The LCP has a specific policy that directs Martin County to ask St. Lucie County to lower development density on the southern end of South Hutchinson. By comparison, St. Lucie’s LCP has a policy that encourages the county to work with Martin County regarding future investment in the bridge facility.

Figure 8

Top 10 Mitigation Projects Identified in Local Mitigation Strategy

RANK	INDIAN RIVER	ST. LUCIE	MARTIN
1	Improved mapping of the CHHA to allow for better and more precise implementation of the County's regulations \$50,000	Virginia Ave. Basin upgrade at crossing of Mayflower Canal \$750,000	Glenwood Acre Drainage Project*
2	Acquisition of land along the Indian River Lagoon within the CHHA up to \$20 million	St. Lucie Gardens Phase I land acquisition for storm drainage \$100,000	Drainage Project*
3	Re-vegetate areas along Lagoon banks	St. Lucie Gardens Phase II land acquisition for storm drainage \$100,000	Drainage Project*
4	Retrofits City of Vero Beach Transmission and Distribution facility \$3,800	Lakewood Park pipe retro-fits \$175,000	Church Street Drainage \$50,000
5	Retrofit City of Vero Beach Recreational Facility \$7,000	Avenue Q12th Street Basin \$300,000	Palm Lake Park Drainage \$2.58 million
6	Retrofit City of Indian River Shores critical facility \$50,000	Special Needs Shelter retrofit, roof repairs to Civic Center \$500,000	Thirteenth Street Drainage \$150,000
7	Retrofit City of Vero Beach Police Department critical facility \$7,500	Structural improvement to cool shelters including shutters, generators etc. \$180,000	Coral Garden Drainage \$ 2.63 million
8	Mapping and assessment of public wellfields and reverse osmosis plant \$100,000	N-6 Pump Station #2 install automatic controls \$12,000	Lake Charlotte Drainage \$200,000
9	Prescribed burns in conservation land \$3,000	N-6 Pump Station #1 install automatic controls \$12,000	Poinciana Gardens Drainage \$3.28 million
10	Acquisition of primary recharge areas \$2 million	Replacement/upgrade of Moore Creek Canal Basin \$6.9 million	Hibiscus Drainage \$1.15 million

Color Code Key of Project Types

Flood Control Measures
Investment in Shelters & Critical Facilities
Land Acquisition
Planning and Assessment
Other

* Data was missing from LMS document, but provided by author verbally

Source: Unified Local Mitigation Strategy Documents prepared by Continental Shelf Associates

Structural approaches to hazard mitigation are more clearly evaluated by examining the ranked list of desired mitigation projects identified in the Unified Local Mitigation Strategy document. Figure 8 shows the top ten mitigation projects counties prioritized for implementation if funding is available. The list of 30 projects includes 16 drainage projects requiring upgraded infrastructure and 6 for hardening of critical emergency shelter facilities. There are also 4 mitigation projects that involve acquisition of land.

The bias toward brick and mortar projects can be partially attributed to the fact that the document is used to determine the eligibility of projects for FEMA post-disaster mitigation grants. According to DCA staff, there is a preference for prioritizing structural projects rather than planning and non-structural initiatives because it is easier to find matching funds for more visible public works. Planners involved in the process of formulating the Unified Local Mitigation Strategy attribute the different emphasis on engineering projects versus land use approaches to the people involved in the process.³³ In Martin County, the Public Works Department, rather than the county's Growth Management Department, was highly involved in the LMS process. Conversely, in St. Lucie County, the Community Development Department was the lead agency and provided most of the staff support for the LMS process.

EMERGENCY MANAGEMENT

The role of emergency preparedness and emergency management within the counties' hazard mitigation framework was assessed by analyzing the LCP in conjunction with the CEMPs. Both documents were reviewed because the CEMPs are procedural handbooks for dealing with the disaster incident and the immediate aftermath, and the LCP is intended to address longer-term policies that focus on sustainable mitigation practices. In addition, both plans include policy governing post-disaster recovery activities.



St. Lucie County staff members work at EOC during a hurricane.

Photo credit: St. Lucie Economic Development Board.

Because all the CEMPs are focused on emergency preparedness and evacuation and are used only during the disaster event period, the plans do not provide a gauge of how important emergency preparedness is to the overall mitigation strategy. The role of emergency preparedness and management strategies in the overall hazard mitigation strategy is thus evaluated in two ways. First, we examined the extent to which the LCP policies focus on measures aimed at loss reduction at the time of the event. Those in-

clude objectives that increased shelter capacity, evacuation access, coordination of first responders, and post-disaster task forces. Second, we analyzed the integration or deference of issues raised in CEMP issues to the policies and objectives created in the LCP.

The LCPs of all three counties make reference to addressing shelter needs and hardening of key facilities. St. Lucie County's plan leans more in that direction than the other counties. The key difference is in the tone and specific policy language. In the St. Lucie Coastal Element, objectives 7.2.1 and 7.2.3 specifically identify the Hurricane Evacuation Report as determining the allowable density. The plan's mitigation objectives include specific references to maximum evacuation clearance times that determine the densities that consider public safety. St. Lucie County's plan also includes specific policies to ensure expansion of the public shelter system. The LCP states that all public facilities must be designed with shelter considerations and existing facilities should be retrofitted where possible.

In contrast, the policy language related to emergency preparedness for the neighboring counties is either narrowly focused on specific projects, such as Martin County's strategy to remove trees prone to uprooting from rights-of-way and Indian River's policy to harden key public buildings, or in broad-sweeping policies calling for intergovernmental cooperation in planning for post-disaster reconstruction. In either case, issues of evacuation and shelter were not the central tenet of the approach in the LCPs.

RECONSTRUCTION POLICIES

State statutes require localities to address post-disaster reconstruction in their LCPs and prepare a Post-Disaster Reconstruction Plan, but the depth and specificity of the stated policy objectives vary. The challenge for policy makers is creating policy that is not only sufficiently flexible to address unknown or altered conditions of the built environment but also suitably specific to be useful. Because of that, the three LCPs' post-disaster planning policy is vague, and the plans defer actions to the recommendations of "Special Recovery Task Forces" that are established by the CEMP or the LCP in the event aftermath, or to policies outlined in the CEMP or LMS documents. Thus, to evaluate the reconstruction policy framework, the relationship of the LCP, the CEMP, and the LMS plans were examined along with the specific policies outlined in the text.

In St. Lucie and Martin counties, the recovery task forces are charged with a variety of post-disaster response activities, including damage assessment, debris removal, stabilization of structures, and limited permit approvals. They are also responsible for the identification of mitigation options, including purchases of key properties and infra-

structure retrofitting and have the ability to impose building moratoria. During the post-disaster phases, local government's long-term redevelopment activities are postponed. The task forces' post-disaster reports are reviewed prior to resumption of public works activities, and key suggestions or recommendations are forwarded to growth management officials for consideration in the LCP.

Indian River's County's Coastal Element identifies the LMS plan as the key document for organizing post-disaster recovery and is a good role model for comprehensive mitigation through coordinated land use, engineered, and emergency management techniques. The LCP's policy language includes a timeframe for creating the LMS and directives to integrate the mitigation goals and strategies into the LCPs. Indian River County's LMS was created by an active multi-departmental committee and includes explicit language to integrate the plan within a comprehensive planning framework.

Figure 9, which highlights key post-disaster recovery policies in the LCPs, shows that the counties address several common issues but differ with respect to the level of restrictiveness imposed by government. For example, all three LCPs borrow the National Flood Insurance Program's concept that requires buildings with damage in excess of 50% appraised value to be rebuilt to current construction standards. The common critique of the policy is that increasing property values continually raise the 50%-of-value ceiling, exempting all but the total-loss damaged properties from the upgraded construction standards. Martin County's regulation is stricter than the neighboring counties in that the 50% damage value is cumulative over 5 years. Thus, if a series of annual storms each produce damage of 20% of the value, after the third year, the entire structure would have to meet the new construction standard. That type of policy might be an important role model if South Florida has entered into a cycle of active hurricane seasons.

The post-Jeanne reconstruction experience has also demonstrated the difficulty in implementing that mitigation strategy. In Vero Beach, for example, beachfront commercial buildings experienced substantial damage, requiring the owners to meet the newer and higher construction standards and current land use regulations that lower the allowable density and have higher parking requirements. According to property owners, the cost of complying with the new standards does not make renovation a profitable option compared to demolition. As the Vero Beach LCP's Future Land Use Plan provides for commercial activities on the barrier island, the implementation of one policy will contradict the intention of another.

Figure 9

Post Disaster Recovery and Reconstruction Policy Embodied in Local Comprehensive Plans

	INDIAN RIVER	ST. LUCIE	MARTIN
Overall Goal or Policy Specific Policies and Objectives	Consistent with the requirement of FS Chpt. 163 and DCA Rule 9J the county shall have a Local Mitigation Strategy as an annex to the IRC CEMP. The LMS shall list and prioritize mitigation projects.	The County shall provide immediate response to post-hurricane situations through the implementation of post-disaster response and redevelopment plans as set forth in the Treasure Coast Hurricane Evacuation Plan.	The establishment of post-disaster procedures for immediate and long-term response to a hurricane or natural disaster, including clean up and redevelopment.
Establishment of Recovery Task Force	Perform initial damage assessment to prioritize recovery resources and assess the need for local state of emergency.	Establishment of a Recovery Task Force, which may consider a temporary moratorium on building until damage assessments are completed.	Establishment of a Post-Disaster Recovery Task Force, which must adhere to CEMP procedures
Responsibilities of Task Force	Maintain LMS and implement short and long-term recommendations.	Task force can review and issue emergency building permits, coordinate with other government entities for assistance, analyze and recommend reconstruction or relocation of public facilities, develop a redevelopment plan, make suggestions for LCP amendments. Recovery Taskforce shall pursue repairs to water, sewer and power facilities, debris removal, stabilization of structures, and minimal dwelling repairs. Long-term redevelopment activities shall be postponed until the Recovery Task Force has completed its task.	Immediate clean-up and repair actions to protect public health and safety shall receive first priority in emergency permitting decisions. There is also a requirement for an assessment by County Environmental Health Unit. Long-term redevelopment activities shall be postponed until the Recovery Task Force has completed its task. But development approvals will be streamlined for property owners that meet all conditions for rebuilding within the coastal area.
Damaged Buildings	Buildings east of DSSL with greater than 50% damage of assessed current market value shall be required to move upland of their location and when possible westward of the DSSL. These buildings will have to meet new CCCL regulations. Structures pre-dating the 1989 FIRM maps and located in a flood zone that sustain 50% damage will have to be elevated 6" above Basic Flood Elevation.	If buildings with excess of 50% damage are to be repaired, they must meet new standards included in the CCCL. Structures that suffer repeat damage to pilings and foundations shall be rebuilt landward of their current location or modified to delete the areas most prone to damage.	If buildings suffer cumulative damage in excess of 50% within 5 years they must meet new standards enacted since construction. Structures that suffer repeat damage to pilings and foundations shall be rebuilt landward of their current location or modified to delete the areas most prone to damage. Water dependent uses are exempt.

Figure 9

Post Disaster Recovery and Reconstruction Policy Embodied in Local Comprehensive Plans

	INDIAN RIVER	ST. LUCIE	MARTIN
Seawalls and Coastal Armoring		Repair or reconstruction of seawall shall be accompanied by beach fill	Repair or reconstruction of seawall will be permitted only if it meets policy 8.4.A3b and shall be accompanied by beach fill
Land Acquisitions Initiatives		The county shall assess the value of all structures in the CHHA and the utility of the land for public assess, and evaluate the potential for acquisition, relocation or other appropriate measure in line with fiscal constraints when post disaster opportunities arise.	The county has pursue acquisition of lands identified in Policy 8.4.a.3 to provide public access, protect natural resources or remove it from development.
Special Barrier Island Regulations			Limit development both before and after a disaster on Hutchinson Island by enforcing the following Hutchinson Island restrictions: any approved development order on BI must meet the following conditions or be null and void: 1) 1/3 or less of improvements committed have not been completed, 2) no active construction for 6 months 3) 50% or more of construction sustained damage. In this case a new petition for development approval must be submitted to the Task Force.
Plan Integration		Taskforce shall review all inter-agency hazard mitigation reports and make Comp Plan recommendations.	The county should coordinate with TCRPC during updates of hurricane technical report for inclusion in LMS

Source: Local Comprehensive Plans of Indian River 2001, St. Lucie 2004 and Martin County 2002.

In November 2005, the Vero Beach Planning and Zoning Board recommended that the city council pass an ordinance that would create an exemption from the land use regulations intended to increase resiliency when hurricane damage creates the opportunity for mitigation. The ordinance would permit property owners who experience more than 50% damage within the commercial C-1A and C-1B zones to rebuild to pre-existing standards, if the construction begins within a year of the damage. In effect, the policy annihilates the intention of reducing asset exposure and strengthening the built envi-

ronment when post-disaster opportunities arise, and supports the notion of entitling owners to the rights they previously held. The dilemma illustrates the complexity of deciding how to fairly allocate the costs associated with raising resiliency.³⁴

Throughout the Treasure Coast, coastal properties with repetitive damage to pilings and foundations are typically required to be relocated landward of their current location or modified to eliminate the vulnerable structure. However the threshold for applying that policy varies. In Martin and St. Lucie, the policy applies to any structure that suffers repeated damage. In Indian River County, it only applies to buildings eastward of their Dune Stabilization Setback Line (DSSL), which is the state's "old" CCCL. The Indian River caveat addresses the most vulnerable and older seaward structures, but as erosion and sea-level rise inch the water's edge westward, the policy's narrow focus will hamper the ability to require buildings west of the DSSL to move landward.

Acknowledging that coastal storms alter the barrier islands more than they do mainland geography, Martin County's post-disaster reconstruction policy for barrier island property seeks to hedge against emergent vulnerability. The Barrier Island Ordinance permits the county to void approved development permits after a hurricane if the project is less than one-third complete or inactive for 6 months, or if more than 50% of the *construction* has been damaged. That gives the government a chance to reconsider construction permits in light of changes created by the storm event. The efficacy of the policy has not been determined, because no permits were pulled after last year's storms.

The key question raised is how do recovery and reconstruction activities support or thwart long-term mitigation objectives that lead to more sustainable resiliency. Our research indicates that at the community level, LCP planning policy is designed to identify mitigation opportunities, create an opportunity for public sector action, and restrict imprudent behavior of private property owners. Recovery and aid programs have been developed to help local governments address some community mitigation objectives. FEMA mitigation grants such as the 406 Program commit about 7.5% of the recovery cost to mitigation. In addition, DCA has several programs for localities to tap, but the funding is insufficient to address all the needs identified, and localities need to be skilled at matching the project request to funding eligibility criteria. The primary obstacle to comprehensive post-disaster mitigation is that although the cumulative damage incurred may be large, it is scattered intermittently over privately-owned parcels, making it difficult to assemble a large publicly supported intervention effort.³⁵

At the level of the individual property owner, insurance reimbursement procedures, softened enforcement of regulations, and inadvertent policy loopholes create situations where the choice for optimal resiliency is passed over. As an example, state coastal en-

engineers cite several post-Jeanne cases where property owners obtained a coastal armor permit to protect their vulnerable oceanfront homes, then shortly afterward bulldozed the old house to sell the parcel for new construction. Because oceanfront parcels with protective seawalls are scarce and expensive, they are developed with ever larger homes, increasing the asset vulnerability.

SUMMARY

Our analysis of the similarities and differences in the LCPs, the CEMP, and the LMS suggest that, overall, Martin and Indian River counties' hazard mitigation policies lean more heavily in the direction of land use approaches that regulate development density, while St. Lucie County's strategy is oriented toward emergency preparedness that emphasizes evacuation, along with ongoing public land acquisition. All three counties have placed restrictions on public investment and infrastructure within the CHHA, although the differences in policy language support the notion that commitment to limiting development and investment varies.

Differences among the counties' use of engineered hardening for mitigation are subtle and difficult to discern solely from the LCPs. Sensitivity to the ecological fragility of the coast has moved the three counties away from engineered solutions such as coastal armoring, using beach and dune restoration for coastal mitigation. At best, the importance of those projects to hazard mitigation objectives can be inferred from the policy language that mandates funding and specifies implementation deadlines, or the degree to which the infrastructure element of the LCP prioritizes projects specifically related to hazard reduction.

The policies that most effectively move the localities toward asset reduction and construction of more resilient buildings are found in the post-disaster reconstruction policies of the LCPs. That effectively defers implementation of controversial policies--policies that are most likely to impact individual property rights by restricting development or increasing construction costs to the period after storm impact. At issue here is whether the degree of storm damage provides an opportunity for implementation of those objectives.

EXPOSURE RISK ANALYSIS

The hazard mitigation paradigm assumes that greater asset exposure, in terms of both the number of assets and their value, increases vulnerability due to the replacement costs associated with storm losses.³⁶ Insurance mitigates some of that risk, but deductibles, exclusions, and the tendency to under-insure usually net some loss. There are also clean-up costs and the opportunity costs to consider. Land without improvements, particularly undisturbed land preserved for storm buffer purposes, reduces vulnerability. Conservation lands are considered the ideal form of long-term mitigation as few assets are lost and the land is able to naturally recover from the storm impact. In between, there is a range of adaptive mitigation measures designed to reduce loss through limiting asset development, positioning assets properly on the landscape, and increasing their engineered and design standards to withstand coastal storm impacts.

METHODOLOGY

Community Vulnerability Analysis is the process of quantifying risk based on the probability of an event of a particular magnitude occurring in relation to the inventory of the assets exposed. The focus of this research was on the asset exposure aspect, as event probability is not within our expertise. The exposure analysis was based on a parcel level analysis of development characteristics in the context of geography. For the barrier island areas under study, we created a geo-referenced database composed of a property parcel layer that was obtained from the local planning agency and the cadastral files obtained from the tax assessor's office. Those data provide information about the size of the parcel, the assessed value, sales and sales date, ownership, age, and use of the parcel improvements. In addition, we obtained aerial photographs documenting the site.

We determined the development status of each parcel to identify which parcels have structural improvements and those that remain undeveloped. The undeveloped land was then grouped according to public or private ownership status. Undeveloped lands held by local, county, state, or federal government agencies were assumed to be protected for conservation, thereby not contributing to vulnerability and enhancing resiliency. Undeveloped lands in private hands were assumed to represent potential future development. Forthcoming development increases vulnerability, although that development should meet more stringent resiliency criteria than pre-existing construction. The vulnerability of pre-existing assets must be evaluated with respect to amount, value, and resiliency characteristics.³⁷ The challenge of assessing the exposure level of

built environment assets is that assets exhibit different resiliency and value characteristics. The analysis was framed in the following manner:

- **Asset Resiliency:** Resiliency of physical assets can be evaluated by the location and engineering characteristics of the structure, which make them stronger or enhance their viability over time. The location of the building and the year built serve as proxies for resiliency, since, over time, regulatory policy aimed at mitigation raised construction standards and tended to promote retreat from seaward locations both horizontally and vertically.

Specifically we examined the assets' year built and location relative to the year of regulation adoption and the geographic delineations outlined in the following regulatory policies:

- *The Flood Insurance Rate Maps were adopted in 1978-81. Construction in the flood zone after that date must meet elevation requirements and is less prone to flooding. We aggregated parcels by where they fall in or out of the 100-year flood zone but did not differentiate between zones subject to wave action and simply flooding.*
- *The comprehensive plans were initially adopted in 1982 but revamped subsequent to the Growth Management legislation in 1990. The state mandate to consider hazard events in coastal planning suggests that development prior to adoption of the LCP may not conform to current mitigation standards and the development objectives targeted for the Coastal High Hazard Area. Thus, older development may include land use or building densities that increase vulnerability.*
- *The new Coastal Construction Control Line was adopted in 1985 (Martin), 1987 (Indian River), and 1988 (St. Lucie). Buildings constructed eastward of the CCCL areas after its adoption have been set back of the frontal dune and the 30-year erosion projection in such a way as to not harm the integrity of the dune system. Older construction was not governed by similar environmentally-*

oriented setbacks, but permitted up to the 1981 CCCL, which is significantly seaward of the current regulations.

- *The Florida Building Code was adopted in 2001.* Structures constructed thereafter must meet hurricane wind resistance of 120 or 140 miles per hour or greater. It was updated in 2004, and includes additional regulations for manufactured housing.
- **Asset Value:** The assessed taxable value of the parcel improvements and land was used as a measure of asset monetary value. That is an imperfect measure but was used because it was available at the parcel level. Assessed tax value does not reflect current market value, especially for homesteaded owners, nor does it measure the value of contents. Moreover, using a monetary value does not quantify cultural, aesthetic, and environmental values of property. As those should be included in a full-cost accounting analysis, they were addressed in other aspects of this report.

The value of assets is also a function of the number of properties. The number of properties corresponds to the number of households that are impacted by losses and the losses associated with personal effects and property contents.

Data Limitations

The greatest limitation to the data set is the lack of complete data on the size of the building improvement in square feet and a digitized footprint of the building on the parcel. The inability to obtain consistent information for the building size parameter forced us to quantify the assets at the tax parcel level. Thus, in quantifying the amount of development, for example, the entire parcel is considered developed if the assessed value of building improvements is greater than zero. That does not mean that all the land on the parcel has been built upon, but rather that there is a building on the site. Likewise, parcels and all their acreage were sorted into flood zone categories if the center of the parcel was located within a flood zone. While the building may be situated on higher ground, the assumption was made that, with a large number of small lots, most dwellings would have to be situated toward the center of the site and at least part of the dwelling might be in a flood area. Finally, it is important to point out that the tax asses-

sor database obtained for Martin County does not include structures constructed after 2002. While most of the barrier island was built-out at that point, the lack of current data skews the findings slightly.

BUILT ENVIRONMENT VULNERABILITY

Total Asset Exposure

The Treasure Coast barrier islands contain 32,946 acres of land and 25,227 tax parcels. The assessed value of the real estate is approximately \$32, billion, representing 40% of all the assessed value in the three counties. Development history and zoning create a textured built environment with parcels of diverse size and location characteristics, as well as variable assessed taxable values. Martin's barrier islands have the greatest acreage, approximately 13,300 acres, and its 8,400 parcels have the highest assessed tax value, approximately \$21.5 billion. In contrast, neighboring St. Lucie's barrier islands contain only 8,300 acres, and its 6,315 parcels have an assessed value of \$3.15 billion. Indian River County's barrier island contains 11,111 acres and 10,512 parcels, with an assessed value of approximately \$7.375 billion.³⁸ Click on [Appendix](#) hyperlink to view detailed tables of the analysis.)

Approximately two-thirds of the barrier island parcels contain development in the form of residential or commercial units, but aggregated those parcels represent only one-third of the land, or 11,363 acres. Approximately one-third of the land is undeveloped, with the majority held for conservation. The lack of building footprint data does not allow one to estimate the amount of land coverage from buildings or parking. Comparing the three counties, one finds that Indian River has the greatest concentration of developed acreage, and St. Lucie the least. However, greater levels of development do not correspond with a greater taxable value. Indian River's older barrier island development, with its smaller lot size and lower real estate values, generates only one-third of the taxable value of the barrier island property in Martin County, despite the presence of affluent areas such as John's Island. St. Lucie County's barrier island segment has the least number of taxable parcels and the lowest values.

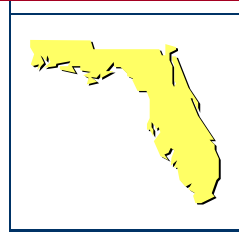
The disparity among the neighboring counties in taxable assessed value is startling, explained primarily by the difference in the average sales price. On the Martin County barrier islands, the average sales price for properties sold through 2002 was \$1,077,625, compared to \$716,725 in Indian River for properties sold through 2004, and \$260,000 in St. Lucie County. The variability might also be influenced by the number of properties

that receive homestead exemptions and the sale turn-over rate; however, a review of the data suggests that those factors are not skewing the data significantly.

Undeveloped Lands

Figures 10a (Indian River County), 10b (St. Lucie County), and 10c (Martin County) show that there are 7,738 parcels with no taxable improvements, representing nearly 20,350 acres ([click on icon to view figures](#)). Nearly half the undeveloped lands are owned by private entities, and half are controlled by government agencies and non-profit land trusts, including Florida Fish and Wildlife, the St. Johns and South Florida water management districts, the Trust for Public Land, the counties' and cities' Parks and Recreation departments, and the federal government. Much of the land is devoted to open-space conservation rather than active recreational use. There are 38 public beach parks for public recreation and approximately 14 miles of public beach.

Figures 10 a-c



Martin County contains the largest amount of undeveloped lands, approximately 9,000 acres, two-thirds of which are public lands. Those findings were compared to the Future Land Use Map that designates lands slated for conservation or recreation and lands available for development. Most of the undeveloped barrier island land of environmental importance has been acquired or is slated for acquisition. In Martin County, there are only two parcels on the barrier island sought for public acquisition, both on the lagoon side.

Approximately 1,140 parcels containing nearly 3,000 acres are in private hands, but that includes non-developable wetlands, deeded submerged land, land used for golf courses, and some privately held conservation land, such as the 81-acre Blowing Rock Nature Preserve. We identified fewer than 200 tax parcels in private ownership that could represent potential development. Current zoning of one unit per acre suggests additional density would be very limited.

St. Lucie County has nearly 6,400 acres of land in parcels with no developed improvements; approximately one-half is held publicly, with the rest in private ownership. However, if the 1,140 acres of conservation land owned by Florida Power and Light are included in the public land, then St. Lucie's portion of open public land is similar to that of Martin County. The county's comprehensive plan targets 142 acres on North Hutchinson and 421 acres on South Hutchinson for public acquisition. Based on the tax parcel database, there are approximately 1,500 un-built tax parcels. According to planning

officials, most of those parcels are not developable, as they include subdivisions platted in barrier island wetlands. The pipeline of future development is limited to less than 10 sites for condominiums and a few single-family subdivisions. There are numerous scattered undeveloped parcels, but they lack reasonable access.

Indian River County has approximately 4,900 acres of land in parcels with no development, nearly two-thirds of which are publicly owned. The remaining undeveloped acreage is divided among 1,700 small parcels. The majority of those parcels will remain undeveloped as they are incorporated within existing development as open space. Nonetheless, there appears to be some development opportunity, especially on the northern end of the island.

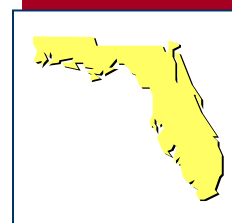
Developed Parcels

The parcels with improvements were then examined based on location and age to assess characteristics of vulnerability. Three sets of maps depicting the parcel analysis of asset resiliency can be viewed by clicking on the map 11a-c, 12a-c, and 13a-c icons. The corresponding detailed tables are included in the Appendix hyperlinks.

New Florida Building Code

Based on the inventory of parcels with improvements, we examined the number and value of exposed assets that were constructed before and after the adoption of the 2001 Florida Building Code. At present, only 6% of the structures on the barrier island were constructed after the more rigorous standards were adopted. That means that 16,200 parcels with an assessed value of \$24.15 billion, approximately 97% of the assessed taxable value, may not meet the new requirements (*click on icon to view maps 11a-c or on [Appendix](#) for the data table*).

Maps 11 a-c



The distribution of structures not meeting today's more protective building standards corresponds to the barrier island development pattern. Indian River and Martin counties' barrier island communities, largely built out before 2000, have the greatest percentage of pre-new building code construction.³⁹ However, because approximately half the development occurred after the 1985 passage of the Coastal Building Zone Act and many of the homes are luxury estates and year-round homes for affluent residents, those homes might have been constructed to standards exceeding the minimum regulated standard of the time.

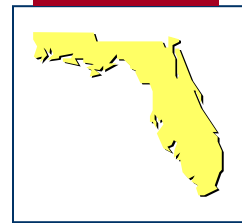
St. Lucie County also has a significant percentage of older buildings and three mobile home or recreational vehicle parks. In contrast to Martin County's barrier island devel-

opment, those homes were constructed for moderate-income owners who moved to the Treasure Coast in the 1980s, prior to the steep rise in coastal property values that encouraged luxury development. Older beach communities, originally vacation bungalows, are scattered throughout the barrier islands and are prone to significant damage because they were not over-engineered. Indian River's barrier island construction stock faces moderate vulnerability. There are older beach communities, such as Vero Beach Estates and Harbor Island Circle, which were constructed in the late 1970s, but they also have the largest percentage of post-2002 construction. Moreover, like Martin, much of the older construction was designed to meet the 1985 Coastal Building Zone standard.

Coastal Construction Control Line Zone

The Coastal Construction Control Line (CCCL) is primarily intended to regulate coastal development for environmental protection. The setback and construction requirements designed to protect the integrity of the dunes also foster disaster resiliency by siting construction behind the dune line. The CCCL affects 17% of the barrier island parcels, but only 10% of those with built structures. Because those properties are closer to or on the beach, they include the most expensive real estate and represent approximately \$12 billion, or one-third of the assessed tax value (*click on icon to view maps 12a-c or on [Appendix](#) for data table*).

Maps 12 a-c



The adoption of the CCCL in the mid- to late 1980s means that approximately one-third of the barrier island properties eastward of the CCCL were constructed after the setback regulations were in place. That suggests that many of the properties most prone to storm surge may not be set back behind the 30-year erosion line. Additional analysis outside the scope of this study would be necessary to determine their number and location. The security of the setback can be ephemeral without beach restoration efforts. Considering that older properties are half way through the 30-year erosion projection and hurricanes have slightly accelerated the erosion conditions in the short term, it might be necessary to re-evaluate the resiliency levels fostered by that regulation. In the aftermath of Hurricane Dennis in the summer of 2005, DEP also acknowledged the shortcomings of its coastal setback policies, including the facility by which owners can be granted variances. They have recommended a re-evaluation and re-establishment of the coastal setback line, although it may take months, if not years, to collect and study the shoreline data.⁴⁰

Examining the data by county, however, one can note that Martin County, which represents the greatest asset value exposure, has nearly 10 times more pre-existing construc-

tion within the Coastal Construction Control Line zone. There are nearly 2,800 parcels eastward of the CCCL, and 1,025 have improvements constructed before 1985. However if those properties were constructed after the adoption of the 1981 county plan, they were required to have a 50- foot setback from the mean high water line.

The vulnerability posed insufficient setback is concentrated in the center portion of the barrier island, part of unincorporated Martin County. The northern portion of the island is largely conservation land, and the portion within incorporated Jupiter Island contains mostly post-1985 housing. Martin County's restrictive barrier island development ordinance will preclude additional risk-prone development east of A1A from occurring.

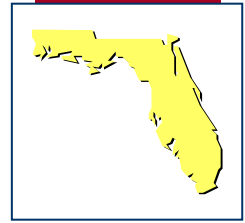
St. Lucie County, which includes several miles of public beach, has the fewest pre-CCCL structures and the least number of undeveloped parcels in private ownership. Those conditions suggest less vulnerability to coastal erosion and storm surge; however, because some of the pre-CCCL construction is older, beachfront multi-family apartment buildings, the existing development in the unincorporated county is highly vulnerable. Some new barrier island development is occurring in Fort Pierce. Those new structures are more resilient than the ones they replace, and the new construction may well create additional pressure for redevelopment of older structures in the surrounding area.

Indian River County has 988 parcels eastward of the CCCL, and 70% have structures. As half of the barrier island construction took place after the adoption of the CCCL in 1987 and much of the early construction was on the upland portion of urbanized Vero Beach, there are only 106 tax parcels with pre-CCCL construction in that zone. The pre-existing structures dot the barrier island, but clusters are found in Vero Beach and the areas to the south. Indian River's barrier islands offer the most opportunities for new development. Some of the undeveloped parcels are located among existing developments, while others will be tear-down lots. To encourage hazard resiliency, those projects should be located landward on the parcel despite regulations that permit a constant line of sight.

Flood Risks

Approximately 80% of the land, or 26,000 acres, and 60% of the barrier island tax parcels are located in a flood zone. The majority of those parcels are not east of A1A but rather are located on the lower-lying Intracoastal side of the barrier islands. Fortunately, 75% of the land in a flood zone--nearly 20,000 acres--is not developed, and most is owned by public entities for conservation and environmental management. Other large flood-prone parcels in private ownership have been used for golf fairways and buffer land ([click on icon to view maps 13a-c or on Appendix for data table](#)).

Maps 13 a-c



The primary flood vulnerability comes from the 9,468 parcels carved out of 25% of the flood-prone land. Those properties represent \$8.7 billion in assessed value, or nearly one-third of the total assessed value. To depict that risk, we identified buildings constructed before and after adoption of the Flood Insurance Rate Maps, known as pre- and post- FIRM, to distinguish among structures that meet the NFIP construction requirements and those that do not. Because the FIRMs were adopted nearly 25 years ago, between 60% and 80% of the construction in flood zone areas meet the construction standards established by NFIP. Moreover, the Coastal Building Zone Act passed in 1985 assured that all barrier island construction, irrespective of flood zone location, meets the NFIP elevation requirements.

There are, however, approximately 700 structures in Martin County and 809 in Indian River County that pre-date those regulations. In Martin County, we identified a cluster of homes in the area of 1100-1350 MacArthur Boulevard, north of Sailfish Point; a cluster on nearby Joe's Point Road; and another cluster near Breakaway Road, by the north causeway. The Indian River properties are largely clustered in the Indian River Shores neighborhoods of the Island Club and parts of John's Island Plantation.

The critiques of the NFIP are extensively documented in the academic literature, and federal policies toward hazard mitigation are often cited as the root cause for increased asset exposure. For the purposes of this study, only the NFIP issues that were raised by local government staff and insurance regulators in reference to Florida's barrier island development are presented.

The most common issue raised is that structures that pre-dated the FIRMs were exempt from the structural requirements outlined by NFIP for new construction. Pre-FIRM properties, as those are commonly referred to, must only meet the new standards if they require renovation or rebuilding that represents greater than 50% of the value of the existing structure.

Because the policy identifies a 50% value threshold, it has been suggested that property owners file building permits with “low-balled” construction estimates, or worse, are discouraged from using more expensive disaster resilient construction techniques in order not to exceed the 50% value figure, which would trigger more extensive retrofitting.

Local officials and insurance regulators note that porches, small additions, and garages are regularly added to those structures, increasing the insured assets at risk without a commensurate increase in premium or additional mitigation of structural inadequacies. The manipulation of the permit values also compromises the municipal property tax revenue, as local governments are unable to capture the tax revenue associated with the increased property value.

In addition, jurisdictions vary in how they interpret the 50% value threshold. Some building departments use tax assessed value; others use market value; yet others use appraised value. That obfuscation changes the number and size of projects that are exempt from compliance during remodeling or rebuilding. Moreover, all three county comprehensive plans use similar “50% of value” language to determine if buildings damaged during storm events must be relocated landward or can rebuild on the existing footprint. Preliminary research on those issues suggests that local building departments and tax appraisers are inclined to permit homeowners maximum latitude in renovation and rebuilding in order not to reach the 50% threshold. Local officials are keenly aware that the cost of a complete structural retrofit unduly burdens homeowners and would cause some long-time residents to sell.⁴¹

Finally, NFIP construction guidelines are focused solely on flood hazards and do not address the issue of beach erosion. One might consider them vertical, rather than horizontal, design regulations. Substantial beach erosion can eventually expose the foundations of beachfront buildings, resulting in structural compromise or collapse. The notion of creating erosion hazard maps and accounting for that hazard has been proposed by experts examining federal hazard mitigation policies. To date, however, funding has not been allocated to develop the prerequisite erosion maps that would be necessary to implement such a policy reform.

HURRICANE IMPACTS AND RECOVERY ASSISTANCE

In the days and months after Hurricanes Frances and Jeanne, numerous estimates of property damage were generated; the most quoted figure for the Treasure Coast region was approximately \$14 billion. Developing a dollar value of the impacts is difficult as the cost is a function of how the impacts are defined and calculated. Within the scope of this research project, we have attempted to organize property damage data from several sources, each of which quantifies a particular aspect of the impact.

Detailed aerial surveys conducted by the Bureau of Beaches and Coastal Systems documented the extent of beach erosion and the number of major coastal structures that were damaged, but not the value of the structures. Insurance data provide a sense of the value of insured property damage, but information available from the Florida Department of Insurance Regulation,⁴² which documents the number of claims received, the total number of losses, and the value of the claims paid, is only available at the county level. Claims for damage obviously do not represent the entire picture. Many individuals are under-insured or fail to file claims. In addition, the figures do not represent the value of deductibles. To supplement that information, we obtained the number and value of both Individual Assistance Grants to citizens and Public Assistance Grants to localities provided by FEMA for Hurricanes Frances and Jeanne. The latter was available in a geo-referenced format by project type and provided insight into the damage to public facilities and infrastructure. Together, the data illustrate the extent of damage and its geographical distribution.



Properties with insufficient setbacks from the ocean are prone to extensive storm surge damage.

DAMAGE SURVEY OF MAJOR COASTAL STRUCTURES

After Hurricanes Frances and Jeanne, the Bureau of Beaches and Coastal Systems conducted a detailed survey of the damage to beaches and major structures in the Coastal Construction Zone.⁴³ As the Coastal Construction Zone only encompasses an area from the mean high water line to 1,500 feet west of the CCCL, it provides a less than complete picture of the storm impacts. Moreover, the survey excludes minor damage to structures; damage to coastal and shore protection structures such as seawalls, revetments, groins, and jetties; and damage to minor structures such as patios, decks, parking lots, and walkways. Figure 14 summarizes the findings.

Figure 14

**Substantial Damages to Major Structures Attributed to
Hurricanes Frances and Jeanne within the Coastal Construction Zone**

	MARTIN COUNTY	ST. LUCIE COUNTY	INDIAN RIVER COUNTY
HURRICANE FRANCES			
Single-Family Dwellings	4	50	54
Multi-Family Dwellings	16	21	23
Other Major Structures	0	29	18
<i>Hurricane Frances Total</i>	20	100	95
HURRICANE JEANNE			
Single-Family Dwellings	4	4	110
Multi-Family Dwellings	5	22	59
Other Major Structures	2	14	24
<i>Hurricane Jeanne Total</i>	11	40	193
2004 September Storms Total	31	140	288

Source: Florida Department of Environmental Protection, Bureau of Beaches and Coastal Systems, Oct. 2004.

Data from the Bureau of Beaches and Coastal Systems indicate that the greatest impact was felt in the counties that experienced the right front quadrant of the hurricanes. St. Lucie and Indian River counties' coastal area sustained 80% more damaged structures than Martin County. Hurricane Frances had a relatively similar impact on St. Lucie's and Indian River's barrier island buildings, but Hurricane Jeanne's impact was more hard felt in Indian River County. The level of damage from Jeanne was partially attributable to structures compromised by the previous storm. Multi-family buildings fared worse than single family dwellings relative to their proportion of inventory. Damage to multi-family structures results in greater displacement of residents, as structural damage can require condemnation and reconstruction of many households' units.

INSURED PROPERTY LOSSES

In the storms' aftermath, Treasure Coast residents filed nearly 200,000 insurance claims for property damage, approximately 9,600 of which were for complete losses. Figure 15 shows that nearly two-thirds of the claims were made after Hurricane Frances. A possible explanation for fewer Jeanne-related claims may be that adjusters and companies appended additional damage to open claims made on Frances. Nearly half of all the claims were from St. Lucie County property owners, who filed 57,835 claims after Hurricane Frances and 31,578 after Hurricane Jeanne. In contrast, Indian River County and

Martin County property owners filed approximately half the number of claims after Frances, but a comparable number of claims after Jeanne.

Hurricane Jeanne's impact on Indian River County is also notable in the number of 'total loss' claims. After Hurricane Frances, St. Lucie County residents filed nearly 4,000 total loss claims, more than twice the number for the other counties. However, after Hurricane Jeanne, Indian River had the greatest number of total loss claims. Because the eyes of both storms came ashore in Martin County, much of the county was not subjected to the harshest winds, and thus the county had the fewest number of claims.

Figure 15

Hurricane Frances and Jeanne Insurance Data for Treasure Coast Counties

County	# of Claims			# of Total Loss			Value of Claim Payments		
	Frances	Jeanne	Total	Frances	Jeanne	Total	Frances	Jeanne	Total
Indian River	31,986	29,271	61,257	1,707	1,069	2,776	\$708,675,056	\$367,136,834	\$1,075,811,890
St. Lucie	57,835	31,578	89,413	4,014	928	4,942	\$1,050,701,929	\$222,937,462	\$1,273,639,391
Martin	24,306	20,648	44,954	1,258	612	1,870	\$386,717,377	\$183,597,461	\$570,314,838
Totals	114,127	81,497	195,624	6,979	2,609	9,588	\$2,146,094,362	\$773,671,757	\$2,919,766,119

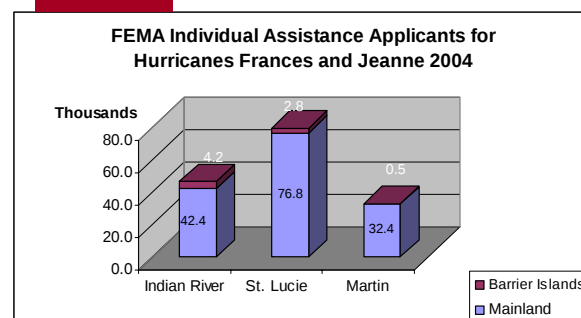
Source: Florida Department of Insurance Regulation, 2006.

In total, Hurricanes Frances and Jeanne caused \$2.9 billion in insured property losses throughout the Treasure Coast, the lion's share of which is attributed to the first storm. Property owners in St. Lucie and Indian River counties each claimed over \$1 billion in losses, while Martin County property owners' claims totaled less than half those of other counties. The average insurance claim was approximately \$18,800 for Hurricane Frances, but \$9,500 for Hurricane Jeanne. There was also a significant difference in the average claim amounts amongst counties. For both storms, the average insurance claim in Indian River County was \$3,000 more than the average for the Treasure Coast. Conversely, insurance claims in Martin County were lower than the average despite the tendency for higher property values.

FEMA INDIVIDUAL AND PUBLIC ASSISTANCE GRANTS

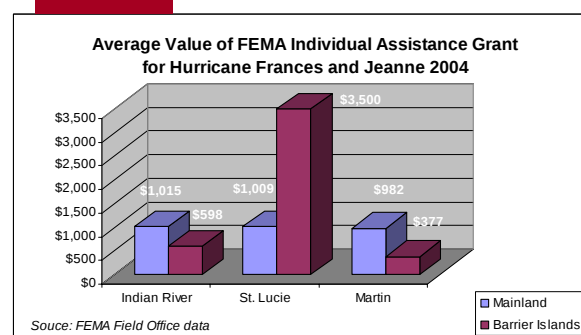
FEMA received 158,945 eligible applications for Individual Assistance Grants from residents of the three-county area; 5%, or 7,429, were from residents of the barrier islands. That is indicative of the relative resiliency of the barrier island communities, as they represent 9% of the regional population. The lower than proportional share of applications is likely correlated with the higher than average income of residents and related levels of insurance coverage that limit eligibility for some types of FEMA individual disaster assistance. Figure 16 shows that the largest number of claims on the barrier islands was in the Indian River portion of the barrier islands that had nearly 4,200 claims, compared to Martin County which had 450 claims. St. Lucie County, which had approximately the same number of claims as the neighboring counties combined, had only 2,809 claims on the barrier island. The number of claims corresponds to the spatial distribution of the population.

Figure 16



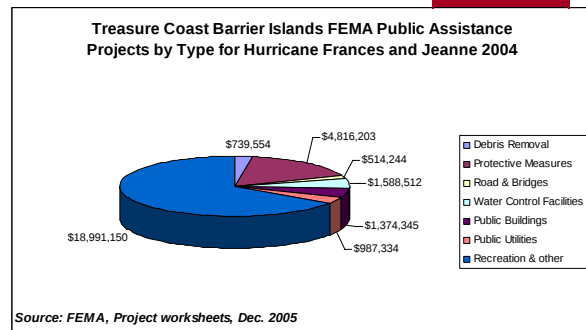
FEMA provided \$164.76 million in Individual Assistance Grants throughout the region; approximately 8% of the total, or \$12.5 million, was distributed to barrier island residents. If one looks at the average claim amount for barrier island residents, it appears that they were 40% greater than those for residents of the mainland (\$1,681 compared to \$1,005), but that camouflages the range of values, as seen in Figure 17. Although St. Lucie barrier island residents filed only 3% of their county's Individual Assistance claims, they received 11% of the money provided to county residents. The average claim amount was \$3,500 relative to the mainland resident grants of \$1,010. The proportions are reversed in Martin and Indian River counties, where individual assistance grants received by barrier island claimants were smaller than those of their mainland counterparts.

Figure 17



Infrastructure and Public Facilities

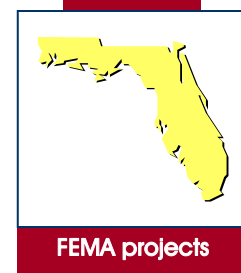
Adoption of comprehensive plans, with their restrictions on investment in public facilities and infrastructure within the Coastal High Hazard Area, has gradually curtailed the number and type of public assets on the barrier islands. The infrastructure that is in place has typically been constructed to meet the engineering standards for a 100-year storm. Nonetheless, the extreme conditions posed by back-to-back hurricanes illustrate that even good engineering cannot supersede nature's destructive power. A review of FEMA public assistance grants⁴⁴ given to local government agencies reveals that the barrier islands sustained significant damage and received approximately \$37.0 million in federal recovery funds. Of that, approximately \$4.8 million was for emergency protective projects to stabilize structures in the first 72 hours after the storm, and nearly \$800,000 was for debris removal. The remaining \$31.5 million was for long-term recovery projects to repair or rebuild public infrastructure and facilities, as noted in Figure 18.



Recreational facilities in all three counties, particularly public beaches, beach crosswalks, life guard stations, beach parking, and comfort facilities experienced widespread damage and accounted for nearly \$19.0 million of the recovery aid funds. It cost over \$400,000 to clear sand and debris from 18 beach parking lots. Numerous public buildings were also damaged. The Historic House of Refuge received \$340,000 for repairs, the Elliott Museum received \$145,000, and Fire Station # 2 was granted \$120,000. In addition there were 63 other public building work projects totaling \$1.374 million. FEMA also provided \$2 million for repair of public utilities, including electrical sub-stations, water treatment plants, and water mains, and \$500,000 to repair roads and bridges. That includes rebuilding the Little Mud Creek Bridge, and .5 miles of A1A along Sewell's Point. [Click on Appendix to view data table.](#)

The map on Figure 19 shows that the damage to public facilities on the barrier islands was concentrated in Indian River and St. Lucie counties, which had 114 and 67 work projects worth approximately \$4.8 and \$5.0 million, respectively. However, Martin County received approximately \$19.1 million for 42 projects, four times the amount of FEMA money received by each of the other counties for work on the

Figure 19



barrier islands. In considering the entire region, however, St. Lucie County, with 1,102 work projects, received a total of \$93.4 million, almost twice the amount of the other counties.

An examination of the breakdown of barrier island projects by type reveals that at least \$12.3 million of the money spent in Martin County was used for restoration of 8.6 miles of public beaches and dunes, and an additional \$1.24 million was used for emergency sand replacement. Damage to public facilities and infrastructure was limited. Indian River County received \$1.7 million for emergency dune restoration but no funds for non-emergency beach restoration. The majority of the FEMA public assistance grants were for numerous small projects; the largest grant was \$745,000 to repair a hole in the wall of the water treatment facility. St. Lucie County received little assistance for dune and beach restoration, but \$628,000 was used for rebuilding beach boardwalks in South Surfside, and Bergalis Beach Parks. In addition, \$821,500 was provided to repair damage to three critical water mains that run under the Lagoon.

DISCUSSION

Over the past 25 years, all three counties have recognized the need to preserve the fragile barrier island ecosystem and created policies that promote land conservation and public parks and land development regulations aimed at managing growth for environmental protection. Those strategies have also reduced community vulnerability to coastal storms, as conservation land permits the ecosystem to absorb the storm impact, and conservation combined with prudent zoning has limited the total number and value of public and private assets exposed. It is difficult to conclude that a particular development typology resulting from land regulations translates directly into greater or lesser vulnerability in the built environment, as the development pattern codified in zoning creates a unique built environment based on numerous local factors, including the real estate history and geographic characteristics. Moreover, vulnerability must be evaluated based on more than construction characteristics, but on social and economic factors as well. The differences among the barrier island land use policies of the three counties and four municipalities result in varying amounts and types of vulnerability in the built, social, and economic components of the community.

Land Use Policy: In Indian River and Martin counties, as well as some of the included municipalities, the current zoning and development regulations restrict new development primarily to low-density residential uses and water-related recreation. The limited amount of commercial and institutional zoning effectively curtails the number and value of economic assets at risk. That land use strategy, along with controls on public facilities and infrastructure investment within the Coastal High Hazard Area, reduces public sector asset exposure and places the majority of the property loss risk on private homeowners who offset the risk with insurance coverage.

The limited development opportunity also drives up land values, encouraging the development of high-end construction that meets or often exceeds the engineering standards of the state building code. Such homes are purchased by affluent homeowners who are typically better able to recover from catastrophic events because they have greater economic and social resources. Moreover, the limited number of dwellings reduces the number of people who must be evacuated, most of whom do not seek public shelters.

On the other hand, that development pattern creates vulnerability of a different nature. In Martin County, for example, a limited number of assets can still be correlated to greater asset value, increasing the exposure risk. The high value of the homes raises several concerns about the viability of insurance options as a primary mitigation tool. Homeowners typically carry replacement value coverage for wind damage through either private companies' property and casualty and surface-line coverage, or the state's Citizen's Insurance Company. They are also eligible for up to \$250,000 of flood insurance through NFIP. The high value of the property assets on the barrier islands points to several challenging issues. First, private insurance companies typically decline to cover those high risk properties, forcing owners into the state's Citizen's Insurance High Risk Account. Citizen's increased liability undermines its financial position and translates into higher premiums for its policyholders.⁴⁵ Recently, a governor's taskforce charged with reviewing Citizen's long-term outlook recommended limiting coverage in the High Risk Account to assets under \$1 million. That would force many barrier island homeowners to turn to the private market surface-line policies. Surface-line policies carry hefty premiums, and there is concern about the capacity of that market segment. In addition, since NFIP is capped at \$250,000, the amount of insurance might be insufficient to cover severe storm-surge and flood damage to those high-valued properties.

Storms that damage or destroy just a few properties can negatively impact municipal revenue in small towns and cities. Reduced revenue compounded with non-reimbursed storm expenses strain municipal budgets at all levels. In Vero Beach, for example, damage to a handful of hotel properties negatively impacted the city's bed tax and property tax revenues and the retail economy of surrounding businesses. Large scale destruction can cripple a county, considering that 40% of the region's assessed taxable value stems from barrier island properties. St. Lucie's tax commissioner noted that after the 2004 storms, the county temporarily removed approximately \$1 billion in assessed property value from its rolls. That represents approximate 10% of the county's assessed property value. The steady increase in new homes and the rising value of resale homes have masked the fiscal impact, permitting the tax-roll and revenue to grow despite the hurricane setbacks. However, it will be more difficult to overcome the public revenue impacts of storms when the counties and towns reach complete build-out or when the real estate market cools, reducing housing values and the rate of sales.

St. Lucie's and Fort Pierce's barrier island land use approach also curtails public investment in the CHHA, but combines significant public land acquisition with moderate to higher density development. Although land conservation reduces the total development potential, permitting multi-family dwellings mixed with other residential and commercial uses produces a different set of vulnerability concerns. The higher density zoning, along with the presence of recreational vehicle parks, the Florida Power and Light facility, and other commercial uses, motivated developers to construct a large number of small condominium units geared to moderate-income seasonal owners. Those owners, in turn, rent the units during the off-season. Social characteristics such as lower-income levels and a higher percentage of renters are correlated with greater vulnerability.

The transfer of development density to oceanside of Highway A1A increases the risk posed by erosion and storm surge, but decreases the risk of flooding by curtailing development on the lower-lying lagoon side of the barrier island. The high-rise buildings, if properly designed and located, may engender less vulnerability than the more low-density pattern of private houses. Their height might make them susceptible to greater wind levels, but the smaller footprint and raised elevation of most of the units limit the flood risk. Because each owner can obtain up to \$250,000 in flood insurance coverage, insurance can cover a good portion of an apartment's value in case of loss. The smaller overall land coverage of apartment towers also permits more land to remain in a natural condition, which may yield a benefit by allowing storm surge to dissipate and rain to percolate. However, at present, the parcels are largely occupied by surface parking.

High-rise development concentrates population densities in specific areas, thereby raising concerns about evacuation. At present, the seasonal nature of peak occupancy keeps evacuation clearance times within acceptable levels, but that occupancy pattern may change in the future. As seasonal residents age, they may extend their stay in the region, increasing the number of vulnerable elderly inhabiting the barrier islands in the autumn months. More important, the maturation of the regional economy and the revival of Fort Pierce will increase the number of year-round residents on the barrier islands. Full time residents use more automobiles than seasonal residents, thus evacuation clearance times need to be recalculated to ensure that prudent criteria can still be met.

Coastal High Hazard Area: Recent storm experiences in Florida and the Gulf Coast states have renewed interest in examining the effectiveness of the CHHA designation in framing mitigation policies within the LCP. Limitations on public infrastructure and investment have served to minimize the public asset exposure, but as demonstrated in this study, the value of assets located in the barrier island portion of the CHHA has continued to grow despite policy intended to curtail development by limiting public investment. In addition, the limitations on public investment expose the tension between the land use policies that encourage enhancing access to the beaches and maintaining or promoting water-related and water-dependant uses and those that prohibited localities from investing in or subsidizing projects that lead toward more intense coastal development or increase public asset exposure.

The desire to increase public access to the waterfront and beaches inherently places public recreational facilities at risk. The 2004 hurricanes resulted in \$19 million in damages to those types of assets. Balancing the level of public asset exposure, accessibility, environmental protection, and related concerns is complex. At present, the amenities available at many of the beach parks are limited to parking facilities, boardwalks, life guard stands, and restrooms. The lack of other amenities, such as dining, recreational facilities, and retail conveniences, curtails the use of many miles of public beach to the broader public, making it attractive primarily to local residents who can quickly go home to grab a bite to eat or retrieve beach supplies. Investment in more public facilities increases the public liabilities, but the current zoning limits opportunities for the private sector to create such amenities. The City of Fort Pierce appears to have acknowledged the impacts of that policy and proposes to rebuild one of its beach parks with dining and recreational facilities.

Second, preliminary research on the economics of some water-related and water-dependant uses suggests that if a policy objective is to retain or promote those uses, the public sector might need to foster creative public-private partnerships to maintain their viability. Marinas, for example, have slim profit margins and often depend on ancillary uses and functions, such as restaurants, banquet facilities, or shops that are not water-related to remain financially viable. The pressure to redevelop waterfront parcels to higher economic uses is extremely strong. However, if, as research suggests, there is an overall economic value in preserving those water-related businesses, then flexibility is need to permit or indirectly subsidize the additional non-water-related development.

Finally, issues have been raised as to whether restrictions that limit infrastructure investment to levels needed to maintain the established LOS hamper governments' ability to maximize hazard resiliency. If established LOS standards are too low, infrastructure improvements needed to accommodate extreme events may be perceived as creating additional capacity that can accommodate greater development. A review of the stated LOS guidelines could address this concern.

Building Codes: The development history of a barrier island is a key factor impacting the resiliency of its communities, as the incremental nature of state and local regulation has gradually curtailed substandard construction practices and imprudent citing decisions. Approximately 75% of the inventory was constructed after adoption of the Coastal Construction Building Zone, but less than one-fifth of the existing inventory was constructed after adoption of the 2001 Florida Building Code. Among parcels subject to the Coastal Construction Control Line regulations, approximately 25% of the properties were constructed prior to adoption of the 30-year erosion and related design standards. Thus, the barrier islands' aged inventory presents a significant vulnerability.

The 2004 hurricanes were the first major tests of the building code enhancements implemented since Hurricane Andrew. The unique characteristics of each storm tested different aspects of the new code and exposed different types of building failures. For example, Hurricane Charley was a rapidly moving storm whose 120mph wind speed met the Uniform Building Code design threshold. Hurricane Ivan, a category 4 storm, produced a 17-foot storm surge that inundated barrier islands and mainland waterways. The winds of Hurricanes Frances and Jeanne were below the wind design speeds, but they were long in duration and produced significant rainfall. Damage surveys throughout the state concluded that the 20th Century inventory built to older standards had more major damage and were unsafe shelters, whereas buildings built to the 2001 Code suffered minor damage and provided safer shelter. Interviews with field inspectors further revealed that, although buildings constructed to the 2001 Code standards did well, those buildings that exceeded the 2001 Code sustained the least damage. The 2005 hurricanes that impacted Miami-Dade and Broward counties helped to confirm those observations. Preliminary analysis of damage caused by Hurricanes Katrina and Wilma confirm that buildings that met the stricter Miami-Dade building code had fewer broken windows and less structural damage than comparable buildings meeting the statewide Florida standards.⁴⁶

The importance of maintaining the high construction standards in the building code and enforcing the building code provisions is key to increasing resiliency. During the 2004 revision of the Florida Building Code attempts were made to relax some of the requirements. Proponents stated that some regulations (such as those that establish window pressure requirements, for example) added construction costs without a proven commensurate benefit in resiliency. Arguments are routinely made that stringent standards reduce homeownership affordability. Nonetheless, efforts to reduce requirements in the name of affordability should be viewed with skepticism, as low-income homeowners are least able to overcome the total property losses associated with severe storm destruction. That has been recognized by several public officials, including Florida's Chief Financial Officer Tom Gallagher and Fort Pierce Mayor Bob Benton. Benton was recently quoted as saying, "We need the Miami-Dade County codes on the Treasure Coast. Our new codes worked, but Dade's are even better and could help reduce insurance premiums."⁴⁷

Localities can also stringently enforce regulations or improve on the design guidelines established by NFIP. For example, localities should discourage utilization of non-living space created below the base elevations that are anticipated to flood or be compromised during storm events. Owners often convert those spaces to ancillary uses or storage and lose the contents when storm surge and flooding ensue. The floating material causes additional property damage to adjacent structures and increases the amount of debris that is hauled away during clean-up. The Local Mitigation Strategy documents also suggest raising the finished floor elevation to 18 inches above base elevation throughout the region.

Rising land values will promote redevelopment of older substandard construction over time, but the rate and pervasiveness of the upgrading are unknown since they are driven by unpredictable market forces. In recent years, such redevelopment has resulted in the replacement of beach bungalows with estate homes, a sort of coastal gentrification. That has not only improved the resiliency of the built environment but also increased asset exposure.

Public policy can approach the issue of aging building stock from two positions. Programs can be developed to retrofit the existing construction, making it more resilient. The Department of Community Affairs has programs to help very low-income families with some structural retrofitting

mitigation, but working-class and moderate-income families are expected to assume the retrofit burden alone. The insurance-based incentives created under Florida Statute 626.0629 for that market segment require insurance companies to provide a reduction in the wind portion of the insurance premiums. It seems that that is an insufficient incentive, as the cost savings for shutters, for example, are typically \$6-\$14 a year, while the cost of the hurricane shutters can be \$100 per window. The cost of retrofitting is expensive, and moderate-income households rarely have the disposable income for those capital investments, especially if they do not translate well into home value. Rising home prices have fueled a growth in home equity lines of credit, but consumers tend to use those funds for a host of credit obligations rather than for home improvements such as hazard mitigation retrofitting. Moreover, in a rising interest rate environment, even that source of financing will be elusive. Additional programs for retrofitting need to be developed.

On the other hand, measures can be adopted that will accelerate redevelopment of inadequate construction. As previously stated, market forces that drive land values up and accelerate obsolescence cause a natural recycling of the built environment, but the timeframe is uncertain. Public policy, including zoning, tax regulations, public infrastructure, and economic development initiatives, can help promote the redevelopment of coastal areas to meet more public objectives, including more resilient development, more natural conservation space, or a combination of both. To date, local policy views coastal redevelopment as a post-disaster reconstruction approach, rather than a proactive mitigation strategy. Tools such as eminent domain and Community Redevelopment Districts, which accelerate redevelopment, are primarily reserved to incentivize redevelopment in areas that have not attracted private sector investment. Coastal areas do not fit that criterion, but the policy aimed at improving public safety, reducing the cost of public services, and supporting economic development is within the realm of local government. Public-private partnerships in coastal redevelopment projects may help ensure that coastal projects meet public objectives of land conservation, public access, income diversity, and “resilient green building design.”

Oceanfront Setbacks: Local Comprehensive Plans and local development regulations have little language regarding building setbacks from the ocean, deferring that issue to regulations established in Florida’s Department of Environmental Protection’s Coastal Construction Control Line

Program. At present, DEP uses a 30-year erosion standard to establish the minimum setback of beachfront construction eastward of the CCCL. Setbacks behind the dune line and a robust beach and dune restoration program have attempted to maintain a status quo between man's built environment and nature's tendency for shoreline fluctuation.

Approximately 18% of the barrier island parcels are subject the DEP's Coastal Construction Control Line regulations. Of those, half have structural improvements and include nearly 1,200 properties constructed before adoption of the new CCCL line; they are presumably at risk to encroaching water in the short term. There are also approximately 1,000 privately owned parcels that remain undeveloped. Continued development and redevelopment of existing oceanfront buildings mean that over time, without more stringent development regulations, communities will grow increasingly dependant on beach nourishment or coastal armoring to protect structures from the encroaching waters resulting from natural erosion, storm erosion and surge, and sea level rise. While those well established measures address some critical problems and benefit recreation and tourism activities, the sustainability of the "preserve the status quo" approach is commonly questioned. The state's beach monitoring program has documented faster than predicted erosion of some restoration projects. Scientists have observed that displaced sand from those projects can bury ecologically fragile off-shore reefs and change the bathymetry, subsequently altering the natural shoreline south of the projects.

In addition, the critical beach erosion experienced in the wake of two active hurricane seasons and the prediction of more to come raise concerns about the protectiveness offered by the current standards and regulations. When coastal storms erode substantial volumes of sand in recurrent seasons, the accurate location of the mean-high water line and the validity of the 30-year period are cast in doubt. Some scientists believe that the pre-existing mean-high water line remains a viable measure to determine construction setbacks, as beaches typically recover from hurricane erosion over the long term. However, others point out that the rate of recovery and the uniformity of the recovery are not well understood. Shoreline conditions vary considerably due to topographic, bathymetric, and contour features, creating unique erosion conditions along the shore. Changes in those features may alter the 30-year erosion projection of proximate parcels. Compounding that problem is the fact that the CCCL regulation creates an exemption for new construction sandwiched between pre-

existing development. Those structures can be located seaward up to the existing line of sight between the pre-existing structures. Thus, one might assume that in a 5-to-10 year period, the recent active hurricane seasons have or will accelerate the 30-year erosion projection in some locations and decrease the rate in other areas. More research is needed on patterns of shoreline fluctuation and storm erosion to determine the efficacy of the current policy solution.

While the scientific data regarding shoreline change are developed and understood, localities may be able to create policy to encourage strategic retreat and more prudent development locations. Localities should consider adopting setback requirements that are more protective than the state's and that place assets on the upland-most portion of the lot, thus allowing for the greatest natural shoreline fluctuation. That will help reduce the need for shoreline armoring in the short term and the dependency on frequent beach nourishment in the longer term. Development ordinances can be created that encourage parcel development closer to the public rights-of-way and away from the dune line. Regulations that discourage excessive land coverage, including non-native landscaping and swimming pools and decks, would also strengthen community resiliency. Finally, new and creative adaptation of land use tools such as rolling easements and transfer of development rights, along with responsive tax-policy, will have to be explored to encourage strategic retreat from vulnerable locations.

The resiliency benefits of strategic retreat approaches will not be realized quickly. Nonetheless, because strategic retreat is regarded as the most sustainable coastal hazard mitigation approach in the long term, the tenets of that principle need to be gradually embedded in a variety of regulatory policies governing coastal land use. The sooner public policy can move away from hazard mitigation aimed at loss reduction through hardening and insurance risk-sharing to creating a resiliency through appropriate development that prevents loss damage, the faster our communities will reach a more optimal balance between cost-positive asset exposure and total storm damage costs.

NATURAL ECOSYSTEMS

Initially, it may seem inappropriate to assess the vulnerability of the natural environment to extreme coastal storm events, because hurricanes are a natural force that the ecosystem has absorbed and adapted to throughout time. However, human development has profoundly altered the natural environment; it has upset the delicate balance of the coastal ecosystem and thus its ability to weather and recover from severe coastal storms. For that reason, we are providing a description of some of the Treasure Coast barrier islands' natural assets and how they were affected by recent hurricanes. This is not a complete assessment of natural and ecological features, but rather highlights key components that are unique to the study area and are related to aspects of the built environment and economy.

The barrier islands that line much of the coast along the U.S. eastern seaboard and Mexico are a dynamic land form with a complex ecosystem. Unlike the mainland or other island forms, they are composed largely of sediment sands and change in contour and location over time due to tidal and ocean wave energy. There are four types of barrier islands, each created by different geological processes. The barrier islands of Florida's Treasure Coast are mostly micotidal and transgressive, meaning their form is largely determined by wave action; they are typically eroding rather than accreting. Those long and narrow stretches of land that protect lagoons and inlets from the ocean have a relatively flat topography and often contain numerous natural washovers that occasionally open new inlets and close others. Washovers indicate a deficient sand supply and a relatively rapid shoreline retreat. Transgressive barrier islands can naturally convert to regressive (accruing sand mass) over time, and vice versa. However, as human development has attempted to stabilize those islands with jetties, channels, armoring, dune fencing, and other types of construction, we have altered the natural dynamics that would normally influence their shape and shifting location. In areas where dunes have been rebuilt or narrow stretches have been hardened to permit roads and bridges, man's footprint has erased washover areas and changed the sand flow that normally nourishes beaches.

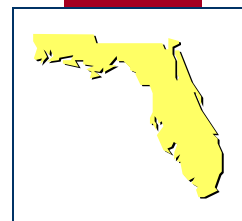
A cross-section of a typical Florida barrier island would illustrate several distinct ecological environments. The Atlantic Ocean on the east is aquatic. Moving westward, there is intertidal beach, the pioneer dune, the foredune, occasionally a backdune (the landward portion of the dune field), the scrub zone, and the barrier flat. The barrier flat, distinguished by forest and sediment soils, is the area that is least dynamic and thus better accommodates human settlement. On the west side of the barrier flat, there are

salt marshes or mangroves, then tidal flats and the Lagoon, or Intracoastal Waterway. The summary of natural assets impacted by last year's storms is presented using the transect framework from Atlantic beaches to the Indian River Lagoon. The barrier flats are excluded, as they are discussed in the section pertaining to the built environment. Where possible, data from before and after the storms have been gathered to illustrate the vulnerability of environmental assets to hurricane impacts.

OCEAN AND BEACHES

There are approximately 22 miles of ocean shoreline in each of the study area counties. The stunning shoreline, with its long contiguous sandy beaches, is a preeminent asset of the region, drawing tourists and residents to the oceanfront year-round. Since the early 1980s, local leaders have acknowledged the importance and ecological sensitivity of the barrier island shoreline, and the need to protect it from overdevelopment while providing ample public access. The 1983 Hutchinson Island Planning and Management Plan outlines policies to protect the beach and dune system and the productivity of the ecological systems and prioritizes the acquisition and maintenance of public beach access.⁴⁸ That type of planning precedent and the policies embodied in the Coastal and Conservation Element of the Local Comprehensive Plan have preserved a vast portion of the region's barrier island beaches as public parks and natural conservation land (*click on Figure 20 for map*). In Indian River County, there are 11 public beaches totaling 4.3 miles. St. Lucie County has 12 beachfront parks totaling 4.5 miles, and Martin County boasts 15 public beaches.

Figure 20



BEACH MANAGEMENT

Over the years the beaches' natural tendency to erode has been slowed by numerous beach restoration projects. The USACE, in conjunction with local governments, and local governments, in conjunction with the state of Florida, have undertaken several major projects. Ambersand Park (R4-17), Vero Beach (R70-R86), Ft. Pierce Beach (R34-R41), and the four-mile Hutchinson Island project in Martin County (R1-R25) are among the largest. In addition, since 1973, the Town of Jupiter Island has periodically nourished the beach between R77-R106. The map in the [Appendix](#) that illustrates Beach Marker monuments in the study region is useful for identifying the location of public beach restoration projects, areas of critical erosion, and where the most severe hurricane damage occurred.

Beach Management Practices

The issue of long-term beach erosion is managed by an extensive beach management program organized by Florida's Department of Environmental Protection (DEP), in cooperation with local governments and the federal government's Army Corps of Engineers (USACE). Typically, the USACE or the Bureau of Beaches and Coastal Systems identifies areas where there has been critical erosion and assets are at risk. DEP will then approach the town or county to determine its interest in applying for a beach restoration program. In recent years the state has allocated \$30 million annually for such programs. Interested localities must then appropriate funding to match funds available through the state. Municipalities typically raise the matching funds by lobbying for federal appropriations and levying taxes. The hotel "bed tax" is commonly tapped for those projects, as beach maintenance is a tourism-directed activity in addition to providing mitigation.

The state appropriation for beach restoration is allocated based on numerous criteria. Details of the prioritization are found in Chapter 62b-36 of the Beach Management Funding Assistance Program. They include:

- The project's eligibility for federal matching funds.
- The degree of public access and public parking.
- The presence assets at risk.
- The locality's ability to finance the ongoing maintenance.
- The project size.
- Whether it is an initial restoration or nourishment project.

The effectiveness and sustainability of those projects are often debated among policy makers and scholars. Over the short term, they provide protection for shoreline homes, maintain turtle nesting habitat, and make the beaches more attractive recreational destinations -- albeit at a price. According to Beach Erosion Control Project Monitoring, by May 2002 segments of the 1999 fill on the Fort Pierce beach had eroded beyond pre-fill conditions; approximately 700,000 of the 830,000 cy of sand placed in 1999 had moved away from the placement area. A third phase restoration was implemented in the most critical area (R34-R36) in 2003. Likewise, the Hutchinson Island project had also lost sand at a faster than predicted rate. A USACE report from 2000 notes that 75% of the sand placed on the beach in 1996 had been displaced by 1999, severe storms being one of the most significant contributing factors.⁴⁹

Prior to the 2004 hurricane season, the Bureau of Beaches and Coastal Systems had determined that much of the Treasure Coast shoreline was critically eroded. A survey completed in 2006 confirmed that the critical conditions persist. The definition of a critically eroded beach is "a segment of shoreline where natural or human activity have caused or contributed to erosion and recession of the beach or dune system to such a degree that upland development, recreational interest, wildlife habitat, or

important cultural resources are threatened." Critical segments may also include peripheral segments between critically eroded areas that might be stable but require attention for continuity of beach management activities.⁵⁰ The Bureau of Beaches and Coastal Systems specifically points out that the definition focuses on areas where conditions threaten the four types of assets described. Eroded areas where assets are not at risk are not designated critical.

The 2004 long term (10 year) Beach Management Program for the Treasure Coast region planned to spend \$180,956,000 on restoration of critically eroded shorelines through 2015. That included \$8.2 million in feasibility and design studies, \$155,725,000 in construction, and nearly \$17,000,000 in monitoring efforts. While 41% of the money would come from federal sources, state and local governments would split the bulk of the investment on the basis of 26% and 33%, respectively.⁵¹ Figure 21 summarizes the budget plan proposed prior to the 2004 hurricane season ([click on figure 21 to view budget plan](#)).

Figure 21



Hurricane Impacts: Hurricanes Frances and Jeanne made landfall in the Stuart area, meaning that the coastline directly north (northern Martin, St. Lucie, and Indian River counties) experienced the brunt of the storms' ferocity. Most of the barrier island beaches within the study area sustained severe erosion due to prolonged periods of aggressive tidal surge and high winds. Immediately after each storm, the Florida Bureau of Beaches and Coastal Systems and the US Geological Survey conducted aerial inspections of the coastline to document and evaluate the damage. Their assessment, which included beach and dune conditions as well as substantial damage to major structures within the Coastal Building Zone, identified a range of conditions from minor to severe.

As detailed in Figure 22, the areas north of Hutchinson Island, with the exception of the Rio Mar Reef embayment in Indian River County, suffered Category IV (major) damage to the beach and dune system. South of Hutchinson Island in Martin County, the damage ranged from minor to moderate, as that area was on the leeward side of the storm. Major damage (Category IV) is defined as dune erosion of more than 10 feet or dune removal. One may not see the beach profile lower; instead, it may appear that the beach width increases, as dune sand is re-deposited at the shoreline. By contrast, minor damage is noted as dune erosion or small scarps of less than three feet.

As previously noted, much of the Treasure Coast shoreline was already designated as critically eroded prior to the storms. The events of September 2004 simply exacerbated the problems and created additional critical situations. The prolonged storm surge displaced millions of cubic yards of fill. Some of the sand was moved landward in areas with significant overwash, filling ground level condominiums and parking lots. Some washed seaward, re-countouring the beach profile and near-shore ridges or sandbars, and some was transferred southward, resulting in some post-storm accretion in specific areas.

Figure 22

Location	Pre-hurricane Condition	Degree of Hurricane Erosion	Cumulative Dune Retreat
INDIAN RIVER COUNTY			
22.4 miles of beaches			
Sebastian Inlet to Rio Mar R1- R86	Critical	IV major	50 -75 ft
Rio Mar Reef embayment R86-R95	Stable	II minor	<3 ft
South County R95-R119	Critical	IV major	80 ft
ST. LUCIE COUNTY			
21.5 miles of beaches			
North Hutchinson Island R1-R33	Stable	IV major	100 ft
Hutchinson Island R34-R98	Critical	IV major	50ft
MARTIN COUNTY			
21.5 miles of beaches			
Hutchinson Island R1-R42	Critical	IV major	30-40 ft
Northern Jupiter Island R43-R77	Critical	II-III moderate	< 10 ft
Town of Jupiter Island R77-R121	Critical	II minor	<3 ft
Blowing Rocks R122- R127	Critical	III moderate	< 10 ft

Source: Florida Department of Environmental Protection, Bureau of Beaches and Coastal Systems, Hurricane Frances and Hurricane Jeanne Post-storm Conditions and Coastal Impact Report October 2004, pp. 14-15.

The storms also narrowed several sections of beach that had recently been nourished, rekindling the debate as to the value of expensive beach nourishment. For example, Ambersand Park, which had completed a nourishment project in 2003, lost nearly 140,000 cubic yards of sand.⁵² It is scheduled to receive additional restoration work in November 2006. Supporters of nourishment, both local officials and coastal engineers, point out that areas where nourishment had occurred experienced significantly less damage to adjacent properties. The dune restoration projects that accompany nourishment were critical in reducing the impact of storm surge flooding.

Two months after the hurricanes, DEP's Bureau of Beaches and Coastal Systems prepared a 2004 Hurricane Recovery Plan to address the storm damage to Florida's beach and dune systems. The November 30, 2004, report sets out both short and long term strategies by county that attempt to coordinate \$68 million in state emergency appropriations for beach restoration, with \$12.6 million in FEMA Emergency Relief Grants and a \$62 million appropriation to accelerate pre-established U.S. Army Corps of Engineers' (USACE) beach restoration projects.⁵³ Approximately \$53 million of the state's funding was used to reconstruct sand dunes, with the balance devoted to expediting USACE projects that were already envisioned but not yet underway from an earlier \$30 million appropriation for beach restoration.

The Treasure Coast region has been allotted \$15.2 million in state emergency beach restoration funds. Indian River County, which had no USACE projects, received the lion's share, approximately \$10 million, and St. Lucie and Martin counties received \$3.8 and \$1.4 million, respectively. In the short-term, a priority was placed on restoring dunes in all the critically eroded areas, as well as executing full nourishment plans for the USACE projects already slated and funded for restoration prior to the hurricanes.

The state's emergency appropriation was critical in advancing mitigation-oriented recovery efforts for several reasons. FEMA grants for emergency dune reconstruction, referred to as emergency berms, are geographically tied to a specific parcel of land. Moreover, FEMA money cannot be used for project planning of areas that are not affected by hurricane damage or for vegetation planting or other dune stabilization projects. In addition, FEMA will not fund sand projects that overlap with existing beach nourishment done by the Army Corps of Engineers. Beaches projects maintained by USACE, in cooperation with local government, have to be addressed by the existing USACE program.

Because the Treasure Coast region has several USACE projects and not every property owner was eligible to receive FEMA aid for dune rebuilding, state funding is critically important to fill in the gaps. Without the Bureau of Beaches and Coastal Systems' careful planning, FEMA's \$12.3 million of assistance for dune reconstruction would result in a discontinuous (patchy) line of bare dunes along oceanfront property: ineffective long-term mitigation. The state's commitment to expediting slated USACE cost-shared projects was also critical. Without it, localities and the state would not be able to quickly tap \$116 million authorized for federal shore projects. Stretches of public beach would have remained in critical condition for extended periods of time.⁵⁴ Figure 23 is a summary of the beach restoration activities planned for the study area.

Planned Beach Restoration Projects for the Treasure Coast After the 2004 Hurricane Season

Indian River County

- R4-R17 Sebastian Inlet and Ambersand Beach Restoration**
The Ambersand Beach Restoration Project will need to be accelerated. It is expected that FEMA will provide funding to replace material loss, and the state and local government will provide the remaining funds. Although this project had already been appropriated in 2003, additional funds will be needed, due to increased volumes of sand. In addition, maintenance dredging activities are planned around the Sebastian Inlet to alleviate the sand trap, which starves Ambersand Beach of migrating sand.
- R17-R86
R100-R107 Northern Indian River County and Vero Beach and South Indian River County**
In both the unincorporated barrier island area of Indian River County and the beachfront that belong to the City of Vero Beach, the state seeks to supplement the FEMA funding to rebuild emergency berms along the length of the region. As the FEMA relief funds are geographically tied to the property parcel that experienced damage, state money will fill in the gaps to create a continuous dune and plant additional vegetation. The estimated cost is anticipated at \$10,030,000, of which the county receives \$5,910,000 for the northern section and \$580,000 for the southern section south of R100. A \$1.9 million contract was awarded to Fischer & Son for sand-replacement on Treasure Shores Park. Work began in January 2005. The City of Vero Beach will receive \$3,540,000 in state cost-share. In addition, the state will accelerate design and permitting for the previously funded projects at Wabasso Beach, Vero Beach, and south county beaches.

St. Lucie County

- R2-R9 Avalon State Park**
The state will assist in the installation of sea oats and sand fencing to facilitate dune recovery.
- R34-R46 Federal St. Lucie County Shore Protection Project**
The state will coordinate with the US Army Corps of Engineers to accelerate the maintenance and nourishment of this federal project. This project had already been planned and will begin in the spring of 2005. While the USACE will provide emergency funding to replace material lost by the storm, the additional volume will be cost-shared between USACE and state and local governments.
- R98-R115 Southern St. Lucie County**
The state will supplement FEMA funding with \$3,760,000 to restore the emergency berms and add vegetation and dune stabilization materials. The state had also committed funds to study the feasibility of beach restoration from R98 to the Martin County line. The state will seek to accelerate this feasibility study.

Martin County

- R1-R36 Martin County Shoreline**
The state will work with USACE to accelerate the previously planned project to nourish the R1-R25 portion of the Martin County shoreline. The USACE will provide emergency funding to replace material lost to the storm, and funding for the remaining maintenance volume has already been appropriated by the USACE and the state and local governments. In the southern portion of Hutchinson Island, the area south of the federal USACE project (R25-36), the state will contribute \$1,220,000 to supplement FEMA monies to restore a contiguous emergency berm.
- R75-R117 Jupiter Island Beach**
FEMA is expected to provide emergency funding to replace material lost due to the storm. The state will accelerate the maintenance and nourishment of this project but has not allocated funding for this segment of beach at this time.
- R126-R127 Southern Jupiter Island**
The state will allocate \$190,000 to supplement the FEMA funding in order to restore a continuous emergency berm and add additional vegetation and dune stabilization materials.

Source: Florida Department of Environmental Protection, Division of Water Resource Management, Bureau of Beaches and Coastal Systems (November 30, 2004), "2004 Hurricane Plan for Florida's Beach and Dune System," pp. 14-16.

Work proceeded on several of the projects from January through August 2005, with generally favorable results, although it is too early to make a determination of ultimate success. Some sand was salvaged from washover areas and parking facilities and placed back on the beach, while in other areas inland sources were tapped. Initially the emergency berms appear unnatural and barren, but over time and with re-vegetation projects, the aesthetics should improve significantly.

According to local newspapers, \$40 million will be invested in the region's beaches.⁵⁵ Nonetheless, that investment will not cover all the work needed for critically eroded areas. Indian River County coastal managers seek to repair sector 1 & 2, (Ambersand Sand Beach), and begin Sectors 3, 5, 7. Currently, they have anticipated a \$10 million dollar shortfall if they proceed with all the projects concurrently. Advocates of beach preservation suggest that sales tax monies be diverted from capital projects, such as new county buildings and prison facilities, to address the beach issues. Additional bonds could be issued to finance the public buildings. Conversely, others point out that voters were promised that approval of the .7 cent sales tax extension would prevent the county from incurring additional long-term debt. County officials have resolved to re-search additional funding sources, such as state grants.

SEA TURTLES

The Treasure Coast is one of world's most important locations for the propagation of sea turtles. Three species of turtles--the Loggerhead, the Leatherback, and the Green--return to the Florida shores annually between March and September to lay eggs. State and local regulators, research institutions, and environmentalists working with volunteers, take inventory of the number of nesting sites and try to estimate trends in turtle populations. Since 1998, they have observed a decline in Loggerheads and annual fluctuations in the number of Green turtles. Scientists have not attributed the decline of Loggerheads to one specific factor but rather suggest that increased development along the shoreline, beach management practices, and off-shore commercial fishing maybe partially be to blame. Oceanfront development has infringed upon the prime nesting habitat on the upland portion of the beach and has often introduced artificial light there. The bright lights attract and disorient the turtle hatchlings that use reflected moonlight to find the water.

In order to help hatchlings return safely to ocean waters, many progressive municipalities have adopted ordinances that reduce artificial light visible on the beach. In addition, during the nesting season, disruptive beach activities such as nourishment and dune reconstruction are restricted. State ordinances are reinforced by local ordinances

that regulate development activities adjacent to beaches. For example, in 1995 Martin County adopted the Barrier Island and Sea Turtle Protection Ordinance (Ord. 462.1) that specifies the type of activities permitted in a dune preservation zone and in specific turtle-sensitive habitat.

Scientific studies have suggested that when beach restoration is necessary, coastal engineers must strive to simulate the beach's natural profile and sand type. Care should be taken to grade the beach slope in such a way as to permit the pregnant female turtles to reach the optimal nesting sites, and to closely match the sand type used for beach restoration with the native. Failure to do so will result in "failed nesting attempts," meaning that turtles may come up on the beach but fail to dig a nest and deposit eggs, either because the sand is packed too hard or because the turtle cannot identify a site with appropriate tide conditions.

Hurricane Impacts: Scientists have been interested in and concerned about the impact of the hurricanes on the sea turtles. Llew Ehrhart, a researcher at the University of Central Florida, estimates that about 44% of the 2004 Loggerhead hatchlings were lost due to the storms. Turbulent seas might have reduced the survival rate of new hatchlings that, as part of their life cycle, must swim out to the warm Gulf Stream currents and cross the Atlantic Ocean.⁵⁶ Moreover, environmentalists are concerned about the integrity of the beach habitat for returning egg-laying females. Severe beach erosion in some areas might have narrowed beaches, reducing the number of viable nesting sites, or left steep scour areas. The lower dune profile and the loss of adjacent beach vegetation raise concern over the visibility of artificial light on the beach from adjacent development.

While beach restoration will remediate some of the beach habitat, in the long run the complexity of beach restoration projects and the competing priorities of oceanfront property owners, the beach-going public, and environmentalists make implementation complex. As emergency repair work on the beaches must ideally be completed during the six-month fall-winter window and prior to the next hurricane season, priority for beach repair was placed on re-establishing a continuous dune line and repairing very critically eroded beaches: projects aimed at securing threatened upland structures prior to the next hurricane season. Other beach restoration and dune re-vegetation projects were delayed to prevent interference with turtle nesting season or until need environmental permits could be obtained.

The conflict between short-term needs and longer term approaches can be illustrated by two relevant examples. In St. Lucie County, the urgent need to restore dunes and repair erosion prompted the county to accelerate a \$4.8 million beach restoration project and use sand from an inland source near Indrio Road and I-95 rather than an indigenous

one. In the months that followed, beach-goers and coastal scientists raised concerns about the quality and compatibility of the sand source. The less aesthetic grayish sand material, it was determined, packed more densely and might interfere with turtle nesting activities. An investigation was launched to determine the impact of keeping or removing the sand from a 3.7-mile dune area.⁵⁷ St. Lucie County proposed to remove 30,000 cubic yards of the material in critical areas, but in January 2006, the State Department of Environmental Protection recommended removing nearly all of the 200,000 cubic yards. How to overcome the fiscal and environmental challenges of that remediation remain unclear.⁵⁸

In Indian River County, private property owners seeking to secure permits for sea walls, sand bags, and sand to protect beachfront dwellings were confronted with regulatory obstacles. The county was prevented from signing off on emergency armoring permits pending approval and adoption of a Habitat Conservation Plan, a turtle-protection policy that resulted from long-standing litigation between Indian River County and the Caribbean Conservation Corporation. The extensiveness and severity of coastal property damage created new intense pressure to resolve the dispute expeditiously. In December, three months after the hurricane events, an agreement was reached that established a model habitat conservation plan and set future seawall standards. In return, the county agreed to proactively assist sea turtle nesting with more enforcement of lighting ordinances, a survey of nesting locations, and predator control.⁵⁹

Meanwhile, two months into the nesting season, scientists were relieved to note an increase in the number of turtle nests. Monitors have observed a 35% increase in nests in Indian River County. Biologists have also reported an abundance of young female turtles on the coast north of St. Augustine. The initial promising results carried through into September. In Martin County, scientists identified 292 Loggerhead nests in 2005 compared to 244 in 2004. Just north, 182 Green turtle and 99 Leatherback nests were found, compared to 100 and 64, respectively, the previous year.⁶⁰ Although enthusiastic about the number of nesting sites, environmental planners are still concerned about deforestation. With only emergency work completed on the dunes, the lack of vegetation may allow artificial light that was previously blocked to be visible on the beaches. That could sabotage an unusually good nesting season if hatchlings fail to return to the ocean.

THE INDIAN RIVER LAGOON

While the hurricanes' impact on barrier island beaches was starkly dramatic, some environmentalists argue that the most devastating impacts were on the Intracoastal side of the barrier islands. The storm surge in the lagoon reached 8 feet. It flooded low lying areas, tossed boats and docks, and littered the shoreline with debris, significantly damaging the fragile mangroves. The large volume of freshwater channeled into canals that flow into the Indian River Lagoon altered the salinity and clarity of the bay water, killing seagrass and impacting animal life.



Photo credit: St. Lucie Economic Development Board.

Coastal storms increase the fresh water discharges from the inland canal systems. This changes the salinity of the Indian River Lagoon and adversely impacts aquatic life.

MANGROVES

Red, Black, and White mangroves are a fragile and important component of the lagoon eco-system, filtering pollutants from run-off and providing food to the lagoon food chain and habitat for native wildlife. Moreover, dense mangroves provide important mitigation from storm wave action, as was noted in the Asian Tsunami damage analysis. Shoreline development and the success of invasive species, such as Brazilian Pepper Trees, have compromised mangrove cover on the Treasure Coast. In addition, the mangroves in the region are particularly fragile due to an infestation of a beetle that bores into the limbs and makes them more brittle.

Hurricane Impact: Damage to the mangroves resulted from tide and wind factors and from debris that washed up. The wind and surge broke many of the trees and thus knocked off the propagules, the seedlings that promote the next year's new growth. Therefore, fewer than the average number of new trees are expected to take root in the coming year. To mitigate that impact and generally help revive mangroves in the area, the Marine Resources Council sponsored a Mangrove Propagule contest that challenges groups to collect floating propagules so they can be properly replanted. The Florida Department of Environmental Protection and the Fish and Wildlife Service, along with other agencies, also provide support for mangrove planting and the removal of invasive species.

Debris, however, posed a more complex challenge. For example, in Martin County a 23-foot boat was tossed into the mangroves, as were pieces of boat dock, siding, and other garbage. The clean up effort is very difficult and expensive. The mangroves are hard to access, and the type of boat that can get through the mangroves has a hard time lugging the garbage out. Of particular concern are pieces of boat dock made from pressure-treated lumber. That material does not decompose easily and is impregnated with chemicals that could damage the fragile ecology.

WATER QUALITY

Hutchinson Island, the primary barrier island of the study area, shields the Intracoastal Waterway and its bays and lagoons on the west from the Atlantic Ocean. The barrier island's changing morphology sporadically opened and closed inlets from the ocean, locally altering the aquatic ecosystem of parts of the lagoon over time. Development of the barrier islands, which often included hardening infrastructure such as seawalls, prevents natural washovers and the creation of new inlets and makes static a naturally dynamic ecosystem.

The waters surrounding the island exhibit distinct characteristics in terms of temperature, salinity, turbidity, and wave action that allow a plethora of marine life to procreate in its shallow and protected shoreline. The Marine Resources Council tracks water quality data for the Indian River Lagoon, using volunteers to sample over 120 sites monthly. In addition, they have begun mapping the density and health of sea grass as a proxy for water quality and the condition of the aquatic ecosystems. Their data revealed that the water quality in the lagoon, with the exception of small geographic pockets and short episodic seasonal variations, remained at acceptable levels. Salinity, a key feature, remained over 20 ppt (between 25-33 ppt or 2.5%-3.5% salt), considered "good." The area of greatest concern was the tributaries of the St. Lucie River where salinity frequently fell to below 15 ppt, a severe threat to clams and other sea life. ⁶¹

Hurricane Impact: Hurricanes have impacted the lagoons and waterways landward of the barrier islands for thousands of years, reshaping the shoreline and periodically flushing the water basin with millions of gallons of fresh rain water. Those processes continue today; however, the extensive canal system built to drain and channel water on the mainland dramatically increases the volume and the duration of flow of storm water to the lagoon.

Because the canal system in the Treasure Coast is used not only to manage flooding in urban and agricultural areas but also to control water levels in Lake Okeechobee, the

volume of fresh water flushed into the bay is immense, and the elevated flow lasts weeks rather than days. The billions of gallons that now flow into the lagoon from a managed canal system rapidly diluted the lagoon's salinity and brought large volumes of sediment and fertilizer that clouded the water and fed algae blooms. The low salinity affects shellfish reproduction, and the algae blooms cause severe anoxia (reduced oxygen levels) that results in fish kills.

Data from the Marine Resources Council indicated that back-to-back hurricanes had a cumulatively degrading impact on the salinity levels of the lagoon system that spread from south to north. The rain from Hurricane Frances diluted lagoon salinity below the critical 15 ppt threshold in the area around the St. Lucie Inlet and the mouth of the Sebastian River. Otherwise healthy areas (salinity over 25 ppt) from just north of Stuart to Vero deteriorated to "stressed," as salinity dropped to between 15-20 ppt. North of Indian River County, a critical area emerged near Turkey Creek and Titusville; however, most of the lagoon still contained levels of salt.

The impact of Hurricane Jeanne, however, was much more significant. In the monitoring periods from September 27 through October 6, 2004, the salinity level of the entire Intracoastal lagoon from north of Fort Pierce to just south of Melbourne reached a critical level, with salinity dropping to between 10-15 ppt. The northern portion of the inlet that, after the previous storm, had managed to remain healthy, became stressed. Moreover, the more powerful storm ravaged sea grass beds, piling up aquatic vegetation on the western embankments.

Fortunately, a relatively dry October and November allowed the lagoon to recover rather quickly. Salinity measurements taken at the end of the 2004 hurricane season indicated that none of the lagoon areas were in critical condition, but that much of the northern portion of the lagoon remained "stressed."⁶² See [Appendix](#) for water quality data.

The disruption of business activity subsequent to the hurricanes is multifaceted and a function of both the severity of the destruction and the time required to resume operations. A proper tally includes more than property damage. It also includes the short-term loss of productivity in terms of lost employee wages and business revenue, depreciated inventory, transportation inefficiencies, and the longer term issues of tarnished business image and business failures. Decline in private sector economic activity impacts the public sector finances, as local governments must finance the additional cost of clean-up and response during a period of reduced tax revenue due to depreciated property value, tax abatement programs, and reduced sales tax expenditures by consumers.

Photo credit: St. Lucie Economic Development Board.



This economic overview describes the Treasure Coast's economy and the contribution of the barrier islands to the region's economic vitality. It is intended to shed light on the value of the economic assets at risk and the vulnerability or resiliency of those assets. Comparisons are drawn between the barrier islands and the region as a whole, and between time periods before and after Hurricanes Frances and Jeanne. Understanding the economic value of coastal assets permits policy makers to appropriately value the amount and type of mitigation needed to protect the region from economic setbacks. The section summarizes data on the diversity of economic sectors and business volume. General business indicators such as retail sales and those specific to tourism, such as bed-tax figures, were collected.

REGIONAL ECONOMIC INDICATORS

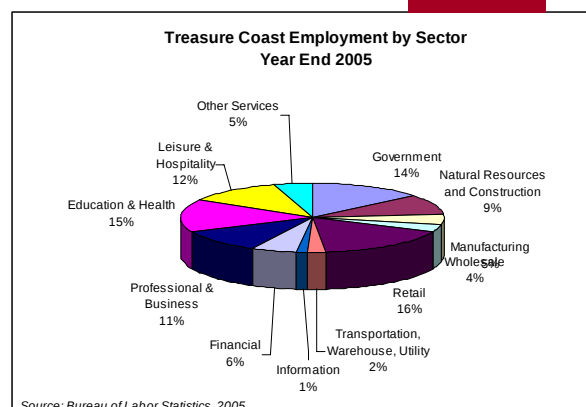
The coastal and ocean economies of the nation have changed dramatically over the last decade. Traditional ocean industries such as offshore oil and gas development, ship building, and fishing are being replaced by the recreation and tourism businesses. Nowhere is that more evident than in Florida, where year-round sunshine, coastal waterfront properties, and beaches are the icon of leisure living. It makes Florida a desirable relocation and retirement state, a national and international tourist destination, and a hub for the recreational boating industry.

Growth on the Treasure Coast is a result of all of those overarching trends that have driven ongoing residential development. The “growth economy,” for example, added 3,600 construction jobs over the past four years and now accounts for 15,000 jobs in the region, nearly 10% of the region’s employment. The majority of the population growth occurred on the mainland, where national and regional developers converted vast tracts of land into residential neighborhoods. Nonetheless, the scarcity of waterfront property, especially lots with ocean access, makes that real estate the most desirable and expensive. New communities require convenient access to goods and services and that subsequently drives the establishment of new businesses and the expansion of others. Historically, the coastal cities of Vero Beach, Fort Pierce, and Stuart, and the connecting corridor, U.S. 1, were the backbone of regional commercial development. New neighborhoods on either side of Interstate 95, however, have encouraged shopping center construction along major east-west throughways, such as Route 60, Kings Highway, and St. Lucie Boulevard.

Employment

In 2004, the region’s two MSAs, Vero Beach and Fort Pierce, contained approximately 163,000 jobs, an increase of 36% from 1994. Comparing the regional MSAs, it is important to point out that St. Lucie/Fort Pierce is three times larger than Vero Beach. Figure 24 shows that employment is diversified among several economic sectors, the largest being retail trade, with over 27,000 jobs, followed by health and education and professional or business services, employing 25,000 and 19,000 persons, respectively. The

Figure 24



top three employers by county represent a mix of industries and emphasize the important roles smaller retail and professional and business play in the regional economy.

Figure 25

Largest Private Employers in Each County in 2005

INDIAN RIVER COUNTY		Employees
Indian River Memorial Hospital		1,373
Publix Supermarkets		931
New Piper Aircraft		688
ST. LUCIE COUNTY		
Liberty Medical Center		1,828
WalMart Stores		1,750
Lawnwood Medical Center		1,260
MARTIN COUNTY		
Martin Memorial Health		2,496
Publix Supermarkets		1,168
Armellini Express		684

Source: Florida Enterprise and Chamber of Commerce in Indian River Cty.

The region's base economy, however, is presently supported by construction, retail, leisure, and hospitality companies. Those sectors have a location quotient of 1.62, 1.46, and 1.25, respectively; anything over 1.25 is considered a base economic sector. Because the Bureau of Labor Statistics does not tally agricultural employment, St. Lucie appears to contain all the base export sectors. The region's, and particularly Indian River County's, worldwide recognition in citrus export is not represented in the figures. The importance of agriculture should not be underestimated, as it represents a \$26 million industry in St. Lucie alone.

A year after the hurricanes, the storms' impact on total regional employment is difficult to detect. Overall, employment grew approximately 5% year to year in the St. Lucie/Fort Pierce MSA and less than 1% in Vero Beach. Moreover, growth was evident in nearly every industrial sector. The only employment losses were in the areas of leisure and hospitality. After the storms, that sector lost approximately 700 jobs, two-thirds of which were in Vero Beach. However, by the first quarter of 2005, those jobs began to return, first in St. Lucie County, where the sector showed net gains by April 2005, and later in Vero Beach where 100 jobs were recovered each month between March and May. At present, the net loss is approximately 200 jobs.

Retail Sales

The comparative concentration of retail and hospitality and leisure businesses, as well as strong residential growth adding new consumers to the market, suggest that retail sales activities are a good proxy of economic activity. Figure 26 shows that all three Treasure Coast counties have realized robust sales growth since 2000. St. Lucie County has shown the largest increase in gross sales, growing by double digits annually over a five-year period. That corresponds with the large number of new commercial establishments and shoppers resulting from residential development in Port St. Lucie.

Figure 26

Gross Sales Tax For All Businesses by County 2000-2004

COUNTIES	2004		2003		2002		2001		2000	
		Ann. Growth		Ann. Growth		Ann. Growth		Ann. Growth		5-Year Change
Indian River	\$3,247,963,907	0.06%	\$3,049,857,347	3%	\$2,961,116,734	-5%	\$3,101,007,040	10%	\$2,828,267,871	15%
St. Lucie	\$5,224,564,476	0.17%	\$4,459,179,186	15%	\$3,865,939,423	1%	\$3,833,612,800	13%	\$3,385,357,464	54%
Martin	\$4,824,797,784	0.1%	\$4,378,642,787	7%	\$4,091,010,417	3%	\$3,964,468,078	3%	\$3,834,610,740	26%
Total	\$13,297,326,167		\$11,887,679,320		\$10,918,066,574		\$10,899,087,918		\$10,048,236,075	

Source: Florida Department of Finance

An analysis of regional economic activity by sector reveals that, since 2003, taxable sales in all industries have increased; however, the fastest growing sectors have shifted from building investment and consumer durable goods to business investment. Consumer non-durables and auto-related sales have remained steady, consistent with the maturation of newly urbanized communities.

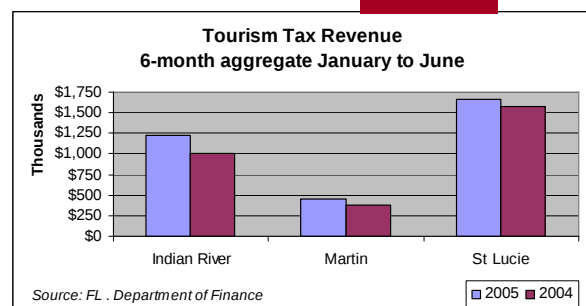
Annual sales growth has increased, despite the disruption of business activity related to the storms. One might assume that storm preparations force residents to stock up on certain types of goods, such as non-perishable food, batteries, generators, chain saws, etc., and in the aftermath victims replace damaged property. Insurance reimbursements and disaster relief funds soften the impact of the losses and stimulate the local economy as households and businesses replace damaged property and inventory and purchase services from contractors. The greatest slow-down in sales has been in tourism and recreation, which slowed from nearly 18% annual growth during 2003-2004 to 3% growth from 2004-2005.⁶³

The reason for the relative decline in that sector is not clear. It may be related to decreased visitor spending or reduced resident spending on recreation items. It does not,

however, appear to be directly correlated to a reduction in visitors due to Hurricanes Frances and Jeanne. The period between Labor Day and Thanksgiving is typically the lodging industry's off-season. After the hurricanes, undamaged hotels were filled to capacity with displaced residents and relief workers, a temporary unanticipated boon for the local hospitality sector that was able to meet the demand for accommodations. Even on the longer-term horizon, tourism tax revenue in the post-recovery period from January to June 2005 increased up to 20% over the same period the year before.⁶⁴ Because tourism tax is generated from hotel stays and short-term lease rentals, it appears that the storms did not have a long-term impact on tourism. The Florida Department of Revenue estimates that tourism taxes for fiscal year 2006 will increase by 11%.

The reliance on tourism for continued economic growth has previously been noted as an economic vulnerability. Economic development officials in the region, as well as in the Panhandle, had adopted marketing strategies aimed at further economic diversification into less weather-dependant sectors. However, that effort has been frustrated by the perception of relocating or expanding firms that disruption attributed to recurrent storm activity makes South Florida a poor location for additional investment. That perception is fueled in large part by the long delay in the restoration of electrical power throughout the Treasure Coast after the 2004 hurricanes and the inability to pump in the wake of Hurricane Wilma in 2005. More than the potential threat of property damage, the idle caused by energy issues--defrosting freezers, shut down computers and telephone switchboards, traffic slowed to a crawl, and mile-long lines at the gas pumps--lingers in the minds of relocation consultants and corporate expansion strategists.

Figure 27



BARRIER ISLAND STUDY AREA

The jurisdictional fragmentation of the barrier islands makes it difficult to quantify their economic contribution relative to the region. They extend over several counties, contain two complete municipalities, and include parts of two others. Therefore, we have compiled previous studies that measure the value of commodities associated with the coastal shoreline and water. Those include research that attempts to quantify the economic value of beaches, the navigational waterways, and the Indian River Lagoon. The studies support the notion that the barrier islands and surrounding waters generate economic benefit primarily through their recreational and tourist uses and enhanced

real estate values. In addition, focus was placed on the impact on the hotel industry by the 2004 storms, as there are many hotels along the beach, and nearly all of those properties experienced storm damage.

Economic studies by Dr. William Stronge about the impacts of beaches on Florida's economy suggest that statewide, beaches create an estimated \$16 billion in property values and \$8.8 billion in annual spending. Our shores attract two million international tourists who spend about \$1.1 billion annually in the state.⁶⁵ The study also estimates that beaches contribute \$320.6 million in annual local government revenues and \$260.1 million in annual state sales tax revenues. In total, Florida's beaches generate \$41.6 billion of economic activity, an average of \$49.7 million per mile. One might argue that much of that relates to heavily urbanized areas such as Miami or Jacksonville, but if we assume that the Treasure Coast region represents an average level of development, the 60 miles of Treasure Coast beaches would generate an estimated \$3 billion in economic activity each year.

In 2001, the Florida Inland Navigation District estimated the value of the Intracoastal Navigational Waterway in each of the study area counties. Their data, which are compiled in Figure 28, suggest that those coastal waters support 7,700 jobs, nearly 6,000 in the recreation or leisure sectors. That represents almost one-third of the Treasure Coast's total leisure and hospitality employment. Businesses related to the navigational waters create nearly \$600 million of economic activity, the majority related to recreation.⁶⁶ Those figures appear conservative considering that a 1994 study of the value of the Indian River Lagoon estimated the lagoon's economic value, in terms of recreational spending and fishing, at \$733 million.

Figure 28

Value of the Intracoastal Waterway in 2001 (in millions)

	Martin	St. Lucie	Indian River	Treasure Coast
TOTAL IMPACT				
Business Volume	\$326.2	\$193.2	\$80.1	\$599.5
Personal Income	\$123.5	\$66.6	\$29.2	\$219.3
Jobs	4,237	2,359	1,185	7,781
COMMERCIAL IMPACT				
Business Volume	\$8.0	\$2.4	\$6.5	\$16.9
Personal Income	\$2.0	\$0.9	\$2.5	\$5.4
Jobs	158	62	150	370
RECREATION IMPACT				
Business Volume	\$318.0	\$190.9	\$73.6	\$582.5
Personal Income	\$80.9	\$65.8	\$26.8	\$173.5
Jobs	4079	2297	1035	7411

Source: G.E.C. county studies conducted for the Inland Water Navigation District.

The 2001 studies also estimate that residents of coastal communities contribute \$219.3 million of personal income to the regional economy. That represents approximately 14%

of the total personal income in the two metropolitan areas. Demographic data from the census support the fact that the barrier islands are home to the region's most affluent residents. Nearly 5,000 households have incomes over \$100,000 per year. Those residents have greater disposable income and help drive the local economy.

Barrier Island Businesses Types

To better characterize the number, type, and distribution of the businesses that are located in the study area, we conducted a survey of the commercial activities on the barrier islands. The survey, summarized in Figure 29, provides an overview of the type of commercial land uses that are present in conjunction with the residential uses. That information may be used to determine the economic vulnerability posed by hazard events that disrupt business activities. It can also be used to promote "emergency plans" for business and industry, as outlined in FEMA's *Emergency Management Guide for Business & Industry*.⁶⁷ Most important, as the goal of Local Comprehensive Plans is to encourage or preserve water-related or water-dependant uses and minimize economic vulnerability, the survey provides insight into the current balance of uses.

Figure 29

Survey of Barrier Island Commercial Establishments

TYPE OF USE	VERO BEACH		FORT PIERCE		JENSEN BEACH	
Retail	33	31%	5	22%	4	17%
Dining and Recreation	9	8%	3	13%	7	30%
Lodging	10	9%	8	35%	4	17%
Business Services	47	44%	2	9%	3	13%
Personal Services	8	7%	5	22%	5	22%
Total Establishments	107		23		23	

Source: Windsheild Survey Conducted Spring 2005

The survey identified three areas with commercial development within the study area. The largest commercial concentration is located in the portion of Vero Beach that extends over the Intracoastal onto Hutchinson Island. That segment developed as an up-scale resort village characterized by boutiques, gift shops, and oceanfront hotels. Vero Beach also contains a concentration of financial service companies and related business services that cater to the affluent residents of nearby communities such as John's Island. There are approximately 107 establishments in the area: 35% are retail stores; only 8% are dining or recreational establishments; and nearly 45% are commercial or investment

banks, real estate companies, and associated business service companies such as attorneys and title companies.

The commercial nodes in the South Beach area of Fort Pierce and the Jensen Beach portion of Hutchinson Island are significantly smaller. Approximately 23 establishments were identified in each cluster, including hotel and motel properties, convenience retail, food service establishments, and marine-related facilities. The Fort Pierce node is located along Seaway Drive at the foot of the North Bridge and is composed mostly of small freestanding buildings. The retail cluster to the south is made up of four small shopping plazas on the west side of A1A.

With respect to vulnerability, it is important to note the ownership type and commercial mix. Overall, the scarcity of commercial uses on most of the island significantly reduces the communities' vulnerability risk. With the exception of Vero Beach, the majority of commercial entities on South Hutchinson Island and Jupiter Island are lodging accommodations and a few tourist-oriented retailers, convenience stores, or service establishments. Barrier island establishments are primarily composed of small business owners, with the exception of some of the hotel properties. Those businesses are perceived to be particularly vulnerable to disruptions in business activity because they are not deeply capitalized and cannot endure long periods of closure or reduced sales. In addition, commercial tenants, in contrast to property owners, may not have the ability to properly secure their storefronts or initiate repairs in response to a hurricane event.

In contrast, Vero Beach contains a significant concentration of financial and professional service businesses that cater to affluent residents in the surrounding area. In addition, there are numerous high-end retailers and dining establishments and a concentration of resort hotels. The vulnerability created by the financial services and professional businesses is not related to the potential job loss, as those companies do not employ large numbers of people, but rather to information loss resulting from building damage and communication or power interruptions. Likewise, retailers such as jewelry and home furnishing stores are apt to maintain valuable inventory on site.

The risks posed by those uses can be mitigated with appropriate emergency planning and zoning. Many of the businesses are not tied to water geographies and are located on the barrier island for the convenience of patrons and owners. Moreover, electronic communications allow data to be backed up in remote locations, thereby reducing the need for geographic proximity. Businesses with well planned emergency preparedness strategies can also reduce the level of business disruption.

THE VULNERABILITY AND IMPACT OF THE HURRICANES ON BARRIER ISLAND BUSINESS

Hospitality

While the concentration and economic dependency on hospitality, leisure, and recreational businesses do not seem to create vulnerability at the regional level, that might not hold true at the local level. The barrier island properties are located directly on the water or in immediate proximity to the beaches and marinas, making them more susceptible to destruction from storm surge and wind. In addition, the barrier island hotels are resort-oriented and geared toward vacationers rather than a more constant stream of business travelers. Although the hurricane season does not coincide with the arrival of seasonal residents and out-of-state tourists, the hotels and restaurants are dependent on the regional summer vacationers--families who visit the beach on the weekends--to provide occupancy in the summer and fall months.



Resort businesses lose money when a storm warning causes canceled vacation bookings.

Resort businesses lose money when a storm warning causes canceled vacation bookings. Unlike business travelers who reschedule immediately after the danger has passed, vacationers are more likely to change destinations. A decline in tourism, irrespective of an actual hurricane landfall, has direct impacts on surrounding businesses dependent on visitor spending.

Actual hurricane landfalls present not only additional challenges but also opportunities. Prior to the storm, barrier island hotels must be evacuated, and hotel staff must help guests find and reach alternative safe accommodations, at the same time preparing the large facilities for the storm impact. Stranded guests end up at public shelters with few provisions, stressing the capacity of the emergency shelter system. Conversely, hotels in safer locations reach 100% occupancy and struggle to maintain the facility fully staffed.

It is assumed that storms that produce extensive damage cause longer-term income loss. While the property may be operable, the loss of amenities such as a pool or banquet facility or the perception that construction activities will interrupt a peaceful vacation is sufficient to dissuade reservations, putting the property at a significant competitive disadvantage. Out-of-state and international tourists may avoid the entire region if media coverage persistently focuses on the devastation. Hotel operators are forced to offer discounts, compounding the problem of additional reconstruction and operation costs.

Finally, because hotel and dining businesses tend to be large employers, hotel operators who close down leave many service workers unemployed. Chambermaids and

grounds-keepers are commonly low wage immigrant workers with limited skills. The loss of those stable jobs has secondary impacts, as struggling families require social services and financial assistance.

Our study showed that, prior to the 2004 hurricane season, there had been 21 hotel and motel properties in the study area with a total of approximately 1,775 rooms (see Figure 30). The properties represent a range of high-end full service resorts, efficiency units, and economical rooms managed by an assortment of national hotel chains, national franchises, and individual proprietors. Nearly all of the barrier island hotel properties and rental condominiums sustained some type of damage from the hurricanes and were closed in the immediate aftermath. A majority of the properties reopened in a matter of weeks or months and have repaired or upgraded their facilities.

As of June 2005, 10 hotels on the barrier islands had not re-opened, resulting in a loss of approximately 425 rooms. At least two had a limited number of rooms available. Among the properties that remained closed, four were undergoing complete renovation and were scheduled to reopen as hotel properties within a year or two. The Palm Court Hotel in Vero Beach was purchased by the Estafan family and is being converted into a 110-room luxury property with a private dining room. The Vero Beach Hotel and Club was undergoing renovation and due to re-open as a condominium hotel with 60 units. The 18-unit Riviera property was sold and scheduled to re-open as the Caribbean Court, a high-end boutique hotel with a new French restaurant. The Courtyard by Marriott in Jensen Beach was undergoing renovation and expected to reopen by year's end. Together those properties will return 282 rooms to the market.

Unfortunately, four properties have closed permanently, and the fate of two others is yet to be determined. The 110-room Radisson Resort in Fort Pierce was demolished, and the property has been sold for condominium development. Three small operators have also closed their doors. The future of the 110-room Holiday Inn in Jensen and the Holiday Inn Express in Fort Pierce is unknown. The larger resort property had completed a \$50 million renovation just a few years ago. Roof damage due to the loss of an air conditioning unit during the hurricane caused significant water damage throughout the building, and dune retreat exposed the pool facility.

Figure 30

Hurricane Impact on Treasure Coast Barrier Island Hotels

Property Name	Address	Location	Rooms	Stories	Status	Notes
Disney Resort	9250 N. A1A	Vero Beach	175	4	open	
Vero Beach Inn	4700 N. A1A	Vero Beach	107	4	open	
Holiday Inn Vero Beach	3384 Ocean Drive	Vero Beach	104	3	open	Was damaged and reopened with new suites
Palm Court Resort becomes Cabana Beach Resort	3244 Ocean Drive	Vero Beach	100	5	renovating	Will open as Cabana in 2007 with 110 rooms
The Driftwood Resort	3150 Ocean Drive	Vero Beach	100	4	open	
The Reef Ocean Resort	3450 Ocean Drive	Vero Beach	60	2	open	
Vero Beach Hotel and Club	3500 Ocean Drive	Vero Beach	54	4	renovating	60 rooms condo hotel will reopen fall 2005
The Aquarius	1526 Ocen Drive	Vero Beach	27	2	open	
The Riviera becomes Caribbean Court	Ocean Drive	Vero Beach	18	2	renovating	New boutique-hotel w/ French restaurant
The Islander Inn	3101 Ocean Drive	Vero Beach	16	1	open	
The Dockside Inn	1152 Seaway Drive	Ft. Pierce	72	2	open	
Holiday Inn Express Hotels	1230 Seaway Drive	Ft. Pierce	70	4	closed	No plans announced
Days Inn	1920 Seaway Drive	Ft. Pierce	36	1	open	
The Beachwood Motel	11. S. Ocean Drive	Ft. Pierce	35	2	open	
Hutchinson Inn	Seaway Drive	Ft. Pierce	21	1	closed	permanently
The Royal Inn	22 Hernando Street	Ft. Pierce	19	3	closed	permanently
The Kiwi Inn	Seaway Drive	Ft. Pierce	10	1	closed	permanently
The Radisson Beach Resort	2600 N Highway A1A	Ft. Pierce	110	4	closed	becoming Condos
Courtyard by Marriott	10978 South Ocean Blvd.	Jensen Beach	110	8	renovated	Re-opened December 2005
Holiday Inn Ocean Side	3793 NE. Ocean Blvd.	Jensen Beach	179	5	closed	Renovating expected to re-open June 2007
Hutchinson Island Marriott Resort	555 NE. Ocean Blvd.	Jensen Beach	276	4	open	Reopened first
Vistana South Beach Club	10740 South Ocean Drive	Jensen Beach	76	9	open	
Total Rooms			1,775			
Permanently Closed			262			

Source: Telephone survey June-July 2005, updated July 2006

The impact of the closures on the local economy cannot yet be accurately accessed. Initial hotel bed tax data for September, October, and November 2004 did not reveal a negative downturn in hotel revenue as a result of the storms. Rather, county bed tax figures were robust as hurricane relief workers and victims filled operational hotels during a typically slow period. Figures for the winter and spring are also up between 12% and 17%, according to tourism officials. Only St. Lucie showed a couple of flat months in the mid-winter, although those figures have also rebounded.⁶⁸ See [Appendix](#).

One can speculate that a change from hospitality lodgings to residential use will alter the form of public revenue generated from the properties, increasing the amount of property tax but eliminating the bed tax monies. More important, the type of occupant will change from short-term visitors to longer-term seasonal residents or permanent residents. Those occupants have different spending patterns, which could impact the local merchants who cater to the tourist trade.

Marinas

Marina businesses throughout Florida face significant challenges, such as the conversion of waterfront property to higher-value residential uses and marina sitting controversies triggered by environmental concerns. The vulnerability to coastal storms is yet another challenge. Storm surge not only inundates the facilities but lifts docks from the pilings and boats from their slips. Surge and wind toss both large and small boats against the piers and onto surrounding land, some inevitably sinking near their slips. In addition, some marinas provide pump-out stations and fueling services that pose a significant environmental threat if breached.



Marina businesses throughout Florida face significant challenges including vulnerability to coastal storms.

Public policy has begun to address the challenges of the marine industry in terms of land use and permitting issues. Local Comprehensive Plans address the need to preserve water-related activities and water access through exemptions that allow public investment to support those functions. The state's "Clean Marina Program" has worked to reduce the environmental impact of marinas on the waterways, encouraging owners to invest in modern technology that limits the risk of contamination from fuel. Nonetheless, state law does not permit marina owners to force boat owners to move their vessels

onto land or into safe harbors. By protecting the boat owners' right to keep their property in the water, the policy increases the damage risk not only to the boat owner but also to marina owners, as empty docks and piers weather the storms better than those smashed by rocking yachts. Marina owners attempt to protect themselves with slip contracts that require boat owners to pay for damage caused by their vessels. But in a storm's aftermath, it is often difficult to determine the degree of damage caused by one particular boat and even more difficult to collect reimbursement from multiple insurance companies. Moreover, marina owners must respond quickly to fuel and oil leaks from sunken vessels in order to limit environmental damage, but then face prolonged delays and controversy regarding reimbursement.

The majority of the region's marinas are located on the mainland side of the Intracoastal Waterway. There is a small cluster on the barrier island, at the foot of the South Bridge in Fort Pierce. The Pelican Yacht Club, with 97 slips, is the largest of the three; Inlet Marina and Dockside Marina each have 20 to 35 slips. Interviews with marina managers revealed that facilities on barrier islands are more difficult to insure. Unlike the mainland, the western shore of the barrier islands does not have protected harbors, making the facilities particularly vulnerable and too risky for private insurance companies. Coverage for flooding is available for upland structures from NFIP, but dock structures are not eligible. Thus, marina owners must self-insure the expensive docks and piers with reserve funds or obtain financing to rebuild.

In contrast, facilities on the mainland, both privately and publicly owned, are able to purchase insurance, although premiums are high. Some public facilities choose to self-insure but are able to rebuild using tax dollars or municipal debt. In the aftermath of the 2004 storms, owners rebuilt the facilities but could not easily recuperate the investment and remain price-competitive with the facilities having lower costs. The destruction caused by Hurricane Wilma in 2005 further challenges their viability.⁶⁹

Florida Power and Light Facility

A major feature of Hutchinson Island is the Florida Power and Light (FPL) facility located in St. Lucie County approximately 8 miles southeast of Fort Pierce. The plant has two nuclear reactors; the first began operation in 1976 and the second in 1983. The plant generates 1700 Megawatt hours, a year's supply of electricity for approximately one-half million homes. The plant employs 790 and generates \$600 million in revenue for St. Lucie County.

In obtaining permission for the facility in the 1970s, Florida Power and Light agreed to lease part of the property to the county for a public beach and to preserve three-quarters of the facility's property for environmental conservation. The more than 2 miles of beach and adjacent property are a wildlife refuge for 180 species of birds and animals, 36 of which are endangered or threatened, and an important turtle nesting habitat. FPL supports scientific programs tracking turtle nesting and provides popular environmental walking tours and education programs for the public.

The FPL facility introduces multiple hazard vulnerabilities to the region. Clearly, the facility represents a source of technological hazard risk and is a potential terrorist target. However, national regulations that govern nuclear power operations specify construction standards and safety protocols that mitigate risks for all types of hazard events, and hurricanes pose one of the lesser challenges. In accordance with emergency protocol, during the 2004 hurricanes the plant was shut down 24 hours prior to the impact of hurricane force winds. FPL also ensures that at least two shifts of employees and sufficient supplies are available at the plant during the emergency event. After the storm, the site is inspected by FPL supervisors, representatives of the Nuclear Regulatory Commission, and FEMA prior to resuming operation. That process caused the plant to be off-line for 10 days after Hurricane Frances and 8 days after Hurricane Jeanne.⁷⁰

According to company representatives, the hurricanes did not damage either of the nuclear reactors but caused \$60 million in damage to the facility's offices and on-site warehouses. Company representatives acknowledge that insurance addressed only a fraction of the loss, as FPL self-insures much of its property. FPL also spent \$17 million to restore dunes and beaches on its property.

DISCUSSION

Sustainable planning for the region and its coastal communities requires balancing economic development objectives with hazard mitigation strategies aimed at reducing asset exposure. Finding equilibrium is not easy. It requires a sophisticated understanding of the vulnerability to impacts, and trade-offs between different decision outcomes. One cannot apply a simple cost-benefit analysis, because in addition to the total dollars spent or invested, one must consider who benefits and shoulders the burdens of mitigation costs and hurricane impacts.

The coastal land use policies in many of the Treasure Coast communities emphasize zoning the barrier islands primarily for residential, open space/conservation, and water dependant and water related uses. Residential uses are assumed to minimize economic vulnerability because the loss risk is transferred to individual households, which subsequently purchase insurance coverage based on their risk and utility preferences. In contrast, locating commercial and industrial uses in vulnerable areas is perceived to jeopardize the economic vitality and potentially result in environmental contamination, depending on the nature of the activity. Disruption in the supply of goods and services results in a loss of business revenue, jobs and tax revenue.

This land-use strategy seems intuitively rational, but should to be qualified with respect to the nature of today's information-technology economy. Where as businesses with valuable and difficult to move inventory and assets do engender greater vulnerability, many businesses' primary commodity is information, which is increasingly digital and portable. Electronic communications allow data to be backed up in remote locations, or transported on a lap-top computer or portable hard-drive. With appropriate emergency preparedness planning, these types of firms can be temporarily be relocated and are comparatively resilient.

Conversely, water dependant and water related uses are geographically limited to coastal areas. As the coastline is a fixed commodity, the scarcity of developable land creates strong pressure to redevelop coastal commercial properties to the "highest economic use", primarily residential. Zoning and public subsidy targeted at encouraging the viability of water-dependant uses, such as commercial ports, marinas, and marine-science

facilities, are justified by the understanding that the peninsula's economy is inextricably related to waterfront access. But it is also important to acknowledge that some commercial and non-profit facilities also diversify the types of coastal experiences available to the public. Public beaches and parks provide regional residents and visitors access to the shore, but their enjoyment of the coastal resource is limited to passive recreation. Maintaining a diversity of uses can allow citizens to work, dine, and celebrate life's special occasions by the shore. It counters the exclusionary tendency associated with residential development.

The research revealed that emergency management and post-disaster recovery issues need to be holistically integrated into Florida's coastal economic development strategy. In the wake of the past two hurricane seasons, we learned that many business owners mistakenly assume the FEMA will provide grant funding, only to discover that FEMA aid comes in the form of low interest business assistance loans provided by the Small Business Administration. These loans must be paid back. Impacted businesses are sometimes reluctant to assume additional debt given the uncertainty of the rate of economic recovery. Moreover, not all businesses will qualify for the loan program, as proprietors are required to furnish financial records and have adequate creditworthiness.

While most business owners carry liability and property coverage, fewer business owners are familiar with specialized insurance lines options. Businesses can greatly mitigate the risk of hurricane events by obtaining "business continuity" insurance coverage, which provides compensation for costs related to maintaining operations during the recovery period. Expanding insurance coverage is challenging. Today, business owners, like homeowners, have also been confronted with skyrocketing insurance rates. In some cases they are unable to afford to purchase appropriate level insurance coverage. The looming insurance crisis in Florida caused Governor Bush to convene an insurance reform task force. This group began to meet in the summer of 2006 and may introduce reforming legislation in the coming year.

Businesses with well planned emergency preparedness strategies can also reduce the level of business disruption.

Historically, public policy regarding natural hazards evolved from the federal provision of emergency relief to increasing state and local involvement in preventive mitigation initiatives. As a result, the loss of life from hazard events has steadily declined. But, the market-driven accumulation of assets in vulnerable geographic areas has driven up the cost of hurricane impacts. The recognition that government intervention is justified not only to protect life and property but also to reduce the public costs of catastrophic



damage has refocused our policy effort on resiliency through sustainable development. Whereas public investment in infrastructure, emergency preparedness, and government-sponsored insurance has dominated hazard mitigation, the resiliency of modern society will grow by addressing community vulnerability through investing in social capital, supporting viable economic development, and integrating hazard mitigation into comprehensive land use and development regulations. The following recommendations address issues specifically germane to the barrier island, noted in the following by the symbol on the left and general mitigation suggestions that apply to the region as a whole.

BI

PEOPLE

Reducing
Social
Vulnerability

The demographic analysis revealed that the barrier islands greatest geographic vulnerability is not always tied to social vulnerability, as illustrated by the demographic characteristics of the barrier islands.

At present, barrier island property owners' high income levels and seasonal occupancy contribute to community resiliency. Their homes contribute approximately \$26 billion in assessed property value, and the residents do not require or consume commensurate resources. That imbalance is perceived as an asset, but it also embodies risk. Moreover, summarizing demographic data in averages obscures the variability of the range, and hazard strategies must acknowledge and address the spectrum of conditions.

- Public education regarding hazard vulnerability and mitigation builds social capital. Education about coastal hazards should address pre-storm preparedness and post-storm recovery strategies and be tailored to specific constituency groups to maximize its effectiveness in modifying behavior. Emphasis should be placed on aspects of individual responsibility and the availability of public services and resources.

BI

Barrier island residents are subject to mandatory evacuations. Nonetheless, they must acquire specific knowledge about properly securing their property and planning for the post-storm recovery period.

- Resiliency is enhanced through supporting economically disadvantaged citizens with a network of social and financial resources. To maximize social service providers' ability to serve community needs, coordination and increased financial and human resources are necessary. Public investment in identifying opportunities for new coordination and resources and creating those linkages are a valuable hazard mitigation project.
- Working parents and those who care for dependent adults face particular challenges after disaster events when established routines are disrupted. It is vital that conflicts posed by childcare, domestic recovery, and employer demands be eased with supportive services and intelligent public policy. Dismissing that is-

sue as outside the bounds of government is naïve. It disregards the impacts that absenteeism and reduced household income have on the regional economy and the potential long-term increase in public assistance and social service needs.

BI The mandatory evacuation policy for barrier island residents and the likelihood of protracted recovery periods in a storm's aftermath suggest that policymakers focus on more than the provision of adequate emergency shelter. They should also recognize the impact of displacement on residents and the economy and the need for innovative short- and longer-term temporary housing solutions.

BI Despite the resiliency demonstrated by high average incomes, realistic strategies must be developed for barrier island residents who lack adequate transportation, need medical services, do not carry sufficient insurance coverage, and face other hardships.

BI Evacuation clearance models must be updated regularly, not simply to account for population growth but also to incorporate shifts in demographic and lifestyle characteristics. Projected changes in resident age, car-ownership patterns, and tenancy of seasonal residents will impact the ability to obtain the desired evacuation results.

PLACE

Creating Resiliency in the Built and Natural Environment

Coastal development policy should sanction activities that respect and accommodate natural coastal dynamics, such as shoreline fluctuation and coastal storm impacts. Public and private development that are antagonist to those processes must be restricted to reduce the costs of protecting such assets and enable investment in initiatives that are ultimately more cost effective and sustainable. Existing public policies will have to be modified and new approaches developed to address the issue of shoreline migration caused by gradual natural erosion, storm surge, and sea level rise. Beach nourishment provides relief from some storm impacts and erosion, but those efforts must be complemented by strategies aimed at reducing asset exposure by using land use tools.

LAND USE

- Planning for resiliency requires vision and proactive intervention. The redevelopment of vulnerable areas must not rely solely on market-driven property trends or opportunities that might arise in the wake of storm damage, as most current policy is focused. The timing and opportunities created by those catalysts are unpredictable.

BI

Whereas current coastal development densities were determined primarily by emergency evacuation clearance standards, future land use regulations should consider broader parameters that encompass a full-cost accounting of the benefits and costs resulting from risk-exposed assets.

BI

Localities should continue to promote land conservation through public acquisition, conservation easements, and transfer of development rights that remove the development potential and promote sustainable hazard mitigation. Conservation land permits the ecosystem to absorb the storm impact and effectively reduces the total amount of potential asset exposure.

- Land acquisition criteria should reference hazard vulnerability and define a prioritization ranking for those parcels. That activ-

ity must not be relegated exclusively to post-disaster recovery activities.

- BI** The assumption that undeveloped barrier island parcels in private ownership will remain open space due to wetland constraints must be viewed with some skepticism. Increasing land values foster creative development proposals that can be realized with extra investment in infrastructure. That investment will be warranted if it can be recaptured in high-market values.
- BI** The predominance of residential land use has effectively curtailed the exposure of commercial assets. However, it has also accentuated the distinctions between private and public space. Revising zoning to accommodate limited amounts of appropriate commercial activities would increase barrier island patronage by providing regional residents with enhanced leisure, dining, and shopping activities in addition to passive recreation.
- BI** Appropriate placement and design of commercial activities would minimize vulnerability to storm damage and strengthen the barrier island business community. Uses that do not require permanent structures of high value might be appropriate for parcels with significant vulnerability to storm surge or flooding.
- BI** Zoning changes that promote smaller building footprints and limited impermeable surfaces should be developed for parcels where preservation of natural cover is an important mitigation factor. Clustered development should be required in PUDs to avoid hazard areas, and high-density residential structures should incorporate structured parking rather than surface lots.

SETBACKS

- BI** Localities should consider adopting setback requirements that are more protective than the state's and that place assets on the upland-most portion of the lot, thus allowing for the greatest natural shoreline fluctuation.
- BI** Defining overlay zones within which density and setbacks can be adjusted to reflect geographically-specific coastal conditions would promote resiliency without undue burden to the larger class of coastal parcels.
- BI** Present policy requires only structures with repetitive damage to be relocated away from the shoreline. To enhance resiliency, reactive policy should be complemented with proactive initiatives. Incentives that offset the cost of relocating existing vulnerable structures should be explored.

PUBLIC FACILITIES AND INFRASTRUCTURE

- BI** Accessibility to the barrier islands' natural resources is good public policy. Investment in facilities that support public access is worth the additional vulnerability exposure, especially if federal and state sources are available for post-disaster reconstruction.
- Localities must quantify the exposure risk to public facilities and plan for recurrent damage. Local capital expenditure budgets must incorporate greater reserves, especially if public facilities are deemed to be "self-insured."
- BI** The vulnerability of segments of Route A1A to storm surge and sea level rise and remediation of potential breached access should be addressed in post-disaster reconstruction plans and in local transportation capital improvement budgets.

- Regional cost-sharing approaches should be explored to distribute the cost of upgrading and maintaining critical large facilities and road infrastructure.
- Local governments must strive to take maximum advantage of National Flood Insurance Programs such as the Community Rating System (CRS) and Flood Mitigation Assistance (FMA). At present, the City of Stuart and the Town of Orchid do not participate in CRS. The CRS program will help lower insurance premiums in the community, and the FMA program has monies available for mitigating flood-prone areas. The counties could strive to increase the CRS ratings to a rank of 8 or 9, rather than 7.

BI

The extension of public sewers to older communities surrounding the Indian River Lagoon and its tributaries should be accelerated to reduce the risk of septic contamination to crucial waterways during flood events.

BI

The barrier islands' changing demographics suggest that the number of evacuees might increase in the coming decades. Plans for development of public emergency shelters should mind the shift toward year-round barrier island inhabitants and their household characteristics, such as age and automobile ownership rates.

- Funding must be committed to improve assessment of beach management impacts to the ecosystem and advancement of the engineering science that makes those projects environmentally neutral and cost-effective. Regional cooperation is needed among the stakeholders and participating government agencies, as the sedimentation of displaced beach fill transcends the political boundaries and jurisdictional control of the agencies involved.

BI

Public investment in natural protective features, such as restoration or enhancement of dunes and vegetation, should be explored as a cost-effective use of mitigation resources.

BI

Localities should explore creative ways of financing beach restoration projects to ensure that costs are borne proportionately by the benefiting constituencies. Special taxing districts, such as the Hutchinson Island Special District in Martin County, are one example of how funds for beach restoration can be generated.

BUILDING AND DESIGN STANDARDS

- Adoption of state building codes has increased the resiliency of the built environment, but more can be accomplished if current building codes are properly enforced, and if advances in engineering science are incorporated effectively in regulation.
- Localities and the state must cooperate in monitoring the effectiveness of building codes in reducing damage to the building inventory. Sharing of data on damage assessment and building construction characteristics is essential, but uniform protocols for recording and documenting information need to be developed to facilitate analysis.
- Electronic and geo-coded databases on building footprint location and design elevations must be created from paper-based parcel level records to facilitate hazard vulnerability and impact scenarios. Without that information, the validity of assessment models, such as HAZUS, cannot be corroborated.
- Building and development code changes should promote the highest standards for hazard mitigation based on the “precautionary principle.” Although raising standards to mitigate storm impacts increases construction costs, thereby raising concerns of affordability, it is better public policy to encourage upfront investment, as the construction process is a more cost-effective time to implement structural hardening.
- Attempts to relax the standards should be resisted, and delays in mandating best-construction practices must be avoided. In rapidly developing Florida, those tactics permit the inventory of sub-optimal construction to increase.

- The resiliency of the built environment would improve if the value of mitigation and the cost of vulnerability were accurately reflected in real estate values. For the public to properly value hazard resiliency and vulnerability characteristics of land and buildings, their expert advisors, including real estate agents, property inspectors, and legal representatives, should be required to explicitly address those hazard issues and the cost of alternative remedies with their clients before and during property transactions.
- Because vulnerability is embodied in the pre-existing older inventory, additional retrofitting programs need to be developed. Programs exist for low-income homeowners and organizations that address economically disadvantaged populations, but new programs and incentives (apart from the reduction in insurance rates that is currently available) must be developed for moderate-income and even higher-income households.
- Post-disaster reconstruction is the last opportunity for structural hardening. Insurance companies and regulators should craft coverage policies that promote enhanced resiliency rather than replacement of similarly vulnerable assets.
- An in-depth analysis must be undertaken of the effectiveness of requiring conformance to current building standards only when property damage exceeds 50% of building value. Construction costs, rising property values, and other factors suggest that the mitigation principle is compromised in practice. Martin County's cumulative damage approach represents an attempt toward greater compliance, while Vero Beach's experience with commercial structures points to obstacles inherent in current land development economics.
- Public policy must support the provision and use of storm-worthy hurricane shutters by all regional residents, and discourage reliance on wood boards that ultimately increase post-storm debris. State law mandates builders to furnish hurricane shutters in new homes, but no provisions were made for the pre-existing residential inventory. The hefty cost of purchasing shutters deters such investments, and insurance rate reductions

are an insufficient incentive. New programs, including property tax credits, rebate programs, ‘hand-me-down’ shutter recycling, or other financial assistance, are needed to promote their ubiquitous acquisition. Conversely, fees tagged to debris removal would discourage improvised plywood solutions.

- The growth and importance of the modular and pre-fabricated building industry in providing housing suggest that additional attention must be focused on that industry segment. Although the new building code regulations enhanced their resiliency, that resiliency must be monitored as the buildings age and experience multiple storms. The manufacturers of such housing stock should be required to adopt the most resilient engineering techniques that emerge, not the minimum statutory standard.



Development and land-use regulations should be reviewed and amended to facilitate the replacement of recreational vehicle parks and other mobile-home type dwellings with sturdier construction on barrier islands. Despite policy intended to avoid public investment in vulnerable areas, some public intervention may be necessary to avoid displacement of existing residents.

INTEGRATING THE PLANNING PROCESS

- Planning related to coastal hazards is carried out at several governmental levels through at least three planning processes (the Local Comprehensive Plan, the Comprehensive Emergency Management Plan, and the Local Mitigation Strategy) involving numerous players. Each plan focuses on discrete aspects of hazard planning, but vertical and horizontal integration are lacking.

- In reviewing their Local Comprehensive Plans, policy makers must move toward greater integration of hazard mitigation policy and objectives throughout the LCP's discrete components, not simply in the Coastal Element and in the coastal development regulations of the Future Land Use Element.
- Hazard assessments should be included in the Future Land Use Element and used to assess development suitability of vacant land and alternative development scenarios. Hazard assessment developed during the CEMP and LMS process, as well as modeling techniques using HAZUS, TOAS, or locally-generated data (such as the Exposure Analysis of this report), should inform land use decision-making.

BI

Electronic and geo-coded databases on building footprint location and design elevations must be created from paper-based parcel level records to facilitate hazard vulnerability and impact scenarios. Without that information, the validity of assessment models cannot be corroborated. The process is time consuming and costly, thus priority should be placed on coastal areas and flood zones.

- A legislative mechanism must be developed to ensure that the analysis and recommendations developed in the LMS and LMS updates find their way into the LCP in a timely manner. If the EAR processes only occur every 6 years, there should be a simple way of updating the plans or putting them on a coinciding cycle of updates and adoption. Integration among plans must focus on ensuring that planning directives have institutional resources for implementation.
- Local governments must work together to maximize the synergies of their planning initiatives and public investment in mitigation. That ranges from joint contracting of emergency and post-disaster services, cooperation in reconstruction efforts, shared investment in infrastructure projects, and regionally coordinated lobbying for federal and state resources.

ECONOMY

Promoting a Resilient and Vibrant Economy

The differential impact of hazards on industrial sectors suggests that economic diversification is important to ensuring that the region can prosper in the aftermath of catastrophic events: while some companies will experience a downturn, others will benefit and expand. That is evident in the Treasure Coast's ability to bounce back after the 2004 hurricanes despite the damage to the shoreline hospitality businesses.

Hazard-conscious economic development strategies must consider both the type of businesses to foster and their appropriate location. The strategy of limiting commercial development on the barrier islands has reduced exposure of economic assets to coastal storms. But it must not undermine the economic value of the beaches and waterways that are fundamental to the regional economy.

- Regionally, planners must target businesses that contribute to resiliency and do not introduce new vulnerability. Firms that are ill-suited for a climate subject to extreme events (for example, companies whose production processes are based on 'just-in-time' inventories or need to store unmoveable inventory) should be identified. It is important to discourage their proliferation and to anticipate the consequences of the absence of those goods and services in the economy.

BI

Barrier island commercial uses should be primarily geared toward recreational, entertainment, tourism, retail and convenience service uses that serve visitors and residents. Portable companies, those with few fixed assets, such as kayak rentals or vendors who occupy temporary booths and stalls, are ideally positioned to enhance tourism and back-up during hazard events.

- Government and business interests must work cooperatively in preparing companies to better cope with and reduce the disruption of business activities. Hazard events challenge firms of different sizes and operational requirements in different ways. Adaptive strategies must be tailored and incorporated into business plans early on to ensure that they are integrated into strategic decisions on capital investment and growth.

LABOR RESOURCES

The ability to adapt to changing demands for human resources without compromising employment levels improves economic and social resiliency. In the aftermath of extreme events, there is a temporary realignment of service demands that must be effectively managed to facilitate regional recovery and minimize personal hardships.

- Ensuring that employers have sufficient staff and that idled companies do not lose their skilled workers promotes economic resiliency. Local government hazard mitigation planning must include development of creative programs that facilitate temporary realignment of labor resources. Corporate human resource departments should proactively develop programs that address those issues as part of “business emergency preparedness plans.”

BI

Barrier island businesses are prone to be closed longer than those in less vulnerable areas. As such, the Chamber of Commerce or similar business organizations could help barrier island businesses network with regional firms that can provide temporary space and resources during the recovery period.

- Regions subject to frequent hazard events will need professionals with specialized skills, including hazard planning and recovery experience. Local colleges and professional schools should offer programs that train people in construction trades, skills needed to repair communication and transportation infrastructure, and financial skills required by the insurance industry and related financial institutions. Companies should employ staff with expertise in crisis and emergency management.

ECONOMIC SECTORS

Tourism remains an important component of the regional economy, and the hospitality sector is an important partner in sheltering residents and hosting recovery personnel. Although that sector fared well in the recovery period, additional measures would strengthen its resiliency in the face of future events.

- The critical role hotels play in emergency evacuation and post-disaster recovery must be recognized and effectively organized. Hotel facilities need to be built to hardened standards and equipped with facilities to accommodate extended stays under emergency conditions.

BI

The hospitality sector should develop more robust emergency operation plans that detail procedures for optimal operations under disaster and post-disaster conditions, including relocation of guests, policies for canceled reservations and extended stays, staffing needs, etc.

- There must be a commitment by both public and private entities to rebuild recreational amenities and arts, culture, and conference facilities that draw tourists and business travelers back to the region in the months and years after a hurricane.
- Small businesses are an important component of the regional economic engine and must receive particular attention in planning for hazard mitigation as they face unique challenges from hazard impacts. They often lack the financial resources to weather business downturns and face obstacles to hurricane preparedness and recovery when landlords are not willing or able to respond to issues regarding property damage or retrofitting.
- Provision of financial assistance by FEMA and the Small Business Administration could be augmented by state and local programs that offer greater flexibility in eligibility requirements.
- The cooperation of private sector banking institutions should be solicited by regional economic development agencies, creating a stronger regional network of financial resources committed to local investment in the face of increased credit risk.
- Existing programs that educate local businesses about emergency preparedness strategies must have resources to advance their training.

- Recovery from disaster events is slowed by shortages of key building materials and reliable licensed contractors to complete the work. The role of the construction sector must be evaluated to determine how it can support regional recovery in the face of competing demands for material and labor resources.
- The Chambers of Commerce and Economic Development Organizations can be instrumental in the recruitment of new companies and expansion of firms that can produce needed supplies locally, thereby helping ensure timely availability of those resources at lower prices.

INFRASTRUCTURE

- The restoration of power is among the most critical issues in minimizing economic disruption and facilitating rapid post-disaster recovery. Localities should install emergency generators at key public facilities and encourage businesses to invest in generator back-up systems, especially systems that are not dependent on gasoline, but rather on natural gas and solar power.
- A public safety campaign about generator use and road safety is needed to reduce accident and injury. Innovative fuel distribution alternatives might be created for emergency periods to reduce the sub-optimal transport and storage of gasoline.

BI The barrier islands' limited transportation options should be expanded. Frequent bus service along AIA could remove trips from the road and increase accessibility to the beaches for regional residents.

BI Provision of off-road bikeways and walkways would also provide an attractive recreational opportunity on the barrier island without increasing vulnerability.

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INTERVIEW LIST

Mr. Philip Baldwin, Florida Oceanographic Center, Staff of the June 6, 2005

Mr. John Basola, Property Tax Assessor Office, St. Lucie County December 13, 2004

Ms. Kate Boer, Treasure Coast Regional Planning Council August 2005

Ms. Lori Burns, Indian River Chamber of Commerce, July 21, 2005

Mr. Doug Coward, Commissioner, St Lucie County, November 20, 2005

Mr. Cheryl Dunn, Indian River County Dept. of Public Health, August 2005

Dr. Robert Deyle, Florida State University, Department of Urban Planning June 16, 2005

Mr. Jeffrey Furst, Property Tax Assessor for St. Lucie County, November 21, 2005

Mr. Tom Gonzalez, Former Florida Power and Light Staff, January 2005

Mr. John Gorham, Coastal Planning Engineer, Indian River County, February 11, 2005 and May 3, 2005

Mr. Bill Glynn, Barrier Island Coalition, July 2005

Mr. John Hoskins, Pelican Yacht Club & Marina, November 4, 2004

Ms. Maggy Hurchalla, Former Martin County Commissioner, February 8, 2006

Mr. John Hurley, South Florida Regional Planning Council July 2005

Ms. Celora Jackson, Coastal Engineer FL. Dept. of Environmental Protection, September 29, 2004

Mr. David Kelley, Senior Planner, St. Lucie County, December 12, 2005

Mr. Larry Koslick, FEMA Field Officer, Orlando Florida June 28, 2005

Mr. Mark Payton, Coastal Engineer, FL. Dept. of Environmental Protection, February 3, 2005

Mr. Mark Perry, Director of the Florida Oceanographic Center, November 4, 2005

Mr. Troy Rice, Staff, St. John Water Management District, March 13, 2005

Mr. Ken Ritzenthale, Actuary, FL. Dept.
of Financial Services, July 15, 2005

Ms. Rachel Scott, Public Relation Offi-
cer, Florida Power and Light July 2005

Ms. Jackie Thompson, Coastal Engineer,
FL. Dept. of Environmental Protection,
July 15, 2004

Mr. Ramon Trias, Former Director of
Planning, City of Ft. Pierce, October 10,
2005

Mr. Gene Verano, Coastal Engineer, FL.
Dept. of Environmental Protection May
4, 2005

Mr. Link Walter, Continental Shelf As-
sociates, November 2004, & September
14, 2005

Mr. Tom White, Mayor of the City of
Vero Beach, May 5, 2005

ENDNOTES

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⁶ Burby, Raymond, et al (1999). *Unleashing the Power of Planning to Create Disaster-Resistant Communities*. American Planning Association Journal, Summer 1999; 65,3 pg 247-259; Burby, Raymond, ed. (1998). *Cooperating with Nature: Confronting natural hazards with land use planning for sustainable communities*. Washington, DC, Island Press; Mileti, Dennis (1999) *Disasters by Design: A Reassessment of Natural Hazards in the United States*, Washington, D.C., National Academy Press; and The H. John Heinz III Center for Science, Economics and the Environment, (2000), *The Hidden Costs of Coastal Hazards*, John Heinz III Center for Science, Economics and the Environment. Washington D.C., Island Press.

⁷ The term 'study area' refers to the aforementioned barrier islands (BI) and surrounding waters. The term Treasure Coast is used to describe the Indian River, St. Lucie and Martin County region. Although the Regional Planning Council's include Palm Beach County in the Treasure Coast region, this study excluded Palm Beach County, as it is tied more closely with the South Florida region and was not impacted by Hurricanes Frances and Jeanne to the same degree. The term 'mainland' refers to data about the various counties which exclude the barrier island study area.

⁸ US Census Bureau, 1990 and 2000 Census, Summary of Population and Housing SF 3.

⁹ Florida Department of Revenue, Florida Legislative Committee on Intergovernmental Relations, revised 6/21/2005 retrieved 8/12/05 from

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¹⁰ Bureau of Economic and Business Research, University of Florida (BEBR), *Projections of Florida Population by County 2002-2030*, January 2003, Volume 36 #1, Bulletin No. 134.

¹¹ US Census Bureau, 2000 Census, Summary of Population and Housing SF 3, p. 24.

¹² US Census Bureau, 2000 Census, Summary of Population and Housing SF 3, p. 8. Age data were aggregated for Barrier Island Census tracts. Barrier Island Census Tracts included for this study are Indian River County: 505.1, 505.2 and 505.3; St. Lucie County: 12, 13, 17.1 and 17.2, and Martin County: 1, 15 and 16.

¹³ Ibid.

¹⁴ US Census Bureau, 2000 Census, Summary of Population and Housing SF 3, p. 42.

¹⁵ Storm's hit the poor worst." 12/04/2004 at <http://www.miami.com/mld/miamiherald/news/10456865.htm>.

¹⁶ US Census Bureau, 2000 Census, Summary of Population and Housing SF 3, p. 52.

¹⁷ US Census Bureau, 2000 Census, Summary of Population and Housing SF 3, H7.

¹⁸ University of Florida, Bureau of Economic and Business research, UF Survey Research Center, unpublished data, 2004 retrieved at http://www.bibr.ufl.edu/Articles/PAA2005_ElderlyMigr.pdf.

¹⁹ "Counties work to ensure poor have a way out in case of a hurricane." 10/3/05 at http://www.palmbeachpost.printhis.clickability.com/storm/content/local_news/epaper/2005/10/3/2005/c1a_evac_1003.html.

²⁰ "Hurricane response lacking for elderly." 11/18/05. at http://www.Palmbeachpost.com/pbnorth/content/local_news/epaper/2005/11/18/a20a.

²¹ <http://www.fema.gov/pdf/nfip/manual10-03/19r1003.pdf>.

²² Test projectiles include a small missile (2 gm at 80 ft./sec.) impact for cladding and components and cladding used in buildings above 30 feet in height, and a large missile (9 lbs, 2x4 at 50

ft./sec.) for components and cladding less between grade and 30 feet.

²³ Statute 161.053 defines the SHWL the line formed by the intersection of the rising shore and the elevation of 150 percent of the local mean tidal range above the seasonal mean high water line.

²⁴

<http://www.bcs.dep.state.fl.us/100ystrm/guide/cert-rpt.pdf>

²⁵ Thus within the study area all post 1985 construction meets the NFIP standards irrespective of location in the flood zone.

²⁶ "Subdivision approved to be built near Indian River County wildlife refuges." 7/12/2005 at http://www.tcpalm.com/tcp/pj_local_news/article/0,2548,TCP_1121_3932660,00.html.

²⁷ Interview, David Kelley, St. Lucie Planning Department, Dec. 10, 2005.

²⁸ Interview, Doug Coward, St. Lucie County Commissioner, Nov. 13, 2005.

²⁹ "Condo developer denied variance." 7/28/2005 at http://www.palmbeachpost.com/localnews/content/local_newspaper/2005/07/28/mlb_slh.

³⁰ "Hutchinson Island plan for mixed development draws controversy." 7/15/05 at http://www.tcpalm.com/tcp/the_news_local_news/article/0,22553,TCP-1028_4007336,00.html.

³¹ Interview with Kate Bower, Treasure Coast Regional Planning Council, August 2005.

³² Interview with David Quigley, Growth Management Department, Martin County, December 2004.

³³ Interview with Link Walters of Continental Shelf Associates, November 14, 2005.

³⁴ "Vero plans to let beachside shops rebuild from storms without bring buildings up to current regulations." 11/24/2005 at http://www.tcpalm.com/tcp/local_news/article/0,2545,TCP_15736_4262750,00.html.

³⁵ This problem has been researched and documented by Drs. Richard Smith and Robert Deyle in a case study on Hurricane Opal. See Smith, Richard, Deyle, Robert, Killingsworth, A. and Williamson G. (1996). *The use and impact of local*

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³⁷ Methodology was adapted from a GIS-oriented Community Vulnerability Analysis used by Dr. Ann-Margret Esnard for assessment of Nags Head, NC. See: Esnard, Ann-Margret, David Brower, and Bruce Bortz. (2001). *Coastal Hazards and the Built Environment on Barrier Island: A Retrospective View of Nags Head in the Late 1990s.* Coastal Management, 29:53-72.

³⁸ The Indian River Tax Assessors database did not contain a year built for 537 parcels. For consistency, those tax parcels were removed for analysis. However, it is worthy to note that 11,049 parcels were counted, and that would increase the total acreage by 1,237 acres. The missing parcels are believed to consist primarily of open space.

³⁹ The Martin County parcel database only included buildings constructed prior to 2002. Thus the percentage of buildings constructed prior to the building code is artificially high. Nonetheless, based on regional development patterns and interviews, we estimate that the number of post-2002 structures on the barrier islands is very low.

⁴⁰ "Rules on Coastal Setback need updating and enforcement." 8/17/05 at http://www.tcpalm.com/tcp/pj_editorial/article/0,254,TCP_1125_4006330,00.html, and Florida Department of Environmental Protection Bureau of Beaches and Coastal Systems, Division of Water Resource Management, (2005, August). *Hurricane Dennis: Post-storm Beach and Dune Erosion and Structural Damage Assessment and Post-storm*

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⁴¹ Interview with Jeff Furst, Property Tax appraiser for St. Lucie County, December 2005.

⁴² Florida Office of Insurance Regulation, Business Development and Market Research Program, Data Collection and Analysis Unit. *Disaster Reporting Summaries 6/20/2005*. Tallahassee, FL: Florida Office of Insurance Regulation.

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⁴⁵ Citizen's Insurance High Risk Account currently insures over 500,000 of Florida's most vulnerable coastal properties. It now holds 1.2 million policies in the state. Those points were raised in a conversation with Mr. Steve Miller of the Florida Insurance Council. Feb. 1, 2006.

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⁴⁸ Hutchinson Island Resource Planning and Management Plan, October 6, 1983, pg 22.

⁴⁹ Florida Department of Environmental Protection, Beach Erosion Control Project Monitoring Database. Retrieved 10/2004 at <http://beach15.beaches.fsu.edu/Martin/Martin.html>, http://beach15.beaches.fsu.edu/JupiterIsland/Jupiter_Island.html, <http://beach15.beaches.fsu.edu/FtPierce/FtPierce.html>.

⁵⁰ http://bcs.dep.state.fl.us/reports/crit_ero.pdf.

⁵¹ Department of Environmental Protection, Bureau of Beaches and Coastal Systems. Florida Beach Management Program, Long Range Budget Plan FY2004-5.

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<http://edr.state.fl.us/data/salestax/stx0506.htm>, 11/2/05.

⁶⁴ Florida Department of Finance, Office of Tax Research, Local Government Tax Receipts reported by County Form 3A.

⁶⁵ Catanese Center for Urban and Environmental Solutions, 2002. *Economics of Florida Beaches: The Economics of Beach Restoration 2002*, and Stronge, W.B. (2002a). The economic benefits of Florida's beaches: Local, state, and national impacts. Boca Raton: Florida Atlantic University. Retrieved May 15, 2002 from <http://www.coastalcoalition.org>.

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⁷⁰ Interview with Janice Karst, Public Relations Officer, Florida Power & Light, July 6, 2005.



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