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HURRICANE IKE IN TEXAS & LOUISIANA

8 Planning for a Sustainable Coast

The Galveston Bay region has been struck repeatedly by hurricanes in the past and will be again in the future. Reconstruction efforts and future development that consider and address the risks will result in communities that have fewer impacts and recover more quickly from future hurricanes. Rehabilitation and reconstruction should incorporate regional strategies that meet the needs of the area's residents and businesses. Chapter 8 addresses general planning approaches.

One of the most critical aspects of establishing sustainable building practices is effective community and regional planning that takes into account the existing geological hazards and the importance of protecting the natural environment. This chapter presents some of the issues that coastal communities face.

Hurricane Ike caused severe damage, leveled many homes, and destroyed a significant amount of infrastructure. In areas where the majority of the buildings were leveled, communities are offered an opportunity to rethink their coastal planning strategies. Rebuilding exactly as before will result in similar or worse damage in future hurricanes. Rather than attempting to rebuild what was there, the residents of these areas have an opportunity to thoroughly evaluate the coastal areas, and develop a responsible approach for their reuse. Taking a holistic view of the land and the environmental conditions that affect it will increase the probability of achieving a more sustainable result.

> "Before crossing the northern Gulf Coast, the counter-clockwise circulation of hurricane wind drives nearshore currents and large volumes of beach and shoreface sand alongshore. High tides, large waves, and strong currents that accompany the storms can leave semi-permanent marks on the barrier islands and beaches." For example, Hurricane Allen (1980) reoccupied more than 60 washover channels through South Padre Island, TX, destroying the main road that runs the length of the island in several places (Morton et al., 2004).

Models for community planning and housing design have changed over the last 50 years. For example, 50 years ago wetlands and marsh areas were not considered important. Over the past 40 years, there has been a growing appreciation of the pivotal environmental role wetlands and marshes play in helping to buffer storms from damaging the built environment. Community planning and building design paradigms are shifting based on current research and studies, and it is vital to disseminate this knowledge to communities to help them plan for a more sustainable future.

The first step in any effective urban planning or land-use planning is to perform a comprehensive evaluation of the site, including a complete understanding of the natural conditions and the forces acting on the site by the surrounding environment. The Gulf Coast ecosystem is dynamic, constantly changing due to the continuous and relentless ocean forces, and subject to drastic modifications during the occasional violent storm. The information that follows is intended to provide some guidelines and a description of some of the issues that coastal communities face.

8.1 Geologic Hazards and Coastal Communities

8.1.1 Geologic Hazards That Threaten Coastal Communities

Southwestern Louisiana and southeastern Texas are in the Chenier Plain, which is the western extension of the Mississippi Delta. The physical characteristics and geologic framework of the Chenier Plain, mainland beaches, barrier islands, and tidal inlets partly determine the trends and rates of shoreline movement and related coastal changes for the region (Morton et al., 2004). There are four external factors that exacerbate the already difficult environment. These include: 1) ground subsidence due to oil and gas withdrawal, groundwater pumping, and consolidation of subsurface soils; 2) rising relative sea levels (almost 1 foot, 8 inches [0.5 meter] in the past century); 3) increasing shoreline erosion resulting from human intervention in the natural system; and 4) destruction of the protective coastal dunes, saltwater marshes, and wetlands.

8.1.1.1 Subsidence and Relative Sea-Level Rise

> **RELATIVE SEA LEVEL**
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> "At any coastal site the relative sea level includes the global sea-level component (eustasy), tectonic uplift or down warping, and at some locations subsidence that is the result of natural sediment compaction or subsidence induced by the withdrawal of subsurface fluids such as groundwater, oil, and natural gas." (Morton et al., 2004)

The effects of subsidence and rising sea levels are not easily differentiated. According to a USGS report, *National Assessment of Shoreline Change: Historical Shoreline Changes and Associated Coastal Land Loss Along the US Gulf of Mexico* (Morton et al., 2004), measurements on Galveston Island, TX, and Grand Isle, LA, show a relative rise in sea level of about 1 to 2 feet (0.3 to 0.6 meter) during the twentieth century, a rate approximately three times faster than the average global rise in sea level (0.6 foot [0.18 meter] per century). The relative rise in sea level is composed of both sea level rise and subsidence. Subsidence occurs as both a natural process and as a result of human activities. In southeast Texas, subsidence is attributed to natural processes, compaction of sediments, and historic withdrawal of groundwater. Most southeast Texas municipalities have now switched to surface water supplies (Ray Newby, personal communication). In Louisiana, subsidence is attributed to groundwater withdrawal and natural sediment compaction (Gabrysch, 1984). An additional manmade cause is that sediment supply to the Mississippi River delta plain has been artificially reduced by controlling the Mississippi River and preventing it from flowing into the Atchafalaya Basin. In addition, recent studies have suggested that hydrocarbon production has been partly responsible for accelerated subsidence and wetland loss (Morton et al., 2004).

Figure 8-1 illustrates the steady rise in sea level at various locations along the Gulf of Mexico. Grand Isle, LA, experienced the steepest increase, with sea level rising about 1 to 2 feet during the twentieth century. Galveston has also experienced one of the steepest increases, with sea level rising about 1 to 2 feet (0.26 foot/year [6.5 mm/year]) during the twentieth century.

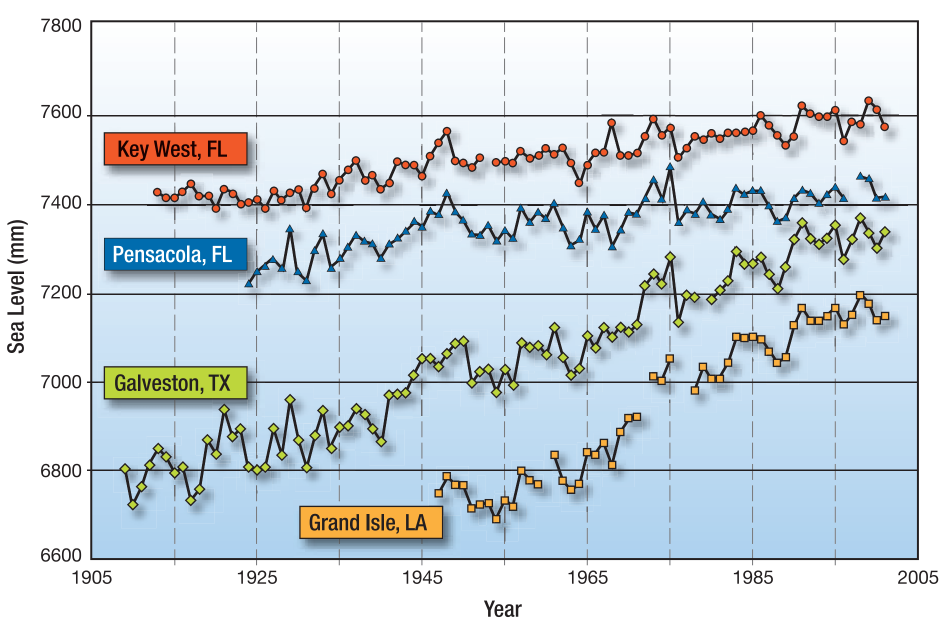
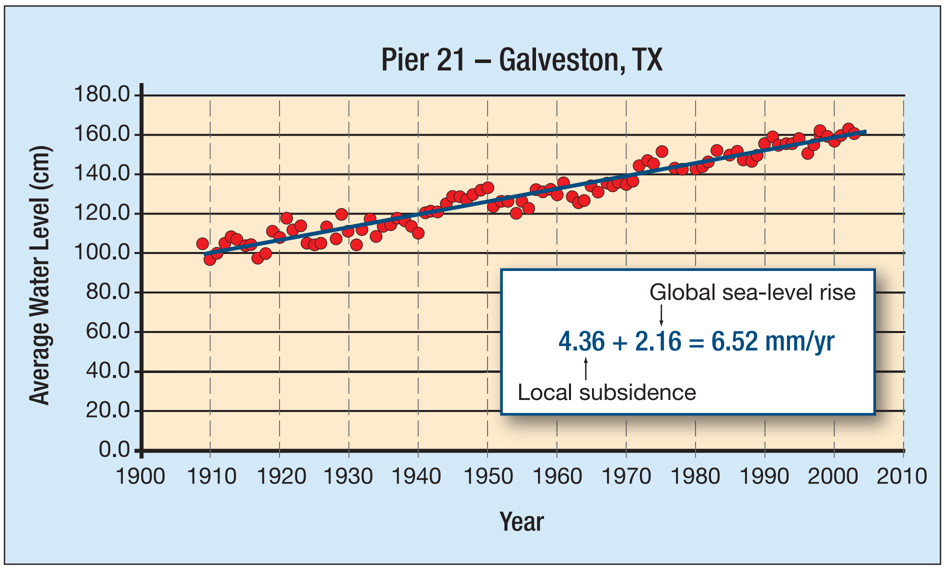


Figure 8-1. Long-term trends in average annual sea level at selected tide gauges in the Gulf of Mexico

SOURCE: MORTON ET AL., 2004

Topographic lines shown on USGS Circular 1182 indicate that Galveston has experienced approximately 1 foot of subsidence over the past 100 years (Galloway et al., 1999). Bolivar Peninsula has likely experienced similar subsidence, as it is on the southeastern edge of the Houston area subsidence bowl (Ray Newby, personal communication). Texas City has experienced 4 feet of subsidence. The east side of Houston, in the Baytown area, has experienced up to 10 feet of subsidence. A recent study conducted by the Harte Research Institute for Gulf of Mexico Studies identifies a 2-foot, 2-inch relative sea level rise at Pier 21 on Galveston over the past 100 years (Yoskowitz and Gibeaut, 2009). The authors attribute 8.5 inches (0.216 meter) of the relative sea level rise to global sea level rise and 1 foot, 5 inches (0.436 meter) to local subsidence (Figure 8-2).

Figure 8-2.
Relative sea level rise at Pier 21, Galveston, TX
SOURCE: YOSKOWITZ AND GIBEAUT, 2009



The average global rate of sea level rise for the past century has been 0.6 foot (Morton et al., 2004). NOAA/National Ocean Service's (NOS) Center for Operational Oceanographic Products and Services (CO-OPS) collects and distributes observations and predictions of water levels and currents to ensure safe, efficient, and environmentally sound maritime commerce. Table 8-1 presents increases in sea level predicted for the next 100 years based on available data from 1957 to 2006.

Table 8-1. Predicted Sea Level Increases

Location	NOAA Station #	Trend based on monthly mean sea level data	Based on Data range	Change in 100 years
Galveston Pleasure Pier, TX – Gulf side of Galveston Island	8771510	1/4 inch (6.84 mm) per year with a 95 percent confidence interval of +/- 0.81 mm/year	1957 to 2006	2.24 feet
Galveston Pier 21, TX – Bay side (west) of Galveston Island	8771450	1/4 inch (6.39 mm) per year with a 95 percent confidence interval of +/- 0.28 mm/year	1908 to 2006	2.10 feet
Freeport, TX – west of Surfside Beach	8772440	5/16 inch (4.35 mm) per year with a 95 percent confidence interval of +/- 1.12 mm/year	1954 to 2006	1.43 feet
Grand Isle, LA	8761724	11/32- inch (9.24 mm) per year with a 95 percent confidence interval of +/- 0.59 mm/year	1947 to 2006	3.03 feet
Eugene Island, LA	8764311	3/8 inch (9.65 mm) per year with a 95 percent confidence interval of +/- 1.24 mm per year	1939 to 2006	3.17 feet
Average global sea level rise	Various. NOAA samples throughout the world, from Iceland to Japan	1/16 inch (1.8 mm) per year	Various. Oldest is 1832 (Sheerness, UK); most recent are typically 2006	0.6 foot

SOURCE: NOAA TIDES AND CURRENTS, http://tidesandcurrents.noaa.gov/sltrends/msltrendstablefc.htm

Grand Isle and Eugene Island, LA, are the highest and Galveston is the second highest of all the U.S. Coastal Stations NOAA is taking readings from. The average global sea level rise is only 0.6 foot. NOAA cites the Intergovernmental Panel on Climate Change (IPCC) Report, which estimates that the global sea level rise was approximately 1.7–1.8 millimeters per year over the past century (IPCC, 2008) based on tide station measurements around the world.

Sea-level rise needs to be considered when planning new houses, businesses, critical facilities, new communities, and during future renovation along the southeast coast of Texas and southwest coast of Louisiana. This is especially true for these areas, as they are experiencing significant sea-level rise compared with other coastal areas monitored by NOAA stations throughout the United States.

8.1.1.2 Shoreline Erosion

The upper Gulf Coast of Texas, which includes Galveston Bay and Bolivar Peninsula, is experiencing significant erosion, submergence, and wetland loss (Morton et al., 2004). Erosion of the Gulf shoreline at Bolivar Peninsula and Galveston Island has threatened numerous buildings in several beachfront communities. Small beach fills have been implemented, and geotextile tubes have been placed by Galveston County and private entities on the public beach to protect residences (Figures 8-3 and 8-4).

Figure 8-3.
Broken geotextile tube at Beachside Drive, Galveston Island, TX

Figure 8-4.
Broken geotextile tube at Beachside Drive, Galveston Island, TX

As of January 2009, surveys at selected locations indicated that Hurricane Ike eroded an estimated 50 to 150 feet of lateral shoreline on Galveston Island, from just west of the Galveston seawall to approximately 6 miles west, and 50 to 100 feet of lateral shoreline on Bolivar Peninsula. Additionally, surveys indicated that an estimated 5 to 10 feet of vertical loss due to shoreline erosion occurred on Galveston Island, west of the Galveston seawall (Dr. John Anderson and Ray Newby, personal communication).

According to the USGS assessment report (Morton et al., 2004), long-term rates of shoreline retreat along the Texas Gulf Coast have been measured up to 48 feet per year. Erosion rates of Gulf beaches in Texas are highest between Sabine Pass and High Island and downdrift (southwest) of the Galveston Island seawall. The most stable or accreting beaches in this area are on southwestern Bolivar Peninsula. Although short-term erosion rates are experienced by only 48 percent of the shoreline, the average short-term erosion rate of 8.5 feet per year is higher than the long-term rate, indicating accelerated erosion in some areas.

In the past decades, installation of jetties and seawalls/groins have affected the shoreline on the barrier island (Figure 8-5). Sand accumulates on the south side of the south Bolivar Roads jetty on Galveston Island, and established foredunes are abundant in that area. West of the 10-mile-long Galveston Island seawall and groin (constructed to protect the City of Galveston from storm events), the beaches are retreating, with rates of erosion at the west end of the seawall reaching 12 feet per year.

Figure 8-5.
West end of the seawall at Galveston, TX. The concrete ramp (right foreground) was the road leading to the beach in the mid-1960s. Since then, the beach has eroded more than 492 feet.

SOURCE: MORTON ET AL., 2004

8.1.1.3 Dunes and Wetland Loss

Dunes are an important natural resource for Galveston County and Chambers County, helping to protect the Texas coast from storms and flooding by dissipating the wave action of hurricanes. The dunes are dynamic, in constant change, and part of a natural cycle that stores sand and ensures the health of the beaches. Sand for the Gulf Coast barrier islands and beaches comes from eroding mainland shores, the continental shelf, and rivers such as the Rio Grande and Brazos Rivers. Historically, the Mississippi River also deposited its load of fine-grained sediments to the littoral system, which flows southwest on Bolivar Peninsula and Galveston Island; due to human intervention, the Mississippi River now deposits its load of fine-grained sediments at the edge of the continental shelf in relatively deep water, where it is unavailable to build beaches and barriers (Morton et al., 2004). Furthermore, the Mississippi River Gulf Outlet, MRGO, designed and constructed to keep channels open and direct the sediment load out to the continental shelf, acted as a funnel to focus the surge directly at New Orleans. Human intervention has resulted in subsidence, erosion, and salt water intrusion into the estuaries and bayous of coastal Louisiana (Warrick and Grunwald, 2005).

> **CASE STUDY – MONMOUTH COUNTY, NJ**
>
> For many years, the natural dunes in Monmouth County, NJ, were removed or altered to accommodate development. This made oceanfront properties more susceptible to damage from waves during major storms. The smaller beaches affected tourism and removed wildlife habitat. Dune restoration projects are now being initiated along the Monmouth County shoreline. These manmade dunes are once again providing storm protection and habitat, increasing the width of beaches and increasing tourism opportunities. (Source: Visit Monmouth County http://www.shore.co.monmouth.nj.us)

Estimates of historic heights of dunes on Galveston Island range from 9 feet North American Vertical Datum of 1988 (NAVD88, 6 feet above a 3-foot beach) to 13 feet NAVD88 (9 feet above a 4-foot beach) on Galveston Island and Bolivar Peninsula (Dr. James Gibeaut, personal communication) to 11 to 14 feet NAVD88 on Galveston Island based on fine-grain size (Dr. John B. Anderson, personal communication). Mean sea level at Galveston is 0.5 foot NAVD88, and the grade height along the beach is typically 3 to 4 feet NAVD88.

Most of the dunes along Galveston Island and Bolivar Peninsula were less than 5 to 6 feet NAVD88 high or non-existent before Hurricane Ike. The majority of developed areas had little to no dune development. Where developed areas were situated further back from the shoreline, the dunes were approximately 6 to 8 feet NAVD88. On the eastern end of Galveston Island, which is benefiting from sand increase trapped by jetties, the dunes were approximately 7 to 10 feet NVAD88 high and about 30 to 40 feet wide (Dr. James Gibeaut and Ray Newby, personal communication). The dunes along Galveston Island and Bolivar Peninsula have been repeatedly damaged during hurricanes and significantly altered from human intervention. Galveston Island and Bolivar Peninsula dunes could help to provide a natural defense for the area if the dunes are allowed to grow back to their former heights, thereby providing significant protection to the residences, commercial buildings, and petrochemical infrastructure in Galveston Bay. While they could still be overtopped by high-water hurricanes, dunes would help to protect the area by taking the impact of the waves (Dr. James Gibeaut, personal communication).

Marshes, swamps, and wetlands play a vital role in the coastal zone. They have tremendous biologic, economic, flood, and coastal defense value. They perform beneficial chemical and physical functions, provide habitat for fish and wildlife, are a major economic resource, and play a critical role in flood mitigation. They help reduce erosion by absorbing and dissipating kinetic wave energy, increasing sediment deposition, and reducing the flooding hazards of hurricanes and other coastal storms by helping to protect coastal and inland properties from erosion and flooding.[1]

> "Wetland losses, which constitute about 75 percent of the total land losses, have dramatically accelerated both directly in response to human activities or indirectly as a result of modifications to the coastal system. Rates of land loss around bays are highest near the heads of the largest bays where long wave fetch and high bluff elevations produce unstable conditions" (Morton et al., 2004, pg. 31).

America's Wetland Resources Center estimates that for every 3 miles of healthy coastal marsh that a hurricane crosses, 1 foot of storm surge is dissipated.[2] Tidal marshes act like a sponge to sop up water that pours in from the sea during a storm. Without marshes to absorb excess water, many low-lying areas would be prone to flooding. The Texas bay areas include wetlands that are 1 to 2 miles wide. While these wetlands are not the scale of the wetlands of Louisiana, with 30+ mile wide stretches of marsh, they do still play a role in helping to dissipate storm surges along with their other biologic and economic value.

8.1.2 Discussion of Conflicts Between Coastal Communities and Geological Hazards

Over the last 100 years, our engineering ingenuity has enabled people to live directly on the beach. More people live along the coast and more people are moving to the coast than ever in our past. According to the U.S. census figures, half of the U.S. population lives in coastal areas comprising 17 percent of the contiguous land area (Crossett et al., 2004). According to the Texas General Land Office (GLO), more than 25 percent of the Texas population lives within the 18 counties that comprise the coastal management zone. Houston is the fourth largest U.S. city, and the third largest metropolitan area close to a coast. In recent years, there has been a rapid rise in development along the upper Texas coast. In the face of increased development and increased interest in living on the coast, communities need to be more aware of the dynamic nature and dangers of the coast and the value of the natural barriers that protect it.

The trends show that more people will be moving to the upper Texas coast. The trends also show an increase in relative sea level rise. In addition, the upper Texas coast has been experiencing coastal ecosystem erosion for some time. The most important value of the natural ecosystem, wetlands and dunes, is that they provide a buffer from hurricane damage, flood control, nursery grounds for fisheries, and water supply and treatment. It is vitally important to the health of the residences, businesses, and infrastructure that the community at large begin to recognize the value of the natural ecosystem and protect it to nurture it back to health.

1 Coastal Texas 2020 Public Input and Scoping Document, Texas General Land Office http://wwwdb.glo.state.tx.us/res_mgmt/ct2020/scopingdocument.cfm.

2 America's Wetland Resources Center, The Basic Facts, http://www.americaswetlandresources.com/background_facts/basicfacts/FAQs.html.

As the dynamic islands change and erosion continues to remove land along the barrier islands, houses are ending up close to the water's edge, or in the water. With development this close to the water, the dunes cannot rebuild. The upper Texas coast needs to consider critical areas for the health of the ecosystem and build sustainable communities for future building. As part of the reconstruction and recovery after Ike, some questions that coastal communities should consider include:

- How do we modify existing communities and redevelop damaged communities in light of the above information?
- Is building higher and stronger the answer?
- How do we address the presence of residences built in critical areas of the ecosystem, in an area that might be considered a no-build zone?
- Should we create a buyout program for those critical areas?
- How do we protect unhealthy coastal ecosystems from further development?
- How do we allow the dunes to restore themselves?
- Are additional regulations needed to enforce dune and coastal wetland protection?
- Are joint efforts with county, State, and Federal agencies needed?

When coastal wetlands are in private ownership, decisions are typically made on the basis of what is best for the owner, not society at large. It is important that the land owners recognize the value of the coastal ecosystem—this can be accomplished through education and public outreach programs (refer to recommendations). Landowners that make wise decisions regarding the coastal ecosystem should be publicly recognized.

8.2 Existing Planning Resources and Programs

8.2.1 Texas

Land use planning is critical to Galveston Island barrier island and to the Bolivar Peninsula, and the risks and vulnerabilities of these areas need to be identified. Texas has existing programs and resources that can be used by municipalities to guide reconstruction and plan for the future.

Coastal Erosion Program and Coastal Texas 2020 Report

The Texas State coastal erosion program was initiated in 1999 when the Coastal Erosion Planning and Response Act, CEPRA, was enacted. In 1996, the Texas GLO submitted the *Texas Coastwide Erosion Response Plan*[3] to the 75th Texas Legislature describing the problems caused by erosion of the Gulf beaches and bay shorelines and the need for funding projects to mitigate

3 Texas Coastwide Erosion Response Plan, 2004 Update http://www.glo.state.tx.us/coastal/cerp/index.html

the damages. In 1999, the 76th Texas Legislature enacted the CEPRA supplying initial funding for 23 erosion response projects (Cycle 1 projects). The 77th Texas Legislature supported funding for another set of projects (Cycle 2 projects). In May 2004, the Texas Legislature supplied funding for half of the initial amount requested for the Cycle 3 projects. The Coastal 2020 report was issued in 2005 and submitted to the 79th Texas Legislature and to the 109th Congressional Delegation. The purpose of the report is to encourage lawmakers, throughout Texas, to consider that coastal issues need to be addressed and require funding.

Geohazards Map Program

Based on recommendations in a report titled "*Living with Geohazards on Galveston Island: A Preliminary Report with Recommendations, Prepared for and submitted to the Galveston, Texas City Council, July 2, 2004,*" (Gibeaut et al., 2004), the Coastal Research Group, Texas Bureau of Economic Geology (BEG) prepared a preliminary geohazards map in July 2004, and has prepared more recent versions showing current conditions for Galveston Island. The map shows low-lying areas and historical erosion rates and projects them into the future. The geohazard map presents a best-case scenario, as it uses only historical average global sea-level rise and subsidence rates, and does not reflect any increase of these rates based on new studies. The historical erosion rates presented in the Galveston Island geohazards map are based on 60 years of aerial photograph documentation that track shoreline migration. The earliest aerial photographs were taken around World War II. The elevation data is from LiDAR measurements taken by the BEG over the last 10 years. Maps such as the City of Galveston geohazard map can provide useful information for homeowners and businesses when selecting a site to locate a building.

8.2.2 Louisiana

This section describes several coastal planning programs and resources in Louisiana.

Coast 2050: Toward a Sustainable Coastal Louisiana

In 1998, Governor Foster and his administration prepared a strategic plan, Coast 2050, to establish a blueprint for comprehensive coastal restoration in Louisiana. The preparation of Coast 2050 was a joint planning initiative between the Louisiana Wetland Conservation and Restoration Authority (LWCRA), the Breaux Task Force, and the Louisiana Department of Natural Resources Coastal Zone Management Authority (LWCRA, 1998).

The development of the plan included:

- Soliciting public opinion and recommendations
- Resolving conflicts between restoration goals, coastal zone development, and infrastructure needs
- Formulating a plan that was acceptable to the public, scientifically sound, and achievable

Coastal Wetlands Planning, Protection and Restoration Act

The Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA), which was submitted by Senator John Breaux and authorized by Congress in 1990, provides for targeted funds to be used for planning and implementing projects that create, protect, restore, and enhance wetlands in coastal Louisiana. The CWPPRA, also known as the "Breaux Act," provides Louisiana with approximately $40 million annually to assist in long-term conservation of Louisiana's coastal wetlands. The Louisiana Coastal Wetlands Program established a Federal task force,[4] the CWPPRA Task Force, which consists of five Federal agencies and the State of Louisiana. USACE tracks the project status of all of the CWPPRA projects. It also constructs many of them.

Coalition to Restore Coastal Louisiana

The Coalition,[5] formed in 1988, is a non-profit advocacy organization whose mission is the protection and restoration of a sustainable coastal Louisiana. The goal is to reverse the pattern of net land loss in coastal Louisiana and to reestablish a sustainable balance to its geologic processes and communities. In pursuit of this goal, the Coalition advocates the implementation of sound coastal policies and monitors coastal activities to ensure that stringent regulations and enforcement policies are maintained.

8.2.3 Nationwide Initiatives

Smart Growth

Rebuilding damaged communities in the Galveston Bay, TX, area and southwest Louisiana, provides local and State governments an opportunity to promote Smart Growth principles. Smart Growth communities promote development in ways that preserve natural lands and critical environmental areas, protect water and air quality, and reuse already-developed land. Smart Growth communities conserve resources by reinvesting in existing infrastructure and reclaiming historic buildings. Smart Growth practices are very old; this is how older urban villages, towns, and cities such as the City of Galveston were shaped.

SMART GROWTH NETWORK

The Smart Growth Network (SGN) is a partner coalition and consists of over 30 public sector, private sector, and nongovernmental organizations seeking to create smart growth in neighborhoods, communities, and regions across the United States. The SGN works to encourage development that serves the economy, community, and environment. Individual membership information, publications, and information about smart growth are available online at www.smartgrowth.org.

Infrastructure, businesses, and residences are concentrated to take advantage of walkable neighborhoods. These denser neighborhoods provide a wealth of resources. The denser neighborhoods provide solutions to concerns facing many communities about the impacts of the highly dispersed development patterns of the last 50 years. The walkable neighborhoods provide an alternative to driving long distances to get to work or to a store each day, especially as

4 http://crcl.org/stateandfederalplans/cwppra.html and http://www.lacoast.gov/cwppra/
5 http://crcl.org/aboutus.html

gas prices rise and while America is dependent on foreign oil. The denser neighborhoods are an alternative to abandoning a neglected urban site and developing instead prime farm land, thereby damaging our environment at the fringe of suburbia. Local and State policymakers, planners, architects, developers, and others are incorporating Smart Growth as a solution to these challenges (International City/County Management Association [ICMA], 2002). Good examples of Smart Growth principles in action on Galveston Island are the City of Galveston and the New Urbanism community, Beachtown (Figure 8-6). The City of Galveston is located behind the seawall. A future location for new construction or renovation could be behind the seawall in this walkable community. Beachtown, located at the east end of Galveston, is one of the few places on the island that is accreting, and new residences could take advantage of this.

Figure 8-6.
Beachtown, TX, under construction

A key element of Smart Growth principles is mixed land use. By mixing land use—such as residential, commercial, and institutional—the framework for a walkable community is in place. Another key element is to provide a mix of housing options, such as high-density residential to low-density residential. Higher density housing will support commercial and institutional uses. For example, a residential neighborhood that provides a 10-story mid-rise development, a three-story courtyard apartment complex, a townhouse development, and single-family houses will provide a mix of residential options. The denser residential buildings will sustain commercial and institutional activities, including commercial areas for groceries, pharmacies, hardware stores, restaurants; professional areas for doctors; and institutional buildings for recreational activities, community centers, and libraries. Open spaces can be preserved for uses such as parks, farmland, and critical environmental needs. A variety of transportation means can be provided, such as bike paths, sidewalks, buses, rail, and automobiles.

Implementing Smart Growth is a change to the way of doing business. It is vital to include community collaboration in decisionmaking related to Smart Growth. Local governments, lenders, community groups, zoning officials, developers, transit agencies, State governments, and others need to work together to provide the necessary changes in the way building and planning are done (ICMA, 2002). For example, there are zoning laws in place that have not caught up with these new practices. These zoning laws would need to be modified to promote Smart Growth practices. A new development called Beachtown under construction along the eastern end of Galveston Island will be a walkable community along the beach with a town center (Figure 8-7).

SMART GROWTH PRINCIPLES

1. Mix land uses
2. Take advantage of compact building design
3. Create a range of housing opportunities and choices
4. Create walkable neighborhoods
5. Foster distinctive, attractive communities with a strong sense of place
6. Preserve open space, farmland, natural beauty, and critical environmental areas
7. Strengthen and direct development toward existing communities
8. Provide a variety of transportation choices
9. Make development decisions predictable, fair, and cost effective
10. Encourage community and stakeholder collaboration in development decisions

For more information:

Smart Growth Web site, www.smartgrowth.org

Getting to Smart Growth: 100 Policies for Implementation (ICMA, 2002)

Figure 8-7. Beachtown, TX, under construction

Historic Preservation

Historic buildings are protected under the NHPA and are a recognized value to our national culture. Historic buildings are part of the history and fabric of Galveston. Additionally, older homes can provide useful information related to sustainable building practices. Older homes were designed to minimize solar gain through the use of deep porches, and overhangs, and they functioned adequately with daylight as the primary source of illumination. They were designed with high ceilings and cross-ventilation, with raised first floors to cool the buildings. Many of these homes may have had their own cisterns for rainwater catchment. With proper attention to disaster-resistant details, these practices can all support passive survivability of the building.

Reuse of existing buildings as opposed to building a new structure is one of the most effective strategies for minimizing environmental impacts. Reuse results in less habitat disturbance and typically less infrastructure development. Rehabilitation of existing buildings results in less waste sent to landfills. However, effective reuse of existing buildings requires that they be retrofitted to reduce the possibility that they will be damaged and destroyed by future hurricane winds or storm surge.

8.3 Recommendations for Rebuilding After Ike

The following are recommendations for communities and municipalities to consider as they begin rebuilding after Ike and planning for the future.

8.3.1 Specific to Local Communities

Sustainable Land Use Planning Recommendations

Coastal Counties:

Recommendation #1: Identify the risks to and vulnerabilities of the coastal communities and develop mitigation strategies to address them as part of the community's master plan. Identify zoning, land ownership, resident populations, tourism, and economic activity, and identify where and how vulnerable these assets are to natural hazards.

City of Galveston and Jamaica Beach:

Recommendation #2: Prepare a Sustainable Land Use Plan that considers that more severe hurricane impacts can be expected in the future and incorporates the geohazards map prepared by BEG, and relative sea-level rise for the next 50 years as a minimum.

Bolivar Peninsula:

Recommendation #3: Prepare a Sustainable Land Use Plan and that considers that more severe hurricane impacts can be expected in the future and incorporates a geohazards map and an additional overlay map that shows relative sea-level rise for the next 50 years as a minimum.

City of Galveston, Jamaica Beach, and Bolivar Peninsula:

Recommendation #4: Provide an overlay map accounting for the natural dynamism of the barrier peninsula. A Sustainable Land Use Plan should be a living document that changes over time. A sustainable landscape is a prerequisite for both storm protection and environmental restoration. Prepare a map showing the amount of shoreline erosion that will occur over the next 50 years if current trends are maintained.

Recommendation #5: Allow new construction and additions only in areas that are deemed safe with low risk, based on the Risks and Vulnerabilities and the Sustainable Land Use Plan, which includes future trends over the next 50 years. This will ensure that development stays out of the fragile coastal zone that needs to be protected for dune dynamism and growth.

Recommendation #6: Municipalities require that future development projects comply fully with the Clean Water Act 404 requirements before granting construction permits.

Galveston Island, Bolivar Peninsula, Galveston Bay Region, and Southeast Louisiana:

Recommendation #7: Build a coalition of municipal, community, and business partners to discuss economic investments at stake. Encourage businesses to think about their response to natural hazards over the long term, both operationally and physically. Emphasize that building codes are intended to provide a minimal level of life-safety and building performance. In coastal areas, it is prudent to design and construct more conservatively. This includes commercial buildings, in order to increase their potential for being operational after a disaster.

Recommendation #8: Using NOAA's "Coastal Resiliency Index: A Community Self-Assessment, A Guide to Examining How Prepared Your Community is for a Disaster" (Emmer et al., Date Unavailable), prepare a Community Self-Assessment and obtain a Coastal Resiliency Index rating. This rating will aid community leaders in predicting if their community will reach and maintain an acceptable level of functioning and structure after a disaster. The goal of this Community Self-Assessment is for every community to become highly resilient; the guide reviews critical infrastructure.

Recommendation #9: Modify land use maps to enable Smart Growth principles to encourage mixed land uses; institute policies to enable Smart Growth.

Protection of the Natural Environment

Local Municipalities

Increase protection of dunes on Galveston Island and Bolivar Peninsula to allow the dunes to stabilize and achieve their natural, undisturbed heights (estimated to be approximately 9 to 14 feet NAVD88). Examples of best practices include:

Recommendation #10: Conduct research into storm history and beach dynamics to determine how wide a buffer strip is necessary to maintain the dunes. These vary according to specific locations. Arbitrary dune widths are not useful and can easily be breached.

Recommendation #11: Prohibit any traffic, including foot and motorized/non-motorized vehicles. Walking on dunes jeopardizes their stability by damaging the fragile anchoring root system. While providing storm protection and habitat, dunes tend to reduce access to beaches. Provide boardwalks over the dunes to protect the vegetation. Pathways could also be designed between the dunes to limit their damage. Placing fences along the pathways will confine pedestrians to the paths.

Recommendation #12: Institute a dune revegetation program and put measures in place to allow dunes to achieve their former heights. High-elevation continuous dunes effectively block storm surges and prevent island overwash. Restoration, maintenance, and protection of dunes are vital to ensuring storm protection, beach stability, and increasing the economic health of the region.

Recommendation #13: Institute community education programs to place signage and provide literature about the importance of dunes.

Several publications are available on topics of dune planting and construction, including: *Restoration of Sand Dunes along the Mid-Atlantic Coast* (Hamer et al., 1992), *Landscaping at the Seashore* (Rutgers, 1980), and *Guidelines and Recommendations for Coastal Dune Restoration and Creation Projects* (New Jersey Department of Environmental Protection, 1985).

AMERICA'S ENERGY COAST

Residences and businesses located in the Chenier Plain—southeast Texas and southwest Louisiana—have many common interests as the alliance, *America's Energy Coast*, has found out. *America's Energy Coast* is a loose alliance of environmentalists, oil companies, government agencies, and shipping interests that is calling on the Nation to do two things that are often seen as mutually exclusive: invest in restoring a degraded ecosystem and, at the same time, protect and increase oil production. For more information, see: http://www.americasenergycoast.org/files/120208AEC-ActionFrameworkFINAL.pdf.

Galveston and Chambers Counties

Recommendation #14: Encourage local municipalities to ensure that building permits are in compliance with Texas Wetlands Conservation Plan. The Texas Wetlands Conservation Plan[6] provides a non-regulatory, incentive-based approach to wetlands management.

Recommendation #15: Initiate a local or regional wetlands protection program. According to the USGS report (2004), not many dune or habitat restoration projects had been started. It is very important that these projects be initiated as soon as possible to begin to establish basic protection. Dunes often take many years to become stable.

8.3.2 General Recommendations – State Level

Recommendation #16: Update and revise accordingly the Coastal 2020 (2004[7]) plan to include the devastation of Ike and recommendations in this Ike MAT report. Fully fund and expedite its implementation.

6 http://www.tpwd.state.tx.us/landwater/water/habitats/wetland/publications/conservation_plan.phtml
7 http://www.glo.state.tx.us/coastal/ct2020/index.html

Recommendation #17: Initiate a regional coalition including coastal communities of southeast Texas and southwest Louisiana to address coastal planning and hazard mitigation. Consider supporting the alliance of *America's Energy Coast*, which includes interests along the southeast Texas coastline (refer to text box).

Recommendation #18: Institute policies to enable Smart Growth.

8.3.3 General Recommendations – Federal Level

Recommendation #19: Federal agencies with technical expertise, such as NOAA, USACE, and others, should help communities identify the most effective protective measures to put in place for coastal wetlands to ensure wetland health.