The Resilient Coast:

Policy frameworks for adapting

The Built Environment

to climate change and growth in coastal areas of the U.S. Gulf of Mexico

For Ralph Rayburn

Associate Director, Texas Sea Grant College Program

April 8, 1947 – January 31, 2008

Thanks for walking with us. Many a stone you kicked out of our way. Many a time you shown the light ahead when we could not see. But mostly — you made the walk a joy. Thanks for the memories. We won't soon forget you.

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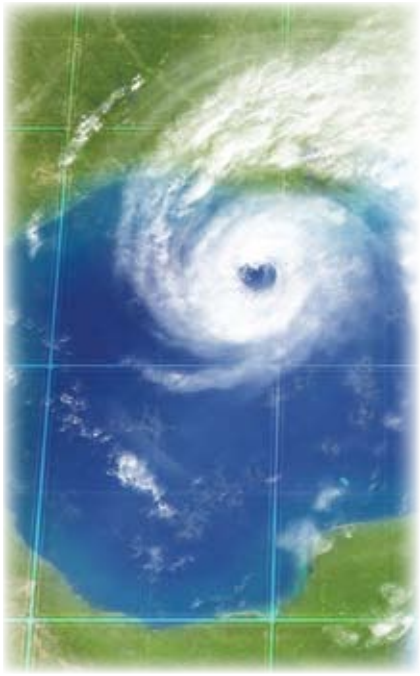


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Executive Summary

The U.S. Gulf Coast is subject to frequent storms and flooding. Climate change may make this coastal area even more hazardous than it already is. Adapting to the potential changes wrought by climate change will require substantial modifications in development practices all along the Gulf Coast. Effective adaptation, however, will require nothing that is not already recommended for safe development in this environment.

Climate change does not need to be invoked to recognize that changes in development practices are needed. Katrina-Rita has made that fact painfully obvious. Large population increases are expected across the Gulf, putting many more people into harm's way. Many of the major cities on the Gulf will nearly double in population over the next 30 or so years, with more than 50 percent of the built environment for 2030 yet to be built in these cities. The science and technology needed to plan and build resilient coastal cities is already in place. Putting this information into practice would constitute a significant adaptation in and of itself, even if the additional hazards associated with climate change were not accounted for. Prudence, of course, would dictate adding additional "freeboard" or buffer to take into account sea level rise as well as potential increases in the frequency and intensity of coastal storms.

A review of the existing legal and institutional frameworks for adapting to growth and climate change in the Gulf states indicates significant weaknesses in the ability of many of the states to adapt to coastal change. More than anything, Gulf Coast communities need to plan for change. Unfortunately, it is very difficult in our culture and our free-market society to implement plans that call for serious land use restrictions, which is exactly what would be required to keep people out of harm's way. Nevertheless, there is much that good planning can do short of serious land use restrictions, and Gulf Coast communities should be doing these things now.

The following recommendations are gleaned from a review of the hazard planning and mitigation scientific literature:

1. Reform the National Flood Insurance Program. Subsidizing insurance in hazardous areas constitutes a moral hazard known as the "safe government paradox," essentially removing risk from those who build and live or work in the most hazardous zones. Charging market-based actuarial rates for insurance in hazardous coastal environments would do more than perhaps any other action to reduce damages from coastal storms.
2. Where subsidized insurance might be deemed to be desirable (essential port areas, for example), communities rather than individuals should be insured, with rates dependent on effective community planning.
3. Federal and state government should put strong mandates in place for effective community plans that incorporate hazard mitigation planning. Local governments, however, should have maximum autonomy in developing and implementing community hazard mitigation plans. Effective citizen participation has been shown to result in better plans.
4. Detailed vulnerability assessments to both current and potential risks are a critical element for adaptation.
5. Vulnerable coastal cities should focus on becoming resilient coastal cities by promoting compact urban form, avoiding hazardous areas, and requiring strict adherence to state of the art building codes.
6. Engineered solutions such as seawalls, levees, and dikes should be reserved for truly "inevitable cities in impossible places," and then only for the most defensible zones in these places.

Hurricane damage.

A "perfect storm" is brewing: coastal growth is occurring in increasingly hazardous areas, areas that may be made even more hazardous from the effects of global warming. Coastal managers and planners need to take action now to prevent disasters waiting to happen. Effective adaptation to climate change will require nothing that is not already recommended for safe development in the coastal zone. Reforming the National Flood Insurance Program would do more than than any other action to reduce future damages.

Photo by Richard K. Wallace, AUMERC/Sea Grant

Introduction

Coasts are hazardous environments, subject to fierce storms, inundation, and erosion. But there will always be extensive populations along the coasts, regardless of the threats: coastal cities are focal points for trade, fishing, and tourism, and thus are indispensable to the economy of any region with a coastline. All coastal cities are in some sense "inevitable cities on impossible sites," even though they may not all be quite as vulnerable as New Orleans, the city that Pierce Lewis (2003) first characterized with this phrase.

Climate change is adding a new dimension to the coastal hazard dynamic: the possibility for more frequent and more intense storms, higher sea levels, and more coastal erosion (Burkett et al, 2001). The exact magnitude of these changes is unknown, but it is quite certain that climate change will introduce significant disturbance: rising sea levels, and perhaps more frequent and more damaging storms.

The purpose of this publication is to examine existing legal and policy frameworks that might hinder or facilitate adaptation to changes brought about by global climate change and population growth in coastal communities along the U.S. Gulf Coast. While we cannot predict exactly what impacts climate change will bring to the Gulf Coast, we can already predict with great certainty that many more people will be in harm's way on this coast in the future. According to the U.S. Census, Texas and Florida grew by at least 12 percent from 2000 to 2006,[1] with a large part of that growth in coastal areas. Mississippi and Alabama grew by about 3 percent during the same period, with Louisiana suffering a population loss due largely to Katrina. Texas and Florida will likely double their coastal populations within the next 30 years. Understanding how existing frameworks enable policy makers to deal with having more people in harm's way might also inform us as to how well these same decision makers will be able to respond to what climate change deals them in the next few decades.

Hazard management for coastal populations, or any population for that matter, is subdivided into mitigation and response. Mitigation is any action that reduces harm from coastal hazards. Response is how a community confronts the hazard during and after the event – basically the emergency and reconstruction dimensions. Both are critical to how a community deals with natural hazards. In terms of adaptation to long term hazards, however, we are mainly concerned with mitigation, with making coastal populations less vulnerable to hazards, both current hazards and those that might occur in the future as a result of climate change.

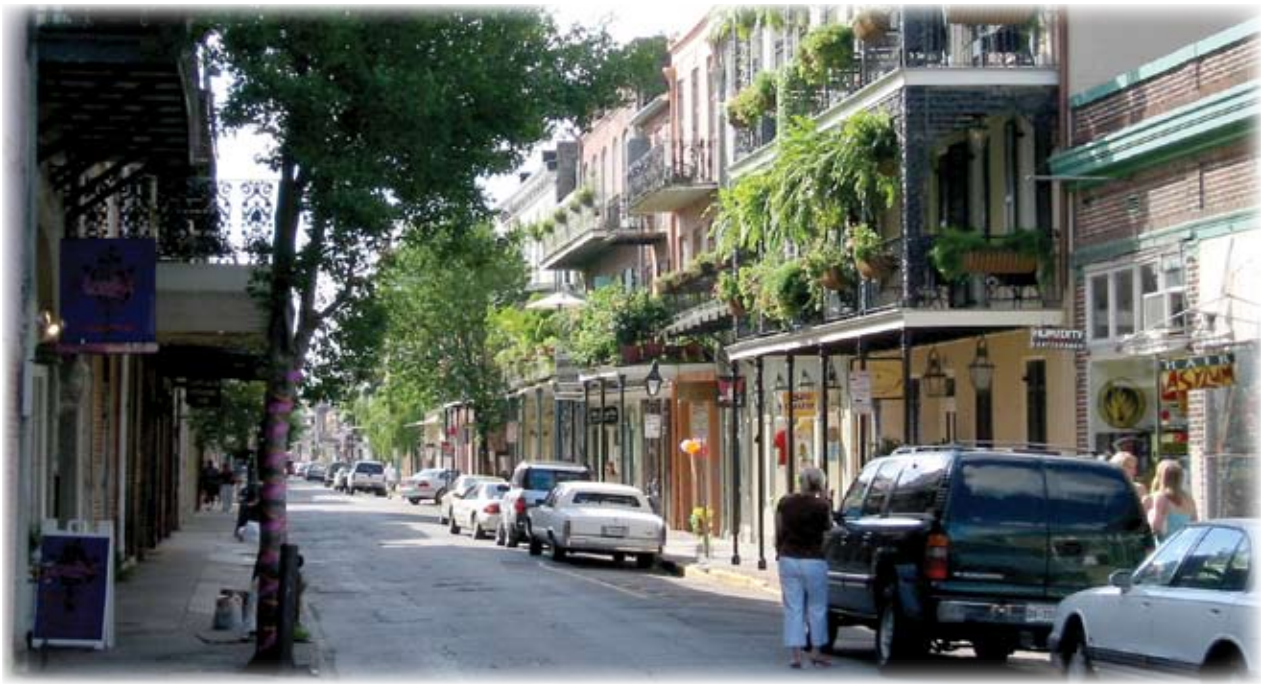
As Katrina vividly laid bare, we are not doing a very good job addressing coastal hazards along most of the U.S. Gulf Coast. We have continued to put more people in hazardous areas over the years, with several federal policies facilitating, and even subsidizing, development of these areas. Most local governments have not been very efficient at imposing stricter regulations on the development that does occur in hazardous areas.

All coastal environments are hazardous to one degree or another, but some locations are much worse than others. Not all of New Orleans, for example, floods equally. The original site for New Orleans, the Vieux Carré, or French Quarter, is on a relatively high river levee, and did not significantly flood during Hurricane Katrina. This natural levee is still very much within a hazardous coastal environment, but it is by far the least hazardous zone in this otherwise "impossible" location.

Guiding development into the right places and out of the wrong places involves a good knowledge of the lay of the land and its

Flooding in New Orleans during hurricane Katrina

[1] *http://www.census.gov/popest/states/tables/NST-EST2006-02.xls*



The French Quarter in New Orleans

Photo by John Jacob

Good siting, proper building codes, and a compact urban pattern form the core elements of resilient coastal communities.

hazards, and at least some predisposition to plan. Land use planning, unfortunately, is not part of the regulatory tradition or framework for most states in the South, except perhaps for Florida. The Gulf states provide an interesting case study in terms of contrasting legal and institutional frameworks and how those differences may affect coastal communities' ability to adapt to climate change.

The French Quarter is also an interesting case study in terms of structures and hazards. Construction in the French Quarter is much more substantial than the "stick-built" structures that characterize most new coastal developments. The older masonry and rubble-fill structures of this area, dating to the Spanish and French occupations, can withstand much more vigorous storms, and if flooded, are much more salvageable than comparable wood-frame structures. These old structures are, to some degree, already "flood-proof," in the modern lingo of flood protection. Masonry structures don't need much more than a good wash-down to be good-to-go after a flood. Walls built with sheetrock on a lumber frame, on the other hand, are much more fragile. Extended periods of flooding, or deep inundation, can easily destroy a wood-frame house with sheetrock interiors.

The urban pattern of the *Vieux Carré* illustrates another planning principal with important implications for adapting to climate change. The relative density of the housing and commercial structures of this district confers a certain amount of resiliency and protection. The pattern that we see in the French Quarter is quite comparable to the patterns espoused by advocates of Smart Growth and New Urbanism. Resilience to coastal hazards has not often figured in discussion of these two movements, particularly New Urbanism (Burke, 2006), but the increased density of these kinds of developments enables communities to be more selective about where developments are placed, and the higher density also means structures can be built much more sturdily because of shared walls, for example. These three issues—good siting, proper building codes, and a compact urban pattern – form the core elements of resilient coastal communities. Achieving these features requires the ability to plan and to regulate. We will explore how the legal and institutional frameworks of the Gulf states hinder or facilitate these abilities.

Proper siting and planning fall under what is known as "soft" mitigation. "Hard,"

or structural mitigation involves engineered structures such as levees, sea walls, groins, jetties, etc. While use of these structures could certainly be construed as adaptation to climate change and growth, in a very real sense they are not at all about adapting human settlements and structures to hazardous environments; for the most part they represent the opposite: an attempt to adapt the natural environment to human constructs. And as we have so very tragically seen, humans do not always win.

Most workers in the field (e.g., Burby 2006, Godschalk 2003, Platt 1999) now view hard structures as more often a part of the problem than the solution. They can give coastal residents a false sense of security. This is not to say they are not important in places — New Orleans under any rebuilding scenario will continue to need levees. Galveston will continue to need its seawall. But for New Orleans to view levee improvement as its primary and perhaps only means of rebuilding flies in the face of the major reforms in land use planning that are needed for long term adaptation. To build a seawall on the rest of Galveston Island beyond the current seawall is inviting disaster.

In the best sense of the word, protective structural methods are not really adaptation, but rather, in a sense, a denial of reality. Structures like these will be needed the more "inevitable" a city is, but they should perhaps be limited to protecting only truly unavoidable or inevitable development. New Orleans is an essential port that needs protection. An argument could be made that strong levees, financed by the federal government, are needed to protect this infrastructure and the community that serves it. There was no inevitability, however, to the location of the Lower 9th Ward and similar areas in New Orleans. Once the levees went up that allowed development in those areas, only the suffering was inevitable.

The main issues explored here, in terms of the legal and institutional framework, have to do, first, with land use planning, and second, with the structural integrity of what is built in hazardous areas. Other issues will be addressed peripherally. Insurance, for example, is not a direct technical issue in terms of how and where to build, but it is a direct policy issue in terms of where development actually gets built, and the particular kinds of structures that get built. Planning for evacuation will certainly be an issue under new conditions imposed by climatic change and growth, and evacuation planning is affected by issues of siting and building resiliency.

Protection of coastal wetlands has some very direct implications for protecting the built environment. Where these wetlands are extensive, as they are in Louisiana, for example, their preservation should be a first-order priority as a means of protecting coastal cities. However, this not an issue than can be addressed meaningfully in the scope of this publication.

The "legal and institutional framework" format is intended to illuminate the main actors (institutional landscape) who might play a role in adaptation to changing coastal conditions on the U.S. Gulf Coast, and the means available (legal framework) to those actors to implement effective adaptation. Under "Adapting to Climate Change and Population Growth," below, we examine steps that might be taken in this landscape to improve coastal community resilience in the face of rapid growth and changing climate.

Houston during Tropical Storm Allison. A wide development-free floodplain allows passage of flood waters with little damage in this area.

Photo courtesy of the Houston Chronicle

Hard structures, like levees, more often than not give coastal residents a false sense of security.

Legal Framework

Federal

Land Use

Land use planning primarily occurs at the state and local level. There is no federal land use law. Although the federal government does not directly engage in land use regulation, outside a few provisions in the Clean Water Act protecting wetlands, it does encourage coastal states to undertake land use planning through such statutes as the Coastal Zone Management Act and the Coastal Barrier Resources Act. The most relevant federal law in terms of land use is therefore case law, developed by the courts, which provides boundaries for state or local policing power related to land use regulation, with the courts' main focus generally on the issue of government takings. Federal laws that directly impact adaptation to climate change deal mainly with mitigation and response to disasters, as described below.

According to Platt (2005), prior to the great Mississippi flood of 1927, preparation for and recovery from floods and other natural hazards was primarily a state and local issue. After this epochal flood, the federal government began to take a much larger role. Rather than taking a lead in risk avoidance, however, the federal role became one of risk reduction and risk sharing (Burby 2006). This shift had a profound effect on how development occurred in hazardous coastal areas. The government was now seen as a "fixer" and a protector. It was thought that hazards could be reduced, if not eliminated, through engineering, and the government was there to bail out citizens and businesses when there were failures. This policy shift essentially facilitated the development of many thousands of acres of hazardous property that likely would not have been developed if left to market forces alone.

Relevant Federal Laws and Agencies

The National Flood Insurance Program

There is essentially no private insurance for flood damage in the U.S. The National Flood Insurance Program (NFIP) was established to aid personal and community recovery after flood events. Coverage through the NFIP is provided at substantially subsidized rates. While the original intent of the program was to assist in recovery from floods and other disasters, the net effect has been to subsidize development in hazardous areas, and thus to perversely increase the number of flood victims over the years.

The **Federal Emergency Management Agency** (FEMA), under the Department of Homeland Security, has a direct mandate to coordinate disaster response when state and local entities are overwhelmed. As a result of this mandate and the agency's coordination of the NFIP, FEMA plays an ever increasing role in guiding state and local mitigation or prevention of loss efforts from natural disasters. FEMA has more impact on and authority over the development and execution of policies that could lead to effective adaptation to climate change on the coast than any other federal agency.

Improvements to the National Flood Insurance Act in the last few decades have required participating local governments to adopt building codes for floodproofing and the elevation of structures above the base flood elevation. In general, the focus of this law has been on floodproofing and otherwise protecting structures rather than restricting development in hazardous areas (May and Deyle, 1998). An important recent enhancement to this law has been the development of the Community Rating System (CRS). Local communities can obtain substantial discounts on insurance premiums paid by their residents by scoring points for exceeding the basic requirements of the NFIP, through such things as better mapping

Flood waters in New Orleans after hurricane Katrina.

Photo courtesy of NOAA.

Local communities can obtain substantial reductions in flood insurance premiums by participating in the Community Rating System, which encourages communities to keep new development out of floodplains.

Photo from the Texas Sea Grant archives.

and better community outreach. Land use planning that keeps new development out of the floodplain is one of the areas that can contribute to a better score. For example, communities can score points for managing the development of land so new projects avoid floodplains or minimize the amount of construction in floodplains. FEMA will award credits for stricter regulation requiring appropriate development and zoning restrictions.

The Stafford Act and the Disaster Mitigation Act

The Stafford Act and the Disaster Mitigation Act mandate advanced planning for mitigation efforts. The Stafford Act provides the statutory authority for most federal disaster response activities. The Act requires states to prepare mitigation plans as a condition of disaster assistance. The Disaster Mitigation Act of 2000 added incentives for increased coordination and integration of mitigation activities. The Act created two levels of state plans: standard and enhanced. States with an approved Enhanced State Plan are eligible to receive additional federal funding for hazard mitigation measures and disaster relief assistance. Local communities are also required to prepare mitigation action plans to be eligible for Federal post disaster mitigation grants.

Federal law, however, does not require that local mitigation actions plans be part of state enhanced mitigation plans or even local comprehensive plans. There is also no requirement for any kind of land use planning, although there is language encouraging it in the guidance documents.[2]

Coastal Barrier Resources Act

The Coastal Barrier Resources Act (CoBRA) (PL 97-348) designates certain coastal barrier islands, or portions of these islands, as ineligible for federal flood insurance, as well as for any federal funding for roads, sewers, or other kinds of infrastructure (May and Deyle, 1998). CoBRA does not prohibit development per se in these areas; it simply restricts federal support of it. Unless a state law or local ordinance prohibits development, owners willing to develop property without federal assistance may do so. Although federal financial assistance is prohibited, CoBRA does allow federal agencies to issue permits for federally regulated activities on barrier islands, such as the discharge of dredge and fill material into waters

So, despite these prohibitions, development does occur on designated barrier islands. Although most units (84 percent) have remained undeveloped since their inclusion in the system, three percent of units have experienced significant levels (100 or more new structures) of development. (GAO, 2007). Three primary reasons for the new development were identified: "(1) a combination of commercial interest and public desire to build in the unit, (2) local government support for development to improve the economic base of the area, and (3) the availability of affordable private flood insurance." (GAO, 2007). Units in the South have experienced greater development then units in the North.

The GAO's research also revealed that state law can have a profound effect on the fate of individual units. In areas where local governments are pro-development, building continues. In areas where local and state law complemented the federal restrictions, future development is unlikely. In most of the Gulf states, however, little or no development is occurring in CoBRA-designated areas for now.

The Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) was passed in 1972 to encourage state governments to better manage their coastal areas. Participation was voluntary, but significant federal resources were made available to states that developed and implemented federally approved coastal zone management plans. In addition, the CZMA authorizes states with approved plans to review certain Federal actions to ensure they are consistent with those plans.

To receive approval from the **National Oceanic and Atmospheric Administration** (NOAA), state coastal management programs must contain a land use component. At a minimum the state must include within their plans "a definition of what shall constitute permissible land uses and water uses within the coastal zone which have a direct and significant impact

[2] *http://www.fema.gov/plan/mitplanning/DMA.shtm.*

on the coastal waters," "an inventory and designation of areas of particular concern," and "broad guidelines on priorities of uses in particular areas."[3] There is considerable variation from state to state in how these elements are addressed. States with strong planning traditions, such as Florida, incorporate land use planning into their coastal management programs. In most of the Gulf States, however, only the minimum requirements are met; i.e. a list of permissible activities and broad designations of sensitive areas.

States wishing to improve their coastal management programs can receive technical assistance and funding from NOAA's Office of Ocean and Coastal Resource Management (OCRM). OCRM, through the Coastal Zone Enhancement Program, provides funds, known as § 309 grants, to help states develop and implement program changes in nine coastal zone enhancement areas of national significance, which include coastal hazards.

Exhibit 2

Federal Floodplain Management and Related Programs by Agency

	Department of Agriculture: Agriculture Research Service	Agriculture Stabilization and Conservation Service	Economic Research Service	Farmers Home Administration	Forest Service	Soil Conservation Service	Department of the Army: Corps of Engineers	Department of Commerce: National Oceanic and Atmospheric Administration	Economic Development Administration	Bureau of Economic Analysis	Department of Energy: Federal Energy Regulatory Commission	Department of Health, and Human Services: Public Health Service	Department of Housing and Urban Development: Community Planning and Development	Federal Housing Administration	Department of the Interior: Bureau of Land Management	Bureau of Reclamation	Geological Survey	Fish and Wildlife Service	Department of Transportation: Coast Guard	Federal Aviation Administration	Federal Highway Administration	Federal Railway Administration	Federal Emergency Management Agency: Federal Insurance Administration	State and Local Programs and Support Directorate	Small Business Administration	Tennessee Valley Authority
Flood Insurance Studies*	–	–	–	–	–	*	*	–	–	–	–	–	–	–	–	*	–	–	–	–	–	–	S	–	–	*
Flood Plain Management Services	–	–	–	–	–	S	S	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	S	–	–	S
Flood Plain Information Studies and Reports																										
Riverine	–	–	–	–	–	S	S	–	–	–	–	–	–	S	–	–	S	S	–	–	–	–	F	–	–	S
Coastal	–	–	–	–	–	I	S	G	–	–	–	–	–	S	–	–	I	S	–	–	–	–	F	–	–	S
Technical and Planning Services**																										
Full Program	–	–	–	–	–	S	S	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F	–	–	S
Program Elements	–	–	I	G	I	S	S	I	S	S	I	–	–	S	I	I	S	–	–	I	I	I	–	I	–	S
Flood Modifying Construction	–	–	–	G	I	S	S	–	F	–	–	–	–	–	–	–	–	–	–	I	–	–	–	F	–	S
Flood Preparedness, Emergency, and Recovery	–	F	–	G	S	S	S	G	–	–	–	S	G	–	–	–	S	–	S	–	–	–	G	SG	G	–
Warning and Forecasting	–	–	–	–	–	–	–	S	–	–	–	–	–	–	–	–	S	–	–	–	–	–	–	I	–	–
Research	S	–	S	–	I	I	S	S	S	–	–	–	–	–	–	S	S	S	–	–	–	–	–	–	–	–
Open Space	–	–	–	–	I	S	–	G	–	–	–	–	G	–	–	–	–	S	–	–	–	–	I	–	–	–

*Administered by the Federal Insurance Administration through reimbursable technical studies by agency shown.
**Land and Water Resources.

S. Staff and Funds
F. Funds
G. Grants and Loans
I. Incidental

Figure 2. Exhibit 2 from Interagency Task Force on Floodplain Management (1986) showing the various federal agencies that impact floodplain management to one degree or another.

Other Federal Authorities

The **U.S. Army Corps of Engineers** (Corps) plays a very large role in how coastal communities respond and adapt to changing conditions on the coast. Undoubtedly the largest single public works agency in the United States, it has an enormous impact on how "safe" the public feels about floodplain and coastal environments. The Corps is not primarily a policy making agency, but rather responsive to state and federal mandates for flood protection. The Corps is typically only involved in large public works projects, such as extensive levee systems and major channel modifications, generated by requests from local governments or the states. Any actions by the Corps are usually mandated directly by Congress. The Corps' budget is not part of the Department of Defense budget, despite affiliation with the U.S. Army, but is funded separately through the Energy and Water Development Appropriation of the U.S. Congress.

A different type of federal influence on coastal community development is that of the **National Sea Grant Program**, a network of 30 independent state university-based programs modeled after the Land Grant program, administered nationally through NOAA. The purpose of the Sea Grant program is to engage coastal communities through an integrated research, education, and extension program. Sea Grant agents are community-based professionals with disciplinary ties back to their university. Sea Grant agents help local coastal communities with coastal hazard and community development issues, among many others. In terms of adaptation to climate change, Sea Grant is a primary broker for the brain trust that exists at state-funded and other universities.

According to the Federal Interagency Floodplain Management Task Force of 1992, there are over fifty federal laws and executive orders relating to hazard management (*Figure 2*). Some twenty-six

[3] *33 U.S.C. § 1455(d)(2).*

Protection of Building Openings

Windows and doors are the weak spots in the wall envelope. Requiring debris impact resistant windows and doors or debris impact protective coverings (shutters) prevents most window and door failures. This helps keep the wind and rain out of the building, reducing structural damage, damage to finishes, and damage to contents.

Improved Roof Sheathing Attachment

Better attachment of the plywood or OSB roof sheathing to the roof structure through appropriate fasteners and closer fastener spacing helps prevent sections of the roof deck from being lifted off by the wind. This reduces progressive failures and wind and water from penetrating the building envelope.

Improved Roof-Wall Connections

Installation of metal 'hurricane clips' or 'hurricane straps' provides a continuous loadpath from the roof to the foundation, helping prevent catastrophic roof uplift failures.

From: Residential Wind Damage in Mississippi Potential Hurricane Damage Reduction Through Improved Building Codes and Construction Practices. January 19, 2006. LSU Hurricane Center

(based upon strategies incorporated in the Dade County South Florida Building Code)

departments or agencies are involved one way or another with floods and natural disasters, and therefore at least indirectly with land use. Most all of these agencies and programs have much less direct impact than either FEMA or the Corps, and thus will not be discussed here, but the figure shows just how complex hazard management can be.

We have treated only the principal federal laws above that impact coastal management, and that could have a direct impact on the development of policy for adapting to change in the coastal zone. The patchwork of federal programs, some limiting development in hazardous zones (e.g., CoBRA), but most facilitating it (e.g., the NFIP), does not promote an "overarching federal policy [that] governs land use and development in hazard prone areas" (May and Deyle, 1998). Such an overarching policy is needed to address climate change issues, and more importantly, to provide critical federal leadership, as discussed below.

Building Codes

There is no federally-enforced building code nor is any federal agency charged with administering building codes at the national level. Rather, the International Code Council (http://www.iccsafe.org/), a nonprofit private organization, maintains the most up-to-date model building codes, which include standards for storm surge and wind damage. These model building codes, which address both commercial and residential construction, can be adopted in part or in toto by state or local governments. Specific provisions have been established for wind and flood hazards (ICC, 2006).

The Institute of Business and Home Safety (IBHS), a non-profit insurance industry group, provides education and outreach on a number of issues dealing with natural hazards, including model codes for state and local governments. The IBHS maintains a comprehensive database of codes and ordinances. Of particular note is the Showcase State Model for Disaster Resistance and Resilience: A Guidebook for Loss Reduction Partnerships (IBHS.2002). Figure 1 shows an excerpt from this plan detailing a checklist for both the building code and land use plan components of this state model.

The IBHS also manages a model program of residential standards, specifically developed for coastal and other hazardous areas, which exceeds the ICC codes. The "Fortified Homes" program[4] uses techniques and materials specifically designed to confer homes with greater resistance to winds and floods. Insurers provide discounts for homes meeting these standards.[5]

FEMA's Coastal Construction Manual[6] provides additional guidance on building techniques for hazardous coastal areas.

	ELEMENT	WHY?	WHAT?
4	Building code	To ensure new construction and redevelopment meet the best standards for resisting natural hazard impacts	☑ Adopt the latest version of one of the model building codes as the minimum code. ☑ Promote code enforcement for new construction and rehabilitation of existing structures. ☑ Use the Insurance Service Office's Building Code Effectiveness Grading Schedule (BCEGS) to measure code enforcement for new construction. ☑ Develop recommendations to amend local codes to incorporate disaster safety measures into standards for repair, remodeling or rehabilitating existing structures.
5	Land use plans	To reduce vulnerability by siting development and redevelopment out of harm's way.	☑ Address relevant hazards and the risks they pose in all state-level land use development decisions. ☑ Encourage adoption of local land use plans that incorporate hazards into decision making. ☑ Use the IBHS *Community Land Use Evaluation for Natural Hazards* as a baseline measurement tool for communities. ☑ Document changes to local comprehensive planning guidelines for inclusion of natural hazards. ☑ Document potential loss reduction benefits of land use planning decisions that eliminate or reduce placement of property in harm's way.

Figure 1. Building code and Land Use Plan elements from the Institute for Business and Home Safety Showcase State Model for Disaster Resistance and Resilience.

[4] *http://www.ibhs.org/property_protection/default.asp?id=8*
[5] *http://www.ibhs.org/newsroom/view.asp?id=449*
[6] *http://www.fema.gov/rebuild/mat/fema55.shtm*

State and Local

Floodplain Management

At the state level there may or may not be a single agency that deals with coastal hazards and development issues. There is certainly no state agency comparable to FEMA at the state level in any of the Gulf states, at least in terms of scope and impact.

Every state has an agency assigned to be the lead on disaster issues. Although the NFIP is a federally managed program, it is implemented with extensive state and local participation. Each state, for example, has a designated NFIP Coordinator[7]. Participating states and communities must enact minimal floodplain regulations to be able to participate in the program, but states are free to enact more restrictive floodplain rules if they choose to do so. Local communities that participate in the NFIP program are required to have Floodplain Administrators to manage the program, to implement specific ordinances the community has enacted with regards to floodplain management, and to review and act on permit applications.

The important point here is that local communities do have significant discretion in how they manage their NFIP programs, should they choose to do so.

Land Use

The South generally takes a fairly *laissez faire* attitude towards land use planning. There is a well-ingrained distrust of the government telling people what to do with their land. In early settlement days, development was rarely intentionally placed in harm's way. People had a much better innate sense of the land. When they came to the coast or built near rivers, they sought out the most protected sites and/or the highest ground (Figure 4). They also perhaps had a better sense of the limits of the land, and perhaps had less faith in the ability of technology or the government to bail them out when they got into trouble. Today, the resistance to government regulation continues, but there appears to be a greater expectation that the government can or should "fix" problems like coastal flooding. The result is that many more people are in harm's way in hazardous coastal environments, without much of a disposition to have limits imposed on their activities in terms of where new development goes or how it is built.

There is a very wide divergence relative to planning powers and authority between Florida and the rest of the Gulf Coast states, at both the state and municipal levels (Tables 1 and 2). Florida has a much stronger planning environment than any of the other states on the Gulf, and apparently it makes a very big difference, as evidenced in disaster relief payments. Burby (2006) cites studies that show one coastal insurance claim per thousand residents from 1978 to 2002 for Florida, versus twenty-one per thousand in Texas during the same period, with per capita insurance payments of $71 for Florida versus $325 in Texas.

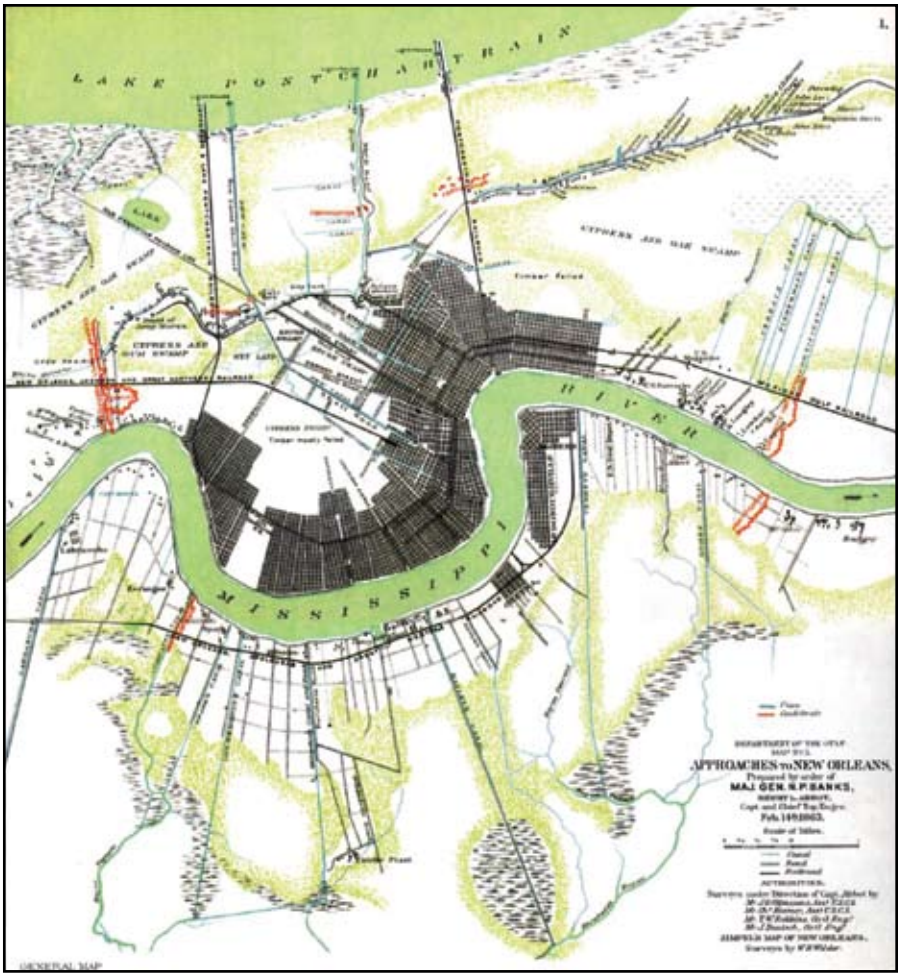


Figure 4. 1863 map of the City of New Orleans (http://www.rootsweb.com/ ~usgenweb/maps/louisiana/) . Almost all of the developed area is on the high levee of the Mississippi River. The area north of the Gentilly Ridge (the ENE trending road in the upper right part of the map) and south of Lake Pontchartrain was not developed in full until the advent of the National Flood Insurance program in the 1960s. The 1863 urban pattern is a good example of proper site selection in a hazardous environment. The stippled light green zones indicate very low lying swampy areas. Most of the land area of this map is now developed (with large areas currently abandoned due to Hurricane Katrina). Most of the pre-Katrina population of New Orleans could fit into a slightly larger area than this 1863 footprint if it were built out at the densities of the French Quarter.

[7] *The contact information for the five Gulf state coordinators can be found at http://www.floods.org/ StatePOCs/map.asp*

Table 1. General State Planning Legislation, through Dec 2005
(http://www.ibhs.org/publications/view.asp?id=302)

State	*Guidelines for state plan*	*Land Use Element in State Plan*	*Hazard Mitigation Element in State Plan*	*Strength of State Role*	*Local plans mandated by State*	*Formal adoption of local plans*	*State specify or suggest elements of local plans*
FL	Yes	Yes	Yes	3	Yes	Yes	Both
AL	Yes	Yes	No	1	No	No	Specify
MS	NO	N/A	N/A	1	No	Yes	Specify
LA	No	N/A	N/A	1	No	No	Specify
TX	No	N/A	N/A	1	No	Yes	No

Table 2. State and local planning authority in the Gulf Coast states
(extracted from the American Planning Association 1996 Summary of State Planning Statutes [http://www.planning.org/growingsmart/summaries.htm]) and internet sources.

State	*State Planning Possible?*	*State Plan in Place?*	*Municipal Planning Authority*	*County/ Parish Planning Authority*	*Regional Planning Authority*	*City/ Municipal Home Rule*	*County/ Parish Home Rule*
FL	Yes	Yes	Yes	Yes	Yes	Yes	Counties can adopt
AL	Yes	Yes	Yes	Yes	Yes	No	No
MS	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LA	Yes	No	Yes	Yes	Yes	Yes	Yes
TX	Yes	No	Yes	No	No	Yes	No

The best plans are produced by communities with a high degree of autonomy ("home rule") and freedom to create good plans and where states have strong requirements to produce such plans.

While land use planning is very much a local government issue, how much authority local governments have to plan is dependent on what has been granted to them by the state (Table 2). Traditionally, the highest degree of independence of a local government is "home rule," which essentially means that a local government may exercise all governmental powers, except those expressly limited by the state (Richardson et al., 2003).

Godschalk, et al. (1999) discuss the powers of local government in terms of the ability to plan and implement hazard mitigation. They list five specific powers —planning, regulatory, spending, taxing, and acquisition. Full use of these powers could theoretically only occur under home rule conditions. The ability to develop, implement and enforce effective hazard mitigation plans obviously depends greatly, then, on whether or not a local unit of government has home rule powers. For the purposes of hazard mitigation and planning, policymakers need to be aware of the limitations of local government authority in their states and take steps to fill any gaps that may exist. One option is a Home-Rule Amendment. According to a leading legal treatise, "under home-rule amendments, cities no longer are depending upon the state legislature for their authority to determine their local affairs and government, but have power granted directly from the people through the state constitution without statutory authorization."[8] Such amendments can significantly increase the ability of local governments to deal with changing circumstances and new threats.

State government plays a role in local planning through its ability to require plans at either the state or local level. As might be expected, there is considerable variation among the Gulf Coast states in terms of practice and/or requirements (Table 1). Most Gulf communities do have zoning plans and ordinances to regulate development, but Florida is the only Gulf state to mandate local plans and the only state to include hazard mitigation within the state plan, and is thus the Gulf state with the strongest overall role by far in terms of planning. All the states have the constitutional ability to plan, but only three of the five states have some kind of state plan in place (Table 1).

In Alabama, where neither county nor municipal governments have home rule, for example, local governments have fairly low autonomy, although both counties and cities can engage in some form of planning. But home rule is apparently not the only parameter that determines the degree of autonomy. A 1980 survey of local discretionary authority (cited in Richardson et al., 2003) rated Alabama significantly higher than Mississippi, where both cities and counties have at least nominal home rule (Table 3).

In Florida, both counties and cities have home rule and the authority to plan, even though the state exercises a very strong presence in terms of planning. Evidence from Florida and other states suggest that it may be the combination of strong state authority combined with strong local autonomy that produces the best results in terms of effective local land use plans (Burby

[8] *56 Am. Jur. 2d. Municipal Corp., Counties, Other Political Subdivisions § 108 (2006).*

2006). For example, Florida's Growth Management Act requires counties and municipalities to develop Local Government Comprehensive Plans that guide future growth and development. Each plan must contain a number of required "elements" that address such things as future land use, coastal management, and conservation. The Florida Department of Community Affairs reviews the plans and provides technical training and financial assistance to help local governments comply with the Act. Coastal counties must include specific "coastal management elements" in their comprehensive plans, and these should attempt to limit densities in higher hazard areas.

Florida also requires its coastal counties to have Comprehensive Emergency Management Plans and Local Mitigation Strategy plans. Most significantly, there is a requirement for counties to at least have a "statement of intent" to develop a Post Disaster Redevelopment Plan (PDRP). The PDRP is significant because the time to plan for recovery and redevelopment is before the storm, not after when strategic planning will be very difficult.

Florida classifies hazard areas along the coast in terms of their vulnerability, and comprehensive plans must address development in each of these areas. The Coastal High Hazard Zone includes areas to be evacuated in Category 1 and higher storms, the Hurricane Vulnerability Zone is roughly defined by Category 3 evacuation zones, and the Coastal Planning Area, is a somewhat broader area often associated with the entire jurisdictions of coastal counties. Florida's Department of Community Affairs (2005) has recently developed an extensive guidebook describing how the Florida system works. *The Protecting Florida's Communities* guidebook also contains a wealth of specific information on best management planning practices that should be studied by any community interesting in minimizing vulnerability to flooding and coastal storms.

Divergence in the authority to plan amongst local levels of government can have some real consequences in terms of how well plans might actually be carried out. In Texas, for example, municipalities have considerable planning and enforcement powers, but counties in Texas have virtually no planning power outside of a few critical health and safety issues. The existence of strict city plans may result in development moving into the less restrictive "unincorporated" areas of the county, thus circumventing city planning. Some Texas counties, particularly in urban areas, have been petitioning the state legislature for years for more home rule powers. The city and county divergence is evident in Table 3, where Texas was ranked highest in the nation in terms of autonomy of municipalities, but near the bottom in terms of counties.

Planning authority and home rule alone, however, are not enough to insure that good plans, particularly land use plans, are in place. Louisiana parishes and municipalities have all the planning power they need (the highest composite ranking for local government in Table 3), but as Katrina laid bare, virtually none had developed any viable land use plans incorporating coastal hazard planning. The Florida example demonstrates that strong state leadership is needed to ensure that counties and cities develop

Table 3. States ranked by degree of local discretionary authority, 1980. *(from Richardson et al. 2003)*

State Rank	*Composite Ranking*	*Cities only*	*Counties only*
1		Texas	
8			Louisiana
10	Louisiana		
11	Texas		
14			Florida
16		Louisiana	
23		Alabama	
26	Florida		
28	Alabama		
30		Florida	
31		Mississippi	
35			Mississippi
37			Alabama
43			Texas
45	Mississippi		

There is a very wide divergence in planning powers and authority between Florida and the rest of the Gulf Coast states. Per capita insurance rates are much less in Florida.

Photo from the Texas Sea Grant archives.

effective plans, but that these are best implemented when local governments have the maximum degree of autonomy. In terms of composite ranking for local autonomy, Florida ranked in the middle of the five Gulf states (Table 3), well below Louisiana and Texas, but neither of these states have strong state mandates for land use plans incorporating hazard mitigation.

While most of the Gulf states aside from Florida have no real land use planning provisions or mandates, all of the states do exercise some control over building in the near-shore area. All of the Gulf states exert jurisdiction over submerged lands and require permits for bulkheads or structures that are built in or impinge on these lands. Coastal sand dues are protected to one degree or another by states and/or local governments across the Gulf. The Texas Open Beaches Act is perhaps the strongest of all state controls in the nation in terms of building on or near the ocean-side Gulf shores. Texas maintains a rolling easement that shifts with the vegetation line on barrier island Gulf-side shores. Houses found on the seaward side of this line after a major storm must be moved.

Drainage and/or flood control districts also play a very important local role in floodplain and drainage management, and could have an important role to play in adapting to the impacts of climate change and population growth. Drainage districts are usually formed on a county level, but frequently are constituted on a sub-county level. Where they occur, they are often also the floodplain administrator. Drainage districts are formed where low-lying terrain results in poor drainage, such that ditches and other drainage or flood control works must be constructed to enable agriculture as well as the establishment of cities and towns. Virtually all of the coastal counties along the U.S. Gulf Coast have drainage districts. Smaller districts, particularly sub-county districts, primarily construct relatively small drainage ditches, while larger districts, such as the Harris County Flood Control District (Houston), are involved in major public works projects including channelization of large streams, and the construction of large detention and retention basins. The bigger districts frequently partner with the U.S. Army Corps of Engineers on larger projects.

Florida is again unique in that drainage and other water functions are coordinated on a regional basis. Florida has five regional water management districts that regulate and manage irrigation, wetland permits, and water supply, as well as drainage and flood control. This regionalization provides Floridians with a much greater degree of adaptability and flexibility for dealing with current and future problems associated with the climate not available to the other Gulf states.

Building Codes

Where states have adopted building codes, they are based on one of the standard codes, usually the International Building Code (IBC) for commercial and multifamily structures, and the International Residential Code (IRC) for single and two-family structures. The latest version of these codes is 2006 (www.iccsafe.org), with wind and flood provisions also updated to 2006.

Only Florida, and recently Louisiana, mandate state codes for both residential and commercial buildings for all municipalities, with specific requirements for counties or parishes on the coast and in high wind hazard areas. (Table 4). Florida's code is managed by the Florida Building Commission, part of the Department of Community Affairs, the same department that manages flood issues and community planning. The building code appears to be enforced primarily at the city and county level. The recently passed Louisiana Building Code is administered and enforced statewide by the Uniform Construction Code Council (UCCC), and implemented through municipal and parish building inspectors.

Alabama and Mississippi have state codes that apply to state buildings only (and a few other buildings in the case of Alabama). Texas has no state building code for either residential or commercial structures, but it does recommend adoption of the 2000 IBC and IRC.

Fortunately, in spite of the fact that there are no statewide codes in effect in three of the Gulf states, cities and counties are free

to adopt their own building codes. There has been a flurry of activity, in fact, as cities in the Katrina impact zone have updated their building codes. In Mississippi, Biloxi, Gulfport, and Pass Christian, for example, now all list the 2004 IBC and IRC as their official building codes, with some amendments (www.municode.com). The Mississippi Legislature passed House Bill 1406 in 2006 requiring stricter building codes for the coastal counties of Hancock, Harrison, Jackson, Pearl River, and Stone (Office of Governor Hailey Barbour, 2006). But the lack of a state mandate still means that many localities in Mississippi do not have updated codes.

In Texas, the coastal city of Rockport mandates the 2003 IBC and IRC, but adjacent Fulton appears to have no building code, and the county they are both located in, Aransas County, also appears to have no specific building code. The Texas Windstorm Insurance Association (TWIA) does require inspections for both commercial and residential structures to be eligible for windstorm (hurricane) insurance, and insured structures, when located in specific wind hazard zones outlined by the TWIA, must be built to withstand wind loads using the 2003 IBC and IRC.

Even in states that have mandatory statewide building codes, codes are implemented and enforced at the local government level. The Municipal Code Corporation[9] is a private company that maintains a database of municipal codes for communities throughout the United States, including both building and land use codes.

Table 4. State Building Codes.

Extracted from Institute for Business and Home Safety Web Site (http://ibhs.org/building_codes/residential_bldg_codes.asp?state=36#results, accessed Jan 2007)

State	*Commercial*	*Residential*
Florida	2003 International Building Code (IBC) Mandated statewide	2004 International Residential Code (IRC) Mandated statewide
Alabama	2003 IBC Only state buildings, hotels, schools, movie theaters; all state funded buildings	None Prefabricated buildings must meet 1999 SBC
Mississippi	1997 Standard Building Code (SBC) Applies to state constructed and leased buildings	None
Louisiana	2003 IBC Mandatory statewide	2003 IRC mandatory statewide
Texas	None Texas Department of Insurance uses 2003 IBC	2003 IRC Not mandatory, local adoption only

[9] *http://www.municode.com/*

Photo by Tanya Baker, Texas Sea Grant

Adapting To Climate Change And Population Growth

Planning for future hazards is a "policy without a public" (May {1991} cited in Burby {2006}). History has revealed that even when people have personally witnessed the destruction of a hurricane or other coastal disaster, the incentives are not there to plan ahead. If people are reluctant to plan ahead for hurricanes, a common occurrence on the Gulf Coast, what can we expect for planning for continued growth, let alone climate change? Figure 3 shows population growth in coastal Galveston County, Texas, compared with historical hurricane strikes. It is abundantly obvious that the potential for another hurricane strike is not figuring into growth patterns in Galveston County. Although it has been over 40 years since a Category 4 storm struck the county, and over 20 years since a Category 3 storm struck, most people are fully aware of the possibility of another hurricane strike. They left in droves when Hurricane Rita threatened in 2005.

Building continues apace in low-lying Galveston County, even after the near-miss of Rita. If very real and serious storms in the living memory of local citizens and policy makers have not impacted land use on the Gulf Coast, it is difficult to see how threats associated with the relatively more uncertain impacts of climate change will capture the imagination of citizens and policy makers along the Gulf Coast.

But it is not just an apparent indifference to the dangers of hurricanes and other coastal hazards that has resulted in growth in hazardous areas along the U.S. Gulf Coast. Government policy has had a direct hand in facilitating this growth. In a perverse way, by working to make coastal areas safe, government policies have actually put more people in harm's way. Reducing consequences associated with relatively frequent events has, unfortunately, greatly increased vulnerability to very large and rare events (Kates, et al., 2006), precisely the kind of events we expect to increase as a result of global climatic change.

The policies that allow and even encourage people to build in hazardous coastal areas, and to build inappropriate structures in these areas, are the same policies that will impede or discourage adaptation to the future effects of global climate change in the coastal zone. Addressing the serious issues of coastal growth, with ever increasing populations in coastal hazard zones, automatically addresses issues of climate change and exacerbating coastal hazards. The same set of policy tools will be used. It is really just a question of adding an extra buffer or "freeboard" to the limits we are already facing.

Preparing in advance for disasters, whether acute like Katrina or chronic like sea level rise, is what mitigation for natural disasters is all about. As discussed above, structural mitigation (seawalls, levees, etc.) is no longer considered to be a first-line option (Association of State Floodplain Managers, 2007). Most structural mitigation projects are "paid for by the many to benefit the few," and are thought to invariably involve adverse impacts of one kind or another. They should only be viewed as measures of the last resort. There are many examples that spring to mind where these kinds of measures will be necessary. Venice, Italy, for example, has such staying power and resilience that extraordinary measures to hold back the sea are justified. Likewise, New Orleans, the "inevitable city on the impossible site," will stay where it is and will continue to need levees for protection (but these should be better levees protecting smaller areas – see below). While necessary to protect "inevitable development," structural mitigation has the deleterious side effect of making hazardous areas seem safer than they are.

Non-structural mitigation, which involves first and foremost planning, is the preferred alternative of almost every knowledgeable

Government policies have been largely responsible for much of the hazardous coastal growth of the last 4 decades.

Motor vessels Sea Wolf and Sea Falcon were washed onto the road in Empire, La., after Hurricane Katrina ripped through the area Aug. 29, 2005.

Photo courtesy of the U.S. Coast Guard

A well-defined system of federal mandates and assistance and maximum local responsibility would be much more effective than a strict top-down structure for effective disaster reponse.

hazard management specialist (Burby, 1998, 2006; Godschalk, 1998, 2003; Larsen et al., 2003; Berke 2006; U.S. Ocean Commission, 2004). An abundance of evidence shows that planning does indeed make a difference (e.g., Brody, forthcoming, and Burby, 2006). The key is figuring out what mix of requirements and incentives are best, and what level of government is best suited to carry out on-the-ground plans. The policy mix that best addresses current coastal hazard management will also best address impacts associated with global climate change.

In this section, we review what the current science says about disaster mitigation as it applies to coastal population growth and climate change, and how coastal managers might address these issues within the existing legal and institutional framework. We first look at lessons learned from Katrina in terms of disaster response (it is unlikely we will ever be able to plan a completely disaster-resistant community and, thus, always need disaster response plans), and then address a series of issues that revolve around planning for resilient coastal communities.

Disaster Response — Lessons From Katrina

Katrina laid bare stark deficiencies in the emergency management system of the United States. Given that more Katrinas are part of many climate change scenarios, what does Katrina tell us about our ability to adapt to changing circumstances?

The lessons learned from Katrina have been detailed in a number of places. The weaknesses of federal, state, and local response mechanisms are evident. Response did not go according to plan, if indeed there was a "plan."

The federal response to emergencies of national significance is laid out in the National Response Plan.[10] In addition, every state has an emergency coordinator assigned to oversee state-level response. All cities and communities have local emergency infrastructure in terms of fire, police, hospitals, etc.

A Katrina-level emergency will overwhelm the ability of almost any local entity to respond and that of most states as well. The problem is getting state and federal presence on the ground once disaster strikes. (There was no federal presence in New Orleans for several days after the disaster struck). The next problem is coordinating amongst all levels of government, and staying flexible enough to cope with changing and often unprecedented conditions.

The first lesson learned from Katrina in terms of disaster response is *don't build in the wrong place*. Building in the New Orleans' low-lying 9th Ward, among other areas, implicitly was a plan for a disaster and a plan for poor disaster response as well. The "safe government paradox" discussed elsewhere in this publication encourages people to settle in very low-lying areas by building levees. Once the levees were in place, builders were not required to elevate ground floors to the base flood elevation (BFE) level, nor were homeowners required to carry flood insurance in these areas, further encouraging complacency.

A second, related, lesson is to ensure the presence of nearby refuges that are sufficiently stout and elevated to withstand storms and flooding. The lesson of Galveston and the 1900 Storm is illustrative of the ability of a few good buildings to save lives. These sanctuary buildings must, however, be near the people who might need them (see discussion below under "The Promise of Compact Growth").

Effective disaster response requires a balance of clear, well-defined authority with the ability to be flexible and creative (Harrald, 2006). In terms of governance, this balance mirrors the previous discussion of disaster mitigation and land use planning and the need for strong state leadership coupled with local autonomy to achieve effective planning. There has been some discussion that a "single-minded devotion to home rule" posed some impediments to response in New Orleans (Kettl, 2006), but there is no evidence that home rule in and of itself was any more to blame than ineptness and lack of coordination at any other level.

More research is needed in this area, but it would seem that a well-defined system

[10] *http://www.dhs.gov/xprepresp/committees/editorial_0566.shtm .*

of federal mandates and assistance and maximum local responsibility would be much more effective than the strict top-down structure currently being built at the federal level. Strong local participation and, where possible, control, may be key to ensuring flexibility in large emergencies. The overly top-down structure of the National Response System failed during Katrina. According to Harrald (2006), "the [Department of Homeland Security] has focused on increasing the discipline in the national system through an extensive development of doctrine, process, and structure, and has neglected fostering the agility (creativity, adaptability, improvisation) that has historically been the key to success."

A principal lesson from Katrina, then, is to encourage more intergovernmental cooperation. Home rule would aid, not hinder, emergency response, if guided by adequate state and federal leadership and assistance. Strong local participation, which must mean strong local authority, is necessary to foster the distributed decision-making and improvisation that are critical in the face of unexpected storms, which it appears we can expect more of as a result of climate change.

The Role Of Integrated Coastal Zone Management In Adaptation To Climate Change And Growth

Integrated coastal zone management (ICZM), like ecosystem-based management and watershed management, is a quest for holistic management that integrates biophysical and social issues within coherent physical geographic zones. Unfortunately, government jurisdictions are rarely aligned along watershed or ecosystem boundaries, much less areas defined as "coastal zones." That integrated management across jurisdictional boundaries is necessary is widely recognized. That effective implementation of trans-jurisdictional integrated management rarely occurs is also widely recognized. ICZM remains a largely unfulfilled quest, in spite of some impressive progress in the last couple of decades.

U.S. Coast Guard during hurricane Katrina rescues.

Photo courtesy of the U.S. Coast Guard

But the concept remains viable and most practitioners and even governments agree ICZM is a goal to strive for.

The problem of why ICZM is not as far along as many think it should be comes down, perhaps, to the issue of governance. The analysis of this publication in terms of the dynamics of local and state governments and mitigation planning for disasters is instructive. The development of effective plans for dealing with disasters requires a delicate balance between local autonomy and federal and state mandates. This review suggests that a strong federal or state mandate for effective plans coupled with strong local autonomy to carry out the planning has resulted in the most effective plans. It appears that few city or county governments have the political will to carry out effective plans that require substantial changes in land use, for example. On the other hand, if they are required to develop plans that make hard choices, local governments are fully capable of doing so, and in fact usually come up with better plans than would be developed and imposed by state or federal entities.

Most local communities in the Gulf Coast region have some home rule powers. Few, if any, are going to give up their autonomy to regional planning agencies — no matter how high-minded the governing principles might be. This is not to say that regional planning can't or doesn't work on the Gulf

The development of effective plans for dealing with disasters requires a delicate balance between local autonomy and federal and state mandates, a balance not yet achieved in ICZM.

Hurricane Rita devastated Holly Beach, La.

Photo by Tom MacKenzie, courtesy U.S. Fish & Wildlife Service

Coast. Regional Councils of Governments (COGs), for example, cover the area, and promote regional planning. There are Metropolitan Planning Organizations (MPOs) for the major cities that deal with transportation planning issues. There are River Authorities and Water Management Districts all along the coast, with service areas that overlap with any number of local governments. Voluntary watershed partnerships, which promote interagency collaboration and greater public stakeholder involvement, are becoming much more common. Several National Estuary Program projects being implemented along the coast promote integrated management of coastal natural resources.

Florida has one of the more interesting complexes of overlapping councils and districts: 11 regional planning councils, 26 MPOs, and 5 regional water management districts, all with varying degrees of authority and review power. Do they all add up to Integrated Coastal Zone Management — probably not, yet! But the message here is that integrated planning is not an alien concept in this area.

The lesson of this analysis is that ICZM will work best when it recognizes the primacy of local government, coupled with the need for very strong federal and state mandates. The balance that ICZM seeks in terms of environmental, economic, social, cultural, and recreational objectives will not take place unless a balance is struck between local, state, and federal governance. Adaptation to climate change will clearly not occur by edict alone. There needs to be strong leadership from the federal government for dealing with current and future disasters. That leadership needs to be funneled through the states that in turn impose mandates on local governments while giving them full authority to adapt plans to local conditions. That truly effective plans have yet to be developed even in Florida suggests that all the steps in the dance of effective governance have yet to be worked out. The fact remains, however, that some of the best plans come from Florida, which suggests that balancing strong state mandates and local autonomy might be one of the main steps in the dance.

The Question Of Urban Resiliency

Resiliency is an emerging concept in the world of urban hazard planning (Allenby and Fink, 2005). In ecology, a system is said to be resilient if it is able "to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes."[11] The concept is gaining meaning in the field of urban hazard planning over the more widespread term "sustainability" because adaptive capacity to recover from disasters is a primary hallmark of long lasting, resilient coastal cities (Godschalk, 2003).

Resilience intuitively refers to the ability to bend without breaking, and to regain the original "pre-bend" shape. What is it that makes some cities more resilient than others in the face of catastrophes? Venice, through subsidence, is facing what many cities would face only under the worst-case scenarios for sea level rise. And yet in spite of serious problems, it is not yet collapsing into a different state. If anything, it is thriving. This kind of resilience is related, in part, to the strength of the urban infrastructure, and to the sturdiness of the structures. Location obviously has a lot to do with it as well. In part, resilience is related to urban form or pattern, as some forms facilitate interaction and interconnectedness more than other forms. Urban form can also make a difference in terms what types of structures are built. This aspect will be discussed in greater detail below under "The Promise of Compact Growth." Urban resilience also involves other, somewhat fuzzier, quantities such as social capital (Adger et al, 2005), which refers to the civic stock of public participation and public engagement that exist in a community — how well people can pull together in a crisis.

An example of a lack of resilience is the subdivision of Brownwood, in suburban Houston, which succumbed to subsidence and flooding, and was not protected, in spite of the considerable infrastructure in the neighborhood (Lockwood, 1996). Granted, there is no comparison with Venice, but the fact that Brownwood was so readily abandoned bespeaks a certain lack

[11] *Resilience Alliance: http://www.resalliance.org/576.php*

of community resilience. There really was nothing worth saving. There was no urban form that contributed to either social or infrastructural resiliency. There was nothing worth struggling for.

Godschalk (2003) and others cited in his paper point out that resiliency involves a balance of opposites: "redundancy and efficiency, diversity and interdependence, strength and flexibility, and planning and adaptability." Resilient cities as described by Godschalk have a "lifeline system of roads … and other support facilities . . . designed to continue functioning in the face of rising water [and] high winds . ." Development is guided away from areas of known hazards. Buildings are constructed to codes designed for specific hazard threats. Natural areas are preserved for storm buffering as well as for other functions, and governments and other agencies have up-to-date information on hazards that they share through effective communication networks. In addition, as elucidated through this analysis, there is a governance structure that gives local governments the maximum authority to create, under strong federal and state mandates requiring minimum standards, land use and hazard management plans best suited for their own conditions.

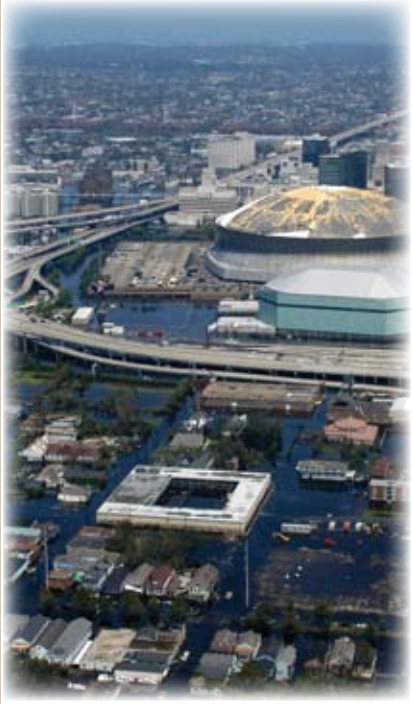
Shifting Burdens

Humans have always been attracted to the coast and other hazardous areas, and they have always found ways to adapt. What has changed in the past 60 years or so is the degree to which the federal government has facilitated enormous growth in hazardous areas, growth that is often occurring in much more hazardous circumstances than would otherwise have occurred. This ill-considered growth has occurred through massive public works projects that built protective structures such as levees; subsidization of insurance; and massive infusion of dollars into recovery efforts, all of which have served to make inherently hazardous areas seem less so.

New Orleans is a good case in point. It was originally settled on the high natural levees on the Mississippi River, a potentially dangerous area to be sure, but by far the safest spot near the mouth of the river (Figure 4). The city has been subjected to storms and floods regularly since its inception. The levee where the French Quarter and other older parts of New Orleans sits is rather narrow, and the city eventually expanded into lower and even more hazardous areas. But it wasn't until the advent of the NFIP in the late 1960's that development began to move rapidly into the wettest and lowest places that had been avoided for generations, such as the lower reaches of the lower 9th Ward.[12] Development had occurred in unpropitious areas in New Orleans well before the NFIP, but the NFIP enabled rapid expansion into much worse areas by removing most of the burden of the risk associated with coastal flooding. This story has been repeated throughout the U.S. No private insurers will insure buildings in unsafe riverine or coastal flood zones. Indeed, no insurance was obtainable until federally subsidized insurance became available.

Major legislative initiatives in hazard management have followed hard on major catastrophic storms or other disasters. The NFIP was no different and was enacted after costly hurricane reconstruction efforts associated with Hurricane Betsy, which struck New Orleans in 1965, in an effort to spread the burden of rescue and reconstruction across a wide group of policy holders. The history of the NFIP is detailed in Platt (1999).

The NFIP was designed to reduce payout of federal dollars for flood damages, but the end result has been a very large increase in federal payments, to the point where payouts have greatly exceeded premiums in the last several years, and the NFIP has had to draw on the national treasury. The principal criticism of the NFIP has been that the burden of risk for developing in inherently hazardous areas has been shifted from the few to the many, through subsidized insurance, and in the process has made otherwise low-value property become very attractive, as part of what Burby (2006) calls the "safe government paradox", and others refer to as a "moral hazard" (Platt, 1999). The government provides assistance for large public protection projects such as levees and seawalls and assumes much of the financial risk for development in hazardous



As the levees failed, most of New Orleans was under water.

Photo courtesy U.S. Navy

A resilient coastal city can take withstand a catastrophic storm without "breaking". Some recovery will be involved, but it won't take long to regain its pre-storm status.

[12] *http://www.gnocdc.org/orleans/8/22/snapshot.html.*

areas through subsidized insurance. (Interestingly, flood insurance is not required in levee-protected areas). The consequences of frequent and small events are greatly reduced, but vulnerability to large and rarer catastrophic events is greatly increased (Kates et al. 2006). That those rare large catastrophic events might become less rare is a principal concern associated with changing global climate. How coastal cities will adapt to climate change through insurance is a necessary part of this discussion.

It is only natural that coastal cities would want to protect development from the ravages of coastal hazards. One of the premises of federal government assistance for large protective public works is that they were necessary to protect existing development, but in most places only a few of the justified benefits for large projects were associated with existing development. In New Orleans, for example, 79 percent of the benefits from new levee building since the 1960s were for new construction that followed after the levees were built (Burby 2006). This history and practice has clear implications for adapting to rising sea levels and increasing storms associated with global climate change. Should the government provide protection for development in areas subject to increasing risk, and assume the financial responsibility for that risk? Clearly, the unintended consequences of putting more people in harm's way should be weighed carefully with the good intentions of "protecting" people.

How insurance is structured is itself a very real form of adaptive capacity for global climate change impacts in coastal regions (Mills, 2005), because it plays such an important role, indeed perhaps the central role, in determining what gets built where. As Mills points out, insurers have had a historical self-chosen role in addressing causal agents for a number of hazardous situations. Insurers were the founders of "the first fire departments, building codes, and auto safety testing protocols" (Mills, 2005). There is little reason to believe that private insurers would be willing to subsidize development in very hazardous areas without a government subsidy. At actuarial insurance rates, building in the coastal "V" zone (the coastal "velocity zone", equivalent to the riverine floodway), or any flood zone for that matter, would no doubt be much more expensive than it is now. Perhaps a case could be made that where coastal cities are truly "necessary", such as critical port facilities at the mouths of major rivers (e.g., New Orleans) some sharing of the risk might be justified. Some kind of private-public partnership could be advisable to share what might well be a necessary risk. But considerable restructuring from the current system would be necessary to avoid the "safe government paradox" and development in ill-considered areas, beyond that needed to sustain critical facilities.

Burby (2006) suggests that a fundamental shift needs to be made from insuring individuals to insuring communities. Insuring a community rather than an individual puts the responsibility where it belongs – on local government. All of the dwellings and buildings in a community would be insured, with the premium based on the risk exposure of the community. This would avoid the problem of less than full participation in the NFIP program in many communities. Burby suggests communities could pay their premiums through a flood-insurance utility operated in much the same way that storm utilities already operate in many communities. A home or business owner's fee would be based on the amount of risk, addressing perhaps the principal problem of the NFIP — the lack of correlation between premiums and risk.

Canceling government subsidies altogether is frequently suggested as the best remedy for the NFIP. Private insurance for coastal areas would be much more expensive, and even unavailable at any price in some areas. The lack of insurance will not necessarily mean the cessation of all development in coastal areas. Beach house owners on Bolivar Peninsula, on the east side of Galveston Bay, for example, can easily expect payback on these houses, in terms of rental income, within five years,[13] a period of time much shorter than the current recurrence interval of even small tropical storms and hurricanes.

Coastal populations are clearly going to be at a greater risk as a result of global climate

Federally-subsidized insurance for development in hazardous areas is a moral hazard known as the "safe government paradox". This subsidy has increased rather than reduced property damage and human suffering in coastal areas.

Traffic jams during hurricane evacuation.

Photo courtesy of the U.S. Coast Guard

change. The natural tendency for many well intentioned researchers and planners is to want to protect those populations from the coming impacts, through protective structures and federal assumption of the risk. But experience has shown that this is exactly opposite of the path needed to minimize damage to life and property. If left to their own devices, local populations usually have a pretty good idea of where it is prudent to build, if made responsible or liable for most of the risk. In terms of climate change, what is needed is communication about increasing risks in areas citizens already perceive as hazardous, and the need to incorporate more "freeboard", both real and metaphorical, into their plans and buildings.

Recommendations:

Remove all subsidies from flood hazard insurance (Berke 2006), except for those areas or communities deemed to be carrying out essential functions, and then only subsidize if the community meets strict flood mitigation requirements involving rigorous land use planning.

Insure communities, not individuals. Local governments should pay premiums based on risk exposure, and charge their citizens accordingly.

Use the 500-year floodplain, rather than the 100-yr floodplain, as the basis for requiring insurance for structures (Burby, 2006). This would act as a minimal "freeboard" to accommodate a certain degree of change associated with global climate change.

Require communities to have a hazard plan as part of a comprehensive plan for participation in any subsidized insurance program.

[13] *Personal communication by builders to Jacob (2005)*

The Primacy of Planning

Keeping people out of harm's way through land use planning is far cheaper than building levees or other structures.

The preponderance of opinion in both the academic (Burby, 2006; Godschalk, 2003; Berke and Campanella, 2006) and practitioner communities (ASFPM 2007) is that keeping people out of harm's way through the "soft mitigation" practice of planning, particularly land use planning, is far preferable to investments in either hard protective structures or investments in community reconstruction after the fact, necessary though these last two occasionally may be. It is a simple truism that prudent people plan. They plan for what they know will happen, but they also plan for what might happen. They even plan for relatively low-probability events which might have very large consequences. They do this unless they live on the coast and have incentives not to do so. Such is the case where national flood insurance removes local responsibility for planning decisions.

Major tropical storms and hurricanes occur with such a relatively low frequency for any one place on the coast (Figures 5 and 6), that planners and engineers can easily become complacent about planning for future risks, especially when there is no requirement to plan or penalty for failing to develop adequate plans. The feeling for many, perhaps, is that these events are "acts of God" about which not much can be done, and the federal government will have to step in at some point anyway (Stehr, 2006).

It should not be assumed that there is a total lack of planning in cities along the Gulf Coast. Plenty of planning has been taking place. But the fact that plans have been made does not mean that good plans have been developed. New Orleans planned the expansion into the Lower 9th Ward. In 1999, just six years before Katrina, the New Orleans Planning Commission stated that further development of this area represented "not only population increases but also significant potential employment for the city" (cited in Burby, 2006). There was clearly a lack of planning for hazards in New Orleans. If there was no planning for the clear and present danger or hurricanes, planning for the effects of global climate change is probably not very high on their list either.

In spite of a near-consensus in the academic planning community on the necessity of good comprehensive planning to reduce hazards, it is sobering to consider just how few municipal or county plans there are that effectively control development in hazardous areas (e.g., Catlin, 1997). In addition to the factors reviewed above, perhaps the greatest obstacle to effective planning is the fear of litigation related to government takings associated with limiting development. Our review of some of the best plans in Florida revealed that the strongest planning language was often limited to indicating *where* hazardous areas occurred, with few limitations, except perhaps with respect to limiting density bonuses on development in these zones. Still, a simple portrayal of hazardous zones in a comprehensive plan has been shown to effectively limit densities to some degree in high hazard areas.[14] And many plans in Florida and elsewhere do strongly tie building codes to hazard zones.

Figure 5. All tropical storm and hurricane tracks for about the past 100 years for the Upper Texas Gulf Coast (taken from the Historical Hurricane Tracker: http://maps.csc.noaa.gov/hurricanes/viewer.html, NOAA Coastal Services Center). Storms increase in intensity in the order green-yellow-red.

[14] *personal communication, Robert Deyle, USF, July 2007.*

Planning on the Gulf is an evolving process. Each major storm and disaster brings greater awareness of the need to plan for safer growth. We know what it takes to plan effectively (reviewed below); sadly, it is unlikely that many of the agreed-upon recommendations of the disaster mitigation community will be implemented before further tragedy strikes.

State Directives, Local Plans

A growing body of evidence suggests that hazard mitigation plans do not happen without some serious guidance from state and/or federal government. Higher levels of government are able to take a longer view of things, and are in a better position to require proper plans of local governments.

But plans, even good plans, can't simply be dictated from above. There is no one-size-fits-all for the difficult process of land use planning that incorporates hazard mitigation. Land use is an inherently local issue, and it is at the local level where effective plans will have to be developed. Only the locals have good on-the-ground knowledge of specific hazards, and perhaps more importantly, a living memory of specific catastrophes and the areas that were impacted. Good plans must be based on detailed local knowledge, not generalized information extracted from afar.

It would appear that the best plans are developed by fairly autonomous communities that have significant discretion in how plans are developed, with strong mandates to plan imposed by the state. Among the Gulf states, Florida appears to have the best combination of strong state directives which enables local communities to construct somewhat workable and functional plans that integrate land use and hazard mitigation (Deyle et al.,1998; Brody et al., 2003).

But there are few communities anywhere that plan as well for hazards as they could or should. Studies of land use/coastal hazard plans in Florida (Catlin, 1997) and North Carolina (Norton 2005), states with strong mandates for local planning, reveal substantial weaknesses that undermine the plans. In particular, Norton (2005) points

Figure 6. Same view as Figure 5 for past 50 years, Category 3 and above storms. This is the recurrence interval that might constitute the outer reaches of a communities "living memory", and thus likely to have at least a marginal impact in planning horizons. While only Category 3 and above storms are shown here, it should be noted that lower category storms can sometimes have devastating consequences. Tropical Storm Allison (2001), not even a hurricane, was the Houston area's costliest storm ever.

to weak linkages in North Carolina plans between land suitability analyses, on the one hand, and policies, maps, and classifications on the other, with many beach communities classifying the most hazardous areas in terms of storm surge for the highest density development. It is the land suitability classification that one would hope would be the strongest area in effective land use and hazard mitigation maps. Norton (2005) agrees with Burby and his colleagues (Burby, 2006) that the best formula for effective plans is to have strong state directives that mandate effective plans at the local level, but concludes that substantially stronger mandates are needed for local governments than currently exist.

A Good Plan

What constitutes a good hazard mitigation plan, particularly one that might accommodate the impacts of global climate change? Land use has to be a fundamental part of any good hazard mitigation plan, because it is precisely the misuse of land – putting buildings or people in harm's way – that has brought us to where we are today. And given that fact, the best hazard mitigation plans will almost invariably be part of a community's comprehensive plan,

A good hazard plan ties land suitability to development constraints.

Photo courtesy of Bill Harvey.

since it is practically impossible to consider land use outside of that context (Godschalk et al., 1998; Berke and Campanella, 2006). Norton (2005) considers a high quality hazard mitigation plan to have:

- A strong factual basis;
- Clearly articulated goals;
- A land suitability analysis (LSA) that clearly identifies constraints for development;
- Policies consistent with the LSA that are directive rather than exhortative;
- Horizontal and vertical consistency;
- Meaningful facilitation of public participation;
- Clear responsibilities for implementation; and
- Monitoring and implementation evaluation procedures.

The above bullets delineate what constitutes a good plan from a technical point of view — what the plan should address, how it should address issues, etc. But there is growing awareness that even the best technical plans have little relevance unless there has been substantial input from the citizens that will be affected by the plan (Berke and Campanella, 2006; Conroy and Berke, 2004). Not only are plans developed with substantive citizen involvement less likely to face opposition from the local communities whose lives will be impacted, they might also be better technically, by incorporating details that emerge from locally engaged citizens, and more effectively monitored by the citizens. Brody et al. (2003), for example, examined plans from across the U.S. and found that a rigorous state mandate for citizen participation was the key factor in insuring effective citizen involvement in community plans, including hazard mitigation plans. In their study, Florida had the strongest such mandate of any state examined and the best level of citizen participation.

A Redevelopment Plan – do one before the disaster.

Very often the best opportunity to correct some of the mistakes from the past is after a disaster. But that is also the very worst time to try to plan for redevelopment, when recovery occupies all available energy and there is little available for strategic planning. Unless some good solid thinking has gone into how hazardous areas destroyed by a storm should be redeveloped, they will most likely redevelop as they were before they storm. The Florida DCA's Protecting Florida's Communities guidebook (Department of Community Affairs, 2005) contains a very useful model recovery and redevelopment ordinance.

Recommendations:

Strong leadership must come from the federal and state governments, with firm mandates for effective local plans. Local governments need autonomy and authority to develop local plans, as opposed to implementing imposed state-developed plans.

In terms of adaptation for climate change, plans need to follow the guidelines given above for plan quality and citizen participation, with the simple requirement that a certain amount of "freeboard" for hazards be incorporated into the plans.

Local governments are likely to need increased funding to facilitate the development of plans.

Vulnerability – The Need To Know

Assessing vulnerability is a key part in the development of any kind of mitigation plan, but knowledge about present and future vulnerability is so crucial that it merits separate treatment. Planners need to have ready access to vulnerability data, and citizens need to be able to fully understand all the risks associated with living in a coastal hazard zone, including the chances for stronger and more frequent storms, and flooding and rising sea level, for plans to have much meaning or acceptance. In this publication, the term vulnerability, unless otherwise specified, includes the full suite of hazard risk assessment terminology, making no real distinction between risk, vulnerability, exposure, sensitivity, etc., although all of these can be teased out separately to some benefit (e.g., see Füssell and Klein, 2006). The issue here is simply to know where problems, such as flooding or storm surges, are occurring or are likely to occur in the future, who or what might be at risk in those areas, and how well they or it might be able to cope with the problems.

Building on Deyle et al. (1998), a vulnerability assessment begins with a solid inventory of the hazards (termed a "risk hazard analysis"). Where and how often does it flood? How far inland and to what elevation might we expect storm surges? The FEMA 100-yr and 500-yr floodplain maps are generally the fallback information available to any community. These maps, however, are not always as accurate as they need to be and local communities may want to invest in developing their own maps with greater detail and precision (Larsen et al., 2003). After Tropical Storm Allison, the most damaging storm ever to hit Houston, Harris County and FEMA invested heavily in new technology to completely remap the floodplains of the county with much greater detail and reliability (Quarles et al., 2002).

The next task in the assessment is to inventory what is in the hazard zones in terms of people, kinds of buildings, houses, roads, sewage plants, etc. (vulnerability assessment for Deyle et al {1998}). What kind of special risk facilities, such as chemical plants, are found in the hazard zones?

Lastly, some idea as to the state of both the infrastructure and the people in the hazard zones is needed (risk analysis by Deyle et al., {1998}, with some overlap with their vulnerability assessment). What buildings are likely to withstand storm surges or flood damage? How hardened are the sewage and chemical plants to storm damage? Which populations are most at risk in terms of potential damage suffered and their ability to evacuate?

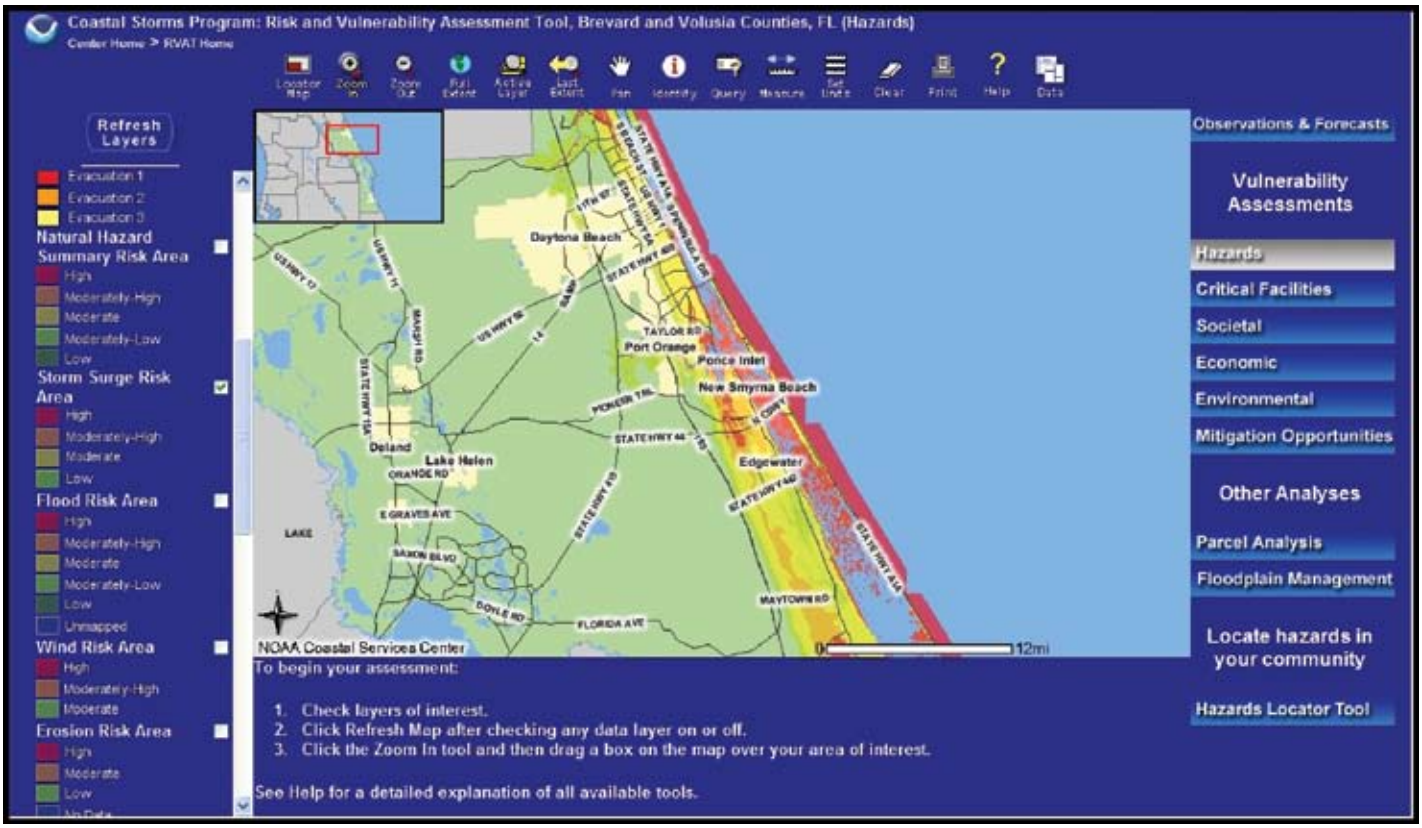
There are many more aspects and details involved with a complete hazard vulnerability analysis than have been addressed here. There is an entire literature dedicated to this subject (e.g., Mileti, 1999; Smith, 2004) that we cannot even begin to cover here. But it is not the details that are important, so much the ways policies that enable adaptation to climate change impacts can be integrated into the overall coastal natural hazard reduction framework, such as it exists. Clearly, a robust and detailed assessment of coastal storm surge and flooding potential will enable more precise placement of whatever buffer or freeboard is necessary to accommodate climate change impacts. Coastal communities that are unclear on the details of how natural hazards impact their community are unlikely to appreciate the need for additional freeboard for climate change impacts, much less what that additional buffer might look like.

The advent of Geographic Information Systems (GIS) greatly facilitates analysis of the many factors involved in all three steps of a complete hazard/ vulnerability/ risk assessment. One of the better examples of how this technology can be used, the Risk and Vulnerability Assessment Tool,[15] was developed by NOAA's Coastal Services Center. Figure 7 shows a screen shot of a pilot project using this tool for Brevard and Volusia Counties in Florida. Citizens and policy makers can use this tool to examine any number of issues related to coastal

Vulnerability is simply about knowing where problems are going to occur, who or what is at risk in those areas, and how well they or it can cope with the problems.

[15] *http://www.csc.noaa. gov/rvat/*

Figure 7. Risk and Vulnerability Assessment Tool for Brevard and Volusia Counties. NOAA Coastal Services Center (http://www.csc.noaa.gov/rvat/). This screen shot shows storm surge risk areas (legend on the left). Panel on the right shows the various layers that can be examined.



hazards —including the kinds of hazards, vulnerable natural areas, and vulnerable infrastructure and populations. These layers installed on a desktop geographic information system[16] would allow very powerful advance querying and analytical functions not available on this web-based tool. The Coastal Services Center also has a Community Vulnerability Assessment Tool[17] that guides a community through the process of a vulnerability assessment.

Neither of the tools listed above specifically address additional impacts associated with climate change. Simple sea level rise could easily be incorporated into these maps. Incorporating features such as increased storm surge would not be difficult per se — what would be difficult would be determining just how much extra land area, for example, to add in for storm surge hazard zones. Maps could be constructed that would show a range of increased hazard zones under a variety of scenarios (say from very likely to the lower limit of what's likely, etc. — perhaps using confidence limits as the IPCC does for its climate change impact estimates). Using the format of CSC's RVAT, an additional layer called "future planning" could be added where the user could explore how storm surge zones and flooding might change under different climate change scenarios.

FEMA developed another powerful GIS-based tool, the Hazards U.S. Multi-Hazard (HAZUS-MH)[18], used primarily to estimate potential losses from floods and other hazards. Users can estimate the impacts, for example, of storm surges on specific populations.

[16] *The tool shown here is a web-based system with much more limited analytical abilities than a desktop-based system.*

[17] *http://www.csc.noaa.gov/products/nchaz/startup.htm*

[18] *http://www.fema.gov/plan/prevent/hazus/index.shtm*

Destruction from the 1900 storm in Galveston, Texas.
Photo courtesy of Rosenberg Library

Compact Urbanism: A New Paradigm For Resilient Cities On The Coast?

Compact urban form is emerging as the central paradigm for sustainable cities, with New Urbanism and Smart Growth as its two very closely related flavors.[19] Considerable research has been carried out on the social and economic benefits of smart growth, as well as some incipient research on the environmental benefits (Berke, 2003; Jacob and Lopez, 2006). But very little research, if any, has been carried out on those specific aspects of smart growth that might lead to greater resilience to coastal hazards. If compact cities could be shown to be safer and more resilient, there would be direct policy implications for how coastal cities should grow and/or rebuild in the face of increasing hazards associated with global climate change. What follows is an exploration of how compact urban form might endow cities with greater resilience, recognizing that each of the questions posed requires much more research.

Smart growth is distinguished from conventional growth principally in that it has considerably higher population densities. There is no precise level of density specified for smart growth, but those areas touted as smart growth or new urban developments will often have densities as high as 10,000 people per square mile, with some as high as 20,000 people/sq mi or even much higher, versus 3,000 – 4,000 people/ sq mile in typical suburban developments.

Many of the benefits that accrue from smart growth devolve from this increased density. Interestingly, a common planning recommendation in coastal hazardous areas is to reduce, rather than, increase density. The discussion below is premised on the position that if a hazardous area is going to have some development, denser development will be safer than more diffuse development.

From the environmental perspective, the most obvious benefit of compact growth is less open space is consumed by development. But the main attraction of smart growth is hardly its environmental dividend. Proximity and compactness, if well designed, confer

The greater density of compact growth may be much safer than the lower density often recommended for hazardous areas (provided more natural open areas are preserved).

[19] *We will use "Smart Growth" in this paper to refer generally to compact growth.*

The Strand in Galveston. These buildings survived the 1900 storm and are an excellent example of mixed-use development.

Mixed-use development could function as a kind of community "safe room" for vulnerable comunities.

a measure of urban vitality not achievable with conventional car-dependent, sprawling development. Using the pedestrian, versus the automobile, as the primary design standard results in a high level of residential and commercial diversity within relatively short distances and, therefore, much more interesting places. It is not necessary to extol the environmental benefits of smart growth to attract people to it. Examining the environmental and disaster-resistant features of smart growth is, however, of benefit to policy makers interested in the larger picture of sustainability and resilience.

Less area to protect

A city of 500,000 people at 4,000 people/ sq mi will occupy 125 sq miles, while the same population at 15,000 people/ sq mi (the density of the French Quarter in New Orleans) will occupy only 33 square miles, a considerably smaller area needing protection. If each of these areas were arranged in a square, and needed protection all the way around, the fist city would require 45 miles of levees, where as the second city would only require 23 miles of levee protection. At five to ten million dollars per mile for levee construction, a savings of close to $200,000,000 could be realized; or more importantly, much better levees, maintained to a higher degree, could be built to protect the smaller area occupied by the same amount of people. Most of the levees built in New Orleans were built to protect and to enable development at suburban densities, areas nowhere close to the French Quarter in terms of density (or livability). Research on the world-wide cost of levees per capita per linear mile compared with the sturdiness of the levees might be illuminating.

More choices of where to locate

With less area to occupy, the denser city will obviously have more choices regarding where development occurs. At 25,000 people/sq mi (the density of a Lyon, France or parts of New York City — but only about a third of a very liveable Paris[20]), only 20 sq miles is needed for 500,000 people, compared to the 125 sq miles at conventional car-dependent densities, affording much greater opportunity for staying out of zones of greater hazard.

Sturdier buildings

More compact growth enables the construction of sturdier buildings in two ways. People living in compact cities are much less dependent on automobiles and all the costs associated with them, and consequently have more money to spend on housing (and could therefore build sturdier houses if they so chose or were required to do so for affordable insurance). Secondly, where buildings share walls, such as in townhomes, the cost of masonry

[20] *http://en.wikipedia.org/wiki/List_of_selected_cities_by_population_density*
[21] *www.fema.gov/mit/saferoom.*

construction per building is much less, making that kind of construction much more affordable. Masonry construction is inherently much more floodproof than conventional stick-built homes.

Proximity of refuge

Mixed use is a hallmark of smart growth. Modern conventional diffuse growth dictates the separation of uses, with miles and miles of suburban residential developments unbroken by business districts. Smart growth practitioners design urban areas where residential and commercial areas are in close proximity, if not intermixed. Commercial buildings can be built to much more rigorous standards than residential single family buildings, no matter what the type of construction. The nearby presence of substantial commercial buildings could provide very real refuge when storms approach with no real time for evacuation. But to be bona-fide refuges, they must be nearby — not miles away as they were in most of the lower 9th ward and elsewhere in New Orleans. This idea of refuge on a community scale is the "safe room"[21] writ large.

Galveston, TX, the site of the deadliest storm in U.S. history, provides a good example of how such a refuge could work. Most of Galveston was destroyed by the 1900 hurricane, but most of the commercial district withstood the storm and still stands today (Picture). The highest survivorship was from people who took refuge in this zone (fewer took advantage of the refuge than could have because they were led to believe that the storm would not be serious {Larson, 2000}). The only way to have substantial buildings within walking distance of residential areas is to build an area compact enough that pedestrian traffic could be a significant part of the retail business. Most municipalities along the Gulf Coast have codes that proscribe this kind of mixed use, and most places prescribe such large lots for single family homes (> 7,000 sq feet) that walkability is out of the question.

Greater social cohesion

An urban pattern that facilitates and promotes more walking perforce promotes and facilitates more social interaction. More social interaction should lead to a greater amount of social capital or social cohesion. Networks of mutual assistance on a neighborhood scale can only occur where there is interaction. Interaction is likely to be less in car-dependent neighborhoods than walkable neighborhoods. Where people can walk to the corner store or coffee shop, they are much more likely to frequently encounter their neighbors, and know more about the details of the lives. For instance, who might need assistance making it to a shelter or evacuating. Little research is available but sorely needed on this specific topic.

Transit and evacuation

Denser cities will have far fewer cars per capita than diffuse cities. Mass transit enables the transport of many more people over equivalent distances than cars can. Whether or not a mass transit system could move more people out of harm's way than the equivalent population in private automobiles is an open question. The debacle of the Rita-inspired Houston evacuation is still fresh. The state and city of Houston, however, have taken extensive measures to insure that contra flow is put in place early, such that the next evacuation could be much smoother. How well a mass-transit aided evacuation would work depends on a number of factors, including the number of busses/trains available and how far transit system extended beyond the areas of immediate danger. It is conceivable that hurricane-safe refuges or sanctuaries could be built at the inland termini of major coastal metropolitan transit systems.

All of the above potential benefits associated with compact growth are presented in a somewhat "self-evident" form, and some might well be — like the length of levees relative to land area. But others are much less self-evident (e.g, social cohesion) and need much more research for validation. The idea of resilience is not tied to specific urban form, to be sure (Godschalk, 2003), but the many other benefits, social and physical, associated with compact urban form, commend it for consideration by natural resource hazard and climate change researchers and practitioners.

Flooding after hurricane Katrina.

Photo courtesy of U.S. Coast Guard.

A compact coastal city has more options of where to locate and less area to protect.

The Role Of Universities

David Godschalk, one of the elder statesmen of planning for hazard reduction, has called for the formation of a "hazard mitigation corps" along the lines of the agricultural extension service model (Godschalk, 2002). The corps would consist of a group of hazard mitigation agents based in "state universities to work with urban communities to provide hazard information and mitigation assistance." The call is a recognition of both the pressing need communities have for hazard-planning assistance as well as the powerful knowledge base contained within the university community, which unfortunately often operates in a somewhat cloistered fashion with respect to the community.

The state university connection is important because that is where the Land and Sea Grant programs are housed. The Land Grant system has been called one of the greatest inventions of the American republic. Founded by Lincoln, the fundamental idea of the Land Grant system is to provide a way to engage the communities the land grant universities are intended to serve. Engagement is a critical term because it implies more than a one-way flow of information from university to the community. It implies feedback from the community to researchers, guiding them in their research, compelling them to answer questions of fundamental interest to the community. Universities are most powerful and credible when they use their resources to engage communities through convocation and deliberation (Gutmann, 2006), which is the classic extension modality.

The heart and soul of the land grant system, still fundamentally agricultural, has been the county agent. The county agent is tied to the university through affiliation, but he/she is based in a particular community and is guided by a community stakeholder committee. Extension specialists, scientists with one foot in the community and the other in the University, serve as effective bridges between the agents, who are generalists, and full time researchers. The Land Grant system of integrated research, extension, and education has been extremely effective, the primary agent in the complete transformation of American agriculture over the past 100 years. Sea Grant has extended this model to the coastal regions, focusing originally on fisheries production, but currently extending the concept to coastal community development and other issues. The framework is in place for the hazard mitigation corps that Godschalk calls for. The pressing issues of population change and movement into hazardous areas, coupled with emerging coastal threats associated with global climate change, render Godschalk's call more relevant now than ever before.

A Hazard Mitigation Corps, run through university extension programs like Sea Grant, would get hazard information and mitigation assistance on the ground quickly and effectively.

Photo by David Bean

Some Conclusions

Freeboard is a concept from the practice of irrigation and drainage science that refers to the amount of water that might rise above a weir in a drainage canal, or to the amount of space above a flood elevation. To be insured under the NFIP, the floor of a house must be at or above the BFE, or base flood elevation. Any elevation above this level would be referred to as freeboard, essentially an additional buffer against the probability of higher floods. Freeboard could be thought of as a metaphor for coastal populations adapting to the increased hazards associated with climate change and population growth. Coastal populations already live in a hazardous environment. The policies and practices needed to adapt to those hazards are well understood, even if infrequently implemented. Climate change will bring about a change in the magnitude of the hazards already faced by coastal populations, but not necessarily a change in the types of hazards. Population growth will likewise expose more people to threats we already understand. What is needed, then, is to add some "freeboard" to policies and practices already in play, or that should be in play, to account for the negative effects likely to be associated with climate change and/or population growth.

Even if coastal populations do not add the needed freeboard to those things they need to do to adapt to the current rigors of coastal living, this much is clear: if they simply put into place those policies and practices currently advocated by leading hazard management practitioners (e.g., Burke, Burby, Deyle, Godschalk, Mileti, May, Platt - cited below), they will have taken giant steps toward adapting to future changes brought about both climate change and population growth. The best policy for enabling coastal populations in the Gulf Coast states to adapt to change, then, is to promote compliance with current best practices. Making state and local policy makers aware of the additional threats presented by climate change may help hasten their adoption of policies they already know they should have.

Coastal populations simply need to add a little "freeboard" to practices they should already have in place to adapt for the increase in storm frequency and power that climate change may bring their way. That many of these practices are not in place in most coastal areas does not bode well for the future.

The following are some basic conclusions drawn from the above review.

- **Reform the National Flood Insurance Program.** Subsidizing insurance in hazardous areas constitutes a moral hazard known as the "safe government paradox", essentially removing risk from those who build and live or work in the most hazardous zones. Charging market-based actuarial rates for insurance in hazardous coastal environments would do more than perhaps any other action to reduce damages from coastal storms.
- Where subsidized insurance might be deemed to be desirable (essential port areas, for example), **communities rather than individuals should be insured,** with rates dependent on effective community planning.
- **Implement adequate hazard mitigation plans, in particular strong land use plans,** and mandate changes in building and development type according to the type and degree of hazard. There should be very little facilitation, if any, of construction in floodplains.
- Where adequate hazard mitigation and land use plans are in place, **add "freeboard"** to account for impacts associated with climate change.
- **Facilitate community level planning efforts.** States need to require municipalities and counties to develop plans, and they need to mandate strong citizen participation. Strong citizen participation results in better plans and more citizen acceptance and buy-in.
- **Strong federal and state leadership** is needed to implement effective hazard mitigation planning at the local level. In addition, **strong local autonomy** is needed to have both the flexibility to develop effective plans, and to have the enforcement authority to implement those plans.
- Detailed **vulnerability assessments** to both current and potential risks are a critical element for adaptation.
- The concept of resilient coastal cities should be promoted, based on the three core elements of:
  - **Proper siting** (staying out of harms way where possible)
  - A **compact urban form** that enables greater conviviality and social capital.
  - **Resistant floodproof and windproof structures.**
- Develop a **"Hazard Mitigation Corps"** to put the resources of state universities in the service of building resilient cities.

Photo by Dwight C. Andrews

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