The Resilient Coast:

Policy frameworks for adapting the

Wetlands

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

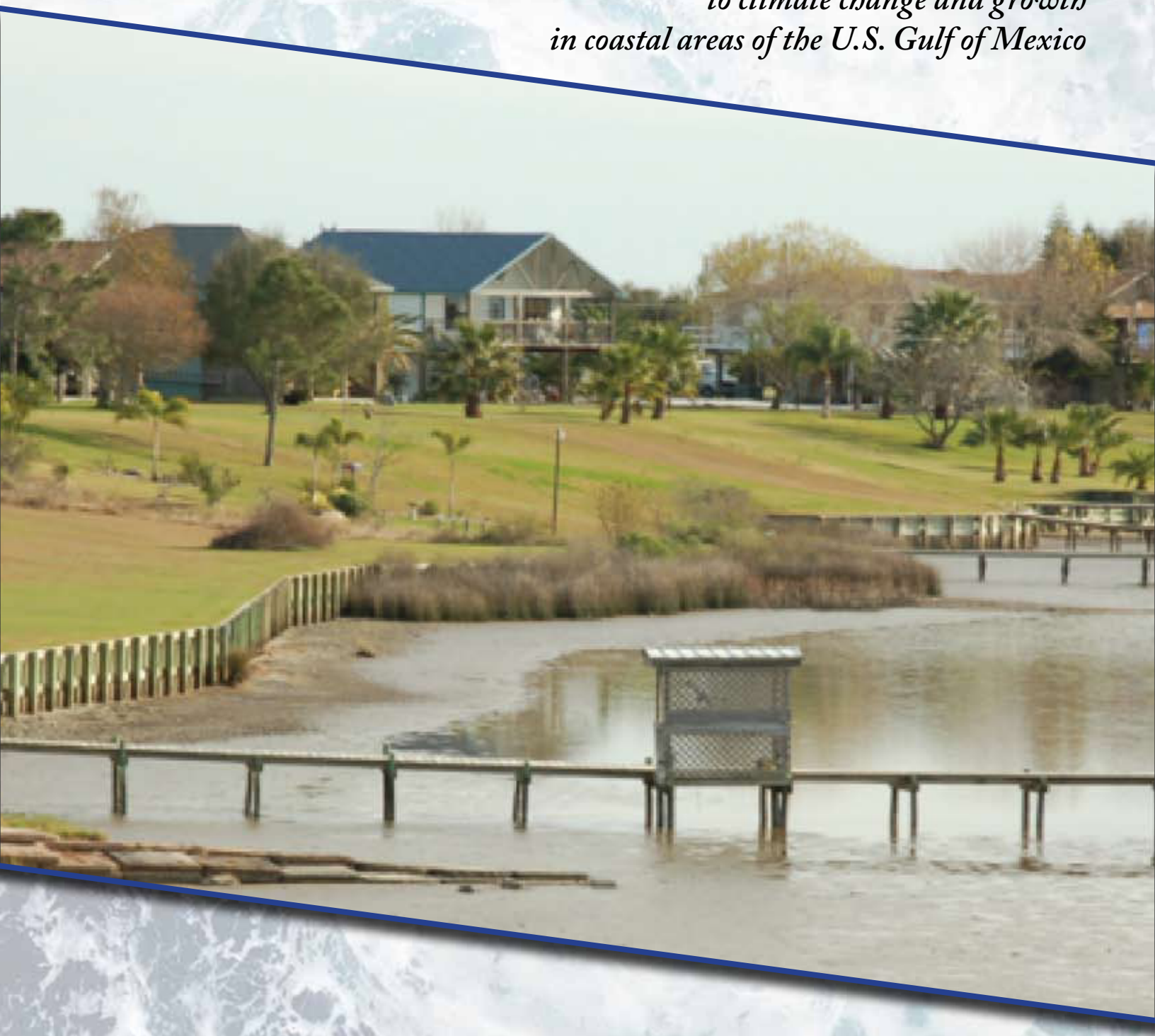

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Photo by Bill Harvey

Executive Summary

Coastal wetlands or salt marshes along the U.S. Gulf Coast are threatened by even the smallest amounts of projected sea level rise (SLR). Salt marshes have very narrow water depth requirements. Where topography rises very gently from the sea, salt marsh wetlands will be able to migrate landward with SLR. In many areas, however, topography rises so abruptly that salt marshes will be lost with SLR, and new wetlands will not form until the sea level rises enough to inundate nearly level slopes at higher elevations, a potential gap of centuries. In addition, many areas just inland from coastal salt marshes have been developed and protected with bulkheads or seawalls, such that wetlands are impeded from migrating inland.

Coastal salt marshes constitute essential fish habitat. Over 90 percent of all commercial and recreational fish species spend some part of their life cycle in a coastal salt marsh. Loss of these wetlands would have serious and substantial impacts on the Gulf Coast fisheries industry. These wetlands also play a critical role in maintaining water quality of coastal estuaries.

Existing wetlands receive some protection from development under a variety of federal, state, and local laws. For example, coastal salt marshes are legally protected "waters of the U.S." under the Clean Water Act. These wetlands cannot be filled without obtaining a permit from the U.S. Army Corps of Engineers and replacing essential wetlands functions through some form of mitigation. The Magnuson-Stevens Act, the primary statute governing U.S. fisheries resources, requires protection of essential fish habitat.

There are no explicit provisions, however, to protect *future* wetlands on lands that may be inundated under SLR. A few existing policy instruments could be used to insure the availability of inundatable lands for the formation of new wetlands. The most promising and perhaps most easily applicable legal framework for wetlands protection would be the adoption of a mechanism similar to the rolling easement provisions of the Texas Open Beaches Act.

States and NGOs could bring pressure on the federal government to include preservation of inundatable lands as acceptable mitigation for some wetland filling. Land trusts and other preservation groups should make inundatable lands priority preservation areas.

Considerable progress has been made in constructing salt marsh wetlands where these wetlands have been lost to subsidence and erosion. Whether or not enough constructed wetlands could be built to sustain coastal fisheries under SLR remains to be seen, but there is little doubt that constructed wetlands could play a significant role in some critical areas.

New policy is needed to insure that new wetlands can form on inundatable lands as sea level rises

Climate Change Impacts on Non-deltaic, Estuarine Wetlands

Sea level rise will almost certainly significantly impact Gulf Coast wetlands in the next century. The 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) states that it is "extremely unlikely" that the climate changes of the past 50 years could be explained by natural changes alone, and forecasts "likely ranges" of 0.18-0.59 m (7-23 inches) sea level rise (SLR) increase for the next century. These SLR ranges, considered by many to be quite conservative, would have very negative effects on the distribution of estuarine salt marsh wetlands along the Gulf Coast, and on the fisheries dependent on these wetlands. While these impacts might seem far off, land use changes occurring in the next few decades could have a very large impact on whether sufficient estuarine wetlands survive to both support existing fisheries and maintain water quality of coastal estuaries.

The purpose of this publication is to review legal and policy frameworks that might hinder or enable adaptation to the next 100 or so years of climate change, in terms of impacts on coastal estuarine wetlands.

This review is limited to non-deltaic estuarine wetlands only, where natural accretion is usually less than existing sea level rise. Sedimentary accretion is a much greater factor in deltaic wetlands, particularly those of the Mississippi Delta. This review is also limited to sea level rise impacts only, although there are additional impacts on coastal wetlands associated with climate change that could be considered – for example, increases in tropical storm intensity and frequency (Michener et al., 1997).

Climate change (CC) induced sea level rise has a fairly straightforward impact on coastal estuarine wetlands: inundation and rising water levels resulting in the conversion of vegetated areas into areas of open water, with a consequent loss of wetland functions associated with the loss of vegetated wetlands. The degree of this change may be subject to some uncertainty and debate, but it is not disputed that water levels are rising.

How quickly wetlands change because of SLR and CC is dependent to a large degree on the topography of the coastal zone, specifically the conformation of the coastal slope in the shoreline zone. In areas of uniform, gently increasing slope (Fig. 1a), we can expect that some new wetlands might form as new areas become inundated.

The purpose of this publication is to review legal and policy frameworks that enable adaptation of coastal estuarine non-deltaic wetlands to climate change.

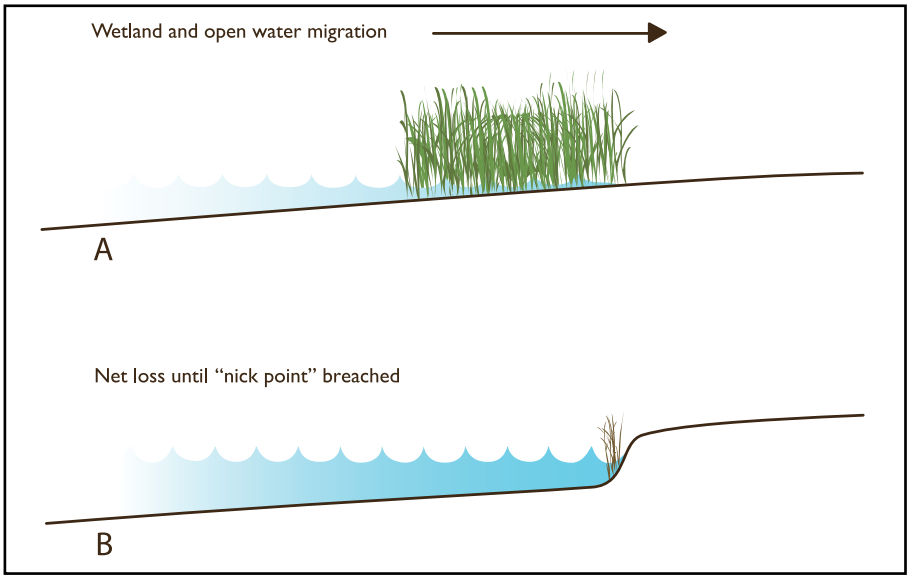
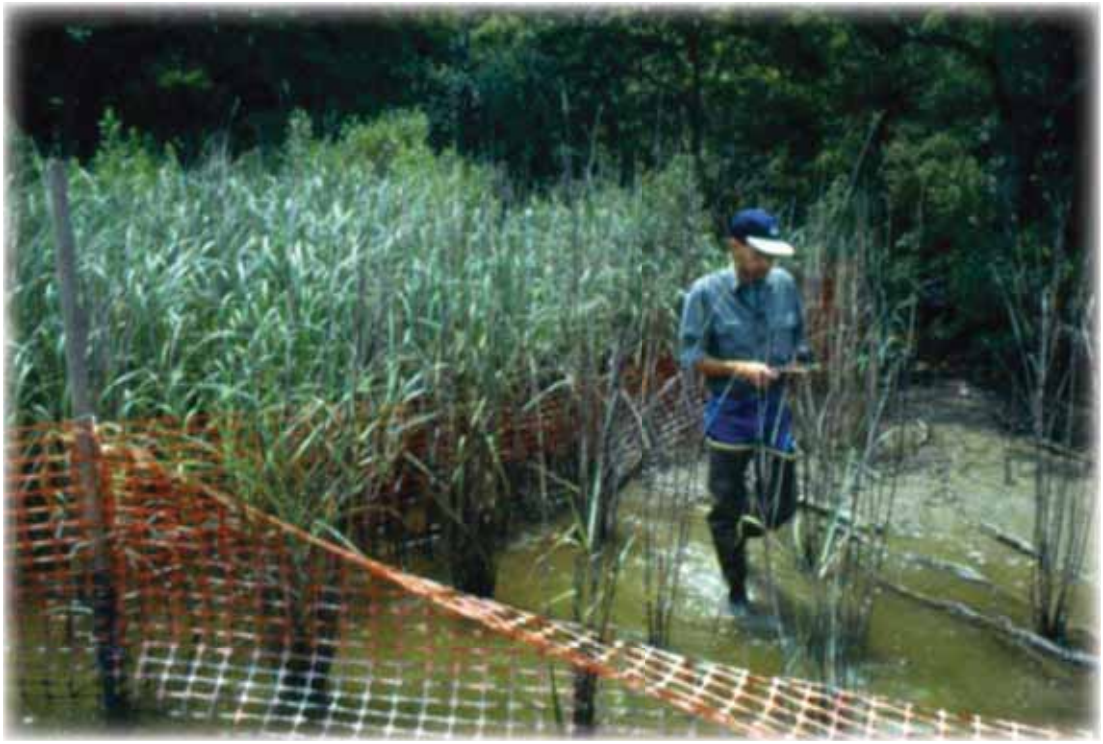


Figure 1. a) smooth slope with migrating band of wetlands and open water surfaces. b) notched slope with nick point impeding landward migration of wetlands until the point is breached by rising waters.



Even the smallest amounts of sea level rise will drown thousands of acres of coastal salt marshes

Wetlands have very specific water elevation tolerances. If the water is not deep enough, it is no longer a wetland. If the water is too deep, the area becomes open water rather than a vegetated wetland. Slowly rising waters on a gentle, continuously rising surface should result in a band of wetlands migrating landward.

Whether or not the formation of new wetlands through inundation would counter the loss of wetlands to rising water will depend on the details of the coastal surface: the complexity of the topography in terms of slope, swales, depressions, and overall drainage density. To a very large degree, replacement will also depend on the nature of the land use in newly inundated areas. Developed and urbanized areas are not likely to be sacrificed to make room for new wetlands.

The replacement process also depends on the speed at which climate change- induced perturbations take place. Change could occur too fast (undefined here, but perhaps over a period of several decades rather than centuries) for stable ecosystem adaptation to occur. Thus, it is possible that wetland functions might not be replaced at the same rate they are lost even if topographic details were ideal for wetland replacement. It should be noted that the steeper the slope, the more narrow the migrating wetland fringe will be, as the appropriate depths will occupy a much narrower range.

All shoreline gradients, of course, are not uniform. There are many areas where there are disjunctions or discontinuities in the slope. For example, there may be notches or abrupt rises in the slope (Fig 1b). This kind of a conformation will result in a very different scenario for wetland loss and replacement under conditions of rising sea level. Once rising waters reach the steeper zone, wetlands will be lost to open waters as the water becomes too deep for wetland vegetation. No new wetlands will form until the water levels rise above the steep slope and inundate the higher, gently sloping surface. How long it takes for the water to reach that point depends on the elevation of the higher surface and the rate of sea level rise. A gap of centuries could be involved. The higher level surface is at about 12-15 feet along much of the Texas Gulf Coast, for example.

Gentle uniform slopes are common in the Gulf Coast in the extensive back bay system. Notched slopes, on the other hand, are common along riverine bays that formed when river valleys flooded as a result of geologic sea level rise at the end of the last Ice Age. Galveston Bay, one of the most

important bays on the Gulf Coast in terms of fisheries, formed in the drowned valleys of the Trinity and San Jacinto Rivers during the last 12,000 years or so, has substantial bluffs or notches ringing the bay, some as high as 15 feet or more above sea level. Many, and perhaps most, of Galveston Bay's fringing wetlands have been lost to human-induced subsidence, with no corresponding migration of wetlands landward because of the abrupt slopes surrounding most of the Bay.[1] Many of the riverine bays along the Gulf of Mexico have this conformation.

The loss of wetlands across the Gulf Coast as a result of SLR will not be uniform. Some areas may lose most, if not all, of their existing fringing wetlands. Other areas, mainly those with gentle continuous slopes, may see wetlands migrate upslope, perhaps maintaining most wetland functions, if inundatable lands are available for the migration. Policy makers need to fully understand the nature of potential wetland loss across the Gulf so that they can design policy frameworks which adequately address wetland loss due to SLR, and insure the maintenance of wetland functions in critical areas.

Gulf Coast fisheries are almost entirely dependent on estuarine wetlands. Over 90 percent of all commercial and recreational species spend some part of their life cycle in a coastal estuarine wetland.[2] Over the last 10 years, annual landings have averaged $771,000,000.[3] Recreational fishing in coastal waters contributes at least another $232,000,000 to the Gulf economy[4]. The contributions of wetlands to the coastal economy are therefore far from trivial. The loss of coastal wetlands due to climate change could have significant economic impacts on local and regional economies. These economic impacts will further ripple through the local economy in terms of jobs and services.

In addition to their direct role in the life cycle of important fisheries, coastal wetlands play an important role in maintaining the water quality of coastal estuaries, and thus an additional indirect role in maintaining the health of coastal fisheries and the overall aquatic and biologic integrity of coastal waters. Increasing rates of urban development along the Gulf Coast are already straining the ability of many coastal wetlands to clean polluted waters from urban runoff. The loss of coastal wetlands due to climate change will only exacerbate an already problematic situation.

Policy makers need to fully understand the nature of potential wetland loss across the Gulf so that they can design policy frameworks which adequately address wetland loss due to SLR, and insure the maintenance of wetland functions in critical areas.

[1] *The rapidity of the subsidence and inundation was also a factor in the lack of replacement wetlands.*

[2] *NOAA Fisheries, Habitat Connections: Wetlands, Fisheries, Economics, Part 4: Wetland Fisheries, Economics in the Gulf of Mexico, http://www.nmfs.noaa.gov/habitat/habitatconservation/publications/habitatconections/num4.htm (last visited July 27, 2007)..*

[3] *NOAA Fisheries, Annual Commercial Landing Statistics, http://www.st.nmfs.gov/st1/commercial/landings/annual_landings.html (last visited July 27, 2007).*

[4] *EPA, Economic Benefits of Wetlands, EPA 843-F-06-004 (May 2006) available at http://www.epa.gov/owow/ wetlands/pdf/EconomicBenefits.pdf.*

LEGAL AND INSTITUTIONAL FRAMEWORK

FEDERAL

There a number of federal laws and regulations providing protections to coastal wetlands. The primary federal law is the Clean Water Act (CWA), which has sections that deal exclusively with the regulation of the fill and use of wetlands. Other principal laws include the Magnuson Stevens Act (provisions addressing essential fish habitat) and legislation associated with marine protected areas programs,[5] but none of these have the regulatory teeth or policy impact of the CWA. A listing of all federal laws relating to wetlands is available on the Environmental Protection Agency's website[6] and an excellent repository of information on all coastal federal and state laws affecting the coast is the Digital Coast Legislative Atlas, being developed by NOAA's Coastal Service Center. [7]

The Clean Water Act

The primary purpose of the CWA is to protect and restore the quality of nation's surface water by eliminating pollution from point sources (industrial outfall pipes, vessels) and non-point sources (agricultural runoff, stormwater). The CWA prohibits the dredge and fill of "waters of the U.S.," which include wetlands, without a permit from the U.S. Army Corps of Engineers.[8] The regulation of wetlands by the federal government has a long legislative history that originates in the 1899 Rivers and Harbors Act (RHA), originally enacted to preserve the navigability of water bodies used for commercial traffic.

Section 13 of the RHA was known as the "Refuse Act." It prohibited the deposit of "any refuse material" into any navigable water or tributary of such navigable water. As the country's focus shifted over the decades from navigation to clean water and the preservation of the biological and ecological integrity of the aquatic system, the Corps' regulatory reach under the RHA extended farther and farther up the tributary system. The Corps' previous experience with regulating obstructions to navigation and disposal of garbage led Congress to grant the agency CWA authority over the dredge and fill of wetlands. This inland expansion has been controversial and the limits of Corps jurisdiction are currently being worked out in the judicial and executive branches of the federal government[9].

The estuarine, coastal-fringing wetlands that are the focus of this review are well within the established reach of the Clean Water Act. There is no debate that tidally-influenced wetlands fall within the scope of the Clean Water Act. There may be some disagreement about where to draw the line in some places in terms of episodic events such as storm tides, but these are issues of details that do not affect the central regulatory focus that we are interested in.

Because wetlands are part of the waters of the U.S., and their filling or destruction could impact the integrity of these waters, any activity that destroys or impacts wetlands requires a permit from the Corps. To obtain a permit, the applicant must show that the activity is water dependent, or that it can occur in no other place. The applicant must also demonstrate that action has been taken to avoid or minimize any impacts through improved design or strategic placement of the facilities. If impact is unavoidable, the applicant must provide a plan to mitigate for the lost functions and values of the wetlands that will be destroyed. Mitigation may take place by constructing new wetlands, or by preserving and enhancing or restoring existing wetlands.

The Clean Water Act prohibits fill or destruction of existing wetlands, but makes no provision for protecting lands that would become wetlands as a result of sea level rise.

[5] *http://mpa.gov/helpful_resources/mpa_legislation.html*

[6] *http://www.epa.gov/owow/wetlands/laws/*

[7] *http://www.csc.noaa.gov/legislativeatlas/*

[8] *33 U.S.C. § 1344*

[9] *Two recent U. S. Supreme Court decisions are at the center of the debate about the hydrologic reach of the CWA wetlands laws and regulations: Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers, 531 U.S. 159 (2001) (the SWANCC decision), and Rapanos, v. United States, 126 S. Ct. 2208 (2006)*

There is no reason the No Net Loss of wetlands policy could not be extended to include protection for potentially inundatable lands.

There is considerable controversy and debate as to just how well the permitting and mitigation system works (Brown and Veneman, 2001; Sudol and Ambrose, 2002). On the national level, there is no targeting of any wetland ecosystems of special concern for special protection. In many Corps districts, there is little proactive investigation of illegal filling activities (investigations are often only made when a report from outside the agency comes in). And there is evidence that many mitigation projects are not performing as designed (Brown and Veneman, 2001). These deficiencies are pointed out not to criticize this system, but as important considerations in terms of how well specific policies, and their execution, might enable adaptation to climate change in terms of wetlands in the Gulf Coast region. The issue of proactive enforcement, in particular, has implications for thinking ahead in terms of the future impacts of climate change.

More importantly, in terms of policy implications for adapting to the potential loss of wetlands to SLR, there is no legal requirement to protect dry, potentially inundatable, lands just inland from coastal wetlands, at either the state or federal level. It is important to remember that the regulatory focus of the CWA is protecting the quality of surface waters. The dredge and fill of wetlands is restricted under the CWA, not because of the importance of wetlands themselves, but because of the impact their destruction can have on water quality and navigation. This traditional water quality and navigation focus may limit the ability of regulatory agencies to expand the scope of the CWA to address climate change impacts.

Section 404 of the Clean Water Act establishes the specific program that regulates discharges and fills into wetlands that constitute waters of the U.S. Section 10 of the Rivers and Harbors Act, which prohibits obstructions to the navigable capacity of waters of the U.S. without a permit from the Corps, is often invoked for wetland-fill activities on waterways and coastal waters, but the § 10 permit program essentially mirrors the §404 program.

Individual states, however, can influence federal permitting decisions through § 401 of the CWA. Under § 401, applicants for federal licenses or permits must provide the federal agency with a certification from the state in which the discharge originates that the discharge will comply with that state's water quality standards. Through the water quality certification process, states can impose conditions on federal permits if they determine water quality will be impaired otherwise. Although §401 is a powerful tool, states may waive their certification authority if they so choose.

It is important to note that the CWA does not preclude any state from developing their own set of wetland regulations, which can be more stringent than the federal statutes. State regulation, if it is to supplant federal reguations may not be weaker than the CWA. The fact that the CWA leaves room for the establishment and implementation of state wetland laws suggests that there is sufficient flexibility within the existing legal framework for state action, if the political will were there.

No Net Loss of Wetlands

The official policy of the federal government is that there shall be "no net loss" of wetlands as a result of development or other activities. The No Net Loss policy means that lost wetlands functions must be restored through the mitigation process of creating new wetlands or preserving existing wetlands and enhancing their functionality. This policy was first put forward by the first President Bush and has remained the official policy since then.

No Net Loss was enunciated as a policy in response to fill of wetlands by development. There has been little if any discussion of the No Net Loss policy being used to ensure the survival of as-of-yet unexisting wetlands, but there is no reason the policy could not be widened to include adaptation for rising sea levels. It is more a question of political will than a policy impediment. If anything, the current policy of No Net Loss should encourage the Corps and other agencies to take a more proactive stance with respect to replacing wetlands lost to sea level rise.

Federal Agency Involvement

The U.S. Army Corps of Engineers (the Corps) is the primary federal agency charged

with administering the CWA and is closest to the ground in terms of day to day decisions and the actual mechanics of how wetlands policy develops and is administered. However, the Environmental Protection Agency (EPA) has oversight responsibilities and is required to develop guidance on policy and technical issues. The EPA is authorized to challenge decisions by the Corps and may "elevate" the challenged permits for resolution by the EPA. Because the EPA is the oversight agency, it may be more institutionally adept at moving wetland protection policy towards protecting inland areas to enable the migration of wetlands as sea level rises. Neither the Corps nor the EPA, however, currently have any statutory authority to protect areas just inland from coastal marshes. That kind of a shift would undoubtedly require a legislative change in the Clean Water Act.

Through numerous permitting processes, additional U.S. federal agencies play advisory roles in wetlands management. The U.S. Fish and Wildlife Service (USFWS) reviews permits for their impacts on fish and wildlife resources. NOAA Fisheries, also know as the National Marine Fisheries Service, reviews permits for impacts on marine resources, including essential fish habitat. The Natural Resources Conservation Service (NRCS) is the lead federal advisory agency for wetlands in agricultural contexts.

The Magnuson Stevens Act and Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. §§ 1801 *et* seq.), and the 1996 Sustainable Fisheries Act amendments to the MSA, established the requirements for sustainable fisheries management plans, in response to, among other things, "direct and indirect habitat losses which have resulted in a diminished capacity to support existing fishing levels". The MSA and its references to habitat losses are important in terms of adaptation to climate change because this language could provide a potential statutory rationale for the ecologic and economic significance of wetlands, and thus the importance of insuring the continued existence of coastal wetlands in the face of sea level rise.

The amendments specifically directed the eight regional fishery management councils established under the MSA to identify the "essential fish habitat" (EFH) for each federally managed fish species. EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity and may include migratory routes, open waters, wetlands, estuarine habitats, artificial reefs, shipwrecks, mangroves, mussel beds, and coral reefs. The regional councils are required to identify EFH for each fishery and any potential adverse

Wetlands are "Essential Fish Habitat." Over 90% of commercial fisheries species depend on coastal wetlands.

effects to that habitat from fishing and non-fishing related activities. Once the councils have identified EFH, federal agencies must consult with the Secretary of Commerce (via NOAA Fisheries) regarding whether their actions may adversely affect EFH. Of primary importance to wetlands, consultation is required prior to the issuance of §404 permits.

The evolution of the implementation of the fisheries management plans and essential fish habitat is still in relatively early stages. Given that almost all commercially important species depend on estuarine wetlands, it would seem logical to include these wetlands as part of the official EFH of any fisheries management plan. And it appears that the fishery management councils are doing just that. The Gulf Coast Fishery Management Council's EFH Final Environmental Impact Statement (FEIS), for example, shows the landward line of the EFH to be the boundary between estuarine and palustrine wetlands or uplands as defined in the National Wetland Inventory maps (Gulf Fisheries Management Council, 2004). The FEIS gives the following specific definition: For the estuarine component, EFH is all estuarine waters and substrates (mud, sand, shell, rock and associated biological communities); sub-tidal vegetation (seagrasses and algae); and adjacent inter-tidal vegetation (marshes and mangroves). In marine waters of the Gulf of Mexico, EFH is virtually all marine waters and substrates (mud, sand, shell, rock and associated biological communities) from the shoreline to the seaward limit of the EEZ (exclusive economic zone).

The Gulf Coast FEIS also designates Habitat Areas of Particular Concern (HPAC), the designation of which "is intended to identify to anyone considering actions that might be potentially threatening to habitat those areas of EFH considered to be of the highest importance in the life cycles of managed species and most in need of protection. An HAPC is expected to be a localized area of EFH that is especially ecologically important, sensitive, stressed, or rare when compared to the rest of EFH." The general focus of Gulf Coast EIS is on fishing impacts on EFH and HPAC and therefore contains no discussion of destruction of EFH-associated wetlands as a result of urban development or other non-fishing activities.

As mentioned above, EFH can figure prominently in §404 wetland permit actions as the Corps is required to consult with NOAA Fisheries regarding the impact of development activities on EFH. While

estuarine wetlands are already protected under §404 of the Clean Water Act, the requirement to consult on §404 permits for potential disturbance or destruction of EFH adds an additional layer of review, and could conceivably provide a mechanism to protect inundatable near-shore dry lands to protect essential habitat in the future.

An interesting question to contemplate would be whether inundatable lands just inland from sea-level-rise marshes could be considered as Habitat Areas of Particular Concern under the MSA.

Marine Protected Areas.

Marine Protected Areas (MPAs) include all state and federal marine reserves and preserves. In 2000, President Clinton issued Executive Order 13158 to "strengthen the management, protection, and conservation of existing marine protected areas and establish new or expanded MPAs." MPAs are defined as "any area of the marine environment that has been reserved by federal, state, tribal, territorial, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein." MPAs "span a range of habitats including areas in the open ocean, coastal areas, inter-tidal zone, estuaries, and Great Lakes waters."[10] There is no specific format or legal arrangement for MPAs in the U.S. and there are different levels of protection and restrictions within the MPAs.

The MPA Executive Order does not establish any new regulatory authority, but rather provides for federal interagency and state coordination. Towards that end, a national MPA Center has been established under NOAA (Office of Coastal Resource Management). In addition to strengthening and expanding the existing network, the E.O also requires the development of a scientifically based, comprehensive national system of MPAs representing diverse U.S. marine ecosystems and natural and cultural resources, and the avoidance of harm to MPAs through federally conducted, approved, or funded activities.

There is statutory authority for the creation of regulated marine protected areas, however, within the National Marine Sanctuaries Act (NMSA). (Flynn, 2004). The NMSA is similar to the Magnuson Act provisions for essential fish habitat in that it focuses on preserving entire marine ecosystems. There are currently 13 national marine sanctuaries, the largest of which is the Monterey Bay National Marine Sanctuary in California. From a policy point of view, the National Marine Sanctuary concept is interesting in that it provides an opportunity for integrated management of an ecosystem that straddles the coastal and marine environment. As stated in the Monterey Bay NMS EIS: "No entity looks to the welfare of all the living and non-living resources of the ecosystem of this entire marine area. *Cumulative impacts* on the resources, arising from various activities subject to the jurisdiction of separate agencies, may escape the attention of any single agency." (U.S. Dept of Commerce, 1992; emphasis added).

The NMSA provides the sanctuaries with considerable regulatory and enforcement powers. Permits must be obtained for otherwise prohibited activities, such as dredging and filling. The Act does not talk about wetlands per se, but the Florida Keys NMS specifically mentions mangroves as one of its protected areas.[11] The NMSA could therefore provide an important tool for managing wetlands in an environment of changing climate.

The Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) was enacted in 1972 to address growth issues in the coastal zone. The CZMA is administered through the Ocean and Coastal Resources Management Division of NOAA. Two programs are administered under this Act: The National Estuarine Research Reserve System (NERRS) and the National Coastal Zone Management Program. The overall program objectives of the CZMA are to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone." The CZMA acts with little or no federal regulatory authority. The program mainly serves to coordinate federal and state coastal programs, and to pass federal coastal monies through to the states.

However, through the CZMA's federal

[10] *MPA Center, A Functional Classification System for MPAs in the United States, available at http://mpa.gov/pdf/helpful-resources/factsheets/final_class_system_1206.pdf .*

[11] *Florida Keys National Marine Sanctuary, Regulations in the Sanctuary, available at http://floridakeys.noaa.gov/regs/welcome.html#Sanct-wideregs .*

consistency provisions the states have a powerful voice in the federal permitting process. The CZMA requires that federal agency activities affecting a state's coastal zone or its resources must be carried out in a manner that is consistent with that state's coastal zone management program. Under this provision, the states have the authority to review federal activities and permit applications for consistency with their laws and regulations. That means a state with stricter coastal wetlands laws could stop or condition federal activities or private development based on those laws. Like the CWA §401 Water Quality Certifications, the CZMA consistency provision is a powerful tool available to states wanting to take a proactive approach to wetlands protection.

Special Area Management Plans (SAMPs)

The CZMA encourages states to develop "plans which provide for increased specificity in protecting significant natural resources, reasonable coastal-dependent economic growth, improved protection of life and property in hazardous areas, including those areas likely to be affected by land subsidence, sea level rise, or fluctuating water levels of the Great Lakes, and improved predictability in governmental decision making."[12] These plans are referred to as Special Area Management Plans (SAMPs). In some ways, the process can be more important than the final product. The development of a SAMP requires all responsible federal and state agencies be brought to the same table to determine how development in a particular geographic area should proceed. There are also public participation requirements which provide for stakeholder input. Eligible coastal states wishing to prepare and implement a SAMP may apply to NOAA for funding assistance.[13]

A number of states have developed SAMPs, but no two are identical and few mandate land use regulations to implement the plans. (Davis, 2004). However, the SAMP provisions of the CZMA could provide a useful policy framework for dealing with climate change wetland impacts, especially on a regional basis.

In 1986, the Corps of Engineers issued a Regulatory Guidance Letter encouraging districts to participate in the development of SAMPs for §404 permitting.[14] The Corps uses SAMPs to assist in long-term planning and reduce challenges associated with traditional case-by-case permit reviews. SAMPs are usually only undertaken for sensitive environmental areas under strong development pressure. Most recently, in April 2007, the Corps approved a SAMP for two watersheds in Orange County, California. The process leads to the development of a management strategy for the area and an alternative §404 permitting process for projects proposed within the SAMP boundaries. The plans identify areas that will be protected and preserved and those areas where future activity will be allowed, if certain criteria are meet. The Corps SAMP process, if embraced by state and local managers, could be a powerful mechanism for managing areas particularly vulnerable to sea level rise.[15]

[12] From the CZM Act: http://coastalmanagement.noaa.gov/about/media/CZMA_10_11_06.pdf

[13] These applications are known as § 309 funding requests.

[14] Available at http://www.usace.army.mil/cw/cecwo/reg/rgls/rgl_05_09.pdf .

[15] Managers in some states may be constrained in their ability to implement SAMPs. Texas state law, for instance, expressly prohibits the development and implementation of SAMPs. However, it is the participatory long-term planning process which is important and that could be embraced by any agency at any level.

Miscellaneous Federal Laws

A number of other federal laws offer additional protection to wetland environments, depending on the location of the proposed development activity and the responsible agencies. For instance, the Endangered Species Act requires federal agencies to consult with the Secretaries of Commerce and Interior to ensure that federal actions, including permitting decisions, do not jeopardize listed species or destroy or adversely modify critical habitat. The National Environmental Policy Act (NEPA) requires federal agencies to consider the environmental impacts of proposed actions and reasonable alternatives to those actions. There are therefore numerous opportunities at various stages of the permitting process to raise the issue of the impact of a federal action or permitting decision on wetlands.

State Law

Although the CWA provides states the option of assuming administration of the federal §404 permit program, only two states in the nation have done so: Michigan and New Jersey. (ELI, 2006). On the Gulf Coast only Florida has elected to enact a regulatory program more expansive than the federal wetlands program, although their program does not supplant the federal CWA. The other Gulf Coast states do play a role in the CWA §404 process, but their role is generally limited to §401 water quality certifications, CZMA consistency reviews, or serving as the point of contact for the federal program.[16] State wetland programs generally mirror the federal program in geographic extent. State authority, therefore, is limited to existing wetlands, and not inundatable coastal lands that would become wetlands under SLR. On the Gulf, only Florida has increased the authority of state agencies to take activities on uplands into account. A review of pertinent Florida law is valuable because does have important implications for adapting to climate change.

In each of the states there are also a host of non-governmental organizations and institutions that have an influence on wetland enforcement and preservation. Land trust organizations in particular are active in preserving wetlands. To our knowledge, no land trusts are currently focusing on preserving near-shore inundatable lands as a buffer for sea level rise impacts. Most of these NGO's are focused on areas where significant loss is occurring right now, and few have the luxury to think decades ahead.

Florida

Florida has the most aggressive state-level program of the Gulf Coast States. Florida implements a state permitting program which operates independently of the federal §404 program. Applicants must obtain both a state and §404 permit. The Florida Environmental Resources Permit (ERP) Program is administered jointly by the Florida Department of Environmental Protection (FLDEP) and four of the five regional Water Management Districts (WMDs). (ELI, 2006). The program, which is in effect throughout the state (except for the Florida panhandle), regulates activities involving the alteration of surface water flows, including new activities in uplands that generate stormwater runoff from upland construction, as well as dredging and filling in wetlands and other surface waters. The basic ERP permit standard is "that activities must not adversely impact water resources, including water quality, water quantity, and the value of functions provided to fish and wildlife and listed species by wetlands and other surface waters" (ELI, 2006).

The Florida wetlands program regulates "any dredging, filling, or construction in, on, or over waters and wetlands that are connected, either naturally or artificially, to 'named waters,'" which include the Gulf of Mexico, estuaries, and lagoons.[17]

Permit applications are initially sent to the FLDEP, applicable WMD, or delegated local government. Permits that cannot be entirely processed by the state are forward to the Corps. From this point, the permitting processes proceed independently. The issuance of an ERP serves as the state's water quality (§ 401) consistency certification and/or waiver. The Corps, therefore, cannot issue a §404 permit until the project has received

[16] *For more information, the Association of State Wetland Managers (ASWM) maintains a web site that provides details on wetlands programs of every state in the union available at http://aswm.org/swp/statemainpage9.htm.*

[17] *Florida Department of Environmental Protection, Environmental Permitting Program website at http://www.dep.state.fl.us/water/wetlands/erp/index.htm .*

the state permit.

The Florida program is distinctive in that it is broader than the federal program, because it regulates the alteration of uplands that may affect surface water flows and "isolated" wetlands falling outside of federal jurisdiction. Florida regulates all land disturbance that could have an effect on state waters, whether or not the activity itself occurs in state waters. From a SLR adaptation perspective, this kind of scope could enable Florida to provide protection to dry, potentially inundatable lands, although there is no indication that they are doing so now.

The other interesting aspect of the Florida framework is that it allows for much more regionalization and local participation. The regionalization of the program - the involvement of the regional water management districts, in particular – is also unique and no doubt would contribute to greater adaptive capacity if policy was developed to deal with climate change impacts on coastal wetlands. The regional water management districts often take a broader watershed approach to environmental management. Such an approach could certainly engender more strategic thinking in terms of protecting wetlands affected by sea level rise, were the officials sufficiently informed and motivated to do so. In addition, the Florida program allows for delegation to local authorities under certain circumstances, although to date only Broward County has received full delegation.

One key piece of legislation that could give Florida significant ability to manage climate change impacts on coastal wetlands is the Florida Areas of Critical State Concern (ACSC) Law (FS 380.05). This law gives the state planning agency, the Division of Community Planning, the ability to establish ACSCs based on unique habitat or cultural value and the nature of the threat that may be endangering these areas. Seven such areas have been established in Florida. The DCP can recommend purchase of state lands in these areas, and has the power to review local and regional plans that could affect the ACSCs. In theory, at least, the DCP could recommend the purchase of (or prohibit development on) low-lying uplands likely to be inundated in the future inland from ACSCs that included estuarine wetlands.

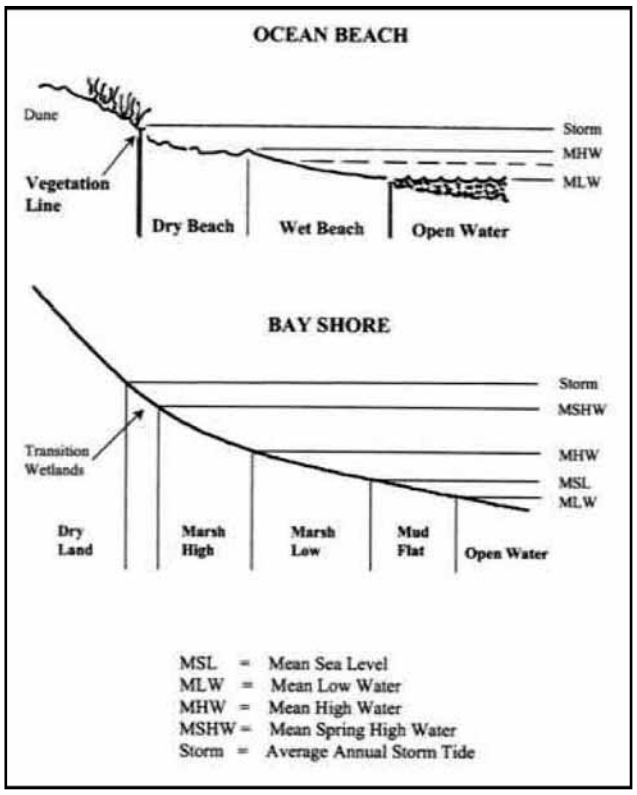
Bay And Ocean-Side Submerged Lands Some Fundamental Differences In Law And Management

Both bay and ocean shores and tidelands are submerged lands claimed under the common law doctrines discussed below. In all five of the Gulf states, a person needs a permit to build on submerged lands. There are significant differences, however, in how the states regulate submerged and adjacent lands, depending on whether these lands are on the bay side or the Gulf (ocean) side.

Figure 2 shows the typical legal zonation along bay shores and ocean beaches found in most states. Ocean beaches for the most part are barrier islands and very sandy. The bay shores are the bay-side shores of the barrier islands and of the mainland. It is instructive to review where states claim ownership in this zonation because how that ownership is exercised impacts the ability to adapt to climate change, especially in terms of ability to armor the shorelines and thus impede inland migration of wetlands.

On the Gulf side, Florida, Alabama, Mississippi, and Texas own up to the wet beach (mean high tide line or MHW), but Louisiana claims both the wet and dry beach (to the vegetation line). Although Texas does not claim ownership of the dry beach, the state does expressly prohibit any construction or other impediments to access along the dry beach. No other state in the Gulf has a similar prohibition to protect access. Only Texas and Mississippi prohibit shoreline armoring or bulkheading on the Gulf shores or ocean side (although there is currently no development at all on the Mississippi barrier islands). Beach nourishment is permitted and occurs on the Gulf shores in all the states.

Things change quite dramatically on the bay side. Armoring, through the construction of bulkheads, the use of rock rip rap, etc., is permitted in all the Gulf states on the bay-side shores (inland from, but possibly impinging on, submerged land), but little or no beach nourishment occurs on the bay side in any of the states. (Titus, 2000).



In all the Gulf states, shoreline armoring is much more common on the bay sides than on ocean shores for a variety of reasons (see Titus 2000, p.742): bulkheads are cheaper to construct on the naturally protected bays, there is much less demand for public access to the bay shores, and beach nourishment, which obviates the need for bulkheads, is not nearly as common as on the ocean beaches. The result of this arrangement is that ocean side beaches generally have fewer bulkheads than bay-side shores and wetlands. Bay shores constitute about 80 percent of the Gulf shores (Titus 1998).

Shoreline armoring may be less common on ocean shores than bay shores in the Gulf states, but only in Texas is any construction on the ocean-side public beach outlawed, and the way this law is set up and managed is an important example of a legal framework that could enable the preservation of near shore inundatable lands for insuring wetland inland migration (transgression) associated with sea level rise.

Figure 2. Ocean beach and bay shore tideland zonation (from Titus, 1998). Florida, Alabama, and Mississippi own up to the wet beach on the ocean. Louisiana claims up to the dry beach. Texas owns the wet beach but maintains a rolling easement on the dry beach for public access. All states claim up to the MHW mark on the bay side.

The Texas Open Beaches Act – an Exceptional Example Of A Rolling Easement

Unique among most states, Texas maintains a "rolling easement" on the Gulf shores to protect public access to the state's beaches. The Texas Open Beaches Act (TOBA) was passed in 1959 to assure that the public has the "free and unrestricted right of ingress and egress to and from" public beaches, defined as the area between the line of vegetation and the mean low tide line. The TOBA further prohibits the construction of an "obstruction, barrier, or restraint of any nature which would interfere with the free and unrestricted right of the public" to access the beach.[18] Holding back the sea, either through bulkheading or seawalls is, therefore, not permitted along public beaches. Buildings located seaward of the vegetation line must be removed if those buildings become an impediment to public access to the beach, as they do when the vegetation line shifts. A structure is an impediment to public access merely by being in the public access zone. Because the vegetation and low tide line shift due to natural coastal processes, the demarcation lines for public beaches are not static. The public's right of access, or easement, moves as well.

One thing that should be noted is that the public easement created by the TOBA does not affect the title to the property to which it attaches. In Texas, as in all the Gulf States, that portion of the beach seaward of the mean high tide line or mean high water (MHW) is owned by the state. Land lying above the MHW can be privately owned. In some cases, the vegetation line may be landward of the MHW. Some portions of the public beaches, therefore, are privately owned. The TOBA, however, makes that ownership subject to an easement that allows the public free and unrestricted use of the beach.

The concept embodied in the TOBA has been termed a "rolling easement" and it evolved from Texas common law which recognized that Gulf beaches have been used by the public since "time immemorial" and that barrier islands are constantly shifting. The TOBA allows private land owners to develop their beachfront property as long as that development does not interfere with public access. If the vegetation line moves, whether as the result of a tropical storm or hurricane or man-made structures such as jetties and groins, the public access easement takes effect immediately.

As might be expected, property owners affected by changing vegetation lines do not take kindly to having to move their houses. Litigation occurs after every major storm when any number of houses end up seaward of the vegetation line, but the Texas courts have uniformly upheld the validity of this law since its inception in 1959.

The majority of the challenges to the TOBA are based on the Takings Clause of the Fifth Amendment which requires the government to compensate landowners when their property is taken for public

Aerial photograph of the west end of Galveston Island right after Hurricane Ike (courtesy NOAA). The vegetation line in this photo has shifted well inland of the first row of houses, and in some cases beyond the second row. If the new line proves to be stable for more than a year, some of these homes will have to be moved out of the public easement.

[18] *Tex. Nat. Res. Code § 61.013(a).*

[19] *Lucas v. S.C. Coastal Council, 505 U.S. 1003, 1019 (1992).*

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

use. Government regulation can result in compensatory takings if a property owner loses all economically viable use the land.[19] Texas has partially protected itself against takings claims under the TOBA. The Act requires that deeds for properties sold after October 1, 1986 contain a disclosure statement to warn buyers of the potential loss of their homes or buildings due to the movement of the vegetation lines. Such statements notify owners that they do not have a right to maintain structures seaward of the vegetation line.

The Texas Open Beaches Act does not explicitly prohibit bulkhead construction landward of the vegetation line. What then, impedes developers from constructing bulkheads inland of the vegetation line? In point of fact, nothing in the law prohibits such construction. Many single-family homes on or near the beach in Texas are built on pilings or stilts to achieve the elevation needed to obtain insurance (17 feet). Little or no bulkheading accompanies stilt-built structures as a matter of practice. There are, however, several high-rise condominium structures going up on the east side of Galveston Island. This part of Galveston Island is one of the relatively few areas on the Texas coast that are undergoing accretion rather than erosion, and the investors must feel there will be enough time to recoup their investment before the vegetation line moves. Other high-rise structures found along the beach in Texas on the vegetation line or just seaward of it were likely grandfathered in place.

Photo by Stephan Myers.

Common Law Framework For A Rolling Easement

It is important to note that no federal or state law dealing with wetlands confers any authority to protect lands inland from coastal wetlands that would become wetlands if the sea level rises, even if they are critical areas needed to replace the functions of lost wetlands. Current law only protects existing wetlands. There are important common law concepts, however, applicable to both state and federal jurisdiction, that cover the dynamic nature of the coast and the public interest in shores and tidelands, and that could provide a legal framework for protecting future wetlands. Two of the most important doctrines are the law of erosion and the public trust doctrine. The discussion here largely follows Titus (1998).

The Law of Erosion

The law of erosion is sometimes called the law of accretion and reliction. This common law is a recognition going back to ancient times, and codified in the Justinian and Napoleonic codes, that the changing nature of shorelines, whether riverine or marine, causes property lines to shift also. If a property or sovereignty line is defined by a natural boundary, particularly those associated with water bodies, then the demarcation shifts with the natural boundary. Ownership migrates with the changing shores, just as state and federal boundaries do, unless otherwise codified. These common law principles have obvious implications for protecting inland areas for future wetlands.

The common law principles of accretion and reliction are recognized by all the Gulf states and by the federal government as well. As mentioned above, the states hold title to the beach up to the MHW line. It is well-established that the boundary between private and public land shifts as the shoreline gradually changes due to natural forces. What is not clear is what happens when the sea has been held back or prevented from migrating inland through the construction of sea walls or bulkheads constructed on dry ground before the inundation occurred (e.g., Figure 6). While all the Gulf states

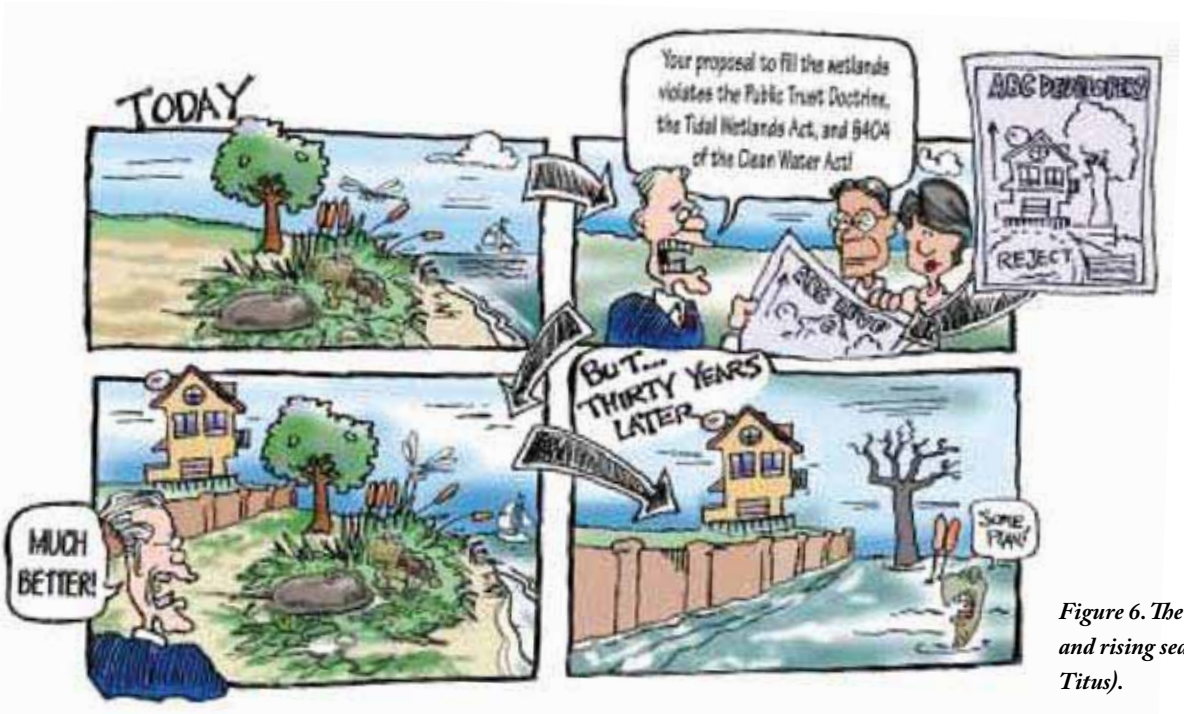


Figure 6. The effect of bulkheading and rising sea levels. (courtesy Jim Titus).

hold title to submerged coastal lands, none of them have any provisions for prohibiting the construction of bulkheads just inland from coastal wetlands or other submerged lands on the bay side. Where bulkheaded coastal development has occurred, the failure to prohibit property owners from holding back the sea effectively nullifies the law of erosion. With coastal populations expected to double over the next 30 or so years along the Gulf Coast, we can expect to see many more developments such as that shown in Figure 3.

Public Trust Doctrine.

The public trust doctrine is an ancient doctrine that declares that all "navigable waters" are held by the responsible government (federal or state) in trust for the benefit of the public. Navigable waters include areas subject to the ebb and flow of the tide, including tidal wetlands, regardless of the ability to float a boat. This doctrine has its roots in the need for public access to tidelands for hunting, fishing, and transportation, and is well established in both common and case law. More recently, the public trust has been recognized in the need to protect essential fish habitat, including coastal wetlands, as described above. The public trust doctrine does not distinguish between bay and ocean tidelands.

In one sense, then, coastal lands subject to the ebb and flow of the tide are to be managed by the state for the public benefit. Together, the law of erosion and the public trust doctrine reserve for the public "a reversionary interest that vests when the land is below mean high water." (Titus, 1998). A conflict is set up, however, because "owners assume land lasts forever, and the public assumes that beaches will always belong to the people."

Figure 3. Oblique aerial view of area in Tampa Bay, Florida, showing a classic example of a bulkheaded canal development that impedes landward migration of wetlands. This development appears to have been constructed on high, for-the-most-part non-wetland ground, perhaps impacting few existing regulated wetlands, but in effect destroying inundatable lands just inland of existing coastal wetlands. Bay waters are at top of the photo, with fringing estuarine wetlands just below. Notice that the canal development, in the lower central part of the photo, is relatively recent, with construction still occurring on the left. Image captured from Google Earth, Jan. 5, 2007.

Adapting To Sea Level Rise Under Existing Policy Frameworks

Loss of existing coastal non-deltaic wetlands with sea level rise is inevitable, and not much can be done to avoid that loss. As sea level rises, water will become too deep where wetlands are now, converting those areas to open water and eliminating all of the functions and benefits that accrue from coastal wetlands, for example essential fish habitat. Even the most conservative estimates of a half foot sea level rise will drown many wetlands. Given the legal and policy framework sketched out above, what options do we have?

There are really only two management options to insure that some coastal wetlands will be present in the coming decades and centuries in this changing environment: raise the elevation of drowned areas by creating/restoring new wetlands, or insure that replacement wetlands can form as inundation occurs through a process of managed retreat.

Creation Of New Wetlands Through Elevation

It is possible to create new wetlands in areas where the water has become too deep to sustain wetland vegetation. The science and practice behind estuarine marsh creation has made great strides within the past two decades. While it is not yet possible to suggest that equally productive replicas of natural wetlands can be created, we are getting much closer and we have a much better understanding of how to create such wetlands.

Texas lost at least 59,000 acres of fringing estuarine wetlands between the 1950s and the early 1990s due to subsidence associated with industrial and municipal groundwater removal (Moulton et al., 1997). Thirty five thousand acres of that loss occurred in Galveston Bay, approximately 20 percent of the estuarine marshes there. (White et al 1993). Few of these wetlands were naturally replaced, both because of the rapidity of the change and because the coastal topography matches that of Figure 1b: inundation proceeded up to the steep slope but did not rise above it.

In response to this massive and rapid loss of wetlands, considerable local, state, and federal resources have been mobilized to restore these wetlands, primarily through the placement of fill and the planting of wetland vegetation. Dredging of the Houston Ship Channel and other waterways provided and continues to provide an abundant and steady source of fill material. A Beneficial Uses Group (the "BUG" group), for example, was formed to marshal resources to build as many new wetlands as possible using dredge-spoil material. Many other groups and agencies are also involved in wetland restoration projects that involve some combination of elevation and plant transfer. Marsh Mania is an annual event involving several entities and sites that draws hundreds of volunteers for marsh plantings.

In spite of these impressive accomplishments, only about 1,500 acres of marsh were created between the mid-1970's and 2002, according to the Galveston Bay Estuary Program's State of the Bay (Lester and Gonzalez, 2002), or less than 5 percent of the loss. No data was provided as to the success of these projects, but there is little doubt of the success of the more recent projects from about the last decade (see for example Figure 9).

Figure 9. Galveston Island State Park TX. Reticulate grid pattern in upper center of photograph is a complex of wetlands restored to a previously subsided area through the placement of fill material and transplanting of vegetation. The grid provides for maximum edge, the single most important factor in the ecological success of constructed tidal wetlands. Google Maps image captured January 2007.

Photo by John Jacob

These creation and restoration projects involve very careful control of the bottom elevation for the new marshes. Fill material is placed to an elevation that guarantees success for current conditions. To our knowledge, few restoration projects are designed with future sea level rise in mind. Most of the wetlands constructed to date will be lost to sea level rise even under the most conservative scenarios. But these wetlands are today performing essential functions, and from a policy adaptation viewpoint, what is learned today from wetland construction projects will be useful in the future to help build replacement wetlands.

Given the expense and difficulty of building new wetlands, it is not certain that wetland creation through elevation could be a major adaptation to rising sea levels. Certainly, it could be an important tool for replacing specific wetland functions in certain high value, critical areas, but it is difficult to know if wetland construction could have widespread impact. Depending on the rate of sea level rise, these creation projects, as currently designed, would have to be redone every decade or so. It would not be all that difficult to engineer constructed wetlands projects in the estuarine zone to allow for some degree of sea level rise: berms or marsh mounds that are a little wider and taller, for example.

Enabling Wetland Migration

Non-wetland areas will be inundated by rising sea levels with the possibility for the formation of new wetlands. The principal management and policy questions are whether the new inundation will be able to occur on lands suitable for the formation of new wetlands, and if suitable, whether that land will be developed and bulkheaded before the inundation occurs, precluding the possibility of the formation of replacement wetlands.

Insuring the availability of inundatable lands inland from existing estuarine wetlands is likely the most feasible adaptation alternative for the vast majority

of the Gulf Coast. Inundation is going to occur regardless of the management measures taken, and new wetlands will form given enough time and stability, if the land is there for them to form on as sea level rises. Managed retreat is a passive approach that requires little or no engineering. From the strictly technical, biophysical perspective, it is the simplest approach. Managed retreat, however, is primarily a land use issue with many inherent complexities and potential for conflict. Land use policy is a local and property rights issue rather than a state or federal issue. Insuring that inundatable lands are available will be critical because landward migration will not only be impeded by development. As discussed above, because of the geomorphic conformation of many bays, abrupt inclines or bluffs will result in total loss of fringing wetlands in some areas until rising sea level breaches the higher level, a gap that could require decades or centuries.

Aside from geomorphic constraints, the main impediment to managed retreat or landward migration of wetlands under sea level rise is not just construction of buildings, but rather, the holding back of the sea through sea walls or bulkheads and their associated fill. A bulkhead confers a degree of permanence not obtained with the simple construction of a beach house on stilts over the natural ground, for example. And once a bulkhead is built, it is reasonable to expect the structure to continue to be built up as sea level rises. No state on the Gulf would require the removal of bulkheads and fill on the bay side even though a rising sea level would have inundated the land at its preconstruction level.

Insuring inundatable lands for the future can be accomplished by preventing development through setbacks or prohibitions, or by modifying the kind of development, particularly in terms of permanence, that can occur in the inundatable lands through rolling easements.

This discussion of managed retreat is taken largely from Titus (1998, 2000).

Prevention of Development

Prevention of development could occur through some kind of regulatory fiat, or it could occur through the purchase of properties or the associated development rights. Regulatory prohibition of development occurs most often through setbacks. Setbacks have a long legal history, and have been used extensively in urban planning and for water quality (stream setbacks in urban areas, for example). Setbacks for the purpose of maintaining a buffer of inundatable lands is fraught with legal issues, however. Setbacks on a street in an urban setting, for example, do not necessarily deprive a land owner of all productive use. A coastal setback could easily do just that, depending on where the setback line was located. Coastal erosion setbacks have in fact been successfully challenged on takings grounds (see Lucas v. South Carolina Coastal Council). Titus (1998) provides an extensive review of the problems with setbacks and other forms of development prohibition or limitation. It is not likely that setbacks by themselves could be an effective policy tool in insuring the availability of inundatable lands. One of the main problems is that courts, including the Supreme Court, have held and are likely to continue to hold that these kinds of setbacks will require compensation to the landowners for lost economic use.

Aside from the legal and compensatory issues associated with setbacks, there is the practical issue of just where to draw the setback line, given the uncertainty of the magnitude of future sea level rise. Would a new setback line have to be re-established periodically as sea level rose?

Removal of the threat of development of inundatable lands through fee simple purchase or through purchase of development rights or conservation easements is perhaps the most straightforward approach for insuring wetland transgression or inland movement under SLR, but it is also the most expensive option by far and thus of limited utility. Purchase of these lands should certainly be considered by land trusts interested in preserving coastal wetlands. Many upland areas are no doubt included as buffers in conservation purchases or set asides of coastal wetlands, but there are very few if any instances of land trusts focusing on preservation of inundatable lands. Where inundatable lands are in short supply because of either topography or development, their preservation should indeed be a top priority for coastal land trusts. There are no policy impediments to land trusts and other organizations purchasing these lands. As discussed below, purchase of inundatable lands, with in-perpetuity conservation easements, would be an excellent use of wetland mitigation resources under §404 of the Clean Water Act. This kind of mitigation would, however, require policy changes at

Where inundatable lands are in short supply because of either topography or development, their preservation should be a top priority for coastal land trusts.

A rolling easement modeled after the Texas Open Beaches Act could permit non-bulkheaded development in the sea level rise impact zone, thus enabling reversion of submerged lands to the state in the event of SLR.

the agency level within the U.S. Army Corps of Engineers, and perhaps even an act of Congress.

Outright purchase of all of the inundatable lands needed to maintain coastal wetland functions could be extremely expensive. Titus (1998) estimates that a land area the size of the state of Massachusetts would be required to preserve coastal inundatable lands for the entire U.S.

A Bay-side Rolling Easement to Insure Wetland Migration

In all of the Gulf States, state ownership of submerged bay-side wetlands will migrate inland as tidal wetlands migrate with rising sea level, due to the common law rules of erosion and the public trust doctrine. In effect, then, a kind of rolling easement already exists on the bay shores in all five states. Wetlands, and the legal protections they enjoy, will migrate inland where topography and lack of development permit the migration.

This de-facto rolling easement, however, has one very significant difference compared to the Texas Open Beaches Act: the common law rules are ineffective in areas were bulkheads have been constructed to hold back the sea since the shoreline does not change as a result of the bulkheading. The boundary line between public and private property has been fixed. Where development occurs landward of coastal wetlands on the bay side (e.g., Fig. 3), none of the Gulf states would force the movement of bulkheaded structures inland of the new mean high water mark in the case of SLR, in effect recognizing the permanence of the bulkheaded structure.[20]

Could a bay-side rolling easement, roughly modeled on the rolling public access easement in the TOBA, be instituted for the purpose of preserving inundatable lands? There is not likely enough political will in any of the Gulf states to put in place the same strict provisions of practically no development in the easement zone that are found in the TOBA, but a rolling easement that would only prohibit permanent, bulkheaded development over inundatable lands might be more acceptable.

The most important feature of this kind of easement is that landowners would not be deprived of the productive use of their land unless and until sea level rises enough to inundate their land with daily tides. To be effective, the easement would have to prohibit holding back the sea through bulkheads and sea walls. A well-designed rolling easement could avoid the issue of constitutional takings, because landowners would not be denied use of their lands for very long periods, and they would have ample notification that they would not have this use in perpetuity.

Titus (1998, 2000) suggests a rolling easement could be strengthened by compensating landowners for the easement. This compensation would not be trivial, but it would be a minor expense compared to the cost of legal battles that would ensue if governments deferred action until the crisis stage of inundation. The rolling easement would be based on the present discounted value of the land, pennies on the dollar compared to the future values. The compensation would further insure against takings litigations.

The principal benefit of the rolling easement as compared to fixed setbacks is that they do not deprive property holders of all economic use of their property. A prohibition against bulkheading is certainly a restriction, but it does not deny all economic use, which is main argument for a takings ruling.

A second benefit is that it is not necessary to draw as careful of a line to establish a buffer for the easement as it is for a setback prohibiting all development. Lines obviously have to be drawn in both cases, but the line for the rolling easement could be much farther inland because development per se is not being prohibited outright.

The rolling easement is perhaps the simplest way to comply with the public trust doctrine and the law of erosion while ensuring a modicum of fairness for coastal landowners. The concept would need considerable study and discussion before it could be implemented. Our purpose here is to put the concept on the table for discussion. As awareness of the impacts of SLR on coastal wetlands grows, this concept will no doubt receive greater attention.

[20] *This assumes that the bulkheaded structure remains above the new MHW mark.*

Easements obtained through Mitigation and Preservation Efforts

Section 404 of the Clean Water Act requires mitigation to offset wetland losses. Thus far, all mitigation required under this act has been for the creation and/or restoration and enhancement of existing wetlands. It would not be that much of a policy stretch to require that at least some mitigation for loss of coastal wetlands include an inland buffer that would contain potentially inundatable lands. Buffers are often required in existing wetland mitigation projects anyway in terms of protection from development and polluted runoff.

But because there is no statutory requirement for protection of dry lands that might one day become wetlands, a major policy change would be needed at the agency level, and perhaps even an act of Congress to effectuate such a change. On the state level, however, especially in a state like Florida with a robust wetland program, it would be relatively easy to require mitigation that preserves inundatable lands, although state politics could also encounter legislative hurdles to overcome to effect such a change.

There is nothing to stop non-profits from purchasing inundatable lands, or purchasing the development rights to those lands. Given the rapid and massive loss of existing wetlands to development right now, it is probably unreasonable to expect many land trusts to devote significant resources to future wetlands. If, however, these organizations were sensitized to the need for this kind of preservation, they might easily be able to work additional upland buffers into coastal wetlands preservation projects that they would be working on anyway.

Deferred Action

Titus (1998, 2000) lists "deferred action" as a management option. In one sense, deferred action is not really a "management option" at all, since it is lack of management and forethought. Deferred action assumes that some kind of reasonable action would take place in the future to maintain wetland functions and values in the face of inundation from sea level rise when the need becomes critical. It is perhaps worth considering as an option, then, because one could compare the political and economic costs of delaying action until the inevitable. If too many inundatable lands were bulkheaded or otherwise held back from inundation, then the government would be forced to buy back lands or forcibly evict property owners, depending on who pays, and then go to the expense of removing bulkheads and fill to enable the creation of enough wetlands to ensure sufficient fish habitat, for example. The cost of the deferment would depend on how much land had become developed or otherwise bulkheaded in the interim. The political costs would be very high indeed and would involve serious legal challenges in terms of government takings, if the cost were placed on the public rather than individual property owners.

Combination or Hybrid Approaches

It is unlikely that a single policy would be completely effective in managing wetlands in the face of sea level rise. A combination of restoration projects through elevation, and the enabling of wetland migration/transgression through combinations of setbacks and rolling easements would likely work best for any one level of government, or levels or governments working together.

It would not be that much of a policy stretch to require that at least some mitigation for loss of coastal wetlands include an inland buffer that would contain potentially inundatable lands.

The best policy combination will be dependent on the specific conditions of each locality. Having precise information about what different sea level rise scenarios might do will be critical to the development of effective policy packages.

Table 1, taken from Titus (1998), concisely lists management options for enabling wetland transgression (or inland migration) under conditions of rising sea level. It divides these measures further in terms of who pays—the public or affected landowners.

Preventing development is the most expensive of the "rational" management options. Putting the cost on private landowners where setbacks reduce the economic value of the land will be subject to takings litigation. Restrictions that do not remove all economic use will have a better chance of success. For example, local or state governments could pass density restrictions (under Hybrids in the table) by requiring large lot sizes, or by creating open space endowments by requiring cluster developments. Large lots are more likely to preserve land for inundation, since a property owner is unlikely to bulkhead his entire waterfront boundary. Grouping principal buildings and structures together on a site, or "clustering," enables developers to reserve land for common open space, conservation, and other purposes. Clustering development and preserving the resulting open space through perpetual easements could preserve critical inundatable lands if the open space easements were placed strategically.

The rolling easement, following the Texas Open Beaches Act, could be a feasible and effective way to ensure the availability of inundatable lands in the future. Buying easements would be a relatively inexpensive way to make the easements more politically palatable and less subject to takings legislation.

Table 1. Inundatable lands protection options (Titus, 1998)

	(a) Taxpayers Pay	(b) Coastal Landowners Pay
Prevent Development	Buy land now. Buy nondevelopment easement now.	Subdivide land with deeper lots. Setbacks that prohibit new construction below a given elevation or within a certain distance of the shore. Dedicate land as part of permit for coastal development.
Deferred Action	Buy land and structures when property threatened.	Evict people from their homes.
Rolling Easement	Buy Texas rolling easement. Buy reversionary interest. Buy purchase option.	Pass a statute declaring that all future development is subject to the rolling easement. Prohibit bulkheads, seawalls, etc. Require individual structures to be subject to rolling easement as condition for building permit. Require entire development to be subject to rolling easement as condition for subdivision, or for activities that require wetlands to be filled. Texas Open Beaches Act.
Hybrid		Density Restrictions. Cluster Developments. Maine Dune Rules. South Carolina Beachfront Management Act.

What Policy Makers Need to Know Now

The preeminent technical question is how to identify which lands could be inundated under a variety of sea level rise scenarios. Depending on the sea level rise scenario chosen (i.e, the number of feet predicted to rise), there may or may not be sufficiently detailed topographic maps available to make these determinations. Most topographic maps along the Gulf Coast have a contour interval of 5 feet. A 5 -10 foot level of precision might be sufficient if wide-enough buffers were established for limiting development. More than likely, however, most local and state governments willing to engage in establishment of buffers would prefer a more precise delineation so as to minimize the amount of land tied up in buffers and/or easements.

A new tool for more precise mapping of low-lying coastal environments, LIDAR (Laser Imaging Detection and Ranging), is now available and has already been used to one degree or another in most of the Gulf Coast states, mainly for floodplain characterization and mapping. LIDAR technology enables the construction of digital elevation models with a one-foot or less resolution, making it reasonably easy to construct fairly precise models of coastal inundation under any number of sea level rise scenarios (Gibeaut 2006), and

to determine with some level of precision the loss and gain of specific kinds of wetlands. This kind of information could be invaluable for determining where hotspots of loss might occur.

The other piece of information critical to protecting inundatable lands would be to have a good projection of where development is going to occur along the coast, particularly in areas subject to losing critical amounts of essential coastal wetlands. This kind of information could help limit areas where rolling easements might be needed or identify where they might be most effective. Jim Titus of the EPA has been constructing maps along the US coast showing where shoreline protection is likely to occur under conditions of SLR in the future, based on current and future development (Fig. 11). Combining development maps with the kinds of maps constructed by Gibeaut (Fig. 10) could help decision makers determine whether sufficient inundatable lands would be available in the future, and perhaps whether or not rolling easements would even be needed.

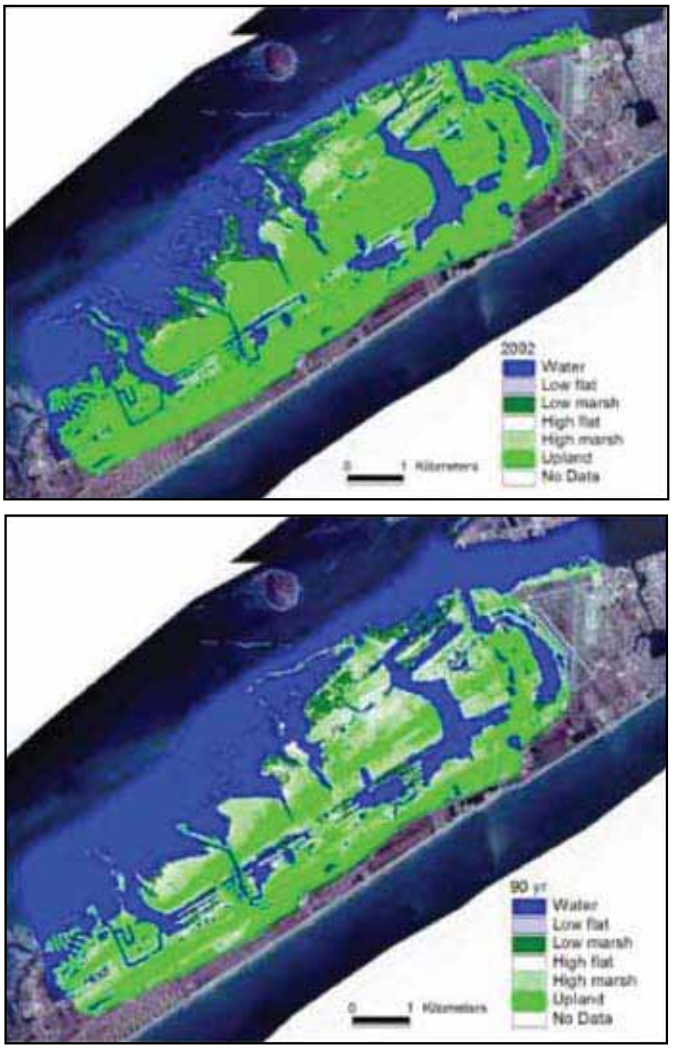


Figure 10. Galveston Island wetland complex in 2002 (above) and 90 years into the future (below) based on sea level rise and subsidence over past 100 years (from Gibeaut, 2006). Note large increase in water area and loss of low marsh and increase in high marsh. This model did not account for possibly accelerating sea level rise.

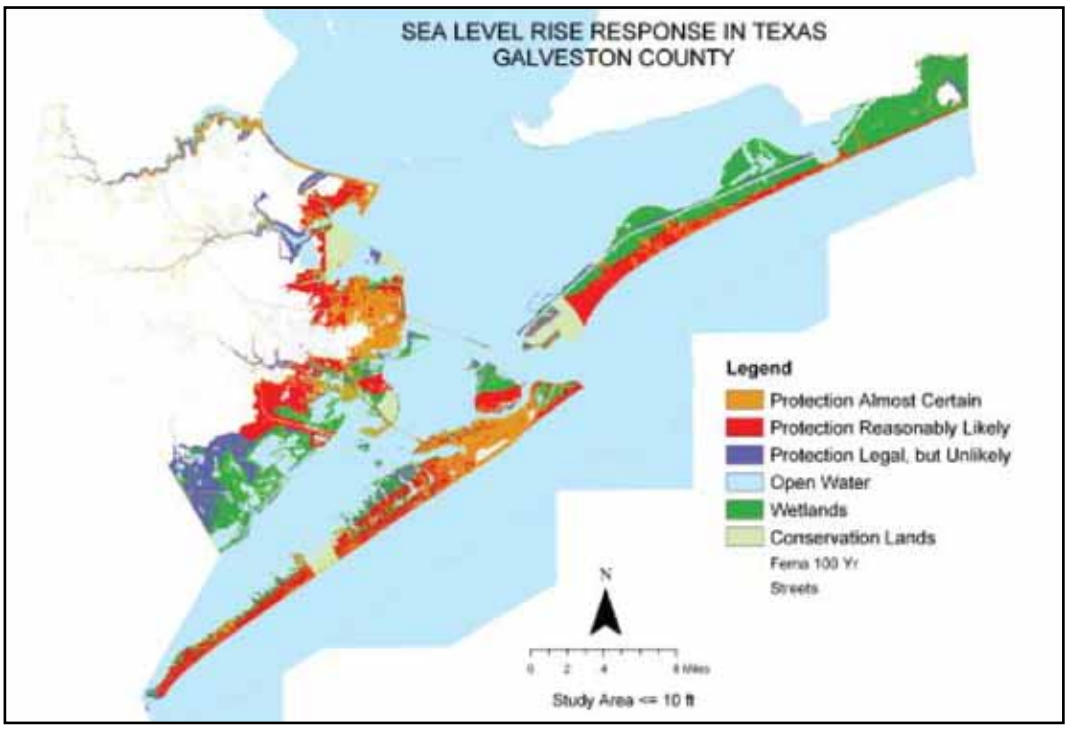


Figure 11. Sea level rise response map constructed for the EPA. Brown indicates developed areas. Red areas are potentially inundatable lands, under 10ft amsl, that are reasonably likely to be developed in the next 50 years or so.

Conclusions

As sea level rises along the Gulf Coast, valuable salt marsh habitat will be lost. How much net loss will there be? Will it be enough to incur substantial damages to coastal fisheries all along the coast, or only in places? These questions have to be answered before the difficult question of how to build political will to deal with the issues can be addressed. The tools to answer the technical questions are readily available: precise LIDAR surveys, sophisticated GIS systems, and a range of sea level rise scenarios. It is critical that these tools be put to work to determine if and where critical wetland loss might occur as a result of SLR.

Current regulatory frameworks to protect existing wetlands, such as the §404 program and EFH provisions, are unlikely to be adapted to protect dry land for future inundation, without legislative changes or significant executive orders. However, the underlying principles of the CWA, the Magnusson Stevens Act, the NMSA, and the MPA program are all consistent with protecting inundatable lands in order to maintain the integrity of the nation's waters. For policy makers interested in promoting protection of inundatable lands as one means of adaptation to climate change, the linkages between aquatic integrity, sustainable fisheries, and threatened wetlands will have to be made patently clear.

Political will to address these questions will be difficult to come by. Climate change and sea level rise are in the future: we do not see any immediate effects, at least not readily. Adapting for changes to wetlands requires taking action not related to anything happening on the ground today, i.e., protecting inundatable lands inland from coastal salt marshes, lands not protected today by any legal framework.

Insuring the availability of inundatable lands is the single most important thing that can be done to insure the presence of salt marsh wetlands as sea level rises in the next century or so. Outright prohibitions of development in these lands may not be feasible, but rolling easements, perhaps purchased at a discount, requiring the cession of land back to the state as it becomes inundated, appear to be a promising option worthy of additional study and consideration.

State and local governments can also take action now to preserve areas that will be critical in the future. This can be done a number of ways. Management area designations (such as wetlands reserves, National Marine Sanctuaries, state parks, wildlife preserves) can include buffer zones to plan for inundation due to SLR. Buffers serve to increase the size of the protected area and provide opportunities for long term planning. States can also adopt policies that require sea level rise be taken into account during zoning and permitting decisions. These policies can then be incorporated into state coastal management programs and applied to federal permitting decisions. States could also require, through the § 401 process and other means, that some wetland mitigation include inundatable upland buffers.

Land trusts and other preservation groups could make inundatable lands priority preservation areas.

Construction of new wetlands in loss zones may or may not be an economically feasible alternative for replacing lost wetlands on a large scale. Nonetheless, the science and practice of wetland creation in submerged lands has made great progress over the last few decades. There is every reason to continue to fund this activity and research into what makes for successful methods. It is very likely that wetland creation could play a critical role in certain high loss areas.

The coming decades will bring us both sea level rise as well as unprecedented population growth and urbanization of the coast. Insuring the availability of inundatable lands will not be an easy task — but the sooner planning starts, the better.

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