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# SYNOPSIS OF AN ASSESSMENT: POLICY TOOLS FOR LOCAL ADAPTATION TO SEA LEVEL RISE



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## ABOUT THE MARINE POLICY INSTITUTE

The mission of the Marine Policy Institute at Mote Marine Laboratory is to strengthen the scientific basis of public policy and societal decision making for economic development and sustainability of our oceans and coastal ecosystems. Working closely with Mote scientists and other programs, the Institute conducts, integrates and communicates multi-disciplinary research on marine and coastal issues in a manner that produces salient, credible assessments and advice in policy (legal, economic, social) to decision-makers, stakeholder groups and concerned citizens.

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## EXECUTIVE SUMMARY

There is broad scientific consensus that global climate is warming largely as a result of increased concentrations of carbon dioxide (CO<sub>2</sub>) and other greenhouse gases in the atmosphere. Sea level rise in the coming decades is anticipated to be a major effect of climate change with mostly negative impacts for many coastal regions, including Florida. North America and other parts of the world are already experiencing climate-related sea level rise.

Importantly, scientists advise that many anticipated impacts from sea level rise can be addressed through early planning and well-designed adaptive responses.

Awareness of global climate change has grown markedly around the world in recent years. A 2009 public opinion survey by Yale University found that the majority of Floridians are becoming more aware of climate change; however few are worried about local impacts.

In Florida, as in many states, policies and processes are being put in place to help mitigate future climate change by reducing greenhouse gas emissions. Yet measures to create plans and policies that will help communities adapt to the anticipated impacts caused by past greenhouse gas emissions have been notably absent. Florida state law does not require that policy makers or planners take sea level rise into consideration in the policies they create for land use planning or development.

Managing the impacts of sea level rise will require adapting human activities in the coming decades through policies, programs and actions so that critical human systems (such as communities, economies and emergency management systems) and natural systems (including wetlands, coastal ecosystems and fisheries) can continue to function effectively and be resilient in the face of climate change.

The good news is that even without special rules for dealing with climate change, there are a number of policy tools local governments already have at hand that they can use to help their communities adapt to sea level rise. They include:

- Local comprehensive land use plans,
- Coastal management and beach preservation authority,
- Ecosystem conservation policies,
- Major public facility and infrastructure investments,
- Post-disaster redevelopment planning.

Though not designed originally for this purpose, these tools can still build both community and natural system resilience to sea level rise. Among these tools, one overarching instrument of local government clearly stands out as a framework for future adaptation actions across all sectors. This is the local comprehensive land use plan.

One of the most immediate and substantial things local governments and communities can do to deal with sea level rise is to begin incorporating adaptive measures in all elements of comprehensive land use plans. An essential part of that action will be recognizing that historical data is no longer adequate by itself for long-term planning since sea level rise rates may accelerate in the coming decades due to increased land ice sheet melt. A longer-term planning horizon (at least 50-years forward) will be needed if adaptive planning is to capture the longer timescales of sea level rise.

Local governments and agencies will also need to strengthen their capacity to work across sectors, disciplines and levels of government in planning for future sea level rise. Adaptive planning is an ongoing process of coordination and collaboration.

Some local governments around the U.S. are already doing so by:

- Designating a centralized office or unit with responsibility for coordinating adaptation planning across agencies
- Creating working groups with representatives of key agencies to collaborate among disciplines and across sectors
- Forming climate change advisory bodies (following the pattern of several Florida counties) to advise on strategies and actions for adapting to sea level rise, with members from all relevant scientific disciplines and the community.

Outreach and partnership building is another key area for leadership action. Such activities should focus on three main objectives: increasing community knowledge about sea level rise and associated climate change, building partnerships with a broad range of stakeholders and promoting supportive policy frameworks at state and federal levels.

Some core principles for adaptation that local officials and residents should keep in mind are:

- Early planning is critical to minimize and avoid local risks and negative impacts from sea level rise. Decisions made — or not made — today will have consequences for decades.
- Existing policy tools can provide powerful entry points for local governments to start early planning for sea level rise. While new state and federal policies will also be required, local planning doesn't have to wait on those changes.
- Plans and actions need to be integrated and coordinated across sectors, disciplines and jurisdictions. Adapting will require strengthened efforts to work in multi-disciplinary teams and to harmonize decision-making — particularly where actions may affect adjacent jurisdictions or regions.

- Climate change adaptation is essentially managing future risk. Decision makers can use risk management techniques to systematically weigh the costs and benefits of different options for dealing with climate change that balance the known vs. the unknown. This is especially important when decisions may be irreversible.

There is a growing sense of urgency among the scientific community that adaptation actions need to begin now. Significant delay into the next decade or beyond as climate continues to change reduces choices and options and increases the probability of more difficult and costly adjustments, accommodations and coping strategies both for human and natural systems.

While average sea level rise can be projected with considerable scientific confidence on a global scale, localized change is more difficult to project because climate data and models are less advanced. Local sea level rise impacts may vary widely from region to region also because of different biophysical and socio-economic features.

Sea level rise adaptation hinges on local action because it is at the local level where specific climate impacts, including sea level rise, will occur. Strong and persistent local leadership will be required to tailor adaptive responses to the specific challenges and circumstances of each region.

*“Florida is more vulnerable to rising ocean levels and violent weather patterns than any other state.”*

— Florida Gov. Charlie Crist, 2007 State of the State speech

## Introduction

In 2007, Gov. Charlie Crist declared global climate change “one of the most important issues that we will face this century.” Since then, the Florida Oceans and Coastal Council and the Florida Energy and Climate Change Action Team also recognized climate change and sea level rise as special challenges for Florida in the 21<sup>st</sup> century.

Florida state and local governments have already paid significant attention to reducing greenhouse gases entering the atmosphere with the aim of stabilizing future climate change. In notable contrast, much less attention has been paid to planning and preparing for the effects of climate change that have already been set in motion by past greenhouse gas emissions.

Recent research on climate and social change has shown that even if communities and individuals have high levels of knowledge, climate change has been largely disconnected from people’s daily lives (e.g., Moser *et al* 2007a, Moser *et al* 2007b). These studies also suggest that communities are beginning discussions on local climate change impacts and talking about options for change.

Adaptation to sea level rise has particular relevance for local policy making because it is at the local level where the effects will play out. Impacts may vary widely by region depending on different biophysical and socio-economic features of various communities. Adaptation will need to be tailored to the specific local vulnerabilities and needs involved. It is local leadership that will steer communities to effective and feasible adaptive responses to local sea level rise, building necessary resilience in both human and natural systems.

This report is a synopsis of a more extensive document — “Policy Tools for Local Adaptation to Sea Level Rise” — a 2008-09 assessment by the Marine Policy Institute at Mote. The assessment looked at policy tools and opportunities local governments already have that can help them as they make plans to help their communities adapt to sea level rise.

A main purpose of the assessment is to stimulate dialogue among local and state policy makers, community leaders and concerned residents about climate-associated sea level rise, vulnerabilities in their communities and options for dealing with those vulnerabilities moving forward. The MPI had four main tasks:

- Highlight and translate present-day scientific understanding about climate-associated sea level rise in a form useful for policy-makers and the community at large;
- Analyze key policy tools already available for local governments and determine how they could be used to address sea level rise;
- Identify some basic principles for climate change and sea level rise adaptation emerging from growing experience at local and state levels;
- Provide observations about specific leadership opportunities and actions that can help communities begin now to build adaptation strategies for the challenges of the coming decades.

This synopsis follows the general organization of the assessment’s full report from which it is drawn. It abstracts that report in the following four sections:

1. Some basics about climate change science and sea level rise.
2. Highlights from an assessment of the five policy tools noted in the executive summary.
3. Key principles of adaptation from emerging experience.
4. Leadership opportunities going forward.

For illustrative purposes, the assessment highlights Sarasota County’s policies and programs.

Those interested in reading the full assessment may download it at [www.mote.org/mpi](http://www.mote.org/mpi). The working draft is available online even as editing continues so that interested parties may have the information in a timely fashion for their review, use and feedback.



# What Climate Science Tells Us About Sea Level Rise

## Some basics

**Mitigation and adaptation defined.** For purposes of this report, “climate change mitigation” referred to here means actions that attempt to reduce the amount of greenhouse gases entering the atmosphere now in order to stabilize future climate change. “Climate change adaptation” here is defined as plans and preparation that governments should take now and into the future in order to adapt to the changes occurring because of greenhouse gases that have already entered the atmosphere.

### **Providers of information about climate science.**

For purposes of the full assessment and this synopsis, we have relied on two major sources of reliable, consolidated climate science information that have targeted policy-makers. First is the Intergovernmental Panel on Climate Change, the IPCC. The IPCC was established by the United Nations in 1988 to provide policy makers with an objective source of information. It produces scientific assessments every six years that synthesize the latest peer-reviewed, published climate science information worldwide. The most recent IPCC assessment, issued in 2007, involved more than 600 scientific authors from 40 countries — including the United States — and representatives of the 113 governments that adopted the final synthesized summary for policy-makers.

The second major source of reliable, consolidated scientific information for policy makers, particularly in the U.S., is the U.S. Climate Change Science Program, the U.S.CCSP. The U.S.CCSP was established by federal law in 2002 and renamed the “U.S. Global Change Research Program” in 2009. It prepares scientific assessments based on the latest climate science research being undertaken by 13 main U.S. federal departments and agencies, frequently in collaboration with universities and other research institutions.

**Scientific uncertainty.** While climate science has made major strides since the 1990s, many challenges remain. These relate to uncertainties about how the complex climate system will react in the future and whether human efforts will sufficiently reduce future greenhouse gas emissions to slow future change. Questions also remain about how abrupt changes will be due to more rapid melt of land ice sheets — especially at the polar caps — and the wide regional variability in effects when compared to global estimates because climate modeling is much less advanced at this level.

## Sea level rise projections and impacts

### **Global Sea Level Rise**

To understand what has been happening with global sea level rise associated with climate change, the starting point is to look at what has been happening to the planet’s land and ocean temperatures. The two main reasons for global sea level rise (each contributing about half) are thermal expansion of the oceans (when the ocean warms, water expands) and increased temperatures over the land triggering more melt of land glaciers and snow cover that flows into nearby seas (CENR 2008, IPCCa).



As sea levels rise in the coming decades, coastal communities like Sarasota will need to adapt. Because communities vary greatly in everything from physical geography to socioeconomic makeup, local government decisions will be critical for resilient communities.

Observations from sites on all continents and in most oceans show that at the global scale, both land and ocean temperatures are rising. Land regions have warmed faster than the oceans. Nevertheless, there is now clear evidence that the oceans are also gradually warming. The IPCC has concluded with 90% scientific certainty that continued greenhouse gas emissions at or above current rates will cause further warming and induce many changes in the global climate system that very likely will be greater than those of the 20<sup>th</sup> century (IPCC 2007a). The IPCC defines “very likely” as more than a 90% certainty.

Consistent with global temperature trends, global sea level increased from the 19<sup>th</sup> to the 20<sup>th</sup> century and was accelerating by the end of the century. According to the IPCC, the total 20<sup>th</sup> century rise is estimated to be about

6.6 inches (IPCC 2007b). The most recent satellite and ground-based observations also show that average global sea level has been accelerating since 1993 (IPCC 2007a). Indicators from historical climate change suggest that global sea levels had been stable for the last 2,000 to 3,000 years and did not change significantly until the late 19<sup>th</sup> century.

As for future projections, scientists have developed scenarios using available data and different assumptions in order to deal with uncertainties such as those noted above. Using best-to-worst case scenarios, the IPCC concluded in its 2007 assessment that projected global average sea level rise by the end of the 21<sup>st</sup> century would be within a range of 7 to 23 inches. This projection was made with more than 90% confidence and assumed that there would be no increase in the rate of polar ice sheet melt from Greenland and West Antarctica. (This assumption was made because of insufficient published data.) Since then, new satellite data confirms that the Greenland and West Antarctic ice sheets are losing mass at accelerating rates, causing recent reports from the U.S. Climate Change Science Program to suggest that the upper end of the IPCC range (about 2 feet average) be used for policy planning.

Including new ice sheet melt data, various peer-reviewed scientific studies published since the 2007 IPCC assessment suggest a sea level rise range of 2.5 to 6.5 feet by 2100, with a mid-point scenario of about 3 feet (1 meter) (e.g., IPYP 2009, ISCCC 2009, Timmer 2009, Rahmstorf 2007, U.S.CCSP 2009a).

It is certain that scientists will continue to improve their analyses and projections with new data and advanced climate modeling. For the present, there appears to be growing consensus in three respects:

- Global sea level likely will rise faster in this century than it did in the 20<sup>th</sup>;
- The IPCC projection of up to 2 feet of sea level rise by 2100 is probably too conservative;
- Polar ice sheet melt will likely be a significant — and perhaps even dominant — factor this century and into the coming century, responding more strongly to

temperature increases in the 21<sup>st</sup> century than the 20<sup>th</sup> century data suggest (Hansen 2007).

### Sea level rise in Florida

Sea rise measurements along U.S. coasts come mostly through several tide gauge stations operated by the National Oceanic and Atmospheric Administration (or NOAA), supplemented by satellite data in some areas in recent years. Based on these data, a 2008 report from the National Science and Technology Council estimates that sea level along most of the U.S. Atlantic and Gulf Coasts has been rising .08 to .12 inches per year (2-3 mm/yr.) — slightly higher than the global average (CENR 2008).

According to a 2009 report from the Florida Oceans and Coastal Council, a persistent upturn in this rate may have begun recently (FCCC 2009). For Sarasota County, the closest NOAA tide station with 30 or more years of data is in St. Petersburg, a station operating since 1947. St. Petersburg data show a monthly mean sea level rise of about .09 inches per year (2.36mm/yr.), translating roughly to 9 inches over a 100 year period (NOAA 2009b).



According to Florida Oceans and Coastal Council climate change has the potential to threaten every aspect of life — from infrastructure to human health: “Negative impacts will outweigh benefits for most sectors that provide goods and services... and place immense strains on public sector budgets...”

all coastal states, according to data collected from NOAA’s Florida tide stations.

Projecting sea level rise in specific regions such as Southwest Florida is difficult even with these historical data because climate models are not well developed and site-specific natural and human factors may affect local changes. Nevertheless, a few recent studies have made projections based on available data and different assumptions.

The Southwest Florida Regional Planning Council, in a 2009 draft technical report, used historical data and scenarios about future global temperature increase and sea level rise to calculate estimates of future sea level rise at the regional level. The report included best-case and moderate-case scenarios. Best case: Calculations indicated a 90% probability of a 5 inch rise by 2050 and a 10.4 inch rise by

2100. Moderate case: A 50% probability of a 9.4 inch rise by 2050 with a 19.8 inch rise by 2100 (Beever *et al* 2009).

A 2007 study by Florida State University allowed for some acceleration from historical rates while still keeping within the trend line of historical data. At the St. Petersburg data site, that study projected a possible rise of almost 14 inches between 2006 and 2080 and recommended that future economic planning in Florida take into account the strong possibility of an accelerating sea level rise (Walton 2007).

Taking the climate model an additional step, a 2007 study by Tufts University included recent estimates of ice sheet melt rates and projected a sea level rise of 17.7 inches by 2050 and 35.4 inches by 2100 if we continue business as usual — that is, if greenhouse gas concentrations continue to rise and ice melt accelerates. This projection approaches the emerging global sea level rise estimate of about 40 inches (1 meter) (Stanton and Ackerman 2007).

In light of new data on ice melt gathered since the 2007 IPCC report and related analyses, the Miami-Dade Climate Change Action Task Force last year revised up its sea level rise estimates for purposes of local adaptation from 2 to 3-5 feet by 2100 (Miami-Dade 2008).

### **Potential impacts in Florida**

Florida and its residents face many challenges with climate change and regional sea level rise in the decades to come. Sea level rise in Florida will have both physical and socio-economic impacts, their severity dependent as much — or more — on how quickly sea level rises as the total number of inches or feet that it rises. In a 2009 report on climate change in Florida, the Florida Oceans and Coastal Council concluded that coastal wetlands, salt marshes and mangroves are all expected to be negatively affected by sea-level rise especially where they are constrained on their landward side or where they are deprived of sediment or freshwater. Even where these natural systems are not constrained, their ability to adapt will depend on the rate and magnitude of inundation (FOCC 2009).

An important secondary impact from sea level rise locally will be greater high tides and storm surges. IPCC climate models indicate that coastal areas in the Gulf of Mexico potentially will be more exposed to storm-surge flooding than some other coastal areas because of likely increased intensity of hurricanes and other storms (IPCC 2007c). Important note: IPCC models do not predict an increase in the number of hurricanes, only an increase in intensity.

These biophysical changes will trigger local and regional social and economic impacts. The Florida Oceans and Coastal Council concluded that climate change has the potential to threaten every aspect of life, from essential infrastructure like roads and water systems to the health of residents and visitors and the state's economic well-being and long-term sustainability (FOCC 2009). According to the Council: “negative impacts will outweigh benefits for most sectors that provide goods and services. The impacts will place immense strains on public sector budgets. The secondary impacts of climate change can include higher prices, reduced incomes, and job losses.”

A National Wildlife Federation and Florida Wildlife Federation study in 2006 looked at the impact of a 15-inch rise in average sea level in this century in nine coastal sites in Florida. Even with this mid-level scenario for sea level rise, the federations found costly consequences for Florida's commercial and recreational fishery as well as coastal tourism. If left unchecked, sea level rise would cause the loss of nearly 50 percent of the salt marsh that is critical fish nursery habitat and a 30 percent loss of the ocean beaches (NWF 2006).

The Tufts University study also projected severe economic consequences for Florida if greenhouse gas emissions are not rapidly stabilized. The Tufts analysis projected the annual costs of inaction (“business-as-usual”) to total \$92 billion by 2050 — that's a \$40 billion loss in tourism and \$23 billion loss in real estate, the two areas most directly linked to sea level rise. There would also be an additional \$5 billion more for the cost of electricity and a \$25 billion increased cost in dealing with damage from more intense hurricanes (Stanton and Ackerman 2007). These projections did not include other sectors such as fisheries, transportation or water systems.

The Centers for Disease Control and Prevention and the U.S. Climate Change Science Program studies have identified long-term health concerns from such sea level rise impacts as salt-water intrusion in freshwater drinking supplies and increased salt content in soil hindering agriculture in coastal areas. They also note that extreme weather events are also coupled with worsening immediate and chronic health problems. (CDC 2009, U.S.CCSP 2008b).

## Key Policy Tools for Local Sea Level Rise Adaptation

The process of adaptation broken down into concrete goals and frames of reference (e.g., land use planning, infrastructure, conservation, etc.), if begun now, provides policy-makers and local communities time to agree upon goals and feasible actions that are science-based and flexible enough to accommodate new information as it develops. For example, even the high global estimates of a 40-inch sea level rise being projected for 2100 is less than half an inch per year or roughly 4 inches in 10 years. That means there is yet time for communities to adapt to sea level rise and they already have a number of tools in hand to begin this work: land use planning, coastal development rules, ecosystem conservation plans, public facilities and infrastructure investments and post-disaster redevelopment planning. For illustrative purposes, examples from Sarasota County's policy framework are included in various parts of the analysis to elaborate specific sea level rise adaptive options and leadership opportunities.

### Local comprehensive land use plans

Land use planning and sea level rise in Florida are intricately linked. Current growth plans and development projections have the majority of residents clustered near the coast or in flood plains, reinforcing current growth patterns. By state law, every county and incorporated city or town in Florida is required to have a local comprehensive land use plan to guide "the orderly and balanced future economic, social, physical, environmental, and fiscal development of [their] area" (FS Ch. 163.3177). Each plan should be consistent with the state comprehensive plan and appropriate regional policy plan when taken as a whole.

State law does not explicitly require consideration of sea level rise in local comprehensive land use plans. However, the plan requires several elements that increasingly need re-examination in light of sea level rise projections. These include the location of land development, provision of public

facilities and infrastructure for residential, commercial and industrial purposes, conservation, use and protection of natural resources, housing, recreation and open space, capital improvements, a future land use plan, and coastal management measures (for coastal counties and cities). Zoning, building codes and other local land development regulations are the implementation tools for the policies adopted in the local comprehensive plan.

Local plans provide a significant overarching tool for implementing strategies to deal with sea level rise as part of overall growth management currently done for sustainable development. A 2008 Florida Atlantic University report, "Florida's Resilient Coasts," identified two specific actions that should be considered by policy-makers in this regard:



Managing the impacts from sea level rise will require changes in human activities: everything from where we build homes and the infrastructure that supports them to where we find our recreation.

"Florida's comprehensive planning laws and procedures will need careful reexamination in light of climate change predictions. In particular, coastal communities and regions that are likely to experience long-term sea level rise and the combination of sea level rise, hurricanes, and storm surge will want to ensure that development over the next several decades does not put people and communities in harm's way... [and] future land use maps will have to be revised, and climate change impacts should be assessed

in Comprehensive Plans, including especially Coastal Management and Capital Improvement elements." (FAU 2008)

New legislation enacted by the Florida legislature in 2009 (Senate Bill 360) gives local comprehensive plans an even more central role in this regard. That legislation aims to stimulate urban infill development and redevelopment by authorizing local governments to exempt certain development projects from existing transportation concurrency and regional development review requirements in dense urban service centers identified in their comprehensive plans. This gives local governments a weightier role in ensuring that the urban service areas designated in their plans are not vulnerable to sea level rise. The legislation also places heightened responsibility on local governments to initiate review processes with their respective regional planning councils

since this will no longer be imposed by state regulations. State law currently specifies a minimum planning horizon of at least 10 years for most elements of the comprehensive plans and of five years for capital improvements (FS Ch. 163). Local governments, however, may extend their planning horizons beyond 10 years as needed to properly plan for future challenges. National surveys show that many local jurisdictions are beginning to employ 50-year planning horizons or longer in order to capture the projected impacts that need to be considered with sea level rise. A 50 year planning horizon was a strong recommendation from recent United States climate assessments.

In Florida, some counties have already moved in this direction. In 2008, after two years of analyses, the Miami-Dade County Climate Change Advisory Task Force



Experts advise that planning for sea level rise should begin now so communities can withstand climate change and be resilient for future generations.

recommended that all county entities use 50 years as their planning horizon for sea level rise and other climate change impact assessments.

Local governments are required to update their local comprehensive plans on a multi-year basis. These processes provide a natural opportunity for beginning to integrate sea level rise adaptation in all sectors of the plan, including future land use plans and maps to reflect those areas and ecosystems most vulnerable to sea level rise and in assessing risks from sea level rise to essential services, functions and infrastructure.

### Sarasota County example:

Sarasota County's most recent land use plan, Comprehensive Plan 2007, illustrates progress along these lines. That Plan, comprising 12 substantive chapters, has taken a first step toward addressing sea level rise concerns by including the issue in its coastal environment chapter (discussed more below). The County has laid an important foundation for incorporating sea level rise concerns in all sectors by adopting a 50-year planning horizon for its future plan, called "Sarasota 2050," and updated elevation data using LIDAR (Light Detection and Ranging) technology in 2009 to more accurately identify flood prone and low-lying areas. That data, combined with climate modeling methodologies developed by Pennsylvania State University on a pilot basis (Frazier et al 2009), will help planners better understand the long-range influence of sea level rise on societal vulnerabilities to hurricane storm surge hazards.

Following a regional trend, Sarasota 2050 incorporates smart growth principles to reduce urban and suburban

sprawl (and associated infrastructure costs), strengthen existing communities, preserve environmental systems and rural areas, direct population growth away from floodplains and conserve water and energy (Ch. 9-5). It defines an Urban Service Boundary to demarcate the county's urban service area within which approximately 90% of Sarasota County's population resides (Ch. 9-67, EarthBalance 2008).

The evaluation and review process already under way for the next update of Sarasota County's Comprehensive Plan (due in 2013) will have Sarasota 2050 as an important baseline upon which the new elevation data and sea level rise projections can be overlaid in order to identify the most vulnerable natural areas and human settlements. That information will provide an important starting point for consultations with the community on adaptive choices available and additional analysis of sea level rise projections and likely impacts that may be needed.

## Coastal development – beaches, shorelines, estuaries

Florida's Coastal Program implements the federal Coastal Zone Management Act, a voluntary federal program providing technical assistance and other benefits for coastal states that participate. That federal act was amended in the late 1990s to recognize the need to begin sea level rise adaptation along the nation's coasts. It advises that state coastal management programs "should at least provide for... the management of coastal development...in areas likely to be affected by or vulnerable to sea level rise..." and encourages states to prepare special area management plans for areas likely to be affected by *sea level rise* (16 U.S.C. 1452). Through this program, local governments have significant authority for local beach and shore preservation and coastal management — two primary areas for *sea level rise* adaptation if coastal communities are to become resilient in the face of sea level rise (FS Ch. 161).

While Florida state law does not explicitly require local governments to integrate sea level rise into their coastal decision making, several provisions contain tools to do so and objectives that will have that effect with time as seas rise. In particular, the state law provides for the use of:

- A coastal construction control line (CCCL) calculated by a 100-year storm model where construction seaward may be subject to additional regulations;
- A coastal setback line (the 30-year erosion projection line) that prohibits major habitable structures seaward of the line;
- And a coastal building zone (an area extending 1,500 feet landward of the mean high water mark) where new construction is required to meet established wind and flood standards enforced through local government building codes.

Beach erosion control measures also are covered seaward of the coast's mean high water line, including coastal construction. Counties may implement more restrictive standards.

State law also requires that coastal management decisions be guided by the coastal component of local comprehensive land use plans. Among the state-mandated objectives for components that will trigger sea level rise adaptation considerations are the:

- "Maintenance, restoration, and enhancement of the overall quality of the coastal zone environment, including its amenities and aesthetic values..."
- continued existence of viable populations of all species of wildlife and marine life, [and]
- avoidance of irreversible and irretrievable loss of coastal zone resources" (FS Ch. 163.3177(6)(g) 1a,1b,1d).



Local governments have significant authority for coastal management and local beach and shore preservation. The rules governing these areas are key places where communities can start adapting to ensure that they are resilient in the face of climate change.

Further, state law spells out specific coastal management elements that each local comprehensive plan shall contain, including several directly relevant for sea level rise adaptation planning — for example, detailed inventory of coastal uses, analysis of impacts from proposed future land use plans, redevelopment of coastal areas where needed and local regulatory and management techniques that will be used to protect the coastal environment by mitigating threats to human life and controlling proposed development and redevelopment (FS Ch. 161.3178(2)).

## Sarasota County example:

Sarasota County provides an example of how these state policies may translate local comprehensive plans into local sea level rise adaptation policies. The County's 2007 Comprehensive Plan introduces for the first time sea level rise concerns into its coastal management component. This is in the context of advancing the Plan's Environment Goal 1 to "protect, maintain and, where deemed necessary in the public interest, restore the barrier island, beach, and estuarine systems of Sarasota County" (Ch. 2, Env. Policy 1.2.3). Noting IPCC projections of global average sea level rise of about 2 feet by 2100, the Plan discussed local sea level rise concerns and planning choices:

“...[Sea level rise] may create or destroy coastal wetlands and salt marshes, inundate coastal sediments, and induce saltwater intrusion into aquifers, leading to salinization of groundwater. Further inland intrusion of saltwater along our shorelines will affect the health, composition, and aerial coverage of our coastal ecosystems and habitats...Changing sea level will also have effects on coastal construction...*How our community responds to these changes may very well determine whether we will have beaches or hardened shorelines in their stead.*” (Ch. 2-29) (emphasis added)

The coastal component characterizes the beaches and dune systems as specific habitats continually adjusting to natural changes (including sea level rise, storm waves and currents) and human-induced changes such as shoreline hardening, channel dredging and beach vegetation removal (Ch. 2-50). In that context, the 2007 Plan calls for regulatory action to tighten restrictions on the construction of seawalls, setting out a policy that prohibits further hardening of Gulf beaches or passes unless found to be in the public interest (Ch. 2, Env. Policy 1.1.2).

This policy was enacted in response to a new, more precise GIS-based inventory of shoreline hardening undertaken in 2005 as part of a state required coastal inventory update that found almost seven miles or about 20% of the County's beaches were bounded by a shore protection structure on the landward side. Impacts from sea level rise are amplified where landward migration of beaches, wetlands and other key natural systems is impeded by development, including shoreline hardening. Thus, this new data raised concerns about more beach erosion and loss explicitly in the context of increasing sea levels and storm surge.

Most of the county's existing shoreline already is developed. Of the county's 33 miles of beach, 22 miles are considered critically eroded by Florida's Department of Environmental Protection (FDEP 2008). The County depends heavily on its attractive beaches for tourism, which brings millions of dollars to the regional economy. Its prime waterfront areas for residential real estate also generate significant revenue from property taxes. In addition, its beaches, estuaries, tidal waters and wetlands provide critical habitat for many wildlife species, including endangered and threatened marine turtles, birds and mammals and serve as buffers from storms for upland property and public infrastructure.

These considerations were central to the new policy and resulted in amendments to the County Coastal Setback Code in 2008 to prohibit further hardening of Gulf beaches or passes unless found by the Board of County Commissioners to be in the public interest (a rigorous test that includes determination that all other less structural alternatives are not feasible, including beach nourishment, moving the residence landward or elevating the upland structure).

Controlling shoreline hardening represents a significant adaptation measure that coastal governments in many regions are increasingly applying to protect their beaches and shorelines. It is one of several options available to local governments. This table identifies several main adaptation options for local governments that can be used as part of a policy toolkit.

Sea Level Rise Adaptation Options for Maintaining and Restoring Beaches, Shorelines, & Estuaries				
Adaptation Options	Additional Management Goals Addressed	Benefits	Constraints	Examples
Allow coastal wetlands to migrate inland (e.g., through setbacks, density restrictions, land purchases)	Preserve habitat for vulnerable species; preserve coastal land/development	Maintains species habitats; maintains protection for inland ecosystems	In highly developed areas, there is often no land available for wetlands to migrate or it can be costly to landowners	Buzzards Bay, Massachusetts
Promote beach nourishment; build up base of wetlands by adding sediment., building base of wetland by bringing in sediment	Maintain sediment transport	Protects coastal land from storms	Requires continual management, e.g., with beach nourishment, wetland sediment maintenance; can be very costly	Beach nourishment: Florida; Wetlands accretion: Southern Louisiana
Prohibit hard shore protection	Preserve habitat for vulnerable species; maintain sediment transport	Allows for species migrations inland	Alternatives to bulkhead construction may be more expensive and more difficult to permit	Numerous states and local governments have drastically reduced permits for hard protection (e.g., Sarasota County, FL; North Carolina; King County, WA)
Remove hard protection or other barriers to tidal and riverine flow (e.g., riverine and tidal dike removals)	Maintain sediment transport; maintain shorelines	May allow for beach and wetland migration	Costly and destructive to shoreline property	King County, Washington
Incorporate beach and wetland protection into infrastructure planning (e.g., transportation planning, sewer utilities)	Maintain water quality; preserve habitat for vulnerable species	Protects beaches and estuaries and important infrastructure		Houston-Galveston long range transportation plan
Manage retreat through a type of easement placed along the shoreline to prevent property owner from holding back the sea, but allow other types of use (sometimes called a 'rolling' easement)	Maintains water quality; maintains sediment transport	Lower long-term costs; sediment transport remains undisturbed; property owner bears risks of sea level rise	Does not prevent migration of salinity gradient	Worcester County, Maryland; South Carolina Coastal Council; California Coastal Commission; Texas

(Adapted from U. S. EPA, 2009. Table 2, pp. 6-7)



**Balancing public and private interests.** Local governments may face near-term challenges implementing some of the above adaptation options, particularly where coastlines already are highly developed for residential use. State legislation enacted in 1995 (the Bert-Harris Act, FS Ch. 70) aimed to clarify constitutional protections and the considerable case law already existing at federal and state levels concerning the “taking” of private property for public use (and thus requiring compensation). That statute, however, has its own intensely fact-specific tests that must be applied on a case-by-case basis, and there has been limited court action to date. In addition, as sea level rise and storm surge increasingly threaten coastal properties and their market values over time, market forces are likely to change the pattern and type of coastal uses, making adaptive options more attractive. Importantly, public policy for sea level rise adaptation needs to continue to strengthen if coastal communities are to build resilience for climate change in the coming decades.

### Ecosystem conservation

The policy tools discussed above are implemented mainly through land development regulations, ordinances and rules. These tools integrate conservation into development, but are not primarily for conservation. Another set of important local policy tools for sea level rise adaptation has conservation as the primary goal. These are voluntary and incentive-based programs, in contrast to the regulatory-based programs above. They involve public acquisition of land or development rights between willing sellers and the local government or other conservation entities in order to reduce development pressures. State law recognizes this option as an important component of local comprehensive planning:

“Each county shall establish a county-based process for identifying and prioritizing coastal properties so they may be acquired as part of the state’s land acquisition programs. This process must include the establishment of criteria for prioritizing coastal

acquisitions which, in addition to recognizing pristine coastal properties and coastal properties of significant or important environmental sensitivity, recognize hazard mitigation, beach access, beach management, urban recreation, and other policies necessary for effective coastal management.” (FS Ch. 163.3178(8))

Land conservation can significantly enhance coastal resilience to climate change impacts by protecting and restoring natural areas for migration of beaches and estuaries inland. A 2008 report of the Florida Energy and Climate Change Action Team gave this option prominence as part of its recommended state Adaptation Planning Framework. Good management objectives, according to the Action Team, should include

“[p]urchasing private coastal lands that have been strategically targeted to provide buffers for retreating shorelines, to preserve and protect habitats and ecosystem functions, and to increase the resiliency of the shoreline to recover from storm events.” (FECC 2008)

We reviewed three supportive policy tools for ecosystem conservation:

- The state-run Florida Forever Program,
- County-led environmentally sensitive lands protection programs,
- Mechanisms for transfer of development rights

To date, these programs have not actively pursued acquisition of coastal properties vulnerable to sea level rise, but they offer significant potential for that purpose.

**Florida Forever Program.** In 2001, the Florida legislature established the Florida Forever Program to support acquisition of lands for conservation throughout the state. Today, the Program is considered the largest of its kind in the U.S., directing billions of dollars to the purchase of land and development rights and protecting thousands of acres important to species for habitat, as ecological greenways, natural floodplains, fragile coastlines, functional wetlands and groundwater recharge areas.



Land conservation can play a key role in helping communities deal with rising sea levels. Strategically protecting and restoring coastal areas can provide buffers that “preserve and protect habitats... and increase the resiliency of the shoreline to recover from storm events,” according to the Florida Energy and Climate Change Action Team.

Importantly, Florida Forever is one of the few state programs that explicitly incorporates climate change and sea level rise. In 2008, the Florida legislature recognized sea level rise adaptation as a valuable purpose for bringing lands into the program and required staff to include a climate-change category in the annual Florida Forever work plan (FS Ch. 259.105(17)(d)). The Program receives state funding annually that is distributed by the Florida Department of Environmental Protection to other state agencies, water management districts, local governments and nonprofit environmental groups for acquisition of lands and development rights to be held in trust for the citizens of Florida.

***Environmentally sensitive lands program.*** Since the late 1980s, a growing and increasingly important initiative started by county governments has resulted in purchase and preservation of endangered and environmentally significant lands throughout the state. Given various formal names, these programs are incentive-based, funded by a small ad valorem taxes approved by voters and used to purchase lands, acquire conservation easements or make other arrangements with willing property owners based on conservation criteria.

Sarasota County, among several in the state, has an Environmentally Sensitive Lands Protection Program, ESLPP, created in 1999 after passage of a voter referendum that was extended by a second referendum in November 2005. The 2005 referendum added a new category called Neighborhood Parklands — an important addition to promote the program within communities — and extended the program another 10 years. Under the ESLPP, Sarasota County had protected 62 parcels totaling 27,465 acres, putting it among the top four counties in the state for acreage protected without federal funds. It had eight neighborhood parkland parcels totaling 32 acres. In addition, private conservation easements have also been promoted. These various forms bring the total land area protected by the county to 28,453 acres as of August 2009 (Sarasota County 2009a).

***Transferable development rights.*** Finally, another voluntary program with increased potential for use in conservation and sea level rise adaptation is transferable development rights (TDRs). The general concept is to give landowners the ability to transfer their development rights over ecologically valuable or sensitive lands to other areas that are suited for more intense forms of development. Since development rights are the focus, arrangements could be envisioned where the property owner kept title subject to a conservation easement, while gaining development rights to another property inland; alternatively there could be a direct land swap. This concept has been available through zoning ordinances in most Florida counties since the 1980s, although it has rarely been used in this region.



Coastal communities will need to carefully plan for infrastructure changes in the face of sea level rise — everything from where highways are built to the location of water and sewer treatment plants. According a Florida State University report, sea level rise has been absent in local government planning for these structures.

Sarasota County's 2007 Comprehensive Plan explicitly recognizes the possible use of this mechanism to promote resettlement from high-risk coastal areas like barrier islands to inland areas that are less vulnerable to nature and natural disasters (Future Land Use Policy 1.1.4). In the coming decades, as sea level rise coupled with storm surge negatively impacts vulnerable coastal properties, this is a policy tool that warrants increased attention and strengthening to make it an attractive and workable option for all interests concerned.

## **Public facilities and infrastructure**

Local governments have a leading role in decision making on public facilities infrastructure — highways, water supply and sewerage systems, wastewater management and stormwater drainage systems. Quality of life and growth in a community is strongly influenced by the location, extent and quality of these investments. The “built” environment also needs attention for sea level rise preparedness and adaptation in vulnerable coastal areas. This is particularly critical for Florida given that 13.7 million people — roughly three-quarters of the state's population as of 2006 — are considered coastal residents.

A 2007 study by the Florida State University (FSU) Department of Urban and Regional Planning, found that sea level rise considerations have been largely absent in public facilities and infrastructure planning by local and regional governments (Deyle *et al* 2007). Among its conclusions, the study found a major reason was that most local planners adhere to minimum planning requirements of the state legislation (five-year and 10-year periods), while regional water supply planning and major transportation projects generally are on a 20-year timeline. None of these timeframes is sufficiently long-range to properly incorporate sea level rise projections over this century for public infrastructure that may actually have a service life of 50 to 100 years.

The FSU infrastructure study recommended that new infrastructure planning use 75-to-100-year ranges in order to capture sea level rise projections and take adaptive measures. It also suggested that use of only historical data for infrastructure design was no longer adequate for long-lived structures since rates of sea level rise may accelerate due to increased polar ice melt in the coming decades.

The 2008 report of the Florida Energy and Climate Change Action Team reached similar conclusions, recommending that a planning horizon of 75 to 100 years be used when calculating the impacts of climate change in design requirements for buildings and structures. Following this trend, the Miami-Dade Climate Change Advisory Task Force in its 2008 report to the Miami-Dade County Commissioners recommended that all county agencies involved with infrastructure or “built investments” incorporate a 50-year planning horizon and an assessment of climate change impacts, including sea level rise, into their planning processes (Miami-Dade 2008).

## **Post-disaster redevelopment**

Florida state law requires that coastal county and city comprehensive plans meet certain state goals, including protection of human life against the effects of natural disasters and limitation of public expenditures that subsidize development in high-hazard coastal areas (FS 163.3177(g)1g and h). Coastal counties and municipalities are required to prepare post-disaster redevelopment plans (PDRPs) as part of the coastal management component of their comprehensive plans. While most counties have indicated their intent to do so, resource and other constraints have delayed development of these plans. To jump-start these efforts, the Florida Department of Community Affairs with the Division of Emergency Management in 2007 launched

an initiative to support several pilot projects in post-disaster redevelopment planning around the state. This initiative will generate concrete plans in the pilot areas and new guidelines for other counties to use in their efforts. These post-disaster redevelopment plans and the development and consultation processes involved provide a timely and important opportunity to begin addressing sea level rise considerations in both pre-disaster preparations and post-disaster redevelopment.

**About Post-Disaster Plans.** Sarasota County is one of the Post-Disaster Redevelopment Plan pilot communities. Other counties include Hillsborough County, Manatee County, Nassau County, Panama City and Polk County. The Sarasota County project began in 2008 with a stakeholders working group and subgroups in economic development, environmental restoration, infrastructure, housing and public outreach. It progressed to public workshops during 2009. Sea level rise considerations will be part of the planning process. In designing post-disaster redevelopment plans, special attention will be given to high hazard coastal areas and flood-prone areas as places vulnerable to future sea level rise and storm surge are identified.

State law requires coastal management elements of local government comprehensive plans to include designation of coastal high hazard areas (CHHAs) and mitigation of negative impacts, including providing evacuation routes for hurricanes, hurricane shelters and transportation facilities (FS Ch. 163.3178(2)(h)). The coastal high hazard area is defined as the evacuation zone for a Category 1 hurricane. Importantly, comprehensive plans are again key policy tools for reflecting these vulnerable areas since state law requires that the coastal management component include the definition of coastal high-hazard area and reflect it on future land use maps (FS Ch. 163.3178(9)(c)).

Accurate floodplain maps will also be required for coastal counties developing their post-disaster redevelopment plans. To manage flood risk and promote community actions to mitigate losses, the Federal Emergency Management Agency (FEMA) and its National Flood Insurance Program invest significant resources to identify local flood hazards and publish the data on local flood maps. Communities adopt these floodplain maps and supporting regulations for floodplain management and development control in high-risk areas in order to participate in the National Flood Insurance Program (NFIP). Community participation in NFIP allows local residents to purchase federal flood insurance.

In Sarasota County and throughout the state, local flood insurance rate maps are being updated with new digital

elevation data. These digital maps “will reflect current flood risks and areas of recent growth, replacing older paper maps produced many years ago. Once adopted, everyone will have up-to-date, reliable, internet-accessible information about their flood risk on a property-by-property basis.” (Sarasota County 2009c) The Sarasota County maps are expected to be updated and digitized by fall 2010. To the extent possible, the maps also will identify the coastal construction control line described earlier.

These new maps will provide a valuable tool to help policy-makers, planners and coastal managers more accurately identify highly flood-prone areas for sea level rise and storm surge in order to deflect post-disaster redevelopment away from those areas. They also will be a valuable resource to inform residents, property owners, insurance companies, real estate agents and the community at large about flood risks and areas needing flood insurance that likely will also be increasingly vulnerable to sea level rise in the future.

### *Emerging practice with sea level adaptation*

1. Sampling of local-level jurisdictions:
  - Miami-Dade County: Climate Change Advisory Task Force recommends 35 specific actions, two-thirds on adaptation.
  - King County, Washington (Seattle area): detailed adaptation plan and guide for local government. (2007)
  - Boston: new Deer Island Wastewater Treatment Plant is built on higher ground and with an increased cost to account for sea level rise based on EPA-commissioned climate change study.
  - New York City: Working to identify vulnerable infrastructure and neighborhoods and working on new protection strategies (Columbia University acting as advisors).
2. Sampling of state level adaptation initiatives:
  - North Carolina: State Coastal Resources Commission manages an adaptation program; overall policy of gradual retreat; no more seawalls
  - Texas: Migratory prescriptive easements now required for beach private property (called rolling easements).
  - New Jersey: Has Coastal Blue Acres acquisition, a public land acquisition of storm-affected and storm-prone coastal areas.
  - Gulf of Mexico Alliance: This group of five-states has the long-term goal of encouraging communities, businesses and individuals to adopt new methods for risk mitigation and resilience (Action Plan II)
  - California, Delaware, Maryland, North Carolina, Washington: Developing new climate change/sea level rise adaptation plans or expanding old ones.
  - Rhode Island, Maine: Sea level rise adaptation plans in place.

## Principles for Sea Level Rise Adaptation

Learning from others in similar situations can provide important insights on approaches worth exploring in this region. Increasingly, these experiences are possible to monitor on the internet and are being distilled in reports, surveys and guidance materials.

In the adjacent box are highlights of a few local and state jurisdictions in Florida and across the nation that have begun incorporating sea level rise into their planning systems, along with the actions being taken:

The following are some key principles that should help guide communities as they build local adaptation strategies for sea level rise. These are drawn from experiences in a growing number of state and local jurisdictions.

1. Plan early. Early planning for the impacts of sea level rise is critical. Many communities and natural systems are already stressed. Decisions made today will have consequences for decades. In addition, many needed adaptations may take decades of gradual change.
2. Build on existing policy tools. Local governments have many policy tools already available to support local actions for sea level rise preparedness. While new policies will also be needed, existing tools provide the means to begin planning now.
3. Integrate across sectors, disciplines and jurisdictions. Adaptation planning, to be effective, cannot be done in isolation from other functions or levels of government. It is an ongoing process involving all sectors and disciplines, as well as intergovernmental coordination across local and regional entities. Building sea level rise adaptation strategies requires strengthened efforts to harmonize decision-making and to address potential cumulative and regional impacts, particularly where actions may affect adjacent jurisdictions or regional resilience.
4. Build capacity to more effectively manage climate risk. As characterized by the Pew Center for Global Climate Change, climate change adaptation is essentially a risk-management strategy (Pew Center 2004). Risk management is not a new concept; it involves assessing vulnerabilities and uncertainties, minimizing or avoiding negative effects and accepting some risk. Using different timeframes and scenarios for projected sea level rise, risk management can provide a systematic

way to identify risks, weigh costs and benefits, as well as political feasibility of different options and chart near-term and long-term courses of action. Taking a precautionary, or cautious, approach to decision-making is an essential part of this process when balancing what is known with uncertainties about the future, especially where the effects of decisions may be irreversible.

## Leadership Opportunities

A primary role for local coastal governments of Florida in the coming years will be to provide leadership in building effective sea level rise adaptation plans and policies for the near-term and long-term. These actions may also serve as a starting point for broader dialogue on other adaptations that also may be needed in the decades to come in order to build resilient communities in the face of climate change.

We offer some observations below on local leadership opportunities for addressing sea level rise and associated climate change challenges facing Southwest Floridians.

### Internal government capacity-building

#### *Designate an Adaptation Focal Point:*

Experience elsewhere suggests that a centralized focal point or office within local government helps to promote coordination across sectors, disciplines and levels of government. A focal office provides a centralized point for sharing sea level rise and related climate change information, identifying additional data needs and gaps, coordinating initiatives and promoting cost-savings by minimizing duplication. Having a formally-designated post helps ensure that coordination on sea level rise adaptation needs and initiatives receives ongoing attention and support. Several Florida counties are now incorporating explicit mandates for climate change adaptation within their sustainability units.



Local governments will need to strengthen internal and external communications to adapt to sea level rise. One way to streamline communications: create a central office to share climate-related information across sectors and jurisdictions.

#### *Create a Local Government Adaptation Working Group or Team:*

Sea level rise and associated climate change will impact many government operations. An important additional internal capacity-building measure is the creation of a climate change adaptation working group or team comprised of representatives from the main government agencies or entities with responsibilities likely to be impacted by sea level rise. Key among these are environmental services, natural resources management (including water resources), floodplain and natural lands management, public facilities and infrastructure entities, planning, emergency management, post-disaster redevelopment planning, office of the budget and government liaison units. Among the functions of this working group could be to coordinate and collaborate on adaptive needs and actions across sectors and share expertise on issues needing multi-disciplinary input.

#### *Establish a Climate Change Advisory Body:*

Designate an existing or establish a new community advisory body of scientists and technical experts from all relevant disciplines to advise on and make recommendations to the local government on priority actions, including data gathering and analyses needed for sea level rise adaptation. The mandate and experience of the Miami-Dade County Climate Change Advisory Task Force, functioning since 2006, provides insights for creating a climate-focused advisory group in other counties. Broward County, Monroe County, and Brevard County, among others,

have begun creating climate change task forces based on the Miami-Dade experience.

### Local development planning

The local government comprehensive land use plan is a key entry point for mainstreaming climate change adaptation and building community resilience to sea level rise and climate change. It defines the vision and development path that the community aspires to take over the long term. As such, it can move communities beyond ad-hoc, short-term

coping strategies to building successful long-term strategies for dealing with sea level rise and climate change. There are three areas that present immediate opportunities for leadership with local planning:

**Expand planning horizons:** Apply a longer-range planning horizon — 50 years or longer — for the local comprehensive plan in order to capture the timeframes associated with sea level rise and climate change. Begin to implement this longer planning horizon within each local government agency or entity for all basic planning and permitting, with interim benchmarks where information is uncertain or actions need to be incremental. Use the best available scientific information to develop near-, medium- and long-term scenarios for assessing local risks and vulnerabilities and developing strategies for public investments and services appropriate for each agency's mandate.

**Incorporate adaptive response measures throughout comprehensive plans:** Based on local agency/entity assessments noted above, use the periodic evaluation and review processes to begin incorporating adaptation strategies in all components of the local comprehensive plan. Components needing this attention include the environment in general (in addition to beaches and estuaries), watershed management, public infrastructure (including schools), transportation, parks and recreation, community housing, economic development, capital improvements, historic preservation, future land use, intergovernmental coordination and citizen participation. Emergency planning also needs to incorporate adaptation considerations, especially in the context of pre-disaster planning, in order to minimize damage from a disaster and pursue post-disaster redevelopment strategies to further reduce risks of damage from future disasters.

## Outreach and partnerships

**Increase community knowledge about science:** Policy-makers, resource managers, businesses, communities and

individuals need reliable and credible scientific information about local sea level rise projections to plan constructive and cost-effective adaptive measures. Severe under-projections may prompt inadequate preparation for change while significant over-estimates may exhaust and redirect resources inappropriately. Adaptation planning for sea level rise requires translating and communicating the latest available science in a form that best fits the decision-making process involved. A number of scientific and technical organizations exist in this region with potential for expanded partnerships with local governments to help translate scientific information, support data gathering and advance community dialogue and awareness. Locally, as a starting point, these include scientific research centers like Mote Marine Laboratory, university departments at the University of South Florida and New College of Florida, specialized government entities like the Sarasota Bay Estuary Program and regional institutions like the Southwest Florida Water Management District (SWFWMD) and the Southwest Florida Regional Planning Council (SWFRPC).



Local governments need to help their residents learn more about the science of climate change so they can participate more effectively in discussions about sea level rise and how their communities will be affected.

### **Build partnerships with a broad range of stakeholders:**

Engage in outreach and education, starting with existing community networks and organizations, including neighborhood organizations such as the Neighborhood Environmental Stewardship Teams (NEST) in Sarasota County, and public/private coalitions like the Science and Environment Council of Sarasota County. Information and outreach campaigns also

are strengthened through partnerships with environmental organizations and membership networks. Beginning with receptive groups help build a base of support, experience and insights for broader outreach and dialogue with the community at large.

**Engage the private sector:** A second main entry point for mainstreaming climate change adaptation into public sector planning is the private sector. Local policy tools may create an enabling environment, but successful implementation will hinge on the ability of local leaders to effectively harness the interests, energies and support of the private sector. For

much of the private sector, sea level rise is not a priority or even a long-range consideration. In order for the public sector to exercise leadership in new policy directions, the private sector needs to be engaged. Constructive dialogue will help identify opportunities for active support and collaboration, areas needing further negotiation and development and areas where support is unlikely, at least over the near term based on current information.

***Promote supportive state and federal policy frameworks:***

Local governments have a lead role to play in defining and promoting state and federal policies that best meet their local needs and priorities. The focus of the MPI assessment has been on local policy tools for sea level rise adaptation. It is necessary as well that state and federal policies provide support. In particular, state action is needed to define the overall policy direction, create a level playing field, promote consistency and provide fiscal incentives for local action wherever possible.

## **Concluding Observations**

Climate protection is not a new policy area for local governments in Florida. Many actions already have been taken to reduce greenhouse gas emissions, particularly through energy conservation, and to protect beaches, shorelines, dunes, rivers and tidal systems as buffers against storms and extreme weather events. Many of these actions have brought other important non-climate benefits and will continue to do so in savings on energy bills, reducing air pollution and sustaining tourism, fisheries and other resource-based economic activity important to our high quality of life.

However, many in the climate science and advocacy communities have continued to be frustrated that not nearly enough is being done in climate change adaptation for the scale of the challenges we face. Climate scientists, with a sense of urgency, have been calling for policy action in climate change adaptation, especially since the 1990s as it became clearer that impacts like sea level rise were unavoidable and could be significant in the coming decades.

In Southwest Florida, sea level rise is a climate change issue that will significantly and persistently challenge local governments, communities and residents for decades to come. With early planning and proactive adaptation, there is good reason for optimism: Benefits can be achieved for long-term social and economic development for present and future generations.

Thomas Friedman, in his book *Hot, Flat, and Crowded*, observed that we have exactly enough time — if we begin now — to make real choices so that the future becomes our choice and not our fate. The kinds of policies, tools, principles, and leadership ideas highlighted in this synopsis and further elaborated in the full assessment offer some initial opportunities for making these choices and building adaptive responses and resilient communities as climate change and sea level rise advance in the coming decades.

## REFERENCES

### AND ADDITIONAL SOURCES OF INFORMATION

- Beever III, James W., Whitney Gray, Daniel Trescott, Jason Utley, Dan Cobb, and Lisa B. Beever. 2009. "DRAFT Southwest Florida/Charlotte Harbor Climate Change Vulnerability Assessment." 317pp. (Technical Report 09-2, draft dated 6/30/2009). (Fort Myers, FL., Southwest Florida Regional Planning Council).
- Centers for Disease Control and Prevention (CDC). Website page on "Climate Change and Public Health", at <<http://www.edc.gov/climatechange/effects/default.htm>> (accessed 02/19/09).
- Committee on Environment and Natural Resources (CENR), National Science and Technology Council. 2008. Scientific Assessment of the Effects of Global Change on the United States. 261 pp. Available online at <[http://www.ostp.gov/cs/nstc/documents\\_reports](http://www.ostp.gov/cs/nstc/documents_reports)>.
- Crist, C. 2007. "Governor Charlie Crist's 2007 State of the State Speech." Available online at <[http://www.flgov.com/2007\\_sos](http://www.flgov.com/2007_sos)>.
- Deyle, Robert E., Katherine C. Bailey, and Anthony Matheny. September 2007. "Adaptive Response Planning to Sea Level Rise in Florida and Implications for Comprehensive and Public-Facilities Planning." 65pp. (Department of Urban and Regional Planning, Florida State University).
- EarthBalance. September 2008. "Native Habitat Mapping and Risk Assessment". (Sarasota County, Resource Protection Services). 112 pp. plus maps.
- Florida Atlantic University (FAU), Center for Urban and Environmental Solutions. 2008. Florida's Resilient Coasts: A State Policy Framework for Adaptation to Climate Change. 72pp. (Florida Atlantic University, Fort Lauderdale, FL).
- Florida Department of Environmental Protection (FDEP). May 2008. Strategic Beach Management Plan. (Bureau of Beaches and Coastal Systems of FDEP).
- Florida Energy and Climate Change Action Team (FECC). 2008. "Florida's Energy and Climate Change Action Plan." Appendix F: Adaptation (ADP) Planning Framework for Florida. Online at <[http://www.dep.state.fl.us/climatechange/actionplan\\_08.htm](http://www.dep.state.fl.us/climatechange/actionplan_08.htm)>.
- Florida Oceans and Coastal Council (FOCC). 2009. "The Effects of Climate Change on Florida's Ocean & Coastal Resources. A special report to the Florida Energy and Climate Commission and the people of Florida." Tallahassee, FL. 34pp. Available on line at <<http://www.floridaoceanscouncil.org/reports/default.htm>>.
- Florida Statutes (FS). 2009. In particular, Chapter 161 (Beach and Shore Protection Act), Chapter 163 (Local Government Comprehensive Planning and Land Development Regulation Act, and the Coastal Management Act), Chapter 259 (Florida Forever Act), Chapter 70 (Bert J. Harris, Jr., Private Property Rights Protection Act). Available online at <<http://www.leg.state.fl.us/STATUTES>>).
- Friedman, Thomas L. 2008. Hot, Flat, and Crowded: Why we need a Green Revolution and How it can Renew America. (Farrer, Strauss, and Giroux: New York).
- Frazier, Tim, Nathan Wood, and Brent Yarnal. 2009. "Influence of sea level rise on societal vulnerability to hurricane storm-surge hazards, Sarasota County, Florida." [Pennsylvania State University study] (forthcoming, available from Tim Frazier, [tfrazier@uidaho.edu](mailto:tfrazier@uidaho.edu)).
- Gulf of Mexico Alliance (GoMA). 2009. "Governor's Action Plan II for Healthy and Resilient Coasts, 2009-2014". 35 pp. Available online at <[http://gulfofmexicoalliance.org/pdfs/ap2\\_final2.pdf](http://gulfofmexicoalliance.org/pdfs/ap2_final2.pdf)>.
- H. John Heinz III Center for Science, Economics and the Environment. 2007. "A Survey of Climate Change Adaptation Planning." 52pp. Online at <[http://www.heinzctr.org/publications/meeting\\_reports.shtml](http://www.heinzctr.org/publications/meeting_reports.shtml)>.
- Hansen, J.E. 2007. "Scientific reticence and sea level rise" in Environmental Research Letters 2 (2007) 024002. 6pp. Available online at <<http://pubs.giss.nasa.gov/authors/jhansen.html>>.
- Intergovernmental Panel on Climate Change. 2007a. "Report of Working Group I: Frequently Asked Question 5.1: "Is Sea Level Rising?" Geneva, Switzerland. Available online at <<http://www.ipcc.ch/ipccreports/ar4-wg1.htm>>.
- Intergovernmental Panel on Climate Change (IPCC). 2007b. "Climate Change 2007: Synthesis Report." Geneva, Switzerland. Available online at <<http://www.ipcc.ch/ipccreports/ar4-syr.htm>>.



- Intergovernmental Panel on Climate Change. 2007c. "Report of Working Group I: The Physical Science Basis – Summary for Policymakers". Geneva, Switzerland. Available online at <<http://www.ipcc.ch/ipccreports/ar4-wg1.htm>>.
- Intergovernmental Panel on Climate Change. 2007d. "Report of Working Group II: Impacts, Adaptations, and Vulnerability", Chapter 6. Geneva, Switzerland. Available online at <<http://www.ipcc.ch/ipccreports/ar4-wg2.htm>>.
- International Polar Year Programme 2007-2008 (IPYP). 2009. Press release: "Polar research reveals new evidence of global environmental change," (25 February 2009). Available online at <[http://www.ipy.org/index.php?/ipy/detail/state\\_of\\_polar\\_research/](http://www.ipy.org/index.php?/ipy/detail/state_of_polar_research/)>.
- International Scientific Congress on Climate Change (ISCCC). New York Times, March 11, 2009. "Researchers: Sea Level May Rise Faster than Expected". Available online at <<http://www.nytimes.com/cwire/2009/03/11/11climatewire-researchers-warn-that-sea-levels-will-rise-m-10080.html>>.
- Miami-Dade Climate Change Advisory Task Force. 2008. "Second Report and Initial Recommendations – presented to the Miami-Dade Board of County Commissioners April 2008. p.1. Available online at <[http://www.miamidade.gov/derm/library/08-10-04\\_CCATF\\_BCC\\_Package.pdf](http://www.miamidade.gov/derm/library/08-10-04_CCATF_BCC_Package.pdf)>.
- Moser, S.C., and Dilling, L. (eds.) 2007a. Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change. 549pp. (Cambridge University Press).
- Moser, S.C., and Tribbia, J. 2007b. More than Information: What California's Coastal Managers Need to Plan for Climate Change. California Energy Commission, PIER Energy-Related Environmental Research Program. CEC-500-2007-046
- National Oceanographic and Atmospheric Administration (NOAA). 2009a. "Smart Growth for Coastal and Waterfront Communities." 53pp. (Project partners with NOAA: U.S. Environmental Protection Agency, International City/County Management Association (ICMA), and Rhode Island Sea Grant. (NOAA, Washington, DC). (Available online at <<http://coastalsmartgrowth.noaa.gov/report.html>>.)
- National Oceanographic and Atmospheric Administration (NOAA). 2009b. "Main Sea Level Trends for Stations in Florida" (trends for Cedar Key, Fernandina, Key West, Miami Beach, Pensacola, St. Petersburg). Online at <[http://tidesandcurrents.noaa.gov/sltrends/sltrends\\_states.shtml?region=fl](http://tidesandcurrents.noaa.gov/sltrends/sltrends_states.shtml?region=fl)>. (Accessed 1/23/2009 and 4/7/2009).
- National Wildlife Federation (NWF) (in affiliation with Florida Wildlife Federation). June 2006. An Unfavorable Tide – Global Warming, Coastal Habitats, and Sportfishing in Florida. 56 pp. (National Wildlife Federation: Reston, VA).
- Pew Center for Global Climate Change. 2004. "Coping with Global Climate Change – the Role of Adaptation in the United States" (report prepared by William E. Easterling III, Pennsylvania State University, Brian H. Hurd, New Mexico State University, and Joel B. Smith, Stratus Consulting, Inc.). Online at <[http://www.pewclimate.org/global-warming-in-depth/all\\_reports/adaptation](http://www.pewclimate.org/global-warming-in-depth/all_reports/adaptation)>.
- Rahmstorf, Stefan. 2007. "A Semi-Empirical Approach to Projecting Future Sea-Level Rise" in 315 Science 368-370, 19 January 2007.
- Sarasota County Government. 2009a. Environmentally Sensitive Lands Protection Program. (information available online at <<http://www.scgov.net/EnvironmentalServices/NaturalResources/ResourceManagement/ESLPP.asp>>. (rechecked 9/09/09).
- Sarasota County Government. 2009b. "Post-Disaster Redevelopment Planning Project" Online at <<http://www.scgov.net/pdrp/default.asp>>. (rechecked 9/09/09).
- Sarasota County Government. 2009c. "Flood Map Updates." Online at <<http://www.scgov.net/FloodMapUpdates/Default.asp>>. (accessed 01/29/09 and 05/22/09).
- Sarasota County Government. 2009d. "NEST Program" (Neighborhood Environmental Stewardship Teams). Online at <<http://www.scgov.net/EnvironmentalServices/Water/Conservation/NEST.asp>>. (rechecked 9/10/09)

- Sarasota County Government. 2008. Coastal Setback Code (Chapter 54, Article XXII of the Sarasota County Code of Ordinances), §54-724(b). Summary of amendment and new code available online at <<http://www.scgov.net/EnvironmentalServices/Coastal/Setback.asp>>. (accessed 1/12/2009 and 4/28/2009).
- Sarasota County Government. 2007. "Comprehensive Plan 2007". Online at <<http://www.scgov.net/PlanningandDevelopment/CompPlan/CompPlan.asp>>. (rechecked 9/09/09).
- Science and Environment Council of Sarasota County (SEC). 2009. Information about this not-for-profit organization online at <<http://www.secsc.org/>>.
- Stanton, E.A., and F. Ackerman. November 2007. Florida and Climate Change – The Costs of Inaction. (Tufts University, Global Development and Environment Institute and Stockholm Environment Institute-US Center). Available online at <<http://ase.tufts.edu/gdae/Pubs/rp/FloridaClimate.html>>.
- Tampa Bay Regional Planning Council. August 2006. "Sea Level Rise in the Tampa Bay Region." 75pp. (Tampa Bay Regional Planning Council: Pinellas Park, FL).
- Timmer, J. March 31, 2009. "Scientists track the ocean's rise as the global warms" (summary of panel discussion at the American Association for the Advancement of Science annual meeting in February 2009). Online website report by ARS Technica: The Art of Technology at <<http://arstechnica.com/science/news/2009/03/scientists-track-the-oceans-rise-as-the-globe-warms.ars>>.
- U.S. Climate Change Science Program (CCSP). 2009a. Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region (Synthesis and Assessment Product 4.1). U.S. Environmental Protection Agency. Available online at <<http://www.climatechange.gov/Library/sap/sap4-1/final-report/>>.
- U.S. Climate Change Science Program. 2009b. Thresholds of Climate Change in Ecosystems (Synthesis and Assessment Product 4.2). Lead Agency: U.S. Geological Survey. January 16, 2009. Available online at <<http://www.climatechange.gov/Library/sap/sap4-2/final-report-all.pdf>>.
- U.S. Climate Change Science Program. 2009a. Thresholds of Climate Change in Ecosystems (Synthesis and Assessment Product 4.2). Lead Agency: U.S. Geological Survey. January 16, 2009. Available online at <<http://www.climatechange.gov/Library/sap/sap4-2/final-report-all.pdf>>.
- U.S. Climate Change Science Program. 2008a. Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources (Synthesis and Assessment Product 4.4). Available online at <<http://www.climatechange.gov/Library/sap/sap4-4/final-report/>>.
- U.S. Climate Change Science Program (CCSP). 2008b. Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems (Synthesis and Assessment Product 4.6). U.S. Environmental Protection Agency, Washington, D.C. Available online at <<http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid+197244>>.
- U.S. Environmental Protection Agency (EPA). 2009. "Synthesis of Adaptation Options for Coastal Areas." (Climate Ready Estuaries Program, EPA 430-F-08-24, January 2009) Washington, D.C., U.S. Environmental Protection Agency. Available online at <<http://www.epa.gov/cre/adaptationoptions.html>>.
- Walton, T. March 2007. "Projected sea level rise in Florida" in *Ocean Engineering* 34 (2007) 1832-1840. p. 1839. This study was folded into a follow-up study on economic impacts: Harrington, J. and T. Walton. August 2008. "Climate change in Coastal Areas in Florida: Sea Level Rise Estimation and Economic Analysis to Year 2080." Florida State University, Tallahassee, FL.





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