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AEC506

Adaptation Approaches to Sea-Level Rise in Florida[1]

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Sea-Level Rise in Florida

There is consensus among the scientific community that climate change is occurring and will have far-reaching effects on our global ecosystems and human systems. Atmospheric and ocean temperatures have risen, the Greenland and Antarctic ice sheets have lost mass, sea levels have risen, and ocean acidification has increased. It is predicted that sea levels will continue to rise as a result of continued warming and ice-sheet melting (IPCC 2013). Florida's ecosystems and human systems are particularly vulnerable to sea-level rise because more than half of the population (Crossett et al. 2004) live near the state's more than 1,200 miles of coastline (FDEP 2013). Some areas of Florida, including coastal ecosystems, transitional habitats, the Everglades, and island ecosystems such as the Florida Keys, likely will experience extreme changes as a result of sea-level rise (Geselbracht et al. 2011). Endemic, rare, threatened, and endangered species that rely upon these ecosystems are particularly at risk of decline and, at worst, extinction (Aiello-Lammens et al. 2011; Fei, Cox, and Whittle 2011). In some cases, the effects of sea-level rise are already being seen as vulnerable populations decline or migrate (Maschinski et al. 2011).

Natural and Human Adaptation

In Florida, adaptation to climate change is occurring in both natural and human systems. Natural systems can adapt to changes on their own, given proper conditions, but people can also do things to help ecosystems change and survive. These measures typically fall into one of four categories: resistance, resilience, response, or realignment. *Resistance* is the process of maintaining current conditions despite climate change. This might include actions like creating berms around vulnerable areas to keep sea-level rise from affecting an ecosystem. *Resilience* focuses on helping an ecosystem survive a disturbance and return to desired conditions. Activities that improve resilience, such as coastal ecosystem restoration, put the ecosystem into the best possible condition. *Response* strategies—like designing habitat corridors to promote species migration—seek to assist the transition of an ecosystem to a new, future condition. *Realignment* is typically used in a heavily disturbed ecosystem and concentrates on its future condition (Millar, Stephenson, and Stephens 2007).

Human adaptation focuses on making communities resilient so that they can withstand future changes. These adaptation approaches may include protection, accommodation, or managed relocation. *Protection* strategies typically include defensive barriers such as shoreline armoring or beach nourishment. *Accommodation* strategies use design measures to allow structures to stay in place when future changes occur. For example, elevating a building allows it to survive flooding. *Managed relocation* is moving assets at high risk to new, safer locations. This can be achieved through rolling easements or Transfers of Development Rights (Deyle, Bailey, and Matheny, 2007).

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Table 1.

Adaptation Approach	How it works
Physical Approaches	
No-rebuild zones/rolling easements	Establish areas where structures will not be rebuilt following severe storm damage, or provide opportunities for inland migration of wetlands and shorelines
Shoreline setbacks	Move the developable area farther from the shoreline
Structural approaches	Design buildings that will withstand future changes in sea level or storm surges, or that allow habitats to adapt to changing conditions
Ecological resiliency	Strengthen the resiliency of existing ecological communities by reducing non-climate-related threats such as invasive species or habitat fragmentation
Habitat corridors	Connect natural areas and enable species dispersal and migration
Habitat acquisition	Acquire and preserve lands that may become future habitats for displaced species
Water-control structures (flood-control and stormwater-management systems)	Design to allow the migration of species inland as sea levels rise
Living shorelines	Support species diversity as well as protection from storm surges
Seed banks	Collect and store seeds from species at risk of extinction or extreme loss
Oyster reef restoration	Restore oyster reefs as a mechanism for reducing erosion and damage from storm surges
Assisted migration	Relocate species that are in danger of losing their habitat
Captive breeding/assisted propagation	Assist species in danger of extinction or extreme loss
Green infrastructure and Low-Impact Development (LID)	Use green features to prevent storm surges and control stormwater runoff
Policy Approaches	
Comprehensive plans	Identify Adaptation Action Areas (as defined in the Florida Statutes) in areas at an increased risk of flooding due to sea-level rise, including AAAs that protect natural resources; use natural adaptation approaches in these areas
Land-Development Regulations	Incorporate physical approaches into local regulations
Process Approaches	
Leverage intellectual and material capital via collaborations among stakeholders	Work beyond jurisdictional boundaries to develop collaborations between government and natural-resource-management agencies; engage staff from multiple departments (natural-resource-management, sustainability, extension, planning, and growth-management) as well as experts from other organizations such as the water-management districts, national parks and forests, environmental groups, US Geological Services, Florida Fish and Wildlife Conservation Commission, and US Fish and Wildlife Service
Reach consensus on scientific data	Establish agreement upon projections and data sets through "science cafes," media, and Extension outreach
Develop localized strategies within regional approaches	Provide flexibility for individual partners to adapt locally while working regionally
Form interdisciplinary teams	Increase flexibility and on-going collaboration between planners, citizens, and scientists
Frame the issues	Recognize different values and interests while working toward common goals
Build community buy-in	Engage local residents and organizations in designing and implementing strategies

Human adaptation often can conflict with the process of adaptation in natural systems. For example, shoreline hardening may prevent sea turtles from nesting further up shore as sea-level rises (Rizkala and Savage 2011), and inhibit inland migration of seagrass and mangrove habitats that are critical fish nurseries. Consequences may include a decline in fisheries or a shoreline's increased susceptibility to hurricanes. As humans move inland due to the pressures of sea-level rise and increased storm intensity, they will begin occupying now undeveloped lands. This could result in increased habitat fragmentation as well as competition with organisms that are also migrating inland or are already present (Noss 2011).

There are, however, human adaptation strategies that can successfully address the needs of both natural and human communities, and these fall into three categories: physical, policy, and process. *Physical* approaches include changes to the natural or man-made environment. *Policy* approaches are typically implemented through comprehensive plans and land development regulations. *Process* approaches are mechanisms by which both physical and policy strategies

can be implemented more effectively. Not all strategies may be suitable for every location or for every species. Determining which adaptation strategies are most appropriate may require an ecosystem- or landscape-scale approach that crosses political boundaries and demands a more collaborative, coordinated effort among multiple governments, agencies, and public and private entities.

As coastal communities prepare for sea-level rise, they can use these and other strategies to integrate natural adaptation processes into their planning processes. Because natural systems rarely follow political boundaries, a more coordinated planning effort between multiple governments and agencies may be necessary. Planners may also consider using an adaptive management approach that would allow the community greater flexibility when responding to unanticipated impacts of climate change. By taking a proactive approach to adaptation rather than a reactive one, communities will be able to better protect the resources upon which they depend.

Helpful Resources

Florida Department of Economic Opportunity (FDEO). *Adaptation planning*. http://www.floridajobs.org/community-planning-and-development/programs/technical-assistance/community-resiliency/adaptation-planning

Florida Sea Grant, Coastal Planning Policy Tools https://www.flseagrant.org/climatechange/coastalplanning/resources/policy-tools/

Climate Adaptation Knowledge Exchange http://www.cakex.org/

Georgetown Climate Center, Adaptation Clearinghouse http://www.georgetownclimate.org/adaptation/clearinghouse

Sea Level Changes in the Southeastern United States: Past, Present and Future http://floridaclimateinstitute.org/images/reports/201108mitchum_sealevel.pdf

Florida Water Management and Adaptation in the Face of Climate Change http://floridaclimateinstitute.org/images/reports/water_management.pdf

National Park Service, Climate Change Response Strategy http://www.nature.nps.gov/climatechange/docs/NPS_CCRS.pdf

National Fish, Wildlife & Plants Climate Adaptation Strategy http://www.wildlifeadaptationstrategy.gov/pdf/NFWPCAS-Final.pdf

EPA Climate Ready Estuaries http://www2.epa.gov/cre

Marshes on the Move http://www.csc.noaa.gov/digitalcoast/_/pdf/Marshes_on_the_move.pdf

Climate Ready Water Utilities http://water.epa.gov/infrastructure/watersecurity/climate/

Rolling Easements http://water.epa.gov/type/oceb/cre/upload/rollingeasementsprimer.pdf

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