

III. CLIMATE CHANGE IMPACTS – GLOBAL & LOCAL



Climate Change Impacts – Global & Local

The existing and potential impacts from global climate change are becoming clearer with each passing day as scientists and researchers throughout the world examine what is currently occurring and what might happen as a result of observed increases in greenhouse gas (GHG) emissions. It is widely recognized that the Intergovernmental Panel on Climate Change (IPCC), a group that represents more than 2,500 scientific expert reviewers, 800 contributing authors, and 450 lead authors from more than 130 countries, represents the mainstream voice on the state of the science of global climate change. Among their findings¹:

- Warming of the climate system is unequivocal.
- Global concentrations of GHG have increased markedly as a result of human activities. In 2005, the concentration of carbon dioxide exceeded by far the natural range over the last 650,000 years.
- Global air and ocean temperatures are increasing.
- Average sea level is rising globally. The rate of global average sea level rise has risen from 1.8 mm/yr to 3.1 mm/yr from 1961 to 1993. The reasons for sea level rise include thermal expansion, melting glaciers, ice caps, and polar ice sheets. Projected sea level rise at the end of the 21st Century will be 18-59 cm.
- From 1990 to 2005, precipitation increased significantly in eastern parts of North and South America, northern Europe, and northern and central Asia but declined in the Sahel, the Mediterranean, southern Africa and parts of southern Asia; and
- Globally, the area affected by drought has likely increased since the 1970's.

While the impacts vary from region to region, some projected regional impacts for North America include:

- Warming in the western mountains with decreased snowpack, more winter flooding, and reduced summer flows, exacerbating competition for over-allocated water resources;
- An increase in the aggregate yields of rain-fed agriculture by 5-20%, but with variability among regions. Major challenges are projected for crops that are near the warm end of their suitable range or which depend on highly utilized water resources;
- An increase in the number, intensity, and duration of heatwaves, with potential adverse health impacts; and
- Increasing stress for coastal communities and habitats due to climate change impacts interacting with development and pollution.

While these impacts represent significant challenges for the continent as a whole, Southeast Florida may be especially vulnerable, as discussed in the following section.

Impacts of Climate Change to Southeast Florida

Changes in Temperature. Global warming is projected to raise Florida's average air temperatures between 4 and 10 degrees Fahrenheit over the next 100 years. Heat waves are likely to become more severe and more common, with new record temperatures and a gradual decline in nighttime cooling. The summer heat index, projected to increase between 8 and 15 degrees Fahrenheit, could be the greatest overall increase in the nation. Because Southeast Florida is highly urbanized, there is a lot of concrete absorbing and radiating heat, and fewer green, open areas to offset sweltering summer temperatures. As summers get hotter due to climate change, the urban environment will amplify these effects, unless changes are made. Heat stress is hard on the entire community, particularly low income, young, and elderly residents.

¹ IPCC, Climate Change 2007: Synthesis Report – Summary for Policymakers, 2007

Warmer air temperatures also contribute to an increase in water temperatures and rates of evaporation and transpiration in both freshwater and salt water bodies, with implications for precipitation patterns, water supplies, and natural systems.

Changes in Precipitation. Rainfall is anticipated to become more intense but also more sporadic, causing worse droughts and storms. Warmer air masses hold more moisture, increasing the overall potential for more rain.

Changes in Extreme Weather. A warmer climate may increase the number of tropical hurricanes we experience in Southeast Florida. However, no definitive connection has yet been established between GHG emissions and the observed behavior of hurricanes.²

Sea Level Rise. Sea-level rise presents one of the greatest challenges to Southeast Florida. Given the lack of topographic relief in Southeast Florida, small increases in sea-level rise can have significant impacts on natural resources, humans, and the economy.

Sea level rise will have severe impacts on low-lying coastal areas. The impacts will be directly proportional to the extent of rise and the existing topography. A recent report included the following illustrations to demonstrate the impact of a 1-meter sea level rise on the coastal area of Hollywood.³



Hollywood, Florida – 2007



Hollywood, Florida - 1-meter sea level rise

Data Source: LIDAR and USGS 10M NED

The report suggests that a sea level rise of just 15 centimeters would cause water use cutbacks for the developed regions.⁴ Coastal Southeast Florida is likely to experience increased potential for flooding and a greater likelihood for water use restrictions.

² Pielke Jr., RA, Landsea, C., Mayfield, M., Laver, J., and Pasch, R. "Hurricanes and Global Warming" in American Meteorological Society, November 2005

³ The 2030 Research Center, "A Coastal Impact Study: Nation Under Siege – Sea Level Rise at Our Doorstep", 2007

Natural Hazards. Warmer temperatures and changes in precipitation could change the frequency, intensity and type of natural hazards. South Florida may experience more frequent and more intense severe weather, flooding, drought, and shoreline erosion. With an elevated risk of droughts, forested areas and portions of the Everglades would likely experience more wildfire events.

Public Health. Climate change can increase heat-related illness, exacerbate poor air quality, and increase the incidence of infectious disease. Senior citizens tend to be most susceptible to these effects - of major significance given the size and economic base this represents in Southeast Florida. Hotter temperatures may make people with certain health conditions less likely to pursue physical activity critical to management and improvement of health.

Infectious disease carriers, such as mosquitoes, are sensitive to temperature and moisture levels, as are their complex patterns of carrying and spreading disease. Temperature changes will change the distribution and dynamics of various infectious disease carrier species. It is possible that climate change will cause tropical diseases, like malaria, to expand into the southern United States.⁵

Climate change will increase the effects of smog and suspended pollution particles and negatively impact the quality of the air we breathe. Higher carbon dioxide concentrations in the atmosphere can also increase production of allergens, such as pollen, which can contribute to asthma.

Flooding can affect public health directly through an increase in injuries and fatalities, and indirectly through loss of livelihood and property, and in turn, degrade mental and social health conditions.

Climate change will increase run-off and pollutant loading into marine water bodies and warm their water temperatures; the growth of toxic organisms and algae that can cause harm to humans may increase. The potential for greater distribution of microorganisms that cause water and food-borne diseases will increase.

Flooding. The impacts of flooding are far-ranging and pose significant threats to public safety and regional economic viability. Flooding affects private properties, businesses, commercial activities, transportation corridors, and can directly or indirectly result in loss of life. The frequency of flood events will increase. While seawalls, levees, and dikes may be considered flood control measures, in some areas the highly porous limestone and sand substrate of Southeast Florida (which presently permits excellent drainage) "will limit the effectiveness of widespread use of levees and dikes to wall off the encroaching sea."⁶ Increased flood frequency and intensity will increase the public investment needed, over time, to ensure public safety and the functioning of flood protection infrastructure.

Shoreline Resources and Infrastructure. Sea level rise is likely to increase the rate and extent of coastal flooding, shoreline erosion, and nearshore habitat loss. Wave encroachment further onto low-lying beaches will cause greater beach erosion. In their natural undeveloped condition, Southeast Florida's islands and coastlines have the ability to shift and change in relation to sea level rise, storms and hurricanes. The development of large portions of the coastline and the construction of buildings, roads, and seawalls prevent the natural regeneration of our coastline and lead to beach erosion. Continued development of Southeast Florida's coastline compounds these effects. With rising sea levels, coastal erosion will increase, depleting the beaches and natural coastal defenses more rapidly. Efforts to replenish the beaches through beach renourishment are currently very costly and complex. Increasing coastal

⁴ Trimble, P.J., Sanke, E.R., and Neidrauer, C.J., "Preliminary Estimate of Impacts of Sea Level Rise on the Regional Water Resources of Southeastern Florida", SFWMD, 1995.

⁵ <http://www.sfrpc.org/data/ClimateChange/Community%20Fact%20Sheet.pdf>, South Florida Regional Planning Council, 2007

⁶ Science and Technology Committee, Miami-Dade County Climate Change Task Force, "Statement on Sea Level in the Coming Century" September 19, 2007

erosion associated with sea level rise and climate change will make these projects more difficult to justify in the future as the need for them becomes more frequent.

Valuable coastal property and key tourist resources will be damaged by rising sea levels. In low-lying areas, sea level rise could force water to flow horizontally and inland-flooding shoreline homes and hotels and eroding beaches. Attempts to block rising seas will be expensive and will almost certainly fail.

Coastal properties and infrastructure will be at greater risk to flooding and damage. With sea level rise, more homes and infrastructure will be in the coastal flood plain, increasing their vulnerability to increased flooding due to storm surge from hurricanes, wind and waves. With increased beach erosion, the natural protective capacity of the coast is diminished, exposing properties to greater damage from storms and waves. In Florida, 79% of properties are in coastal areas. The insured value of coastal properties vulnerable to hurricanes is nearly \$2 trillion.

Ports. Both Broward and Miami-Dade Counties are hubs for the flow of international goods and services, especially from Europe, the Caribbean, and Latin America. Each day, tons of international cargo pass through the area's seaports and airports. Sea level rise may hinder these trade flows. With a one- to two-foot rise in sea level, it is likely that the ocean will begin to inundate the seaports, unless planning measures are taken.

Parks and Recreational Facilities. Parks and recreational facilities along the coastal zone could face damage from flooding and loss of property.

Water Supply and Management. Under climate change scenarios, there is an increased likelihood of chronic droughts, which will affect the availability of water in Southeast Florida. Southeast Florida's drinking water today comes largely from the Biscayne Aquifer. While much of the water in this Aquifer is generated from local rainfall, the Biscayne Aquifer resources may face increasing pressure during periods of drought. This makes planning and investment in alternative water supplies even more important.

Should the frequency of drought events increase in Southeast Florida, the region might experience more frequent and prolonged water restrictions, particularly if utilities are unable to develop the necessary alternative water supplies to meet their demands in a timely fashion.

Climate change will increase the likelihood of drought conditions and cause sea levels to rise, making it easier for saltwater to seep into coastal water supplies. Depending on the extent of sea level rise, the regional water management system could be threatened as well.

Water Quality. Increases in the earth's surface temperature are expected to lead to an increase in heavy rain events and the run-off of sediments and pollutants from the ground's surface into adjacent water bodies. Heavy rain events will also increase the likelihood of sewer overflow. Untreated stormwater runoff could adversely impact not only the quality of these waters but also the plants and animals that need clean water to live. Drought events could result in a reduction of water movement through canals, exacerbating aquatic growth and requiring more frequent application of chemicals for treatment. Warmer air temperatures could lead to warmer water temperatures, affecting the survival and reproductive success rates of certain forms of aquatic life.

Wastewater Operations. Increased volumes of rain can increase infiltration and inflow into wastewater systems, which can lead to wastewater back ups and overflows.

Stormwater Control. Significant increase in rainfall intensity would affect the quantity and quality of stormwater runoff, and may make ongoing stormwater management more challenging. Stormwater facilities constructed in the past may fall short of achieving required protection levels needed in the future.

Impacts to Biodiversity and Ecosystems. Natural ecosystems are likely to be damaged more than agriculture, because management to address climate change changes is less likely to be effective in protecting these areas.

Coastal wetlands, one of the most valuable and the most rapidly disappearing ecosystems are at risk to projected sea level rise. Salt marshes and mangroves, the two most common coastal wetland types, can withstand rising seas provided that the sediment beneath them builds up at the same rate as sea level rises or coastal migration is feasible. If coastal migration is blocked by bluffs, coastal development, or shoreline protection structures, then they will be “squeezed” out of existence as they are submerged by rising seas. Because Southeast Florida has a highly developed shoreline, there will be fewer natural areas of coastline unless protected as conservation areas or through development review.

Coastal estuaries play an important role in Southeast Florida’s ecosystem by serving as nursery areas for marine fish and other sea life. Additional or reduced fresh water inflows into these estuaries will change the salinity, nutrient and sediment concentrations of these waters, affecting their ability to support the same types of marine life as currently found there.

Southeast Florida’s coral reefs and the marine life that depend on them are already at risk. Climate change will increase their vulnerability through rises in sea temperature and ocean acidification. Coral bleaching events are projected to increase and cause coral reef die-off, unless reefs can adapt. Ocean acidification with high CO₂ concentrations will weaken the ability of marine organisms to build additional reefs.

Several imperiled plant communities in Broward County are particularly susceptible to climate change impacts; namely, its pine rocklands, tropical hardwood hammocks and scrub.

Average temperature and rainfall, both quantity and timing, help determine what types of plants and animals live in Southeast Florida. Changing climate will alter or eliminate the areas suitable for many of Southeast Florida’s native plants and animals. Plants and animals will typically migrate to more hospitable areas, when their habitat changes. Because Broward County is a highly populous urbanized county with limited natural lands, the potential for animals and plants to relocate within its boundaries is limited. Climate change may increase the threat of invasive species and pests.

Everglades Restoration Impact. Southeast Florida is partnering with the state and federal governments to restore and protect the Florida Everglades. The Comprehensive Everglades Restoration Plan (CERP) is designed to restore the historic sheet flow of water across the Kissimmee-Okeechobee-Everglades ecosystem, restoring natural habitats and helping to protect the region’s water supply. Global climate change will make this historic restoration effort more difficult and costly to complete.

Sea level rise could also have severe irreversible impacts on low-lying areas of Florida’s Everglades. Under higher sea level rise scenarios, the Everglades would be almost completely inundated by salt water, and effectively destroyed. Some researchers, without considering sedimentation, have suggested that sea-level rise will inundate the southern Everglades, enlarging Florida Bay. Others, not considering sea-level rise, predict that the Bay will fill with sediments. More likely, some combination of these processes will occur.⁷

Florida’s Everglades is home to many threatened and endangered species of wildlife which may be directly affected by any sea level induced ponding depth, frequency or duration change (e.g., Cape Sable Seaside Sparrow).

⁷ <http://sofia.usgs.gov/publications/fs/156-96/> “Sedimentation, Sea-Level Rise, and Circulation in Florida Bay”, United States Geological Survey FS-156-96

If sea level rise occurs at a slow enough rate, natural ecosystems such as mangroves would be able to migrate inland, however, the opportunity for migration is limited by infrastructure that already exists.

Agriculture. Some commercial crops will benefit in the short run from climate changes, as well as the fertilizing effects of an atmosphere richer in carbon dioxide. However, important cash crops like sugarcane, tomatoes, and citrus will face declining yields over the long run.

During the winter growing season, when water demand is highest in Southeast Florida, agricultural lands may face increasing competition for available water resources.

Changes in seasonal temperatures, precipitation and resulting disruptions in natural predator-prey dynamics may cause the incidence of some pest, pathogen, and weed species to increase, while causing others to decrease.

Insurance Industry. Higher insurance costs will result from climate change impacts. As coastlines become more vulnerable to hurricane effects, it is likely that insurance prices will rise or coverage may be revoked, leaving businesses with additional risk and/or higher costs. The expense of post-disaster recovery and business interruption could increase as storm surge impacts extend farther inland and hurricanes intensify, affecting more homes and businesses. Southeast Florida's summer temperatures are projected to rise as the world's climate changes, increasing summer cooling demand for businesses and homeowners. These cost and risk factors could make the region less attractive to business interests.

Increases in coastal insurance rates by private insurance companies to reflect increasing risk to storm surge and coastal erosion are probable. Some insurance companies may withdraw coverage. Additionally, the State would need to spend more to insure homeowners through government programs.

Energy. Warmer temperatures are likely to lead to increased energy demand for air conditioning.

Workforce Impacts. Many of the negative workforce impacts will be felt by the tourism industry. Tourism is a major economic driver in Southeast Florida. Climate change has the potential to adversely impact our major tourist attractions. Beach erosion and sea level rise will make it more costly and more difficult to maintain and access some of the region's beaches. Deteriorating water quality conditions, coral bleaching, and changing weather patterns are additional challenges that the tourism industry and area business leaders will face as a result of climate change.

Climate change will also have direct adverse effects on the health of our workforce, in turn having negative economic impacts such as increases in sick days, health care expenses and insurance claims.