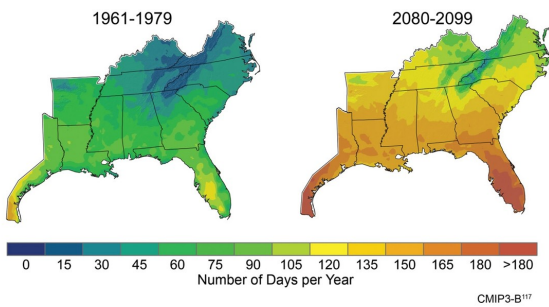# Climate Change Impacts on South Florida

Climate change is already happening. Over the past century, the average global temperature has increased 1.5° F (USGCRP 2009). Historically, global temperature has risen and fallen with levels of carbon dioxide (CO_2) in the atmosphere. Since the late 1800's the amount of CO_2 in the atmosphere has increased dramatically due to the burning of fossil fuels and to deforestation (IPCC 2007). In the last 15 years, we have added the same amount of CO_2 to the atmosphere that it took 1000 years to add naturally after the last ice age.

The effects of warming temperatures include:

- More extreme weather events
- More heat waves
- More severe droughts
- More intense rainstorms,
- Potentially fewer, but more intense hurricanes
- Sea level rise

Atmospheric Carbon Dioxide Concentration and Temperature Change

These physical and weather related impacts have social and economic impacts, particularly for marginalized or vulnerable groups such as lower income families and the elderly. Higher temperatures and heat waves are dangerous for those who are in poorer health, those who live in dense urban areas which tend to trap heat, and those who wo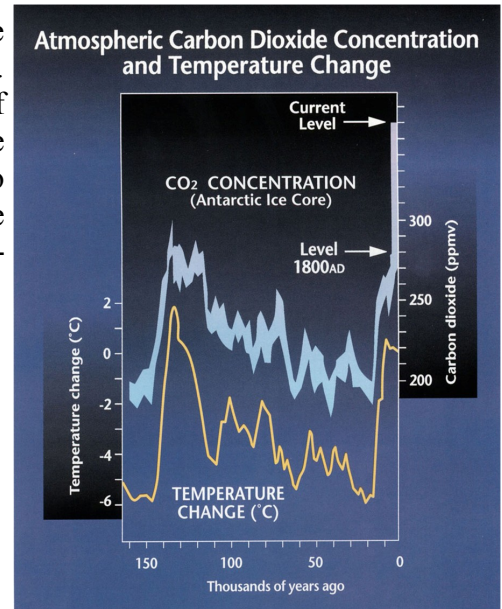rk outside such as agricultural and construction workers. Higher temperatures mean people will need to use more air conditioning, which will put an increased burden on lower income households, and will also contribute to further CO_2 emissions. Higher temperatures also mean changes in rainfall patterns, with less rainfall in the dry season and more in the wet season. This could have an impact on agriculture and the availability of local produce. It also represents a challenge for water managers to balance the needs of industry, people and natural areas such as the Everglades, all of whom depend on the availability of fresh water.

The number of days per year with peak temperature over 90°F is expected to rise significantly, especially under a higher emissions scenario[91] as shown in the map above. By the end of the century, projections indicate that North Florida will have more than 165 days (nearly six months) per year over 90°F, up from roughly 60 days in the 1960s and 1970s. The increase in very hot days will have consequences for human health, drought, and wildfires.

U.S. Global Change Research Program, 2009

Hurricanes have always been a concern for South Florida, but climate change will likely increase the intensity of hurricanes as well as the damage from these storms (Misra et al. 2011). Due to the warming of the oceans the number of tropical storms and hurricanes is expected to decrease, but the remaining storms are expected to increase in intensity by 2-11%, and Florida could have 2 category 5 storms by 2090. Sea level rise will also contribute to higher storm surges. Since 1965 South Florida has experienced 5 category 3+ storms, but no direct hit on the major metropolitan areas of Miami, Ft. Lauderdale or Palm Beach. Economic losses from hurricanes have been increasing as more and more people move to coastal areas and property values increase. South Florida has over $15 billion of property value vulnerable to storm surge from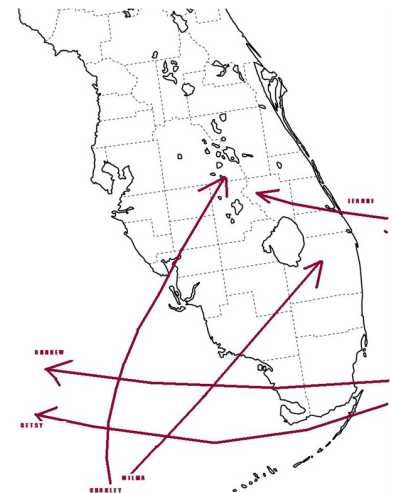 just a category 1 hurricane. Many homeowners are at risk for storm surge but do not have flood insurance because they are not in FEMA flood zones, which designate risk from fresh water flooding only (CoreLogic 2012).
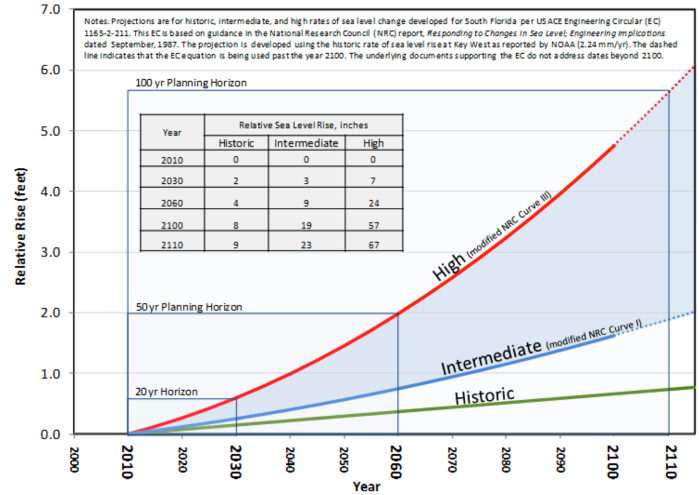

Perry Williams, southernwx.blogspot.com

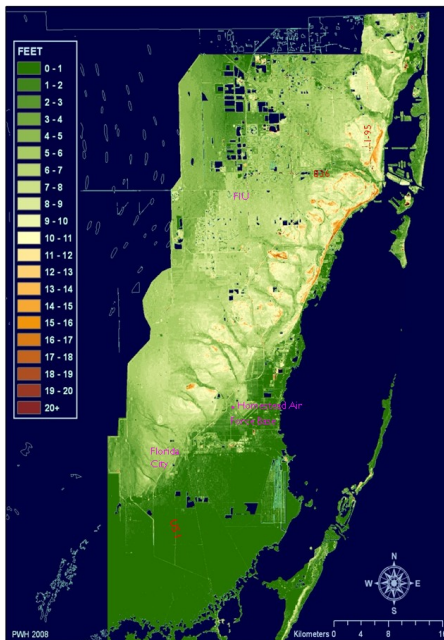**FIU**
FLORIDA INTERNATIONAL UNIVERSITY

Research after hurricanes such as Andrew in 1992 and Katrina in 2005 shows that groups who are more marginalized and therefore have less political power and economic resources are more vulnerable to harm from "natural" hazards (Morrow 1999). Factors such as age, income and race influenced who lived in higher risk areas and who was able to evacuate, producing differentiated vulnerability and outcomes in terms of survival and recovery (Finch et al. 2008).

Due to its low elevation and large population along the coast, South Florida is one of the most vulnerable areas in the world to sea level rise. As temperatures warm, glaciers melt and oceans expand, causing the volume of the ocean to increase. Sea level already risen about 6 inches in South Florida since 1950. This has reduced the capacity of gravity driven storm water drainage systems, resulting in urban flooding during heavy rains. Sea level will continue to rise over the next century and may accelerate, especially if melting of the Greenland ice sheet reaches a "tipping point." The Regional Climate Change Technical Ad hoc Work Group consisting of scientists and planners from local universities and agencies, projected a rise of 3-7 inches by 2030, 9-24 inches by 2060, with the possibility of up to 5 feet by 2100 with an increasingly rapid rate of rise (SEFRCCC TAWG 2011).
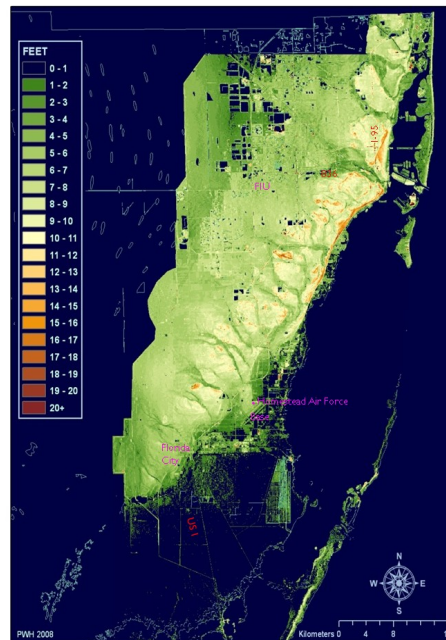

DRAFT Sea Level Rise Scenarios for South Florida

Notes: Projections are for historic, intermediate, and high rates of sea level change developed for South Florida per US ACE Engineering Circular (EC) 1165-2-211. This EC is based on guidance in the National Research Council (NRC) report, Responding to Changes in Sea Level; Engineering Implications dated September, 1987. The projection is developed using the historic rate of sea level rise at Key West as reported by NOAA (2.24 mm/yr). The dashed line indicates that the EC equation is being used past the year 2100. The underlying documents supporting the EC do not address dates beyond 2100.

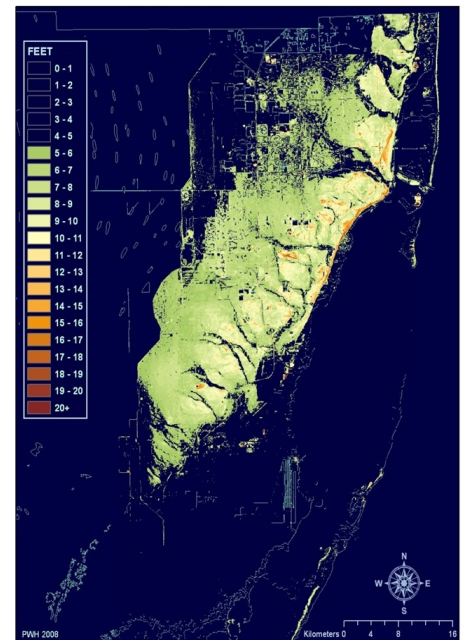| Year	Relative Sea Level Rise, inches		
	Historic	Intermediate	High
2010	0	0	0
2030	2	3	7
2060	4	9	24
2100	8	19	57
2110	9	23	67

Although South Florida is often thought of as a very flat landscape, it does have small variations in elevation that will influence how soon different parts of the area are impacted by sea level rise. The highest elevations are along a limestone ridge which is indicated by the white shaded areas in the maps below. The ridge is intersected by low lying areas where water historically flowed from Lake Okeechobee south through the Everglades and out into the ocean. Initially, the areas most at risk from flooding will be low lying areas along the coast, such as large areas of South Dade, and parts of Miami Beach. Eventually, inland areas will experience flooding as well, as water comes up through the porous limestone base (Obeysekera et al. 2011).

Current Miami-Dade topography

1 foot of sea level rise
2040-2070

5 feet of sea level rise
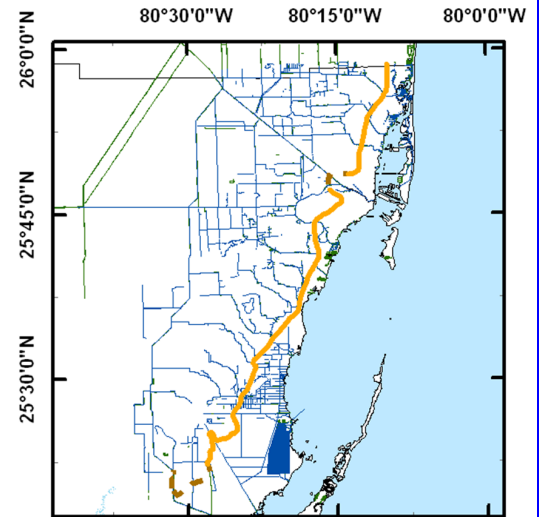2105-?

Maps by Peter Harlem

Some low lying areas already experience flooding during extreme high tides, such as certain areas of Miami Beach. The western side of the barrier island was originally a mangrove swamp which was cleared and filled in for development in the early part of the century. Drainage pipes flow out into the bay and during extreme high tides water flows up into the streets, so that drivers, pedestrians, and bus riders have to navigate large puddles. When high tide coincides with heavy rains, reduced drainage capacity puts homes and yards at risk of flooding.

At left, apartment building in Flamingo Park neighborhood, Miami Beach, 5/23/2012. At right, intersection of 10th St. and Alton Rd, Miami Beach, 10/29/2011.

Sea level rise will also hasten salt water intrusion into the underground freshwater aquifers which we draw our drinking water from. The yellow line on the map at right shows the current interface line between freshwater and salt water along the coast of Miami-Dade County. Just to the north, the City of Hallandale Beach has already had to abandon 6 of its 8 wells and is now getting water from the City of West Park to the west (Giovanelli 2011). As the interface line moves westward, freshwater sources will become more scarce and desalination plants are being constructed, which use large amounts of energy and will significantly increase the cost of water in South Florida. Keeping surface water levels in lakes and canals high slows down salt water intrusion, but water managers must balance this with preventing flooding of low lying inland areas, many of which were developed by draining former wetlands.

South Florida Water Management District, 2011

These are only some of the impacts that climate change may have on our urban environment. Ecosystems will also be impacted, including plant and wildlife populations that are crucial to the health of our environment and our ability to adapt. Mangrove coastlines can act as barriers against hurricanes and storm surge, but they need space to migrate inland as sea level rises. Human health impacts are also just beginning to be explored, such as possible increased incidence of mosquito born diseases, and even psychological impacts of dealing with potentially enormous changes. The situation is indeed challenging but humans are very adaptable, and if we begin now there are many things we can do to avoid many of the more serious consequences. We will need a combination of technical, ecological, social, political, legal, and economic solutions in order to surmount these challenges, and everyone will have something to contribute. Climate change will touch everyone in some way or another, and our best bet will be to work together to adapt in a way that is just, inclusive, and based on the best science available.

Salt Marsh, Accessgroup-Florida.com

References:

2012 CoreLogic Storm Surge Report: Residential Storm-Surge Exposure Estimates for U.S. Coastal Areas. Available on-line at: http://www.corelogic.com/about-us/researchtrends/asset_upload_file659_15276.pdf.

Finch, C., Emrich,C.T. & Cutter, S.L. (2010). Disaster disparities and differential recovery in New Orleans. *Population and Environment* 31:179–202.

Giovannelli, M. (2011). "Wall of saltwater snaking up South Florida's coast - Saltwater intrusion is an issue along South Florida's coast — and it's moving west." *Miami Herald, The (FL)*, September 3.

IPCC (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds. Cambridge, UK: Cambridge University Press.

Misra, V., E. Carlson, R. K. Craig, D. Enfield, B. Kirtman, W. Landing, S.-K. Lee, D. Letson, F. Marks, J. Obeysekera, M. Powell, S.-l. Shin. (2011). Climate Scenarios: A Florida-Centric View. Florida Climate Change Task Force. [Available online at http://floridaclimate.org/whitepapers/]

Morrow, B. H. (2008). Community Resilience: a social justice perspective. New Orleans: Community and Regional Resilience Initiative.

Southeast Florida Regional Climate Change Compact Technical Ad hoc Work Group (SFRCCC TAWG). April 2011. A Unified Sea Level Rise Projection for Southeast Florida. A document prepared for the Southeast Florida Regional Climate Change Compact Steering Committee.

United States Global Change Research Program (USGCRP). (2009). Global Climate Change Impacts in the United States. Available on-line at: http://www.globalchange.gov/.

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