# Climate Change

There is consensus among the world's leading scientists that global climate change is among the most significant problems facing the world today. Florida is considered one of the most vulnerable areas to climate change, with Southeast Florida on the frontline to experience its impacts, especially rising sea levels.

Miami-Dade County has been in the forefront of these issues for many years. The Miami-Dade Board of County Commissioners and County departments have been implementing policies and initiatives to address climate change, environmental protection and other important sustainability issues including energy efficiency and water conservation.

By tracking greenhouse gas (GHG) emissions early on, reviewing and analyzing climate change data and information, we have taken steps to reduce GHG emissions and avoid or reduce the severity of anticipated climate change impacts. This work, and efforts to date, will be developed into an overall climate action strategy, which will become an integral component of GreenPrint.

# Climate Change

*Assessment Area*

One of the most significant challenges facing Miami-Dade County is the threat of climate change impacts. Ice cores show that the earth has experienced natural cycles in atmospheric concentrations of $CO_2$ and temperature for over 600,000 years. However, as a result of human activities, there is now an unprecedented build-up of greenhouse gases (GHGs) in the earth's atmosphere, causing the atmosphere to progressively trap more of the sun's heat energy. As a result, changes are occurring worldwide that are impacting the many interconnected systems and feedback loops that determine precipitation, temperature, severe weather patterns, ocean currents and acidification, and sea level throughout the world.

Recognizing very early on that climate change was an issue of great importance, Miami-Dade County established a Long-Term Urban $CO_2$ Emissions Reduction Program in 1993 and has continued implementing GHG emission reduction initiatives since that time. Despite reducing or avoiding approximately 34 million equivalent tons of $CO_2$, through the implementation of this program, the County did not reach its reduction goal. In fact, total equivalent carbon dioxide gas emissions increased by 8.5 million tons from 1988 to 2005. Several factors contributed to this increase including: an increase in the County's population by approximately 27 percent; an increase in electrical usage per household resulting from larger homes and personal electronics; the advent and proliferation of sport utility vehicles (SUVs); and an absence of stricter national Corporate Average Fuel Economy (CAFE) standards. Important lessons were learned during the implementation of this Program which are being carried forward as the County continues to implement successful emission reduction projects and looks for opportunities to further reduce emissions. In fact, Miami-Dade continues to be a leader in aggressively tackling emissions reductions by being the first local government in the Southeast to become a member of the Chicago Climate Exchange (CCX), thereby committing to reduce its fuel-related carbon emissions by 6% from the year 2000 levels by 2010.

As a low-lying coastal community, Miami-Dade is more susceptible to many of the potential impacts which may occur as a result of climate change, particularly those associated with sea level rise and severe storm events. Once again recognizing the local importance of this issue early on, the County formally began its climate change adaptation planning in 2006 with the creation of the Climate Change Advisory Task Force (CCATF). This diverse group of knowledgeable and engaged individuals from various sectors of the community is charged with reviewing and analyzing climate change data and information, and subsequently providing recommendations to the Board of County Commissioners for actions that would further reduce greenhouse gas emissions, avoid or reduce the severity of anticipated climate change impacts. These recommendations and efforts will be developed, along with additional GHG emissions reduction initiatives, into an overall climate action strategy, which will become an integral component of GreenPrint.

***SUMMARY OF KEY SUSTAINABILITY CHALLENGES***

*Main challenges identified through collaborative stakeholder analysis of assessment data & indicators*

**Climate Change Mitigation**

- Affecting and accomplishing significant and measureable GHG emissions reductions community-wide from the residential, commercial, and industrial sectors in order to meet regional GHG emission reduction goals.
- Reducing GHG emissions associated with county operations' (internal) energy and fuel use while continuing to provide, and even increase services, to the community such as mass transit (busses & commuter rail), solid waste disposal, adequate drinking water supply, sewer services, flood protection, etc.
- Effectively communicating the benefits and need for GHG emission reduction to all sectors of the community.
- Revising existing county policies and procedures for land use, transportation, and construction in light of climate change and sea level rise data.

Adapting to climate change will be a cornerstone of the County's overall resiliency to an ever changing climate, and will ultimately determine the community's sustainability. The key challenges associated with climate change adaptation are as follows:

***SUMMARY OF KEY SUSTAINABILITY CHALLENGES***

*Main challenges identified through collaborative stakeholder analysis of assessment data & indicators*

**Climate Change Adaptation**

- Determining and/or predicting local and regional changes in climate trends (precipitation, temperature, severe storm events) and sea level rise, based on national and global information and models.
- Developing regional climate change impact scenarios depicting the extent and timing of sea level rise, weather trend changes, and severe storm events for adaptation planning purposes, despite the inherent uncertainties associated with numerous interconnected feedback loops and ever-changing data and models.
- Protecting the aquifer from salt water intrusion and preventing or minimizing flooding in low-lying areas as sea level rises.
- Effectively communicating the urgency and necessity of climate change adaptation planning in order to obtain necessary resources and support for implementation now.
- Enacting and implementing changes in policies, codes, programs, and capital investments.

## ***ASSESSMENT DATA & INDICATORS***

*Data and analysis to identify key challenges & establish a sustainability baseline*

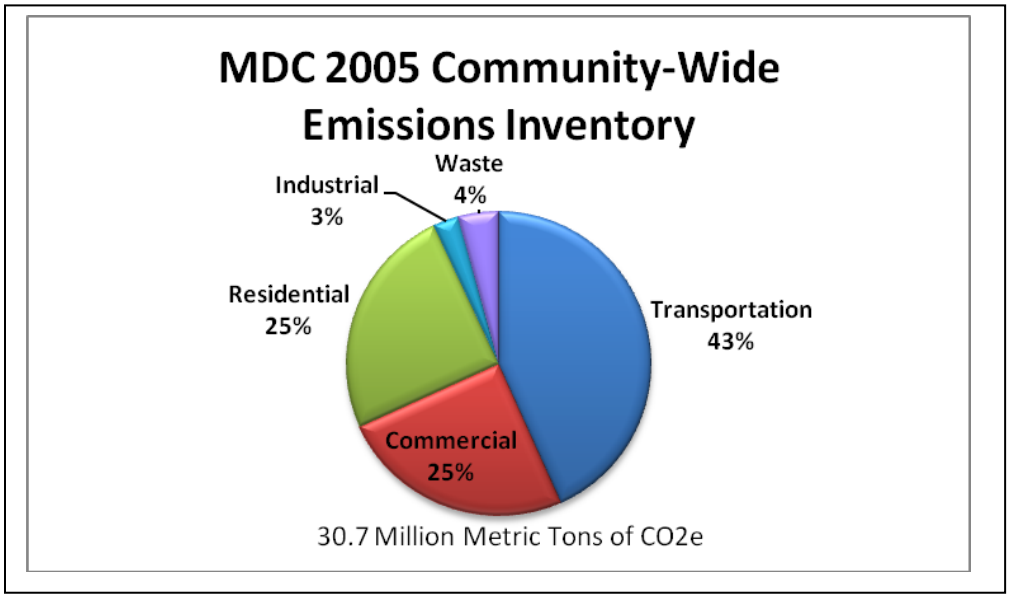
**Climate Change Mitigation**

Fossil fuel and electricity consumption are directly correlated to emissions of Greenhouse Gases (GHGs) and are the primary source of these emissions in Miami-Dade County, both

internally for county operations, and community-wide. As a result, efforts to reduce GHG emissions are focused on reducing fossil fuel and energy use and therefore, many indicators, initiatives, and programs identified in the Energy, Land Use, and Government Operations Areas of this report would result in fuel and/or energy use reduction. Since these topics are discussed at length in the above-mentioned report areas, the information provided in this section focuses on the relationship of these topics to emissions and emission reductions. A review of these above-mentioned report areas is suggested to better understand the specific indicators and initiatives mentioned below, and should be kept in mind while reading this section

As part of the forthcoming climate action strategy, the County has established a new GHG emissions baseline for calendar year 2005, with an estimated total of approximately 30.7 million metric tons of $CO_2$ Equivalents ($CO_2e$) county-wide (Chart 1). An emissions baseline was also calculated for the County's internal government operations, which totaled approximately 983,000 metric tons $CO_2e$ (See Chart 4), or approximately three percent of the community-wide regional emissions. Emissions are calculated in $CO_2$ equivalents, using various emission coefficients for other GHG emissions, to account for their contribution to the overall baseline. Chart 1 shows the overall community GHG emissions from both fossil fuel and electricity use, broken down by the primary community sectors. It is from both the overall community-wide baseline and the internal government operations baseline that the County will measure progress in its emission reduction efforts.

**Chart 1**

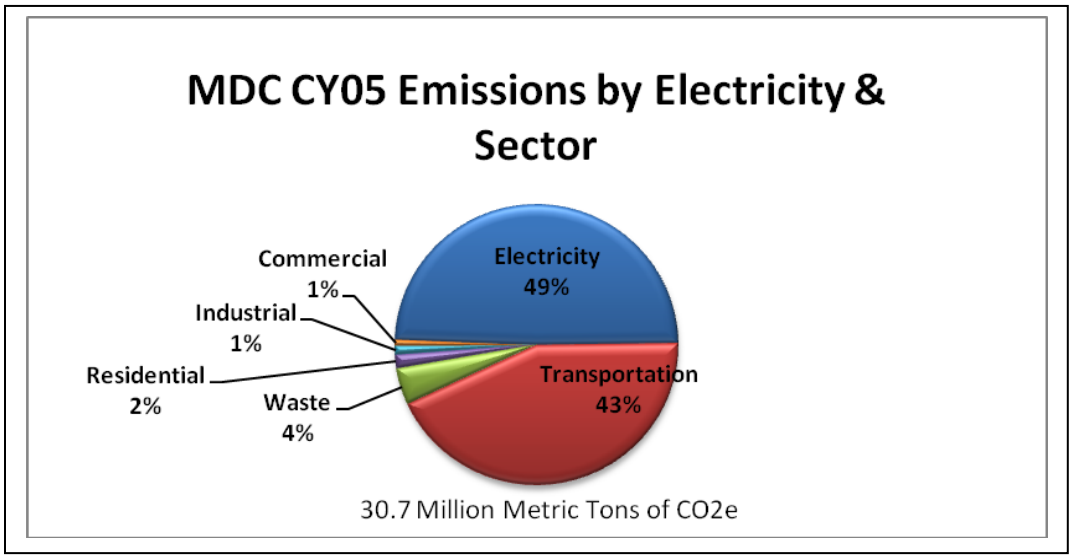



*(Source: Miami-Dade Department of Environmental Resources Management)*

When fuel and electricity emissions are combined together, as in Chart 1, the Residential and Commercial sectors' emissions are almost equivalent. Taking the same emissions information in Chart 1 above and separating the fuel emissions from the electricity emissions reveals that electricity and transportation are by far the greatest contributors to community-wide emissions and are roughly equivalent in their contribution (Chart 2 below). When comparing Chart 1 above with Chart 2 below, it becomes apparent that the primary source of emissions from the Residential and Commercial sectors is electricity use, since the other sectors' emissions remain relatively the same in both charts. The small remaining components shown for Residential, Industrial, and Commercial sectors in Chart 2 are from other fossil fuels such as coal and

natural gas. Emissions from the waste sector are primarily due to methane released from the landfills, which is approximately 21 times more potent as a GHG than $CO_2$.

**Chart 2**

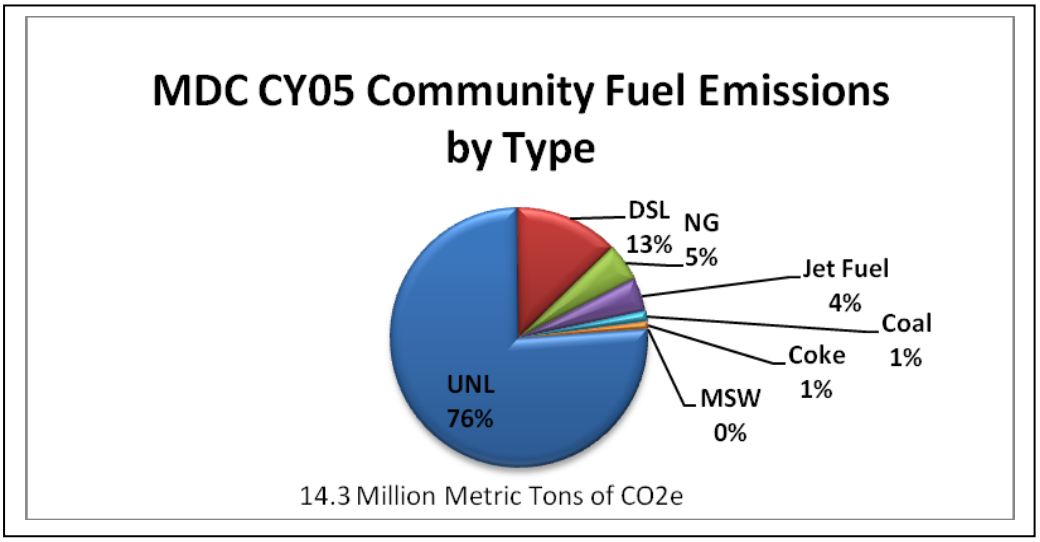



*(Source: Miami-Dade Department of Environmental Resources Management)*

**Emissions from Fuel Use**

Under the overall Transportation sector, unleaded fuel use by light duty (passenger) vehicles accounts for approximately 76 percent of the transportation emissions, and diesel fuel comprises approximately 13 percent the total (Chart 3). The substantial portion of emissions from unleaded fuel reveals that personal passenger cars are still the greatest overall contributor to the community-wide fuel emissions.

**Chart 3**




*(Source: Miami-Dade Department of Environmental Resources Management)*

The longer and farther individuals travel in their personal vehicles, the more GHG emissions are released. Therefore, vehicle miles travelled (VMTs) and vehicle hours travelled (VHTs) serve as descriptive indicators of community-wide and government operations' fuel-derived emissions and should be a prime target for reduction initiatives. Reduced use of personal vehicles and

associated VMT and VHT community-wide can be accomplished by improving public transportation function and accessibility, and increasing use of public transportation (See Transportation Area) and by promoting walk-ability, bike-ability, infill, mixed-use, and transit-oriented development (TOD) (See Transportation, Land-Use, and Government Operations Areas). Providing the service and accessibility to public transportation is only part of the challenge; the other critical element is changing individuals' perceptions and behaviors to reduce use of personal vehicles. This source of emissions has historically proven difficult to reduce, and is very challenging because it is not under direct control of County government. However, new federal legislation was proposed on September 15, 2009, by Environmental Protection Area (EPA) and the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) that will improve fuel economy for all new cars and trucks sold in the United States and will result in reduced GHG emissions (See "*Existing Efforts*").

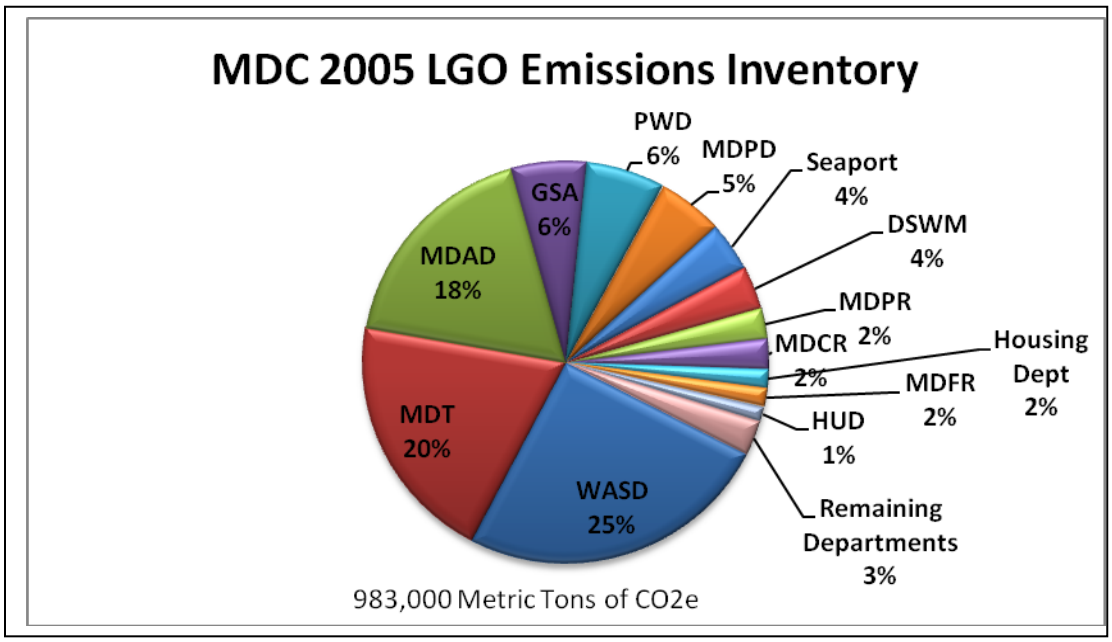
Miami-Dade County fleets and operations consumed approximately 7.5 million gallons of unleaded fuel and approximately 20 million gallons of diesel fuel in 2005. This fuel is used for a wide variety of purposes such as light duty passenger cars; heavy duty vehicles such as buses, fire trucks and garbage trucks; heavy duty equipment such as mowers, bulldozers, and bucket trucks; and pumps for water and sewer services and storm water control (See Energy and Government Operations Areas). Each of these uses offers various opportunities for fuel use and/or emissions reduction, ranging from more efficient motors and engines, to use of alternative fuels, to a decrease in the use of vehicles overall through improved efficiencies and increased use of video-conferencing and telecommuting. Due to the high volume of use and variety of uses, an effective emissions reduction program must employ many different technologies.

In addition to VMTs and VHTs, other indicators can be used to track fuel-derived emissions and emissions reductions for the community as well as for internal local government operations (LGOs). These indicators include but are not limited to the following (See Energy, Transportation, & Government Operations Areas for more detailed discussion of these indicators):

- Fuel consumption by community sectors and departments
- Public transportation ridership
- Overall and individual County fleet fuel efficiency (garbage trucks, buses, heavy equipment, light duty fleet, etc.)
- Ratio of bio-diesel to standard clean diesel fuel consumed
- Ratio of hybrid technology vehicles to standard vehicles in County fleets

Chart 4 below shows the County departments' relative contribution to the government operations emissions baseline when fuel and electricity are combined. These emissions are primarily from electricity used to power buildings and equipment, in addition to fuel and electricity to run vehicles and equipment that provide services to the community. It is important to note that some of the emissions generated from county facilities, such as landfill gases from waste degeneration and emissions from private aircraft and marine vessels, are accounted for in community-wide emissions summaries, but are not included in the diagram below. The "Remaining Departments" component is comprised of the other 48 departments whose contributions to the baseline are less than one percent of the total.

**Chart 4**




*(Source: Miami-Dade Department of Environmental Resources Management)*

It is important to note here that the majority of departments with the most substantial emissions contributions are those departments that provide significant and essential services directly to the community. One exception to this is General Services Administration (GSA), whose bulk of emissions (86 percent) are due to electricity use from the buildings they manage, which is a service provided to other County departments as opposed to the community. Further breaking down the emissions to the primary sources within each department, as below, helps identify both challenges and opportunities for GHG emissions reductions.

| DEPT | Source | Emissions (mt) | % |
|---|---|---|---|
| WASD | Buildings | 175,109 | 70.69% |
| | Pumps (etc.) | 60,035 | 24.24% |
| | Fleet | 11,260 | 4.55% |
| | Other (Equip.) | 1,306 | 0.53% |
| | TOTAL | 247,711 | 100.00% |

Approximately 95 percent of the Miami-Dade Water and Sewer Department (WASD) emissions are for water supply and sewer services.

| DEPT | Source | Emissions (mt) | % |
|---|---|---|---|
| MDT | Transit Buses | 114,729 | 58.13% |
| | Metrorail | 47,548 | 24.09% |
| | Refrigerant (HFC-134a) | 16,876 | 8.55% |
| | Buildings | 14,723 | 7.46% |
| | Fleet | 3,064 | 1.55% |
| | Other (Equip.) | 439 | 0.22% |
| | TOTAL | 197,380 | 100.00% |

Approximately 82 percent of Miami-Dade Transit (MDT) emissions are from providing public transportation (buses and MetroRail).

| DEPT | Source | Emissions (mt) | % |
|---|---|---|---|
| MDAD | Buildings | 171,660 | 97.49% |
| | Fleet | 2,844 | 1.62% |
| | Other (Equip.) | 1,578 | 0.90% |
| | TOTAL | 176,082 | 100.00% |

Approximately 97.5 percent of Miami-Dade Aviation Department (MDAD) emissions are from powering the buildings at Miami International Airport. *(The summary provided here reflects those emissions resulting from support operations at airport facilities. Emissions from aircraft during take-offs and landings is captured in the community-wide emissions summaries, but are not included here.)*

| DEPT | Source | Emissions (mt) | % |
|---|---|---|---|
| PWD | Street Lts/Traffic Sig | 54,316 | 87.67% |
| | Buildings | 3,649 | 5.89% |
| | Fleet | 3,623 | 5.85% |
| | Other (Equip.) | 364 | 0.59% |
| | TOTAL | 61,952 | 100.00% |

Approximately 88 percent of Public Works Department (PWD) emissions are from operation of street lights and traffic signals.

| DEPT | Source | Emissions (mt) | % |
|---|---|---|---|
| MDPD | Fleet | 34,083 | 65.63% |
| | Buildings | 10,365 | 19.96% |
| | Equipment | 4,245 | 8.17% |
| | Planes/Helicopters | 1,702 | 3.28% |
| | Generators | 1,081 | 2.08% |
| | Motorboats/Cycles | 453 | 0.87% |
| | Total | 51,929 | 100.00% |

Approximately 66 percent of Police Department emissions are from the operation of patrol and non-patrol vehicles.

| DEPT | Source | Emissions (mt) | % |
|---|---|---|---|
| DSWM | Fleet | 27,113 | 93.82% |
| | Buildings | 1,391 | 4.81% |
| | Other (Equip.) | 395 | 1.37% |
| | Total | 28,898 | 100.00% |

Approximately 94 percent of Department of Solid Waste (DSWM) emissions are from fleet fuel use, 85 percent of which is from the operation of garbage and recycling trucks. *(The summary provided here reflects those emissions from waste collection and processing operations. Landfill gas emissions are accounted for in the community-wide emissions summaries, but are not included here.)*

It is a significant challenge for the County to maintain or increase these essential community services while simultaneously reducing emissions from the fuel and electricity used to provide them, and will require further improvement in efficiency, innovation, and resourcefulness.

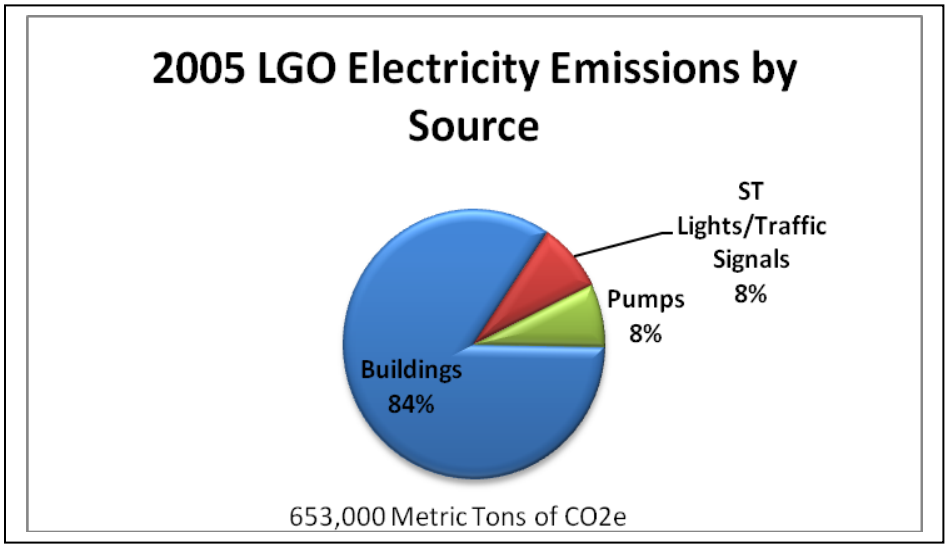
**Emissions from Electricity Use**

Greenhouse gas emissions and introductory information on energy as it relates to Climate Change is provided in this section. More detailed information on electricity production and use is located in both the *Energy* and *Government Operations Areas* of this report.

All electricity consumption and electricity consumption data for both the community and internal county operations is obtained from the utility provider, Florida Power & Light, Inc. (FPL), and is provided in Kilowatt Hours (kWh) units. The only exception to this is the electricity provided by the single municipal-owned utility in the County, Homestead Electric Company, which provides electricity for Homestead and comprises approximately 1.4 percent of the overall community electricity derived emissions. As shown in Chart 2 above, electricity use contributes approximately 49 percent of the total community-wide GHG emissions. As detailed in the *Energy Area* of this report, electricity consumption in the County has grown roughly two percent per year since 1995. The most efficient and cost effective method for reducing emissions from electricity generation is through increased energy efficiency.

Chart 5 below reveals that approximately 84 percent of the County's operational emissions from electricity usage results from energy used to operate and power buildings. The remaining 16 percent is divided evenly between electricity used to provide water, sewer and flood protection services for the community, and street and traffic lighting for the community. Once again, as highlighted above, significant emissions result from providing essential services to the community. As the climate action strategy is developed, this information will be used to help target initiatives for emissions reductions, which will be evaluated and measured on a regular basis to determine the progress in reaching reduction goals.

**Chart 5**




*(Source: Department of Environmental Resources Management)*

Successful and measurable efforts to reduce GHG emissions are already being implemented to improve energy efficiency and will continue, such as energy performance contracting to retrofit county buildings and retrofitting traffic lights to Light Emitting Diode (LED) bulbs. For example, as of April 2009, 80,000 incandescent traffic light bulbs have been converted to LED, resulting in an annual reduction of approximately 18,000 mega watt hours (MWh), which equates into an annual emissions reduction of approximately 10,000 metric tons of CO2 equivalents and an annual savings of approximately $1.8 million.

For the County's climate action strategy, initiatives to further reduce GHG emissions will be developed based on the opportunities for reduction that are identified within each department and community sector, based on energy use. The following indicators can be used to determine

progress towards the GHG emission reduction targets (mitigation), and will be converted to $CO_2$ Equivalents as appropriate. These indicators include, but are not limited to:

- Energy consumption/GHG emissions per Community Sector (Residential, Commercial, Industrial, Transportation, Waste)
- Energy consumption/GHG emissions per County department
- Kilowatt hour (KWh) Per capita consumption
- Kilowatt hours (KWh) per square foot consumption
- The number of certified Green buildings

In addition to measuring overall GHG emissions, individual programs to reduce emissions will be measured and the amount of emissions avoided or reduced will be calculated and tracked. This is particularly applicable to pertinent grant projects associated with American Reinvestment and Recovery Act (ARRA) funding, such as the Energy Efficiency & Conservation Block Grant (EECBG) program.

**Recycling Rates**

Although solid waste only comprises four percent of the community-wide emissions, it bears mentioning in this section because past experience has shown that recycling can result in significant emissions reductions. As a result of the County's original GHG mitigation efforts from 1990 to 2005, over 34 million tons of equivalent CO2 greenhouse gas emissions were reduced or avoided overall. Approximately 76 percent, or 26 million tons, of these avoided GHG emissions were due to recycling. By diverting waste, recycling realizes significant emissions reductions through avoidance of methane gas production from landfills. Therefore efforts to increase recycling rates should continue, which will also align with The Energy, Climate Change, and Economic Security Act of 2008 (House Bill 7135) signed into law by Governor Crist, which established a new statewide recycling goal of 75 percent to be achieved by the year 2020. Therefore, recycling rates will also serve as an indicator of GHG emissions and emissions reductions.

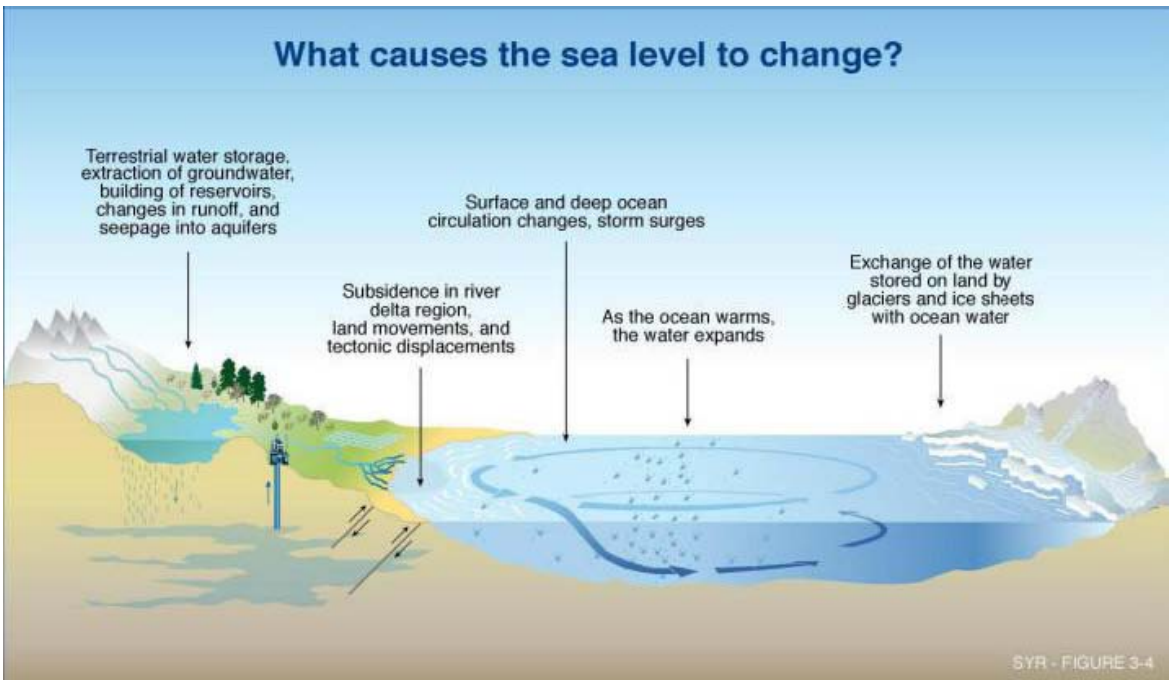
**Climate Change Adaptation**

Miami-Dade County, and in general southeast Florida, is a low-lying coastal community with a distinct climate and natural resources, and as such, is extremely susceptible to certain projected climate change impacts. Because of the low elevation and porous substrate, the area will be very susceptible to impacts from sea level rise, which will adversely affect infrastructure and drinking water availability and will lead to flooding, storm surge, and stormwater issues. The unique climate will be impacted from changing weather patterns such as increased strength and frequency of severe storm events, as well as variations in precipitation and temperature patterns. Many factors and interrelated systems form complicated feed back loops that are affected by climate change and in turn may either diminish or intensify climate change impacts. Some of the interrelated factors and systems include, but are not limited to: atmospheric temperature and composition; ocean temperature and currents; thermal expansion; solar radiation and cloud cover; the albedo effect, and the amount of ice cover and melting; and the extent of human activities. It is these complex interrelationships that make the extent and timing of climate change impacts so difficult to predict and therefore the development of scenarios and planning regimes so challenging. There are certain primary indicators, such as those detailed below, that will be monitored and studied in order to develop scenarios for use in climate change adaptation planning.

**Rate and Timing of Sea Level Rise**

Sea level is considered to be one of the primary indicators and challenges of climate change. "Global Sea Level" is the average height of the Earth's oceans world wide and provides a good

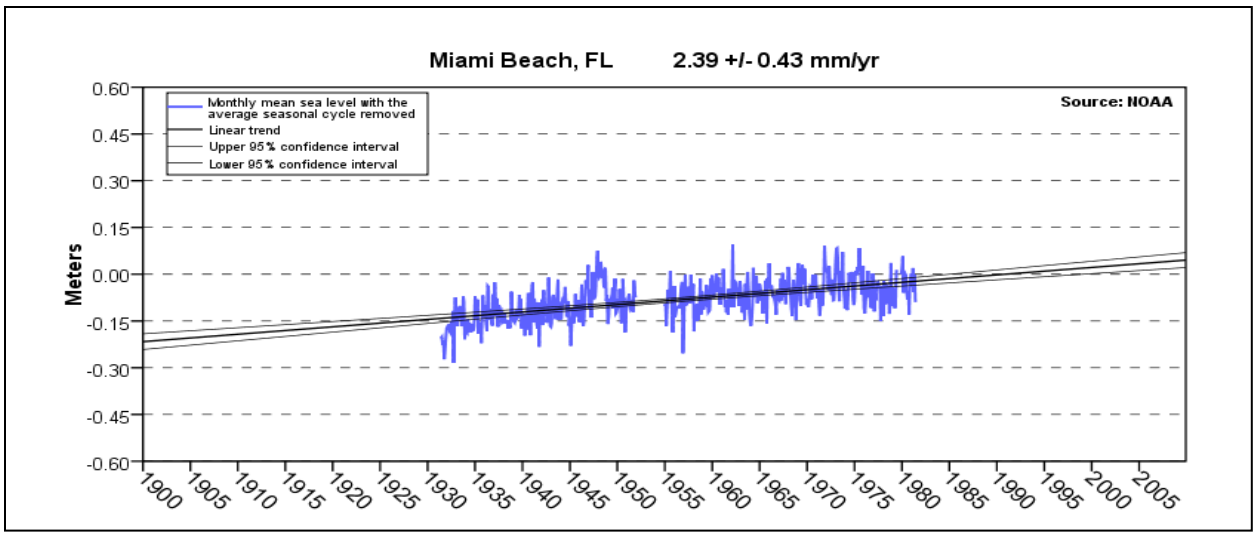
example of the complicated interrelationships mentioned above. It is affected primarily by changes in the ocean's volume from ice melt and thermal expansion. These processes are affected by atmospheric temperatures, and reflectance (the albedo effect), which in turn forms a positive feedback loop whereby increased atmospheric temperatures lead to more thermal expansion and ice melt. This, in turn results in less reflectance due to diminishing ice sheets, and therefore more ice melt, leading to increased freshwater input into the oceans, further amplifying melting. It is these complicated and closely tied systems which make the rate, timing, and extent of sea level rise so difficult to predict. "Local Sea Level" is a measurement of the height of the ocean water in reference to a specific point on land and is based on Global Sea Level, in conjunction with any vertical movement of land elevation due to natural occurrences such as tectonic motion or subsidence, as well as tidal trends. The diagram below[1] helps illustrate the various factors affecting global and local sea level.




It is important to note that relative sea level trends vary through out the world and therefore, it is the Local Sea Level or local Mean Sea level Trend that will be monitored and used for various planning needs associated with coastal zone mapping, management, restoration, and now, climate change adaptation planning.

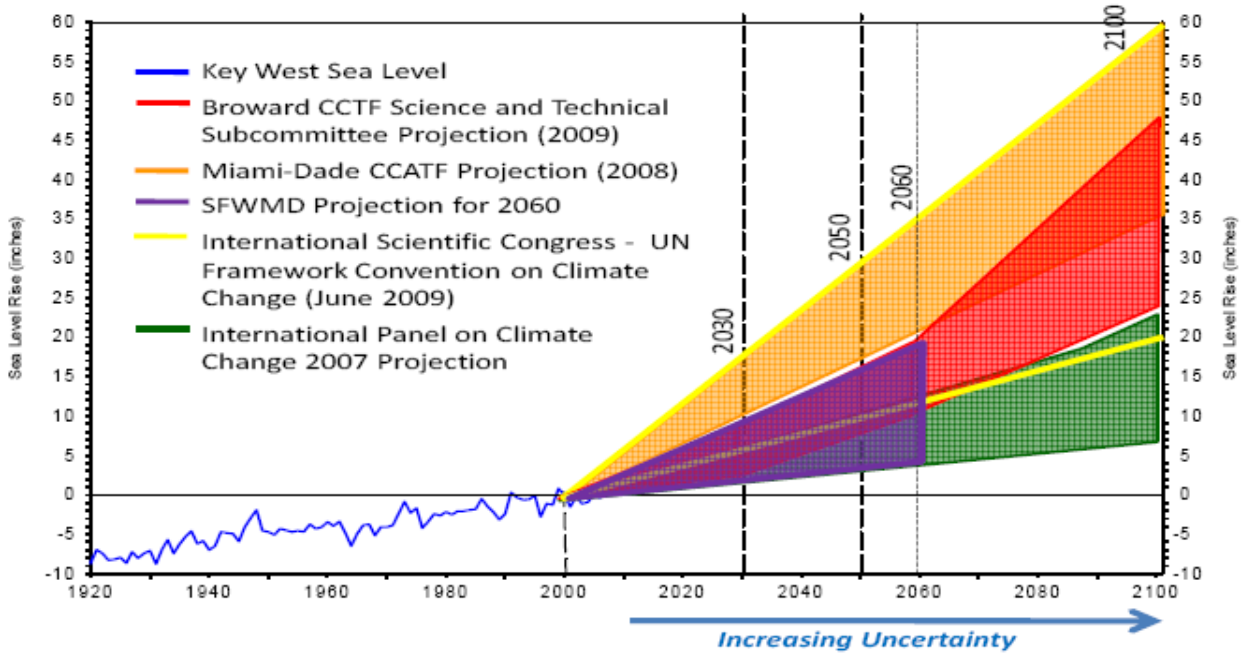
The National Oceanographic and Atmospheric Administration (NOAA) has three gauges located in the SE Florida region that measure mean sea level trend; Miami Beach, Vaca Key, and Key West. The graph below reflects the mean sea level trend at the Miami Beach Tide gauge from 1931 to 1981.

[1] **IPCC**, 2001: *Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Integovernmental Panel on Climate Change* [Watson, R.T. and the Core Writing Team (eds.)]. Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA, 398 pp.




According to NOAA, the mean sea level trend is 2.39 millimeters/year with a 95 percent confidence interval of +/- 0.43 mm/yr based on monthly mean sea level data from 1931 to 1981 which is equivalent to a change of 0.78 feet in 100 years.

Various organizations have published predictions on the amount of sea level rise expected in this century. The CCATF Science Committee released their "Statement on Sea Level in the Coming Century," predicting that Southeast Florida would experience a rise in sea level of at least 1.5 ft.-3.0 ft. by 2060 and a total of at least 3 ft.– 5 ft. by the end of the century. The chart below, was presented by Dr. Nancy Gassman, Natural Resources Administrator, Broward Environmental Protection and Growth Management Department, at the Southeast Florida Regional Climate Leadership Summit and shows the variations in sea level rise projections by several different organizations.

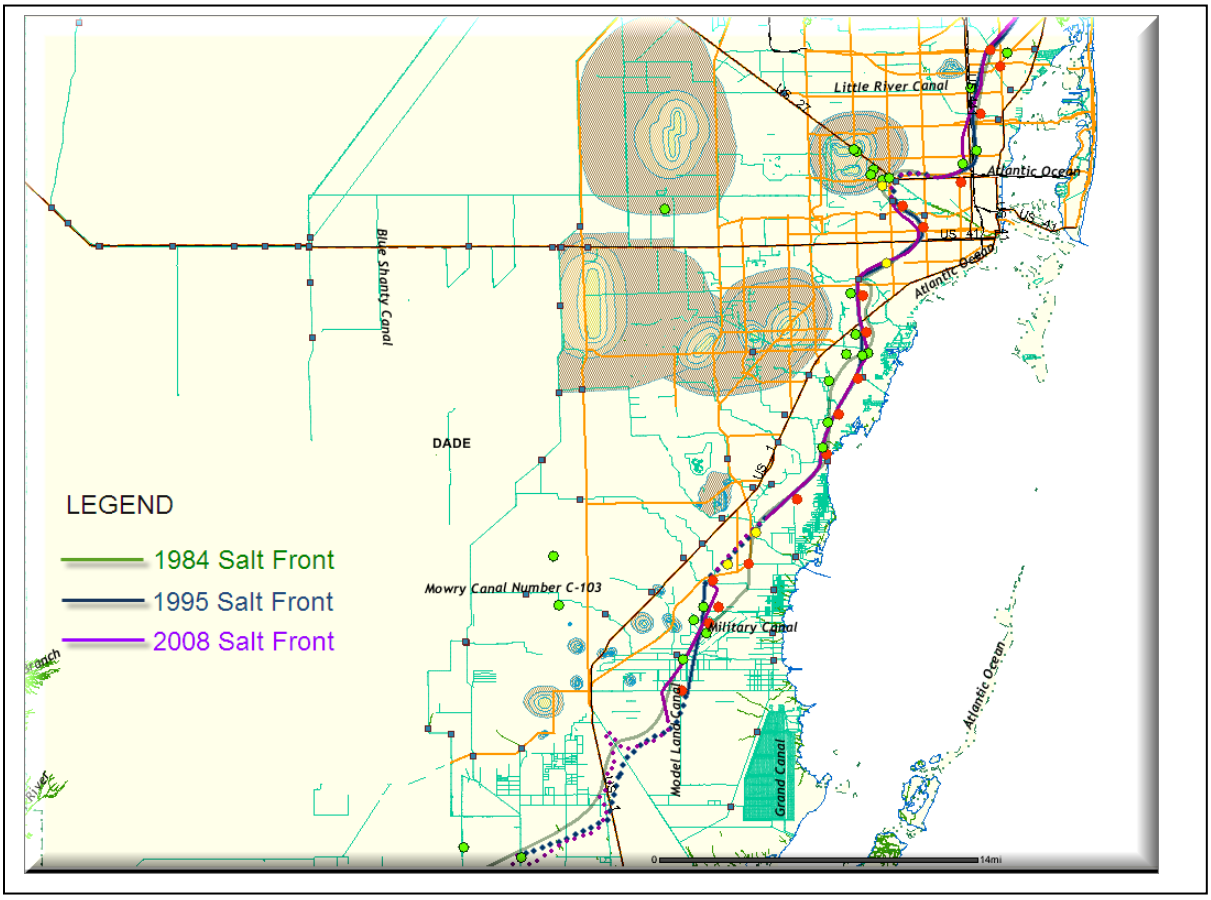


This clearly highlights the need for regional collaboration on climate change models and planning scenarios. This regional collaboration was initiated at the Regional Climate Change Leadership Summit on October 23, 2009, when all four participating counties; Monroe, Miami-Dade, Broward, and West Palm Beach, all agreed to sign the Southeast Florida Regional Climate Change Compact. By signing this Compact, these southeast Florida counties, representing approximately 30 percent of the population in the State of Florida, agreed to develop joint policy positions and legislation with respect to climate change issues, and committed to developing a Southeast Florida Regional Climate Change Action Plan. The challenge, in addition to uncertain data and timelines, will be putting this Compact in to action and including other key regional stakeholders such as the Regional Planning Council and the South Florida Water Management District, while simultaneously addressing other key needs and strained resources and budgets.

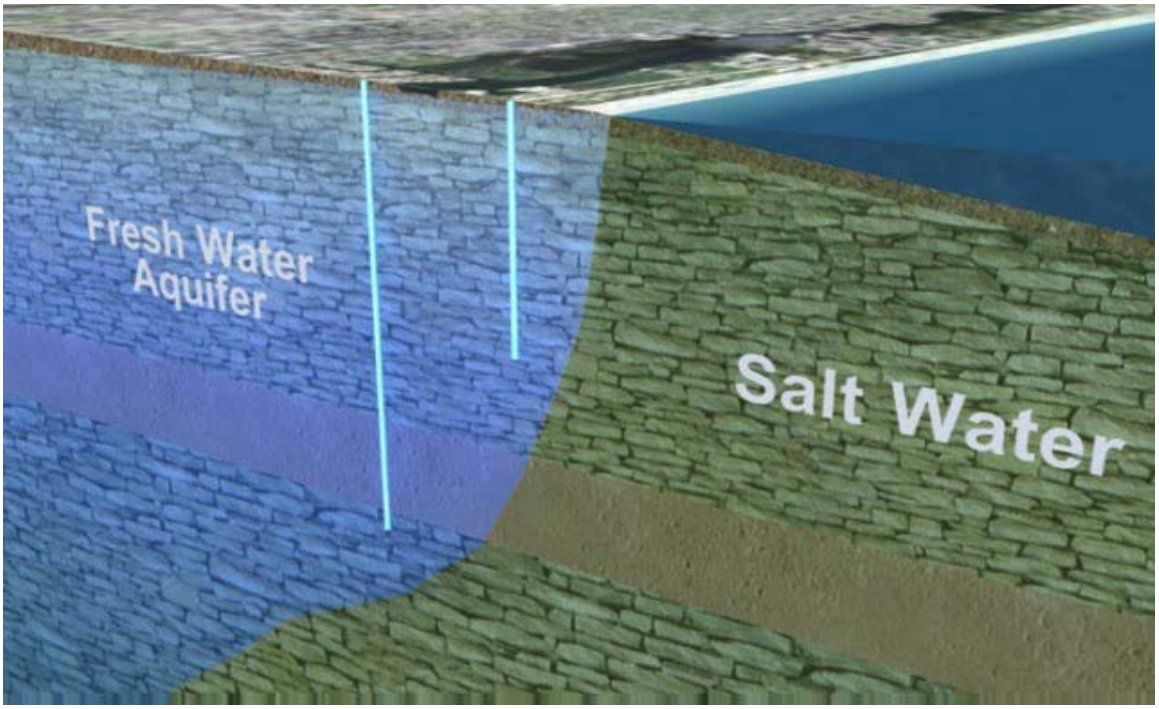
**Variations in Salt Water Intrusion Lines**

Underlying all of South Florida is the Biscayne Aquifer, a shallow, porous limestone formation that has historically provided all urban and agricultural freshwater supply. Due to the porous nature of the substrate, this groundwater table is hydrologically connected to the ocean. As described in more detail in the Environment Area of this Report, early and on-going practices of excavation, drainage, and consumption have facilitated salt water intrusion into the freshwater aquifer. As sea level rises the hydrologic pressure will drive the isochlor line, or "salt-freshwater boundary," further inland, threatening contamination of the County's drinking water wells. The map below illustrates the change of the isochlor line from the time period of 1984, 1995, and 2008 with respect to the spatial distance of the wellfield protection areas (tan ovals).

**Map1**



The image below by Dr. Jayantha Obeseykera, Chief of Hydrologic and Environmental Systems Modeling, South Florida Water Management District, provides a visual illustration of the isochlor line below the ground surface, showing the relative proximity and vulnerability of Miami-Dade's freshwater drinking wells. This anticipated impact to potable water availability will be a key challenge that the County must address in preparing for climate change. One of the primary methods for protecting fresh groundwater from salt water intrusion is to allow increased flow of freshwater from the west, building up a "freshwater head" that increases the hydrologic pressure eastward, staving off further saltwater intrusion. In order to do this effectively, the outflow of freshwater from canals must be reduced by keeping flood gates closed, which results in an increased groundwater table height, bringing it closer to the ground surface. This becomes an inherent conflict with storm water management, which is based upon managing canal flood gates and the level of groundwater whereby storm water will be quickly and effectively "absorbed" underground and/or released to the ocean. Therefore, this intrinsic conflict will pose a significant challenge as the County addresses reduced potable water availability and increased flooding, both of which are anticipated future impacts from climate change.




**Seasonal/Annual Precipitation & Temperature Trends**

Although the specifics are unclear, it is certain that climate change will have a direct affect on weather patterns in the region, including seasonal and annual precipitation and drought trends, seasonal and annual temperature trends, and frequency and strength of severe storm events. These weather patterns are affected by naturally occurring weather phenomena such as the Atlantic Multi-Decadal Oscillation (AMO), and the El Nino Southern Oscillation (ENSO). The climate trends associated with these phenomena are summarized in Chart 6 below. It is important to note that these are general trends and that annual and seasonal variations are known to occur.

**Chart 6**

## Natural Variability: Climate Tendencies

| | Rainfall | | Atlantic Hurricanes |
|---|---|---|---|
| | Wet Season | Dry Season | |
| **El Niño** | No clear pattern | Wetter | Less activity |
| **La Niña** | No clear pattern | Drier | More activity |
| AMO Warm Phase | Wetter decades; droughts still occur | | Greater # of major storms |
| AMO Cold Phase | Drier decades; very wet years still occur | | Lesser # of major storms |

HYDROLOGIC & ENVIRONMENTAL SYSTEMS MODELING

*Presented on August 12, 2009, at the University of Miami Rosenstiel School of Marine & Atmospheric Sciences, by Dr. Jayantha Obeseykera, Chief of Hydrologic and Environmental Systems Modeling, South Florida Water Management District.*

Although global trends are uncertain, they are being predicted with more confidence than local and regional trends. Therefore, bringing this data and modeling down to the regional and local level is a significant challenge. Even models for the Southeastern United States region may not accurately reflect weather patterns for southeast Florida, since the local climate is much different from even that of northern Florida.

While there is ongoing research and modeling to bring these trends and predictions down to the local level, a recent report by the U.S, Global Change Research Program[2] provides some of the most current information for precipitation and temperatures trends. The chart below from this report summarizes the observed temperature and precipitation changes in the Southeast.

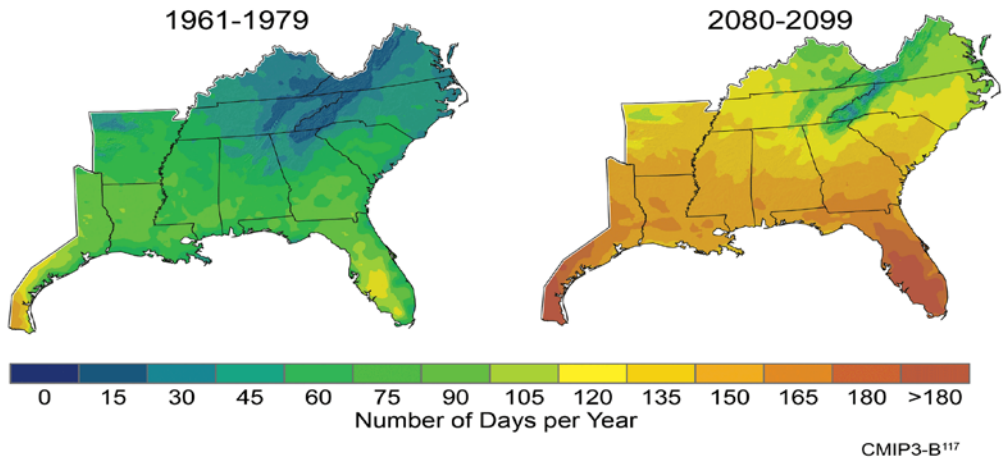
**Average Change in Temperature and Precipitation in the Southeast**

| | Temperature Change in °F | | | Precipitation change in % | |
|---|---|---|---|---|---|
| | 1901-2008 | 1970-2008 | | 1901-2008 | 1970-2008 |
| Annual | 0.3 | 1.6 | Annual | 6.0 | -7.7 |
| Winter | 0.2 | 2.7 | Winter | 1.2 | -9.6 |
| Spring | 0.4 | 1.2 | Spring | 1.7 | -29.2 |
| Summer | 0.4 | 1.6 | Summer | -4.0 | 3.6 |
| Fall | 0.2 | 1.1 | Fall | 27.4 | 0.1 |

Observed temperature and precipitation changes in the Southeast are summarized above for two different periods.[380] Southeast average temperature declined from 1901 to 1970 and then increased strongly since 1970.

[2] Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009

According to the illustration below[3] there is expected to be a significant future increase in the number of days with temperatures over 90 degrees. In addition, "climate models project continued warming in all seasons across the Southeast and an increase in the rate of warming through the end of this century."[4] These temperature changes will also impact evapotranspiration and precipitation, and may lead to a future increase in heat-related illnesses, as well as additional demands on water supply.




The number of days per year with peak temperature over 90ºF 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 90ºF, 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.

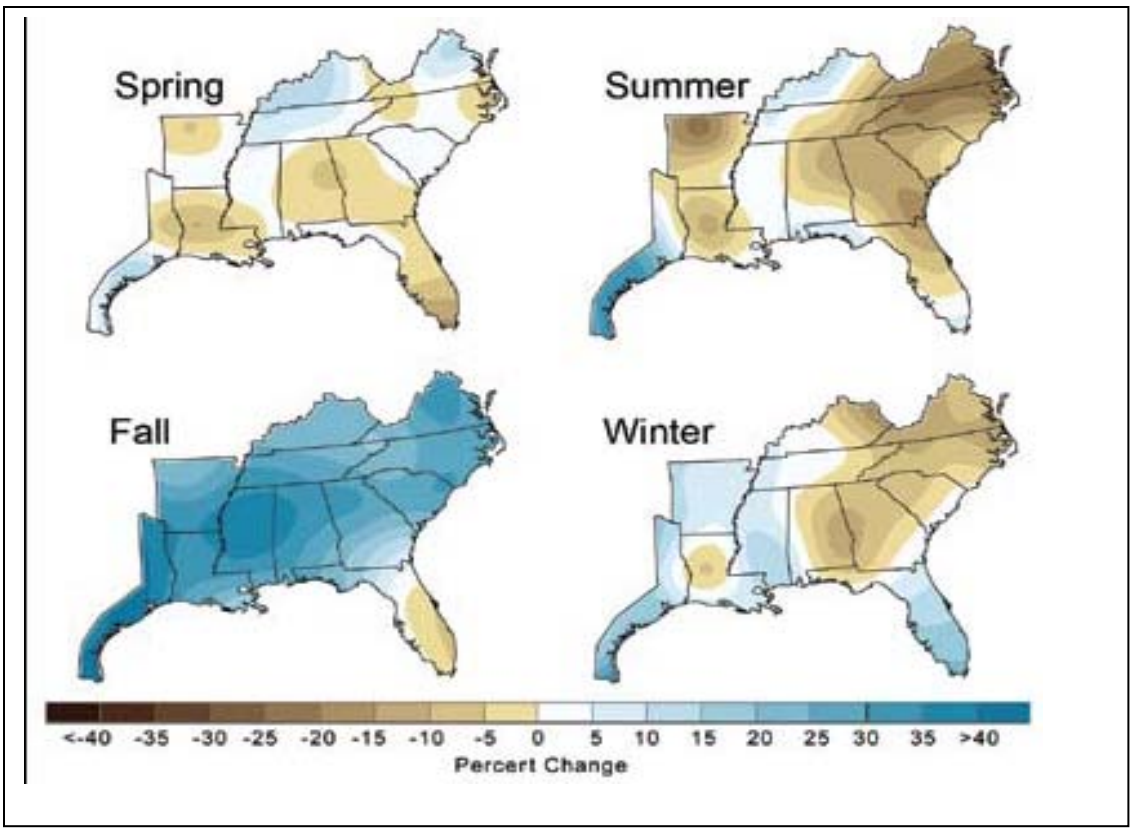
The illustration below[5] from NOAA's National Climatic Data Center, shows observed changes in precipitation from 1901 to 2007. In addition to the general temperature trends illustrated above, the "…decline in fall precipitation in South Florida contrasts strongly with the regional average (autumn precipitation increase of 30 percent),"[6] and may further impact future water supply if the trend continues.

[3] Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009, p.111.

[4] Ibid, p. 111.

[5] Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009, p.111.

[6] Ibid, p. 111.




While average fall precipitation in the Southeast increased by 30 percent since the early 1900s, summer and winter precipitation declined by nearly 10 percent in the eastern part of the region. Southern Florida has experienced a nearly 10 percent drop in precipitation in spring, summer, and fall. The percentage of the Southeast region in drought has increased over recent decades.

[7]

The South Florida Water Management District released in February 2010 a white paper entitled, "Climate Change and Water Management in South Florida". It provides further information and discussion specific to the south Florida region.

**Severe Storm Events**

There is much debate about how climate change is affecting the frequency and intensity of severe storms such as hurricanes and some of the models vary widely in their predictions. As shown above in Chart 6, the frequency of Atlantic hurricanes is affected by naturally occurring weather phenomena such as AMO and ENSO. The strong correlation between the strength of hurricanes and warm ocean surface temperatures is well documented, which supports the projection that hurricanes may become stronger as ocean temperatures increase with climate change. Wind shear may also increase with warmer atmospheric and ocean temperatures, which may serve to reduce the number of storms in the Atlantic Ocean.[8] It is hoped that the intensity and frequency of tropical storms will become more predictable as more data and better models become available.

[7] Ibid, p. 111.

[8] Florida Oceans and Coastal Council. 2009. The Effects of Climate Change on Florida's Ocean and Coastal Resources. Tallahassee, FL. 34 pp.

**Flooding Frequency and Patterns**
Due to the porosity of the substrate and the hydrologic connection between the ocean and the groundwater table, the groundwater level will rise concurrently with sea level, bringing the water table closer to the ground surface. This will affect the frequency of flooding during heavy rain events and, as discussed above, will also affect the ability of the ground and canal systems to absorb and dissipate stormwater during heavy rain events, severe storm events, and storm surges.

**Additional/Secondary Impacts & Costs**
In addition to the impacts specifically mentioned above, the County will likely experience other primary or secondary impacts. These include, but are not limited to:

- Increased susceptibility to high tide and storm surge flooding impacts
- Increased flooding from heavy rain events
- Increased beach erosion and damage and/or loss of coastal wetlands
- Infrastructure damage
- Population displacement
- Loss of crucial economic drivers such as tourism & agriculture
- Land use changes
- Displacement or die off of non-salt tolerant plant and animal species
- Loss of biodiversity
- Increased disease vectors and infectious diseases
- Increased heat-related illnesses
- Increased energy demand
- Increased wildfires

A critical, yet difficult adaptation planning step will be to estimate the costs of action versus inaction associated with these impacts. According to a 2007 study, "Ranking the World's Cities Most Exposed to Coastal Flooding Today and in the Future," by the Organization for Economic Co-operation and Development, Miami ranked first in terms of assets exposed to coastal flooding in the 2070's, with a projected potential cost estimated at ~ $3.5 trillion. Furthermore, a 2007 publication, "Florida and Climate Change, the Costs of Inaction," by the Global Development & Environment Institute at Tufts University, projected an annual cost of inaction to the state of Florida to total $92 billion by 2050. This estimate only considered impacts from loss of tourism revenue, increased hurricane damages, at-risk residential real estate and increased electricity costs. Based on the list of additional impacts above, this estimate is probably very conservative. Therefore, it will be critical for the County to address and estimate these costs so they may be properly factored in to adaptation planning decisions.

**Communications**
There are numerous reasons why communication about climate change is one of the most challenging efforts associated with climate change adaptation planning. The inherent unpredictability of the extent and timing of impacts is a significant challenge, further amplified by the long term nature of suspected impacts. Communicating to stakeholders and decision makers the urgency of actions needed now to address impacts that may not be apparent or experienced for another 10 to 30 years is a challenge. This is particularly true when other more immediate and acute problems are being experienced, such as the current economic crisis. There is a need to evaluate and calculate the cost of action versus non-action to clearly justify the need for action *now* and to communicate this to all stakeholders in a common language that is easily understood.

## *EXISTING EFFORTS*

*Consolidates current plans, goals, and initiatives related to the specific assessment area*

As stated repeatedly in this section, other programs and initiatives which lead to decreased fuel and electricity usage will help reduce GHG emissions. Therefore, goals and initiatives in the Fuel and Energy Sections of this Report will be pertinent to this section, as well as land-use policies promoting Transit Oriented Development (TOD), infill, and smart growth.

**Comprehensive Development Master Plan**

The CDMP's Conservation, Aquifer Recharge and Drainage Element contains one goal and one objective contributing to climate change. The goal is to provide for the conservation, environmentally sound use, and protection of all aquatic and upland ecosystems and natural resources and protect the functions of aquifer recharge areas and natural drainage features in Miami-Dade County. Objective CON-1J specifically addresses climate change and states that Miami-Dade County shall continue to implement its CO2 Plan recommendations to reduce CO2 levels.

There are several other county plans containing goals and objectives that while not directly addressing climate change, contribute to overall climate change mitigation goals through the implementation of various fuel and energy reduction strategies. Some of the plans include the Long Range Transportation Plan, the Open Space Master Plan, and the 2003 Strategic Master Plan.

**Existing Legislation**

Federal, state and local legislative efforts all have and will continue to impact climate change mitigation and adaption, transportation, fuel and energy supply and demand.

**Federal**

There are several new federal legislation items at various stages of implementation, some of which will have a direct affect on local regulated industries.

- *Proposed Greenhouse Gas Permitting Requirements on Large Industrial Facilities:* On September 30, 2009 EPA proposed new thresholds for GHG emissions that define when Clean Air Act permits under the New Source Review and Title V operating permits programs would be required. The proposed thresholds would tailor these permit programs to limit which facilities would be required to obtain permits and would cover nearly 70 percent of the nation's largest stationary source GHG emitters—including power plants, refineries, and cement production facilities, while shielding small businesses and farms from permitting requirements.

- *Final Mandatory Reporting of Greenhouse Gases Rule:* EPA has issued the Final Mandatory Reporting of Greenhouse Gases Rule. Signed by the Administrator on September 22, 2009, the rule requires in general that suppliers of fossil fuels and industrial greenhouse gases (GHGs), manufacturers of vehicles and engines outside of the light duty sector, and facilities that emit 25,000 metric tons or more of GHGs per year to submit annual reports to EPA. The rule is intended to collect accurate and timely emissions data to guide future policy decisions on climate change.

- *EPA and NHTSA Propose National Program to Cut Greenhouse Gas Emissions and Improve Fuel Economy for Cars and Trucks*: On September 15, 2009, EPA and the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) proposed a new national program that would reduce greenhouse gas emissions and improve fuel economy for all new cars and trucks sold in the United States. EPA proposed the first-ever national GHG emissions standards under the Clean Air Act, and NHTSA proposed Corporate Average Fuel Economy (CAFE) standards under the Energy Policy and Conservation Act. This proposed national program would allow automobile manufacturers to build a single light-duty national fleet that satisfies all requirements under both Federal programs and the standards of California and other states.

**State**

- *State of Florida Executive Order 07-126: Establishing Climate Change Leadership by Example: Immediate Actions to Reduce Greenhouse Gas Emissions from Florida State Government*

- *State of Florida Executive Order 07-127: Establishing immediate actions to reduce Greenhouse Gas emission within Florida*

- *State of Florida Executive Order 07-128: Establishing the Florida Governor's Action Team on Energy and Climate Change*

**Local**

The following list includes some of the Board's adopted legislation related to climate change. A complete inventory of sustainability related legislation is provided as an appendix.

- *R-35-91: Resolution authorizing Dade County's participation in ICLEI's Cities for Climate Protection Campaign*

- *R-335-91: Resolution authorizing application to the International Council for Local Environmental Initiatives to participate in the urban CO2 Initiative, committing staff resources, stating intent to implement specific CO2 reduction projects and develop a long term CO2 plan by 1993*

- *R-1323-97: Resolution urging Congress to support House concurrent resolution 106 to protect the earth's climate*

- *R-111-97: Resolution ratifying the County Manager's actions of applying for, accepting, and executing a grant from the EPA and the Dept. of Energy for the ClimateWise Program*

- *R-1148-98: Resolution ratifying the County Manager's action to apply for, accept and execute a grant in the amount of $60,000 from the International Council for Local Environmental Initiatives for the Climate Wise Program*

- *R-1356-99: Resolution ratifying the County Manager's action of executing a grant from the International Council for Local Environmental Initiatives for the Climate Wise Program; and authorizing the County Manager to exercise the modification provisions therein*

- *R-132-99: Resolution authorizing Miami-Dade County's participation in the Cities 21 Project sponsored by the International Council for Local Environmental Initiatives*

- *R-966-00: Resolution urging State and Federal action and response planning regarding global warming*

- *O–06-113: Ordinance creating the Miami-Dade County Climate Change Advisory Task Force (CCATF)*

  In July of 2006, the Board of County Commissioners passed an ordinance that established the CCATF. The task force's 25 appointed members are a diverse and highly knowledgeable group of individuals representing various sectors of the community who are charged with reviewing and analyzing climate change data and information, and subsequently providing recommendations to the Board for actions that should be taken now and in the near future to further reduce greenhouse gas emissions, and plan and prepare for future projected climate change impacts. Six task force committees have been established to focus on specific areas of climate change mitigation and adaptation. The original 34 recommendations are in Appendices section of this report. The recommendations are in varying stages of evaluation and implementation and will be incorporated into GreenPrint as appropriate.

- *R-324-07: Resolution authorizing and directing the County Manager to apply for and obtain Miami-Dade County membership in the Chicago Climate Exchange as a Phase II Member for direct emissions*
  Miami-Dade County became a member of the Chicago Climate Exchange in 2007 which requires the County to reduce fuel-related emissions six percent below the year 2000 baseline by 2010.

- *R-1431-08: Resolution endorsing Miami-Dade County's participation in U.S. Cool Counties Program and its goals and objectives including the Climate Stabilization Declaration*
  Through our participation in U.S. Cool Counties Program and its goals and objectives including the Climate Stabilization Declaration, the County commits to reducing its Greenhouse Gas emissions by 80 percent by 2050.

- *R-1388-09: Resolution establishing Southeast Florida Regional Climate Change Compact*

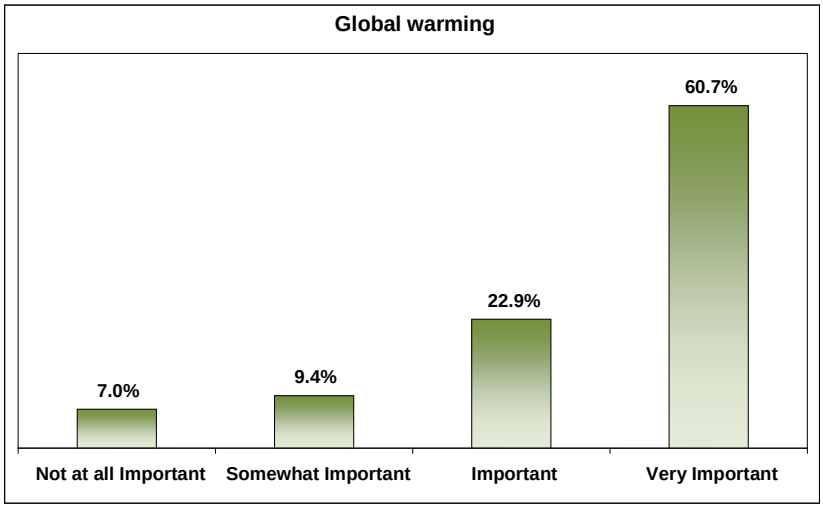
**US Conference of Mayor's Climate Protection Program**
Mayor Carlos Alvarez signed the US Conference of Mayor's Climate Protection Agreement in July 2007, in which the County agrees to meet or beat the Kyoto Protocol of reducing global warming pollution levels to seven percent below 1990 levels by 2012.

## ***COMMUNITY FEEDBACK***

*Feedback & results gathered though the planning process or surveys*

***2035 Miami-Dade County Long Range Transportation Plan***
***Public Involvement Survey – October 2008***
Public feedback was collected through both an online survey and the use of the Option Finder Technology during public involvement sessions held throughout the County. A total of 417

responses were collected through the online survey, while a total of 294 responses were collected during public involvement sessions. The following is the result of the climate change-related question:




***Major Issues related to climate change as identified during public workshops for the 2010 Evaluation and Appraisal Report – Summer 2009***

During the summer of 2009, several public workshops were held to solicit community feedback on the County's Comprehensive Development Plan, as part of the Evaluation and Appraisal Report process required by the State of Florida. From the input received, the following issues were identified as preliminary "Major Issues" to be addressed specifically in regard to Climate Change/Sea Level Rise.

- Address the Interrelationship of Federal, State, Regional, and Local studies on climate change (including impacts of sea level rise and reduction of greenhouse gas emissions) and the applicability of these studies to Miami-Dade County;
- Summarize the County's work to date regarding Mitigation and Adaptation Strategies;
- Evaluate the current Comprehensive Plan Policies with regard to HB 697; and
- Explore New Comprehensive Plan Policy options.

Furthermore, since growth management and transportation issues are closely tied to climate change mitigation (GHG emissions), several other issues identified under Growth Management and Transportation/Mobility were identified:

- Explore Potential Strategies and Incentives for Directing Growth to existing and future urban centers, densifying major corridors, creating new employment centers
- Protect of Natural resources;
- Address Redevelopment and Infill potential;
- Address Comprehensive Everglades Restoration Plan impacts;
- Address the transportation component of HB 697 (Energy);
- Discuss how the County can more effectively achieve pedestrian friendly and walkable communities;
- Promote park connectivity on a countywide basis;
- Explore concepts such as mobility fee zones to help supplement existing transportation facilities and services; and
- Evaluate potential incentives for transit oriented development.