REGIONAL CLIMATE ACTION PLAN

HIA

Minimizing the Health Effects of Climate Change in the South Florida Region: A Health Impact Assessment

FINAL REPORT

September 2013 - March 2014

Florida Public Health INSTITUTE
Research. Policy. Education.

BROWARD COUNTY FLORIDA

SOUTHEAST FLORIDA REGIONAL COMPACT CLIMATE CHANGE

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Acknowledgments

The Florida Public Health Institute (FPHI) would like to extend a special thank you to the Regional Climate Action Plan (RCAP) health impact assessment (HIA) steering committee members for their commitment to monthly meetings, reviewing HIA materials in a timely manner, and valuable expert input and guidance into this HIA process. An additional thank you is due to the Southeast Florida Regional Climate Change Compact (SEFRCCC) for their visionary efforts to include the health impacts of climate change in the consideration of climate change-related policies in Southeast Florida.

FPHI is a freestanding 501(c)(3) corporation incorporated in 2001, that conducts action oriented research and promotes leadership, partnerships and collaborations to build capacity for strong public health policy, programs, systems and practices. FPHI serves as a neutral convener working with various local, state and national leaders to develop public-private partnerships that provide recommendations and solutions to health-related matters for the citizens of Palm Beach County, the state of Florida and the national community. FPHI's mission is to "advance the knowledge and practice of public health to promote, protect and improve the health of all." FPHI accomplishes this by promoting improvements in health by providing information and knowledge to inform health policy, conducting applied research and supporting multi-stakeholder collaborations to support leaders in taking aligned actions for measurable results in order to build healthy communities and create positive health system change.

The SEFRCCC, created in 2010, is a collaborative of four Southeast Florida counties: Broward, Miami-Dade, Monroe, and Palm Beach, to coordinate county efforts in climate change adaptation and mitigation activities across county lines. In 2012 the SEFRCCC released the RCAP and accompanying Implementation Guide, a framework outlining 110 policy recommendations for reducing greenhouse gas (GHG) emissions and building climate resilience throughout the Southeast Florida region. The Compact is currently lending support to the Southeast Florida Partnership in the development of a seven-county, 50-year Prosperity Plan in the area of climate resilience.

This project was made possible by funding from Broward County. The following HIA report was produced by Florida Public Health Institute with support from Urban Health Solutions.

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Executive Summary

The RCAP HIA comprehensively assessed the 110 climate change adaptation and mitigation policy recommendations put forth in the SEFRCCC RCAP to determine the health effects of climate change, specifically sea level rise (SLR) and heat waves. The HIA has the potential to describe the magnitude and distribution of climate change-related health impacts for a portion of the 5.6 million residents in Broward, Miami-Dade, Palm Beach and Monroe counties. Therefore, an understanding of the widespread impact of SLR and heat waves on the health of millions of constituents will be of value to jurisdictions, stakeholders, and decision-makers at multiple governmental and community levels.

HIA Objectives

The purpose of this HIA is to assess the potential health impacts of the 110 climate change adaptation and mitigation recommendations put forth by the SEFRCCC's RCAP. The HIA focuses on the following four objectives:

- Identify potential direct and indirect health impacts of climate change in Southeast Florida due to SLR and heat waves.
- Assess the impact of RCAP recommended climate change adaptation and mitigation policies and resilient strategies on human health outcomes.
- Inform on incorporating RCAP's recommendations for adaptation and mitigation policies and strategies that recognize the need to prepare and address the health impacts due to SLR and heat waves.
- Increase knowledge and awareness throughout the Southeast Florida region of climate change health impacts due to SLR and heat waves.

HIA Methodology

An HIA is a process of assessing the health impacts of a policy, program or plan drawing on a variety of data sources and analytical methods as well as the input from various stakeholders. HIAs can be used for a wide range of policies, programs and plans across many sectors. HIAs are typically done before the implementation of a policy, program, or plan to inform decision makers on the potential health impacts implementation will have on a population. The HIA process typically involves a six step process: 1) Screening, 2) Scoping, 3) Assessment, 4) Recommendations, 5) Reporting, and 6) Monitoring and Evaluation.

There are three types of HIAs: rapid or "mini" or "desk-top," intermediate, and comprehensive or "maxi." This RCAP HIA was an intermediate HIA. An intermediate HIA gives a more thorough assessment of predicted health outcomes than a rapid HIA and provides insight on predicted specific impacts, but does not provide as exhaustive an assessment from multiple angles as would a comprehensive HIA. An intermediate HIA typically requires significant time and resources, taking several months to complete. This RCAP HIA collects and analyzes existing data and gathers qualitative information from key stakeholders and conducts geo-spatial analysis to include in the HIA process. Rapid HIAs usually focus on

existing data, while extensive input from key stakeholders and new data collection was limited. Comprehensive HIAs include the existing data, key stakeholder input and go one step further than intermediate HIAs by collecting new data in an inclusive manner to fully inform the potential health outcomes of a policy, protocol, or program.

During the screening phase it was determined that the RCAP HIA would examine the climate change-related health impacts of SLR and heat waves as the focus of this assessment. It was determined during this phase that health impacts related to SLR and heat waves were particularly pertinent to Southeast Florida given the region's higher temperatures and expansive coastlines. The scoping phase identified the geographic and demographic population of focus for this HIA, identified HIA goals and objectives, prioritized health impacts, developed HIA research questions, and outlined assessment methodology.

Data collection for the assessment phase included a literature review on climate change, SLR, heat waves, and the 11 CDC health effects; two focus groups in rural populations, an existing conditions data analysis; and the mapping of SLR and heat wave vulnerabilities in each of the four Southeast Florida counties. Additional assessments were considered but deemed not feasible in the scope of this HIA but outlined for further research.

Recommendations were developed to inform decision-makers on prioritizing RCAP recommendations with an impact on health effects associated with SLR and heat waves. HIA results and findings were disseminated to relevant local, regional, and state stakeholders through online and print tools using a variety of channels. In-person presentations of the HIA findings were presented to the key stakeholders: Broward County's Natural Resources Planning and Management Division, Rural Health Network of Monroe County, Florida Atlantic University's Center for Environmental Studies, South Florida Regional Planning Council, Florida Department of Health's (FDOH) Building Resilience against Climate Effects (BRACE) Program, FPHI, U.S. Centers for Disease Control and Prevention (CDC), Oregon Public Health Institute, FDOH's Bureau of Environmental Health, and the Institute for Sustainable Communities. The HIA report, fact sheets, and steering committee information and meeting minutes available online at the FPHI website: www.flphi.org. Social media tools like blogs, Facebook, and Twitter posts helped HIA results reach a wider audience in sharing findings from the report and directing interested parties to more information.

HIA Recommendations

The HIA report provides six recommendations designed to inform the RCAP how to best incorporate health considerations into their current guidelines for policies and protocols related to SLR and heat waves. The six recommendations are the following:

1. *Integrate public health planning with municipal and regional planning to prepare Southeast Florida for the broader impacts of Climate Change.*

2. *Educate the public and elected officials on health outcomes associated with climate change.*

3. *Include heat vulnerability, health, and socio-economic factors when developing vulnerability mapping or determining priority zones.*

4. *Encourage, foster, and support investigative work to fully understand the impacts and economic costs attributed to climate change and health.*

5. *Establish health-related metrics to use when planning for adaption strategies to mitigate climate change effects.*

6. *Revisit city and county development plans and revise based on heat vulnerability mapping a specific amount of shade trees or canopy to increase safe active access to goods in extreme heat*.

List of Tables, Figures, Maps, and Diagrams

List of Acronyms

AAA	Adaptation Action Area
ACS	American Community Survey
AHCA	Agency for Healthcare Administration
BRACE	Building Resistance against Climate Effects
CCATF	County Climate Change Advisory Task Force
CDC	Centers for Disease Control and Prevention
CERP	Comprehensive Everglades Restoration Plan
CHIP	Community Health Improvement Plan
CLRD	Chronic Lower Respiratory Disease
CRA	Comparative Risk Assessment
DALY	Daily Adjusted Life Years
DOTs	Departments of Transportation
EPA	United States Environmental Protection Agency
FAU	Florida Atlantic University
FDOH	Florida Department of Health
FGBC	Florida Green Building Coalition
FPHI	Florida Public Health Institute
FWHA	Florida Highway Administration
GHG	Greenhouse Gases
GIS	Geographic Information System
HIA	Health Impact Assessment
ICELI	International Council for Local Environmental Initiatives
LBW	Low Birth Weight
LEED	Leadership in Energy & Environmental Design
LST	Land Surface Temperature
MPOs	Metropolitan Planning Organizations
NACo	National Association of Counties
NCD	Non-Communicable Disease
NOAA	National Oceanic and Atmospheric Administration
PM	Particulate Matter
PTSD	Post-Traumatic Stress Disorder
RCAP	Regional Climate Action Plan
SEFRCCC	Southeast Florida Regional Climate Change Compact
SHIP	State Health Improvement Plan
SLR	Sea Level Rise
SPI	Standard Precipitation Index
STZC	Surface Thermal Zone Classification
UHS	Urban Health Solutions
USACE	United States Army Corps of Engineers
USGS	U.S. Geological Survey
UV	Ultraviolet
WHO	World Health Organization
YLL	Years of Life Lost
YLD	Years Lost due to Disability

Introduction

The RCAP HIA was conducted to assess the SEFRCCC RCAP's 110 climate change adaptation and mitigation policy recommendations to determine the effects of climate change, specifically SLR and heat waves, on the health of four Southeast Florida counties. The HIA describes the potential vulnerability and health impacts some of the 5.6 million residents living in Broward, Miami-Dade, Palm Beach, and Monroe counties will face as climate change affects Southeast Florida's SLR and heat waves. An understanding of the widespread impact of SLR and heat waves on the health of millions of constituents will be of value to jurisdictions, stakeholders, and decision-makers at multiple governmental and community levels. This HIA serves as a decision-making tool that informs local and regional decision-makers on maximizing positive health outcomes when prioritizing the implementation of RCAP recommendations.

Southeast Florida Regional Climate Change Compact

Florida's vulnerability to the effects of climate change has been on the agendas of Southeast Florida counties and cities for many years. In 2009, officials from Broward, Miami-Dade, Monroe, and Palm Beach counties recognized the need for a more coordinated effort in developing SLR scenarios and baseline emissions figures. Elected officials from four Southeast Florida counties- Broward County, Miami-Dade County, Monroe County, and Palm Beach County came together to commit their efforts to host the first Regional Climate Leadership Summit in October of 2009 to bring together local officials and the communities for a discussion on the challenges climate change posed for Southeast Florida. Four months later, in January of 2010, the SEFRCCC was ratified by each of the four County Commissions. The Compact committed to the following:

- Joint legislative policy development;
- Development of a regional GHG baseline;
- Development of regionally consistent SLR projections for the coming
- decades;
- Development of Preliminary Inundation Mapping;
- Development of a RCAP; and
- Coordination of Annual Leadership Summits.

Since its inception, the Compact has successfully created an inventory of baseline GHG emissions in Southeast Florida and developed unified SLR projections and an SLR vulnerability assessment to provide a technical foundation for addressing regional climate issues. The group produced the *Analysis of the Vulnerability of Southeast Florida to Sea Level Rise* report on regional vulnerability with an inventory of property and infrastructure vulnerable at SLR scenarios. The Compact works with local, regional, state, and federal agencies such as National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), and the U.S. Army Corps of Engineers (USACE), among others, to champion these efforts. Between 2010 and 2012, the Compact coordinated state and federal legislative programs on climate change issues leading to the successful amendment of Florida law to designate Adaptation Action Areas (AAA). AAAs are identified as areas particularly vulnerable to climate change impacts, especially SLR, and are highlighted to encourage technical assistance and funding support in planning for future climate change effects. The Compact's accomplishments have garnered attention from a variety of audiences

including federal legislators, local universities, and funders. Most recently, the White House made a request to the Compact to produce a white paper about the Compact for the White House Domestic Policy Council. Additionally, the Compact has won multiple awards for their work towards sustainability and their coordinated efforts, such as the "Process Innovation to Institutionalize Sustainability" award from the International Council for Local Environmental Initiatives (ICLEI) Local Governments for Sustainability USA in 2010 and the National Association of Counties (NACo) Achievement Award in 2010 for conducting the Southeast Florida Regional Climate Leadership Summit and in 2011 for progress implementing the Compact

Regional Climate Action Plan

In early 2011, the Compact steering committee, with the input from almost 100 experts, academics, non-profits, government, and private sectors, began work on the development of the RCAP. Their input drew from best practices at the local and regional levels, while also including new methods for integrating climate change planning into local and regional governmental decision-making processes.

The RCAP was released in October 2012 and included 110 policy recommendations for reducing GHG emissions and building climate resilience throughout the region. The objective of the RCAP was and still is to integrate climate change adaptation and mitigation planning into existing local decision-making systems by providing a framework for local and regional implementation. The recommendations fell under one of the seven RCAP goals to be accomplished over the course of five years. These goals are:

1. Sustainable Communities and Transportation Planning
2. Water Supply, Management and Infrastructure
3. Natural Systems
4. Agriculture
5. Energy and Fuel
6. Risk Reduction and Emergency Management and
7. Outreach and Public Policy

Several approaches for implementing the 110 policy recommendations were outlined in the RCAP. These approaches include: using existing legal structures and decision-making processes; developing new policy guidelines; developing operational guidance documents; developing consistent goals and progress indicators throughout the local governments in the region; coordinating multi-disciplinary outreach and education efforts; and developing processes for focusing and prioritizing investments.

The RCAP serves as a framework for the Compact counties and their partners to guide the implementation of policies and programs taking into account the differing government structures, procedures, agencies, and environments of each individual. The RCAP is a living document that will evolve over time as data becomes available, projections are revised, and best practices are developed.

Looking Forward

The Compact is currently lending support to the Southeast Florida Partnership in the development of a seven county, 50-year Prosperity Plan, called Seven50, in the area of climate resilience and will share HIA findings upon project completion. Within the next two years, the Compact will begin to prioritize

areas to implement the RCAP. In the screening phase, the HIA was designed to be timely so its findings and recommendations are able to assist decision-makers and jurisdictions within the Compact planning area and the seven county region in understanding the local health implications of climate change for each of the seven goals of the Climate Change Compact's Action Plan.

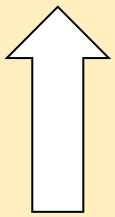
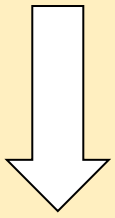
Links to all of the SEFRCCC documents, including the RCAP, are available in the Appendix F: Resources section of this report.

Screening

Methodology

The National Research Council of the National Academies in *Improving Health in the United States: The Role of Health Impact Assessment* defined the HIA as "HIA is a systematic process that uses an array of data sources and analytic methods and considers input from stakeholders to determine the potential effects of a proposed policy, plan, program, or project on the health of a population and the distribution of those effects within the population." An HIA provides recommendations on monitoring and managing those effects." **Table 1** identifies and defines each of the six steps of the HIA process.

Table 1: Steps of the HIA Process

Screening	
Determine whether an HIA is needed and likely to be useful.	
Scoping	
In consultation with stakeholders, develop a plan for the HIA, including the identification of potential health risks and benefits.	
Assessment	**Public input encouraged at each step.**
Describe the baseline health of affected communities and assess the potential impacts of the decision.	
Recommendations	
Develop practical solutions that can be implemented within the political, economic or technical limitations of the project or policy being assessed.	
Reporting	
Disseminate the findings to decision makers, affected communities and other stakeholders.	
Monitoring and Evaluation	
Monitor the changes in health or health risk factors and evaluate the efficacy of the measures that are implemented and the HIA process as a whole.	

Source: The Health Impact Project, www.healthimpactproject.org/

Screening

The purpose of the HIA process is to better inform decision-makers before decisions are made on a policy, program, or project. Screening, the first step in the HIA process, was used to screen in projects, programs, or policies that were feasible, timely, and add value to the overall decision-making process while screening out those that do not fit this criteria. Screening also determines whether health has already been considered in the policy, project, or program and the scope with which the HIA took.

FPHI was awarded a grant from Broward County to conduct a HIA to comprehensively assess, through a health lens, the 110 recommendations put forth by the SEFRCCC RCAP. This HIA helps the SEFRCCC and other stakeholders and decision-makers better understand the local health impacts climate change will have on the residents of four Southeast Florida counties so that these decision-makers are better informed during their decision-making process.

A preliminary screening was conducted for the grant proposal with SEFRCCC participants followed by a more extensive screening that incorporated feedback and input from the steering committee. A categorization of the recommendations was conducted on the health impacts of SLR and heat waves to help inform the final recommendations prior to the HIA assessment. It was determined that this would be the most valuable way to inform decision-makers on how best to prioritize RCAP recommendations to maximize positive health outcomes. Thus far, the RCAP recommendations have not considered the health impacts of SLR and heat waves in the implementation of the 110 recommendations; therefore, it was determined that as assessment of this would be valuable information for decision-makers.

Feasibility

The HIA was screened and it was determined that adequate information and resources were available to conduct the HIA within the timeframe.

An important resource in the HIA process was the participation of key stakeholders who served as projects partners from the beginning of the HIA process, starting with the screening step and until its conclusion. FPHI identified key stakeholders from the SEFRCCC; Florida HIA Consortium; FDOH; Southeast Florida Partnership and members of the Partnership's Seven/50; the Florida Center for Environmental Studies at FAU; the CDC; Rural Health Network of Monroe County; South Florida Regional Planning Council; Florida Center for Environmental Studies; FDOH's BRACE Program; Broward County's Natural Resources Planning and Management Division; Oregon Public Health Institute; FDOH's Bureau of Environmental Health; and the Institute for Sustainable Communities.

The exposures to be assessed, SLR and heat waves, were prioritized on four qualitative rather than quantitative factors. First, a review of the RCAP found that the term "health" was mentioned throughout the report in more general terms relating to sustainable healthy communities and healthy habitats. The potential health benefits of the RCAP recommendations were not looked at closely in the HIA report. Secondly, during a meeting with SEFRCCC participants, the group expressed interest in reviewing SLR and heat waves. Thirdly, the HIA was an intermediate assessment conducted over a six-month period and focusing on two exposures that kept with the HIA feasibility. Finally, Southeast Florida is recognized as being one of the most vulnerable regions in the world to SLR, due in large part to the region's low-lying, porous land. Statewide and local efforts related to SLR are already underway, demonstrating that the community was ready to look at the health effects of SLR.

Ideally, an HIA on the entire spectrum of climate change health impacts relevant to the proposed recommendations would be assessed, but this was determined to not be feasible given timing and funding.

Decision Points

The HIA informs the SEFRCCC on the potential health impacts of proposed RCAP policy and protocol recommendations and provide recommendations for prioritizing those RCAP recommendations with the greatest positive health impact on the populations of the four counties. The SEFRCCC plans to prioritize implementing these recommendations within the next two years. Therefore, the decision was made to have the HIA conducted over a six-month period from September 2013 to March 2014 so that the SEFRCCC and relevant local, regional, and state decision-makers had the necessary information to inform their decisions on prioritization during the implementation timeframe.

Relevance

The RCAP HIA was particularly relevant and important to Southeast Florida given the regions aforementioned vulnerability to the effects of SLR. Current SLR projections show that Southeast Florida's populations will be experiencing the effects of SLR within the coming decades. Florida's policy-makers have already begun to plan and adapt for the effects SLR will have on the populations and existing infrastructure.

With the growing need to implement adaptation and mitigation climate change policies at the local, regional, and national levels, this HIA comes at an important point in the climate change policy-making discussion. Within the past few years Florida has implemented a number of initiatives focused on adapting to and preparing for the effects of climate change. In 2012, the FDOH adopted the CDC BRACE framework. This BRACE framework is a five step process that provides guidance to health departments in states and cities to develop strategies and programs to confront the health implications of climate change.

5 Steps of the BRACE Framework	
Step 1	Forecasting Climate Impacts and Assessing Vulnerabilities
Step 2	Projecting the Disease Burden
Step 3	Assessing Public Health Interventions
Step 4	Developing and Implementing a Climate and Health Adaptation Plan
Step 5	Evaluating Impact and Improving Quality of Activities

Source: CDC (2012)

This HIA directly contributes to Step 1 in the framework: *Forecasting Climate Impacts and Assessing Vulnerabilities*, by identifying the scope of climate impacts, the potential health outcomes and vulnerable populations and geographic locations. BRACE is currently working in Step 1 and messages for Step 2: *Projecting the Disease Burden* will be completed by March 2014 when the HIA was completed. The HIA team worked closely with BRACE to assure that the health indicators identified in Step 1 were considered for the HIA assessment. Considering the large number of residents in Southeast Florida that will potentially be affected by SLR and heat waves, this HIA helps demonstrate how to best prioritize recommendations and policies at the local and regional levels with the greatest impact on minimizing the negative health outcomes of SLR and heat waves.

This HIA is the first of its kind in assessing the health impacts of SLR and heat waves and is the model on how to assess the potential health impacts of these climate change factors within the policy prioritization and decision-making process. While previous HIAs have looked at climate change impacts this is the first HIA to conduct such a detailed analysis of both existing and new data to contribute to the policy-makers' understandings of the health impacts.

Stakeholder Engagement

One of the fundamental elements of an HIA is the inclusion of key stakeholders and the public in the HIA process. The HIA laid out the process for engaging the public and stakeholders at the beginning of the HIA by drafting a Public Involvement Plan that outlined how the public was included throughout the HIA process; the goals, objectives, and strategies for involvement; and how this involvement was measured for evaluation. At the start of the HIA process, a steering committee was created comprised of key stakeholders including county representatives, researchers from FAU, HIA professionals, the FDOH, the CDC, representatives from local councils, and local and regional public health and climate change institutes. The steering committee was tasked with prioritizing research questions, providing expertise on research plan and analysis, reviewing drafts of the final report, helping disseminate findings, and providing feedback throughout the entire HIA process.

In addition to the steering committee, other partners and community members who participated throughout the HIA process. Transparency was an important value in the HIA process and in order to ensure this principle was upheld, all HIA report drafts and steering committee meeting minutes were posted on the FPHI website available to the public.

Scoping

The scoping step identified the project research plan and timeline for conducting the HIA and defined the research questions, priority health issues, and methodology.

FPHI and the Broward County Natural Resources Planning and Management Division developed the scoping process with input from key stakeholders. The scope of analysis was defined by FPHI and the Broward County Natural Resources Planning and Management Division in September 2013 and was submitted for review by the HIA steering committee.

Geography

The geographic area of interest was the Broward, Miami-Dade, Monroe, and Palm Beach counties in Southeast Florida.

Map 1: Florida's Broward, Miami-Dade, Monroe and Palm Beach Counties

Source: Florida Department of Transportation

Palm Beach County is the largest of the four counties, followed closely by Miami-Dade County (**Table 2)**. In total, the four counties cover more than 6,000 square miles of the state.

Table 2: Land Area in Square Miles, 2010

Area	County				Florida
	Broward	Miami-Dade	Monroe	Palm Beach	
Land area in square miles	1,209.79	1,897.72	983.28	1,969.76	53,624.76

Source: U.S. Census Bureau (2014)

Population

The populations identified encompass the 5.6 million residents of the Broward, Miami-Dade, Monroe, and Palm Beach counties.

Table 3 demonstrates that approximately one-fifth of the population in the state of Florida as well as Broward, Miami-Dade, and Palm Beach counties are under the age of 18. This was true for a smaller proportion in Monroe County (14.9%). Monroe and Palm Beach counties have a larger percentage of older adults than Broward and Miami-Dade counties by four and six percentage points respectively.

Table 3: Percent Population by Age, 2012

Population	County				Florida
	Broward	Miami-Dade	Monroe	Palm Beach	
Under 18 Years	21.6%	21.0%	14.9%	20.1%	20.7%
65 Years or Older	14.7%	14.5%	19.0%	22.1%	18.2%

Source: U.S. Census Bureau (2014)

Race and Ethnicity

The populations of all four counties are predominantly White; however, only Monroe County has a White population higher, 90.2%, than the state population of 78.3% (**Table 4)**. Broward County has the largest population of Black or African Americans at 27.9% compared to the other counties and state population. Miami-Dade County has a much higher percentage of Hispanics or Latinos at 64.3% compared to the other counties and state, which all fall in the 20% range.

Table 4: Race and Ethnicity, 2012 (Percent Population)

Race and Ethnicity	County				Florida
	Broward	Miami-Dade	Monroe	Palm Beach	
White	66.1%	77.6%	90.2%	76.9%	78.3%
Black or African American	27.9%	19.2%	6.4%	18.2%	16.6%
American Indian and Alaska Native alone	0.4%	0.3%	0.5%	0.6%	0.5%
Asian	3.5%	1.7%	1.2%	2.6%	2.7%
Native Hawaiian and Other Pacific Islander	0.1%	0.1%	0.1%	0.1%	0.1%
Two or More Races	2.0%	1.2%	1.6%	1.6%	1.9%
Hispanic or Latino	26.5%	64.3%	21.4%	20.1%	23.2%
White alone, not Hispanic or Latino	41.9%	16.3%	69.9%	58.7%	57.0%

Source: U.S. Census Bureau (2014)

**Race groups do not add up to 100% due to the Census consideration that Hispanic origin is not a race, and persons of Hispanic origin may be of any race.*

Table 5: Education-Level, 2007-2011 (Percent Population 25 Years and Older)

Education	County				Florida
	Broward	Miami-Dade	Monroe	Palm Beach	
High School Graduate or Higher	87.3%	77.6%	89.3%	87.1%	85.5%
Bachelor's Degree or Higher	29.9%	26.2%	27.8%	32.2%	26.0%

Source: U.S. Census Bureau (2014)

Education

Miami-Dade County has the lowest percent of the population earning a high school degree or higher at 77.6% (**Table 5**). Broward, Monroe and Palm Beach Counties all have higher rates than the state average of 85.5%.Palm Beach County has the highest percent of the population with a bachelor's degree or higher (32.2%) and all four counties are above the state average of 26.0%.

Income and Poverty

Table 6 indicates that Miami-Dade County has the lowest median household income ($43,957) than the state average ($47,827) and the other three counties. Broward, Monroe and Palm Beach Counties are all above the state average. Miami-Dade County has the highest percentage of population with persons living below the poverty level at 17.9% (**Table 7**). The other three counties are all below the state average of 14.7%.

Table 6: Median Household Income, 2007-2011

Household Income	County				Florida
	Broward	Miami-Dade	Monroe	Palm Beach	
Median Household Income	$51,782	$43,957	$53,889	$52,951	$47,827

Source: U.S. Census Bureau (2014)

Table 7: Persons Below Poverty Level, 2007-2011 (Percent Population)

Poverty Level	County				Florida
	Broward	Miami-Dade	Monroe	Palm Beach	
Persons Below Poverty Level	13.0%	17.9%	11.6%	13.3%	14.7%

Source: U.S. Census Bureau (2014)

Goal

The goal of the HIA was to determine the health impacts of the 110 recommendations from the RCAP pertaining to SLR and heat waves if incorporated into existing systems at the local and regional levels in Southeast Florida.

Objectives

The four objectives for the HIA are listed in **Table 8.** The HIA identified potential health impacts of climate change, assessed the effect the RCAP's recommended policies and strategies relating to SLR and heat waves will have on these health impacts, informed on which RCAP recommendations prepared and addressed these health impacts and increase knowledge and awareness.

Table 8: Health Impact Assessment Objectives

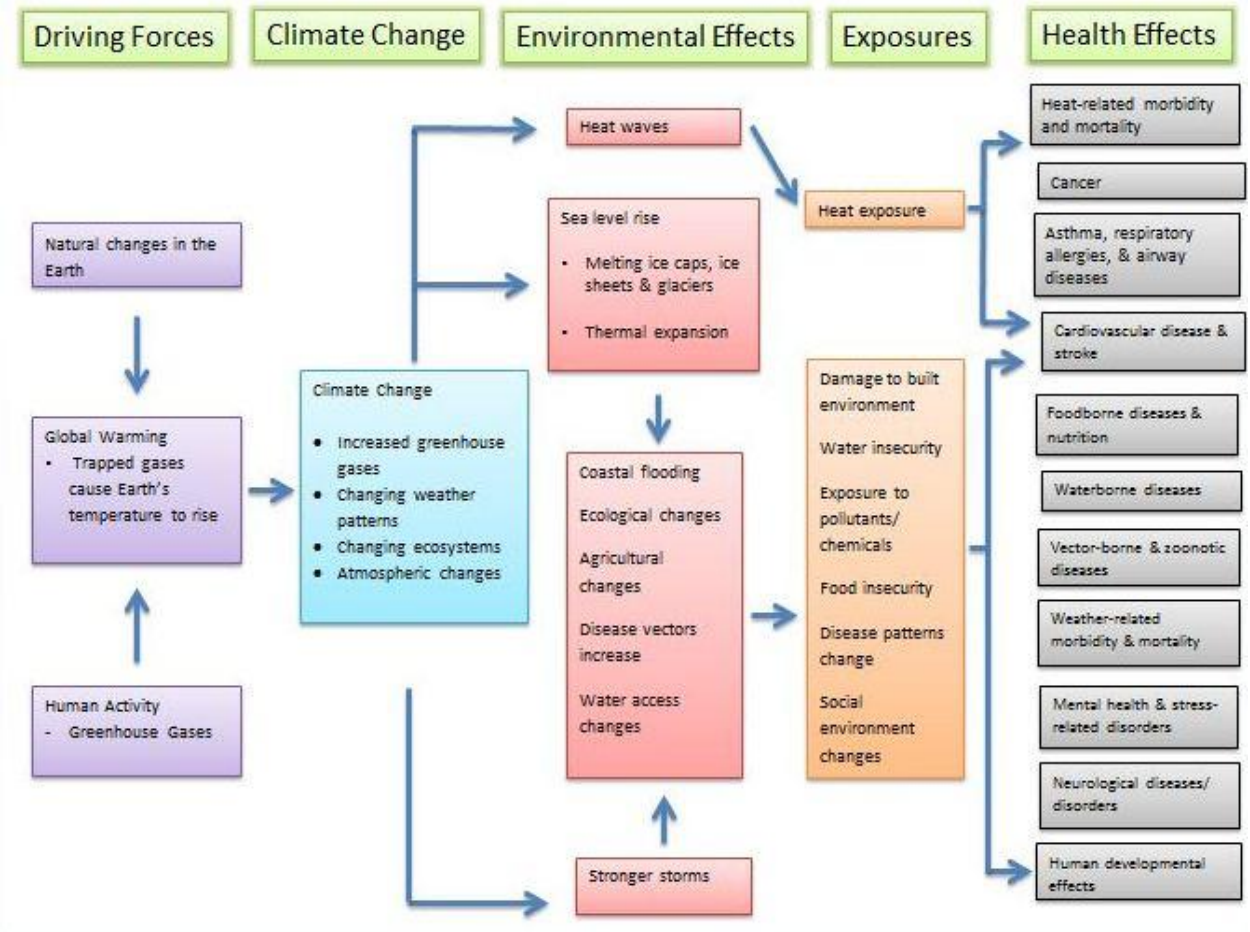
Objective 1	Identify potential direct and indirect health impacts of climate change in Southeast Florida due to sea level rise and heat waves.
Objective 2	Assess the impact of RCAP recommended Climate Change adaptation and mitigation policies and resilient strategies on human health outcomes.
Objective 3	Inform on incorporating RCAP's recommendations for adaptation and mitigation policies and strategies that recognize the need to prepare and address the health impacts due to sea level rise and heat waves.
Objective 4	Increase knowledge and awareness throughout the Southeast Florida region of climate change health impacts due to sea level rise and heat waves.

The HIA focused on the 110 recommendations put forth by the SEFRCCC on climate change from the RCAP that related to SLR and heat waves and how these recommendations were likely to impact health. The 110 recommendations were categorized within the RCAP under six chapters and were further divided into 14 categories to be cross analyzed with the CDC's list of 11 potential health effects of climate change: (1) weather-related morbidity and mortality; (2) vector-borne and zoonotic diseases; (3) waterborne diseases; (4) mental health and stress-related disorders; (5) human developmental effects; (6) neurological diseases and disorders; (7) foodborne diseases and nutrition; (8) cardiovascular disease and stroke; (9) cancer; (10) health-related morbidity and mortality; (11) asthma, respiratory allergies and airway diseases. These health effects were analyzed by category and within their objective.

Pathways Diagram

A causal pathways diagram was created to conceptualize the proposed pathways between climate change and the potential health outcomes of SLR and heat waves. This was a preliminary diagram that evolved over the life of the HIA as research was conducted and assessments were made.

Diagram 1: Climate Change Health Effects from Sea Level Rise and Heat Waves Diagram



Source: CDC http://www.cdc.gov/climateandhealth/effects/default.htm; Kjellstrom, T. and McMichael, A. (2013). Climate change threats to population health and well-being: the imperative of protective solutions that will last. Global Health Action, 10, 3402.

Assessment

A four-step process of assessment of the potential health impacts was selected for this HIA, to be precluded by an existing conditions data assessment to determine what baseline health conditions currently exist for comparison. These findings described the direction, magnitude, and distribution of potential health impacts. The assessment began by cataloging the 110 recommendations of the RCAP, followed by an existing conditions data collection, and a literature review on climate change, SLR, heat waves, and each of the 11 CDC health effects. Surveys and focus groups were conducted to gather the opinions of climate change-related professionals, community members, and those residing in rural areas. A CRA was originally intended to be applied to local data to understand the risk for the region and identify those recommendations with the greatest potential health impacts due to mitigation. Daily adjusted life-years (DALYs) were then going to be calculated to determine the value of mitigating strategies health outcomes, and a cost-effectiveness analysis would followed to inform local decision-makers on the impact of adopting the recommendations set forth. Finally, mapping of each county's vulnerability to future SLR and heat wave scenarios provided a visualization of the distribution of these vulnerabilities.

Evaluation of Potential Health Impacts

Cataloging the 110 Recommendations

The first step of analysis for the HIA determined the health effects of the proposed recommendations pertaining to SLR and heat waves outlined in the RCAP. To determine these health effects, the RCAP's 110 recommendations within six chapters were categorized during a preliminary review into 14 categories. Considering the focus of this HIA is on SLR and heat waves, those categories directly pertaining to SLR and heat waves were singled out for review of their potential health impacts. **Table 9** lists the categories for review, corresponding health impacts and adaptation and mitigation strategies for each category.

Existing Conditions Data Collection

Existing conditions data was collected for each of the four counties and for the Southeast Florida region if available. The existing conditions data collection focused on current local and regional trends in climate change policy and protocol adoption; related health issues that were omitted from assessment; and the current status of health issues related to SLR and heat waves in the Southeast Florida region. Data on the current health conditions was collected from a number of sources: U.S. Census Bureau, FDOH, Agency for Healthcare Administration (AHCA), National Vital Statistics System, NOAA, EPA, USGS.

Literature Review

A literature review was conducted following the existing conditions analysis of each of the nine categories that relate to SLR and heat waves and their corresponding 11 health effects to determine the extent of evidence of the impact on the health effects.

Mapping

Vulnerability mapping for SLR and heat waves was created for each of the four counties. The mapping assessment looked at which areas had populations within each of the four counties most vulnerable to specified SLR and heat wave scenarios. Maps took into account rates of relevant potential health effects identified as potentially being affected by climate change.

Cataloging the 110 Recommendations

All of the 110 recommendations proposed in the RCAP are designed to address multiple facets of climate change. In the original screening, 57 of the 110 were selected based on their direct applicability to SLR and heat waves. These recommendations were then cross analyzed with the CDC's 11 potential climate change health effects and it was determined that all of the 11 potential health effects related to SLR and heat waves were reviewed. This step was valuable at the beginning and as a final step in the assessment. Once the other components were completed, the HIA practitioners applied the gathered information to inform specific policy and implementation strategies through the report's recommendations.

The 110 recommendations fall into the following categories:

RCAP Recommendation Categories	
Sustainable Communities and Transportation Planning	**SP**
Water Supply, Management and Infrastructure	**WS**
Natural Systems	**NS**
Agriculture	**AG**
Energy and Fuel	**EF**
Risk Reduction and Emergency Management	**RR**
Public Outreach	**PO**
Public Policy	**PP**

Table 9a: Cataloging of RCAP Recommendations for Sea Level Rise and Heat Wave

RCAP Recommendations Specific to Mitigating and Adapting to Sea Level Rise and Heat Waves	
Recommendation	**Synopsis**
SP-1	Incorporate 110 recommendations into land use and policy decisions.
SP-2	Develop policies, programs that will guide climate change-related planning.
SP-17	Convert areas of blight to gardens and markets to help reduce urban heat island effect.
SP-18	Engage multiple sectors in developing transportation services thru adaptation and mitigation.
SP-19 (all)	Focus transport investments on adaptation and mitigation strategies and resiliency.
SP-20	Require development to include more alternate modes of transport (walking, biking, etc.).
WS-7	Develop integrated water management plans.
WS-9	Incorporate and prioritize climate adaptation improvement projects.
WS-10	Support scientific research on improving understanding of local and regional climate impacts, including sea level rise.
WS-11	Identify and fill in data gaps.
WS-14	Cultivate partnerships (NOAA, etc.) as important potential resources.
WS-15	Monitor changes in precipitation to predict future.
PO-1	Provide outreach on importance of addressing climate change, develop education programs.

PO-2	Counties, municipalities, and agencies collaborate on outreach and education.
PO-3	Educate and communicate on energy conservation and technologies.
PP-1	Advocacy for policies recognizing Southeast Florida's unique vulnerabilities, especially sea level rise.
RR-3	Local risk assessments, develop strategies for post-disaster planning and hazard mitigation.
Total:	**17**

Table 9b: Cataloging of RCAP Recommendations for Heat Wave

RCAP Recommendations Specific to Mitigating and Adapting to Heat Waves	
Recommendation	**Synopsis**
SP-30	Increase amenities to transit riders, such as providing shade.
Total:	**1**

Table 9c: Cataloging of RCAP Recommendations for Sea Level Rise

RCAP Recommendations Specific to Mitigating and Adapting to Sea Level Rise	
Recommendation	**Synopsis**
SP-3	Identify AAAs vulnerable to sea level rise.
SP-4	AAAs and sea level rise.
SP-5	Conduct vulnerability analysis on sea level rise.
SP-6	Develop policies for AAAs to improve resilience to sea level rise.
SP-7	Develop sea level rise maps for planning.
SP-8	Identify AAAs and vulnerable areas for improved resilient infrastructure.
SP-9	Coordinate regional efforts to identify improvements needed in AAAs.
SP-10	Develop rules and regulations to prevent developing in areas with sea level rise risk.
SP-11	Identify vulnerable populations in AAAs.
SP-12	Develop flood maps of 100-year storm with future sea level rise scenarios to advise future development.
SP-14	Identify "Growth Areas" of high elevation and with existing infrastructure for development.
SP-15	Develop new transportation standards for development that includes environmental supportive materials and storm water management.
SP-16	Develop policies addressing transportation infrastructure development in flood vulnerable areas.
WS-1	Develop local and regional reserves of water supplies.
WS-2	Develop regional saltwater intrusion baselines.
WS-3	Use inundation maps to identify areas of increased risk of flooding, sea level rise.
WS-4	Evaluate impacts of sea level rise on soil storage, infiltration rates, inflow to storm water and wastewater collection, consider long-term effects on water quality.
WS-5	Develop hydrological/ hydraulic models to evaluate water management systems and flood control infrastructure.
WS-6	Identify flood control and storm water management infrastructure already operating.
WS-8	Develop and test water management and drainage system adaptation improvements

WS-12	Develop and exchange information, methods, and technical capabilities addressing concerns of sea level rise.
WS-13	Develop agency capabilities to provide rapid resources during times of storm events and intense rain.
WS-16	Manage water storage to protect high quality water supply.
WS-17	Comprehensive Everglades Restoration Plan- sea level rise and saltwater intrusion.
WS-18	Land acquisition to protect high quality water supply.
NS-1	Develop vital signs and trends monitoring for sea level rise and saltwater intrusion.
RR-1	Vulnerability analysis on economic value of infrastructure at risk of sea level rise.
RR-2	Evaluate and improve adaptation responses for communities at risk of flooding.
RR-4	Identify transport infrastructure at risk under sea level rise scenarios.
RR-5	Enforce coastal construction line.
RR-6	Adopt consistent plans at regional level to address and integrate mitigation, sea level rise and adaptation.
RR-7	Implement and enforce building codes requiring new construction and improvements against flood, sea level rise.
PO-5	Regional education campaign for residents, policy makers, business on preserving open land as 'insurance policy' for sea level rise adaptation.
PO-6	Develop early warning systems/ social media apps informing residents on high tides and overall sea level rise awareness; also road signage.
PO-10	Coordinated outreach efforts with emphasis on sea level rise.
PP-8	Advocate for implementation/ funding at state and federal levels of CERP in water planning, especially under sea level rise.
PP-9	Advocate for capacity of Water Management Districts' support for integrated water management planning- sea level rise, flood control, and saltwater.
PP-11	Urge Congress to prioritize AAAs for federal funding.
PP-12	Urge Congress to prioritize funding infrastructure projects, especially infra vulnerable to sea level rise and extreme weather.
Total:	**39**

Existing Health Conditions Analysis

To understand the potential impact of climate change it is important to take inventory of the recent past and current state of climate-related health data in the existing study area.

Existing Conditions Data Collection

Data collection included population data and health indicators for each of the 11 potential health effects of climate change. This data was collected from a number of sources, including:

- CDC's Behavioral Risk Factor Surveillance System: Florida Behavioral Risk Factor Data by County, 2002-2010
- U.S. Environmental Protection Agency (EPA)
- Florida Charts Health Indicator Data by County, 2003-2012
- Florida Environmental Public Health Tracking by County, 2002- 2012
- U.S. Census Data county-level Summary of General Housing Characteristics data, 1990

Current geological data on SLR rates and heat wave trends were collected from the following:

- NOAA Mean Sea Level Trends in Miami Beach, FL (1931-1981); Key West, FL (1931-2012); and Vaca Key, FL (1971-2012)
- NOAA Satellite and Information Services Standard Precipitation Index (SPI) Division Data for the Florida Keys (2000-2013) and the Lower East Coast (2000-2013)
- USGS Water-Resources Investigations Reports
- USACE SLR projections in Key West, FL (1913-1999)

Health Conditions Data

Health Effects in Florida

Each of the CDC's 11 potential climate change health effects will likely impact the health of Southeast Florida's population to varying degrees under climate change depending on a number of variables including the severity of future climate change scenarios, vulnerable populations, geographic location, and existing protective systems and infrastructure. Some health effects will pose more serious threats than others to Southeast Florida's health in terms of being caused or exacerbated by climate change-related SLR and heat waves. In future SLR and heat wave scenarios certain health conditions or events that were not serious issues of concern or were only minor problems before climate change may become a threat to Southeast Florida's population as sea levels and temperatures rise.

According to existing conditions data and information gleaned from academic literature, five of the 11 CDC health effects were identified as health conditions that will likely have the greatest impact on the health of the populations in Broward, Miami-Dade, Monroe, and Palm Beach counties under the climate change factors of SLR and extreme heat events.

- **Asthma, Respiratory Allergies and Airway Diseases**
  Asthma rates have increased while other respiratory conditions rate changes vary with data showing both increases and decreases depending on the county. However, despite some past variability, if air pollution, extreme heat events, and urban health islands intensify and occur more frequently, alone or together these conditions may exacerbate and cause more adverse asthma, respiratory, and airway conditions.

- **Foodborne Diseases and Nutrition**
  Rates of foodborne diseases, nutritional deficiencies hospitalizations, and low birth weight (LBW) rates have been rising. Changing precipitation patterns, possible flooding or contamination of freshwater resources, and rising temperatures could threaten Southeast Florida's agriculture and food supply. LBW and pregnant women with nutritional deficiencies could lead to developmental issues for infants and future mental health problems.

- **Mental Health**
  Rates of suicide have increased in more of the counties and overall in the state than rates have decreased. Self-reported data shows an increase in "good mental health" among Southeast Florida's population, however the potential mental health effects from the displacement of populations living along Southeast Florida's densely populated coastal areas and other inland areas that will likely be affected by SLR could cause serious stress and other mental health issues. Additionally, extreme weather events, such as heat waves, and vulnerable populations with preexisting medical and/ or mental health conditions will also be at an increased risk of experiencing mental health impacts from climate change.

- **Vectorborne and Zoonotic Diseases**
  Total enteric disease rates have been increasing over the past decade. Changing water bodies due to SLR and rising temperatures could alter the geographic distribution, transmission, and reproductive patterns of vectorborne and zoonotic disease hosts.

- **Waterborne Diseases**
  Some waterborne disease rates demonstrate an increase in rate change over a decade time period. With changing precipitation patterns, stronger storm events, rising sea levels, the greater potential for flooding, and the possibility of the contamination of water systems threaten to increase the spread of waterborne diseases.

Asthma, Respiratory Allergies and Airway Diseases

Asthma hospitalization rates on average decreased in all four counties and Florida between 2003 and 2012. Rates in Broward, Miami-Dade, and Palm Beach counties and in the state of Florida experienced slight increases in 2010 despite the declining trend. Miami-Dade County had the highest rates of asthma hospitalizations in 2003 at 23.6 per 100,000 followed by Broward County with 22.1. By 2012, Broward County's rates had dropped to 17.4 and Miami-Dade County's to 16.7 per 100,000. Monroe County had the lowest rates of the four counties and state during the time period.

Table 10: Rates of Asthma Hospitalizations per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	22.1	20.4	20.3	19.1	18.5	18.0	18.9	19.1	18.6	17.4	-21.3%
Miami-Dade	23.6	22.1	20.3	19.4	18.2	17.7	18.2	18.7	17.2	16.7	-29.2%
Monroe	14.2	11.1	10.1	13.1	12.3	11.2	13.0	12.8	11.2	10.2	-28.2%
Palm Beach	17.8	16.6	15.1	14.5	14.3	16.4	16.8	18.5	17.5	16.3	-8.4%
Florida	17.1	15.9	15.5	14.6	14.5	14.9	15.9	16.0	15.2	14.9	-12.9%

Source: Florida Charts

In 2002, Monroe County reported the greatest percentage of people, 7.2%, who currently have asthma of the four counties and state average. Monroe and Palm Beach counties were the only counties to experience a decrease in rates of people who currently have asthma from 2002 to 2010. Broward County had the largest rate change of 68.1% and saw their percentages of people with asthma rise from 4.7% in 2002 to 7.9% in 2010.

Table 11: Percentages of Adults Who Currently have Asthma

	2002	2007	2010	Percent Rate Change
Broward	4.7%	5.2%	7.9%	68.1%
Miami-Dade	4.1%	4.6%	6.3%	53.7%
Monroe	7.2%	6.1%	5.7%	-20.8%
Palm Beach	7.0%	4.7%	6.8%	-2.9%
Florida	6.3%	6.2%	8.3%	31.8%

Source: Florida Charts, CDC Behavioral Risk Factor Surveillance System

Yearly chronic lower respiratory disease (CLRD) death rates in all counties were on average lower than the state rates, with the exception of Monroe County in 2003 and 2005. Rates in Broward, Monroe and Palm Beach counties decreased between 2003 and 2012, while Miami-Dade County rates had an increase in CLRD death rates during the time period of 7.2%. The state had a smaller increase in CLRD death rates between 2003 and 2012 than Miami-Dade County of .3%. Rates in Monroe fluctuated throughout the 10 year timeframe, especially from 2007 to 2008. Monroe County had the greatest decrease in rates between 2003 and 2012 from 40.1 to 27.8, a -30.7% rate change. As first and secondhand tobacco smoking of tobacco and other novel nicotine products are major risk factors for CLRD, decreases in CLRD death rates could be due to the decrease in adults who report they are current smokers. Smoking rates have decreased statewide and the four counties since 2002.

Table 12: Rates of Chronic Lower Respiratory Disease Deaths per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	34.1	32.6	35.1	29.0	32.5	33.3	33.8	32.0	32.5	30.0	-12.0%
Miami-Dade	26.5	25.4	27.2	25.0	27.0	27.7	26.2	29.2	27.1	28.4	7.2%
Monroe	40.1	35.6	40.5	28.9	21.8	34.4	24.8	21.8	33.0	27.8	-30.7%
Palm Beach	27.0	27.7	29.0	26.0	24.5	25.9	26.1	27.1	25.8	24.9	-7.8%
Florida	39.0	37.8	39.0	35.5	36.5	38.8	38.3	39.3	38.6	39.1	0.3%

Source: Florida Charts

Overall, emphysema death rates have decreased in all four counties from 2003 to 2012, following the decreasing state trend. Monroe County had the greatest decrease in emphysema deaths with a rate change of -75.3%. Monroe County had the highest emphysema death rates in 2003 at 9.7 per 100,000 and experienced spikes in rates in 2004, 2008, and 2010, while fluctuations in all other counties and state remained small.

Table 13: Rates of Emphysema Deaths per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	5.6	5.5	5.6	3.7	4.5	3.3	3.3	3.2	3.1	2.4	-57.1%
Miami-Dade	3.8	2.8	3.2	2.8	2.2	2.5	2.7	2.7	1.9	1.8	-52.6%
Monroe	9.7	12.6	8.5	4.4	3.7	6.0	0.7	3.2	2.5	2.4	-75.3%
Palm Beach	2.5	2.6	2.6	2.2	1.6	1.4	1.9	0.7	1.1	0.8	-68.0%
Florida	4.5	4.1	4.1	3.4	3.6	3.0	2.7	2.5	2.3	2.0	-55.6%

Source: Florida Charts

Rates of pneumonia decreased in all four counties. Monroe County had the highest rate in 2003 of 15.5 per 100,000 and experienced the greatest decrease by 2012 with a rate of 6.8, a rate change of -56.1%. Monroe experienced a spike in rates in 2008 of 10.6 per 100,000 up from 3.7 the year before, but rates continued to drop after that year and only rose again in 2012. Broward County had the smallest decrease in pneumonia death rates with a -8.7% rate change.

Table 14: Rates of Pneumonia Deaths per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	9.2	9.4	7.8	7.4	6.7	7.1	7.0	8.5	7.5	8.4	-8.7%
Miami-Dade	14.6	15.0	13.1	9.4	9.0	8.6	8.3	8.0	8.9	8.1	-44.5%
Monroe	15.5	11.5	5.5	5.3	3.7	10.6	6.8	5.3	4.3	6.8	-56.1%
Palm Beach	10.3	8.9	7.9	5.9	6.5	5.2	6.4	6.2	6.8	5.7	-44.7%
Florida	13.0	12.5	11.4	9.5	8.6	8.5	8.5	8.5	9.0	8.4	-35.4%

Source: Florida Charts

Air Quality

Ground-level ozone and particulate matter (PM) are known to cause and/ or exacerbate health conditions, especially those related to respiratory and lung function. To understand past and current respiratory-related health conditions in Broward, Miami-Dade, Monroe, and Palm Beach counties, recent air quality measures must be examined to provide a more comprehensive picture of the potential effects of climate change-related environmental effects on health. PM levels and ozone concentrations measured by the national air quality standards are reviewed here.

The 1970 Clean Air Act required the EPA to address the health and environmental effects of harmful air pollutants by developing national air quality standards for particulate matter (PM), ground-level ozone, and other air pollutants. In recent years, the EPA has made efforts to strengthen national ambient air quality standards for ground-level ozone in a coordinated effort with states and other key partners in reducing the ozone air pollution (EPA, 2014). The EPA is currently in the process of designating counties as "attainment" areas that meet, or "nonattainment" areas that do not meet the ground-level ozone standards. Currently Broward, Miami-Dade, Monroe, and Palm Beach counties are classified as "Unclassifiable/ Attainment" designations, suggesting that the counties either have not been classified or do meet the ground-level ozone standards (EPA, 2012).

Miami-Dade County had the highest number of years, five years, between 2002 and 2011 with percent days with PM levels over the national ambient air quality. Broward County had the highest single percentage than any other county at 1.9% in 2007. Broward County had three years in which days had PM levels were over the national ambient air quality standard. Palm Beach County only had two years, 2007 and 2011, over the standard with days at .8% and .3% respectively. Broward County had a slightly higher percent average of .28% than Miami-Dade County's .21% average. Data for Monroe County was unavailable.

Table 15: Percentages of Days with Particulate Matter (PM2.5) Levels over the National Air Quality Standard

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Broward	0.6%	0	0	0	0	1.9%	0	0	0	0.3%	0.28%
Miami-Dade	0.3%	0	0.6%	0	0	0.6%	0.3%	0	0.3%	0	0.21%
Monroe	--	--	--	--	--	--	--	--	--	--	--
Palm Beach	0	0	0	0	0	0.8%	0	0	0	0.3%	0.11%

Source: Florida Environmental Public Health Tracking

Broward County had the highest yearly average between 2002 and 2011 of ambient concentrations of PM with an average of 14.1. Miami-Dade County had the second greatest 10 year period average of 8.7 followed by Palm Beach County's 7.3 average. Both Broward and Palm Beach counties' highest yearly averages were in 2006 at 8.4 and 8.2 respectively. Miami-Dade County's highest yearly average was in 2005 at 9.7. Data for Monroe County was unavailable.

Table 16: Averages of Ambient Concentrations of Particulate Matter (PM2.5 per ug/m3)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Broward	8.0	8.2	8.4	8.3	8.5	8.2	7.7	7.0	7.0	6.8	7.8
Miami-Dade	9.1	9.4	9.6	9.7	9.5	8.9	8.1	7.6	7.8	7.4	8.7
Monroe	--	--	--	--	--	--	--	--	--	--	--
Palm Beach	7.3	8.1	8.1	8.1	8.2	7.3	6.6	6.1	6.4	6.4	7.3

Source: Florida Environmental Public Health Tracking

Miami-Dade County had the most days with maximum eight hour average ozone concentration over the national air quality standard between 2002 and 2011 with 20 days, followed by Broward County with eight days, and Palm Beach County with seven days. Miami-Dade County, Palm Beach County, and Broward County all had the greatest number of days with maximum concentrations in 2006. Broward, Miami-Dade, and Palm Beach counties all had their highest number of days during this time period in 2006. Monroe County data was unavailable.

Table 17: Number of Days with Maximum Eight Hour Average Ozone Concentration over the National Air Quality Standard

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Broward	1	0	1	1	4	0	1	0	0	0	8
Miami-Dade	1	3	1	0	6	2	4	1	1	1	20
Monroe	--	--	--	--	--	--	--	--	--	--	--
Palm Beach	0	1	0	0	3	0	1	0	1	1	7

Source: Florida Environmental Public Health Tracking

Cancer

Rates of all cancer deaths fell starting in 2003 in all four counties and statewide. Monroe County experienced an increase in rates in 2010 of 184.6 per 100,000, up from 149.7 in 2009. Monroe County had the largest decrease in rates between 2003 and 2012 from 201.9 per 100,000 to 160.8, a -20.4% decrease. Broward County had the smallest decline in all cancer death rates during the time period with a -5.2% rate change.

Table 18: Rates of All Cancer Deaths per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	166.7	173.9	174.5	163.5	167.0	165.8	164.3	158.3	154.2	158.1	-5.2%
Miami-Dade	160.5	155.3	153.4	151.8	142.8	142.3	139.3	140.1	137.7	139.6	-13.0%
Monroe	201.9	184.0	200.3	178.1	153.6	146.4	149.7	184.6	156.4	160.8	-20.4%
Palm Beach	159.0	159.2	158.6	148.9	152.8	148.4	151.1	142.9	140.5	144.7	-9.0%
Florida	177.5	176.2	174.7	168.6	163.8	164	162.9	161.2	159.9	160.3	-9.7%

Source: Florida Charts

The rates of melanoma incidence have decreased from 2002 to 2010 in Broward, Miami-Dade, and Palm Beach counties. Monroe County rates were the only county rates that increased during the time period with an 11.0% increase, more than double the statewide increase of 4.3%. Miami-Dade County have the largest percent rate decrease during the time period at -25.5%. Rates of melanoma deaths decreased in all four counties between 2002 and 2010, while the statewide rate increased slightly by 3.3%. Monroe County had the greatest decrease in rates by -88.5% with rates decreasing from 6.1 per 100,000 in 2003 to .7 in 2012. Broward County had the smallest decrease in trends at -3.6%.

Table 19: Rates of Melanoma Incidence per 100,000 Population

	2002	2003	2004	2005	2006	2007	2008	2009	2010	Percent Rate Change
Broward	18.8	13.9	15.7	14.4	15.2	20.1	17.6	16.5	17	-9.6%
Miami-Dade	10.6	9.9	10.1	8.6	8.4	7.9	8.6	8.3	7.9	-25.5%
Monroe	28.1	21.8	21.1	15.7	21	18.7	25.2	18.9	31.2	11.0%
Palm Beach	24.7	22.3	22.7	22.5	20.6	23.4	23.8	20.5	19.7	-20.2%
Florida	16.3	15.7	16.3	17.6	16.6	18.7	18.4	17.8	17.0	4.3%

Source: Florida Charts

Table 20: Rates of Melanoma Deaths per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change

Broward	2.8	3.1	3.0	3.4	2.5	3.4	2.2	2.3	2.6	2.7	-3.6%
Miami-Dade	2.0	1.7	1.1	1.5	1.6	1.1	1.5	1.1	1.4	1.7	-15.0%
Monroe	6.1	2.7	5.1	4.4	3.7	2.1	7.6	4.5	4.9	0.7	-88.5%
Palm Beach	3.0	2.6	2.1	3.2	2.6	2.4	3.1	2.5	3.2	2.7	-10.0%
Florida	3.0	2.9	2.8	2.9	2.9	2.8	3.0	2.7	3.0	3.1	3.3%

Source: Florida Charts

All four counties and the state had a decrease in rates of lung cancer incidence and deaths between 2002 and 2010. Monroe County had the greatest lung cancer incidence rate decrease of -23.7% followed by Broward County with -19.0%. Miami-Dade County had the smallest decrease in incidence rates with -4.5%. Monroe County's incidence rates in 2002 were much higher than the other three counties and remained the highest in 2010, despite the large positive rate change. Broward and Monroe counties had the greatest decrease in lung cancer deaths rates between 2003 and 2012. Monroe County had the highest rates of lung cancer deaths than the other three counties almost every year of this time period, with the exception of 2008 and 2009 when Broward County had the highest rates.

Table 21: Rates of Lung Cancer Incidence per 100,000 Population

	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Percent Rate Change**
Broward	67.5	69.1	65.4	65.8	61.2	64.5	62.5	60.4	54.7	-19.0%
Miami-Dade	48.9	47.7	53.9	50.2	50.3	47.7	47.8	43.8	46.7	-4.5%
Monroe	79.7	87.6	77	67.4	79	60.7	59.7	54.1	60.8	-23.7%
Palm Beach	62.9	62.5	63.3	64.4	62.1	58.4	59.0	61.5	53.5	-14.9%
Florida	72.1	71.5	73.9	72.3	68.5	65.9	67.0	65.5	63.4	-12.1%

Source: Florida Charts

Table 22: Rates of Lung Cancer Deaths per 100,000 Population

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Percent Rate Change**
Broward	48.4	47.5	48.2	44.4	42.7	45.1	42.6	38.6	38.3	37.3	-22.9%
Miami-Dade	34.5	35.1	35.3	35.0	33.3	32.1	31.6	31.4	29.3	29.3	-15.1%
Monroe	53.6	52.5	58.1	51.2	48.9	35.2	42.3	57.5	40.3	41.4	-22.8%
Palm Beach	43.7	42.3	42.8	41.2	41.0	39.2	40.2	38.3	36.1	37.6	-14.0%
Florida	53.1	53.4	52.0	50.1	47.8	48.1	47.3	46.2	44.9	45.0	-15.3%

Source: Florida Charts

It is important to note that tobacco smoking is the biggest risk factor for lung cancer, surpassing ambient air quality. Both first and secondhand smoke from cigarettes and other nicotine products can increase a

person's chance of developing lung and other cancers. The state of Florida ranks higher than the national average on smoking-attributable adult mortality rates. The decreases in rates of lung cancer incidence and deaths in the four counties could be a result of the decrease of tobacco smoking in all four counties and statewide. Monroe County has the highest rate of current adult smokers which may explain the high rates of lung cancer incidence and deaths from the first and secondhand smoking health effects of nicotine products.

Cardiovascular Disease and Stroke

Heart disease death rates in all four counties and across the state have decreased between 2003 and 2012. Miami-Dade County had the highest rates at 237 per 100,000 in 2003 and had the greatest rate decrease of -31.8%. Monroe County had the lowest rate of 171.3 per 100,000 in 2003 had had the smallest rate decrease of -19.9%. Monroe County was the only county to have a rate decrease less than the state rate change during this time period of -26.3%.

Table 23: Rates of Heart Disease Deaths per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	208.5	199.0	200.0	188.8	172.5	168.1	160.8	165.3	150.9	153.4	-26.4%
Miami-Dade	237.0	227.2	223.3	200.9	187.8	177.4	169.2	171.1	156.9	161.6	-31.8%
Monroe	171.3	165.5	172.1	160.8	165.2	150.9	131.6	150.1	129.1	137.2	-19.9%
Palm Beach	189.0	168.0	162.6	143.3	149.1	142.2	133.8	134.6	133.4	137.1	-27.5%
Florida	210.7	196.5	189.3	175.3	163.8	158	152.8	158.3	153	155.3	-26.3%

Source: Florida Charts

Myocardial Infarction, or heart attack, death rates decreased between 2003 and 2012 in all four counties and the state. Broward County had the largest rate decrease during this time period with -48.9%. Monroe County had the smallest decrease in rates of -24.7%. Miami-Dade County had the highest single yearly rate of all counties in 2003 of 63.2 per 100,000, but rates decreased by almost half by 2012.

Table 24: Rates of Heart Attack (Myocardial Infarction) Deaths per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	53.8	50.5	43.5	37.1	36.5	35.0	33.0	33.2	26.9	27.5	-48.9%
Miami-Dade	63.2	61.1	59.0	51.2	45.9	39.9	39.1	43.9	34.8	33.8	-46.5%
Monroe	29.6	42.4	36.4	23.3	23.8	30.6	21.8	36.6	18.2	22.3	-24.7%
Palm Beach	38.7	29.8	29.5	27.2	24.7	24.3	25.2	24.1	24.6	25.7	-33.6%
Florida	47.7	42.7	38.7	34.8	31.0	30.1	29.2	29.3	27.2	27.5	-42.4%

Source: Florida Charts

Rates of stroke hospitalizations decreased for all counties and the state with the exception of Monroe County between 2003 and 2012. Monroe County stroke hospitalizations rates increased during this time

period, despite rates falling to the lowest of all counties and state in 2009. Miami-Dade County had the largest stoke hospitalization rate decrease at -27.8%. Rates of stroke deaths decreased for all four counties between 2003 and 2012. Monroe County had the greatest decrease in rates decreasing by over half from 43.1 per 100,000 in 2003 to 19.0 in 2012, a 55.9% change. Palm Beach County had the smallest rate decrease of -18.3%. Broward and Miami-Dade counties stroke death rates decreased by the same amount during this time period, -25.8%.

Table 25: Rates of Stroke Hospitalizations per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	309.8	301.6	286	270.6	260.3	263.8	257.1	244.8	237.4	236.7	-23.6%
Miami-Dade	373.5	353.0	335.9	307.9	302.3	287.6	283.0	282.0	283.6	269.8	-27.8%
Monroe	225.4	236.1	220.5	187.0	177.9	184.5	150.1	198.1	197.9	239.2	6.1%
Palm Beach	280.1	270.0	247.0	237.2	243.9	234.4	232.5	223.7	221.0	214.6	-23.4%
Florida	320.5	312.6	296.7	282.8	279.0	272.1	268.8	267.7	264.6	266.2	-16.9%

Source: Florida Charts

Table 26: Rates of Stroke Deaths per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	43.8	44.1	43.3	38.9	36.9	36.2	36.6	34.1	34.6	32.5	-25.8%
Miami-Dade	38.4	35.9	34.6	34.0	33.0	31.2	29.3	28.0	28.8	28.5	-25.8%
Monroe	43.1	31.2	34.8	32.8	31.8	25.8	18.4	26.6	22.7	19.0	-55.9%
Palm Beach	34.9	34.6	35.3	29.0	28.0	26.9	29.1	29.2	27.5	28.5	-18.3%
Florida	42.9	40.4	38.2	35.3	33.9	31.9	30.9	32.0	31.5	31.2	-27.3%

Source: Florida Charts

Foodborne Diseases and Nutrition

Rates of *E.coli, Salmonellosis, and Campylobacteriosis* were used to assess foodborne diseases in Southeast Florida. *E.coli* rates in all counties except Monroe increased between 2003 and 2012. Monroe County rates were zero every year with the exception of 2008 and 2011 when rates were 2.7 and 1.4 per 100,000 respectively. The highest *E. coli* rates occurred in Monroe County in 2008 at 2.7 per 100,000. *E. coli* rates in Broward, Miami-Dade, and Palm Beach counties spiked in 2007. Rates in Broward County were highest in 2009, and in 2010 in Palm Beach County. Miami-Dade and Broward counties had the greatest increases in rates during this time period of 300.0% and 150.0% respectively, although the rates remained below 1 per 100,000 population.

Table 27: Rates of *E.Coli* per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	0.2	0.5	0.1	0.2	1.0	0.5	0.5	0.7	0.2	0.5	150.0%

Miami-Dade	0.1	0.2	0	0.1	1.7	0.9	0.9	0.8	0.7	0.4	300.0%
Monroe	0	0	0	0	0	2.7	0	0	1.4	0	--
Palm Beach	0.4	0.5	0.4	0	0.7	0.5	0.4	0.5	0.6	0.7	75.0%
Florida	0.3	0.4	0.4	0.2	0.8	0.5	0.5	0.5	0.5	0.5	66.7%

Source: Florida Charts

Salmonellosis rates increased in all counties except Miami-Dade County between 2003 and 2012. Monroe County had the greatest increase in rates during the time period of 82.1%. Monroe County had the highest *Salmonellosis* rates of the time period in 2005 at 41.4 per 100,000.

Table 28: Rates of *Salmonellosis* per 100,000 Population

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Percent Rate Change**
Broward	19.9	17.5	20.3	18.7	17.3	23.9	26.8	25.3	25.8	25.6	28.6%
Miami-Dade	24.5	19.4	27.9	26.1	17.9	22.3	24.2	19.9	23.9	23.6	-3.7%
Monroe	19.0	25.5	41.4	37.0	26.7	20.3	34.0	23.3	24.8	34.6	82.1%
Palm Beach	21.3	21.9	29.0	26.5	26.2	27.1	31.7	32.6	31.5	32.2	51.2%
Florida	26.3	23.7	30.2	26.3	27.1	28.5	36.0	33.4	31.4	34.6	31.6%

Source: Florida Charts

Campylobacteriosis rates increased for all four counties and the state between 2003 and 2012. Monroe County had the greatest rate change with a 400% increase, far surpassing the second largest rate increase in Broward County of 94.9%. *Campylobacteriosis* rates were highest in all Broward, Miami-Dade, and Palm Beach counties and the state of Florida in 2011 and 2012. Monroe County rates were highest in 2010 and 2012. Miami-Dade County had the highest rate of the time period in 20011 at 16.3 per 100,000.

Table 29: Rates of *Campylobacteriosis* per 100,000 Population

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Percent Rate Change**
Broward	5.9	5.4	4.3	4.8	5.0	6.9	5.1	6.1	9.8	11.5	94.9%
Miami-Dade	7.4	6.5	6.6	6.7	5.6	6.2	6.9	7.6	16.3	13.6	83.8%
Monroe	2.5	3.8	0	1.3	1.3	2.7	4.1	5.5	4.1	12.5	400.0%
Palm Beach	9.1	5.7	4.8	6.4	5.1	6.6	5.6	5.8	7.8	11.0	20.9%
Florida	6.0	5.6	4.9	5.0	5.5	6.0	6.0	6.4	10.8	10.4	73.3%

Source: Florida Charts

Nutritional deficiency hospitalization and death rates provide insight into nutritional health outcomes in Southeast Florida. This health indicator measures malnutrition in terms of weight that was converted to standard deviations and measured against the reference population.

Nutritional deficiencies preventable hospitalization rates increased in Broward, Miami-Dade, and Palm Beach County and Florida between 2003 and 2012. Palm Beach County had the greatest increase in

rates from 2003 to 2012 with a 927.8% increase. Broward County had the smallest rate change, although the change was still large, of 448.2%. Rates for Monroe County were only available for 2008 and 2012 when they were the highest rates out of the four counties at 16.3 and 18.7 per 100,000 respectively. Monroe County's rate of 18.7 per 100,000 in 2012 was the highest rate between 2003 and 2012 of the four counties.

Table 30: Rates of Preventable Nutritional Deficiencies Hospitalizations per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	2.7	2.2	2.0	1.3	2.4	7.7	9.6	12.3	15.4	14.8	448.2%
Miami-Dade	1.0	1.4	1.4	1.3	1.3	4.3	4.2	5.1	5.7	8.4	740.0%
Monroe	--	--	--	--	--	16.3	--	--	--	18.7	--
Palm Beach	1.8	1.2	2.7	1.2	1.7	7.3	9.5	13.3	16.7	18.5	927.8%
Florida	2.1	1.8	2.1	2.0	3.2	10.8	15.5	17.5	20.0	20.9	895.2%

Source: Florida Charts

Nutritional deficiencies death rates in Broward and Palm Beach counties had no rate change between 2003 and 2012. Monroe County nutritional deficiencies hospitalization rates were the highest in 2003 and remained higher than the other three counties and the state in all years except for 2004, 2007, 2008, and 2011 when rates were zero per 100,000. Monroe County had a larger decrease in rates of -25.0% during this time period than Miami-Dade County's rate decrease of -30.0%.

Table 31: Rates of Nutritional Deficiencies Deaths per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	0.3	0.3	0.2	0.3	0.2	0.3	0.2	0.2	0.2	0.3	0%
Miami-Dade	0.4	0.3	0.4	0.3	0.2	0.3	0.3	0.3	0.3	0.3	-25.0%
Monroe	2.0	0	1.1	1.2	0	0	1.1	1.1	0	1.4	-30.0%
Palm Beach	0.2	0.1	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0%
Florida	0.8	0.5	0.6	0.4	0.4	0.5	0.4	0.4	0.4	0.4	-50.0%

Source: Florida Charts

Mental Health

Suicide rates decreased in Miami-Dade and Monroe counties and increased in Broward and Palm Beach counties and Florida between 2003 and 2012. Suicide rates are almost two times higher in Monroe County than the next highest county of Palm Beach in 2003, 2004, 2009, 2011 and 2012. Palm Beach County had the largest rate increase between 2003 and 2012 of 27.7%, while Monroe County had the greatest decrease in suicide rates during this time period of -13.3%.

Table 32: Rates of Suicide per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	11.9	12.6	9.5	10.4	12.2	13.1	12.4	12.9	12.2	12.3	3.4%
Miami-Dade	8.5	8.0	7.8	7.5	10.4	9.0	9.2	8.2	7.6	8.0	-5.9%
Monroe	25.5	26.3	12.8	20.3	18.7	20.5	29.3	17.4	25.9	22.1	-13.3%
Palm Beach	11.2	12.2	11.3	11.2	14.0	13.5	14.0	13.2	13.8	14.3	27.7%
Florida	12.8	13.0	12.3	12.4	13.1	13.8	14.5	13.5	13.5	14.2	10.9%

Source: Florida Charts

Self-reported mental health of adults may be a more accurate description of the state of mental health in the four counties and Florida than suicide rates as suicide was a more extreme result of poor mental health. Percentages of good mental health among adults in the four counties and Florida increased in only Monroe County from 2007 to 2010. All other counties and Florida had good mental health percentage rates decrease between the time periods. Broward County had the greatest decrease in good mental health rates with a percent change of 2.1%, followed by Miami-Dade County at 2.0%, and Palm Beach County at 1.6%. Broward County and Florida had the same decrease in percentages of good mental health during 2007 and 2010.

Table 33: Percentages of Adults with Self-Reported Good Mental Health

	2007	2010	Percent Difference
Broward	91.3%	89.2%	2.1%
Miami-Dade	89.5%	87.5%	2.0%
Monroe	84.6%	90.9%	-6.3%
Palm Beach	92.2%	90.6%	1.6%
Florida	90.3%	88.2%	2.1%

Source: Florida Charts, CDC Behavioral Risk Factor Surveillance System

Human Developmental Effects

Lead poisoning, pesticide exposures resulting in a health effect, low birth weight, and nutritional deficiencies hospitalization and death rates were used to ascertain information on human developmental effects. Indicators for lead poisoning and pesticide exposures resulting in a health effect are not necessarily ideal measures of human developmental effects from climate change, as for example those exposed to lead poisoning or pesticides may already be fully developed or may not pass this exposure on to fetuses or young children. However, these indicators were the best available data for this health effect category and they provide insight into the potential effects on the population. Low birth weight and nutritional deficiencies hospitalization and death rates may be the more informative indicators of human developmental effects as malnutrition in pregnant women causes low birth weight, other poor birth outcomes, and later in life developmental deficiencies.

Rates in all counties, with the exception of Monroe County, decreased between 2003 and 2012. Miami-Dade County lead poisoning rates in 2003 are almost three times higher than the next highest county of Palm Beach. Miami-Dade County's highest rate of 13.3 per 100,000 was in 2004 and Monroe County's highest rates of 4.1 per 100,000 occurred in 2008 and 2011. Monroe County was the only county to have

an increase in rates during this time period from 2.5 per 100,000 in 2003 to 4.2 in 2012, a 68.0% increase. Broward County had the greatest rate decrease of -97.6% followed by Miami-Dade County at -65.7%, and Palm Beach County with -53.6%. Florida had the smallest percent rate change at -4.2%.

Table 34: Rates of Lead Poisoning per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	4.1	2.8	1.7	1.3	2.2	2.2	2.2	1.2	4.3	0.1	-97.6%
Miami-Dade	13.1	13.3	6.7	6.1	7.3	7.8	6.9	9.7	5.4	4.5	-65.7%
Monroe	2.5	0	0	1.3	2.7	4.1	1.4	1.4	4.1	4.2	68.0%
Palm Beach	5.6	3.0	1.5	1.6	0.8	2.5	3.4	3.0	3.6	2.6	-53.6%
Florida	4.8	3.7	2.8	2.1	2.2	2.9	2.9	4.9	3.9	4.6	-4.2%

Source: Florida Charts

Data for rates of pesticide exposures with a health effect were only available for the year of 2011. Palm Beach County had the highest rate, almost double that of the rates of any of the other three counties, at 8.26 per 100,000. Broward County had the second highest rate at 5.44, Monroe County at 4.24, and Miami-Dade County at 3.54. Florida's rate of 6.55 was higher than Broward, Miami-Dade, and Monroe counties.

Table 35: Rates of Pesticide Exposures with a Health Effect per 100,000 Population

County	2011
Broward	5.44
Miami-Dade	3.54
Monroe	4.24
Palm Beach	8.26
Florida	6.55

Source: Florida Environmental Public Health Tracking

Low birth weights, as defined for this indicator as live births under 2500 grams, increased from 2003 to 2012 in all counties and Florida except for Monroe County. Broward County had the largest rate increase of 5.8%, followed by Palm Beach County 3.5%, Miami-Dade County with 2.3%, and Florida with 1.2%. Monroe County's rate had a slight rate decrease between 2003 and 2012 of -1.6%. Broward County had the highest rates of the four counties and Florida in all years except for 2004 and 2007 when Palm Beach County had the highest rates and 2010, when Miami-Dade County tied with Broward County.

Table 36: Rates of Live Births Under 2500 Grams (Low Birth Weight) per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	8.7	8.8	9.3	9.1	9.2	9.8	9.7	9.1	9.3	9.2	5.8%
Miami-Dade	8.6	8.4	9	8.6	9	9	9	9.1	8.7	8.8	2.3%
Monroe	6.3	7.3	7.9	8.8	8.3	7.3	6.4	6.8	7.2	6.2	-1.6%

Palm Beach	8.5	9.3	9.2	9	9.4	9.1	9.3	8.9	9.1	8.8	3.5%
Florida	8.5	8.6	8.8	8.7	8.7	8.8	8.7	8.7	8.7	8.6	1.2%

Source: Florida Charts

Nutritional deficiencies preventable hospitalization and deaths rates were previously discussed in the *Foodborne Diseases and Nutrition* section in reference to **Tables 30** and **31**. Nutritional deficiencies hospitalizations rates increased in Broward, Miami-Dade, and Palm Beach County and Florida between 2003 and 2012. Palm Beach County had the greatest rate increase in nutritional deficiencies hospitalization rates and Broward County had the smallest rate change during the time period. Hospitalization rates for Monroe County were only available for 2008 and 2012 when the highest rates out of the four counties. Monroe County nutritional deficiencies death rates were the highest in 2003 and remained higher than the other three counties and the state in all years except for 2004, 2007, 2008, and 2011 when rates were zero. Nutritional deficiencies death rates in Palm Beach and Broward counties had no percent rate change between 2003 and 2012.

Heat-Related Morbidity and Mortality

The number of hospitalizations from heat increased in all four counties between 2003 and 2012, although numbers fluctuated year to year. Broward County had the highest average number of heat-related hospitalizations during this time period with 32.6 deaths. Miami-Dade and Palm Beach counties followed closely at 29.5 and 29.2 deaths respectively. Data from Monroe County was only available for 2005, 2007, and 2010 each with only five reported heat-related hospitalizations. The greatest number of hospitalizations in one year was in Broward County in 2010 with 48 hospitalizations. The greatest number of yearly hospitalizations in Miami-Dade County was in 2005 with 46 and 47 in Palm Beach County in 2011.

Table 37: Number of Heat-Related Hospitalizations

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average
Broward	21	19	35	26	37	26	33	48	43	38	32.6
Miami-Dade	18	25	46	24	34	20	30	39	30	29	29.5
Monroe	5	--	--	--	--	--	--	5	--	5	5
Palm Beach	17	30	29	22	29	17	29	33	47	39	29.2

Source: Florida Charts

Rates of heat-related deaths increased in Palm Beach and Miami-Dade counties during the 2003-2012 time period. Rates doubled from .04 per 100,000 in 2003 to .08 in 2012 in Miami-Dade County. Broward County stayed relatively constant with a 0% rate change between 2003 and 2012. Monroe County rates stayed at zero, with the exception of 2010 when the rate increased slightly to 1.37 per 100,000. Florida rates decreased by -25.0% during the time period.

Table 38: Rates of Heat-Related Mortality per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	0.06	0.06	0.06	0.17	0	0.06	0.06	0.06	0	0.06	--
Miami-Dade	0.04	0.13	0.04	0	0.04	0	0.16	0.04	0.08	0.08	100%

Monroe	0	0	0	0	0	0	0	1.37	0	0	--
Palm Beach	0	0.08	0.23	0.08	0	0.23	0.08	0.08	0	0.15	--
Florida	0.08	0.13	0.11	0.13	0.07	0.09	0.16	0.11	0.07	0.06	-25.0%

Source: Florida Charts

Neurological Diseases

Parkinson's and Alzheimer's disease rates were collected to look at the current conditions of neurological diseases in the four counties. Rates of deaths from Parkinson's disease increased from 2003 to 2012 in Broward and Miami-Dade counties by 29.8%. Rates in Monroe County varied the greatest year to year and had the highest Parkinson's death rates of all four counties and Florida from 2003 to 2005. Monroe County had the greatest decrease in rates between 2003 and 2012 with a -30.5% rate change. Palm Beach County rates also decreased during the time period by -10.3%.

Table 39: Rates of Parkinson's Deaths per 100,000 Population

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Percent Rate Change**
Broward	5.7	6.0	6.7	5.5	7.7	7	6.4	7.7	6.5	7.4	29.8%
Miami-Dade	4.7	5.2	5.1	4.8	4.8	5.7	5.9	5.9	6.7	6.1	29.8%
Monroe	11.8	12.7	11.6	5.5	10.4	3.2	6.0	10.1	5.9	8.2	-30.5%
Palm Beach	7.8	6.5	7.6	7.2	7.2	6.8	7.3	8.2	8.3	7.0	-10.3%
Florida	5.8	5.4	5.8	5.5	5.9	5.7	5.8	6.6	6.5	6.7	15.5%

Source: Florida Charts

Alzheimer death rates decreased between 2003 and 2012 in all four counties and Florida. Broward County experienced the greatest rate decrease of -35.7%. Monroe County had the smallest percent rate change of the four counties during the time period of -14.7%. Monroe County had the highest rates of Alzheimer's deaths during the time period in 2006 with a rate of 25.6 per 100,000.

Table 40: Rates of Alzheimer's Deaths per 100,000 Population

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Percent Rate Change**
Broward	14.3	12.1	12.1	12.2	12.3	12.5	9.9	13.1	9.0	9.2	-35.7%
Miami-Dade	21.1	20.5	21.1	19.6	16.5	16.5	16.9	19.3	15.7	13.9	-34.1%

Monroe	25.2	11.5	13.1	25.6	17.2	15.7	8.9	17	16.9	21.5	-14.7%
Palm Beach	15.7	14.4	15.4	14.7	17.4	14.7	10.9	10.7	11.9	11.9	-24.2%
Florida	18.1	16.8	17.8	17.5	16.8	16.3	15.5	17.6	16.1	15.6	-13.8%

Source: Florida Charts

Vectorborne and Zoonotic Diseases

Dengue Fever, Malaria, and *West Nile* Virus rates were collected for the assessment of vectorborne and zoonotic diseases. Monroe County, especially Key West, FL, experienced an outbreak of *Dengue Fever* in 2009 and 2010 with rates of 28.5 and 74 per 100,000, respectively. In the previous six years, from 2003 until 2008, there were no reported cases of *Dengue Fever* in Monroe County. Rates decreased again in 2011 in Monroe County and across Florida, however the number of cases remained high likely due to greater worldwide prevalence. The percent rate changes of Miami-Dade County and Florida are very high, however rates were only high in 2009 and 2010 in Monroe County. Although transmission typically occurs during foreign travel and local transmission has not been the usual method in which the disease has been acquired in recent years, both reported cases in Miami-Dade County in 2012 were locally-acquired infections.

Table 41: Rates of *Dengue Fever* per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	0	0	0	0.1	0.6	0.8	0.3	1.3	0.2	0.9	--
Miami-Dade	0.2	0	0	0	0.1	0.2	0.4	2.1	1.0	2.1	950.0%
Monroe	0	0	0	0	0	0	28.5	74	2.8	0	0%
Palm Beach	0	0	0	0	0.4	0.3	0.1	0.7	0.8	0.6	--
Florida	0.1	0	0	0	0.3	0.2	0.3	1.0	0.4	0.7	600.0%

Source: Florida Charts

Most *Malaria* cases were acquired out of state and were foreign in origin from 2003 and 2012. Over the 10-year period, Monroe County only had reported *Malaria* cases in 2003 and 2007 of rates of 1.3 per 100,000. Miami-Dade County rates reached their highest in 2010 at 1.4 per 100,000. Broward County *Malaria* rates also reached 1.4 per 100,000, their highest during this time period, in 2009 and 2010. Palm Beach County's rates were highest in 2003 and 2010 at 1.2 per 100,000. All four counties and the state average experienced a rate decrease between 2003 and 2012.

Table 42: Rates of *Malaria* per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	0.7	0.6	0.3	0.3	0.2	0.7	1.4	1.4	0.9	0.6	-14.3%
Miami-Dade	0.8	0.9	0.6	0.5	0.4	0.5	0.8	1.4	0.8	0.4	-50.0%

Monroe	1.3	0	0	0	1.3	0	0	0	0	0	-100.0%
Palm Beach	1.2	1.0	0.6	0.5	0.4	0.3	0.8	1.2	0.5	0.3	-75.0%
Florida	0.5	0.5	0.4	0.3	0.3	0.4	0.5	0.7	0.6	0.3	-40.0%

Source: Florida Charts

West Nile Virus was introduced to Florida in 2001 following a drought. Since this introduction, *West Nile Virus* cases peaked in 2003 in Florida and remained at zero from 2005 until 2011 across the state and in all of the four counties, with the exception of a 0.1 per 100,000 rate in the state of Florida in 2005 and 2010 and in Palm Beach County in 2006. Low rates at this time were likely due to dry conditions from 2006 to 2009. Despite an increase in Florida cases in 2012, mostly located in the state's Panhandle, there were no reported cases of *West Nile Virus* in Broward, Miami-Dade, Monroe, or Palm Beach counties that year. *West Nile Virus* cases tend to be localized in Florida. Average rate changes for all four counties and the state indicate an overall decrease in *West Nile Virus* cases between 2003 and 2012.

Table 43: Rates of *West Nile Virus* per 100,000 Population

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Percent Rate Change**
Broward	0.2	0.1	0	0	0	0	0	0	0	0	-100.0%
Miami-Dade	0.3	0.7	0	0	0	0	0	0	0.1	0	-100.0%
Monroe	1.3	0	0	0	0	0	0	0	0	0	-100.0%
Palm Beach	0.2	0	0	0.1	0	0	0	0	0.1	0	-100.0%
Florida	0.4	0.2	0.1	0	0	0	0	0.1	0.1	0.3	-25.0%

Source: Florida Charts

Waterborne Diseases

Rates for *Vibrio, Giardiasis*, and *Cryptosporidiosis* were used for assessment of waterborne diseases. Rates of *Vibrio* increased in all four counties and Florida from 2003 to 2012 except for Palm Beach County, whose rates decreased by half during this time period. Miami-Dade County had the greatest rate increase during this time period of 66.7%, although rates remained low reaching their highest, 1.5 per 100,000, in 2012. Palm Beach County rates never surpassed 1.0 per 100,000 and Miami-Dade County rates never exceeded .6 per 100,000 during the time period. Monroe County rates reached their highest in 2009 at 6.8 per 100,000.

Table 44: Rates of *Vibrio* per 100,000 Population

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Percent Rate Change**
Broward	0.2	0.3	0.4	0.2	0.3	0.1	0.5	0.7	1	0.5	150.0%

Miami-Dade	0.3	0.1	0.1	0	0	0.3	0.2	0.6	0.4	0.5	66.7%
Monroe	1.3	2.6	5.2	5.3	0	4.1	6.8	1.4	0	1.4	7.7%
Palm Beach	1.0	0.8	0.7	0.6	0.5	0.2	0.7	0.5	1.0	0.5	-50.0%
Florida	0.7	0.6	0.6	0.5	0.5	0.5	0.6	0.7	0.9	0.9	28.6%

Source: Florida Charts

Rates of *Giardiasis* decreased in all counties and Florida between 2003 and 2012 except for Broward County. Broward County's rates increased by 12.8% during this time period. Miami-Dade County had the highest rates of *Giardiasis,* peaking at 32.4 per 100,000 in 2010. Broward County's highest rates were in 2010 of 8.5 per 100,000, Monroe County's highest were in 2008 at 18.9 per 100,000, and Palm Beach County's highest rate was in 2010 at 32.4 per 100,000. Miami-Dade County had the higher *Giardiasis* rates than the other three counties and Florida in every year except 2008, when Monroe County's rate exceeded Miami-Dade County's rate.

Table 45: Rates of *Giardiasis* per 100,000 Population

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Percent Rate Change**
Broward	4.7	4.9	3.7	4.0	3.7	6.1	7.7	8.5	5.5	5.3	12.8%
Miami-Dade	10.7	13.5	10.2	9.7	11.1	12.6	31.4	32.4	12.5	9.4	-12.2%
Monroe	5.1	5.1	0	0	2.7	18.9	4.1	15.1	5.5	0	-100.0%
Palm Beach	6.3	4.1	5.7	6.0	5.5	9.0	9.4	7.7	6.3	5.2	-17.5%
Florida	6.4	6.3	5.5	6.2	6.9	7.5	10.6	11.4	6.6	5.8	-9.4%

Source: Florida Charts

Cryptosporidiosis rates decreased in Broward County between 2003 and 2012. Miami-Dade County's rates remained the same, while Monroe and Palm Beach counties increased. Palm Beach County had the largest increase in rates of 214.3%, smaller than Florida's rate increase of 257.1%. Despite these changes, *Cryptosporidiosis* rates remained relatively low in all four counties between 2003 and 2012. Miami-Dade and Monroe counties experienced their highest rates in 2008 of 2.7 and 4.1 per 100,000 respectively. The three years prior to and following Monroe County's rate of 4.1 per 100,000 in 2008 were all zero. Broward County rates were highest in 2006 and Palm Beach County rates were highest in 2007.

Table 46: Rates of *Cryptosporidiosis* per 100,000 Population

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Percent Rate Change**
Broward	1.8	2.5	2.7	2.9	1.3	3.2	0.9	1.3	2.4	1.5	-16.7%
Miami-Dade	0.9	0.8	1.5	1.8	2.0	2.7	1.0	0.9	0.9	0.9	0%
Monroe	1.3	3.8	0	0	0	4.1	0	0	0	1.4	7.7%

Palm Beach	0.7	0.2	1.7	1.5	3.5	2.8	3.3	1.7	2.6	2.2	214.3%
Florida	0.7	0.9	1.6	3.2	4.0	3.0	2.7	2.2	2.3	2.5	257.1%

Source: Florida Charts

Vectorborne and waterborne diseases, total enteric diseases displayed in **Table 47**, in all four counties and on average in Florida increased between 2003 and 2012, with Monroe and Miami-Dade counties experiencing the largest rate increases. The rates of change for total enteric diseases indicates that the rates of diseases in all four counties and the state have increased between 2003 and 2012. Monroe County experienced the greatest increase of the four counties with a rate change of 232.0%. Palm Beach County experienced the smallest increase with a rate increase of 2.7%. Monroe County experienced the highest rate of the four counties and the state average of enteric diseases in 2010 of 82.3 per 100,000. It is important to note that many of these enteric diseases can be transmitted through food or water and case records are not always clear.

Table 47: Rates of Total Enteric Diseases* per 100,000 Population

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Percent Rate Change**
Broward	1.1	1.2	2.0	1.5	2.1	2.9	2.6	3.2	1.4	2.9	163.6%
Miami-Dade	5.3	4.7	3.6	1.4	2.9	5.5	6.5	14.6	14.1	11.7	120.8%
Monroe	2.5	10.2	7.8	6.6	5.3	5.4	34	82.3	9.6	8.3	232.0%
Palm Beach	11.1	9.9	9.1	8.2	6.8	9.3	9.3	6.3	8.8	11.4	2.7%
Florida	8.0	8.0	7.8	7.7	9.0	10.0	11.5	13.8	14.8	15.1	88.8%

*Campylobacteriosis, Cryptosporidiosis, Cyclosporiasis, E. Coli, Shiga Toxin Producing, Giardiasis, Hepatitis A, Salmonellosis, Shigellosis, and Typhoid Fever.
*Pre-2009 Includes: Campylobacteriosis, Cryptosporidiosis, Cyclosporiasis, E. Coli, Shiga Toxin + (Serogroup Non-0157), Entrohemorrhagic E. Coli (EHEC) 0157:H7, Escherichia Coli, Shiga Toxin Producing, Giardiasis, Hepatitis A, Salmonellosis, Shigellosis, and Typhoid Fever.
Source: Florida Charts

Weather-Related Morbidity and Mortality

Drowning rates do not necessarily capture the full picture of the potential for weather-related morbidity or mortality due to climate change-related factors as these deaths may not be due to flooding or climate change-related factors. To understand these true numbers considering the nature of the causes of death are not included in these health rates, the causes of deaths would have to be explored individually. Examining the causes behind these death rates was beyond the scope of this HIA, however drowning rates can provide insight into the potential effects SLR and flooding exacerbated by SLR may have on the morbidity and mortality of the populations in these heavily populated coastal counties.

Drowning rates have decreased between 2003 and 2012 in all counties and across the state of Florida with the exception of Monroe County. Monroe County rates increased by 39.5% and experienced high rates of drowning in 2004-2009 and 2011, with the highest rates in 2006 and 2008 at 9.6 per 100,000. Monroe County's highest rates were the highest of the four counties and Florida between 2003 and 2012.

Table 48: Drowning Rates per 100,000 Population

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percent Rate Change
Broward	2.6	1.9	1.8	2.3	2.1	3.0	1.6	2.3	2.4	2.4	-7.7%
Miami-Dade	2.0	1.4	1.8	1.5	1.8	1.7	1.7	1.2	1.0	0.9	-55.0%
Monroe	3.8	6.8	9.5	9.6	7.6	9.6	6.3	3.8	5.6	5.3	39.5%
Palm Beach	2.2	1.7	2.5	2.2	2.8	2.9	2.7	2.0	1.7	1.5	-31.8%
Florida	2.2	2.0	2.0	2.2	2.1	2.0	2.0	2.0	1.8	1.8	-18.2%

Source: Florida Charts

Omitted Health Conditions

Certain health data for Monroe County was unavailable and therefore omitted from analysis due to a lack of available data. Data on the prevalence of the health effects of harmful algal blooms in Southeast Florida was unavailable and could not be included in the assessment.

Literature Review

Climate Change Overview

Over the past 50 years, global temperatures have increased more than 3.6 degrees Fahrenheit, or 2 degrees Celsius, as GHGs, particularly from carbon dioxide from human activities like the burning of fossil fuels for transportation, have become trapped in the earth's atmosphere, warming the planet (Karl, Melillo, & Peterson, 2009; Pachauri & Reisinger, 2007). By the end of the century, these temperatures are projected to rise another 1.8 to 4 degrees Celsius (Pachauri & Reisinger, 2007). This global temperature warming has led to environmental changes in precipitation patterns; the melting of ice caps, sheets and glaciers causing sea level rise; the heating and acidification of oceans; and more frequent extreme weather events like stronger storms, heat waves and droughts (Karl, Melillo, & Peterson, 2009; Pachauri, & Reisinger, 2007). Environmental changes have created changes in waterborne, vectorborne, and foodborne disease patterns; coastal flooding; air and water quality; and ecology and agriculture to name a few (Karl et al., 2009).

Climate Change in South Florida

Climate change impacts will be felt globally, but certain areas and populations are recognized as particularly vulnerable to climate change impacts, including Miami, greater New York, Mumbai, Shanghai, and New Orleans (Heimlich, Bloetscher, Meeroff, & Murley, 2009; Pachauri & Reisinger, 2007). The Southeast Florida region, with its low-lying coasts, subtropical climate, porous ground, and particular water hydrology, is one of the most vulnerable areas in the world where climate change threatens both the natural environment and the population living there (Heimlich et al., 2009). The region's largest city, Miami, ranks among the top 10 cities in terms of exposed populations to the effects of climate change (Hanson, Herweijer, Patmore, Hallegatte, Corfee-Morlot, Chateay, & Muir-Wood, 2008). With 30 percent of the state's population living in this one region, climate change represents a serious threat to a significant population (U.S. Census Bureau, 2012).

Sea Level Rise

The melting of ice caps, ice sheets, and glaciers from the global temperature rise resulting in a significant loss in ice mass and the thermal expansion of the oceans waters have both contributed to SLR and is expected to continue (Karl et al., 2009). South Florida is considered to be one of the most vulnerable regions to the effects of SLR (SEFRCCC, 2011). Saltwater intrusion, inundation, erosion, and increased storm surges from increased extreme weather events like hurricanes, pose serious threats to this low-lying region and its populous coastal communities. In one SLR scenario of a one and a half foot rise by 2100, an estimated 193,000 Miami-Dade County residents will be affected, 169,000 in Broward County, and 3,500 in Palm Beach County (Zhang, 2011).

The USACE, using Key West tidal data from 1913-1999 with a base projection from 2010, projected that SLR in Southeast Florida will raise one foot from the 2010 baseline between 2040 and 2070 and could raise two feet by 2060 (USACE, 2009). SLR projections could mean that Southeast Florida's energy systems, transportation infrastructure, agricultural lands, and the largest wetland in North America with its delicate ecosystem could be damaged (Zhang, 2011; Karl et al., 2009). Florida's crucial

interdependent water management systems and water resources that play an important role in assuring the regions habitability will likely be impacted by storm surges exacerbated by rising sea levels during extreme weather events (Heimlich et al., 2009).

Extreme Heat Events

As global temperatures rise, extreme heat events, also called heat waves, are becoming more intense and frequent (Portier et al., 2010). The EPA defines extreme heat events as "periods of summertime weather that are substantially hotter and/or more humid than typical for a given location at that time of year" (2008). Adding to these extreme heat events, is the urban heat island effect created by urban development where land and vegetation have been replaced with solar reflective, heat trapping materials and closely packed, tall buildings that trap heat in a literal urban island (EPA, 2008).

Between 1949 and 1995, the frequency of heat waves increased 20 percent in the U.S. and is projected to continue increasing in frequency, duration, and intensity (Kravchenko, Abernethy, Fawzy, & Lyerly, 2013). Two of the largest cities in Southeast Florida, Key West and Miami, rank first and second respectively as the hottest cities in the U.S. (NOAA, 2008). With South Florida's large population of elderly, a group particularly vulnerable to heat-related morbidity and mortality, extreme heat events pose a threat to the region's vulnerable populations (Luber & McGeehin, 2008; US Census Bureau, 2012).

Climate Change and Human Health Effects

Climate change is a serious public health threat that has already begun to affect human health outcomes and disease patterns (Haines, Kovats, Campbell-Lendrum, & Corvalan, 2006). Although preventative, mitigative and adaptive strategies for climate change will help lessen negative health impacts, human health will continue to be affected from present climate change conditions (Hess, McDowell, & Luber, 2011). Rising sea levels, intensified by storm surges, increased precipitation and flooding; and the increasing frequency and severity of extreme heat events that can cause droughts, wildfires and worsened air pollution, present the greatest threats to human health outcomes (Kjellstrom & McMichael, 2013; Portier et al., 2010).

Climate change will both aggravate existing human health risks and conditions and create new ones, while the health impacts will vary and have both direct and indirect effects (Kjellstrom & McMichael, 2013). Populations with physical (pregnant women, children, the elderly, coexisting conditions), social (low socioeconomic status), and geographical (urban and coastal areas) vulnerabilities will be most affected (Portier et al., 2010). The health impacts will be felt to different degrees throughout various parts of the world, but certain areas have already been identified as the most vulnerable (Brian, 2005; Doherty & Clayton, 2011; Hanson et al., 2008; Rose, Epstein, Lipp, Sherman, Bernard, & Patz, 2001; SEFRCCC, 2011).

Asthma, Respiratory Allergies, and Airway Diseases

Rising temperatures from carbon dioxide in GHG emissions has led to correlating peaks in ozone levels in recent years (Brian, 2005). Seasonal climate changes and poor air quality from air pollutants like particulate matter (PM), tropospheric ozone, nitrogen dioxide caused by carbon dioxide, and rising

temperatures have the potential to impact lung function and the incidence and prevalence of asthma, respiratory allergies, and airway diseases (Shea, Truckner, Weber, & Peden, 2008). Extreme heat events increase PM in the air and the chances of harmful algal blooms becoming aerosolized, aggravating asthma and respiratory diseases, while wildfires can release respiratory irritant and carcinogenic substances into the air exacerbating asthma and allergic diseases. Evidence shows that increased carbon dioxide increases pollen production, earlier flowering periods, and longer pollen seasons for some allergenic plants (Shea et al., 2008). Increased rainfall and flooding along with rising temperatures can lead to the growth of mold and fungi indoors, aggravating asthma and respiratory allergies (Mendell, Mirer, Cheung, & Douwes, 2011).

Cancer

While the causes of certain cancers are known, the exact exposures that cause many cancers are still not well understood (American Cancer Society, 2013). Exposure to air pollution, PM, and ultraviolet radiation (UV) are known risk factors for certain cancers (Tucker, 2009). Air pollution and PM, two known causes of lung cancer, are already present in the atmosphere due to increased levels of carbon dioxide, but these conditions are also exacerbated during heat waves, increasing human exposure (Stone, 2005). The depletion of stratospheric ozone as a result of climate change has increased UV exposure, placing people at risk of developing skin cancers (Beelen, Hoek, van den Brandt, Goldbohm, Fischer, Schouten, & Brunekreef, 2008). Research on human exposure to toxic chemicals and heavy metals does not fully understand the relationship with cancer, but these hazardous materials are suspected of causing or increasing a person's risk of developing cancer. Flooding following heavy precipitation or storm surges can cause the leaching or runoff of chemicals and metals into the environment, potentially exposing humans to cancer-causing toxins (Portier et al., 2010).

Cardiovascular Disease and Stroke

High temperatures and heat waves are well-documented as being associated with having a direct impact on adverse health effects like cardiovascular disease and stroke (Lin, Luo, Walker, Liu, Hwang, & Chinery, 2009; Luber & McGeehin 2008). The health impacts of air pollution and an increase in ozone and PM are amplified during extreme heat events and contribute to cardiovascular disease and stroke (Stone, 2005). Evidence also indicates that acute psychological stress caused by disasters and chronic psychological stress triggered by extreme events can lead to cardiovascular disease. The stress of displacement following disasters can create stress-related cardiac conditions, while a lack of access to adequate medical care following extreme weather events may interrupt medical care for persons with chronic cardiovascular conditions (Dimsdale, 2008).

Foodborne Diseases and Nutrition

Food production and food quality are expected to be affected by climate change, placing humans at risk of foodborne disease, food insecurity, and malnutrition. Foodborne diseases represent a significant public health threat because of their sheer number of cases reported each year and resulting economic costs (Rose et al., 2001). The food supply may become contaminated following floods that cause contamination of agricultural lands, food, water, and soil from sewage and pesticides irrigation or from harmful blooms in coastal waters that increase in warmer temperatures (Rose et al., 2001; Tirado, Clarke, Jaykus, McQuatters-Gollop, & Frank, 2010). Food safety standards can also be disrupted

following an extreme weather event, leading to the spread of foodborne diseases. Foodborne illness-causing bacteria like salmonella thrive in warmer temperatures, like during extreme heat events, which not only increases the risk of spread but also may create more virulent pathogens (Tirado et al., 2010).

Extreme weather events, like droughts and storm surges can damage or destroy crops and food supplies, disrupting food distribution and security (Tirado et al., 2010). Disruptions to food distribution can create food insecurity from either a lack of access to healthful foods or through rising food prices. A lack of access to healthful foods either through availability or prices places people at risk of going hungry or having to rely on foods with poor nutritional value that can lead to health issues ranging from malnutrition to obesity (Bloem, Semba, & Kraemer, 2010).

Heat-Related Morbidity and Mortality

Heat waves cause more weather-related mortality in the U.S. than hurricanes, tornadoes, floods, lightening, and earthquakes combined. Extreme heat events can cause heat exhaustion, syncope, heat strokes, and death among other conditions (Luber & McGeehin, 2008) and are associated with an increase in hospital admissions for cardiovascular and respiratory diseases (Lin et al., 2009). The elderly and persons living alone, without air conditioning, with pre-existing conditions like cardiovascular disease and mental disorders, and on certain medications are particularly at high risk of heat-related morbidity or mortality (Luber & McGeehin, 2008). Additionally, people living in urban environments are vulnerable to the urban heat island effect and the amplified effects of extreme heat (Brian, 2005).

In recent decades, heat-related morbidity and mortality has decreased, likely due to early warning systems, increased access to air conditioning, and better forecasting (Kalkstein, Greene, Mills, & Samenow, 2011). However, projections estimate that with increasing global urbanizations creating urban heat islands, urban populations will experience greater heat health impacts in the future (Wilby, 2008). Extreme heat events are increasing and are projected to become more intense and frequent (Pachauri & Reisinger, 2007).

Human Developmental Effects

Harmful environmental exposures or a disruption in development during the fetal development period and early childhood have been shown to lead to developmental changes and deficits that can have negative health effects throughout a person's life (CDC, 2013). Malnutrition and exposure to contaminants and biotoxins represent the two greatest climate change threats that could impact human development (Portier et al., 2010). Maternal and early childhood malnutrition have been shown to alter normal human development and lead to chronic diseases in adulthood (Victoria, Adair, Fall, Hallal, Martorell, Richter, & Sachdev, 2008; Wu, Bazer, Cudd, Meininger, & Spencer, 2004). Population displacement from flooding following storm surges and exacerbated by SLR can cause food insecurity that can lead to malnutrition (Haines et al., 2006).

Flooding increases the chances of human exposure to harmful chemicals, toxins, and metals, like mercury or lead, or pesticides known to alter normal human development, through the contamination of water systems (Portier et al., 2010; Schettler, 2001). Humans can also be exposed to biotoxins from harmful algae blooms through seafood or exposure during a flooding event (Portier et al., 2010). Future agricultural practices will have to adapt to the effects of climate change on agricultural pest and disease

patterns. This may require the use of more pesticides and herbicides and/ or the development of more effective pesticides that could expose humans through the environment, during extreme weather events, or through food systems to these chemicals (Boxall, Hardy, Beulke, Boucard, Burgin, Falloon, & Williams, 2009).

Mental Health and Stress-Related Disorders

Mental illness has already been recognized in the U.S. following natural disasters (Patz, McGeehin, Bernard, Ebi, Epstein, Grambsch, & Trtanj, 2000). Climate change is expected to directly and indirectly cause significant negative short and long-term mental health effects, especially among those most vulnerable to climate change and with preexisting mental health conditions (Doherty & Clayton, 2011). Different extreme weather events relate to different mental health impacts. Acute and long-term anxiety reactions, such as post-traumatic stress disorder (PTSD) and depression, are linked to acute weather events like floods, heat waves, and wildfires (Berry, Bowen, & Kjellstrom, 2010). Evidence shows increased PTSD in children after Hurricane Andrew and substantially higher anxiety and mood disorders than the general population among those who experienced Hurricane Katrina (Galea, Brewin, Gruber, Jones, King, King, & Kessler, 2007; La Greca, Silverman, Vernberg, & Prinstein, 1996). Extreme weather events like flooding that cause immediate health effects on affected populations through displacement and disruptions in access to resources and to social networks can cause mental health issues (Dimsdale, 2008). Extreme heat events have been associated with an increase in mental stress manifested in an increase of violence, suicide, homicide and spousal abuse (Doherty & Clayton, 2011).

Neurological Diseases and Disorders

Certain neurological diseases and disorders are expected to increase in prevalence from an increased risk of exposure to contamination and toxins resulting from climate change (CDC, 2013; Portier et al., 2010; Schettler, 2001). Climate change effects on the oceans have resulted in harmful algal bloom neurotoxins in fresh and marine waters that bioaccumulate in shellfish and other sea life that humans consume. The frequency, geographic range and delivery of toxins from harmful algal blooms may be altered by rising temperatures and extreme weather resulting from climate change, which will likely affect those coastal communities that use seafood as a food sources and are vulnerable to SLR and flooding (Portier et al., 2010).

Research shows that human exposure to harmful chemicals, toxins and metals, like mercury or lead, or pesticides during developmental periods can cause neurological issues when coupled with other environmental exposures (CDC, 2013; Schettler, 2001). Flooding increases the chances of human exposure to these harmful chemicals, toxins and metals through the contamination of water systems. Pregnant women and children are at greatest risk of the health effects of environmental contaminants as extreme weather events, SLR, and flooding increase in frequency and severity with climate change (Portier et al., 2010).

Vectorborne and Zoonotic Diseases

Many of the vectorborne and zoonotic diseases that once caused significant morbidity and mortality in the U.S., such as yellow fever, have been controlled, however they have been replaced by other vectorborne diseases like Lyme disease (Gage, Burkot, Eisen, & Hayes, 2008). The transmission of

vectorborne diseases depend on a number of factors including social, economic, ecological, climatic conditions, and human immunity (McMichael, Woodruff, & Hales, 2006). Climate variability is known to likely affect the transmission, incidence, and geographical range of vectorborne diseases (Gage et al., 2008; McMichael et al., 2006). Warming global temperatures and changing precipitation patterns will affect the development and reproduction patterns of the many cold-blooded vectors, increasing vector capacity for diseases like Chagas and West Nile, making new environments that are warming from climate change ideal conditions for these diseases to flourish (Gage et al., 2008).

Many mosquito vectorborne diseases, including malaria and dengue fever, are some of the most sensitive diseases to climate change (Patz, Epstein, Burke, & Balbus, 1996). Human migration following displacement and damage to health infrastructure can contribute indirectly to changing patterns in disease transmission (Patz et al., 1996). Population movement from changing environments or following extreme weather events like flooding or extreme heat events could expose populations to new vectorborne and zoonotic diseases (Gage et al., 2008). Future modelling on the effects of climate change on vectorborne diseases project that climate change will have an increasing effect on future transmission, however these models do not take into account non-climatic, public health prevention measures that could offset transmission (McMichael et al., 2006).

Waterborne Diseases

Extreme precipitation has already been associated with waterborne disease outbreaks in the U.S. (Curriero, Patz, Rose, & Lele, 2001). Waterborne diseases are associated with three types of weather events: heavy precipitation, flooding, and rising temperatures (Hunter, 2003). The increasing frequency and severity of precipitation events and storm surges causing flooding coupled with SLR will increase the risk of exposure of more people to waterborne disease pathogens (Curriero et al., 2001).

With increasing climate variability, deficiencies in storm drainage, treatment, and storage will put humans at risk of exposure to contamination (Rose et al., 2001). Exposure to gastrointestinal illnesses can lead to chronic and extended illnesses and even death, especially in vulnerable populations (Rose et al., 2001). Rising temperatures may also lead to an increase in the frequency of harmful algal blooms. Algal blooms coupled with runoff from heavy precipitation can contaminate recreational waters, placing people in coastal communities and those exposed through contact at risk of negative health effects (Curriero et al., 2001; Rose et al., 2001).

Weather-Related Morbidity and Mortality

Floods, heavy precipitation, and storms are extreme weather events that cause weather-related morbidity and mortality in the U.S. (Goklany, 2007). The frequency of heavy precipitation and increase in severity of storm events in the U.S. has already increased and is projected to continue increasing (Pachauri & Reisinger, 2007). This increase in precipitation coupled with stronger storm surges and rising sea levels indicate that coastal communities are at a greater risk of morbidity and mortality from storms and flooding, especially during and immediately after the event. (Karl, Meehl, Miller, Hassol, Waple, & Murray, 2008).

Once extreme weather has passed, the risk from other health hazards persists. Waterborne disease outbreaks, a damaged health care infrastructure, and mental health disorders following displacement

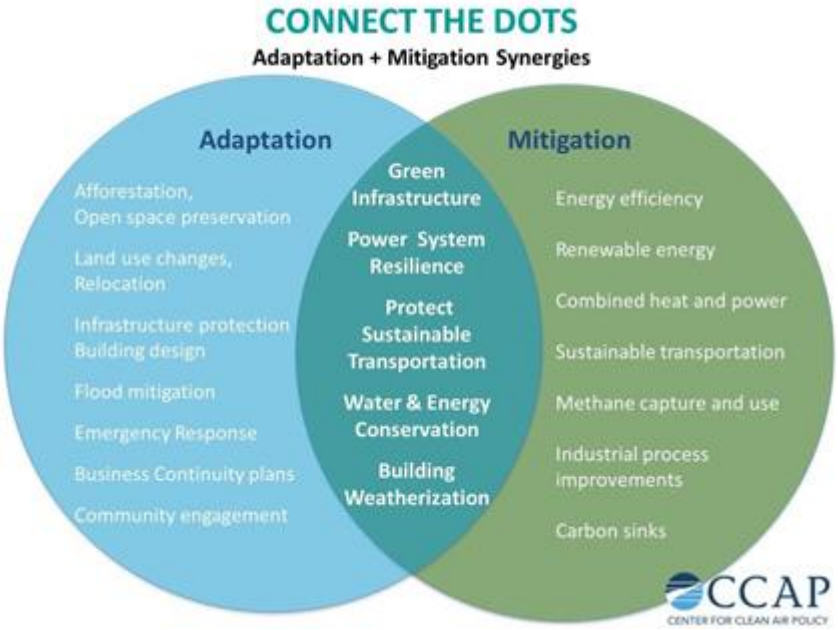
from weather events like flooding can place people at risk of negative health impacts (Haines et al., 2006; Hunter, 2003; Patz et al., 1996). Although weather-related morbidity and mortality has declined in recent years suggesting the effective adaptive capacity of the U.S. during weather events, the experience with Hurricane Katrina serves as an example of how this capacity could be strengthened (Goklany, 2007).

Climate Change Adaptation and Mitigation Strategies

Incorporating adaptation and mitigation strategies into public health policy is crucial to reducing climate change vulnerability and poor health outcomes (Haines et al., 2006). Climate change adaptation and mitigation strategies, policies, and protocols focus on short and long-term changes with an emphasis on sustainable development (Metz, 2007). Adaptation refers to protecting systems and building resilience in response to anticipated climate stimuli and their effects in order to reduce harm or exploit benefits (Keim, 2008; Parry, 2007). Mitigation is the preventive approach of implementing policies, strategies, and protocols that work to reduce current and future GHG emissions (Hamin & Gurran, 2009). Adaptation and mitigation are the methods to reach the objective of reducing vulnerability and risks associated with climate change to reach the goal of resilient communities (Hamin & Gurran, 2009). While the two strategies both work towards the same goal of preventing the effects of climate change, the timeframes and distribution of benefits of the two strategies vary. Adaptation can be both reactive and proactive to the effects of climate change, working locally to directly create benefits. Mitigation is a proactive approach that provides benefits to preventing the effects of climate change (Metz, 2007).

Effective climate change strategies cannot include one without the other. Adaptation and mitigation must be incorporated into climate change strategies and policies together to achieve effective, sustainable environmental outcomes and positive health outcomes (Laukkonen, Blanco, Lenhart, Keiner, Cavric, & Kinuthia-Njenga, 2009). However, the relationship between the two strategies is not always complimentary when it comes to human health outcomes (Hamin & Gurran, 2009). The adaptive strategy of installing air conditioning systems in buildings can reduce morbidity and mortality from extreme heat events, but the energy required to run these systems goes against the mitigation goal of reducing greenhouse emissions (Metz, 2007; Luber & McGeehin, 2008). It is important that adaptation and mitigation strategies do not undermine one another, but that they focus on the larger goals of creating sustainable development and preventing climate change (Hamin & Gurran, 2009). **Diagram 2** provides a good description of different adaptation and mitigation strategies and how they can overlap in preventing and preparing for climate change (Center for Clean Air Policy, 2014).

Diagram 2: Adaptation and Mitigation Synergies



**Source: Center for Clean Air Policy (2014)*

Climate change adaptation and mitigation strategies and public health strategies often have co-benefits. Health-focused climate change strategies can directly and indirectly benefit the environment and climate change adaptation and mitigation policies will often have a favorable impact on health outcomes (Frumkin, Hess, Luber, Malilay, & McGeehin, 2008; Haines, 2012; Metz, 2007). Many mitigation policies reducing GHGs will have co-beneficial health effects of reducing morbidity and mortality, especially from chronic illness (Haines et al., 2006). For example, mitigative policies reducing individual vehicular use by encouraging the use of public transportation, walking, or biking and increasing vegetable intake while decreasing meat consumption would also directly help address the U.S. obesity epidemic and other chronic conditions (Frumkin et al., 2008; Haines, McMichael, Smith, Roberts, Woodcock, Markandya, & Wilkinson, 2010). However, some co-benefit scenarios like this one may only apply to more developed countries and will depend community to community depending on other factors such as the reliability and availability of public transport or safety when walking or biking (Haines et al., 2010). Focusing on implementing policies that maximize these co-benefits can help to benefit health outcomes and prevent climate change (Haines, 2012).

Adaptation and mitigation strategies focusing on cost effectiveness are important for the health sector. Some adaptation and mitigation strategies have already demonstrated success (Haines et al., 2006). Early warning systems for extreme heat events have already proven to be a much more cost effective policy to decrease morbidity and mortality than to treat heat-related illness (Harlan & Ruddell, 2011; Kalkstein et al., 2011). Cost-benefit analyses have been conducted to determine the economic valuation of the health benefits of mitigation strategies such as lowering greenhouse emissions to reduce air pollution and the associated health impacts from reduced air pollution. While results varied on exact cost savings, all calculations determined that the cost savings of health benefits made up for a substantial portion of the costs of mitigation (Metz, 2007).

Responses to the health impacts of climate change cannot just be isolated to the public health sector. Climate change adaptation and mitigation strategies impacting health outcomes strategies should emphasize multiple benefit actions across multiple sectors (Metz, 2007). Approaches for addressing these issues must be cross-sectoral, including stakeholders from transportation, building and housing, energy production, land-use planning, and more (Hallegatte, 2009). Adaptation activities must include a full range of stakeholders from the community, government, and public and private sectors to ensure effective implementation (Ebi & Semenza, 2008). Choosing to implement mitigation strategies that engage key stakeholders from multiple sectors will help to overcome implementation barriers in creating a more cohesive sustainable development (Metz, 2007).

Climate Change Public Health Messaging

Despite a basic understanding of the causes and general threats of climate change, the general public in the United States are only somewhat aware of the health implications of climate change (Maibach, Nisbet, Baldwin, Akerlof, & Diao, 2010; Weber & Stern, 2011). Climate change is very technical, and because of this people often rely on mass media's reporting's from the experts for their information on climate change (Weber & Stern, 2011). As climate change is most well understood as a scientific issue, climate change is generally framed in scientific terms as an environmental problem (Maibach et al., 2010; Weber & Stern, 2011). While it may be true that climate change is largely an environmental problem, framing the issue in this way distances people from the issue and diminishes public engagement and investment in the issues. Developing solutions using an environmental approach fails to make climate change's impacts relevant to the individuals' life. Framing the issue in terms of public health and the potential impacts climate change will have on health makes the issue more relevant and significant. Influencing adaptation and mitigation behaviors will likely require messaging at both the individual and community-levels (Maibach et al., 2010).

New, creative strategies are needed to effectively improve the public's understanding and incite action (Weber & Stern, 2011). These strategies may be modeled off of communication methods that have already demonstrated effectiveness in altering individual-level behaviors, like mass media messages about reducing household electricity use or putting "green" labels on products. Creating a new health framework to redefine the impacts of climate change could help people understand climate change impacts in terms of problems they are already familiar with, like asthma and the rise of new vectorborne diseases in their communities rather than making it an issue that is just affecting other people in other parts of the world. This new type of framing also has the potential to create new multisectoral and multilevel communication partnerships (Maibach et al., 2010).

Finally, targeting the individuals and communities are important to changing individual and local-level behaviors, however, decision makers at all levels- elected officials, leaders in business and nongovernmental organizations, community leaders- represent an important audience. This audience has the ability to influence community structure through policies, media and messaging, infrastructure, the regulation of products and services (Weber & Stern, 2011). Additionally, mass media should be both a target audience and a partner in communication as many people get their climate change information from these sources (Weber & Stern, 2011).

Sea Level Rise and Heat Waves Data Analysis

Historical Trends

Historically, global mean sea levels have fluctuated naturally throughout history in response to global climate change's cycles of heating and cooling periods. Over the past century, since the end of the 19th century and the start of the 20th century, global sea levels have increased at a faster rate than geologically normal.

Table 49 provides the mean sea level trend changes over 100 years for three NOAA stations in Southeast Florida. The data shows that based on data collected from 1931 to 1981 in Miami Beach, FL mean sea level trends have increased 9.36 inches. In Key West, FL, mean sea level trends based on 1913-2006 sea level data has risen 8.76 inches over 100 years. Vaca Key, FL data collected from 1971 to 2006 indicates a 10.92 inch rise in sea levels over 100 years.

Table 49: Mean Sea Level Trend Changes Over 100 Years

NOAA Station Location	County	100 Year Mean Sea Level Change	Data Collection Time Range
Miami Beach, FL	Miami-Dade	.78 feet (9.36 inches)	1931-1981
Key West, FL	Monroe	.73 feet (8.76 inches)	1913-2006
Vaca Key, FL	Monroe	.91 feet (10.92 inches)	1971-2006

Source: *NOAA (2013)*

Current Trends

Current and historic SLR data was collected from NOAA. NOAA collects SLR data in two of the four Southeast Florida counties from this HIA: Miami-Dade County and Monroe County. The Miami-Dade County station is located in Miami Beach, FL, while two stations are located in Monroe County, one in Key West, FL and the other in Vaca Key, FL.

Table 50 illustrates the changes in mean sea level trend averages in three NOAA stations located in Miami Beach, FL in Miami-Dade County, Key West, FL and Vaca Key, FL, both in Monroe County in measurements from 1971 to 2006 and 2012. Mean SLR trends in from 1971 to 2006 are 2.39 mm/yr. in Miami Beach, FL; 2.24 mm/yr. in Key West, FL; and 2.78 mm/yr. in Vaca Key, FL. Updated measurements from 1971 to 2012 in Key West, FL show a 0.05 mm/yr. increase in mean trends to 2.29. Updated measurements in Vaca Key, FL for 2012 have a 0.3 mm/yr. increase in mean sea level to 3.08. The 2012 mean trend was unavailable for Miami Beach, FL.

Table 50: Mean Sea Level Trends in MM/YR from 1971 to 2006 and 2012

NOAA Station Location	**County**	**1971-2006**	**1071-2012**	**Mean Difference**
Miami Beach, FL	Miami-Dade	2.39	--	--
Key West, FL	Monroe	2.24	2.29	+.05
Vaca Key, FL	Monroe	2.78	3.08	+.30

Source: *NOAA (2013)*

Future Projections

There are a wide variety of SLR projections for the 20th century based off various mean sea level trends based off calculations extrapolated from different measurements. For the purposes of this HIA, following the SEFRCCC's adoption of the USACE SLR projections. The USACE extrapolated the historic rate of SLR from 1913 to 1999 based off of the 2010 levels in Key West, FL. These future projections calculate SLR through 2100. **Table 51** indicates projected time ranges for SLR increases of one, two, and three feet in Southeast Florida based on 2010 levels. Sea levels in Southeast Florida are projected to rise one foot between 2040 and 2070, two feet between 2060 and 2115, and three feet between 2078 and 2150. The projection was developed based on NOAA Key West, FL historic rates of SLR from 1913 to 2006 (2.24 millimeters/ year) and projections for increasing future rates.

Table 51: Sea Level Rise Projections

Projected Increase in Feet	Time Range
1	2040-2070
2	2060-2115
3	2078-2150

Source: *USACE (2009)*

Hydrological Conditions

The most recent U.S. Census data available on the four counties' plumbing facilities, including water sources and sewage disposal, was from 1990. This outdated information was not ideal to understand the current state of household water source and sewage disposal information, however it can provide insight into what has been in the past commonly used by the four counties' residents. Understanding where residents in the four counties source their water from and how it was disposed provides insight into the potential for water source contamination.

In all four counties, over 90% of housing units source their water from the public system or a private company. Palm Beach County had the highest percentage of individual drilled wells used for a housing unit water source at 8%, followed by Miami-Dade County with 2%. Public sewers more the most common used sewage disposal methods in all four counties, although Monroe County's use of public sewers was much lower than the other three counties. 49% of housing units used public sewers in Monroe County, while 48% used septic tanks or cesspools. 15% of Miami-Dade County's housing units used septic tanks or cesspools, 11% of Palm Beach County, and 9% or Broward County. 3% of Monroe County used "Other Means" for sewage disposal, 1% in Miami-Dade County, and Broward and Palm Beach counties both had less than 1% (U.S. Census Bureau, 1992).

Table 52: Water Sources for Housing Units in All Four Counties

County	Total Housing Units	Public System or Private Company	Individual Drilled Well	Individual Dug Well	Some Other Source
Broward	628,660	99%	1%	0%	0%
Miami-Dade	771,288	98%	2%	0%	0%
Monroe	46,215	97%	1%	1%	1%
Palm Beach	461,665	92%	8%	0%	0%

Source: U.S. Census (1992)

Table 53: Percentages of Housing Units Sewage Disposal in All Four Counties

	Units	Public Sewer	Septic Tank or Cesspool	Other Means
Broward	628660	91%	9%	<1%
Miami-Dade	771288	84%	15%	1%
Monroe	46215	49%	48%	3%
Palm Beach	461665	89%	11%	<1%

Source: U.S. Census (1992)

Saltwater intrusion into Southeast Florida's freshwater aquifers, especially the Biscayne Aquifer which serves as the principal water supply for Southeast Florida and the Florida Keys, has been a concern for Florida since the early 20th century. Some surface aquifers in Southeast Florida have already experienced saltwater intrusion while other surface and coastal aquifers remain at threat of SLR. USGS studies in Miami-Dade County in 1995 and Palm Beach County in 1997-1998 demonstrated the vulnerability of water sources in these areas to saltwater intrusion, although this was not related to SLR (Sonenshein, 1996; Hittle, 1999). As sea levels rise and droughts persist, saltwater intrusion is expected to increase the extent of saltwater intrusion. Broward, Miami-Dade, Monroe, and Palm Beach counties' freshwater supplies are all vulnerable to saltwater intrusion from SLR.

Extreme Heat Events Data

To determine extreme heat events in Southeast Florida, the Standard Precipitation Index (SPI), collected by the NOAA, was used for comparison. The SPI is a probability measure of precipitation that measures short-term (SP01 for one month measurements), mid-term (SP12 for 12-month measurements) and long-term drought (SP24 for 24-month measurements). These SPI measurements are standardized to create an index that is negative during drought and positive during wet conditions. Measurements become more or positive or negative as conditions become more severe. **Table 54**, from NOAA, demonstrates what the different SPI values mean in terms of drought.

Table 54: Classification Values for SPI

SPI Value:	Drought Category:

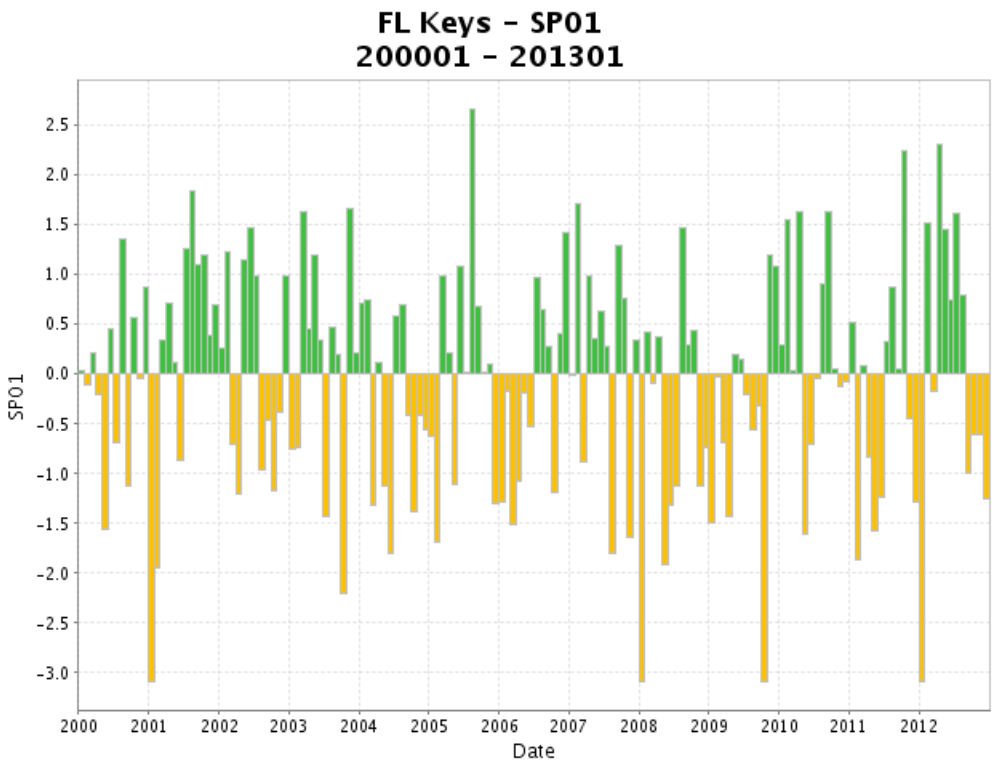
2.00 and above	Extremely wet
1.50 to 1.99	Very wet
1.00 to 1.49	Moderately wet
-0.99 to 0.99	Near normal
-1.00 to -1.49	Moderately dry
-1.50 to -1.99	Severely dry
-2.00 and less	Extremely dry

Source: NOAA (2013)

NOAA has two divisions in the geographic area of this HIA, one in the Florida Keys and the second is the Lower East Coast. Short-term (SP01 one month) and long-term (SP24 24-month) SPIs were used to determine Southeast Florida's current and historically recent dry conditions between January 2000 and January 2013.

Figure 1 and **Figure 2** graphically depict SP01 one-month and SP24 24-month measurements respectively in the Florida Keys between January 2000 and January 2013. **Figure 1** demonstrates that conditions reached the SPI categorization 'extremely dry' (-2.0 and up) in early 2001, late 2003, early 2008, late 2009 and early 2012. Conditions were 'severely dry' (-1.50 to -1.99) in mid-2000, early 2001 following 'extremely dry' conditions, mid 2004, early 2005 and 2006, late 2007, early 2008, mid-2010, and early and mid-2011.

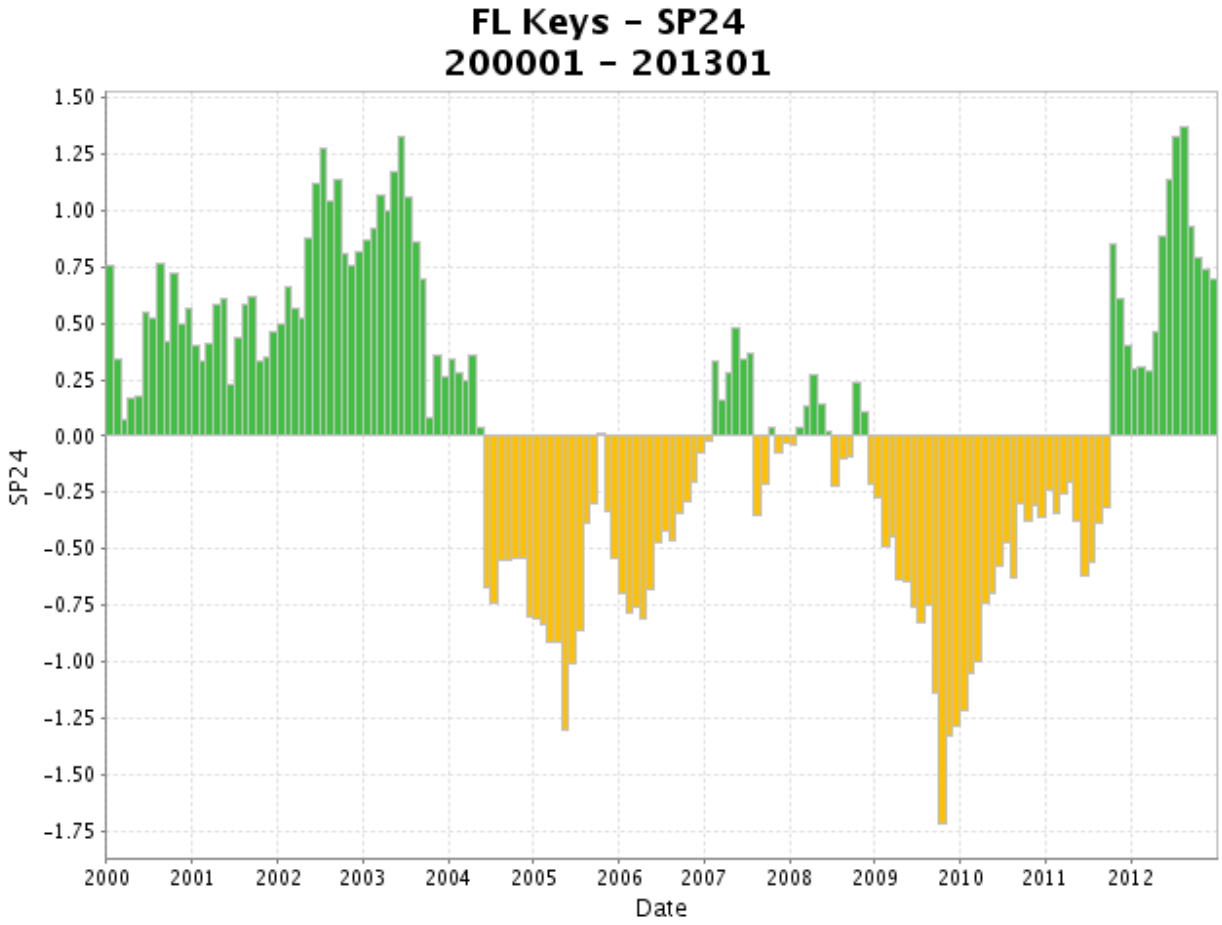
Figure 1: Standard Precipitation Index SP01 from the Florida Keys



Source: NOAA Satellite and information Service

Figure 2 provides a larger picture at what SPI dry condition measurements in the Florida Keys from January 2000 to January 2013 in the long-term. Compared to **Figure** 4 showing long-term dry conditions in the Florida Lower East Coast, the Florida Keys has drier conditions for more prolonged periods of time, but the dry conditions tend to be less extreme or severe. **Figure 2** shows how conditions overall were drier in the Florida Keys from mid-2004 to late 2005, late 2005 to early 2007, mid to late 2007, mid to late 2008, and early 2009 to late 2011. Much of these drier periods were still within the normal conditions that would not be classified as reaching 'moderately dry'. Conditions reach 'moderately dry' (-1.0 - -1.49) only in mid-2005 and mid-2009 to early 2010. Conditions were 'severely dry' (-1.50- -1.99) once near the end of 2009.

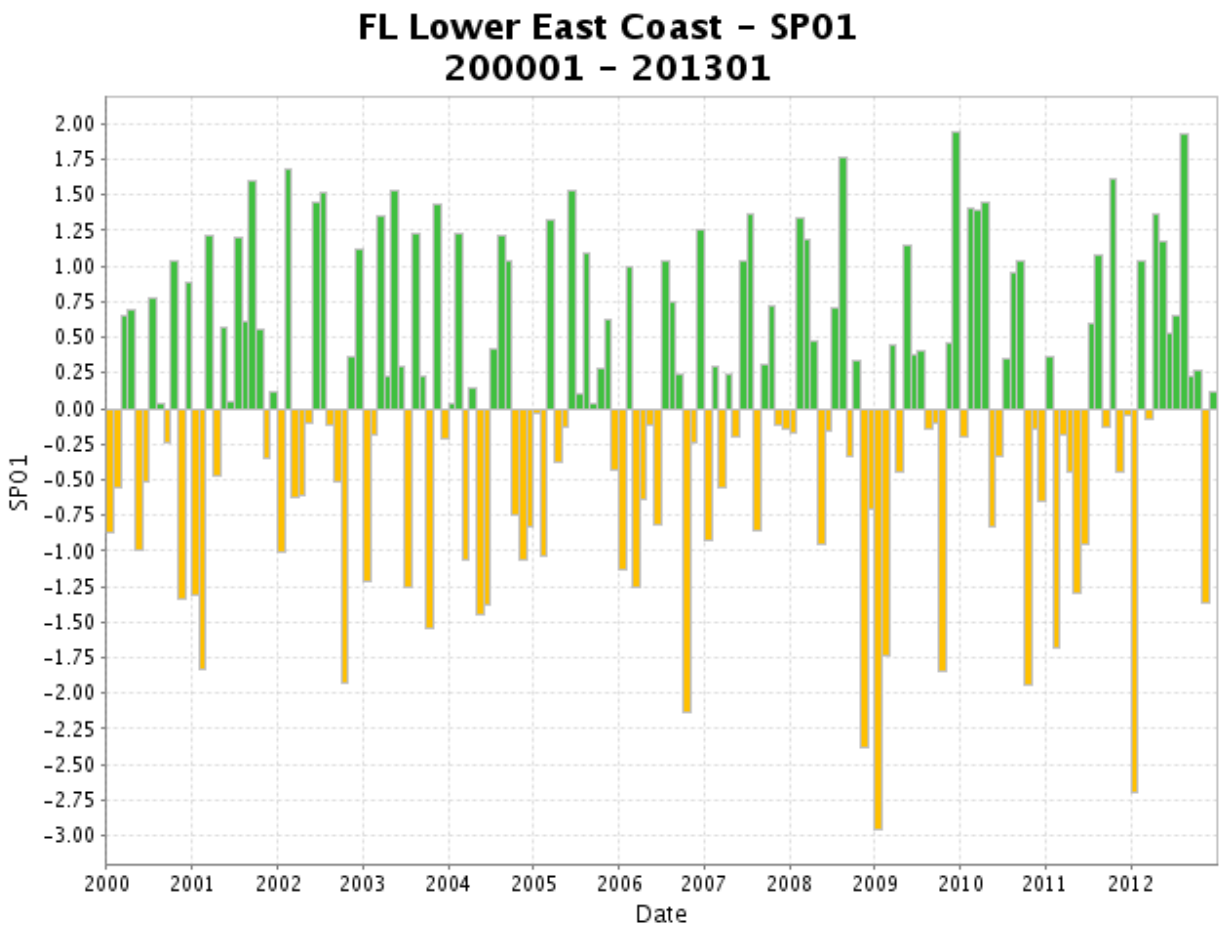
Figure 2: Standard Precipitation Index SP04 from the Florida Keys



Source: NOAA Satellite and information Service

Figure 3 and **Figure 4** graphically depict SP01 one-month and SP24 24-month measurements respectively in the Florida Lower East Coast between January 2000 and January 2013. **Figure 3** shows that dry conditions reached SPI categorization 'extremely dry' (-2.0 and up) in late 2006, late 2008, early 2009, and early 2012. Conditions were 'severely dry' (-1.50 to -1.99) in early 2001, late 2002, late 2003, early 2009 following 'extremely dry' conditions, late 2009, late 2010, and early 2011.

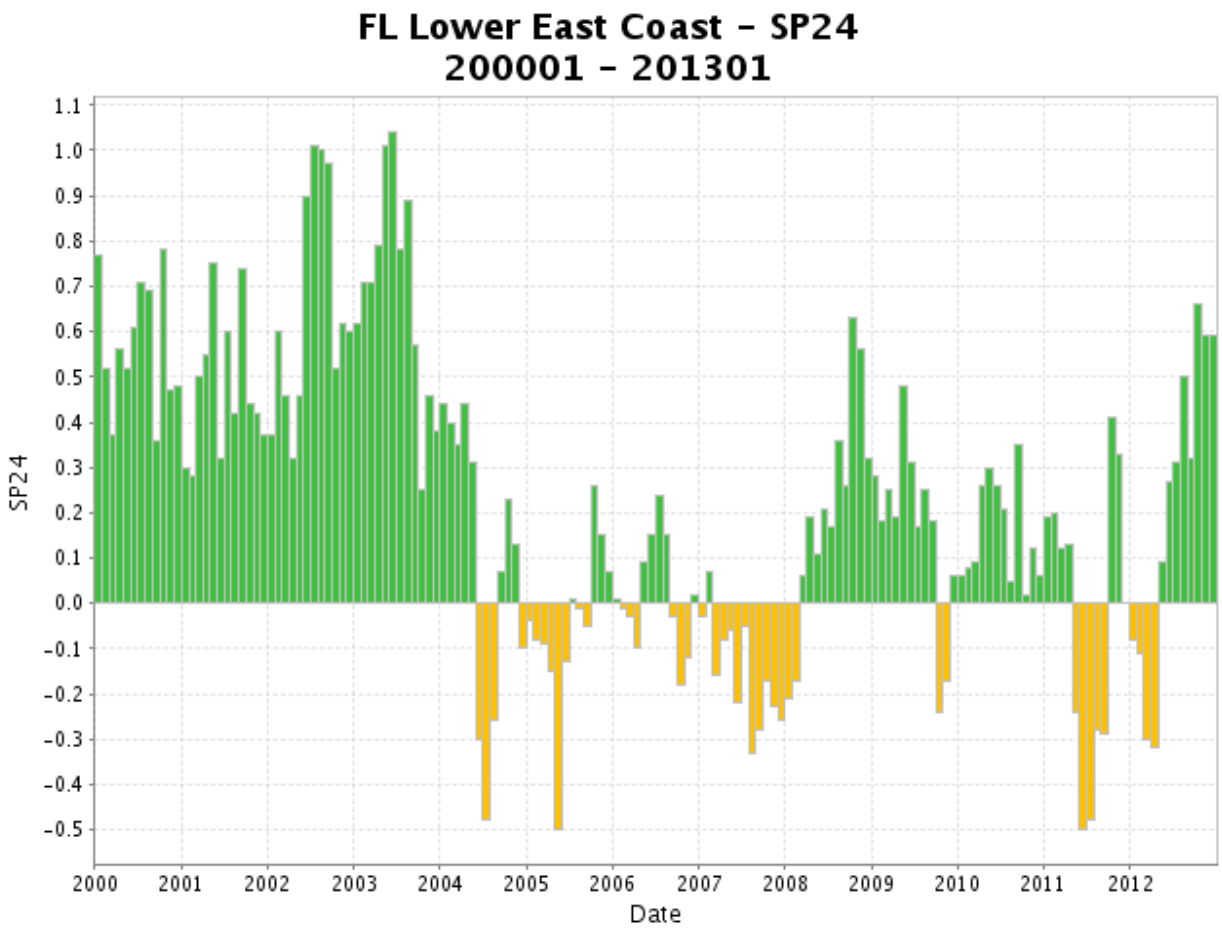
Figure 3: Standard Precipitation Index SP01 from the Florida Lower East Coast



Source: NOAA Satellite and information Service

Figure 4 provides a larger picture at what SPI dry condition measurements in the Florida Lower East Coast from January 2000 to January 2013 in the long-term. Conditions were much wetter long-term than in the Florida Keys, although the few dry conditions were much drier. In mid-2004, mid-2005, mid-2007 to early 2008, late 2009, most of mid- 2011, and early 2012 conditions were 'extremely dry' (-2.0 and up) in the Lower East Coast sometimes reaching SPI indexes of -3.0, -4.0, and -5.0. Conditions were 'severely dry' (-1.50- -1.99) in mid-2005, early 2007, and late 2009. 'Moderately dry' (-1.0 - -1.49) measurements were recorded in mid-2005, early 2006, and early 2012.

Figure 4: Standard Precipitation Index SP24 from the Florida Lower East Coast



Source: NOAA Satellite and information Service

Adaptation and Mitigation Policy Assessment

Statewide Policies for Local Governments

In recent years, local and regional governments in Southeast Florida have been increasingly implementing policies, initiatives, and programs addressing climate change. The levels of response across the state vary, but some communities have been responding to climate change-related concerns for almost three decades. In 2006, the state began to respond to growing concerns by implementing the first of mitigative policies focused on reducing GHG emissions. In 2008, two key pieces of legislation passed that engaged local governments in GHG reduction. The first piece of legislation required all local governments to include GHG reduction in the Comprehensive plans while the second directed that all newly built local government buildings must meet the requirements of at least one of three "green" building rating systems. In 2010, legislation passed giving authority to local governments to make recycling targets more aggressive and to create energy financing and retrofitting programs. As of 2011, local governments may now establish "adaptation action areas" in their Comprehensive Plans to identify areas vulnerable flooding, storm surge, extreme high tides, and other related impacts of SLR to prioritize funding for infrastructure and adaptation.

In the Florida State Health Improvement Plan (SHIP), emerging issues related to climate change are addressed as a focus area for public health practitioners. Florida must also be prepared to deal with the continual threat of natural disasters, health emergencies, health misinformation, tropical diseases and epidemics, which lends the opportunity to integrate municipal plans that address mitigation and adaption policies with public health requirements. The local Community Health Improvement Plans (CHIP) for each county are intended to mirror the state plan, and therefore apply resources to these emerging climate-related issues. In this role, local communities will be key to translating this work to practice in monitoring climate change-related health changes.

Southeast Florida Regional Climate Change Compact

In 2010, the four counties that are the focus of this HIA- Broward County, Miami-Dade County, Monroe County, and Palm Beach County- together created the SEFRCCC, a partnership focused on mitigating the causes of climate change and adapting to climate change consequences. Formed in 2009, this regional collaboration allows for these local governments to set their respective adaptation agendas while providing a means for which state and federal government agencies can provide technical assistance and support to the governments in a more efficient and resourceful manner. Since its inception, the SEFRCCC has developed the five-year RCAP consisting of 110 adaptation and mitigation climate change recommendations, an Implementation Guide to engage all public and private stakeholders in implementation of the 110 recommendations, and has advocated for climate change policy measures at the state and federal levels. The SEFRCCC advocates at the state and federal levels for climate change-related policies and strategies, specifically those related to SLR and vulnerabilities in the region. The Compact has successfully advocated for policies at the federal and state levels to address issues related to SLR and to implement the designation of the "adaptation action areas." The Compact meets annually to discuss emerging issues and review progress.

Broward County

In 2007, the Broward County Board of County Commissioners adopted the Broward County Resolution to Reduce Greenhouse Gases to reduce GHGs and support the U.S. Mayor's Climate Protection

Agreement as a participating city promoting local, state, and federal GHGs reduction. A Climate Change Interagency Task Force was convened in 2008 and in 2010 the group developed the Broward County Government Operations Climate Change Report to identify climate change-related impacts, gather baseline GHG information and provide recommendations for reduction, and identify Broward County GHG reduction strategies. The report demonstrates a detailed level of research the Workgroup conducted to understand the various impacts climate change will have on the community, including SLR, to inform policy making. The report demonstrates the level of preparedness Broward County has achieved thus far in mitigation strategies.

In 2008, Broward County joined the other three counties as a member of the ICLEI, an international organization supporting comprehensive approaches to supporting local governments achieve sustainability, climate protection, and clean energy goals. In the same year, Broward County joined support for the Cool Counties Program by committing to reduce GHG emissions, committing to work with all levels of county government to achieve 80 percent reduction by 2050, and to urge the federal government to adopt the same reduction goal. In the same year, the Board of County Commissioners adopted the United States Green Building Council's Leadership and Energy Environmental Design (LEED) standards to develop a "green building policy" to be used for the construction of new county-owned buildings. The Board also adopted a resolution to support the Airports Council International World Board and affiliate organizations commitment to action on climate change. The Board also supported state legislation focused on supporting renewable energy alternatives. In 2009, the Board passed a resolution supporting climate change legislation supporting adaptation and mitigation strategies.

Miami-Dade County

Miami-Dade County has been involved in planning for climate change for almost three decades and in recent years has made great progress in implementing climate change adaptation and mitigation measures. In 1991, Miami-Dade County served as a founding member of the ICLEI and in 2009 was selected by the organizations to develop a plan for the sustainability planning toolkit pilot program which will be used as a model for local communities. Since 1993, Miami-Dade County has been focused on reducing GHGs with the adoption of the Urban CO2 Reduction Plan. In 2007, Miami-Dade County joined the Chicago Climate Exchange pilot program and began tracking GHG emissions resulting from local government operations which has led to a successful reduction in GHGs. In 2006, the Miami-Dade County Climate Change Advisory Task Force (CCATF) was created in 2006 by The Mayor's Sustainability Advisory Board to identify potential climate change impacts in Miami-Dade County and provide adaptation and mitigation measures.

GreenPrint, released in 2010, is a community plan of partners from private and public organizations across multiple sectors designed as a framework to integrate sustainable environmental, economic, and social benefits into policies, programs, and initiatives implemented by Miami-Dade County. *GreenPrint* implemented 27 new initiatives in the categories of creating new partnerships and leadership, water and every efficiency, the environment and ecosystems, responsible land use and smart transportation, building a sustainable economy and green business, and healthy and sustainable communities. The Climate Change Action Plan was created as an integral component of *GreenPrint* that assesses the potential impacts of climate change in the community and provide a five-year GHG emissions reduction plan. As a part of the Action Plan, MDC committed to reduce GHG emission by 10 percent by 2015, 80 percent by 2050 as ta part of the Cool Counties Program.

Monroe County

Like the other three counties, Monroe County supports the U.S. Mayor's Climate Protection Agreement to reduce GHG emissions. To fulfill their commitment to this Agreement, Monroe increased climate change awareness, created an inventory of GHG emissions, set a reduction target goal, and developed the Energy Efficiency Conservation Strategy. Monroe County created a target for reduce GHGs by 20 percent by 2020 and developed mitigation strategy goals to achieve this goal.

Monroe County has also been a member of the ICLEI since 2008. Also in 2008, the Green Initiative Task Force/ Green Building Code Task Force was created to provide recommendations on addressing adaptation and mitigation climate change needs and environmental sustainability. The County adopted the Florida Green Building Coalition's green commercial building standard for all newly built county-owned buildings. In 2011, the Board of County Commissioners formed the Climate Change Advisory Committee to provide climate change adaptation and mitigation policy recommendations. Monroe County adopted the SEFRCCC SLR projections to guide Climate Change Advisory Committee in determining community impacts of SLR. In 2013, the Monroe County Community Climate Action Plan was released to coordinate a countywide strategy to reduce GHG emissions and adopt adaptation and mitigation strategies in countywide activities.

Palm Beach County

Palm Beach County has been addressing climate change though action since 2008 with the development of the Green Task Force on Environmental Sustainability and Conservation to "identify actions and policies that can be implemented by the county to encourage a healthier, more resource efficient and environmental sustainable living through efficient buildings and natural resources conservation." Like the other three counties, Palm Beach County mayors are also signatories on the U.S. Mayor's Climate Protection Agreement and also joined the ICLEI in 2010. In 2009, a website for the Go Green Initiative was launched, providing information on existing Palm Beach County sustainable and conservation programs, policies and initiatives for government agencies and departments to increase energy efficiency and increase environmental sustainability.

Climate change initiatives and strategies were implemented throughout local government departments; for example the public transportation train the Palm Tran is committed to switching to bio-diesel fuel and the Health Department coordinates public outreach activities and events promoting the reduction of GHG emissions and air pollution. In 2012, PBC achieved the prestigious Florida Green Building Coalition (FGBC) Certified Silver Green Local Government status for their work with local partners in protecting and conserving local natural resources, enhancing government efficiency, and raising awareness among the public about the benefits of environmental stewardship.

Summation

Over the past three decades, local and regional governments in Florida have already begun to take action in planning for climate change. These policies, programs, and initiatives focus on reducing GHGs and preparing for the effects climate change will have on communities. These strategies involve multiple sectors across many categories including energy, ecosystems, infrastructure, health, water resources, agriculture, and coasts. Assessing the existing strategies implemented in the four counties that are the focus of this HIA demonstrate that Florida counties have already thought about the impacts of climate

change and how their communities can take action. A look at the climate change actions that have been implemented in these counties demonstrates the variability and research, preparation, and planning that goes into each community to address their specific issues and needs.

Community Engagement

Surveys

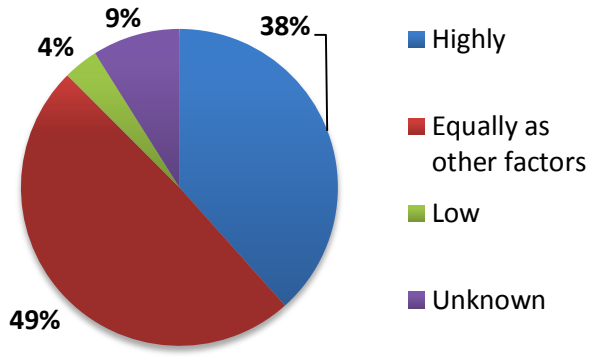
Professional Survey

In the fall of 2013, a paper administered survey was completed by 113 professionals. The participants were attending a regional planning or SLR conference, and currently resided in South Florida. A climate change and health survey was distributed in various occasions to professionals interested in the prioritization, changes, and health factors related to climate change. The following information represents the professional's survey results:

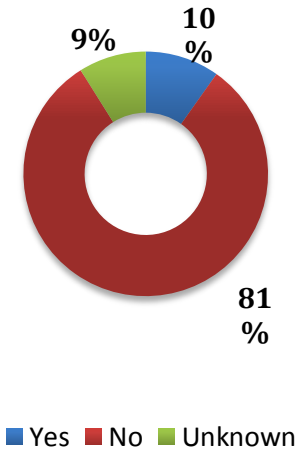
Respondents Professions:

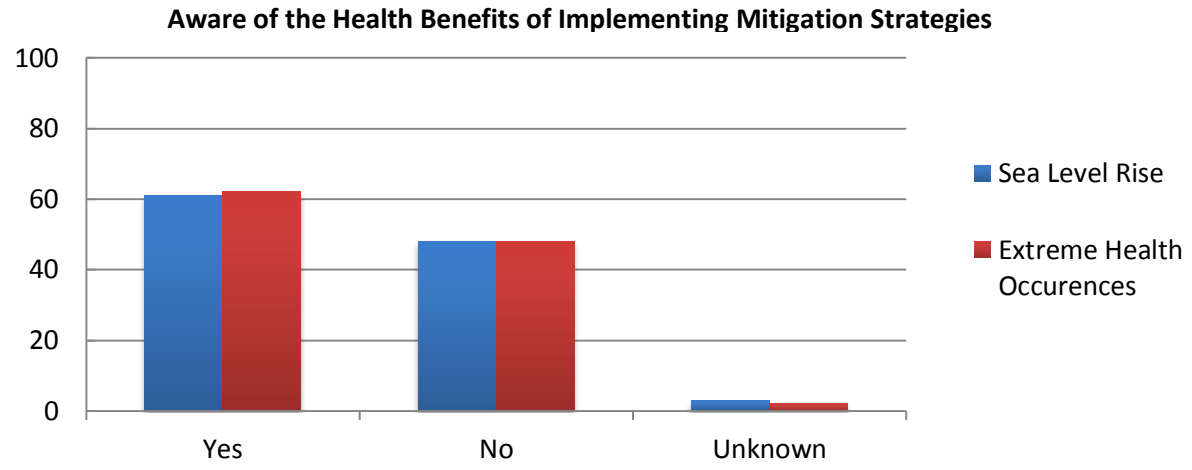
- Educators: 11%
- Engineers: 7%
- Government: 12%
- Law: 7%
- Researchers: 9%
- Scientists: 5%
- Others: 49%

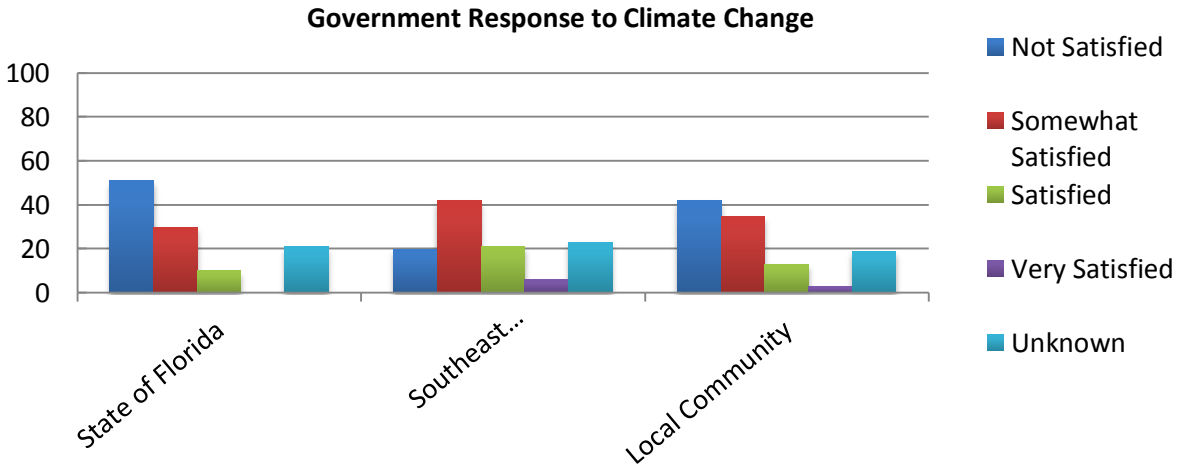
Prioritizing Health Co-Benefits



Community Awareness of Health Impact







Florida, the southeast region, and communities could prioritize health benefits by:

- Raising public awareness
- Creating incentive based strategies
- Educating the public
- Emphasize health co-benefits

Public Survey

A climate change and health survey was distributed and posted online to FPHI's listserv and website visitors, as well as community wide groups with large reach including Consortium for a Healthier Miami-Dade, Transforming Our Community's Health in Broward County, Monroe County local paper Free Press, and Monroe County Area Health Education Center. Several social media sites posted the survey and as a

result 7% were referred from Facebook. A total of 162 South Floridians participated in the survey, age ranging from 20-75+. The following information represents the public survey results:

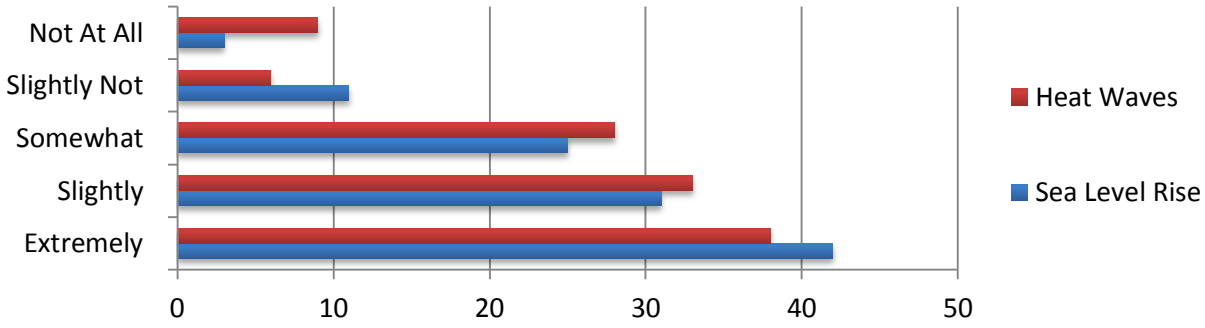
Respondents Gender:

- 60% Males
- 40% Females

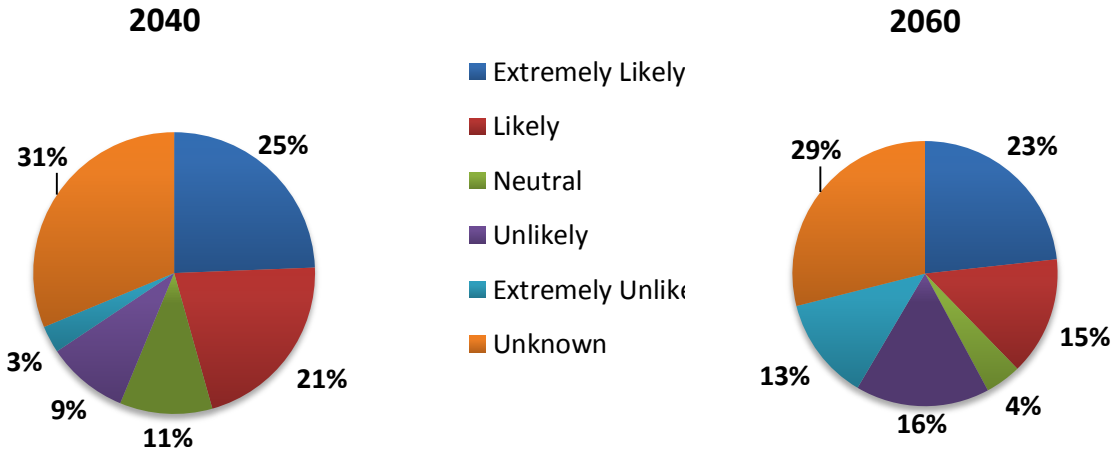
County Residency:

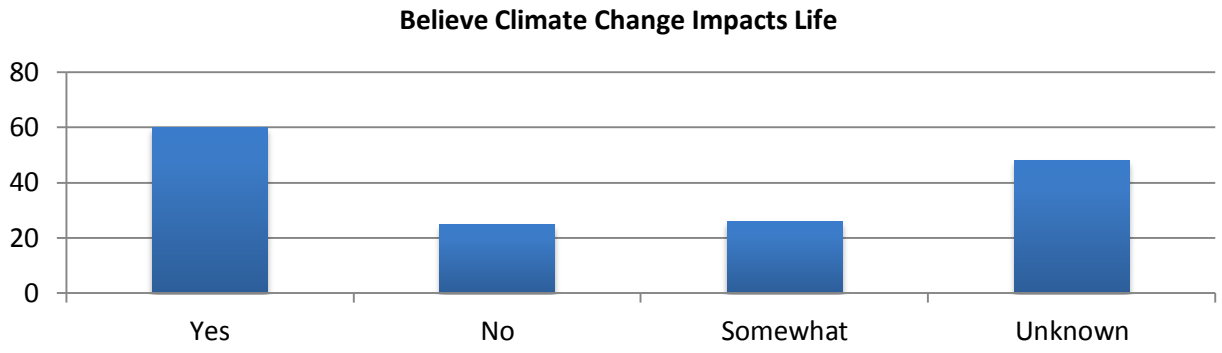
- Miami-Dade: 36%
- Broward: 24%
- Palm Beach: 10%
- Monroe: 1%
- Unknown: 29%

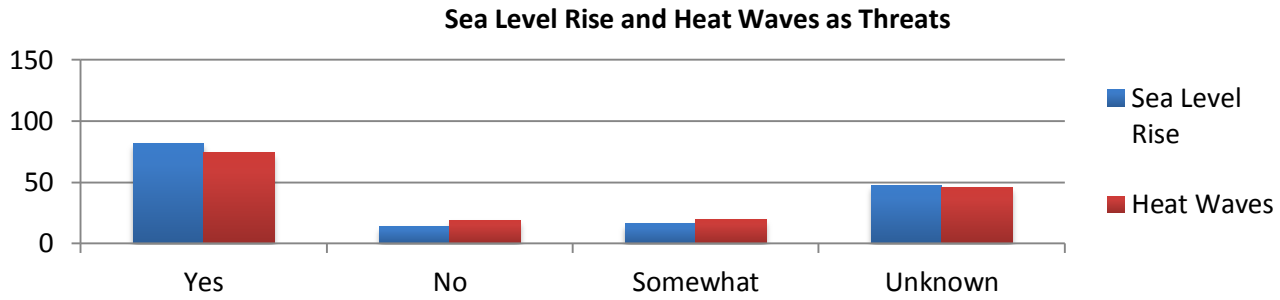
Sea Level & Heat Wave Concern in The Coming Decades

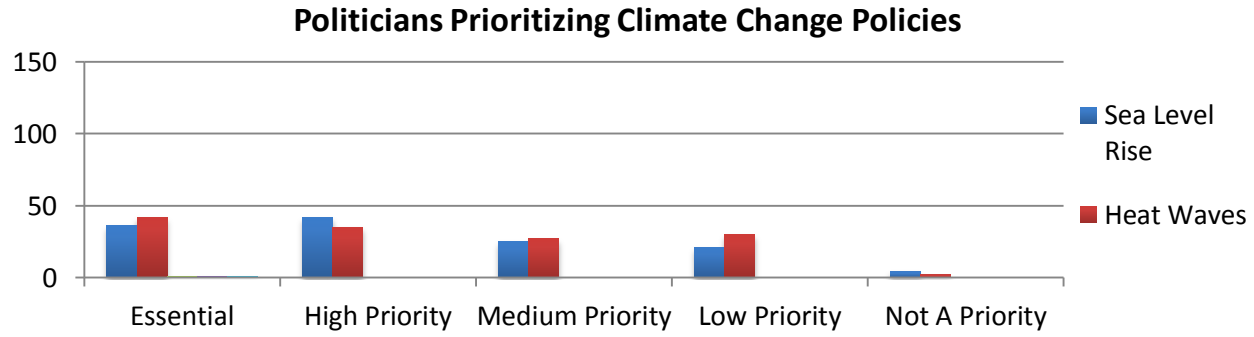


The Impact on Life if Sea Level Rose One Foot




Believe Climate Change Impacts Life
80
60
40
20
0
Yes
No
Somewhat
Unknown


Sea Level Rise and Heat Waves as Threats
150
100
50
0
Yes
No
Somewhat
Unknown
Sea Level Rise
Heat Waves


Politicians Prioritizing Climate Change Policies
150
100
50
0
Essential
High Priority
Medium Priority
Low Priority
Not A Priority
Sea Level Rise
Heat Waves

Focus Groups

The HIA sought to determine the contrasting viewpoints relating to climate change among a sample of Florida rural populations, including: residents of Key Largo in Monroe County and residents of rural Belle Glade in Palm Beach County. Florida's definition of rural is based on the state statutory definition of "an area with a population density of less than 100 individuals per square mile or an area defined by the most recent United States Census as rural". Florida's rural areas differ from other U.S. rural communities in that they often have close proximity to resources (FDOH).

The assessment included perceptions and knowledge on how climate change, particularly SLR and heat waves, will affect the health of people living in Southeast Florida and how local decision-makers can use this information to create policies, laws, and programs with the greatest impact.

The purpose of these two focus groups was to learn about perceptions of people living in rural areas of Southeast Florida and the need to prepare for the health effects of SLR and extreme heat conditions through policies and systemic changes. The guided focus group discussion solicited perspectives and opinions on thoughts about how local and regional government systems should prepare for these health effects.

A total of 14 people participated in the two focus groups, five in Key Largo and nine in Belle Glade and 92% of participants were female. The two rural communities in Palm Beach and Monroe have some definite similarities of: rural geography, limited infrastructure and services, dependence upon county municipality, and close proximity to water and or water tables. Both communities are dependent on a specific industry, Belle Glades leading occupation being agricultural and Monroe's leading occupation including retail and tourism relating to the geography. Both community representatives at the focus group demonstrated a local knowledge base of sensitive changes to the sea and landscape. The answers to the questions, while vastly different, reflect a global perspective with local observations.

Findings

Participants in both focus groups all had some knowledge about climate change, although views varied. Only one participant in the Belle Glade focus group expressed skepticism over climate change predictions, while another participant in the same group thought that there was some hype associated with climate change factors. Participants in both focus groups expressed a variety of concerns over climate change, including the potential effects on food systems, ecosystems, animal species, and the UV index. Climate change's effects on food systems was the most cited concern, with one participant in the Belle Glade focus group noting that they are already seeing the effects of hot, dry conditions on food production in some areas.

All of the Key Largo participants indicated that they were concerned about the health effects of UV issues resulting from changes in the ozone layer. Belle Glade participants focused more on SLR affecting sewage systems and the spread of diseases and on the changing salinity of sea water and saltwater intrusion on local water supplies. In preparing for health issues related to climate change, participants noted the need to conserve resources; health prevention measures, like eating organic, teaching health and wellness in schools, and wearing sunscreen. One particular concern with rising temperatures and the UV index was the limiting effect this will have on people who are active outdoors. Participants noted

that government responsibilities in preparing for climate change-related health effects could be to increase research funding, increasing public messaging and developing educational programs on reducing GHGs, holding companies accountable, stop holding businesses back on green certifications, and to sign the Kyoto Protocol.

Some of the major concerns over SLR included sewage contamination following flooding, weak hydrological infrastructure, displacement, saltwater intrusion of freshwater resources, and the threat it poses to nuclear plants in close vicinity to SLR-related flooding. One participant in Key Largo noted a local canal flooding more in the past decade than in previous years. The Key Largo group was knowledgeable on the work of their local Board of Commissioners working on creating a climate change advisory group to advocate changes in the system. The group expressed concern over roads and flooding, delegating funds to strengthen pipes and sewage lines. Engineers and builders as a potential part of the solution. In the Belle Glade group, only four participants agreed that they would support political leaders in adopting SLR mitigation policies (such as sea walls and fixing water systems), while two disagreed with these kinds of policies.

Both groups were aware of how heat waves can affect vulnerable populations and outside activity. Key Largo again expressed concern over the effects heat waves will have on crop production. The Key Largo group also expressed concern over rising sea temperature causing more intense hurricanes and storm events. Both groups had great suggestions for how their local governments can assist people during heat waves, like helping low income people pay for higher energy costs from running air conditioners longer, and adapt their communities to rising temperatures, like creating a community that is active at night. Both groups were familiar with ways their governments help people during heat events, although they had many suggestions on how this could be improved. There were concerns expressed over how greed has fueled the need for more cars, production, and competing interests with big oil that have led to more toxins in the air. Participants were concerned about how heat events would affect local industry, property values, and energy bills.

Vulnerability Mapping

Vulnerability mapping was conducted for sea level rise (SLR) and heat wave scenarios.

Sea Level Rise Vulnerability Mapping

Maps 2-5 depict SLR, poverty, and non-communicable diseases (NCD) vulnerability in each of the four Southeast Florida counties. Census tract data were used as parameters for identifying areas of vulnerability. Tract characteristics for selection included:

- Tracts connected to a body of water affected by a two foot SLR;
- Tracts with above the county rates of poverty; and
- Tracts with above the county rates for any of three NCD: chronic lower respiratory disease (CLRD), heart disease, and cancer.

Tracts with any disease above county rates, above county poverty rates, and with all coastal or inland bodies of water affected by SLR scenarios were selected for SLR vulnerability mapping. One and two foot SLR scenarios were mapped for each county. The NCDs chronic lower respiratory disease (CLRD), heart disease, and cancer were used for SLR vulnerability mapping as they are listed as potential climate change health effects by the CDC.

Methodology

The methodology was the same for each of the four SLR, poverty, and NCD vulnerability maps. A vulnerable tract for the purposes of these maps were defined as a tract with an above county rate of persons below poverty AND an above county crude rate for ANY of the diseases potentially impacted by climate change (cancer, heart disease, CLRD) AND intersecting an SLR of 2 feet of hydrologically connected OR unconnected water bodies. All tracts from each of the four counties were analyzed and only those above county rates for any of the four diseases and poverty were selected.

NCD data was obtained from Florida Charts for years 2006 to 2010 for each county. The FDOH reports death counts for several NCDs by census tract which are summarized over this five year period. Rates are not reported. In order to make a rate of NCD per census tract, the summarized counts of deaths from the NCDs potentially exacerbated by climate change were converted into crude rates per 100,000 population per tract based on 2009 U.S. Census population . The formula for the tract NCD crude rate for each county is:

$$\text{Tract Death Crude Rate per disease} = \left(\frac{\text{Sum of total deaths per disease(t)}}{\text{Total Population (t)}}\right) * 100{,}000$$

(t)=tract

If a tract within one of the four counties had a crude rate above the following values in **Table 55** then it was selected as a disease-vulnerable tract. Note that the crude rates for these NCDs are based on *summarized* counts of deaths over five years (2006-2010), indexed to the 2009 population. Therefore, these rates are much higher than a crude rate for a single year.

Table 55: County Rates for Non-Communicable Diseases and Poverty

County	Denominator: Population, ACS 2009	CLRD	Heart Disease	Cancer	Diabetes	Poverty
Palm Beach	1,268,601	225	1,243	1,122	105.16	11.50%
Broward	1,759,132	187	1,052	905	95.56	11.70%
Miami Dade	2,457,044	149	1008	774	127.02	16.90%
Monroe	74,024	159	836	966	66.19	10.30%

SLR data was obtained from NOAA[1] as polygons, for 1 ft. and 2 ft. SLR of hydrologically disconnected and connected SLR inundation areas. SLR 1 & 2 foot polygons layers were merged into one shapefile to represent SLR up to two feet. The NOAA SLR data is based on Mean Higher High Water surface generated from the NOAA VDATUM model. It takes into account the variable tidal surface, based on hydrodynamic modeling of the tides over a period of around 80 days. This data is a surface average that is used as zero from which 1ft. SLR increments are added. It is important to note that many of the inundation areas on the SLR maps are existing bodies of water.

Sea Level Rise Vulnerability Mapping Analysis

A total of 122 census tracts were selected from the four counties as having above county rates of any of the NCDs that are also impacted by an SLR of two feet. **Table 56** shows the breakdown by county of tracts that meet this qualification. Miami-Dade County had the most number of tracts with 58, followed closely by Broward County with 49 tracts. Monroe and Palm Beach counties' had the least number of selected tracts. A total of 715,061 people reside within these selected tracts.

Table 56: Number of Tracts per County with Above County Rates of Any Non-Communicable Disease, Above Poverty and Impacted by a Sea Level Rise of 2 Ft

County	Number of Tracts per County (Census 2000)	Number of Selected Tracts Above Any Disease, Above Poverty, and Impacted by Sea Level Rise of 2ft	Percent of Tracts Selected	Total Population of Selected Tracts (Census 2009)
Broward	278	49	18%	285,433
Miami-Dade	345	58	17%	377,684
Monroe	26	7	27%	20,642
Palm Beach	265	8	3%	31,302
Totals	914	122		715,061

[1] 2012 SLR data was obtained from NOAA, Department of Commerce (DOC), National Ocean Service (NOS), and Coastal Services Center (CSC).

As expected with SLR, most of these four counties' SLR vulnerability was located along coastlines and get more prevalent throughout the more southern counties of Miami-Dade and Monroe counties. SLR one and two foot scenarios become more prevalent

Monroe County had the lowest average rates of CLRD, heart disease, and below poverty and had the second lowest average of rates of cancer compared to the other three counties. These low averages help explain why Monroe County has the lowest number of selected vulnerability tracts, with two of the three selection criteria offering better results than the other counties.

Table 57: Average Rates of Non-Communicable Diseases and Poverty

County	Average Rate of CLRD	Average Rate of Cancer	Average Rate of Heart Disease	Average Rate of Below Poverty
Broward	229	1,064	1,314	20
Miami-Dade	239	950	1,411	26
Monroe	203	1,013	1,018	16
Palm Beach	232	1,143	1,184	17
Average	226	1,043	1,232	20

Table 58: Number of Tracts with Rates Above County Averages for Non-Communicable Diseases and Poverty Rates

County	Tracts with Above County Rate of CLRD	Tracts with Above County Rate of Heart Disease	Tracts with Above County Rate of Cancer	Tracts with Above County Rate of Below Poverty	Number of Selected Tracts Above Any Disease and Impacted by Sea Level Rise of 2ft
Broward	34	31	36	49	49
Miami-Dade	43	43	45	58	58
Monroe	4	6	4	7	7
Palm Beach	4	2	4	8	8
Total	85	82	89	122	122

Table 59: Disease Death Crude Rates per County per 100,000 Population (Based on Summarized Deaths from 2006-2010)

County	CLRD	Heart Disease	Cancer
Broward	187	1,052	905
Miami-Dade	149	1,008	774
Monroe	159	836	966
Palm Beach	225	1,243	1,122

Table 60: Percent of Population Poverty Rates by County

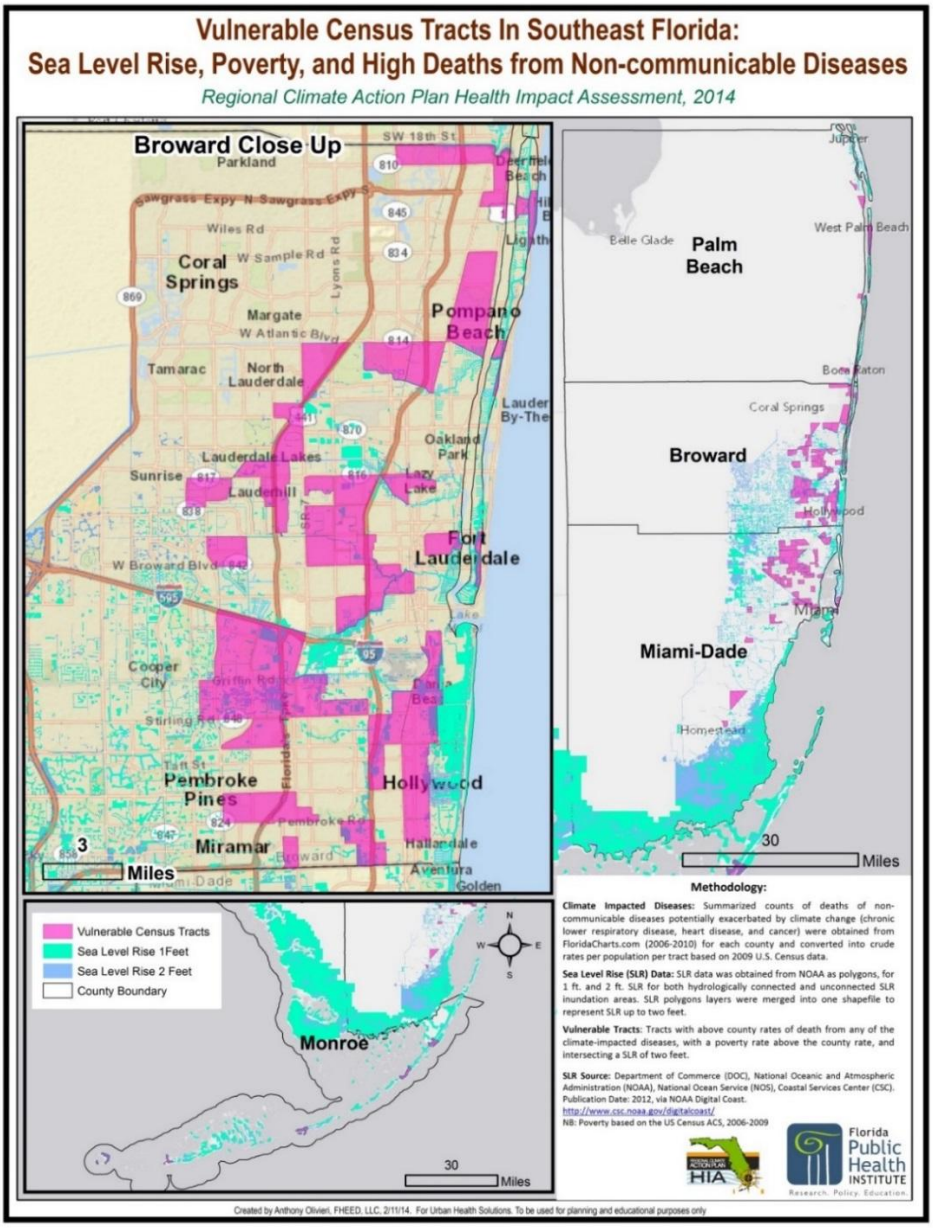
County	Poverty Rates
Broward	11.7%
Miami-Dade	16.9%
Monroe	10.3%
Palm Beach	11.5%
Average	12.6%

Source: *American Community Survey (ACS) 2009 based on S1701*

Broward County

Broward County, with its 49 selected vulnerability tracts out of 278 total, shows that most of these tracts are at risk of either one or two foot SLR scenarios. A majority of these tracts are not along the county's coastline, but rather are inland. The map shows how one and two foot SLR scenarios could potentially have an impact on the interior of the county, occurring miles inland.

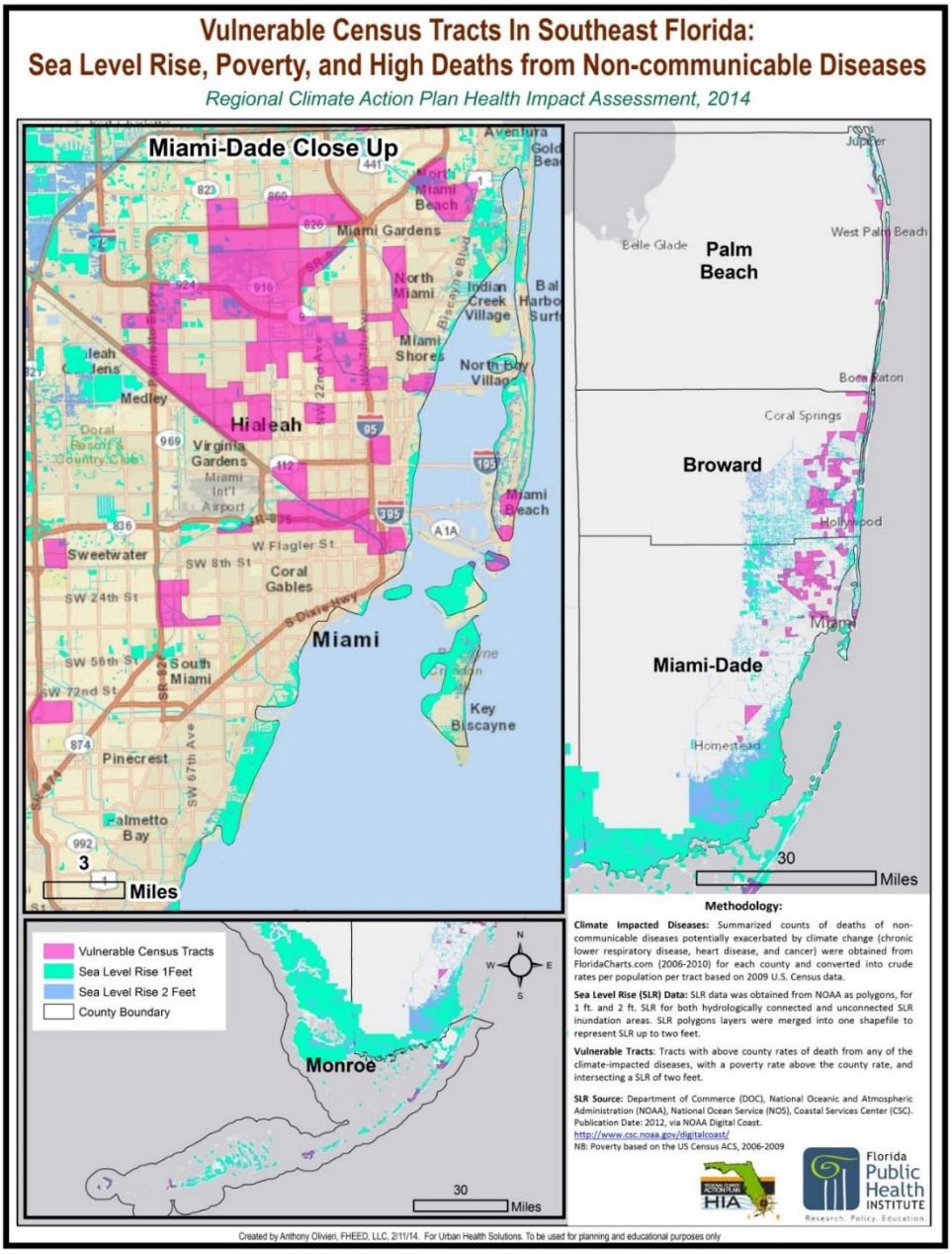
Map 2: Sea Level Rise, Poverty, and High Deaths from non-Communicable Diseases: Broward County Close Up



Miami-Dade County

58 of Miami-Dade County's 345 tracts were selected as vulnerable tracts. Much of Miami-Dade County's vulnerable tracts lie in the county's northeastern corner. Tracts in Miami Beach also show vulnerability. All of Miami-Dade County's southeast corner will be inundated under the one and two foot SLR scenarios, although no vulnerable tracts were identified in or near this area.

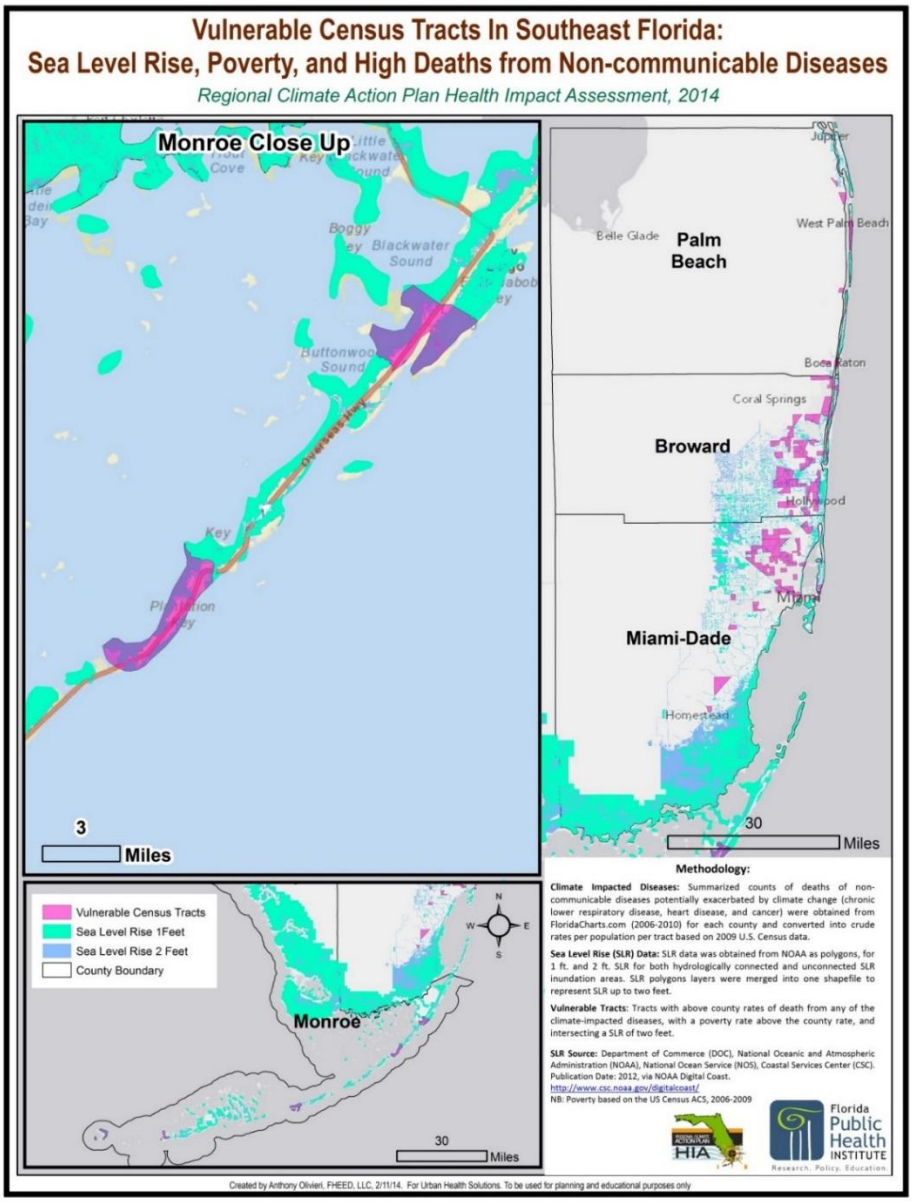
Map 3: Sea Level Rise, Poverty, and High Deaths from non-Communicable Diseases: Miami-Dade County Close Up



Monroe County

Monroe County fairs better than the other three counties in mapping vulnerability. Only seven tracts of 26 total were selected for vulnerability. This low number was likely due to the county having lower disease death and poverty rates compared to the other counties. **Table 59** demonstrates the county's low disease death rates and **Table 60** shows how Monroe County's poverty rates are lower than the other three counties.

Map 4: Sea Level Rise, Poverty, and High Deaths from non-Communicable Diseases: Monroe County Close Up

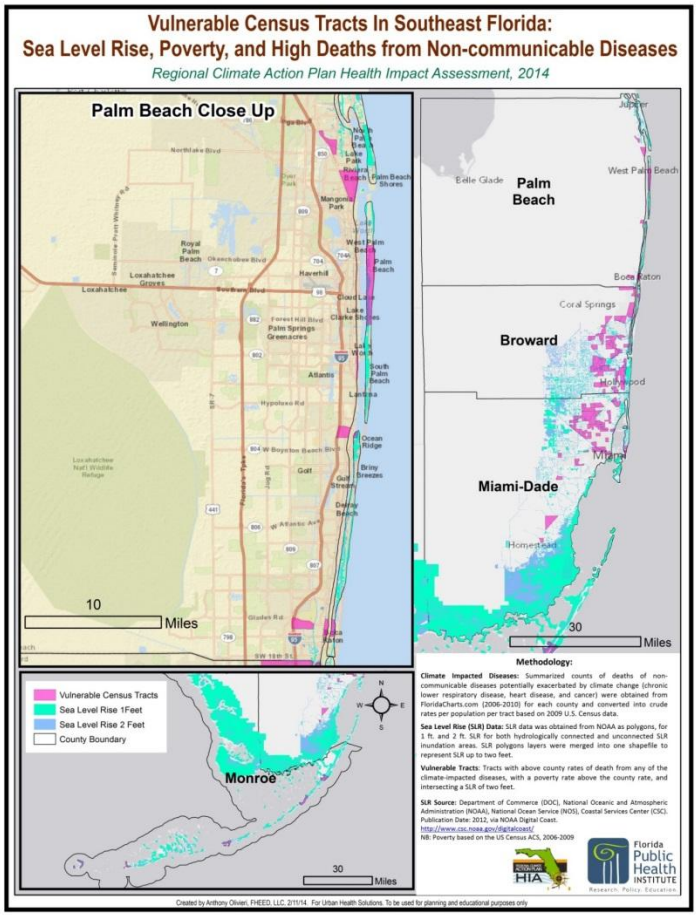


Palm Beach County

Eight of Palm Beach County's 265 tracts were selected for vulnerability. Of the eight vulnerable census tracts shown in **Map 5**, about half of the tracts are located within one foot SLR scenarios. These tracts also are located on the island areas of Palm Beach, Ocean Ridge, and Boca Raton on the county's coast. Inland Palm Beach County, under the parameters of this methodology using the NCDs of CLRD, heart disease, and cancer do not show any vulnerable tracts.

Of note is the fact that not all health impacts are represented in the CDC's 11 potential climate change health effects. Rural areas of Palm Beach County have very high rates of diabetes, which makes these individuals vulnerable to the effects of SLR, but a disruption in diabetes management or access to health services does pose a threat to the health outcomes of this vulnerable population. If diabetes above county rates in Palm Beach County were included in the vulnerability definition, many more predominantly black, poorer census tracts would have been included on the vulnerability map. This part of the county also has a higher elevation than the rest of region which will also account for the area not falling under the selection criteria of intersecting an SLR of 2 feet of hydrologically connected or unconnected water bodies.

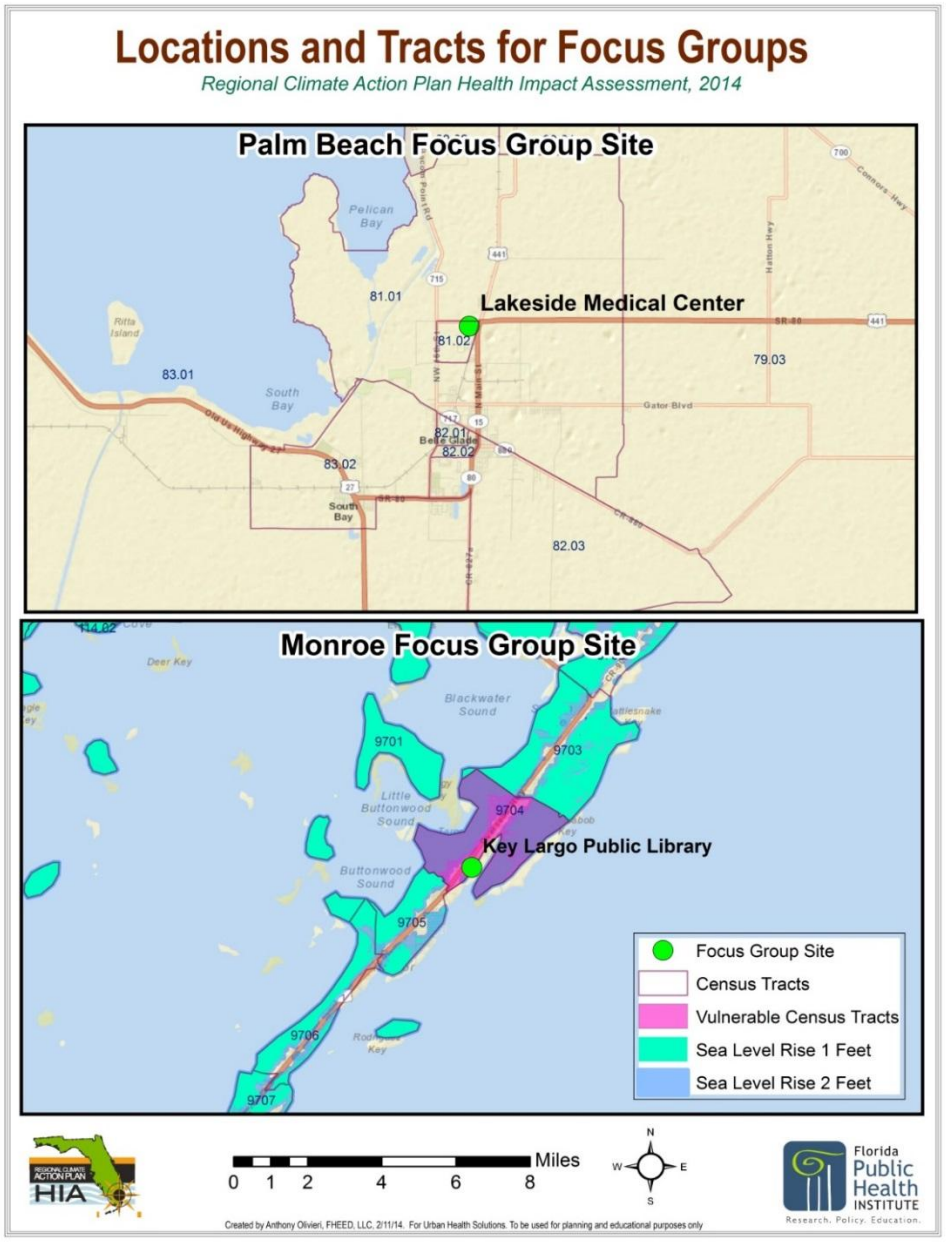
Map 5: Sea Level Rise, Poverty, and High Deaths from non-Communicable Diseases: Palm Beach County Close Up



Focus Group Locations

Map 6 provides a close up view of SLR vulnerability for one and two foot future SLR scenarios for the Palm Beach County focus group at the Lakeside Medical Center in Belle Glade, FL and the Monroe County focus group at the Key Largo Public Library. The map shows that Palm Beach County focus group was not in an area of SLR vulnerability under both scenarios. The Monroe County focus group, however, does lie in a vulnerable census tract at the one and two foot scenarios.

Map 6: Locations and Vulnerability Tracts for HIA Focus Groups



SLR Vulnerability Maps Comparison

Trend of SLR vulnerability increasing North to South, especially in South Miami-Dade County and Monroe County's keys. The islands and peninsulas off Palm Beach, Broward, and Miami-Dade counties' eastern coasts are particularly vulnerable to one and two foot SLR scenarios, although only a few tracts are vulnerable likely due to these areas being more affluent. Vulnerability tracts tend to cluster around middle to South Broward and North Miami-Dade counties.

Heat Waves Vulnerability Mapping

Maps 7 and 8 show surface temperatures in the Southeast Florida region. **Map 9** shows the surface thermal zone classifications of Southeast Florida. **Maps 10-14** demonstrate community determinants of heat vulnerability in each and all of the four counties in Southeast Florida. These maps show the areas within each county in which persons are vulnerable to heat waves based on four selected environmental, health, and socioeconomic community determinants. **Maps 15- 16** break down the data used for the determinant based on land surface temperatures. **Map 15** shows the land surface temperatures grouped by quintile starting with the percent of tracts in lowest, low, moderate, high, and highest quintiles along with heat hot spot tracts. **Map 16** shows selected census tracts, tracts greatly above normal temperatures, and heat hot spot tracts.

Methodology

Heat wave vulnerability mapping was conducted following a methodology adapted from Reid et al. (2009) that finds high correlation between select determinants that represent vulnerable factors related to heat-related morbidity and/ or mortality. Four environmental, health, and socioeconomic community determinants were identified as increasing vulnerability to heat waves:

1) Greatly above normal rates of surface area temperatures;
2) Rates of diabetes deaths above county rates;
3) Low educational attainment below the county rate; and
4) Predominance of non-white populations below the county rate.

Heat wave data was modeled based on high definition Landsat thermal 30 meter resolution imagery data for abnormal land surface temperatures, also called hot spots or urban heat islands. Three Landsat satellite 5 images from 2011 and one Landsat satellite 8 images from 2013 for the months of November and January were selected and treated to produce a surface thermal zone classification (STZC) map in each of the four counties. Abnormal land surface temperatures (LST) were then identified in the four counties. The STZC map was then created for the four counties identifying three classifications of "normal", "moderately above normal", and "greatly above normal" thermal zones, where "normal" corresponds to the spatial average land surface temperature of each satellite image. 2010 census tracts were combined with the STZC maps in order to identify the percent area of the four counties covered by each of the three classifications.

Diabetes was the only disease used in heat wave vulnerability mapping because it was the only disease to show any correlation with tract heat surface area. Diabetes death counts obtained from the FDOH Florida Charts for 2006 to 2010 were converted to rates per population using the ACS 2009 population

rate as the denominator. Demographic and education data were based on ACS data from 2006 to 2009. All census tracts used in mapping are in census 2000 polygons from the U.S. Census.

Heat Waves Vulnerability Mapping Analysis

151 vulnerable tracts were selected for analysis. **Table 60** shows that Miami-Dade County had the greatest number of selected vulnerable tracts and tract hot spots, followed by Broward County. Hot spots were calculated using GeoDa from Arizona State University. The hot spot analysis tested the clustering of tracts with high rate of surface area covered with greatly above normal temperatures. Of the selected determinants for county analysis in **Table 60**, Monroe and Palm Beach counties both had no hot spots, while Palm Beach County had 15 selected vulnerable tracts and Monroe County only had one. Miami-Dade County scores highest on all of the selected determinants for heat wave vulnerability. The County has the highest diabetes death rates, the greatest non-white population, the most population with less than a 9th grade education, and the most tracts with "greatly above normal". Monroe County has the lowest mean of diabetes death rates, the smallest non-white population with the smallest mean of the population who have less than a 9th grade education, with only slightly more than have of average tracts with "greatly above normal" surface area heat. Broward and Palm Beach counties have similar means of diabetes death rates and non-white populations, while Palm Beach County has slightly higher rates of population with less than a 9th grade education and Broward County has slightly more surface area with "greatly above normal" heat.

For **Maps 10-14** (determinants), the strongest correlation (+0.60) with the rate of tract area "greatly above normal" was the "percent of white population" per tract. The more white the tract, the lesser the rate of being "greatly above normal" heat. Therefore, non-white tracts tend to have higher rates of surface heat. The rate of "greatly above normal" heat areas correlated the most with these variables, with "percent less than a 9th grade education" being the highest. Diabetes was the only disease which has a noticeable correlation with "greatly above normal" heat; other diseases have a flat correlation. Hot spot tracts tend to be the closest to the trend line with diabetes. Therefore, "greatly above normal" heat areas tend to be in non-white communities with low educational attainment, and higher diabetes death rates. From this information it can be determined that mostly low-educated, non-white communities have greater tract rates of normal surface temperatures and these are the same areas that have higher diabetes deaths. This follows the findings from Reid et al. closely.

Table 60: County Tract Hot Spots and Selected Vulnerable Tracts

County	Tract Hot Spots	Selected Vulnerable Tracts
Broward	24	44
Miami-Dade	72	91
Monroe	0	1
Palm Beach	0	15
Totals	96	151

Table 61: County Summaries of Select Determinants

County	Diabetes Death Crude Rate Mean	Percent White Mean	Not White Percent Mean	Less than 9th Grade Educational Attainment Mean	Greatly Above Normal Heat: Average Tract Surface Area Percent
Broward	160.9	21.0	79.0	9.3	70.0%
Miami-Dade	205.9	5.3	94.8	21.2	80.5%
Monroe	109.9	66.9	33.1	7.4	52.8%
Palm Beach	177.3	23.4	76.7	17.2	56.7%

Table 62: County Thresholds for Demographic, Education, and Health Determinants

County	Percent White Thresholds Selected if below these rates	Diabetes: Select if above these rates	Percent Less Than 9th Grade Education (Above mean) Select if Above these rates
Broward	64%	105.2	6%
Miami-Dade	49%	95.6	5%
Monroe	18%	127.0	12%
Palm Beach	73%	66.2	3%

There are a number of considerations to take into account with the heat wave vulnerability maps. First, there are limitations to using hot spots. Hot spots depend on the "neighbors" in that area. If a tract has an above average heat area, but was surrounded by cold spots, then the heat island effect can be lost. In this case, hot spots serve as a visual aid in locating epicenters of clusters of hot tracts. For these reasons, quintiles may be a better method for selecting tracts since "neighbors" are not a factor. With quintiles, the top 40% highest "greatly above normal" rate correlates strongly positive with hot spots. Therefore, the top quintiles do capture the hot spots.

Another factor taken into consideration was the effect of urban canopy on thermal zones. Upon analysis, one would expect to find higher temperatures in population dense areas as these areas tend to be built up. This was not necessarily the case in Southeast Florida. In North America, densely populated areas tend to have large numbers of people living in high apartment buildings and condominium towers that can create urban canopies that shade the surrounding neighborhood, cooling thermal temperatures. This canopy effect taking place in these areas in Southeast Florida could be due to primarily white communities living in planned communities with lots of canopy cover, while lower income neighborhoods that are built near open parking lots, freeways, and large industrial zones with asphalt, black rooftops, and little shade.

One limitation to using Landsat imagery is that it captures pictures of Southeast Florida at specific times during the day at a 30 meter resolution that can include shaded streets, which can reduce the mean land surface temperature estimated at each pixel characterized by these urban canopy effect conditions. Additionally, hot spots captured by Landsat imagery during the daytime are not necessarily the same as night time, when vulnerable populations are most affected because they do not have time to recuperate

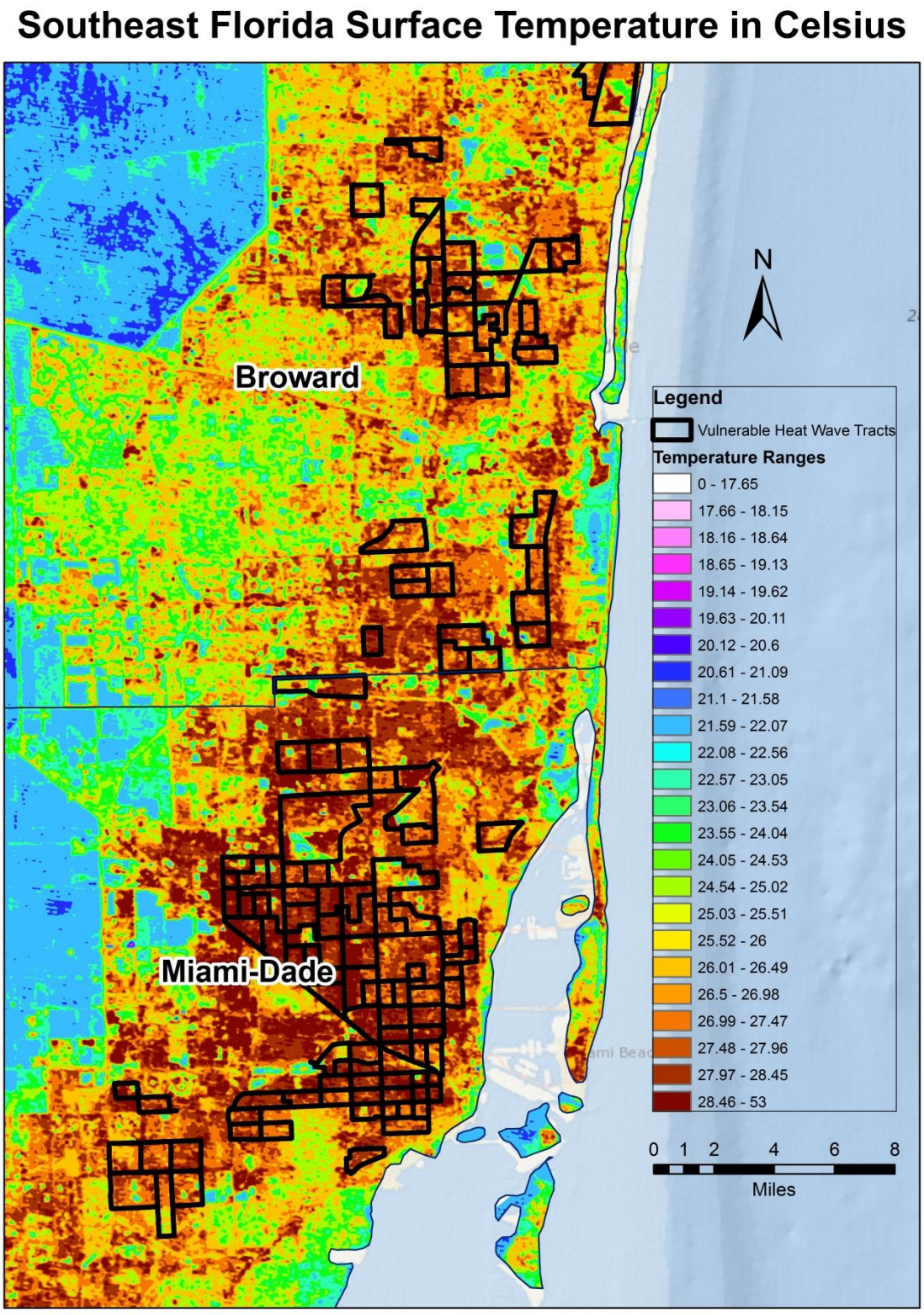
from the heat stress felt during the day. This possible dissimilarity was due to the varying capacities of the different surface materials to retain heat.

Southeast Florida Surface Temperatures

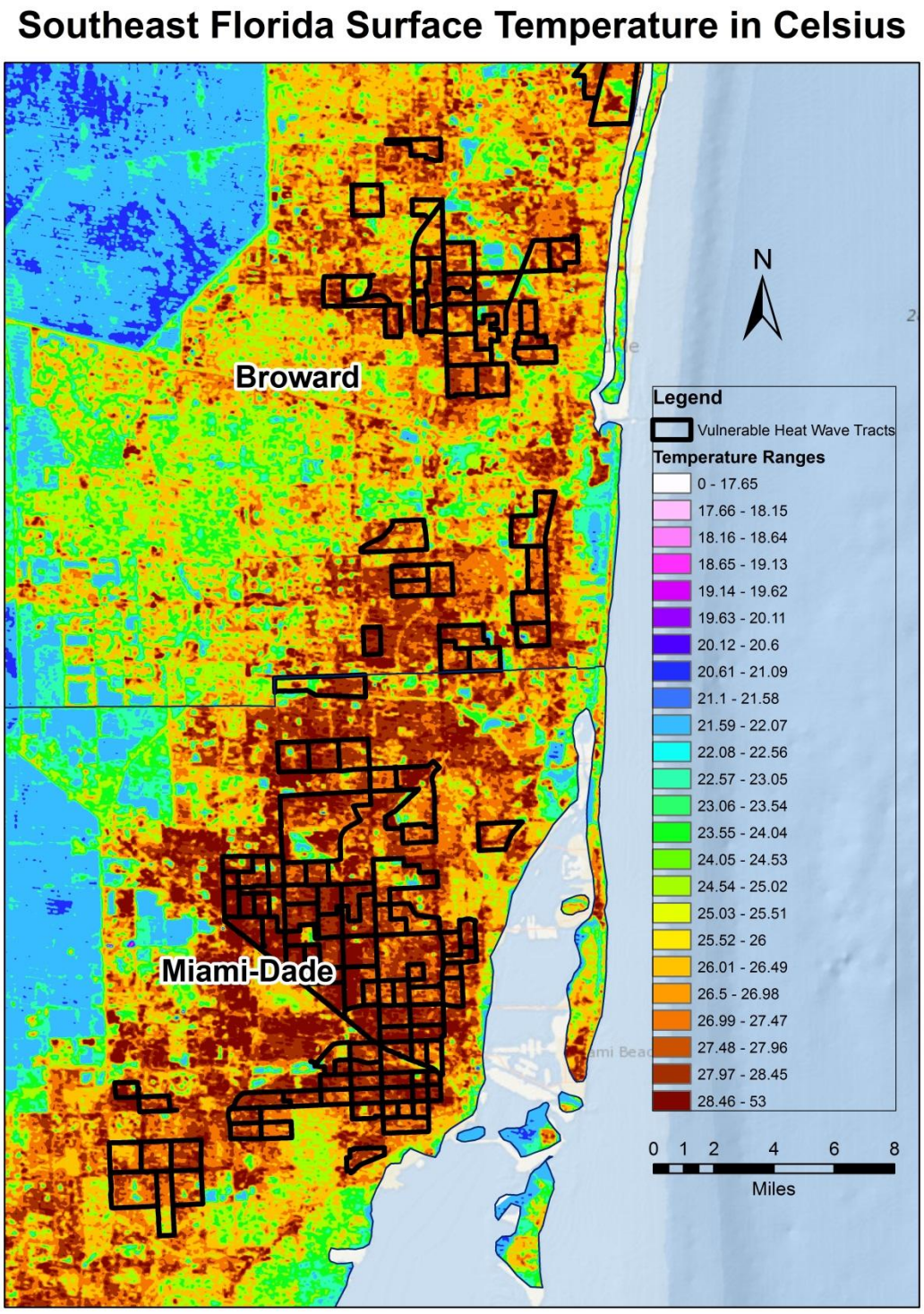
Maps 7 and 8 depict surface temperatures ranging from 0 to 53 degrees Celsius in Southeast Florida. The maps show that the hottest surface temperatures were recorded on the more populated coastal areas of Broward, Miami-Dade, and Palm Beach counties. Miami-Dade County has the highest concentration of the highest temperatures, especially in the northeastern corner of the county. As expected, inland and rural areas in the counties have lower temperatures.

Miami-Dade County had more of the highest temperatures, reaching the 28.46 to 53 degrees Celsius, followed closely by Broward County. Much fewer tracts in Palm Beach County reached the higher temperature ranges. These higher temperature ranges were dispersed throughout the county, both coastal and inland. Monroe County had the lowest temperatures in Celsius of the four counties, with only a few areas reaching the mid to lower 20 degrees.

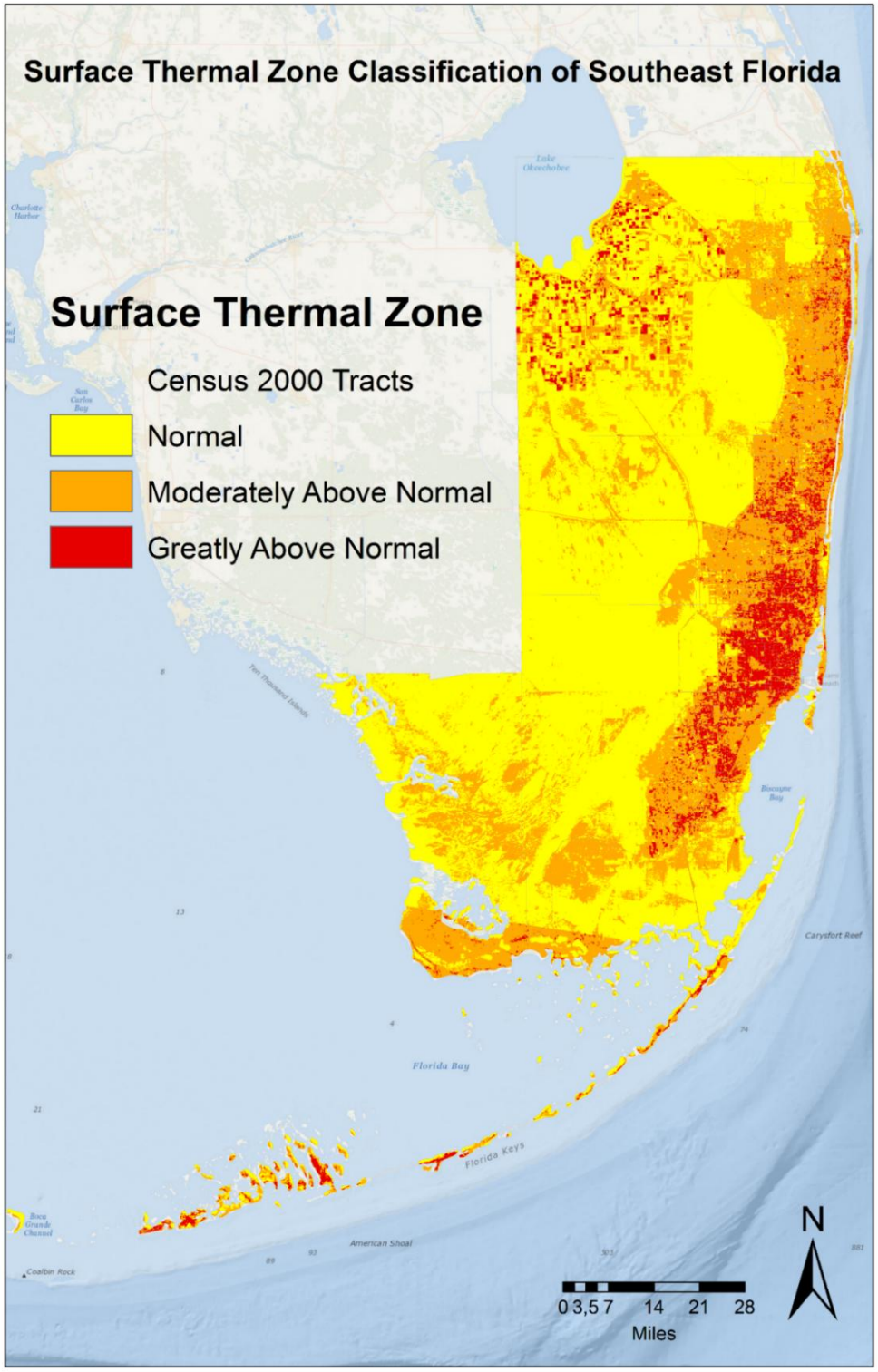
Map 7: Southeast Florida Surface Area in Celsius



Map 8: Southeast Florida Surface Area in Celsius: Broward and Miami-Dade Counties Close Up



Map 9: Surface Thermal Zone Classification of Southeast Florida


Surface Thermal Zone Classification of Southeast Florida
Surface Thermal Zone
Census 2000 Tracts
Normal
Moderately Above Normal
Greatly Above Normal
Lake Okeechobee
Charlotte Harbor
Ten Thousand Islands
Biscayne Bay
Carysfort Reef
Florida Bay
Florida Keys
American Shoal
Boca Grande Channel
Coalbin Rock
0 3,5 7 14 21 28
Miles
N

Broward County

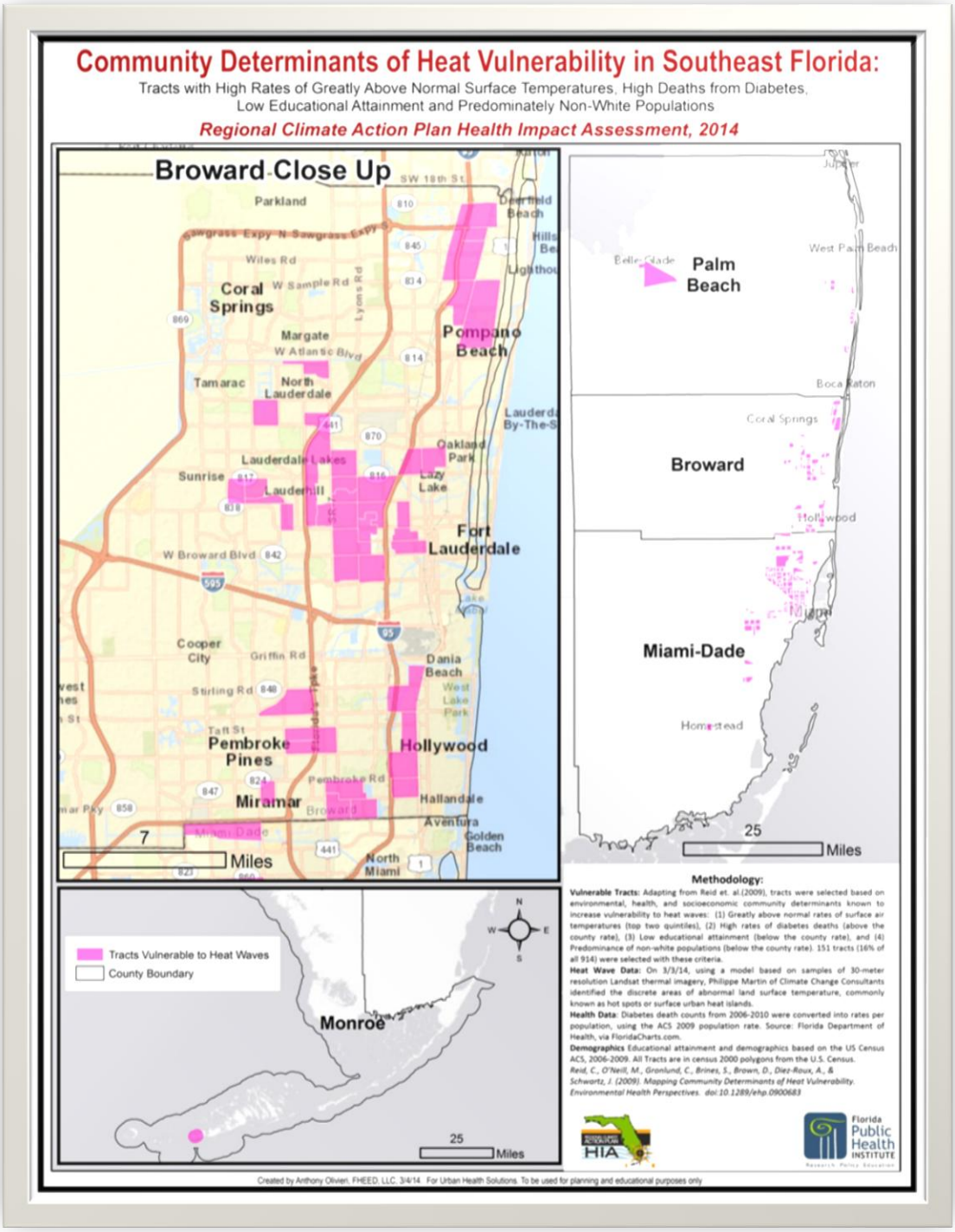
Broward County's selected 44 tracts are located in the eastern part of the county, within about 10 miles of the coastline, but not on the coastline. These selected tracts are primarily concentrated in the neighborhoods of Pompano Beach, Fort Lauderdale, and Hollywood.

Table 63: Demographics for Pompano Beach, Fort Lauderdale, and Hollywood

Demographic Variable	Pompano Beach	Fort Lauderdale	Hollywood
White alone, percent, 2010	62.6%	62.6%	72.7%
Black or African American alone, percent, 2010	28.9%	31.0%	16.7%
Hispanic or Latino, percent, 2010	17.5%	13.7%	32.6%
High school graduate or higher, percent of persons age 25+, 2008-2012	81.0%	85.0%	86.2%
Persons below poverty level, percent, 2008-2012	21.2%	19.5%	14.5%

Source: U.S. Census Bureau

Map 10: Community Determinants of Heat Wave Vulnerability in Broward County



Miami-Dade County

Miami-Dade County (**Map 11** and **12**) had the most tracts selected for heat vulnerability with 91. These tracts are primarily located in the county's northeastern corner within 10 miles of the eastern coastline, though not directly on the county's coastline, likely due to the coastline consisting of high income populations. Most of Miami-Dade County's selected tracts are located adjacent to or near one or more of Miami-Dade County's many interstate highways, expressways, or state roads.

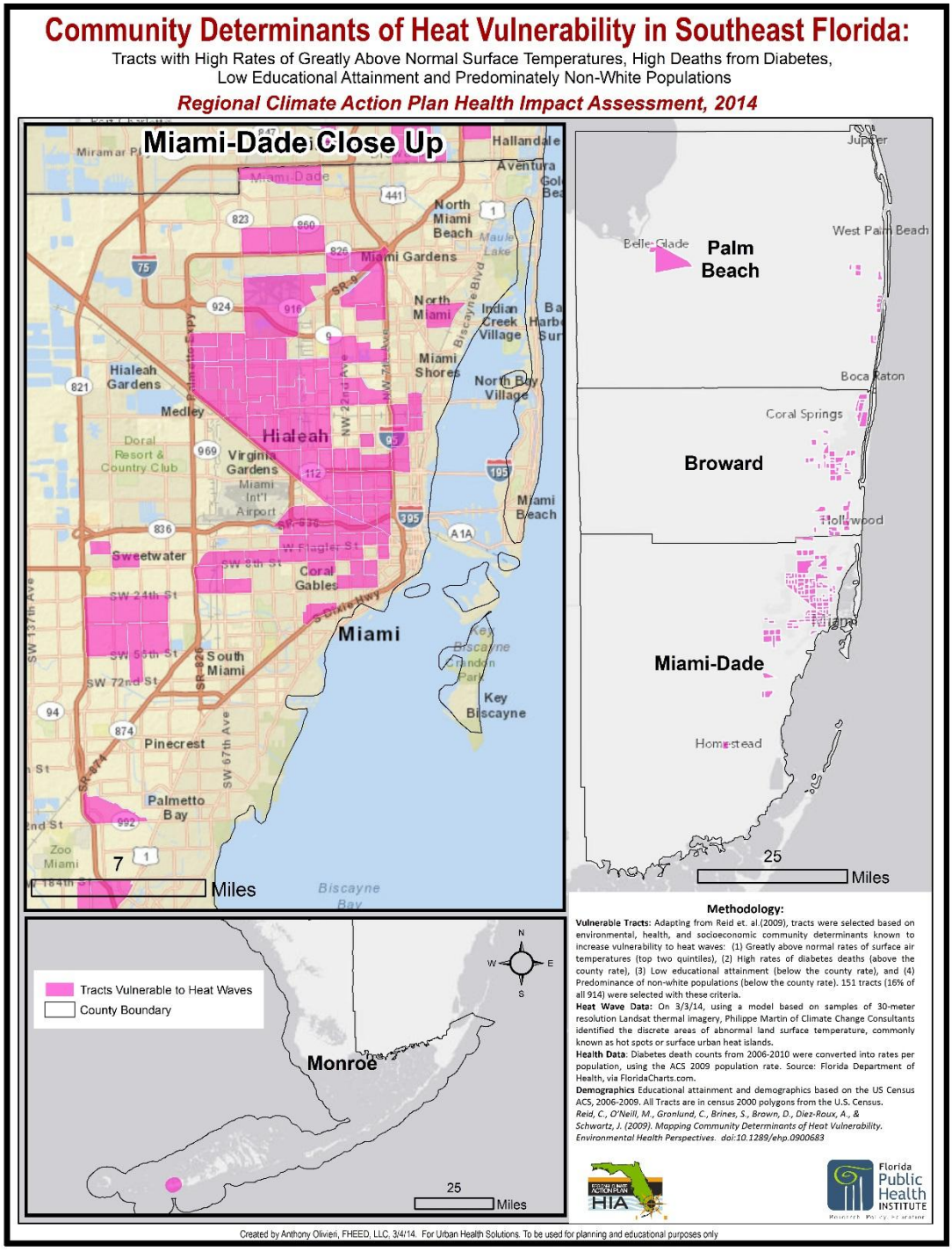
A majority of the selected tracts are located in the mostly white, low-income neighborhood of Hialeah, located around several interstates and freeways. Selected tracts are also located in North and South Miami, Miami Gardens, and Palmetto Bay. The city of Homestead was the most southern and most isolated tract in the county to be selected. Homestead is located near the Florida Turnpike highway and the Homestead Air Reserve Base. The city is predominantly white and Hispanic or Latino, with almost 70% of the population have a high school education or higher, and one third of the population living below the poverty level.

Table 64: Demographics for Hialeah and Homestead

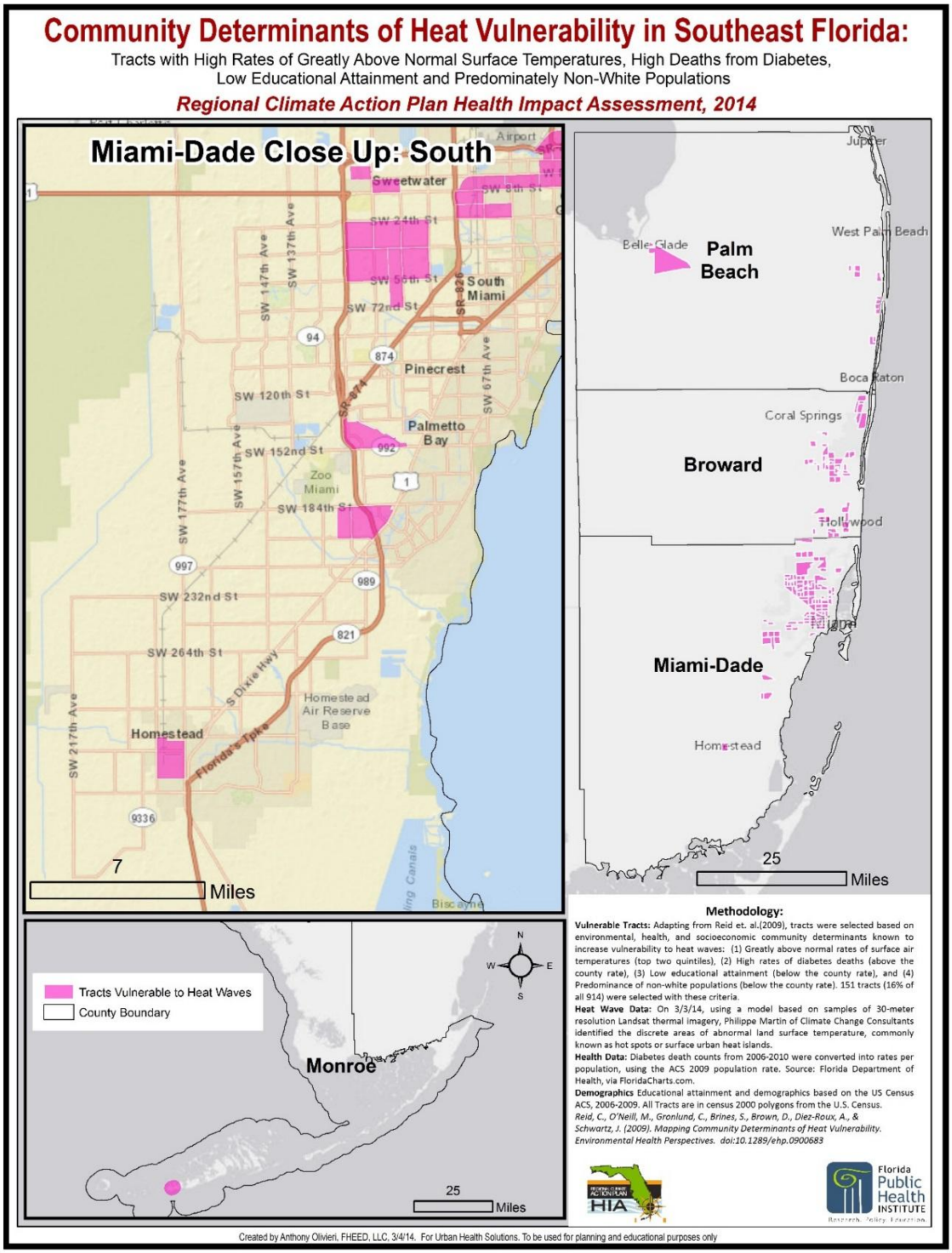
Demographic Variable	Hialeah Percentage	Homestead Percentage
White alone, percent, 2010	92.6%	66.9%
Black or African American alone, percent, 2010	2.7%	20.4%
Hispanic or Latino, percent, 2010	94.7%	62.9%
High school graduate or higher, percent of persons age 25+, 2008-2012	69.2%	69.8%
Persons below poverty level, percent, 2008-2012	22.6%	30.3%

Source: U.S. Census Bureau

Map 11: Community Determinants of Heat Wave Vulnerability in Miami-Dade County



Map 12: Community Determinants of Heat Wave Vulnerability in South Miami-Dade County



Monroe County

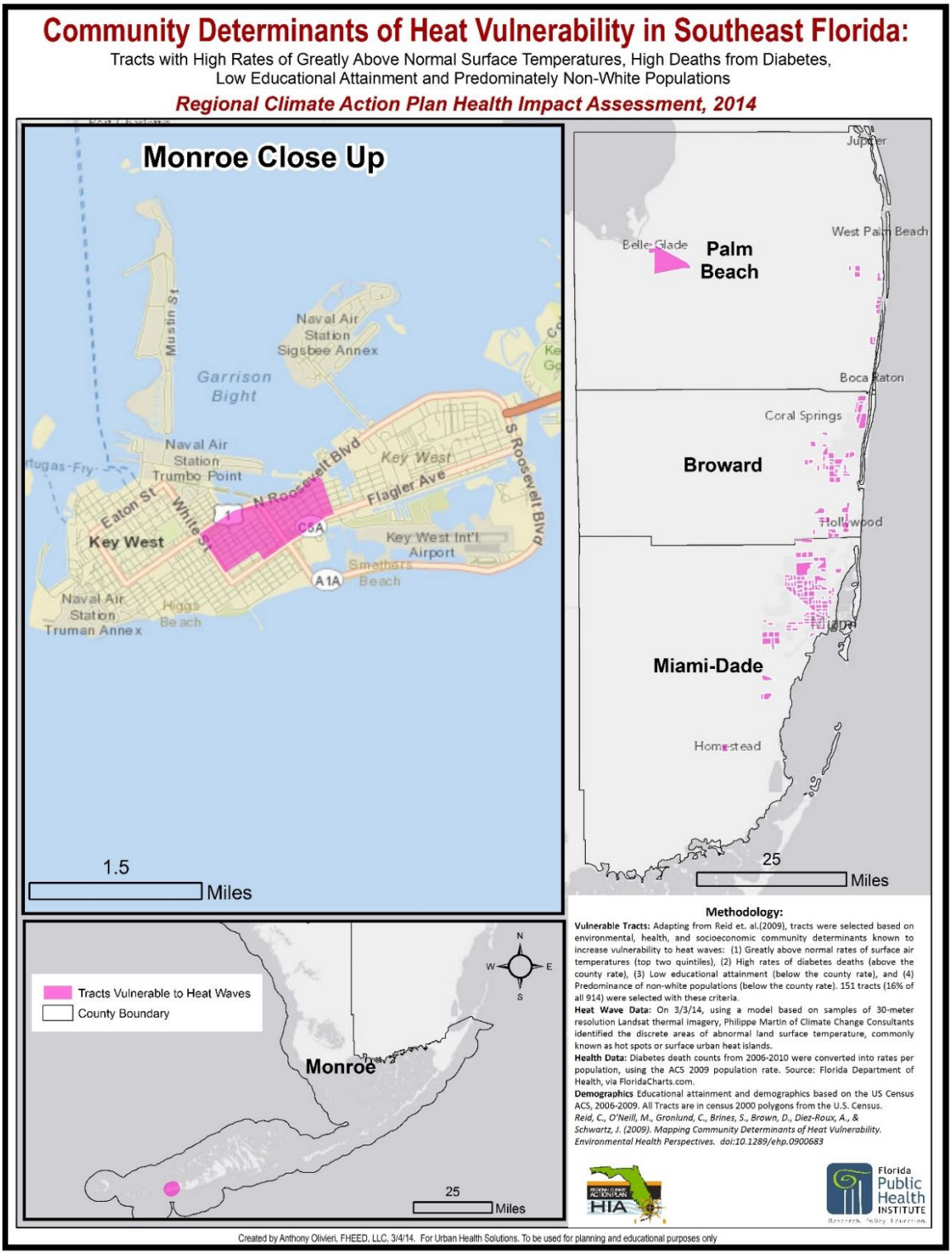
Monroe County had the smallest number of vulnerable tracts with only one tract selected and no tract hot spots identified. The one county tract selected showing vulnerability to heat waves was located in Key West.

Table 65: Demographics for Key West

Demographic Variable	Percentage
White alone, percent, 2010	83.8%
Black or African American alone, percent, 2010	9.7%
Hispanic or Latino, percent, 2010	21.2%
High school graduate or higher, percent of persons age 25+, 2008-2012	90.1%
Persons below poverty level, percent, 2008-2012	11.7%

Source: U.S. Census Bureau

Map 13: Community Determinants of Heat Wave Vulnerability in Monroe County



Palm Beach County

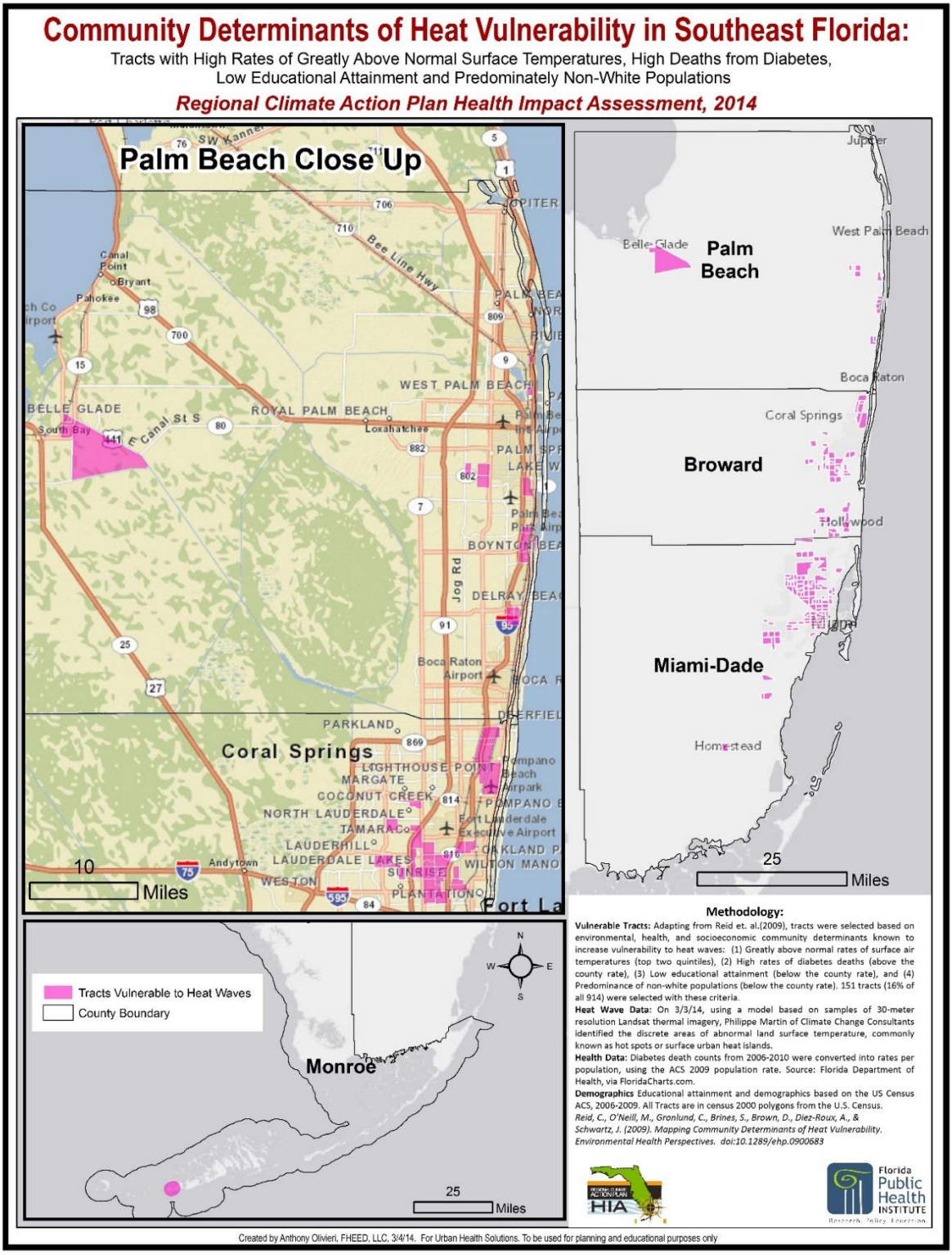
Palm Beach County had the second smallest number of vulnerable tracts with only 15. A majority of these tracts are located along the county's eastern coastline. One tract was located inland in Belle Glade, where one of the focus groups was located. Belle Glade is a majority black or African-American, low income population with over a third of the population living below the poverty level (**Table 67**).

Table 67: Demographics for Belle Glade

Demographic Variable	Belle Glade Percentage
White alone, percent, 2010	31.1%
Black or African American alone, percent, 2010	56.3%
Hispanic or Latino, percent, 2010	34.2%
High school graduate or higher, percent of persons age 25+, 2008-2012	59.8%
Persons below poverty level, percent, 2008-2012	35.1%

Source: U.S. Census Bureau

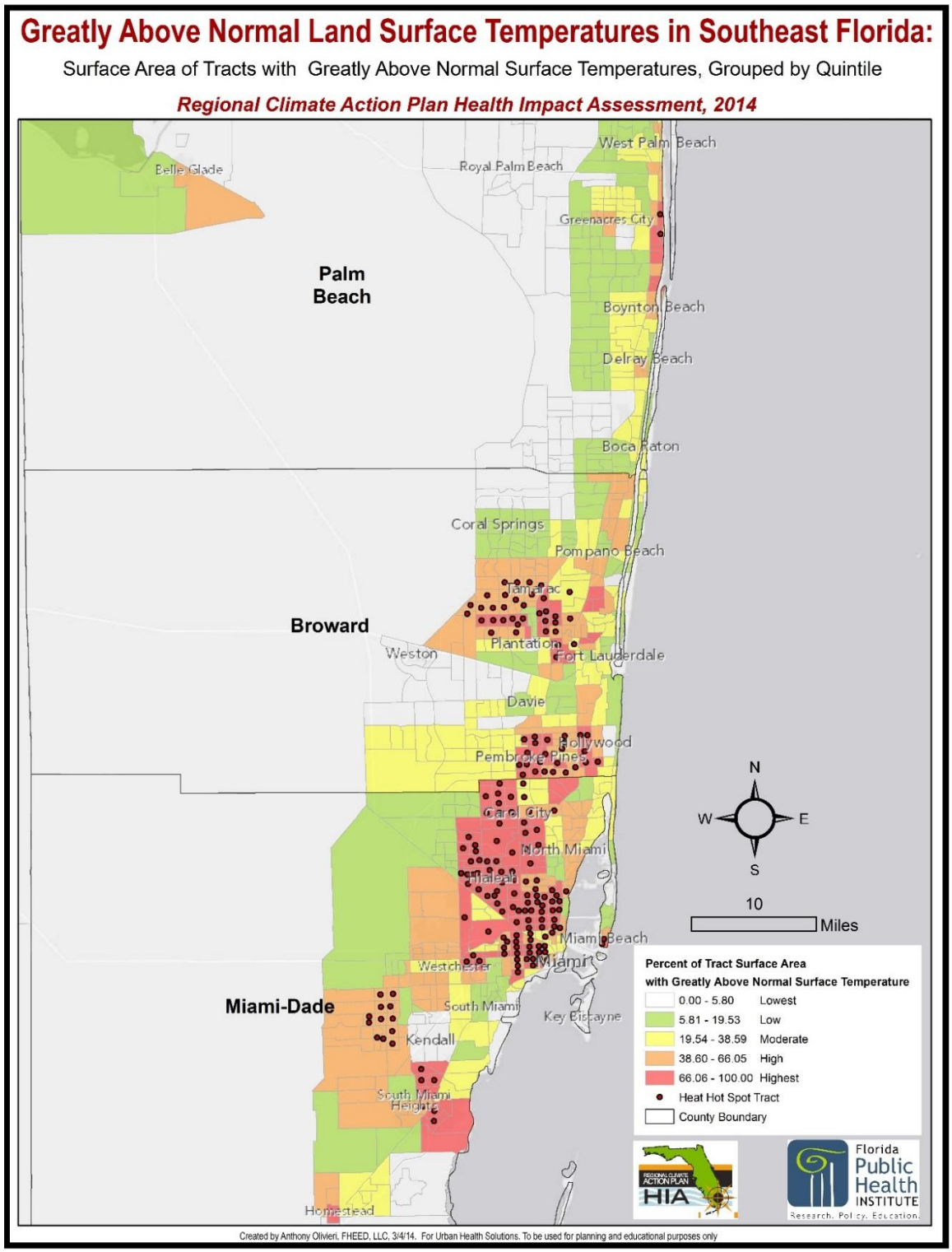
Map 14: Community Determinants of Heat Wave Vulnerability in Palm Beach County



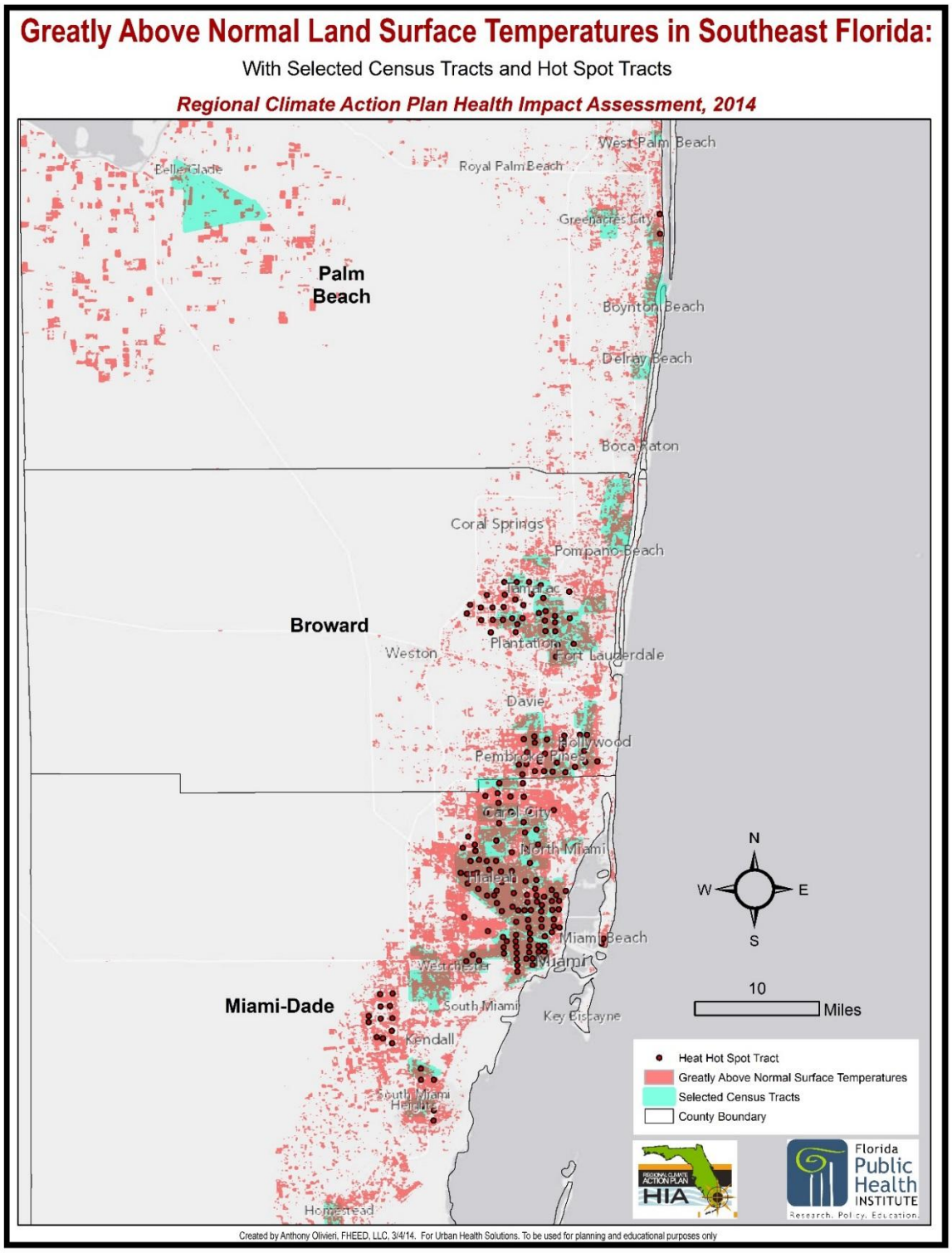
Greatly Above Land Surface Temperatures in Southeast Florida

Maps 15 and **16** depict the overlay of hot spot over "greatly above normal" surface temperature tracts. Palm Beach County only has two hot spots, Broward County has 58, and Miami-Dade County has the most hot spots concentrated in the northeast corner of the county in the areas of Hialeah, Carol City, Miami, and North Miami, similar to the distribution of selected tracts in **Map 11.** Miami-Dade County hot spots are located in tracts with "greatly above normal" surface temperatures in the "high" and "highest" quintiles. Palm Beach County's distribution of "greatly above normal" quintiles was similar to the distribution of selected tracts in **Map 10.** Most of the tracts are located along the county's coast, with the "highest" quintiles located directly on the coast. As seen in **Map 10**, "low" and "high" quintiles are located in the city of Belle Glade. The two hot spots in Palm Beach County are located along the coast in Palm Beach, in two tracts in the "highest" quintile.

Map 15: Greatly Above Normal Land Surface Temperatures in Southeast Florida: Surface Area of Tracts with Greatly Normal Land Surface Temperatures, Grouped by Quintile


Greatly Above Normal Land Surface Temperatures in Southeast Florida:
Surface Area of Tracts with Greatly Above Normal Surface Temperatures, Grouped by Quintile
Regional Climate Action Plan Health Impact Assessment, 2014
Palm Beach
Broward
Miami-Dade
Belle Glade
Royal Palm Beach
West Palm Beach
Greenacres City
Boynton Beach
Delray Beach
Boca Raton
Coral Springs
Pompano Beach
Tamarac
Plantation
Weston
Fort Lauderdale
Davie
Hollywood
Pembroke Pines
Carol City
North Miami
Hialeah
Miami Beach
Miami
Westchester
South Miami
Key Biscayne
Kendall
South Miami Heights
Homestead
N
W
E
S
10
Miles
Percent of Tract Surface Area
with Greatly Above Normal Surface Temperature
0.00 - 5.80 Lowest
5.81 - 19.53 Low
19.54 - 38.59 Moderate
38.60 - 66.05 High
66.06 - 100.00 Highest
Heat Hot Spot Tract
County Boundary
HIA
Florida Public Health INSTITUTE
Research. Policy. Education.
Created by Anthony Olivieri, FHEED, LLC, 3/4/14. For Urban Health Solutions. To be used for planning and educational purposes only

Map 16: Greatly Above Normal Land Surface Temperatures in Southeast Florida: With Selected Census Tracts and Hot Spot Tracts



Heat Wave Vulnerability Maps Comparison

Similar to as seen in the SLR vulnerability maps, heat vulnerability tracts tend to cluster around middle to South Broward and North Miami-Dade counties. Heat vulnerability tracts do not show on any of the islands and peninsulas off the eastern coasts of Palm Beach, Broward, and Miami-Dade counties.

Further Assessments Considered

Initial findings from the CRA provide a guide for future assessments evaluating the risk of burden of climate change-related health effects. The process and suggestions for further analysis might be of value to other researchers and have been included in the final HIA report.

Comparative Risk Assessment

A risk assessment was explored to systemically estimate the level of risk and attempt to quantify the likelihood and severity of illness from SLR and extreme heat conditions for the Southeast Florida population. The primary intent of incorporating this tool in the in the HIA was to provide support for decisions about managing risks associated with specific policy and protocol implementation that would impact the region's readiness to prepare for SLR and heat waves.

The HIA team considered the CDC's list of 11 potential climate change health effects for the CRA to estimate aggregate burden attributable to risk factors associated with sea-level rise and heat wave in Southeast Florida. Based on the literature review and extensive existing conditions report, local data and research for each potential health effect is summarized in **Table 68**.

Table 68. Summary of Data and Research Obtained for the CDC 11 Potential Climate Change Health Effects

Health Effects	Data and Research
Heat-Related Morbidity and Mortality	Numbers of heat-related hospitalizations Rates of heat-related mortality Mapping of heat vulnerable areas based on land surface data Literature Research: - Heat waves cause more deaths than other extreme weather combined. - Association with increase in cardiovascular disease and respiratory diseases. - Vulnerable populations include: elderly, people living in cities, people living alone, people with pre-existing conditions. - Global urbanization is creating urban heat islands with implications for greater health impacts.
Asthma, Respiratory Allergies, and Airway Diseases	Rates of asthma hospitalizations Percentages of adults that currently have asthma Rates of chronic lower respiratory disease deaths Rates of pneumonia Rates of emphysema Air quality - particulate matter and ozone concentrate levels for Broward, Palm Beach, and Miami-Dade counties Literature Research: - Air pollution from increases in particulate matter, ozone, and carbon dioxide with rising temperatures has the potential to increase these health issues. - Extreme heat intensifies particulate matter and chances that harmful algal blooms will aerosolize.

	- Carbon dioxide increases affect pollen seasons and production. - More rain and higher temperatures suggest a greater chance of indoor molds and fungi, aggravating respiratory allergies and asthma.
Vectorborne and Zoonotic Diseases	Rates of *Dengue Fever* Rates of *West Nile Virus* Rates of *Malaria* Rates of total enteric diseases Literature Research: - Climate variability likely to change vectorborne diseases' transmission, incidence and geographic range. - Increasing temperatures and precipitation may change development and reproduction patterns of vectors and increase capacity. - Population movement and displacement will change exposures.
Cardiovascular Disease and Stroke	Rates heart attack deaths Rates of hospitalizations associated with stroke Rates of stroke deaths Rates heart disease deaths Mapping of heart disease by Census tract Literature Research: - Air pollution, particulate matter and ozone, with higher temperatures can aggravate cardiovascular and stroke. - Stress from disasters can lead to cardiovascular. - Stress from displacement and lack of adequate medical care can aggravate chronic cardiovascular diseases.
Weather-Related Morbidity and Mortality	Rates of drowning Literature Research: - Flooding, increase in heavy precipitation, and increased frequency of storm events can cause morbidity and mortality exacerbated by sea level rise. - Coastal communities at greatest risk. - Post-event hazards include: disease outbreaks, mental health issues, lack of adequate medical care. - Rates have decreased in the US in recent years, but Hurricane Katrina serves as example of how much more capacity strengthening is needed.
Waterborne Diseases	Rates of *Vibrio* Rates of *Giardiasis* Rates of *Cryptosporidiosis* Contaminating hydrological systems Infrastructure not being built up enough to prevent contamination Rising temperatures Increasing frequencies Literature Research: - Disease association with extreme precipitation.

	- Disease association with three weather events: extreme precipitation, flooding, and higher temperatures. - Systematic deficiencies in capacity to deal with storm drainage, water treatment and storage will put humans at risk. - Gastrointestinal illnesses can cause chronic health issues. - Rising temperatures may increase frequency of harmful algal blooms and will put coastal communities and visitors to the areas most at risk.
Human Developmental Effects	Rates of lead poisoning Rates of lead poisoning with a health exposure Babies born with low birth weight Exposures to metals and toxins, algae, and pesticides Literature Research: - Environmental exposures can lead to developmental deficits that create life-long health issues. - Causes include: malnutrition, contaminants, and bio toxins. - Population displacement exacerbated by sea level rise can cause food insecurity that can lead to malnutrition. - Flooding increases chances of exposures to pesticides, metals, and toxins. - Future agricultural practices may need to use more pesticides to compensate for climate changes, increasing humans' risk of exposure.
Mental Health and Stress Related Disorders	Suicide rates Self-reported good mental health days Literature Research: - Climate change can directly and indirectly create short and long-term mental effects. - Acute anxiety and stress following major events likely. - Post-traumatic stress disorder (PTSD), depression linked to acute weather events like wildfires, heat waves and floods. - Flooding can cause displacement and disruption of social networks, placing these populations at risk of mental health disorders. - Extreme heat events associated with increase in mental illness and violence, like during Hurricane Andrew, can cause increase in anxiety and mood disorders. - Corporal heat increases when stress is laced on the body, making an individual with PTSD more sensitive to extreme heat conditions.
Neurological Diseases and Disorders	Rates of Parkinson's deaths Rates of Alzheimer deaths Literature Research: - Expected to increase with risk of exposure to contamination/ toxins from climate change. - Climate change affects ocean temperatures and harmful algal bloom frequency range likely will change. - Harmful algal blooms will likely affect coastal communities, while sea level rise and flooding increase risk of exposure.

	- Exposure to toxins, metal, and chemicals can lead to human developmental effects. - Flooding increase chances of human exposure and contamination of water sources. - Pregnant women and children very vulnerable.
Cancer	All cancer deaths Rates of melanoma incidence and deaths Rates of lung cancer incidence and deaths Mapping of most vulnerable places for cancer, sea level rise, and heat-related Literature Research: - Exposure to particulate matter, air pollution known risk factors for lung cancer. - Exposure ultraviolet rays is a known risk factor for skin cancers. - Depletion of stratospheric ozone increases ultraviolet ray exposure. - Exposure to toxic chemicals and metals suspected of increasing person's risk of some cancers. - Flooding will increase people's exposures to toxins.

The four stages of the CRA are: 1) identifying climate-sensitive health outcomes, 2) determining dose-response relationships for baseline climate, 3) selecting future climate scenarios, and 4) estimating the climate change–attributable burden of disease and the burden that is avoidable by plausible reductions in the risk factor.

First, the population-specific quantitative models of the climatic effects for health outcomes, or sufficient reliable disease and environmental data are needed to allow construction of appropriate models for the CRA. Inference models are developed on the basis of the relationship or more specifically on the dependence between the variables of interest (the health outcomes) and the explicative variables (the climate indices; SLR and heat waves). Although the literature states that there exists effects of SLR and heat waves on certain health indicators, these dependencies need to be present in the observed (or collected) data in order to develop an adequate inference model. Most of the health indicators presented in this report consist of annual data for the 2003 and 2012 period, which is a considerably small sample size of 10 values per variable. From these 10 values, a minimum of eight are required to calibrate the model and two other values are left for the model validation. The main implication of calibrating and validating the model with such small sample sizes is that the inferred health values from the future climate scenarios may be inaccurate, and even at times random. In order to adequately calibrate the model, the sub-sample destined for the calibration process needs to represent most of the natural variability of the observed health and climate indicators. Ideally, a 30-year period of annual data for climate analyses would be used. Statistical models cannot infer accurate results without a substantial amount of quality data. Although, obtaining this data was outside the current HIA scope, obtaining the data would be possible with sufficient time and resources.

Secondly, the dependence structure of variables used for the dose-response model must be furthered explored. As mentioned before, the performance of the models is based on the quantity of data available, as well as the relationship between the variable of interest and the explicative variable. Plausible dependence structures (translated by significant correlations) between these two types of

variables is necessary for the development of the inference models considered. In certain cases, some health-climate variable pairs may not be correlated, in which case, the development of a model relating these two variables could be unreliable. In other cases, the variables may only be correlated within a certain time lag, which needs to be determined before developing the model. This would be unknown prior to the actual analysis whether or not certain dose-response relationships would be valid. To develop a relatively robust model and reduce the uncertainty of the inferences, the correlations and the dependence between the variable of interest and the explicative variables need to be significant. Again, although there is a possibility of insignificance, the HIA practitioners agreed it would be of value to be further explored.

Specifically, for predicting SLR and heat waves scenarios for the dose-response modeling, the following steps might be necessary to apply and would depend on the epidemiological data available:

- Treat the sea level scenario data to be compatible with the health indicator format for integration in the dose-response model;

- Define and apply a heat wave index taking into account near surface air temperatures to characterize the baseline climate. Two possible alternatives: (a) using the heat wave index to estimate the future heat wave values using temperature data from future climate scenarios of large scale global climate models, or (b) same method as option (a), but using instead the SPI and precipitation data;

- Using the scenarios generated in steps 6 and 8, evaluate the health response of future climate scenarios using the dose-response model developed;

- Several additional climate indices can be calculated monthly, seasonally or yearly to characterize extreme precipitation and temperature events both in current and future scenarios such as the maximum number of consecutive dry days, the 90th percentile of precipitation intensity or of the daily temperature. Such climate indices may also explain part of the variability in the health indicators that can be used to develop further the dose-response relationships of interest.

A few researchers have employed CRA tactics to climate change associated variables, and the World Health Organization's (WHO) standardized CRA methodology serves as a template for further analysis. This model and others should be considered for replication upon completion of the dose-response relationships.

Daily Adjusted Life Years (DALY)

Additionally, to accurately compare health risks attributed to climate change the HIA practitioners had proposed incorporating a summary measure of population health, such as the DALY, to combine effects of mortality and morbidity. This would only include climate change outcomes that have well-defined links to disease risk, and in which well-characterized and quantified disease burdens have been identified. DALYs for a disease or health condition are calculated as the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for people living with the health condition or its consequences.

For YLL, it would be number of deaths and standard life expectancy at age of death in years. YLD would

include number of incident cases, disability weight, average duration of the case until remission or death (in years), and social value weights. These factors would be used to assign weight disability factors that entail the severity of the health issues (values between 0 and 1 indicating respectively perfect health and death), and to determine the social value weights attributed to the years lost due to disabilities (YLL).

WHO has provided updates for the Global Burden of Disease Study for years 2000 to 2004. The WHO report also applied several social value weights in the calculation of DALYs for diseases and injuries. Apart from the disability weights, these also included time discounting and age weights and can serve as guidance in applying this methodology.

Understanding the severity of the disease identified in the CRA from perfect health to death, would be of value in communicating to decision makers the need to address health affects in climate change mitigation and adaption strategies.

Cost-Effectiveness Analysis

The messaging targeting decision-makers entailing the number of lost years of "healthy" life, would be effective in depicting the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability. Associating a dollar amount to how effective it would be for decision-makers to be proactive and address the issue prior to losing a year of life, would again, make the case for supporting mitigation and adaption strategies earlier rather than later. HIA practitioners found this step to be of much value conceptually, but with the first step, CRA, not being feasible the cost-effectiveness analysis was not explored in this research.

Recommendations

The HIA report recommendations were designed to inform the RCAP how to best incorporate health considerations into their current guidelines for policies and protocols related to SLR and heat waves. Their implementation will have the greatest positive health impacts on the population, and will assist decision-makers in understanding the impacts of SLR and heat waves on the health of South Floridians. The following recommendations are accompanied by a brief description based on the assessment section of the HIA, as well as the corresponding RCAP recommendation polices most closely associated.

1. *Integrate public health planning with municipal and regional planning to prepare Southeast Florida for the broader impacts of Climate Change.*

   The Florida State Health Improvement Plan (SHIP) is the blueprint for all 67 counties to collectively aim at achieving a shared vision with partners and stakeholders to improve population health and the specific data, programs, and evaluation to support its implementation. Each county creates a Community Health Improvement Plan (CHIP) that mirrors the SHIP and is reflective of specific local needs. The HIA recommends for coordination among policies and protocols at a County and municipal level (i.e. CDMPs) including health plans such as the CHIPs.

   Policies: SP-1, SP-2, SP-9, SP-14, SP-15, SP-17, SP-18, SP-19 (all), SP-20, WS-1, WS-8, WS-16, RR-6, RR-5, RR-7, PP-8, PP-9, PP-11, PP-12

2. *Educate the public and elected officials on health outcomes associated with climate change.*

   Throughout the stakeholder engagement process of the HIA, each sector clearly described a need for further public education; better messaging of health benefits to elected officials; or had not considered health when reflecting on climate change and was unaware of associated health impacts. The steering committee members stressed the importance of messaging, public education, and integrating health promotion efforts of agencies to include climate change. A vast majority of professionals currently working in the field of climate change were not aware of potential co-health benefits from adapting to climate change impacts. Additionally, the community members who participated in the focus groups spoke extensively on the need to have better communication between government officials and the public on how local agencies were responding to SLR and heat waves.

   Policies: PO-1, PO-2, PO-3, PO-5, PO-6, PO-10, PP-1

3. *Include heat vulnerability, health, and socio-economic factors when developing vulnerability mapping or determining priority zones.*

   The existing conditions report highlights the significance of health factors associated with climate change particularly asthma, respiratory allergies and airway diseases, foodborne diseases and nutrition, mental health, vectorborne and zoonotic diseases and waterborne diseases. Additionally, heat maps provided a lens on how minority communities with poor education and poor health are at greater risk for extreme heat conditions. Therefore, it is recommended RCAP consider health and socio-economic data in general climate change

analysis, as well as specific heat vulnerability mapping to inform its policies and protocols to adapt to climate change.

Policies: SP-3, SP-4, SP-5, SP-6, SP-7, SP-8, SP-9, SP-10, SP-11, SP-12, SP-16, WS-2, WS-3, WS-5, NS-1, RR-3

4. *Encourage, foster, and support investigative work to fully understand the impacts and economic costs attributed to climate change and health.*

   Current constraints have required agencies to deal with limited financial and human resources. An eminent challenge is to balance long-term needs with urgent requirements in addressing climate change impacts. In order to make the best use of local means, further exploration of the health risks and its societal cost associated with climate change should be investigated.

   Policies: WS-10, WS-11, WS-12, WS-14, WS-15, RR-1

5. *Establish health-related metrics to use when planning for adaption strategies to mitigate climate change effects.*

   Performance measures and metrics to support the monitoring and evaluation of policies and objectives in planning documents has become a norm. The rich information provided in the literature review and existing conditions report exemplifies why health metrics should be routinely collected and used to inform appropriate planning processes for adaptation strategies to mitigate climate change.

   Policies: WS-7, WS-9, WS-13, RR-2, RR-4

6. *Revisit city and county development plans and revise based on heat vulnerability mapping a specific amount of shade trees or canopy to increase safe active access to goods in extreme heat.*

   Under extreme heat the vulnerable populations, who most readily rely on active transportation, would need to access goods and services such as food, jobs, and medical clinics. The need to require for developers to incorporate additional shade trees and canopies in these communities is recommended.

   Policies: SP-30

Cataloging the recommendations was a preliminary screening process that allowed for the identification of RCAP recommendations pertaining to SLR and heat waves. Following assessment and the categorization of the RCAP recommendations fall under HIA recommendations, four RCAP recommendations did not fall under the HIA recommendations. WS-4, WS-6, WS-17, and WS-18 were the four that did not fall under the six HIA recommendations. This does not mean that these recommendations are not important to creating positive health outcomes if they are implemented, but they do not fit in the prioritized recommendations for this HIA.

Monitoring and Evaluation

The results of the HIA were made available to key stakeholders, project partners, participating organizations, elected officials and residents of Broward, Miami-Dade, Monroe, and Palm Beach counties, environmental advocates, city planners and engineers, and sustainability professionals and academics. The HIA findings were presented in a final report and presentation to key stakeholders. The report was disseminated to key stakeholders and made available to the public for download on the FPHI website. Findings and recommendations from the final report were translated into dissemination tools such as fact sheets; presentations; and social media marketing through blogs, the FPHI website, and other online outlets.

As a part of the HIA process of assessing the health impacts of the RCAP's 110 recommendations in SLR and heat wave scenarios in Southeast Florida, a process evaluation was conducted of the HIA process itself. Self-assessment surveys of the HIA process were completed by steering committee members to evaluate the activities, roles, and responsibilities of the steering committee, the HIA process itself, and HIA products.

Self-Assessment Survey Results

46% of the surveys were completed and returned by deadline. Overall, feedback was positive from the steering committee members. Responses indicated that the steering committee were well informed on their roles and responsibilities expected throughout the HIA process. Members were satisifed with their level of input throughout the process and found that materials provided before and after each meeting (monthly deliverables, meeting agendas, and post-meeting notes) were useful. Members did indicate that they would have liked more time before each meeting to review meeting materials. Overall, the steering committee felt that they gave their best input into the HIA process and were satisfied with the HIA products. Comments received were positive. Steering committee members praised project management and the work that everyone involved put into the HIA final product.

Process Evaluation

The primary focus of evaluation for this HIA was process with the understanding the the impact of the recommendations of the HIA report were beyond the scope of this intermediate HIA. The impact that the HIA recommendations will have on local and regional Southeast Florida decision-makers' prioritization of the RCAP recommendations will be an important measurement of the utlity of this HIA as a decision-making tool. As the RCAP recommendations were designed with an implementation time frame of zero to five-year, evaluations will need to be conducted during these assigned time frames at to evaluate and measure the health and economic impacts of the implementation of the HIA recommendations as they pertain to specific RCAP recommendations. Additionally, as climate change data and prediction models are updated and refined, the models and maps of the health effects of SLR and heat waves in Southeast Florida may need to be revised to reflect changing conditions.

This HIA serves as the foundation for a two year project FPHI began in January 2014 with funding from the Kresge Foundation to include public health in the SLR adaptation planning efforts and to identify and model the health impacts SLR will have on South Florida's residents. In partnership with FAU, the project will identify the communities in Palm Beach, Broward, Miami-Dade and Monroe counties most

vulnerable to sea-level rise impacts; determine specific health risks associated with sea-level rise and apply them to 2030 and 2060 population models for these vulnerable communities; share the information with local decision makers to create more robust adaptation plans that include human health considerations; and develop a technical guide and toolkit that may be shared with other coastal communities. The RCAP HIA will serve as a building block upon which further research and assessment on the health impacts climate change conditions will have on the health outcomes of South Florida.

Conclusion

The HIA addressed each of the four objectives outlined in the Screening section of the report.

- *Identify potential direct and indirect health impacts of climate change in Southeast Florida due to SLR and heat waves.*

  In the Existing Health Conditions Analysis and Literature Review sections, the HIA identified direct and indirect health impacts related to climate change both in general and specific to the four Southeast Florida counties. Based on existing data, it was determined that asthma, respiratory allergies and airway diseases; foodborne diseases and nutrition; mental health; vectorborne and zoonotic diseases; and waterborne diseases were identified as health conditions that will likely have the greatest impact on the health of the populations of the four counties under the climate change factors of SLR and extreme heat events. SLR and heat waves vulnerability mapping further described the health impacts of SLR and heat wave scenarios by identifying areas of particularly vulnerable populations, especially those in the northeastern corner of Miami-Dade County and the southeastern corner of Broward County.

- *Assess the impact of RCAP recommended climate change adaptation and mitigation policies and resilient strategies on human health outcomes.*

  The cataloguing the 110 RCAP recommendations relevant to SLR and heat waves and categorizing them within the six HIA recommendations identified those climate change policies and strategies that local and regional decision-makers can implement to address creating positive health outcomes. Assessing past and existing adaptation and mitigation policies implemented in Florida and each of the four counties, concisely informs on the work being done in each county. Finally, the HIA outlined what types of future research, including a CRA and cost-effective analysis, could contribute to the knowledge of how climate change adaptation and mitigation policies and resilient strategies can effect human health outcomes.

- *Inform on incorporating RCAP's recommendations for adaptation and mitigation policies and strategies that recognize the need to prepare and address the health impacts due to SLR and heat waves.*

  The HIA report assessment and suggested recommendations will inform local and regional decision-makers, key stakeholders, and community partners on RCAP policies and strategies related to SLR and heat waves that will have the greatest impact on the health outcomes of Southeast Florida. HIA recommendations outline strategies and the specific RCAP recommendations that decision-makers can focus on when implementing these strategies and policies to ensure that health outcomes are incorporated into their implementation plans. Recommendations, such as *Establish health-related metrics to use when planning for adaption strategies to mitigate climate change effects*, provides a sustainable suggestion for a tool decision-makers and stakeholders can use to include health in all climate change adaptation and mitigation planning.

- *Increase knowledge and awareness throughout the Southeast Florida region of climate change health impacts due to SLR and heat waves.*

  The focus groups and two surveys provided insight into the opinions and views the public and local professionals have towards climate change, how they expect it to impact their lives, and what role they would like to see their local governments have in preparing for climate change. The focus groups revealed that one of their biggest requests of local governments was for more education and information programs and campaigns on how the individual can take action in preventing climate change and focusing on their health. From this information, the HIA report is able to inform local and regional decision-makers on how they can develop strategies to address their communities concerns on climate change.

  To address increasing the public's knowledge and awareness, easy to digest informational materials, such as the use of social media resources and a one page summary of the report findings and recommendations, will inform the public and help the HIA team inform a wide audience. Additionally, the report will add to the growing body of research in Southeast Florida focused on the impacts of climate change, SLR, and heat waves on Southeast Florida.

Lessons Learned

Inherently in conducting an HIA, there will be limitations to the process depending on the type of the HIA. Funding was the biggest limitation for the RCAP HIA. The limited financial resources dictated the time frame for the HIA, requiring the project to be a six-month intermediate HIA, limiting the scope and depth of analysis of the project. Two climate change scenarios, SLR and heat waves, were chosen for assessment, but it is likely that other climate change-related changes, like extreme weather events and heavy precipitation, will also potentially have an impact on the health of populations in the four counties that should also be assessed.

Also of important note is that the 11 CDC potential climate change health effects do not represent an exhaustive list of health effects that Southeast Florida's populations may see resulting from climate change, there will likely be other health impacts beyond these 11. As noted in the Vulnerability Mapping section, other non-communicable diseases, like diabetes, would have changed the number and layout of vulnerable tracts in Palm Beach County and included more rural areas. During the assessment phases there were a few instances in which data for health variables in the Existing Conditions Data Collection section and CRA were incomplete or unavailable, either as a whole or for certain counties, as was seen multiple times with Monroe County. Finally, the mapping of critical hydrological infrastructure and access points and routes to healthcare outlets, such as local hospitals, would have been an important addition to SLR vulnerability mapping. Unfortunately, this kind of mapping required more detailed statistical mapping that was beyond the scope, budget, and broad assessment of the RCAP HIA. This is a level of vulnerability analysis that would be beneficial to decision-makers in understanding the vulnerability of populations in the four counties in the future, especially under flooding and storm surge climate change scenarios. The mapping of critical infrastructure and healthcare access points is an assessment that researchers should consider conducting in the near future.

Strengths

This HIA had a number of important strengths guiding it throughout the process. First, the steering committee was comprised of an impressive collection of local representatives, mapping specialists, HIA professionals, climate change scientists, and public health professionals who provided expert guidance and input throughout the entire HIA process that contributed significantly to making this HIA a stronger, more comprehensive HIA. Another strength of this HIA was the ability to include input from Southeast Florida professionals, rural communities, and online participants to provide valuable insight from these different groups on climate change concerns and expectations of decision-makers on the issues of climate change and adaptation and mitigation policies. In addition to the strong show of support from the HIA steering committee and interested parties, the community of Southeast Florida was willing to help assist the HIA team whenever the team reached out for help.

The HIA was originally intended to be a rapid HIA, relying solely on existing data. However, during the HIA process it became apparent that to create a stronger HIA, a more in-depth assessment would be necessary. Despite limitations on funding, the final HIA assessment product was a comprehensive assessment including both existing and new data. Fortunately, timing and feasibility allowed for the mapping on SLR and heat wave vulnerability to provide a more holistic picture of where the health effects of climate change in relation to SLR and heat waves throughout the four counties. The inclusion of new data from focus groups, survey sand mapping of vulnerability has set the foundation for future assessments and planning for climate change and health impacts in Southeast Florida. This level of data collection also serves as a model for future impact assessments on the health impacts of climate change-related adaptation and mitigation policy planning in terms of considering all the components of a comprehensive analysis that includes the magnitude and distribution of climate change-related health impacts, vulnerability, and cost-effectiveness.

References

American Cancer Society. (2013, September 23). *What Causes Cancer?* Accessed from: http://www.cancer.org/cancer/cancercauses/index

Beelen, R., Hoek, G., van den Brandt, P. A., Goldbohm, R. A., Fischer, P., Schouten, L. J., & Brunekreef, B. (2008). Long-term exposure to traffic-related air pollution and lung cancer risk. *Epidemiology*, *19(5),* 702-710.

Berry, H. L., Bowen, K., & Kjellstrom, T. (2010). Climate change and mental health: a causal pathways framework. *International Journal of Public Health*, *55(2),* 123-132.

Bloem, M. W., Semba, R. D., & Kraemer, K. (2010). Castel Gandolfo Workshop: An introduction to the impact of climate change, the economic crisis, and the increase in the food prices on malnutrition. *The Journal of Nutrition*, *140(1),* 132S-135S.

Boxall, A. B., Hardy, A., Beulke, S., Boucard, T., Burgin, L., Falloon, P. D., & Williams, R. J. (2009). Impacts of climate change on indirect human exposure to pathogens and chemicals from agriculture. *Environmental Health Perspectives*, *117(4),* 508.

Center for Clean Air Policy. (November 6, 2013). *Connecting the Dots: Adaptation + Mitigation Synergies*. Accessed from: http://ccap.org/connecting-the-dots-adaptation-mitigation-synergies/

Centers for Disease Control and Prevention. (2012). *CDC's Building Resilience Against Climate Effects (BRACE) Framework.* Accessed from: http://www.cdc.gov/climateandhealth/BRACE.htm

Centers for Disease Control and Prevention. (2013, October 3). *Birth Defects: Exposures and Risks*. Accessed from: http://ephtracking.cdc.gov/showBdExposureRisk.action

Center for Clean Air Policy. (November 6, 2013). *Connecting the Dots: Adaptation + Mitigation Synergies*. Accessed from: http://ccap.org/connecting-the-dots-adaptation-mitigation-synergies/

Curriero, F. C., Patz, J. A., Rose, J. B., & Lele, S. (2001). The association between extreme precipitation and waterborne disease outbreaks in the United States, 1948–1994. *Journal Information*, *91(8).*

Dimsdale, J. E. (2008). Psychological stress and cardiovascular disease. *Journal of the American College of Cardiology*, *51(13),* 1237-1246.

Doherty, T. J., & Clayton, S. (2011). The psychological impacts of global climate change. *American Psychologist*, *66(4),* 265.

Ebi, K. L., & Semenza, J. C. (2008). Community-based adaptation to the health impacts of climate change. *American Journal of Preventive Medicine, 35(5),* 501-507.

Environmental Protection Agency. (2008). *Reducing Urban Heat Islands: Compendium of Strategies*. Accessed from: http://www.epa.gov/hiri/resources/pdf/BasicsCompendium.pdf

EPA. (April, 2012). *2008 Ground-level Ozone Standards — Region 4 Final Designations*. Accessed from: http://www.epa.gov/airquality/ozonepollution/designations/2008standards/final/region4f.htm

EPA. (January 21, 2014). *Ground-level Ozone Standards Designations*. Accessed from: http://www.epa.gov/airquality/ozonepollution/designations/index.htm

Frumkin, H., Hess, J., Luber, G., Malilay, J., & McGeehin, M. (2008). Climate change: the public health response. *Journal Information*, *98*(3).

Gage, K. L., Burkot, T. R., Eisen, R. J., & Hayes, E. B. (2008). Climate and vectorborne diseases. *American Journal of Preventive Medicine*, *35(5),* 436-450.

Galea, S., Brewin, C. R., Gruber, M., Jones, R. T., King, D. W., King, L. A., & Kessler, R. C. (2007). Exposure to hurricane-related stressors and mental illness after Hurricane Katrina. *Archives of General Psychiatry*, *64(12),* 1427.

Goklany, I. M. (2007). Death and death rates due to extreme weather events. *Civil Society Report on Climate Change*, 47.

Haines, A. (2012). Sustainable policies to improve health and prevent climate change. *Social Science & Medicine*, *74*(5), 680-683.

Haines, A., Kovats, R., Campbell-Lendrum, D. & Corvalan, C. (2006). Climate change and human health: impacts, vulnerability and mitigation. *The Lancet. 367*, 2101-2109.

Haines, A., McMichael, A. J., Smith, K. R., Roberts, I., Woodcock, J., Markandya, A., & Wilkinson, P. (2010). Public health benefits of strategies to reduce greenhouse-gas emissions: overview and implications for policy makers. *The Lancet*, 374(9707), 2104-2114.

Hallegatte, S. (2009). Strategies to adapt to an uncertain climate change. *Global Environmental Change*, *19(2),* 240-247.

Hamin, E. M., & Gurran, N. (2009). Urban form and climate change: Balancing adaptation and mitigation in the US and Australia. *Habitat international, 33(3),* 238-245.

Hanson, R., Herweijer, C., Patmore, N., Hallegatte, S., Corfee-Morlot, J., Chateay, J., & Muir-Wood, R. (2008). Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes. *OECD Environment Working Papers,* No. 1, OECD Publishing.

Harlan, S. L., & Ruddell, D. M. (2011). Climate change and health in cities: impacts of heat and air pollution and potential co-benefits from mitigation and adaptation. *Current Opinion in Environmental Sustainability*, *3(3),* 126-134.

Heimlich, B., Bloetscher, F., Meeroff, D., & Murley, J. (2009). Southeast Florida's Resilient Water Resources: Adaptation to Sea Level Rise and Other Climate Change Impacts. *Florida Atlantic University*.

Accessed from:
http://www.ces.fau.edu/files/projects/climate_change/SE_Florida_Resilient_Water_Resources.pdf

Hess, J. J., McDowell, J. Z., & Luber, G. (2012). Integrating climate change adaptation into public health practice: using adaptive management to increase adaptive capacity and build resilience. *Environmental Health Perspectives, 120(2)*, 171.

Hittle, C.D. (1999). *Delineation of saltwater intrusion in the surficial aquifer system in eastern Palm Beach, Martin, and St. Lucie Counties, Florida, 1997-98. Water-Resources Investigations Report 99-4214.* U.S. Department of the Interior, USGS.

Hunter, P. R. (2003). Climate change and waterborne and vector-borne disease. *Journal of Applied Microbiology*, *94(s1),* 37-46.

Kalkstein, L. S., Greene, S., Mills, D. M., & Samenow, J. (2011). An evaluation of the progress in reducing heat-related human mortality in major US cities. *Natural Hazards*, *56(1),* 113-129.

Karl, T., Meehl, G., Miller, C., Hassol, S., Waple, A., & Murray, W. (Eds.). (2008). Weather and Climate Extremes in a Changing Climate Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands. Accessed from: http://downloads.climatescience.gov/sap/sap3-3/sap3-3-final-all.pdf

Karl, T., Melillo, J. & Peterson, T. (Eds.). (2009). Global Climate Change Impacts in the United States. Cambridge University Press.

Keim, M. (2008). Building Human Resilience: The Role of Public Health Preparedness and Response as an Adaptation to Climate Change. *American Journal of Preventive Medicine 35(5),* 508-516.

Kjellstrom, T. & McMichael, A. (2013). Climate change threats to population health and well-being: the imperative of protective solutions that will last. *Global Health Action, 10*, 3402.

Kravchenko, J., Abernethy, P., Fawzy, M. & Lyerly, K. (2013). Minimization of Heat Wave Morbidity and Mortality. *American Journal of Preventive Medicine. 44(3),* 274-282.

La Greca, A. M., Silverman, W. K., Vernberg, E. M., & Prinstein, M. J. (1996). Symptoms of posttraumatic stress in children after Hurricane Andrew: a prospective study. *Journal of Consulting and Clinical Psychology*, 64(4), 712.

Laukkonen, J., Blanco, P. K., Lenhart, J., Keiner, M., Cavric, B., & Kinuthia-Njenga, C. (2009). Combining climate change adaptation and mitigation measures at the local level. *Habitat International, 33(3),* 287-292.

Lin, S., Luo, M., Walker, R. J., Liu, X., Hwang, S. A., & Chinery, R. (2009). Extreme high temperatures and hospital admissions for respiratory and cardiovascular diseases. *Epidemiology*, *20(5),* 738-746.

Luber, G. & McGeehin, M. (2008). Climate Change and Extreme Heat Events. *American Journal of Preventive Medicine. 35(5),* 429-435.

Maibach, E. W., Nisbet, M., Baldwin, P., Akerlof, K., & Diao, G. (2010). Reframing climate change as a public health issue: an exploratory study of public reactions. *BMC Public Health*, 10(1), 299.

McMichael, A. J., Woodruff, R. E., & Hales, S. (2006). Climate change and human health: present and future risks. *The Lancet*, *367(9513),* 859-869.

Mendell, M. J., Mirer, A. G., Cheung, K., & Douwes, J. (2011). Respiratory and allergic health effects of dampness, mold, and dampness-related agents: a review of the epidemiologic evidence. *Environmental Health Perspectives*, *119(6),* 748.

Metz, B. (Ed.). (2007). *Climate Change 2007-Mitigation of Climate Change: Working Group III Contribution to the Fourth Assessment Report of the IPCC* (Vol. 4). Cambridge University Press.

National Oceanic and Atmospheric Administration. (2008). *Extremes in U.S. Climate*. National Climatic Data Center. Accessed from: http://www.ncdc.noaa.gov/extremes/extreme-us-climates.php

NOAA. (2013). *Mean Sea Level Trend 8723170 Miami Beach, Florida*. Accessed from: http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8723170

NOAA. (2013). *Updated Mean Sea Level Trends 8724580 Key West, Florida*. Accessed from: http://tidesandcurrents.noaa.gov/sltrends/sltrends_update.shtml?stnid=8724580

NOAA. (2013). *Updated Mean Sea Level Trends 8723970 Vaca Key, Florida*. Accessed from: http://tidesandcurrents.noaa.gov/sltrends/sltrends_update.shtml?stnid=8723970

NOAA. (2014). NOAA Satellite and Information Services Standard Precipitation Index Division Data. Accessed from: http://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp#

Pachauri, R., & Reisinger, A. (Eds.). (2007). Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the fourth assessment report to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. *IPCC, Geneva, Switzerland.* 104 pp.

Parry, M. L. (Ed.). (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Fourth Assessment Report of the IPCC Intergovernmental Panel on Climate Change* (Vol. 4). Cambridge University Press.

Patz, J. A., Epstein, P. R., Burke, T. A., & Balbus, J. M. (1996). Global climate change and emerging infectious diseases. *JAMA: The Journal of the American Medical Association*, *275(3),* 217-223.

Patz, J. A., McGeehin, M. A., Bernard, S. M., Ebi, K. L., Epstein, P. R., Grambsch, A., & Trtanj, J. (2000). The potential health impacts of climate variability and change for the United States: executive summary of the report of the health sector of the US National Assessment. *Environmental Health Perspectives*, *108(4),* 367.

Portier, C., Thigpen Tart, K., Carter, S., Dilworth, C., Grambsch, A., Gohlke, J., Hess, J., Howard, S., Luber, G., Lutz, J., Maslak, T., Prudent, N., Radtke, M., Rosenthal, J., Rowles, T., Sandifer, P., Schrage, J., Schramm, P., Strickman,D., Trtanj, J., Whung, P-Y. (2010). A Human Health Perspective On Climate

Change: A Report Outlining the Research Needs on the Human Health Effects of Climate Change. Research Triangle Park, NC: Environmental Health Perspectives/National Institute of Environmental Health Sciences. doi:10.1289/ehp.1002272 Accessed from: www.niehs.nih.gov/climatereport

Rose, J. B., Epstein, P. R., Lipp, E. K., Sherman, B. H., Bernard, S. M., & Patz, J. A. (2001). Climate variability and change in the United States: potential impacts on water-and foodborne diseases caused by microbiologic agents. *Environmental Health Perspectives*, *109(Suppl 2),* 211.

Schettler, T. (2001). Toxic threats to neurologic development of children. *Environmental Health Perspectives, 109(6),* 813.

Semenza, J. C., Rubin, C. H., Falter, K. H., Selanikio, J. D., Flanders, W. D., Howe, H. L., & Wilhelm, J. L. (1996). Heat-related deaths during the July 1995 heat wave in Chicago. *New England Journal of Medicine*, *335(2),* 84-90.

Shea, K. M., Truckner, R. T., Weber, R. W., & Peden, D. B. (2008). Climate change and allergic disease. *Journal of Allergy and Clinical Immunology*, *122(3),* 443-453.

Sonenshein, R. S. (1996). *Delineation of saltwater intrusion in the Biscayne Aquifer, eastern Dade County, Florida, 1995.* US Department of the Interior, US Geological Survey.

Southeast Florida Regional Climate Change Compact Technical Ad hoc Work Group. (2011). A Unified Sea Level Rise Projection for Southeast Florida. A document prepared for the Southeast Florida Regional Climate Change Compact Steering Committee. Accessed from: http://southeastfloridaclimatecompact.org/pdf/Sea%20Level%20Rise.pdf.

Stone Jr, B. (2005). Urban heat and air pollution: An emerging role for planners in the climate change debate. *Journal of the American Planning Association*, *71(1),* 13-25.

Tirado, M. C., Clarke, R., Jaykus, L. A., McQuatters-Gollop, A., & Frank, J. M. (2010). Climate change and food safety: A review. *Food Research International*, *43(7),* 1745-1765.

Tucker, A. (2009). Melanoma Epidemiology. *Hematology/ Oncology Clinics of North America, 23(3):* 383–vii.

U.S. Census Bureau. (1992). *1990 Census of Housing General Housing Characteristics Florida*. U.S. Department of Commerce Economics and Statistics Administration Bureau of the Census. Accessed from: https://www.census.gov/prod/cen1990/ch1/ch-1-11.pdf

U.S. Census Bureau. (2012). *State and County Quickfacts: Florida*. Accessed from: http://quickfacts.census.gov/qfd/states/12000.html

U.S. Census Bureau. (January, 62014). *State and County QuickFacts.* Accessed from: http://quickfacts.census.gov/qfd/states/12000.html

U.S. Army Corps of Engineers (USACE). 2009. *Water Resource Policies and Authorities, Incorporating Sea level Change Considerations in Civil Works Programs*. Expires July 2011. CECW-CE Circular No. 1165-2-211.
Washington, D.C.: Department of the Army, U.S. Army Corps of Engineers.

Victora, C. G., Adair, L., Fall, C., Hallal, P. C., Martorell, R., Richter, L., & Sachdev, H. S. (2008). Maternal and child undernutrition: consequences for adult health and human capital. *The Lancet*, *371(9609),* 340-357.

Weber, E. U., & Stern, P. C. (2011). Public understanding of climate change in the United States. *American Psychologist*, 66(4), 315.

Wilby, R. L. (2008). Constructing climate change scenarios of urban heat island intensity and air quality. *Environment and Planning. B, Planning & design*, *35(5),* 902.

Wu, G., Bazer, F. W., Cudd, T. A., Meininger, C. J., & Spencer, T. E. (2004). Maternal nutrition and fetal development. *The Journal of Nutrition*, *134(9),* 2169-2172.

Zhang, K. (2011). Analysis of non-linear inundation from sea-level rise using LIDAR data: a case study for South Florida. *Climatic Change. 106,* 537-565.

Appendices

Appendix A: Percentages of Adults Who are Current Smokers

	2002	2007	2010	Percent Rate Change
Broward	17.7%	18.1%	13.7%	-22.6%
Miami-Dade	18.8%	15.4%	10.6%	-43.6%
Monroe	29.2%	22.3%	21.1%	-27.7%
Palm Beach	22.2%	17.5%	9.0%	-59.5%
Florida	22.2%	19.3%	17.1%	-23.0%

Appendix B: RCAP Recommendations for Analysis

Sea Level Rise and Heat Waves Recommendations	
SP-1	Support implementation of the Regional Climate Action Plan by including recommendations from the Plan into existing land use and policy decisions and related elements of the municipal and county Comprehensive Plans, as appropriate; and recognize the Plan as a basis for the development of new goals, objectives and policies through the appropriate local government Comprehensive Plans.
SP-2	Develop policies, strategies and standards that will serve as guidance for climate change related planning efforts. Municipal and County planning authorities are encouraged to develop policies to improve resilience to coastal and inland flooding, salt water intrusion, and other related impacts of climate change and sea level rise in their Comprehensive Plans, Sustainability Action Plans, Vision Plans, Storm water Master Plans, Transit Development Plans, Long Range Transportation Plans, Adaptation Action Area Plans, Climate Change Plans and other green planning efforts.
SP-3	Incorporate "Adaption Action Area" definition (as provided for in Florida law) into municipal and/or county Comprehensive Plans, to provide a means to identify those areas deemed most vulnerable to sea level rise and other climate change impacts including but not limited to extreme high tides, heavy local rain events, and storm surge for the purpose of prioritized funding and adaptation planning.
SP-4	Develop criteria in collaboration with municipal and county planning authorities for the purpose of defining Adaptation Action Areas as well as other areas requiring adaptation improvements related to coastal flooding and sea level rise that may include, but not be limited to: • Areas below, at, or near mean higher high water; • Areas which have a hydrological connection to coastal waters; • Areas designated as evacuation zones for storm surge; and/or • Other areas impacted by climate related drainage/flood control issues.

SP-5	Conduct new or utilize existing vulnerability analyses and other technical tools as they are developed as a means for identifying Adaptation Action Areas as well as other areas requiring adaptation improvements related to coastal flooding and sea level rise, to provide guidance for adaptation planning efforts in areas especially at risk to sea level rise, tidal flooding and other related impacts of climate change.
SP-6	Develop policies, as provided for in Florida law and in collaboration with the appropriate municipal and county planning authorities, related to areas designated as Adaptation Action Areas or similarly vulnerable areas to improve resilience to coastal flooding, sea level rise and other climate related vulnerabilities and provide guidance for other adaptation planning efforts.
SP-7	Develop sea level rise scenario maps to be considered for inclusion in appropriate Comprehensive Plans and/or regional planning documents as determined by the appropriate local government to guide municipal and county government climate adaptation planning efforts and continue to update regional and local planning efforts as more data becomes available and scientific projections are refined.
SP-9	Coordinate regionally across municipalities and county planning authorities on the development of projects and funding proposals to seek prioritized funding for identified infrastructure needs and specific adaptation improvements required within Adaptation Action Area or other related adaptation planning areas.
SP-10	Work with appropriate local, regional and state authorities to revise building codes and land development regulations to discourage new development or post-disaster redevelopment invulnerable areas to reduce future risk and economic losses associated with sea level rise and flooding. In these areas, require vulnerability reduction measures for all new construction, redevelopment and infrastructure such as additional hardening, higher floor elevations or incorporation of natural infrastructure for increased resilience.
SP-12	Develop new community flood maps reflective of a 100-year storm event under future sea level rise scenarios and use this information, in conjunction with similarly updated storm surge models for revising required elevations for new and redevelopment, and in the permitting/licensing of transportation projects, water management systems, and public infrastructure.
SP-15	Modify or develop new design standards for transportation infrastructure located in identified vulnerable areas to include environmentally supportive road materials, bridge design, elevation, and storm water management. Include different pitches combined with storm water design to effectively remove water from the roadway; explore roadway materials that may be utilized in road construction that are more tolerant of extended periods of extreme temperatures.
SP-16	Develop policies to address new transportation infrastructure development in light of anticipated future climate impacts, such as consideration of future floodplain conditions and vulnerable areas which could require the rerouting of roads because of potential flooding and related damage.
SP-17	Analyze potential blighted sites and develop an approach for converting underutilized or unused properties and structures, including properties in financial distress, into community gardens or farmers' markets. (i.e., Redfields to Greenfields)

SP-18	Identify means to effectively engage the multiple public and private sector entities with roles and responsibilities involving the provision and maintenance of transportation infrastructure and the delivery of transportation services in the region, in climate adaptation and mitigation initiatives. Document current and evolving coordination efforts among these entities.
SP-19 (all)	Focus transportation investments and service expansions on projects and strategies contributing to GHG emissions reductions and enhancing resilience to climate change.
SP-19a	Continue to enhance and implement regionally coordinated transportation planning through the Regional Long Range Transportation Plan (RLRTP). Identify goals and objectives in the RLRTP which, as they are attained, reinforce the desired achievement of GHG emission reductions and enhanced resilience to climate change. Articulate the supportive role of these goals and objectives for emissions reductions and climate resiliency.
SP-19b	Give higher investment priority to and advocate for state and federal transportation infrastructure investments, programs and services that will reduce GHG emissions and enhance resiliency and adaptability to climate change. Performance standards for climate and related metrics, such as reduced VMT and increased mode split, should be incorporated in transportation plans and programs. Transportation planning should include performance measures in major decision-making phases such as land use visioning, long-range transportation plans, corridor studies, programming, environmental review, and performance monitoring.
SP-19c	Incorporate evaluation criteria and processes to prioritize projects that meet RLRTP goals and objectives, into local and regional planning and programming processes, with an initial emphasis on evaluation criteria that reduce VMT and increase use of transportation modes other than the personal vehicle. Projects that enhance economic vitality should also be given priority, such as projects and service expansions along transit-oriented corridors and those that improve connections to major airports and seaports
SP-19d	Prioritize studies funded through existing programs and other sources addressing effective climate adaptation and mitigation strategies, particularly those addressing barriers to adaptation and assisting in integrating land use and transportation planning.
SP-19e	Improve coordination among economic development, land-use/housing, transportation and water resource planning activities. Review local and regional planning and decision making processes to ensure a complementary approach towards developing and maintaining a transportation network, including for purposes of reducing VMT and providing more transportation choices.
SP-20	Require that new development and redevelopment in areas with existing and planned multimodal corridors that connect urban and other centers in the region be planned and designed to support walking, biking and transit use
SP-30	Increase the amenities and infrastructure available to transit riders, such as shade, shelters, kiosks utilizing solar power when feasible, and route and real time boarding information.
Water Supply, Management and Infrastructure	
WS-1	Develop local and, where appropriate, regional inventories of existing potable water supply delivery and collection systems, vulnerable well fields, wastewater collection and/or treatment infrastructure, septic tanks/drain fields, and storm water drainage and treatment facilities; assess the potential impact from climate change of each component; and develop different climate change scenarios and adaptation strategies for high-risk utilities and/or infrastructure which may require replacement, reinforcement, or relocation to ensure the

	long term viability of the system (e.g., modified site, depth, elevation, materials, or connection requirements).
WS-2	Develop a regional saltwater intrusion baseline and utilize saltwater intrusion models to identify well fields and underground infrastructure at risk of contamination/infiltration by saltwater with increases in sea level.
WS-3	Utilize existing and refined inundation maps and storm water management models to identify areas and infrastructure at increased risk of flooding and tidal inundation with increases in sea level, to be used as a basis for identifying and prioritizing adaptation needs and strategies.
WS-4	Evaluate the impacts of rising sea and groundwater levels on soil storage, infiltration rates and inflow to storm water and wastewater collection and conveyance systems; consider longer-term influences on water quality; and develop strategies for implementing reclaimed water and storm water reuse projects that account for current and future conditions.
WS-5	Develop and apply appropriate hydrologic and hydraulic models to further evaluate the efficacy of existing water management systems and flood control/drainage infrastructure under variable climate conditions. Quantify the capacity and interconnectivity of the surface water control network and develop feasible adaptation strategies.
WS-6	Coordinate with the South Florida Water Management District, Drainage/Water Control Districts, and utilities/public works officials to identify flood control and stormwater management infrastructure already operating below the design capacity. Further examine water control structures to ensure that they can provide for inland or upstream migration of riparian species as freshwater habitats become more saline.
WS-7	Develop Integrated Water Management Plans that present a joint assessment and planning strategy involving local water utilities, wastewater service providers, water managers, and partners to the Southeast Florida Regional Climate Change Compact, for coordinated consideration of stormwater use and disposal, traditional and alternative water supplies, wastewater disposal and reuse, and water conservation measures for use by local leadership to guide planning decisions as well as amendments to applicable codes and regulations.
WS-8	Develop and test water management and drainage system adaptation improvements needed to maintain existing levels of service relating to drainage, flood control, and water supply, and use cost-benefit analyses to prioritize potential improvements.
WS-9	Incorporate and prioritize preferred climate adaptation improvement projects in capital improvement plans and pursue funding.
WS-10	Encourage, foster, and support investigative work and scientific research that improves the understanding of local and regional climate change impacts specific to south Florida including: • Improved down-scaling of global climate models for representation of precipitation at the regional/local scales. • Identification and targeting of gaps in monitoring to improve quantification of the hydrologic system and its response to climate change, such as evapotranspiration, groundwater levels, and precipitation, and local sea level; • Development of risk-based decision support tools and processes for application in analysis of infrastructure design, water resource management, natural systems management, and hazard mitigation alternatives. Tools should provide for consideration of potential economic costs of comparative planning scenarios, management decisions, and infrastructure investments and the evaluation of potential tradeoffs.
WS-11	Undertake efforts to fill identified data gaps through local program efforts, agency

	collaborations, and advocacy for additional state/federal resources, as needed.
WS-12	Foster the development and exchange of new information, methods and technical capabilities to address key questions of concern related to climate variability and sea level rise to support management decisions: • Assess impacts of observed and predicted climate variability and sea level rise on the frequency, duration, and intensity offloading as a result of extreme tidal excursions, storm surge, and 100-yearstorm events, and where impacts are likely to be greatest. • Examine the effects of climate change on water availability and groundwater vulnerability due to sea level rise, and predicted changes in precipitation and evapotranspiration patterns and rates. • Establish a venue for a periodic exchange of ideas between resource managers, policymakers, and researchers.
WS-13	Develop agency capabilities to provide rapid deployment of resources in immediate response to intense precipitation and storm events through use of Next RAD technology.
WS-14	Cultivate partnerships with federal and state agencies, and professional associations with expertise in integrated water resource planning (such as the U.S. Army Corps of Engineers Institute for Water Resources, the United States Geological Survey, and Water Foundations)as sources of important research, reports and information regarding climate change, and efforts being undertaken in other communities.
WS-15	Monitor changes in rainfall patterns, temperature means and extremes and SLR through coordination with NOAA, and other key organizations/partners, to better predict future wet-season and dry-season rainfall. Monitor emerging science in order to assess the adequacy of regional climate models. Choose an annual conference or other venue at which such trends can be reviewed at regular intervals.
WS-16	Cultivate partnerships with federal and state agencies, and professional associations with expertise in integrated water resource planning (such as the U.S. Army Corps of Engineers Institute for Water Resources, the United States Geological Survey, and Water Foundations) as sources of important research, reports and information regarding climate change, and efforts being undertaken in other communities
WS-17	Support complete implementation and funding for the Comprehensive Everglades Restoration Plan (CERP) and its updated versions as fundamental to Everglades restoration, to include increased freshwater flows to the Everglades system, thereby improving water quality, maximizing regional freshwater storage and aquifer recharge, and providing potential to abate saltwater intrusion, which will become increasingly important under variable climate conditions and in the face of sea level rise.
WS-18	Combine existing and develop new land acquisition priorities in a regional setting to protect high quality drinking water supply.
Natural Systems	
NS-1	Develop a vital signs status and trends monitoring program for biological communities. Key parameters may include rate of sea-level rise; saltwater intrusion boundary and monitoring wells; landscape-level vegetation patterns; percent coral cover and condition in offshore reef zones; water temperature and pH in areas; and occurrence and range of invasive exotic plants and animal species.
Risk Reduction and Emergency Management	
RR-1	Perform vulnerability analysis to identify and quantify the economic value of regional infrastructure at risk under various sea level rise scenarios and other climate change scenarios

	utilizing inundation mapping, modeling, and other appropriate tools. While the initial regional vulnerability assessment completed by the Compact Counties for use in this Regional Climate Action Plan has yielded important new insights on regional risk, additional and ongoing analysis is required to further refine our current understanding and to monitor changes in Southeast Florida's risk profile over time.
RR-2	Evaluate and improve adaptation responses for communities at risk, to include: • Development and implementation of methodologies for the assessment and • evaluation of evacuation and relocation options; • Development of model evacuation policies and procedures for communities at increased risk of flooding; and • Development of model relocation policies for affected communities.
RR-3	Incorporate climate change adaptation into the relevant Local Mitigation Strategy (LMS) to reduce or eliminate long-term risk to human life and property from disasters. Within the LMS, update local risk assessments to include climate change in the hazard analysis and vulnerability assessment section. Develop strategies for hazard mitigation and post-disaster redevelopment planning.
RR-4	Identify transportation infrastructure at risk from climate change in the region; determine whether, when, where, and to whom projected impacts from climate change might be significant. Employ inundation mapping, modeling and other appropriate tools to assess the vulnerability of transportation infrastructure to the projected impacts of climate change under various sea level rise and other climate change scenarios. At a minimum, assess the vulnerability of the following transportation infrastructure: • local transportation networks of the Compact Counties • the Regional Transportation Network designated by the Southeast Florida Transportation Council composed of interconnected, strategic corridors (roadway, rail line, waterway), hubs (airports, seaports, intermodal terminals, freight terminals, passenger rail and intercity bus terminals) and connectors critical to the mobility of people and freight and the region's economic competitiveness and quality of life; and evacuation routes adopted under the Statewide Regional Evacuation Corridor Program.
RR-5	Enforce Coastal Construction Line and build upon goals, objectives and policies related to Coastal High Hazard Area designations in Comprehensive Plans.
RR-6	Adopt consistent plans at all levels of regional government that adequately address and integrate mitigation, sea level rise and climate change adaptation. The following plans must all be consistent: Disaster recovery and redevelopment plans; Comprehensive plans; Long range transportation plans; Comprehensive emergency management plans; Capital improvement plans; Economic development plans, Local Mitigation Strategy, Climate Change Action Plan; Future Land Use Plan.
RR-7	Continue to implement and enforce strong building codes that require new construction and substantial improvements to existing structures to mitigate against the impacts offloading, severe winds, and sea level rise, and which are consistent with Climate Change Adaptation policy.
	Public Outreach
PO-1	Provide outreach to residents, stakeholders and elected officials on the importance of addressing climate change adaptation and preparedness and develop a program to educate specific interest groups about the Compact, Regional Climate Action Plan, and the benefits of

	Adaptation Action Area. Consider utilizing the Leadership Academy concept to educate elected leaders, academic interests and other decision makers.
PO-2	Counties, municipalities and appropriate agencies will collaborate to develop and carry out outreach/educational programs to increase public awareness about hazards exacerbated by climate change, mitigation efforts, and adaptation strategies to minimize damage and risk associated with climate change.
PO-3	Provide education and improve communications on energy conservation and available technologies with a focus on both short-term and life-cycle economic benefits, and incentives available within the region
PO-5	Initiate a regional public education campaign to educate residents, business owners, policymakers on the merits of preserving open land as an 'insurance policy' for adaptation to sea level rise in Southeast Florida.
PO-6	Develop early warning systems and social media applications to both inform residents and visitors of extreme high-tide events and to raise overall awareness on sea level rise and climate change issues. Also consider roadway signage for tidal flooding zones.
PO-10	Coordinate outreach efforts with states, regions and counties that are subject to the impacts of climate change with special emphasis on coastal entities experiencing sea level rise and coastal flooding to create a national Climate Adaptation Coalition for the purpose of impacting public policy and influencing appropriations requests.
Public Policy	
PP-1	Compact Partners will continue the support for the core Compact policies and the role of joint advocacy as provided for in Sections 1 – 4 of the Compact calling for changes to federal law that better recognize the unique vulnerabilities of Southeast Florida to climate change and for providing appropriations based on vulnerabilities, with special attention to funding infrastructure projects to adapt to sea level rise.
PP-8	Support and advocate for continued implementation and funding on the state and federal levels for the Comprehensive Everglades Restoration Plan (CERP) in recognition of the important role of CERP in climate adaptation planning and local water resource management related to regional water storage and aquifer recharge, important under variable climate conditions and sea level rise.
PP-9	Advocate to interests in Tallahassee for the preservation of the authority and resource capacity of the Water Management Districts in support of their continued participation in integrated water resource planning, particularly in Southeast Florida where climate change and sea level rise pose additional challenges to the complex issues of alternative water supply development, Everglades restoration, salt water abatement, and drainage and flood control operations.
PP-11	Urge Congress to provide recognition of an "Adaptation Action Area" designation in federal law for the purpose of prioritizing funding for infrastructure needs and adaptation planning, with special attention to modifications in law that enhance funding opportunities through USACE and EPA appropriations processes, as requested by members of Congress.
PP-12	Urge Congress to pass legislation that would create a permanent funding source to finance infrastructure projects to adapt to the impacts of climate change with emphasis on investments in areas such as water management, water supply, transportation and other projects that serve to reduce risks to urban infrastructure from extreme weather events and rising sea levels.

Appendix C: Climate Change and Health Survey

This survey is gathering information about the perceptions of health and its impacts on Climate Change. Please take a moment to answer the questions below.

1. When addressing Climate Change issues, how should health co-benefits be prioritized?

Highly prioritized	Equally prioritized as other factors	Low prioritization
☐	☐	☐

2. Do you think your local community understands the health impacts and the need for prioritizing the health co-benefits in preparing for Climate Change?

☐ Yes ☐ No

3. Are you aware of the health benefits of implementing mitigation and/or adaptation strategies associated with Sea Level Rise?

☐ Yes ☐ No

If so, which one?

_____

_____

4. Are you aware of the health benefits of implementing mitigation and/or adaptation strategies associated with extreme heat occurrences?

☐ Yes ☐ No

If so, which one?

_____

_____

The following questions are going to ask how you think Florida, this region and your local community is dealing with overall Climate Change mitigation strategies:

5. How satisfied are you with how the State of Florida is dealing with the health impacts associated with Climate Change?

Very Satisfied	Satisfied	Somewhat Satisfied	Not Satisfied
☐	☐	☐	☐

6. How satisfied are you with how the Southeast Region of Florida is dealing with the health impacts associated with Climate Change?

Very Satisfied	Satisfied	Somewhat Satisfied	Not Satisfied
☐	☐	☐	☐

7. How satisfied are you with how your local community is dealing with the health impacts associated with Climate Change?

Very Satisfied	Satisfied	Somewhat Satisfied	Not Satisfied
☐	☐	☐	☐

8. What is your zip code? _____

9. What is your profession? _____

10. Is there anything you would like to add about how Florida, this region, and your local community could better prioritize health benefits when implementing adaptation and mitigation climate change strategies?

_____
_____
_____

Thank you for your time and please visit the Florida Public Health Institute website (www.flphi.org) for more information.

Appendix D: Public Climate Change Survey

What are your perceptions of Climate Change? Does it or will it affect your health? Take five minutes to tell us today and enter a chance to win a $50 gift certificate.

This survey can be found online at: http://urbanhp.wufoo.com/forms/regional-climate-action-plan-hia-survey/.

Your input and feedback will be kept anonymous and used to help guide a health impact assessment on a Climate Change action plan. Do you wish to continue with this survey?

☐ Yes ☐ No

Survey Questions

1. How long have you lived in Southeast Florida?

1-5 years	☐
6-10 years	☐
11-15 years	☐
16+ years	☐
My whole life	☐

2. What county do you live in?

Broward County	☐
Miami-Dade County	☐
Monroe County	☐
Palm Beach County	☐
None of the above, but I DO reside in FL	☐
None of the above, and I reside OUTSIDE of FL	☐

3. Is climate change something you have worried will affect your life while living in Southeast Florida?

Yes	☐
No	☐
Somewhat	☐

4. Do you consider sea level rise to be a threat to Southeast Florida?

Yes	☐
No	☐
Somewhat	☐

5. Do you consider heat waves to be a threat to Southeast Florida?

Yes	☐
No	☐
Somewhat	☐

6. How concerned are you about an increase in sea level rise over the coming decades?

Extremely concerned	☐
Slightly concerned	☐
Somewhat concerned	☐
Slightly not concerned	☐
Not at all concerned	☐

7. How concerned are you about an increase in frequency and severity of heat waves over the coming decades?

Extremely concerned	☐
Slightly concerned	☐
Somewhat concerned	☐
Slightly not concerned	☐
Not at all concerned	☐

8. If the sea level were to rise 10 feet by 2040 in Southeast Florida, how likely would that impact your life?

Extremely likely	☐
Likely	☐
Neutral	☐
Unlikely	☐
Extremely unlikely	☐

9. How would your life be affected if the sea level rose 10 feet by 2040 in Southeast Florida?

	Very affected	Somewhat affected	Not affected	Slightly not affected	Not affected
Housing	☐	☐	☐	☐	☐
Transportation	☐	☐	☐	☐	☐
Education	☐	☐	☐	☐	☐
Job	☐	☐	☐	☐	☐
Local Services	☐	☐	☐	☐	☐
Health	☐	☐	☐	☐	☐
Social Interactions	☐	☐	☐	☐	☐

10. If the sea level were to rise 20 feet by 2060 in Southeast Florida, how likely would that impact your life?

Extremely likely	☐
Likely	☐
Neutral	☐
Unlikely	☐
Extremely unlikely	☐

11. How would your life be affected if the sea level rose 20 feet by 2060 in Southeast Florida?

	Very affected	Somewhat affected	Not affected	Slightly not affected	Not affected
Housing	☐	☐	☐	☐	☐
Transportation	☐	☐	☐	☐	☐

Education	☐	☐	☐	☐	☐
Job	☐	☐	☐	☐	☐
Local Services	☐	☐	☐	☐	☐
Health	☐	☐	☐	☐	☐
Social Interactions	☐	☐	☐	☐	☐

12. How should your local politicians prioritize climate change policies regarding sea level rise?

Essential	☐
High priority	☐
Medium priority	☐
Low priority	☐
Not a priority	☐

13. How should your local politicians prioritize climate change policies regarding heat waves?

Essential	☐
High priority	☐
Medium priority	☐
Low priority	☐
Not a priority	☐

14. What's the most important thing you want your local and regional politicians to consider when preparing for climate change?

_____
_____
_____

15. What's the most unfavorable thing your local regional politicians could do when preparing for climate change?

_____
_____
_____

16. Gender

☐ Male ☐ Female

17. Age
18.

Under 14	☐
14-20	☐
21-29	☐
30-45	☐
45-60	☐

61-75	☐
75+	☐

Please fill in your contact information below for a chance to win the raffle. We will only contact you if you are the winner.

Name: (First) _____ (Last) _____
Phone Number: _____
Email: _____

http://www.flphi.org/

Thank you for participating.

Appendix E: Climate Change HIA Focus Group Guide

I. Sign-In and Snacks

Welcome everyone to the focus group and tell them to please help themselves to lunch.

Ask that everyone please sign in on the Sign-In Sheet. Make sure that each participant signs in before beginning.

II. Introduction

Introduce yourself and anyone else who is there with the HIA project to the group. Ask if everyone has signed sign in sheet.

Turn on Tape Recorder

Explain the Purpose of the Focus Group

Thank you for agreeing to participate in this focus group. Before I ask for each of you to consent to participating in this discussion I will tell you what this focus group discussion will be about and what it is for.

We are conducting an assessment on how climate change, particularly sea level rise and heat waves, will affect the health of people living in Southeast Florida and how local decision makers can use this information to create policies, laws and programs will have the greatest impact on the health of you and other Southeast Florida residents.

The purpose of this focus group is to learn about your perceptions of people living in rural areas of Southeast Florida of the need to prepare for the health effects of sea level rise and extreme heat conditions through policies and systemic changes. We are interested in hearing each of your perspectives and opinions on how you think your local and regional government systems should prepare for these health effects.

III. Consent Process

Consent for this focus group will be obtained verbally and by having participants sign in on the Sign-In Sheet. Verbal consent must be obtained from each participant and each participant must sign the Sign-In Sheet before the focus group discussion begins. Below is what the facilitator will say to obtain verbal consent.

The information you give us today is completely confidential and nothing you say or do during this focus group will be associated with your name or anything else that would identify who you are.

We would like to tape the focus group so that we can make sure we don't miss anything that you have to say. We want to be able to capture all of your thoughts, opinions and ideas. No names will be attached to the focus groups and the tapes will be destroyed as soon as they are transcribed.

We understand how important it is to respect the privacy of each of you in this room and we ask that you please respect each other's confidentiality.

You can refuse to answer any question or withdraw from the focus group at any time.

If you have any questions now, during or after the focus group, we will provide each of you with our business cards that have our email and phone numbers. Please feel free to contact us at any time.

Before we begin the discussion I will need to get a verbal agreement from each of you individually that you give your consent to participating in this focus group. Do each of you agree to participate in this focus group? I will go around to each of you and please answer "yes" or "no" to participating in this focus group.

Go around the room and have each person answer "yes" or "no" to this question. Record each person's answer.
You have been given a number to wear on your shirt. As we engage in the discussion today you should state your number before your responses. For example, [turn to a co-facilitator] how many years have you lived in Monroe County? [Co-facilitator responds] I have lived in Monroe County for 10 years.

Introductions
Go around table and have each person say how long they've lived in the area. Also record gender.

How many years have you lived in Monroe County? How many years have you lived in South Florida (Palm Beach, Broward, Miami-Dade, or Monroe County)?

IV. Focus Group Discussion

Explain the Focus Group Process

Ask if anyone in the group has ever participated in a focus group before.
Explain that focus groups are being used more and more in health research.

Logistics:

- Focus group will last 1 hour (until 12:30 PM)

- Feel free to move around or go to the bathroom if you need to
- Indicate where the bathrooms and exits are located
- Urge them to help themselves to lunch

Ground Rules:
Explain that there are typically some common ground rules to focus groups.

- Everyone please participate
- Information provided in the focus group must be kept confidential
- Stay with the group and please don't have side conversations
- Turn off or silence cell phones if possible, please don't check phones during the focus group
- Have fun

Ask the group if they agree on these ground rules.
Ask the group if there are any other rules they would like to add. If they want to add any, have the group agree upon these rules.

Ask the group if there are any questions before we get started, and address those questions.

The focus group will officially begin here. Make sure people get enough time to think before answering the questions and don't move too quickly. Make sure that everyone gets a chance to answer. Use the probes to make sure that all issues are addressed, but move on when you feel you are starting to hear repetitive information or information that is not relevant to the question or focus group topic.

Questions

A. Category 1: Climate Change
Let's start the discussion by talking about climate change in general.

- What do you know about climate change?
- What do you think will be climate change's impact?

B. Category 2: Health
Let's talk about climate change and health.

- How do you think climate change will affect your health?
- What do you think an individual should do to prepare for potential health issues related to climate change?
- How should the government be responsible for preparing for and preventing harmful health effects from climate change?

C. Category 3: Sea Level Rise

- What do you know about sea level rise from climate change?
- Have you seen this affect your area? Have you felt any effects from it yourself?

Southeast Florida is already experiencing sea level rise and it's expected to rise 1-2 feet more at least by the end of the century. Sea level rise can threaten people's health in a few ways:

contaminating their water supply, affecting crops and agriculture, potentially spreading diseases during times of flooding.

Let's talk about policies that have to do with preparing for sea level rise. Policies that can help deal with preventing these issues are things like creating higher sea walls or fortifying local water systems.

- What do you think about these policies that can help prevent and prepare for sea level rise?
- Do you know of any measures taken in your area to prepare for sea level rise?

D. Category 4: Health Waves

- What do you know about heat waves from climate change? How do they affect people?
- What have your experiences been with heat waves?

Heat waves are also called extreme heat events and include things like droughts. Heat waves can cause people to have heat exhaustion, heat strokes, cardiac problems, and even death.

Let's talk about policies that can help people during heat waves. Some examples actions taken to help people before and during heat waves are making sure everyone has an air conditioner, knowing where people vulnerable to heat waves, like the elderly are and having someone check in on them, providing cooling stations and transportation to get to these cooling stations.

- Are you aware of how your government helps people during heat waves?
- What do you think about these policies that help guard people against the harmful effects of heat waves?

Probes for Discussion:

- Economic impact
  - Financial situation
  - Job
- The individual's experiences
- Fears
- Where they get their information
- Vulnerable populations

V. Additional Information on the Project

That concludes our focus group. Thank you so much for coming and sharing your thoughts and opinions with us. The information you've provided to us today will help inform the final report on the assessment we are conducting on how to prepare for health impacts due to sea level rise and extreme heat conditions through policies and systemic changes.

Again, please feel free to contact us if you have any questions.

VI. Compensation

If there is any additional compensation for the focus group, distribute this to participants now. In Belle Glade's case, this will be lunch.

VII. Adjourn

Thank everyone again for coming and make sure each person leaves with a business card with contact information.

Materials and supplies for the focus group:

- Sign-In Sheet
- Pens
- Tape recorder
- Extra batteries for the tape recorder
- Extra tape for a tape recorder
- Back up recorder (cell phones work)
- Refreshments
- Paper or notepads for note taking
- Focus Group Discussion Guide for the Facilitator

Appendix F: Resources

The following are links to downloadable copies of these documents.

SEFRCCC Documents

Regional Climate Action Plan

Regional Climate Action Framework: Implementation Guide

Analysis of the Vulnerability of Southeast Florida to Sea Level Rise

More SEFRCCC documents can be found on the Compact's website at:
southeastfloridaclimatecompact.org/compact-documents/