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# EXECUTIVE Summary

MONROE COUNTY is proud to present our first big step toward identifying our vulnerability to climate change and sea level rise. We have identified some of the best adaptation strategies to mitigate and adapt to those risks. As an island community with most of our land at or near sea level, the County must continue the momentum generated by this **GreenKeys! Sustainability Action Plan** (“GreenKeys!”) in our future planning efforts to give us the best possible chance of remaining ahead of the curve of sea level rise and prepared to respond to future climate changes.

GreenKeys! provides the results of the County’s sea level rise vulnerability assessment, initial sea level rise modeling efforts, greenhouse gas (“GHG”) emissions inventory update, sustainability evaluation, and a summary of public outreach activities. It provides 165 recommendations and a 5-Year Work Plan designed to place the County on a highly proactive path towards increased sustainability

**“One of Florida’s greatest climate change threats is sea level rise, of great concern to Monroe County since we have over 1,700 islands that stretch 120 miles from Key Largo to Key West.”**

### Key Largo Flooding

PHOTO SOURCE: GreenKeys! Project Team



**Boca Chica Key, FL**

PHOTO SOURCE: Rhonda Haag



through mitigation and overall resilience to climate change and sea level rise. The County and its residents will be better prepared to handle the effects of climate change when well made plans are written and implemented.

One of Florida's greatest climate change threats is sea level rise, of great concern to Monroe County since we have over 1,700 islands that stretch 120 miles from Key Largo to Key West. This project is Monroe County's initial plan to address climate change and sea level rise to ultimately find ways to **mitigate** impacts to residents, infrastructure (including streets and buildings) and the environmental habitat and **adapt** accordingly.



Monroe County, like many Florida counties, stands at a crossroads faced with uncertainty over what the actual impacts of climate change and sea level rise will be and how soon they will be felt. The County is currently ranked third highest in the country in terms of areas to be impacted by tidal flooding, with nearly 36% of our population expected to be displaced if the forecasted high of two (2) feet of sea level rise is received by 2060. By 2100, 54.8% of our population will be affected with the forecasted high of 2.7 feet of sea level rise and 83.1% affected with 5.4 feet of sea level rise. The County's low lying land elevation and many islands contributes most to our vulnerability.

Sea level rise will impact County residents in the coming years through increased nuisance flooding, fluctuations in storm severity, and the resulting changes in our ecosystem and species populations. Climate change will also affect our average temperature and precipitation rates. Human health impacts will also be felt. By implementing proactive planning and making informed decisions, we can minimize these impacts to ensure our environmental and economic viability remain healthy well into the future, and residents and visitors alike will continue to enjoy the fabulous Florida Keys.

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## GreenKeys! Purpose, Structure, and Contents

GreenKeys! provides a well-chosen path for moving Monroe County into the future. Guidance is provided for current and future decision makers such as the Board of County Commissioners, County employees, and County residents and business owners. Through this planning process, we integrate decision making across multiple County disciplines to incorporate sea level rise adaptation, mitigation, and response into our policies and procedures.

GreenKeys! contains six (6) main **Focus Areas** aligned with County priorities for future planning and project implementation:

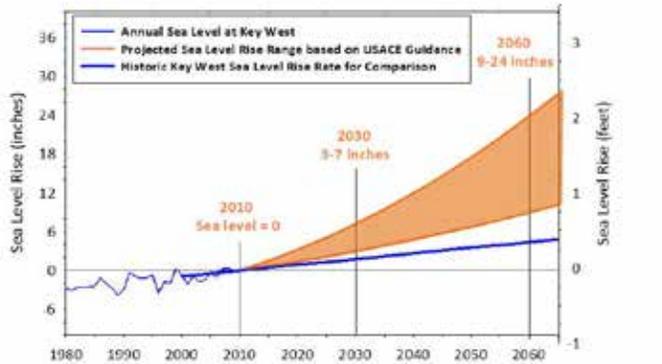
- Government Operations
- Climate & Energy
- Natural Systems
- Built Environment
- Health & Safety
- Education, Arts & Community; Economy & Jobs; Equity & Empowerment (combined)

Each Focus Area includes goals and recommendations with key implementation timeframes, funding sources, and associated implementation options.

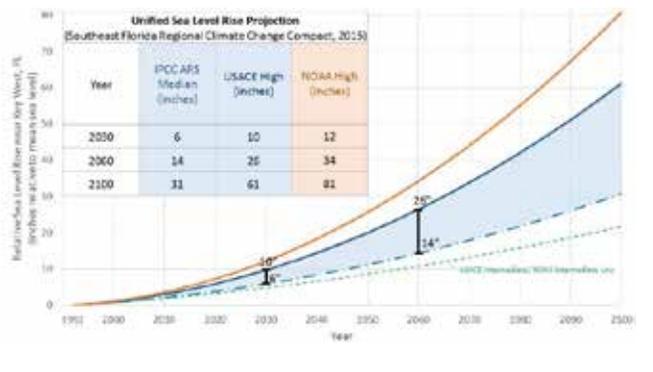
## GreenKeys! Results Summary

The results of our vulnerability analysis for habitat, facilities, roads, utilities, water, and wastewater infrastructure; sea level rise modeling to identify risks to homes and businesses; 2012 GHG emissions inventory update; and overall sustainability assessment are summarized below. We used the 2011 SE FL Compact's recommended sea level rise projections for the analyses provided in GreenKeys!.





**Unified Southeast Florida Sea Level Rise Projection for Regional Planning Purposes.** This projection uses historic tidal information from Key West and was calculated by Kristopher Esterson from the United States Army Corps of Engineers using USACE Guidance (USACE 2009) intermediate and high curves to represent the lower and upper bounds for projected sea level rise in Southeast Florida. Sea level measured in Key West over the past several decades is shown. The rate of sea level rise from Key West over the period of 1913 to 1999 is extrapolated to show how the historic rate compares to projected rates.



The Compact recently updated its projections to adjust the projection baseline from 2010 to 1992, extend the projection timeline from 2060 out to 2100, and include processes that affect the local rate of sea level rise. The net result of this recent update is one (1) additional inch of sea level rise by 2030 beyond the 3-7 inches and three (3) additional inches by 2060 beyond the 9-24 inches, which is due to the additional years included in the forecast.

## Vulnerability Analysis

### Roads

We utilized the Florida Department of Transportation’s Sketch Planning Tool to evaluate our road vulnerability County-wide. This analysis shows both the impacts to roadways during nuisance floods in King Tide events and as a result of daily tidal inundation flooding. The total impacted roadway miles are shown to the right.

“As sea level rises, we see an increased conversion of upland and freshwater-dependent land covers into tidal wetlands and open water over time. Many of our upland habitats show dramatic decreases in cover as sea level rise increases.”

Roads	Nuisance Flooding		Daily Tidal Flooding	
	2030	2060	2030	2060
US Highway 1	2.3-3.2 miles	4.0-14.3 miles	0.1-0.4 miles	0.7-4.0 miles
All Roads	143.6-188 miles	217.6-449.9 miles	14.8-23.5 miles	54.7-217.6 miles

### County Buildings

All but two (2) of our thirty-five (35) buildings evaluated show potential exposure to regular tidal flooding by the year 2060 (not considering storm surge) due to sea level rise and future access issues. Many others show potential exposure to larger Hurricane Wilma-type events amplified by sea level rise, as follows:

- Bayshore Manor Assisted-living Facility, Key West;
- Freeman Substation, Cudjoe Key;
- Marathon Substation, Marathon;
- Roth Building, Tavernier;
- Radio Transmission Shop and Offices, Plantation Key;
- Clarence Higgs Beach Structures, Key West; and
- East Martello Tower Museum, Key West.

Habitat Type	2030 Low	2030 High	2060 Low	2060 High
<b>Habitat Change (% Change)</b>				
Inland Fresh Marsh	-53%	-76%	-66%	-93%
Brackish Marsh	-12%	-42%	-24%	-96%
Mangrove	+4%	-3%	-6%	-47%
Salt Marsh	-18%	-25%	-26%	-86%
<b>Inundation (% Possibly Lost)</b>				
Freshwater Wetlands	-27.8%	-42.2%	-42.7%	-6.6%
Hammock	-5.4%	-9.3%	-11.3%	-14.1%
Pineland Forests	-1.8%	-3.5%	-4.8%	-22.6%

## Habitat

We used the Sea Level Affecting Marshes Model (“SLAMM”) to evaluate the impacts of sea level rise on our natural habitats. As sea level rises, we see an increased conversion of upland and freshwater-dependent land covers into tidal wetlands and open water over time. Many of our upland habitats show dramatic decreases in cover as sea level rise increases, as shown by the percentages in the table at left.

## Infrastructure

None of our wastewater treatment plant structures show risk of regular tidal flooding by 2030, and no risk of regular tidal flooding at 2060 under a low sea level rise scenario. There is however the potential foreground level flooding to some of the structures, including KW Resort Utilities, Key Haven (to be decommissioned), Bay Point, Duck Key, Cudjoe, Layton, and North Key Largo [in 2060 under a high sea level rise scenario].

Potential saltwater corrosion of water supply infrastructure from increased tidal exposure is another risk that may be of increasing concern to the Florida Keys Aqueduct Authority (“FKAA”) and County over the next decades. Long-term monitoring and updated hydrologic modeling indicates that a wedge of saltwater intrusion has penetrated into the Biscayne Aquifer along the Card Sound Road Canal toward the FKAA wellfield, requiring both near- and long-term mitigation measures to avoid loss of our wellfield.

Finally, all of our assessed electrical utility infrastructure has ground elevations that are higher than the predicted tidal flood risk at 2060 under the high sea level rise scenario. This means that even under the worst case sea level rise scenario modeled, our utility infrastructure will not be impacted.





**Hurricane Wilma Flooding**

PHOTO SOURCE: GreenKeys! Project Team

## Sea Level Rise Modeling for Properties

The Coastal Adaptation to Sea Level Rise Tool (“COAST”) model mimics floods from storms and sea level rise on homes and businesses. COAST shows us the cost of **not** adapting to sea level rise and the costs and benefits of implementing various adaptation actions. We used this tool to evaluate sea level rise adaptation strategies for two (2) of our communities: Key Largo and Stock Island. The County evaluated three (3) adaptation actions for Key Largo, including: 1) elevating and floodproofing buildings, 2) building an offshore barrier, and 3) a voluntary buyout.

In Key Largo, elevating and floodproofing buildings (not already elevated or floodproofed) proved to be the most beneficial adaptation action saving the residents and County up to \$12-13 in damages for every \$1 spent. If we implement this strategy, residents could avoid between \$871 Million (low cost scenario) and \$992 Million (high cost scenario) in damages to homes and other structures from sea level rise.

For Stock Island, we evaluated elevating and floodproofing buildings (not already elevated or floodproofed) as a strategy to combat sea level rise. Again, if this adaptation strategy is implemented, residents could avoid between \$169.1 Million (low cost scenario) and \$149.6 Million (high cost scenario) in damages to homes and other structures from sea level rise. Therefore, we should encourage elevating and floodproofing those structures not already protected as the most cost-effective strategy for those structures.

## 2012 Greenhouse (GHG) Emissions Inventory Update

As part of this project, we updated the County’s GHG Emissions Inventory. This new data suggests significant reductions in both government operations and on the community scale, as shown in the graphic to the right.

With these reductions, we surpassed the 20% emissions reduction target by 2020 (as compared to the 2005 baseline) that we set in our 2011 Energy Efficiency and Conservation Strategy. It is important to note that there were significant reductions on the community scale due to a one-time transition from municipal solid waste being entirely landfilled to the majority being incinerated in a waste-to-energy facility. Such significant reductions will be more difficult to demonstrate in future updates.

## Sustainability Evaluation

To fully understand how sustainable we are as a County, we used the Sustainability Tools for Assessing and Rating Communities (“STAR”) to determine our baseline sustainability score. STAR provides local leaders with a framework for assessing their community’s sustainability, setting targets for moving forward, and measuring progress along the way.

We completed our STAR evaluation in June 2015, becoming certified as a 3-STAR Community. With this 3-STAR designation, we earn national recognition as a sustainable community in Florida. As the third County in Florida to become STAR certified, we also position ourselves as a state-wide leader in sustainability.



### Linkage to Other Plans

GreenKeys! includes a total of 165 recommendations to make the County and its residents more resilient and sustainable. Sixty-six (66) of these further initiatives recommended in the Monroe County Climate Action Plan (“MCAP”) and sixty-seven (67) further the Southeast Florida Regional Climate Change Compact’s (“Compact”) Regional Climate Action Plan (“RCAP”) recommendations. To effectively implement these recommendations, we developed a 5-Year Work Plan with specific projects to be accomplished over the next five (5) years, containing 181 projects.

### Summary of GreenKeys! Recommendations In the Focus Areas

Climate change and sea level rise will affect each of the six (6) Focus Areas addressed in GreenKeys!. To address these affects, the Team identified important goals for the County within each of the Focus Areas and developed a comprehensive set of recommendations under each identified goal to ultimately help the County transition into a more sustainable and more resilient community. There are a total of 165 recommendations provided within GreenKeys!. Each of the recommendations in this document are prioritized as either short-, medium- or long-term with regard to the recommended timeline for implementation. A brief summary of the goals



**Shaw Drive Flooding  
Monroe County, FL**

PHOTO SOURCE: Stephanie Russo

(and in some instances specific recommendations to achieve those goals} are provided for each of the Focus Areas as follows:



**Government Operations.** Our government buildings and facilities will become increasingly vulnerable as sea levels continue to rise in the Florida Keys. We have several goals to address this vulnerability, with fifty-seven (57) specific recommendations to help us accomplish these goals, examples of which include:

- Conducting detailed site level assessments of the most vulnerable County facilities;
- Creating improved LIDAR elevation data County-wide;
- Performing energy audits on County facilities to develop retrofit priorities;
- Creating a list of incentives to encourage construction of energy efficient and water conserving structures;
- Continued GHG inventory updates and reductions;
- Increasing rates of waste diversion and recycling;
- Improving employee sustainability practices.



**Climate & Energy.** To help offset climate change and sea level rise impacts, we must make changes in energy consumption, technology and daily operations. Nineteen (19) specific recommendations are made to help us accomplish these mitigation goals, which include:

- Creating a database of nuisance flood events;
- Ensuring that nuisance flood data informs future road decisions;
- Developing a ranking process to identify the most vulnerable neighborhoods first;



- Continuing sea level rise vulnerability discussions;
- Creating a list of energy and water efficiency incentives within the Rate of Growth Ordinance (“ROGO”);
- Adopting a plan to improve the resource efficiency of community businesses.



**Natural Systems.** Our marine and terrestrial habitats are among the most vulnerable in the U.S. to climate change. Long-term climate change and sea level rise will inundate our upland ecosystems. We will see large-scale changes in the composition and productivity of our marine ecosystems as the ocean continues to acidify and warm. Sea level rise will impact our intertidal mangrove wetland diversity, causing changes in sedimentation patterns and the need for human engineering interventions. To mitigate these effects, we identified several goals and twenty-four (24) recommendations to help accomplish these goals, which include:

- Continued cooperation with federal, state and private partners in support of coral reef restoration;

- Completing a County-wide tree inventory;
- Identifying and mapping natural inundation buffers;
- Maintaining natural habitat corridors;
- Identifying and protecting “core areas” with the best chance of persisting and adapting to sea level rise;
- Incentivizing protection of natural resources on sites;
- Promoting living shorelines and mangrove restoration;
- Continuing invasive exotic species management throughout the County.



**Built Environment.** Over the long-term, we will increasingly need to focus planning activities on adapting to sea level rise impacts through available adaptation strategies, which include: avoidance, accommodation, and protection. To guide this planning, we developed twenty-five (25) specific recommendations to help us adapt, including:

- Maintaining and strengthening setback policies;
- Imposing use restrictions in areas most vulnerable to flooding;



**Murray Nelson Government Center, Key Largo, FL**

PHOTO SOURCE: GreenKeys! Project Team

- Adopting an “environmentally-challenging locations” ordinance;
- Incentivizing resiliency construction standards;
- Establishing adaptation action areas;
- Increasing mileage of bicycle lanes/shared use paths;
- Identifying strategies to provide better public transportation options;
- Adopting a complete streets policy;
- Incorporating Dark Skies practices into land development regulations;
- Adopting zoning and development regulations that allow farmers markets, community gardens and urban agriculture.



**Health & Safety.** We expect that climate change and sea level rise will impact emergency response and evacuation routes and times and the health of County residents.

To ease these affects, we identified several goals – including twenty (20) specific recommendations to help us accomplish these goals – examples of which include:

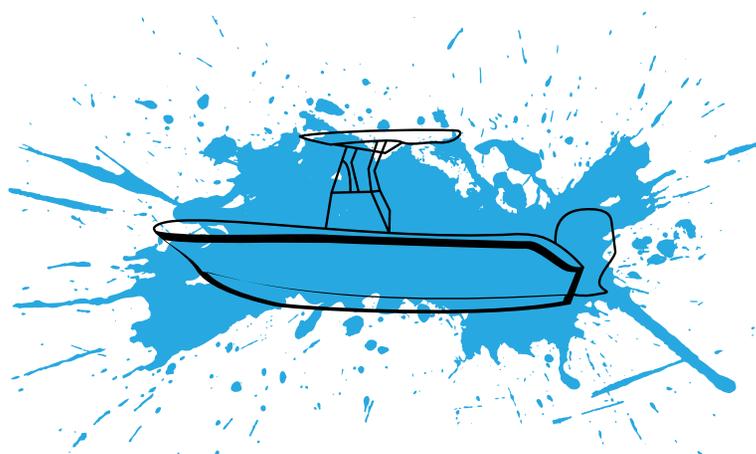
- Incorporating future sea level rise impacts into emergency management plans;
- Supporting school district participation in Florida's Farm to School program;
- Encouraging the sale of local catch by charter captains;
- Including active living or active transportation in the Comprehensive Plan;
- Creating guidelines to encourage the incorporation of active building design in new buildings;
- Adopting a health-in-all policies statement;
- Encouraging workplace wellness programs;
- Identifying resources for disposal of toxic materials;
- Developing informational resources on how to properly dispose of unused medicine.



**Economy & Jobs; Equity & Empowerment; Education, Arts & Community.** As the County and our residents becomes more sustainable, we will see several important **benefits** including increased economic opportunities for sustainably-focused businesses and an overall shift toward a “greener” economy. As tourism and coastal recreation patterns change with the climate and sea level, so to must our economy. To facilitate this adaptation, we identified several goals and twenty (20) specific recommendations to help us accomplish these goals, examples of which include:

- Developing an “arts, culture and innovation” policy or plan;
- Building on the County’s success in its commitment to public art to create opportunities on major streets;
- Encouraging sustainable practices in the County’s Art in Public Places Program;
- Encouraging diverse community involvement in County government;
- Adopting policies or regulations to increase market demand for green buildings and materials;
- Developing and maintaining a Sustainability Handbook for business owners;
- Encouraging sustainable business practices; and
- Creating or supporting promotional campaigns to bank locally, buy locally, or buy from small independent businesses.





### GreenKeys! 5-Year Work Plan

To facilitate the implementation of all 165 recommendations in GreenKeys!, we developed a 5-Year Work Plan & Budget. The projects in the 5-Year Work Plan are prioritized for County implementation over the next five (5) years.

The Work Plan includes recommended capital projects, policy and code revisions (Comprehensive Plan and land development regulations), education and outreach initiatives, operational and programmatic considerations, and some budget estimates that we can implement to become more sustainable and resilient to climate change and sea level rise. Financial and staff resources are critical to the successful implementation of these recommendations and projects over the next five (5) years.



**Electric Vehicle Charging Stations, Marathon Airport**

PHOTO SOURCE: GreenKeys! Project Team



**Community Outreach**  
PHOTO SOURCE: GreenKeys! Project Team



## Outreach, Education and Next Steps

Going forward, we will continue to educate residents, business owners and our employees to ensure continued progress toward sustainability and community resilience. As we evolve and adapt to the changing climate and rising seas, we will continue highlighting these GreenKeys! results through future outreach activities. This will help to ensure that our residents and business owners remain informed about changing conditions and engaged in the process of adapting to predicted impacts.

We also plan to use pilot projects to demonstrate and study the effectiveness of particular recommendations in GreenKeys!. For example, we may conduct a pilot project on the feasibility of flood-proofing or elevating structures to help us further prioritize future adaptation strategies within the County. Similarly, we may conduct a pilot project to assess stormwater and tidewater impacts on particularly vulnerable County roads.

This GreenKeys! project is only our first big step toward understanding our unique vulnerabilities and determining the best ways to adapt and mitigate impacts. We are committed to continuing on this path to ensure that we, as a community, can move forward and evolve with the changing conditions. By focusing on strategic planning, wise investment and adaptations now, we can make proactive changes to maximize our preparedness and overall resilience while the impacts of climate change and sea level rise are still minimal. Efforts to be proactive rather than reactive in the face of these changes will exponentially benefit the County and its residents by minimizing the resources necessary to prepare, preserving our unique quality of life long into the future.



### Monroe County, FL

PHOTO SOURCE: GreenKeys! Project Team



**Islamorada Nuisance Flooding**

PHOTO SOURCE: Ariana Lawson

## LIST OF ABBREVIATIONS AND ACRONYMS

ACSC	Area of Critical State Concern
APA	American Planning Association
BOCC	Monroe County Board of County Commissioners
CCAC	Monroe County Climate Change Advisory Committee
CEQ	Council on Environmental Quality
COAST	Coastal Adaptation to Sea Level Rise Tool Compact – Southeast Florida Regional Climate Change Compact
Corps	U.S. Army Corps of Engineers
CRS	Community Rating System
EPA	Environmental Protection Agency
FDEM	Florida Division of Emergency Management
FDEO	Florida Department of Economic Opportunity
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FEMA	Federal Emergency Management Agency
FKAA	Florida Keys Aqueduct Authority
FKEC	Florida Keys Electric Cooperative
FKNMS	Florida Keys National Marine Sanctuary
FWS	United States Fish & Wildlife Service
FY	Fiscal Year
GHG	Greenhouse Gas
GIS	Geographic Information Systems
KES	Keys Energy Services
LIDAR	Light Detection and Ranging
MHHW	Mean Higher High Water
MCAP	Monroe County Climate Action Plan
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
OFW	Outstanding Florida Waters
RCAP	Southeast Florida Regional Climate Change Compact Regional Climate Action Plan
ROGO	Rate of Growth Ordinance



SLAMM	Sea Level Affecting Marshes Model
STAR	Sustainability Tools for Assessing and Rating Communities
SFWMD	South Florida Water Management District
USGS	United States Geological Survey

