SEA LEVEL RISE IN THE FLORIDA KEYS
INFRASTRUCTURE VULNERABILITY FOR 2030 AND 2060

29th Annual Environmental Permitting Summer School – Florida Chamber
July 9, 2015
Rhonda Haag, Monroe County
(305) 453-8774
OVERVIEW OF GREENKEYS! PLANNING PROCESS

GreenKeys!
A Plan to Create a Sustainable Florida Keys

CLIMATE:
Forecasting Tools & Modeling

SUSTAINABILITY
ENERGY SAVINGS

- County Assets
- Infrastructure
- Habitat

- Community Impacts

- Government Operations
- Natural Systems
- Built Environment
- Health & Safety
- Education, Arts & Community
- Economy & Jobs
- Equity & Empowerment
THE PROJECT TEAM

Erin L. Deady, Esq., AICP, LEED AP

Jason Evans, PhD, Stetson University

Chris Bergh, The Nature Conservancy

VHB/Miller Sellen

Catalysis Adaptation Partners

Quest Ecology

EcoSmart
Sea level has risen about 9 inches over past 100 years.
SEA LEVEL RISE SCENARIOS
Adopted by Southeast Florida Regional Climate Compact

http://www.broward.org/NaturalResources/ClimateChange/PublishingImages/FinalUnifiedSLRProjection.jpg

4 Total Scenarios Run
1. What impacts to County assets, infrastructure and habitat will occur from sea level rise in 2030 (at 3” and 7”) and in 2060 (9” and 24”)?
   - Today’s presentation

2. How can the County address those impacts?
   - Next phase of analysis
No single analytical tool can determine individualized sea level rise impacts to Monroe County habitat and infrastructure. Team used multiple analytical tools and approaches.
Key Largo, Present Day
Key Largo, **9 inches** Sea Level Rise (2060, Low Scenario)
Key Largo, **24 inches** Sea Level Rise (2060, High Scenario)
BIG PINE KEY AND VICINITY, PRESENT DAY
Big Pine Key and vicinity, **3 inches** Sea Level Rise (2030, Low Scenario)
Big Pine Key and vicinity, **7 inches** Sea Level Rise (2030, High Scenario)
Big Pine Key and Vicinity, **9 inches** Sea Level Rise (2060, Low Scenario)
Big Pine Key and vicinity, **24 inches** Sea Level Rise (2060, High Scenario)
KEY WEST, PRESENT DAY
Key West, **3 inches** Sea Level Rise
(2030, Low Scenario)
Key West, 7 inches Sea Level Rise (2030, High Scenario)
Key West, 9 inches Sea Level Rise (2060, Low Scenario)
Key West, **24 inches** Sea Level Rise (2060, High Scenario)
WHAT IS NUISANCE FLOODING?

Defined by NOAA as 1.08 feet above Mean Higher High Water (MHHW) at the Key West tide gauge.
NUISANCE VS. WILMA AT KEY WEST

http://cdn1.vtourist.com/4/2436059-Pics_of_Key_West_Hurricane_Wilma_Key_West.jpg
INCREASE IN “NUISANCE FLOODING”

1980-1982
.67 per year

2010-2012
2.3 per year

2030 at 3”
20 per year

2030 at 7”
78 per year

2060 at 9”
139 per year

2060 at 24”
672 per year

Flooding More Than 1x Per Day
HABITAT
3 inches of sea level rise (2030, Low Scenario) could bring *daily saltwater tides into 19% of Monroe County’s Freshwater Wetland Areas* *Analysis based on Monroe County Habitat dataset (2009)*

Freshwater pond on Big Pine Key

24 inches of sea level rise (2060, High Scenario) could bring daily saltwater tides into 94% of Monroe County’s Freshwater Wetland Areas*

*Analysis based on Monroe County Habitat dataset (2009)
3 inches of sea level rise (2030, Low Scenario) could bring daily saltwater tides into 2.3% of Monroe County’s remaining Tropical Hardwood Hammock*

*TAnalysis based on Monroe County Habitat dataset (2009)
24 inches of sea level rise 2060, High Scenario) could bring daily saltwater tides into 42% of Monroe County’s remaining Tropical Hardwood Hammock*

Trees killed by saltwater intrusion (Big Pine)

*Analysis based on Monroe County Habitat dataset (2009)
County-Maintained and All Roads
MONROE COUNTY ROADS

- 875 Total Road Miles
- 299 Miles County-Maintained
3 INCHES OF SEA LEVEL RISE (2030 “LOW” SCENARIO)

- **9 Miles** of All Roads (Less Than 1%) Flooded Daily
- **4 Miles** (1.3%) County-maintained Flooded Daily
7 INCHES OF SEA LEVEL RISE (2030 “HIGH” SCENARIO)

- 5.3% (46 Miles) Of All Roads Flooded Almost Daily
- 6.7% (20 Miles) County-maintained Roads Flooded Almost Daily
9 INCHES OF SEA LEVEL RISE
(2060 LOW SCENARIO)

- 7.3% (64 miles) of all roads flooded almost daily
- 9.7% (29 miles) County-maintained roads flooded almost daily
24 INCHES OF SEA LEVEL RISE (2060 HIGH SCENARIO)

- 33.0% (289 miles) of all roads flooded almost daily
- 46.5% (139 miles) county-maintained flooded almost daily
PRESENT DAY ROADS

Road centerlines and aerial imagery: Monroe County Property Appraiser’s Office
Road centerlines and aerial imagery: Monroe County Property Appraiser’s Office
2030 HIGH SCENARIO
7 INCHES SEA LEVEL RISE

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Road centerlines and aerial imagery: Monroe County Property Appraiser’s Office

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Big Pine Key

- Flooded at MHHW
Road centerlines and aerial imagery: Monroe County Property Appraiser’s Office
2060 High Scenario
24 inches sea level rise

Road centerlines and aerial imagery: Monroe County Property Appraiser’s Office
1. Use results from this analysis to inform flood mitigation for **near-term paving projects**

2. Systematically **document locations and dates** for nuisance flood events

3. Develop **survey-grade digital elevation data** for road surfaces
FKAA Groundwater Wells

http://lcat.usgs.gov/immage/immage.html
1. Model results supplied by USGS do not show saltwater contamination to FKAA well field by any 2030 or 2060 sea level rise scenario

2. Potential for development of new wells in west Dade and increased severity of drought episodes not factored into these models
COUNTY FACILITIES AND BUILDINGS

1. Evaluated 74 parcels with County-owned buildings and facilities

2. 41% (26 parcels) show flooding encroachment at 3 inches of sea level rise

3. 53% (36 parcels) show flooding encroachment at 24 inches sea level rise

4. Overlays with aerial photos show buildings generally located on highest ground
Key Largo Government Center, 3 inches sea level rise (2030 Low Scenario)
KEY LARGO GOVT CENTER, 24 inches sea level rise (2060 High Scenario)
Flooded electrical substation
Tewkesbury, England
1. Evaluated 12 electrical facility locations and support infrastructure
   a) 6 Keys Energy Services
   b) 6 Florida Keys Electrical Cooperative

2. Good News!
1. The **Florida Keys are clearly vulnerable** to impacts from long-term sea level rise

2. **Roads** will be the “canary in the coal mine”

3. **Lower and Middle Keys** will feel earlier and more widespread effects as compared to the Upper Keys

4. Impacts to other infrastructure **will gradually increase** through 2030 scenarios

5. High sea level rise scenario brings a **Wilma-like event** to Key West **twice a year by 2060**

6. Effective **adaptation planning** requires continuous development and enhancement of information
Human Habitat
## Human living areas impacted by tidal flooding 2 feet of sea level rise, 2060*

<table>
<thead>
<tr>
<th>Rank</th>
<th>County</th>
<th>County population displaced</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Tyrell, NC</td>
<td>45%</td>
</tr>
<tr>
<td>2.</td>
<td>Hyde, NC</td>
<td>42%</td>
</tr>
<tr>
<td>3.</td>
<td><strong>Monroe, FL</strong></td>
<td><strong>Land that’s dry now that will go under water by 2060 in relation to the number of people living there</strong></td>
</tr>
<tr>
<td>4.</td>
<td>Dare, NC</td>
<td>21%</td>
</tr>
<tr>
<td>5.</td>
<td>Currituck, NC</td>
<td>20%</td>
</tr>
</tbody>
</table>

*Matthew Hauer, Applied Demography Program, University of Georgia*
WHAT COULD THIS MEAN?

“STILTSVILLE”, NEAR MIAMI

DEcision Making Paradigm Shift

Land Acquisition / Management
Species, Habitat and Adaptation/Mitigation

Policy Implementation -
Departmental Collaboration, Comp Plan, Code, Legal Issues

Project Planning -
Addressing Priority Vulnerabilities, Budget Implications (New Cost Considerations), Departmental Collaboration
WHAT HAS THE COUNTY DONE TO BEGIN PREPARING?
STOCK ISLAND FIRE STATION (KEY WEST)

Station Floor Located Here

2/13/13
Under Construction, Elevation 1.5 ft. above Code
STOCK ISLAND FIRE STATION (KEY WEST)

Cost To Elevate: $100,000.
- More fill
- Longer drive for the garage area
- More concrete to raise the elevated floor of the other part of the building (living areas)
- Longer stairs and ramps.
- Equipment (a/c condensers and generator) needed to be elevated more.
- More labor on the plumbing
- TOTAL COST $3.2 Million
COMMUNITY MODELING
The suggestion would model:

- Elevation in V-Zones (red)
- Floodproofing in A-Zones (green)
- Action to different heights.

>> subject to group input.

- 100% of parcels are protected.

>> subject to group input.
Scenario 2: Construct Breakwater

The suggestion would model:

1) Two 1-mile constructed barriers.
2) At water level.
   >>> subject to group input.
3) Near to shore.
   >>> subject to group input.

Note: will not protect against sea level rise. Will only protect against some wave action during extreme flooding events, and only for some parcels.
A form of rolling easement where:

- Voluntary buyouts are offered in two phases across the Key.
- Phase 1: for parcels expected to have high tide at their center in 2030 (red).
- Phase 2: for parcels expected to have high tide at their center in 2045 (green).
- 100% of land owners accept the buyout in each phase.

>> subject to group input.

Parcels in red = lost to sea level rise 2010-2030.
Parcels in green = Parcels lost to sea level rise 2030-2060.

Note: No title transfer until 2045 or when the “high” Four-County Compact sea level rise scenario hits 14’ – whichever comes first. Voluntary buyouts not offered for undeveloped land.
### Benefit Cost Ratios of Actions by Year 2060

<table>
<thead>
<tr>
<th>Action 1: Elevate &amp; Floodproof</th>
<th>Benefit/Cost Ratios – Using Low Cost Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low SLR</td>
</tr>
<tr>
<td></td>
<td>10.75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Action 2: Construct Breakwater</th>
<th>Low SLR</th>
<th>High SLR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.12</td>
<td>2.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Action 3: Voluntary Relocation</th>
<th>Low SLR</th>
<th>High SLR</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% Participation Now, 50% in 2030</td>
<td>0.44</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Discounted 3.3%, Values over 1.0 are considered positive.
Sustainability Update: STAR and Surveys

**GreenKeys!**
- Plan Drafting in progress
- Final Public Workshops in Fall 2015
- Plan finalized prior to Southeast Regional Climate Compact (Dec. 1-3, Key West Casa Marina)

**Sustainability Tools for Assessing and Rating Communities**
- One year process
- 3 STAR Certification Achieved

**Community Survey**
- 161 Responses
- 31 questions on sea level rise and sustainability
Sustainability Update: Focus Areas and Objectives

<table>
<thead>
<tr>
<th>Built Environment</th>
<th>Climate &amp; Energy</th>
<th>Economy &amp; Jobs</th>
<th>Education, Arts &amp; Community</th>
<th>Equity &amp; Empowerment</th>
<th>Health &amp; Safety</th>
<th>Natural Systems</th>
</tr>
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<tbody>
<tr>
<td>Ambient Noise &amp; Light</td>
<td>Climate Adaptation</td>
<td>Business Retention &amp; Development</td>
<td>Arts &amp; Culture</td>
<td>Civic Engagement</td>
<td>Active Living</td>
<td>Green Infrastructure</td>
</tr>
<tr>
<td>Community Water Systems</td>
<td>Greenhouse Gas Mitigation</td>
<td>Green Market Development</td>
<td>Community Cohesion</td>
<td>Civil &amp; Human Rights</td>
<td>Community Health &amp; Health System</td>
<td>Invasive Species</td>
</tr>
<tr>
<td>Compact &amp; Complete Communities</td>
<td>Greening the Energy Supply</td>
<td>Local Economy</td>
<td>Educational Opportunity &amp; Attainment</td>
<td>Environmental Justice</td>
<td>Emergency Prevention &amp; Response</td>
<td>Natural Resource Protection</td>
</tr>
<tr>
<td>Housing Affordability</td>
<td>Industrial Sector Resource Efficiency</td>
<td>Quality Jobs &amp; Living Wages</td>
<td>Historic Preservation</td>
<td>Equitable Services &amp; Access</td>
<td>Food Access &amp; Nutrition</td>
<td>Outdoor Air Quality</td>
</tr>
<tr>
<td>Public Spaces</td>
<td>Resource Efficient Public Infrastructure</td>
<td>Workforce Readiness</td>
<td>Poverty Prevention &amp; Alleviation</td>
<td>Natural &amp; Human Hazards</td>
<td>Working Lands</td>
<td></td>
</tr>
<tr>
<td>Transportation Choices</td>
<td>Waste Minimization</td>
<td></td>
<td></td>
<td>Safe Communities</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Total Score: **261.3** = 3-STAR Community – 200-399 points
Recognized for sustainability leadership

- **Built Environment**: Low Score - 33.2/100
- **Climate & Energy**: High Score - 52.6/100
- **Economy & Jobs**: 36.3/100
- **Education, Arts & Community**: 31.5/70
- **Equity & Empowerment**: 20/100
- **Health & Safety**: 42.9/100
- **Natural Systems**: 39.9/100
- **Innovation & Process**: 5/50
Community Comparisons (Certified Communities only)
60 More in process (Sarasota County and WPB in FL)

- Albany, NY; Atlanta, GA; Birmingham, AL; Chandler, AZ; Cleveland, OH; Des Moines, IA; El Cerrito, CA; Fayetteville, AR; Fort Collins, CO; Indianapolis, IN; Lee County, FL; Palm Bay, FL (249.6); Park Forest, IL; Reading, PA; Rosemount, MN & Woodbridge Township, NJ  
  **200-399 Points**

- Austin, TX; Broward County, FL (436.7); Burlington, VT; Davenport, IA; Dubuque, IA; Evanston, IL; Memphis, TN; Plano, TX; Portland, OR; Raleigh, NC; Tacoma, WA; Tucson, AZ & Washington, DC  
  **400-599 Points**

- Baltimore, MD; Northampton, MA & Seattle, WA  
  **600 + Points**
Survey Monkey- 31 Question/161 Responses

Key Themes

Top Goal Areas
- Natural Systems
- Climate & Energy
- Economy & Jobs

Managing Water Supply
- FKAA go to higher pricing to push conservation
- More events and outreach
- Water audits for homes and businesses

Overall Sustainability
- Not doing nearly enough, but good on small things
- We are doing good but could do better

Priority for County sea level rise preparation
- Amend Code so new development incentives address climate prep
- Address flooding on roads and in neighborhoods
- Pursue funding sources to make properties resilient

How prepared is the County on sea level rise?
- Not nearly enough and do more quickly
- I don’t have a view on preparedness
- We are minimally prepared but making progress

Should Monroe budget funds to prepare for sea level rise?
- Yes and they should be new funds in addition to current budget
- I’m neutral, it’s a County decision
- Yes County should budget specific funds
7th Annual SE FL Climate Change Summit

December 1-3, 2015
Casa Marina
1500 Reynolds Street
Key West, FL 33040

Register • Sponsor • Exhibits
QUESTIONS?

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