Economic Impacts of Sea Level Rise and Coastal Storms in Dania Beach, Florida

Southeast Florida Economic Forecasting Partnership

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AECOM Sustainable Economics Practice

– Headquartered in San Francisco, works across the Americas

– Economic consulting on issues at the forefront of climate adaptation strategy and implementation

– Public, private and non-profit clients

– Specialties include:
  • Environmental and resource economics
  • Urban and real estate economics
  • Public funding and financing
Other Relevant Studies

- AECOM
  - Lower Manhattan Coastal Resiliency
  - San Francisco Flood Resilience
  - Port of Oakland, Port of Long Beach,
  - Multiple jurisdictions in California

- Other
  - Bay Area HayWired Scenario, Earthquake
  - Broward County, COAST
  - Tampa Bay, Sea Level Rise Cost of Inaction
  - Hillsborough County, Hurricane Analysis
Literature Review

- **Disaster Response:** Creative destruction, recovery to trend, no recovery
- **Reinvestment:** Only analyzing losses gives an unrealistic view of outcomes
- **Uneven Effects:** Responses vary by geography, community and household
- **Long Term Impacts:** Frequency of events influences levels of outmigration
Presentation Overview

- Background
- Analysis Part I: Before REMI
  - Physical Damages to Dania Beach Businesses
  - Selected Inputs
  - Selected Outputs
- Analysis Part II: REMI
  - Impacts to Broward County and the Rest of Florida
  - Selected Inputs
  - Selected Outputs
- Moving Forward
  - Policy Implications
  - Challenges and Lessons Learned
Background
Study Purpose

How can Dania Beach (and Broward County) support adaptation actions and redevelopment investments that promote economic resilience in the context of coastal hazards?

- For businesses in Dania Beach, estimate the economic costs from coastal storms and sea level rise (SLR) if no action is taken.

- For businesses in Dania Beach, estimate the economic costs and benefits associated with common adaptation responses.

- Recommend strategies to decrease vulnerability of the business community in Dania Beach and increase effectiveness of adaptation investments.
Defining Resilience

- **Resilience:** The ability to recover from or adjust quickly to changing circumstances.

- **Economic Resilience:** The ability of the economy to withstand and adapt to future coastal hazard conditions.
Key Concepts & Assumptions

- Risk assessment modeling
  - Deterministic vs. probabilistic

- Impact types
  - Temporary vs. permanent impacts
  - One-time vs. recurring impacts

- Results reporting
  - Single-event vs. cumulative

- Static built environment

- Economic evaluation methods
  - Economic damage
  - Economic impact
  - Fiscal impact
  - Economic value*
Business Community Context: Survey Findings

- Businesses are already impacted by severe weather events & are concerned about negative impacts resulting from an increase in storms and extreme rain events, less so for temperature.

- Many businesses are dependent on goods, services, employees, and clientele from outside the City.

- Low staff wages and profit margins limit employee and operational resilience.

- Businesses have limited capacity to pay for special assessments or utility fees that could fund infrastructure improvements.

**What services or products do you offer?**

- Retail Trade, 32%
- Wholesale Trade, 14%
- Real Estate Rental/Leasing, 23%
- Accommodation /Food Services, 9%
- Arts/ Entertainment/ Recreation, 9%
- Finance and Insurance, 5%
- Other Services, 9%

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## Physical Scenarios Evaluated

**Temporary Event-Based Coastal Storm Impacts (USACE)**

- 3-year coastal storm, king tide and 1 foot of SLR in 2030 and 2040
- 3-year coastal storm, king tide and 2 feet of SLR and 2070
- 20-year coastal storm, king tide and ~2 feet of SLR in 2050

**Permanent Progressive SLR Impacts (NOAA MHHW)**

- Mean higher-high water with one foot of SLR in 2030
- Mean higher-high water with two feet of SLR in 2060
Analysis Part I: Before REMI
Physical Damages to Dania Beach Businesses
Physical (Direct) Damages to Dania Beach

What are the physical impacts of SLR and coastal storms to business properties in Dania Beach?

- **Inputs**
  - Property characteristics
  - Business information
  - Vulnerability

- **Outputs**
  - Temporary damages to Dania Beach businesses
  - Permanent damages to Dania Beach businesses

- **Tools**
  - Custom economic models built off of industry standards and tailored to local conditions
## Selected Inputs

### Property and Business Information

<table>
<thead>
<tr>
<th>Property</th>
<th>Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square footage</td>
<td>Industry</td>
</tr>
<tr>
<td>Land use</td>
<td>Annual Sales</td>
</tr>
<tr>
<td>Assessed value</td>
<td>Annual Wages/Salaries</td>
</tr>
<tr>
<td>Stories</td>
<td>Number of Employees</td>
</tr>
</tbody>
</table>

### Vulnerability: Flood Depth & SLR Data

![Map of Flood Depth & SLR Data]

Legend:
- **0.0 - 1.01**
- **1.01 - 3.56**
- **3.58 - 7.78**
- **7.78 - 17.00**
- **17.00 - 58.86**
Selected Outputs: Damages per Storm

Business Sales Impacts from a 3-Year and 20-Year Storm*

- **3-Year Storm**
  - $2.1M

- **20-Year Storm**
  - $2.4M

Selected Outputs: Damages per Storm

- **Southeast Florida Economic Forecasting Partnership**
  - 3-Year Storm: $2.1M
  - 20-Year Storm: $2.4M

Direct Property Impacts from a 20-Year Storm*

- **Contents/Inventory & Clean Up**: $42
- **Structural**: $8
- **Hotel/Motel**: $4
- **Institutional**: $4

*Five most impacted industries shown

*Five most impacted land uses shown
Selected Outputs: Cumulative Damages

Coastal Storm Events: Cumulative Damages*
2030-2070: $719M

Sea Level Rise: Cumulative Damages
2030-2070: $1.2B

*Using assumed event occurrence

<table>
<thead>
<tr>
<th>Damage Type</th>
<th>2030-2070 (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td>$165</td>
</tr>
<tr>
<td>Contents &amp; Clean Up</td>
<td>$539</td>
</tr>
<tr>
<td>Sales Losses</td>
<td>$11</td>
</tr>
<tr>
<td>Displacement</td>
<td>$5</td>
</tr>
<tr>
<td>Sales and Tourist Development</td>
<td>$1</td>
</tr>
<tr>
<td>Tax Losses</td>
<td>$-100</td>
</tr>
<tr>
<td>Clean Up</td>
<td>$-200</td>
</tr>
<tr>
<td>Damage (Millions)</td>
<td>$-300</td>
</tr>
<tr>
<td>Sales Losses</td>
<td>$-400</td>
</tr>
<tr>
<td>Displacement</td>
<td>$-500</td>
</tr>
<tr>
<td>Tax Losses</td>
<td>$-600</td>
</tr>
</tbody>
</table>

*Fiscal Impacts 5%
Market Value Loss 5%
Sales Losses 90%
Analysis Part II: REMI
Impacts to Broward County and the Rest of Florida
Impacts to Broward & the Rest of Florida

How will different response actions, or no action, affect the Broward County economy? How will they affect the rest of Florida?

- **Inputs**
  - Response actions
    - Purpose, Beneficiaries and Physical Impacts, Costs and Sources of Funds, Involved Industries, Timeframe

- **Outputs**
  - Impacts to Broward County
  - Impacts to the Rest of Florida

- **Tools**
  - REMI PI+
## Selected Inputs: Response Actions

<table>
<thead>
<tr>
<th>Response Actions</th>
<th>Description</th>
<th>What damages are addressed?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No Preemptive Action</strong></td>
<td>Nothing is done to mitigate future SLR and coastal storm conditions, but structures are rebuilt post-event</td>
<td>Temporary &amp; Permanent</td>
</tr>
<tr>
<td><strong>Relocate</strong></td>
<td>Low-lying businesses subject to tidal inundation from SLR relocate to higher ground in Dania Beach or outside of the City boundaries</td>
<td>Permanent</td>
</tr>
<tr>
<td><strong>Fortify</strong></td>
<td>Construct a seawall to prevent low-lying business from being subject to tidal inundation from SLR</td>
<td>Permanent</td>
</tr>
<tr>
<td><strong>Accommodate</strong></td>
<td>Elevate structures so their first floor elevation is higher than the base flood elevations of modeled coastal storms</td>
<td>Temporary</td>
</tr>
</tbody>
</table>
## REMI Model Analysis Elements

<table>
<thead>
<tr>
<th>Elements</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Stock Loss</td>
<td>Businesses subject to damage from coastal storms and SLR</td>
</tr>
<tr>
<td>Output Loss</td>
<td>Direct output loss resulting from building, content, and inventory damage</td>
</tr>
<tr>
<td>Employment Change</td>
<td>Employment loss due to disruption, gains from recovery efforts to rebuild or</td>
</tr>
<tr>
<td></td>
<td>relocation of vulnerable businesses</td>
</tr>
<tr>
<td>Population Change</td>
<td>Combination of direct loss from damage, indirect loss from employment loss</td>
</tr>
<tr>
<td></td>
<td>and other migration</td>
</tr>
<tr>
<td>Government Spending</td>
<td>Funding for rebuilding or relocating businesses has some boosts to the</td>
</tr>
<tr>
<td></td>
<td>economy, but may be offset by cuts in other public services</td>
</tr>
<tr>
<td>Government Revenue Sources</td>
<td>Simulate increases to property taxes, sales taxes, and tourist development</td>
</tr>
<tr>
<td></td>
<td>taxes, but may be offset by decline in other consumer spending</td>
</tr>
</tbody>
</table>

*Source: Adapted from Kroll et al. 2018*
## Selected Outputs: Summary Table

<table>
<thead>
<tr>
<th></th>
<th>CONTROL</th>
<th>TEMPORARY</th>
<th>PERMANENT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Change</td>
<td>Control</td>
<td>No Preemptive</td>
<td>Accommodate</td>
</tr>
<tr>
<td></td>
<td>2030-2070</td>
<td></td>
<td>Action</td>
<td></td>
</tr>
<tr>
<td>Broward County</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment</td>
<td>312,810</td>
<td>1,810</td>
<td>-6,830</td>
<td>-36,410</td>
</tr>
<tr>
<td>GDP (Millions)</td>
<td>$131,150</td>
<td>$100</td>
<td>-$690</td>
<td>-$4,750</td>
</tr>
<tr>
<td>Population</td>
<td>584,770</td>
<td>-8,580</td>
<td>-10,350</td>
<td>-41,210</td>
</tr>
<tr>
<td>Rest of Florida</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment</td>
<td>1,758,020</td>
<td>1,720</td>
<td>-2,060</td>
<td>-13,260</td>
</tr>
<tr>
<td>GDP (Millions)</td>
<td>$918,090</td>
<td>$120</td>
<td>-$240</td>
<td>-$1,700</td>
</tr>
<tr>
<td>Population</td>
<td>3,520,990</td>
<td>1,140</td>
<td>-2,500</td>
<td>-18,800</td>
</tr>
</tbody>
</table>
Selected Outputs: Employment in Temporary Scenarios

Temporary Scenarios
Broward County Employment vs. Control

No Preemptive Action
Accommodate

Temporary Scenarios
Rest of Florida Employment vs. Control

No Preemptive Action
Accommodate
Selected Outputs: Employment in Permanent Scenarios

Permanent Scenarios
Broward County Employment vs. Control

Permanent Scenarios
Rest of Florida Employment vs. Control
Moving Forward
Key Public Sector Recommendations

- Prioritize phased adaptation investments with an eye toward long-term risk
- Invest in regional strategies
- Establish an accessible data platform to identify vulnerability
- Improve disaster preparedness
- Expand assessment of projected damages
- Have standards in place to build back better in the event of disaster
- Evaluate tradeoffs of response actions (e.g., built vs. natural environment)
Key Private Sector Recommendations

- Develop business continuity plans
  - Evaluate vulnerability to future conditions both on-site and to suppliers
  - Consider how public infrastructure damages could affect employees’ ability to work
  - Review insurance policies (e.g., indirect business interruption)
- Work with others in the same industry to develop industry-wide preparedness and limit duplicate efforts
- Work with public sector for data needs
- Work with public sector to ensure business continuity is a key consideration in adaptation strategy development
Challenges

- City focused-analysis in a regional model is limited
- Access to and interpretation of flood and sea level rise models
- Data collection via survey considerations could be refined
- Assumptions required for calculating physical (direct) damages and changes in damages overtime
- Assumptions required for developing a set of adaptation strategies and response actions (e.g., level of adoption, who will pay, beneficiaries, effectiveness, etc.)
- With broader geography, additional data cleaning and assumptions will be necessary to ensure consistency (e.g. assessor data between counties, handling of sales taxes between jurisdictions)
Other REMI Factors to Consider in Future Studies

- Increased insurance to businesses
- Increased construction costs
- Assumed built-in resilience and ability for small businesses to weather impacts
- Changes in property values
- Non-pecuniary (amenity) impacts
- Ability to effectively deploy funds
- Timing of events (e.g., deterministic vs. probabilistic)
- How to present sensitivity analyses (e.g., don’t overwhelm the reader)
Other Considerations

<table>
<thead>
<tr>
<th>Icon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$</td>
<td>Paying for adaptation</td>
</tr>
<tr>
<td>🧑‍🤝‍🧑</td>
<td>Accounting for equity</td>
</tr>
<tr>
<td>💸♀️</td>
<td>Disadvantaged populations</td>
</tr>
<tr>
<td>🕊️</td>
<td>Opportunity costs</td>
</tr>
<tr>
<td>⚠️</td>
<td>Reputation risks and associated impacts</td>
</tr>
</tbody>
</table>
Q & A

Thank you for your time!

Questions?

Feel free to contact me:
aaron.mcgregor@aecom.com