Measuring Resiliency: It's More Than Just Math

Lynette Cardoch
Moffatt & Nichol

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Measuring resiliency: it’s more than just math

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Resilience Supports Continuity

Capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience.

(100 Resilient Cities, Rockefeller Foundation)
Western Wildfires, California Firestorm Summer–Fall 2018

Rockies and Plains Hail Storms August 6–7

Southwest/Southern Plains Drought 2018

Colorado Hail Storm June 18–19

Texas Hail Storm June 6

Central and Eastern Tornadoes and Severe Weather April 13–16

Southern and Eastern Tornadoes and Severe Weather July 19–22

Northeast Winter Storm March 1–3

Central and Eastern Severe Weather May 13–15

Northeastern and Eastern Winter Storm January 3–5

Hurricane Florence September 13–16

Central and Northeast Severe Weather May 1–4

Southeastern Tornadoes and Severe Weather March 18–21

Hurricane Michael October 10–11

Central and Eastern Severe Weather May 13–15

Northeastern and Eastern Winter Storm January 3–5

Hurricane Florence September 13–16

Central and Northeast Severe Weather May 1–4

Southeastern Tornadoes and Severe Weather March 18–21

Hurricane Michael October 10–11
<table>
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<tr>
<th>Rank</th>
<th>Date</th>
<th>Event</th>
<th>Insured loss</th>
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<td>1</td>
<td>Aug. 25, 2005</td>
<td>Hurricane Katrina, storm surge, damage to oil rigs</td>
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<td>2</td>
<td>Mar. 3, 2011</td>
<td>Fukushima earthquake (Mw 9.0) triggers tsunami</td>
<td>38.1</td>
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<td>3</td>
<td>Sep. 19, 2017</td>
<td>Hurricane Maria</td>
<td>32.0</td>
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<td>4</td>
<td>Oct. 24, 2012</td>
<td>Hurricane Sandy, storm surge</td>
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<td>5</td>
<td>Sep. 6, 2017</td>
<td>Hurricane Irma</td>
<td>30.0</td>
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<td>6</td>
<td>Aug. 25, 2017</td>
<td>Hurricane Harvey</td>
<td>30.0</td>
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<td>7</td>
<td>Aug. 23, 1992</td>
<td>Hurricane Andrew, storm surge</td>
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<td>8</td>
<td>Sep. 11, 2001</td>
<td>Terror attacks on WTC, Pentagon and other buildings</td>
<td>25.9</td>
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<td>9</td>
<td>Jan. 1, 1994</td>
<td>Northridge earthquake (Mw 6.7)</td>
<td>25.3</td>
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<td>10</td>
<td>Sep. 6, 2008</td>
<td>Hurricane Ike, floods, damage to oil rigs</td>
<td>23.1</td>
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</tbody>
</table>

*Top 10 Costliest World Insurance Losses, 1970-2017 (2017 $; SwissRe)*
Evolution of Resiliency Measurements

Organizations  Change  Engineering  Robust Structures  Social Communities  Ecology  Ecosystem Services
Integrated Resiliency Measurements

Community Resiliency

Engineering
Organizations
Ecology
Social
Evolution of Roles

Planning  Engineer  Construction
Integrated Teams

Coastal Resiliency Project

- Upland Planning
- Design
- Construction
- Grant Funding
- Waterfront Design
- Permitting
- Regulatory Support
- Hazard Identification
- Environmental
- Condition Assessments
Chronic Stressor: Fiscal Resiliency

- Revenue Streams
- Tax Base
- Concentration of assets
GOODBYE, MIAMI

By century’s end, rising sea levels will turn the nation’s subtropical urban fantasyland into an American Atlantis. But long before the city is completely underwater, chaos will begin.

By Jeff Goodell
Miami-Dade has become a victim of its own success as ballooning prices have made single-family homes unaffordable to 82% of Miami-Dade’s households.

Miami-Dade County’s housing-affordability crisis is so dire it now poses as much of a threat to the region as sea-level rise, according to a recent market update prepared by Florida International University’s Jorge M. Pérez Metropolitan Center. The study shows that more than half of Miami-Dade’s cost-burdened renters (household spending more than 30% of their income on rent) are “severely” cost-burdened, meaning they spend more than 50% of their income on rent. For more than 55% of them, (142,466), the condition qualifies as "severe."

Even worse, the number of severely cost-burdened renter households in Miami-Dade has increased by 13% (16,203 households) since 2012. “We’re seeing a surge of households in this category,” said Ned Murray, associate director of the Metropolitan Center. “Once you hit that level of severe cost burden, staying in Miami becomes prohibitive and people start to leave. This is a major challenge, like sea-level rise, that impacts the economy, education, and quality of life in Miami. We need to take it on as a primary policy issue.”

The report is part of the data that Murray has been collating since January for two upcoming reports critical to the area’s future:

• The City of Miami Affordable Housing Master Plan, which is completed and scheduled to be workshopped by city commissioners on October 24.
Rising Risks: ‘Climate gentrification’ is changing Miami real estate values – for better and worse

A new Harvard study claims climate change is altering home values both on the coast and inland, coining the term, “climate gentrification.”

“Higher elevation properties are essentially worth more now, and increasingly will be worth more in the future,” according to Harvard’s Jesse Keating.

Universities, climate research groups and the National Oceanic and Atmospheric Administration have made dire predictions of sea-level rise in Miami.
Decision Making in Light of Uncertainty

Scenario Planning

Probabilistic Approaches

Dynamic Adaptive Policy Pathways

- First Floor Elevation
- Site Grading
- Nuisance Flooding
- Greening Measures
- Extreme Rainfall
- Deployable Protection
- Future Storm Surge Elevations
- Storm Surge Probability
- Sea Level Rise Probability
- Economic Consequences
- Trade-off Analyses
The Resiliency Lens

- Interconnectivity of systems
- Asset versus system resilience
- Acute shocks & chronic stressors
Hurricane Michael
Mexico Beach, FL
(October 2018)
Invest $25 M Annually
Statewide ROI = $189.9/$1

• 8 Coastal Counties (Direct)
  • $1.66 B
  • ROI = $66.5/$1

• 8 Coastal Counties (Direct & Indirect)
  • $3.33 B
  • 38,600 jobs

• Statewide (Direct & Indirect)
  • $4.74 B
  • 48,700 jobs

• Economic effect to 92 non-coastal counties
  • $1.4 B
  • ROI $56/$1
Beach & Inlet Management Strategies Effective

Value of Coastal Property At Risk

• 1998 Setback Factors = $11.73 B
• 2012 Setback Factors = $11.12 B

• $600.8 M risk reduced for 8 counties
• $818.8 M risk reduced for 5 managed counties
### 2017 Infrastructure Grades

<table>
<thead>
<tr>
<th>Infrastructure Type</th>
<th>Grade</th>
<th>Change</th>
</tr>
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<tbody>
<tr>
<td>Aviation</td>
<td>D</td>
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<tr>
<td>Bridges</td>
<td>C+</td>
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<tr>
<td>Dams</td>
<td>D</td>
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<tr>
<td>Drinking Water</td>
<td>D</td>
<td></td>
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<tr>
<td>Energy</td>
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<tr>
<td>Hazardous Waste</td>
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<tr>
<td>Inland Waterways</td>
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<td>Levees</td>
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<td>Parks and Recreation</td>
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<td>Ports</td>
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<td>Rail</td>
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<td>Schools</td>
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<tr>
<td>Solid Waste</td>
<td>C+</td>
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<td>Transit</td>
<td>D-</td>
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<tr>
<td>Wastewater</td>
<td>D+</td>
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</table>

#### America's Cumulative Infrastructure Grade
- **A**: Exceptional
- **B**: Good
- **C**: Mediocre
- **D**: Poor
- **F**: Failing