Insurance and Behavioral Economics: 
*Improving Decisions in the Most Misunderstood Industry* 
(with Mark Pauly and Stacey McMorrow) 

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New Frontiers in Systemic Risk Measures and Extreme Risk Management  
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What is Great and Not-So-Great about Insurance

An insurance market can be a highly efficient and effective device for cushioning the consequences of large losses.

It can also encourage risk mitigation through premium reductions.

Behavioral economics raises some problems and challenges for buyers, sellers, and policymakers particularly for low-probability, high-consequence (LP-HC) events.
What is Great and Not-So-Great about Insurance

Some insurance markets work well

- Term life insurance
- Auto collision insurance
- Homeowners’ insurance

But LP-HC events puzzle consumers, insurers and politicians/regulators

- Consumers: Very limited personal experience with events
- Insurers: Correlated losses pose challenges
- Politicians/Regulators: Concerned with re-election, as well as fairness and equity
Outline of Talk

A New Era of Catastrophes

Linking Intuitive and Deliberative Thinking for Dealing with Extreme Events

Guiding Principles for Insurance

Insurance Voucher and Mitigation Loan Program

Challenges and Questions for Discussion
WORLDWIDE EVOLUTION OF CATASTROPHES, 1980-2014


- Overall losses (2014 values)*
- Of which insured losses (2014 values)*
- Trend in overall losses
- Trend in insured losses

* Values adjusted for inflation using the Consumer Price Index (CPI) of each country.

Source: Munich Re NatCatSERVICE

<table>
<thead>
<tr>
<th>$ BILLION</th>
<th>EVENT</th>
<th>VICTIMS</th>
<th>YEAR</th>
<th>AREA OF PRIMARY DAMAGE</th>
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<tbody>
<tr>
<td>78</td>
<td>Hurricane Katrina; floods</td>
<td>1,836</td>
<td>2005</td>
<td>USA, Gulf of Mexico</td>
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<td>41</td>
<td>9/11 Attacks</td>
<td>3,025</td>
<td>2001</td>
<td>USA</td>
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<td>37</td>
<td>Earthquake (M 9.0) and tsunami</td>
<td>19,135</td>
<td>2011</td>
<td>Japan</td>
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<tr>
<td>35</td>
<td>Hurricane Sandy; floods</td>
<td>237</td>
<td>2012</td>
<td>USA</td>
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<td>26</td>
<td>Hurricane Andrew</td>
<td>43</td>
<td>1992</td>
<td>USA, Bahamas</td>
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<td>22</td>
<td>Northridge Earthquake (M 6.6)</td>
<td>61</td>
<td>1994</td>
<td>USA</td>
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<tr>
<td>22</td>
<td>Hurricane Ike; floods</td>
<td>136</td>
<td>2008</td>
<td>USA, Caribbean</td>
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<td>16</td>
<td>Hurricane Ivan</td>
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<td>2004</td>
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<td>15</td>
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<td>815</td>
<td>2011</td>
<td>Thailand</td>
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<td>15</td>
<td>Earthquake (M 6.3); aftershocks</td>
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<td>New Zealand</td>
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<td>Hurricane Wilma; floods</td>
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<td>2005</td>
<td>USA, Gulf of Mexico</td>
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<td>12</td>
<td>Hurricane Rita</td>
<td>34</td>
<td>2005</td>
<td>USA, Gulf of Mexico, et al.</td>
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<tr>
<td>11</td>
<td>Drought in the Corn Belt</td>
<td>123</td>
<td>2012</td>
<td>USA</td>
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<tr>
<td>10</td>
<td>Hurricane Charley</td>
<td>24</td>
<td>2004</td>
<td>USA, Caribbean, et al.</td>
</tr>
<tr>
<td>10</td>
<td>Typhoon Mireille</td>
<td>51</td>
<td>1991</td>
<td>Japan</td>
</tr>
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</table>
HONSHU EARTHQUAKE:
• 10,000+ FATALITIES
• $183 BILLION IN DAMAGE

SICHUAN EARTHQUAKE:
• 70,000+ FATALITIES
• 5 MILLION HOMELESS

HURRICANE IVAN:
• $889 MILLION IN DAMAGE
• (365% OF GRENADA GNP)

HURRICANE SANDY:
• $65 BILLION IN DAMAGE
• 285 FATALITIES
Hurricane Sandy, October 2012

$4.75 billion in damage to Metropolitan Transit Authority infrastructure that MTA is responsible for repairing or restoring:

The South Ferry Station in Lower Manhattan was flooded to the mezzanine level.
Source: A Stronger, More Resilient New York (2013)
Credit: MTAPhotos

The Battery Park Underpass in Lower Manhattan flooded from floor to ceiling.
Source: A Stronger, More Resilient New York (2013)
Credit: NYCDOT
What’s Happening?
The Question of Attribution

- Higher Degree of Urbanization
- Huge Increase in the Value at Risk

Weather Patterns and Sea Level Rise
- Changes in climate conditions and/or return to a high hurricane cycle?
- Sea level rise will cause more flood damage
- More intense weather-related events coupled with increased value at risk will cost more…much more

What Will 2015 Bring?
KEY FINDINGS FOR FUTURE PROJECTED CHANGES

- Illustrate a broad-based acceleration of climate change in coming decades
- Show significant climate risks for New York City, especially heat waves, extreme precipitation events, and coastal flooding
- Valid for New York City and the metropolitan region
Sea Level Rise Projections

Newly-released sea level rise projections account for processes not well reflected in global climate models, including the possibility of rapid ice loss.

- High estimate projections are higher than the Panel’s 2009 “Rapid-ice melt” Scenario
- Sea level rise for New York City is projected to exceed the global average

<table>
<thead>
<tr>
<th>Sea level rise¹ Baseline (2000-2004) 0 inches</th>
<th>Low-estimate (10th percentile)</th>
<th>Middle range (25th to 75th percentile)</th>
<th>High-estimate (90th percentile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020s</td>
<td>2 inches</td>
<td>4 to 8 inches</td>
<td>11 inches</td>
</tr>
<tr>
<td>2050s</td>
<td>7 inches</td>
<td>11 to 24 inches</td>
<td>31 inches</td>
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</tbody>
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¹ Based on 24 GCMs and 2 Representative Concentration Pathways.
NORTHERN EUROPE IF GREENLAND’S ICE SHEET MELTS
Outline of Talk

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Linking Intuitive and Deliberative Thinking for Dealing with Extreme Events

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Linking Intuitive and Deliberative Thinking for Dealing with Extreme Events
Intuitive Thinking (System 1) & Deliberative Thinking (System 2)

System 1 operates automatically and quickly with little or no effort
- Individuals use simple associations including emotional reactions
- Highlight importance of recent past experience
- Basis for systematic judgmental biases and simplified decision rules

System 2 allocates attention to effortful and intentional mental activities
- Individuals undertake trade-offs implicit in benefit-cost analysis
- Recognizes relevant interconnectedness and need for coordination
- Focuses on long-term strategies for coping with extreme events
Behavior Triggered by Intuitive (System 1) Thinking

**Availability Bias** – Estimating likelihood of a disaster by its salience

**Threshold Models** – Failure to take protective measures if perceived likelihood of disaster is below threshold level of concern

**Imperfect Information** – Misperceives the likelihood of event occurring and its consequences.

**Myopia** – Focus on short-time horizons in comparing upfront costs of protection with expected benefits from loss reduction
The Lowland family resides in the Rockaways and is considering whether to invest $1,500 in flood proofing their house so it is less susceptible to water damage.

Hydrologists have estimated that the chances of storm surge from hurricanes affecting their home is 1/100, and that if it occurs, the savings from flood proofing will be $27,500.

If premiums reflect risk their annual insurance cost will be reduced by $275 (i.e., 1/100 $27,500) if they undertake this investment.
Responses by the Lowland family prior to Hurricane Sandy

- **Imperfect information:** Lowland family misperceives flood risk, thinking that it is $1/1000$ rather than $1/100$
- **Threshold model:** Flood risk is below their level of concern
- **Myopic behavior:** Failure to consider long-term benefits of flood protection
- **Cancellation of flood insurance:** Consider it to be a poor investment since they have not suffered any flood-related damage

Many banks do not enforce the flood insurance requirement

Many states do not enforce building codes

- $1/3$ of the damage from Hurricane Andrew (1992) could have been avoided had Florida enforced its building codes.
- Today, Florida has well-enforced codes (Learning from a disaster)
Lack of Interest in Protection Against Disasters: Cancellation of Flood Insurance Even When Required

Many homeowners cancel their flood policy if they have not experienced a flood for several years.

**Reason:** Flood insurance was not a good investment.

**Data:** Of 1,549 victims of a flood in August 1998 in northern Vermont, FEMA found 84% of residents in SFHAs did *not* have flood insurance. 45% were required to purchase it. (Tobin and Calfee, 2005).
# Dynamic Analysis of Flood Insurance Tenure

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</thead>
<tbody>
<tr>
<td>Housing Units</td>
<td>841,000</td>
<td>876,000</td>
<td>1,186,000</td>
<td>986,000</td>
<td>849,000</td>
<td>1,299,000</td>
<td>974,000</td>
<td>894,000</td>
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<tr>
<td>1 year</td>
<td>73%</td>
<td>67%</td>
<td>77%</td>
<td>78%</td>
<td>76%</td>
<td>73%</td>
<td>74%</td>
<td>73%</td>
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<tr>
<td>2 years</td>
<td>49%</td>
<td>52%</td>
<td>65%</td>
<td>65%</td>
<td>63%</td>
<td>59%</td>
<td>58%</td>
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</tr>
<tr>
<td>3 years</td>
<td>39%</td>
<td>44%</td>
<td>57%</td>
<td>55%</td>
<td>53%</td>
<td>48%</td>
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<tr>
<td>4 years</td>
<td>33%</td>
<td>38%</td>
<td>50%</td>
<td>48%</td>
<td>44%</td>
<td></td>
<td></td>
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<tr>
<td>5 years</td>
<td>29%</td>
<td>33%</td>
<td>44%</td>
<td>38%</td>
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<tr>
<td>6 years</td>
<td>25%</td>
<td>30%</td>
<td>33%</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>7 years</td>
<td>22%</td>
<td>26%</td>
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<tr>
<td>8 years</td>
<td>20%</td>
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</tbody>
</table>

Note: our analysis of the American Community Survey reveals that the median length of residence was about 6 years over this period.

*Sources: Michel-Kerjan, Lemoyne de Forges and Kunreuther – Data from NFIP/FEMA*
Aiding Decision Makers to Undertake Deliberative (System 2) Thinking

Provide better information on the role of insurance
  • The best return on an insurance policy is no return at all

Use availability bias to focus on consequences
  • Highlight financial problems if disaster occurred and the property were destroyed because it was unprotected and it was uninsured

Overcome threshold model by stretching time horizon
  Example: Likelihood of 100 year flood
  • Next year: 1 in 100
  • 25 years: greater than 1 in 5 chance of experiencing at least 1 flood during this period
Prior to 9/11, insurers did not charge anything for terrorism coverage despite the attempted bombing of the World Trade Center in 1993, the 1995 Oklahoma City bombing and terrorist attacks throughout the world.

After 9/11, most insurers refused to offer terrorism insurance, or if they did provide coverage they charged extremely high premiums.
Responses by insurers

• **Threshold Behavior:** Prior to 9/11 insurers treated the likelihood of a terrorist attack in the U.S. as below their threshold level of concern so ignored potential consequences.

• **Availability Bias:** After 9/11 insurers focused on enormous potential claim payments from another terrorist attack. As a result they felt terrorism was an uninsurable risk.

• **Imperfect Information:** Insurers failed to take into account the likelihood of a future terrorist attack when determining premiums they would have to charge for coverage, and how much firms would be willing to pay for protection.

**Example:** 6 months after 9/11 a brokerage firm negotiated an insurance policy where an industrial company paid $900,000 for $9 million in coverage for damage to their building next year from a terrorist attack.
Aiding Insurers to Undertake Deliberative (System 2) Thinking

Overcome threshold model

- Construct worst-case scenarios before a disaster
- Assign likelihoods to worst-case scenarios after a disaster to show that risk is insurable

Provide multi-year insurance along with annual policies

- Provides rate stability to insureds
- Diversifies risk over time and reduces variance in losses ($\sigma^2$ decreases as a function of $1/n$)
- Reduces marketing costs
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**Guiding Principles for Insurance**

**Principle 1: Premiums reflecting risk**
- Signals to individuals the hazards they face
- Encourages investment in cost-effective adaptation measures

**Principle 2: Dealing with equity and affordability issues**
- Provide vouchers to individuals requiring special treatment
- Only provide vouchers if homeowners mitigate their property to reduce future flood losses

**Principle 3: Multi-year insurance contracts**
- Premiums reflecting risk with vouchers to deal with affordability
- Addresses myopia
- Encourages investment in loss reduction measures through loans
Insurance Vouchers: Existing Programs as Models

Food Stamp Program

Mission: Vouchers to purchase food based on annual income and family size

Low Income Home Energy Assistance Program

Mission: Assist low-income households in meeting immediate energy needs

Universal Service Fund

Mission: Provide discounts to low-income individuals in rural areas so rates for telecommunications services are comparable to urban areas
Cost of Adaptation Measure: $1,500 to flood-proof their home

Nature of Disaster:

– 1/100 chance of disaster

– Reduction in loss ($27,500)

Expected Annual Benefits: $275 (1/100 * $27,500)

Annual Discount Rate: 10%
Expected Benefit-Cost Analysis of Adaptation (Annual Discount Rate 10%)
Rationale for Multi-Year Flood Insurance: Making Adaptation Affordable with Multi-Year Loans

Illustrative Example: The Lowland Family

Cost to flood-proof their home: $1,500

Expected annual benefit of partial roof adaptation:
$275 (1/100 * $27,500)

Annual payments from 20 year $1,500 loan at 10% annual interest rate: $145

Reduction in annual insurance payment: $275

Reduction in annual payments due to adaptation:
$275-$145 = $130
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Proposed Strategy for Reducing Future Flood Losses

Encourage Investment in Loss Reduction Measures

- Risk-based premiums based on updated FEMA flood maps
- Home improvement mitigation loans tied to property
- Premium reductions for undertaking mitigation measures

Address Affordability Issue

- Means-tested vouchers for current residents
- Covers insurance premium and mitigation loan
- Condition for a voucher: You must mitigate
- Required flood insurance and loans tied to the property not the homeowner
Dealing with Affordability in Ocean County, NJ (Population 580,000)

Legend

Ocean County Tracts

% of households with income under $50k

- 9.7% - 26%
- 26.1% - 32%
- 32.1% - 40.3%
- 40.4% - 56.2%
- 56.3% - 100%

Values based on quartiles of the distribution.
Two Families Residing in Ocean County NJ

Family 1 is in the A Zone and pays $4,000 for flood insurance.

Family 2 is in the V Zone and pays $18,550 for flood insurance.

- Both homes are 3 feet below Base Flood Elevation (BFE)
- Each family has an annual income of $50,000 per year

Cost of elevating home to 1 foot above BFE:

- Family 1: $25,000 20-Year 3% Loan (Annual Payment $1,680)
- Family 2: $55,000 20-Year 3% Loan (Annual Payment $3,660)

Means-tested voucher covers insurance and mitigation costs above $2,500 (i.e., above 5% of income)
Cost to the Federal Government and the Two Families
Estimates of Program Costs for Ocean County Tracts that Experienced Storm Surge

<table>
<thead>
<tr>
<th>Cost of Program in Millions of Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insurance Voucher</td>
</tr>
<tr>
<td>140</td>
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</table>
Everyone is a Winner

**Homeowner:**
Lower total annual payments

**NFIP:**
Reduction in flood losses

**Financial institution:**
More secure investment due to lower losses from disaster

**Federal government:**
Lower voucher costs due to reduced insurance premiums because property is mitigated (e.g., elevated; flood-proofed)

**General taxpayer:**
Less disaster assistance
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Risk-based premiums for second homes and those with repetitive flooding (Principle 1)

National Academy of Sciences study on affordability to examine feasibility of different options that includes means-tested vouchers (Principle 2)
Stimulated by NIMTOF behavior----Nov. 2014 election

Recognized concerns of people impacted by Hurricanes Sandy and Katrina----will their property be stigmatized by high insurance premiums?

Rescinded principle that insurance premiums reflect risk
Long-term strategies for reducing flood risk, given climate change (e.g., sea level rise) 
(Deliberative thinking)

Short term incentives for encouraging this behavior 
(Intuitive thinking)

Develop risk management strategy that recognizes the importance of equity and affordability 
(Policy analysis)
Future Research to Encourage Investment in Loss Reduction Measures

• Make the impact of climate change more salient
• Stretch time horizon on likelihood of disasters occurring
• Highlight expected benefits of loss reduction measures to key interested parties
• Tie loans and insurance to the property (not to the individual) through assumable mortgage contracts or via property taxes
• Examine role of multi-year insurance contracts tied to the property in encouraging investment in loss reduction measures
Conclusions

Insurance markets can help spread the risk of unavoidable disasters and offer incentives to mitigate risk. But they cannot work miracles, especially in LP-HC settings.

Insurers can encourage deliberative thinking for themselves and their policyholders by utilizing new technology, focusing on the long-term while providing short-term incentives for acting now rather than waiting until after the next disaster.
The Challenges of Linking Flood Insurance with Adaptation Measures
Climate Change is Now Front and Center Given Release of National Climate Change Assessment Report
Part I: Contrasting Ideal and Real Worlds of Insurance
Chapter One: Purposes of this Book
Chapter Two: An Introduction to Insurance in Practice and Theory
Chapter Three: Anomalies and Rumors of Anomalies
Chapter Four: Behavior Consistent with Benchmark Models

Part II: Understanding Consumer and Insurer Behavior
Chapter Five: Real World Complications
Chapter Six: Why People Do or Do Not Demand Insurance
Chapter Seven: Demand Anomalies
Chapter Eight: Descriptive Models of Insurance Supply
Chapter Nine: Anomalies on the Supply Side

Part III: The Future of Insurance
Chapter Ten: Design Principles for Insurance
Chapter Eleven: Strategies for Dealing with Insurance-Related Anomalies
Chapter Twelve: Innovations in Insurance Markets through Multi-Year Contracts
Chapter Thirteen: Publicly-Provided Social Insurance
Chapter Fourteen: A Framework for Prescriptive Recommendations