Managing Risk for an Uncertain Future

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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 Loss Reduction Loan Program

Challenges and Questions for Discussion
WORLDWIDE EVOLUTION OF CATASTROPHES, 1980-2012

Overall losses and insured losses 1980-2012 (US$ bn)

Source: Munich Re Topics Geo 2012
## Twenty-Five Most Costly Insured Catastrophes Worldwide, 1970–2012 (in 2011 prices) (16 in the USA, 18 since 2001)

<table>
<thead>
<tr>
<th>$ BILLION</th>
<th>EVENT</th>
<th>VICTIMS (dead and missing)</th>
<th>YEAR</th>
<th>AREA OF PRIMARY DAMAGE</th>
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</thead>
<tbody>
<tr>
<td>76.3</td>
<td>Hurricane Katrina; floods</td>
<td>1,836</td>
<td>2005</td>
<td>USA, Gulf of Mexico</td>
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<td>39</td>
<td>9/11 Attacks</td>
<td>3,025</td>
<td>2001</td>
<td>USA</td>
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<tr>
<td>35.7</td>
<td>Earthquake (M 9.0) and tsunami</td>
<td>19,135</td>
<td>2011</td>
<td>Japan</td>
</tr>
<tr>
<td>35.0</td>
<td>Hurricane Sandy; floods</td>
<td>237</td>
<td>2012</td>
<td>USA</td>
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<tr>
<td>26.2</td>
<td>Hurricane Andrew</td>
<td>43</td>
<td>1992</td>
<td>USA, Bahamas</td>
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<td>21.7</td>
<td>Northridge Earthquake (M 6.6)</td>
<td>61</td>
<td>1994</td>
<td>USA</td>
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<tr>
<td>21.6</td>
<td>Hurricane Ike; floods</td>
<td>136</td>
<td>2008</td>
<td>USA, Caribbean</td>
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<td>15.7</td>
<td>Hurricane Ivan</td>
<td>124</td>
<td>2004</td>
<td>USA, Caribbean</td>
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<tr>
<td>15.3</td>
<td>Floods; heavy monsoon rains</td>
<td>815</td>
<td>2011</td>
<td>Thailand</td>
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<tr>
<td>15.3</td>
<td>Earthquake (M 6.3); aftershocks</td>
<td>181</td>
<td>2011</td>
<td>New Zealand</td>
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<td>14.7</td>
<td>Hurricane Wilma; floods</td>
<td>35</td>
<td>2005</td>
<td>USA, Gulf of Mexico</td>
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<tr>
<td>11.9</td>
<td>Hurricane Rita</td>
<td>34</td>
<td>2005</td>
<td>USA, Gulf of Mexico, et al.</td>
</tr>
<tr>
<td>11.0</td>
<td>Drought in the Corn Belt</td>
<td>123</td>
<td>2012</td>
<td>USA</td>
</tr>
<tr>
<td>9.8</td>
<td>Hurricane Charley</td>
<td>24</td>
<td>2004</td>
<td>USA, Caribbean, et al.</td>
</tr>
<tr>
<td>9.5</td>
<td>Typhoon Mireille</td>
<td>51</td>
<td>1991</td>
<td>Japan</td>
</tr>
<tr>
<td>8.5</td>
<td>Hurricane Hugo</td>
<td>71</td>
<td>1989</td>
<td>Puerto Rico, USA, et al.</td>
</tr>
<tr>
<td>8.4</td>
<td>Earthquake (M 8.8); tsunami</td>
<td>562</td>
<td>2010</td>
<td>Chile</td>
</tr>
<tr>
<td>8.2</td>
<td>Winter Storm Daria</td>
<td>95</td>
<td>1990</td>
<td>France, UK, et al.</td>
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<tr>
<td>8.0</td>
<td>Winter Storm Lothar</td>
<td>110</td>
<td>1999</td>
<td>France, Switzerland, et al.</td>
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<tr>
<td>7.4</td>
<td>Storms; over 350 tornadoes</td>
<td>350</td>
<td>2011</td>
<td>USA (Alabama, et al.)</td>
</tr>
<tr>
<td>7.2</td>
<td>Major tornado outbreak</td>
<td>155</td>
<td>2011</td>
<td>USA (Missouri, et al.)</td>
</tr>
<tr>
<td>6.7</td>
<td>Winter Storm Kyrill</td>
<td>54</td>
<td>2007</td>
<td>Germany, UK, NL, France</td>
</tr>
<tr>
<td>6.2</td>
<td>Hurricane Frances</td>
<td>38</td>
<td>2004</td>
<td>USA, Bahamas</td>
</tr>
<tr>
<td>6.0</td>
<td>Hurricane Irene</td>
<td>55</td>
<td>2011</td>
<td>USA, Caribbean</td>
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</tbody>
</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 2014 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></th>
<th>Sea level rise(^1)</th>
<th>Low-estimate (10(^{th}) percentile)</th>
<th>Middle range (25(^{th}) to 75(^{th}) percentile)</th>
<th>High-estimate (90(^{th}) percentile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (2000-2004)</td>
<td>0 inches</td>
<td></td>
<td></td>
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<tr>
<td>2020s</td>
<td>2 inches</td>
<td>4 to 8 inches</td>
<td>11 inches</td>
<td></td>
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<tr>
<td>2050s</td>
<td>7 inches</td>
<td>11 to 24 inches</td>
<td>31 inches</td>
<td></td>
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</tbody>
</table>

\(^1\) Based on 24 GCMs and 2 Representative Concentration Pathways.
NORTHERN EUROPE IF GREENLAND’S ICE SHEET MELTS
<table>
<thead>
<tr>
<th>GLOBAL MEETINGS</th>
<th>TAXONOMY OF CHOICES:</th>
</tr>
</thead>
<tbody>
<tr>
<td>COUNTRY</td>
<td>REDUCING CARBON EMISSIONS</td>
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<tr>
<td>REGION</td>
<td></td>
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<tr>
<td>INDUSTRY</td>
<td></td>
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<tr>
<td>INDIVIDUAL</td>
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</table>
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 Loss Reduction Loan Program

Challenges and Questions for Discussion
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.
Illustrations of Intuitive (System 1) Thinking

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)
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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<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>
<td>3 years</td>
<td>39%</td>
<td>44%</td>
<td>57%</td>
<td>55%</td>
<td>53%</td>
<td>48%</td>
<td></td>
<td></td>
</tr>
<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>
<td></td>
<td></td>
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<tr>
<td>7 years</td>
<td>22%</td>
<td>26%</td>
<td></td>
<td></td>
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<tr>
<td>8 years</td>
<td>20%</td>
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</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
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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
Making Investment in Adaptation Measures Affordable to the Lowland Family

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 \( (1/100 \times 27,500) \)

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% - 28%
- 26.1% - 32%
- 32.1% - 40.3%
- 40.4% - 56.2%
- 56.3% - 100%

Values based on quantiles 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
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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Challenges and Questions for Discussion
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)*

Biggert-Waters Flood Insurance Reform Act of 2012 (BW12) Greatest Potential Achievement in Reducing Flood Risk
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)
Framework for Chapter 2  WGIII AR5  IPCC
Integrated Risk and Uncertainty Assessment of Climate Change
Response Policies

Impact of Risk and Uncertainty on Climate Change Policy Choices

Risk Perception and Responses to Risk and Uncertainty (Descriptive Analysis)

Managing Uncertainty, Risk and Learning via Robust Policy Response Strategies and Instruments (Prescriptive Analysis)

Tools and Decision Aids for Analyzing Risk and Uncertainty (Normative Analysis)
Climate Change is Now Front and Center Given Release of National Climate Change Assessment Report
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
  ➢ Flood or hurricane with a 100-year return period (.01 annual likelihood) translates into .22 probability of at least one flood or hurricane in 25 years
• 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 the role of multi-year insurance contracts tied to the property in encouraging investment in loss reduction measures
• Examine how new technology can encourage deliberative thinking
Future Challenges and Questions for Discussion

LONG-TERM ISSUES

How long will it take FEMA to develop new maps that more accurately assess the risks of flooding that reflect climate change projections?

How costly will programs be to the Federal government and residents in flood-prone areas in the United States?

SHORT-TERM CHALLENGES

How can we restore the best features of Biggert-Waters into the NFIP?

How can the impacts of climate change be incorporated in designing flood insurance to encourage investments in adaptation measures?

What are the most appropriate ways of dealing with affordability issues?

• What empirical data should be collected?
• What controlled experiments/surveys should be undertaken?
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.

Climate change with its impact on sea level rise raises a set of challenging questions with respect to implementing mitigation and adaptation measures.

We need to encourage deliberative thinking by focusing on the long-term while providing short-term incentives for acting now rather than waiting by assuming it will not happen to me.
The Challenges of Linking Flood Insurance with Adaptation Measures
“It’s settled…We agree to sign a pledge to hold another meeting to consider changing course at a date yet to be determined.”
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