Insuring Infrastructure Against Disaster Losses

(with Erwann Michel-Kerjan)

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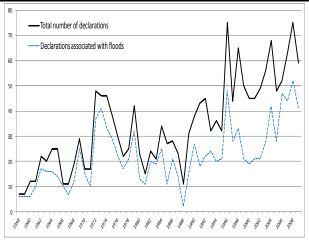
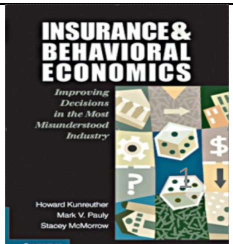
Managing the Risk of Catastrophes:

Protecting Critical Infrastructure in Urban Areas

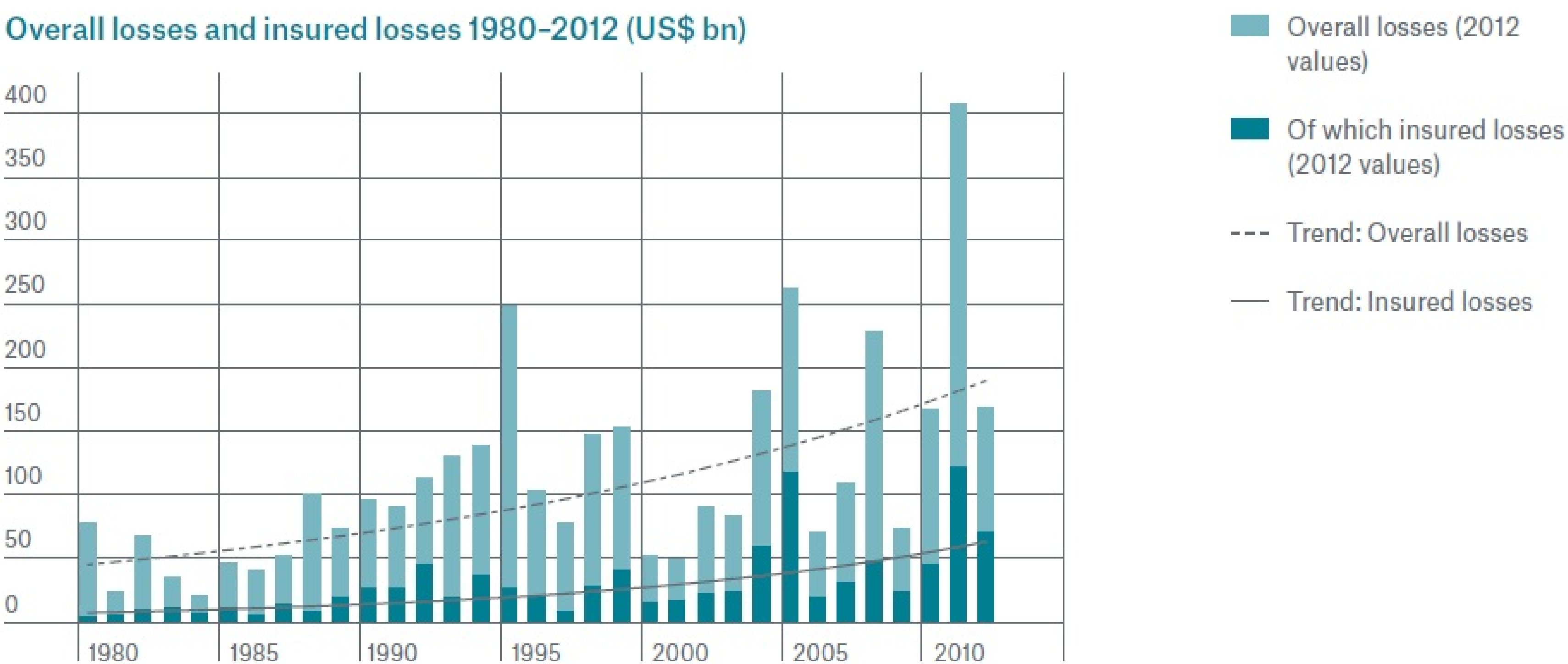
Federal Reserve Bank of New York

November 1 2013





WORLDWIDE EVOLUTION OF CATASTROPHES, 1980-2012



Source: Munich Re

Twenty-Five Most Costly Insured Catastrophes Worldwide, 1970–2012 (in 2011 prices)
(16 in the USA, 18 since 2001)

$ BILLION	EVENT	VICTIMS (dead and missing)	YEAR	AREA OF PRIMARY DAMAGE
76.3	Hurricane Katrina; floods	1,836	**2005**	**USA,** Gulf of Mexico
39	9/11 Attacks	3,025	**2001**	**USA**
35.7	Earthquake (M 9.0) and tsunami	19,135	**2011**	Japan
35.0	Hurricane Sandy; floods	237	**2012**	**USA**
26.2	Hurricane Andrew	43	1992	**USA**, Bahamas
21.7	Northridge Earthquake (M 6.6)	61	1994	**USA**
21.6	Hurricane Ike; floods	136	**2008**	**USA**, Caribbean
15.7	Hurricane Ivan	124	**2004**	**USA**, Caribbean
15.3	Floods; heavy monsoon rains	815	**2011**	Thailand
15.3	Earthquake (M 6.3); aftershocks	181	**2011**	New Zealand
14.7	Hurricane Wilma; floods	35	**2005**	**USA,** Gulf of Mexico
11.9	Hurricane Rita	34	**2005**	**USA,** Gulf of Mexico, et al.
11.0	Drought in the Corn Belt	123	**2012**	**USA**
9.8	Hurricane Charley	24	**2004**	**USA,** Caribbean, et al.
9.5	Typhoon Mireille	51	1991	Japan
8.5	Hurricane Hugo	71	1989	Puerto Rico, **USA,** et al.
8.4	Earthquake (M 8.8); tsunami	562	**2010**	Chile
8.2	Winter Storm Daria	95	1990	France, UK, et al.
8.0	Winter Storm Lothar	110	1999	France, Switzerland, et al.
7.4	Storms; over 350 tornadoes	350	**2011**	**USA** (Alabama, et al.)
7.2	Major tornado outbreak	155	**2011**	**USA** (Missouri, et al.)
6.7	Winter Storm Kyrill	54	**2007**	Germany, UK, NL, France
6.2	Storms and floods	22	1987	France, UK, et al.
6.2	Hurricane Frances	38	**2004**	**USA**, Bahamas
6.0	Hurricane Irene	55	**2011**	**USA**, Caribbean

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 2013 Bring?

Hurricane Sandy, October 2012

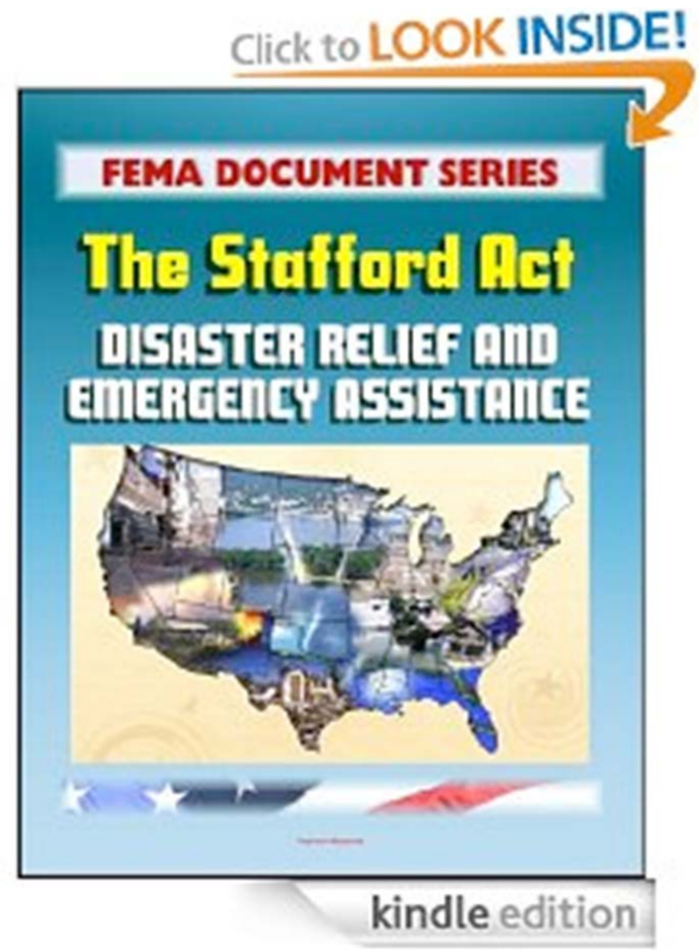
Damage to Infrastructure in NYC that includes damage for which the Metropolitan Transit Authority (MTA) is responsible for repairing or restoring

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

Setting the Tone

Imagine that we experienced a repeat of Hurricane Sandy on its first anniversary and a request was made to the Federal Government for disaster relief funding.



Nature of Stafford Act

Public Assistance program which reimburses state and local governments for the long- term rebuilding of public facilities.

Hazard Mitigation Grant Program which provides funding for state and local governments following a disaster to undertake projects to mitigate future damage.

Eligible costs: Based on pre-disaster design of the facility in conformity with codes, specifications and standards applicable at the time at which the disaster occurred.

Status of Funding for Restoring Infrastructure Damaged by Sandy

Comparing Katrina and Sandy in getting Congressional approval

Katrina: 3 days to provide $10.5 billion relief package; one week later Congress appropriated an additional $51.8 billion

Sandy: 3 months to provide $50.5 billion

Delays can be very costly due to interdependencies (e.g., business interruption)

NYC and HUD reports recommended upgrading infrastructure due to climate change

Can get funds to improve facilities but the procedure is time-consuming and needs special approval from DHS and FEMA

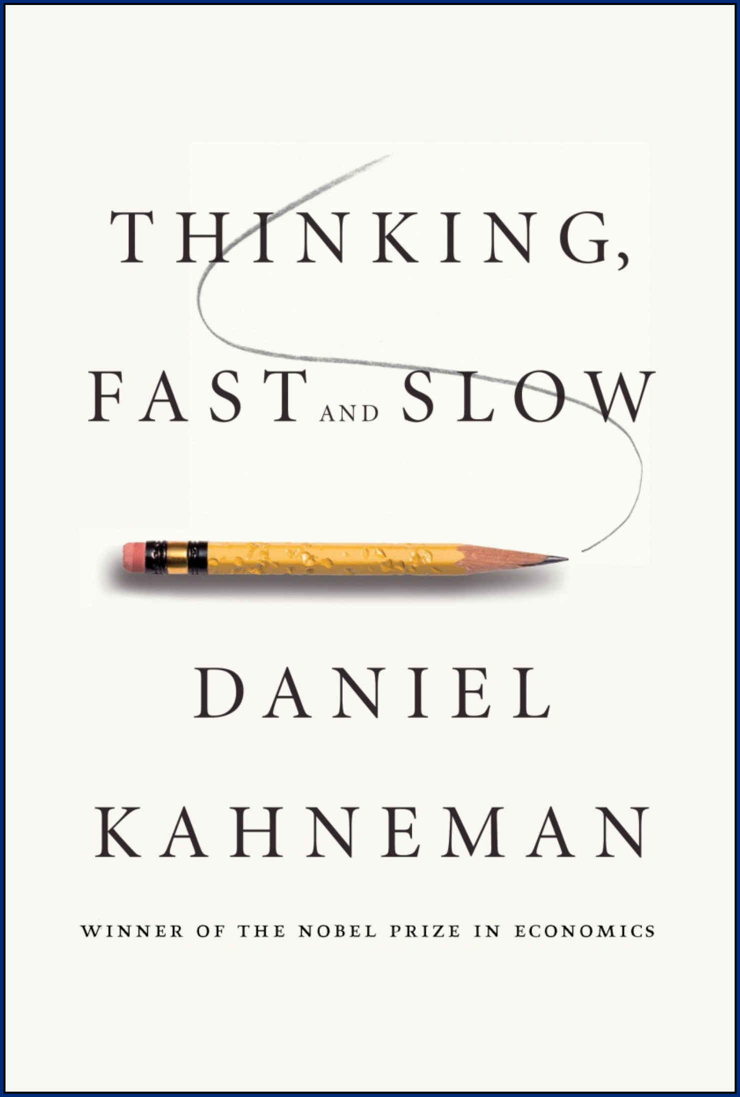
Role of Insurance in Providing Protection Against Losses from Disasters and other Catastrophes

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 such as Hurricane Sandy.

Linking Intuitive and Deliberative Thinking for Dealing with LP-HC Events



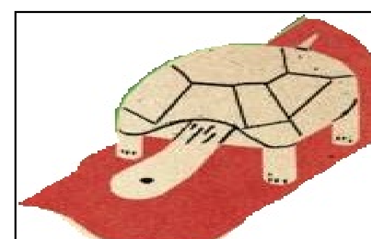
Intuitive Thinking (System 1) & Deliberative Thinking (System 2)

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**

Illustrative Example: Metropolitan Transit Authority (MTA)

Insurer Behavior: Pre- and Post-Sandy:

- Prior to Sandy, an insurer provided the Metropolitan Transit Authority with $1 billion coverage against damage from floods and other causes.
- After the storm , "It was impossible to get that kind of coverage. Even half a billion dollars' worth would have cost twice as much."

Laureen Coyne , MTA director of risk and insurance management

Responses by insurers after Sandy:

- ***Availability Bias:*** Insurers focused on enormous potential claim payments from another Sandy.
- ***Imperfect Information:*** Insurers did not adequately consider the likelihood of future hurricanes when determining premiums to charge for coverage, and how much those at risk would be willing to pay for protection.

Illustrative Example:
Metropolitan Transit Authority (MTA) (cont'd)

MTA Behavior: Post-Sandy:

- MTA was concerned about protecting itself against flood-related damage
- Purchased cat bond for $200 million for 3 years at a price of $46 million a year
  - Implied annual probability of damage of $200 million or less is 46/200= .23
  - Odds of another Sandy are 1/175 per year or approximately = .02
- Very high price to pay for this coverage.

Responses by MTA after Sandy:

- ***Availability Bias:*** MTA focused on enormous potential claim payments from another Sandy.
- ***Imperfect Information:*** MTA did not adequately consider the likelihood of future hurricanes when determining the premium it would be willing to pay for coverage.

Guiding Principles for Insurance

Principle 1: Premiums reflecting risk

Insurance premiums should be based on risk in order to provide signals to individuals as to the hazards they face and to encourage them to engage in cost-effective mitigation measures to reduce their vulnerability to catastrophes. Risk-based premiums should also reflect the cost of capital that insurers need to integrate into their pricing to assure adequate return to their investors.

Principle 2: Dealing with equity and affordability issues

Communities in high hazard areas that may need special treatment should be given low interest loans to assist them in their mitigation efforts that would come from public funding. It can be justified by avoiding the very large disaster relief bill following another large-scale disaster

Principle 3: Multi-year insurance

To provide stability and encourage investment in preventive or protective measures, insurers should design multi-year contracts with premiums reflecting risk.

Proposed Strategy for Flood Insurance for Infrastructure

Premiums reflecting best estimate of the risk

Low interest loans and/or grants to encourage investment in loss reduction measures

Multi-year insurance contracts (e.g. 5 years) with stable premiums

Insurance Supplemented by Federal Government

Role of Insurance

- Stable premiums over time
- Guaranteed claims payments with little delay
- Incentive to upgrade facilities in advance of next disaster
  - Reduced risk will lower premiums
  - Inspections to assure improvements have been made

Role of Federal Government

- Accurate maps with respect to damage from future flooding
- Providing communities with low interest loans for improving infrastructure

Making Investment in Adaptation Affordable to MTA

Cost of Adaptation Measure:

$1.5 million to make infrastructure more resistant to flood damage

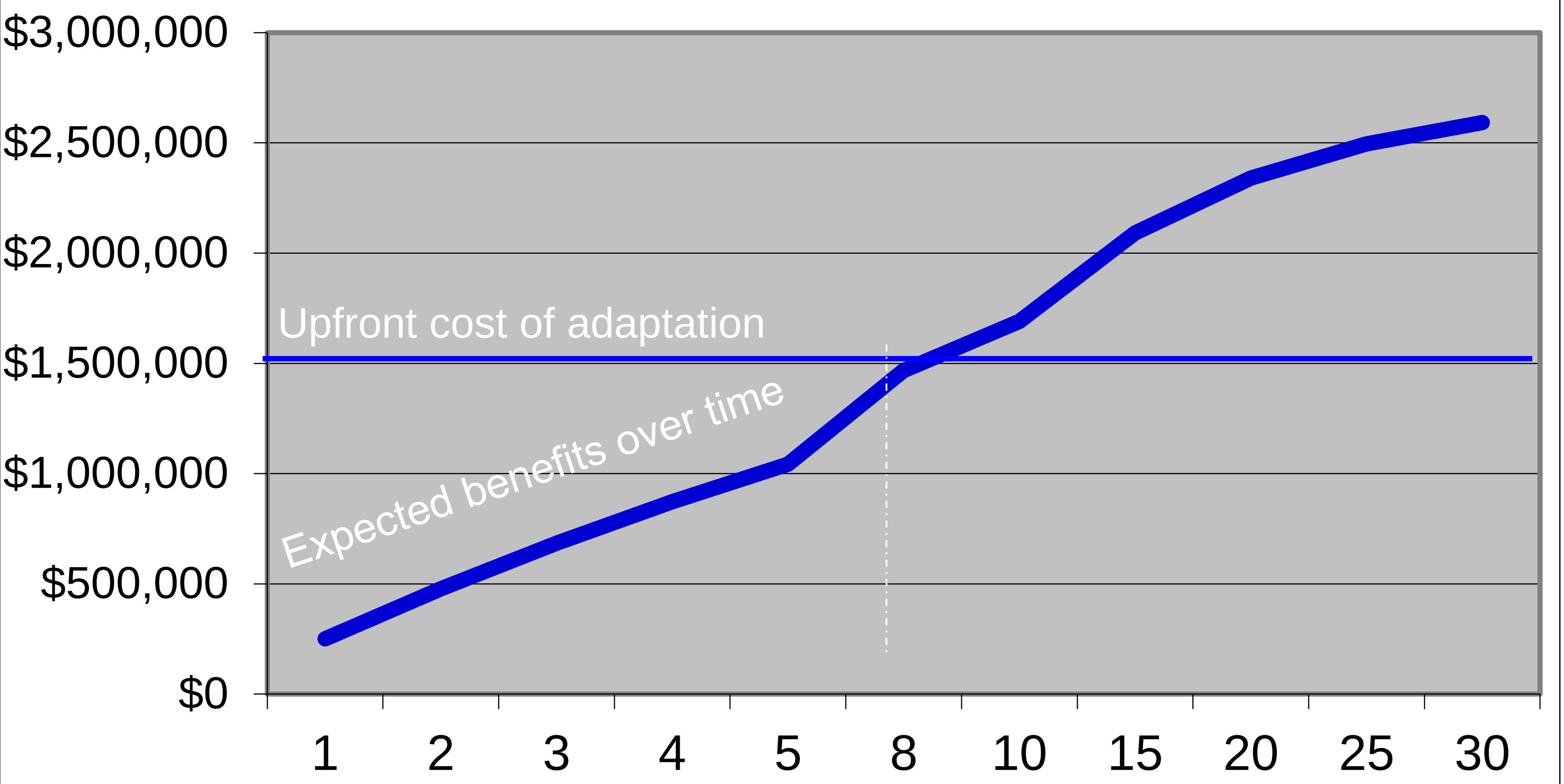
Nature of Disaster:

- 1/100 chance of storm surge from hurricane damage to MTA infrastructure
- Reduction in loss from adaptation measure ($27.5 million)

Expected Annual Benefits: $275,000 (1/100 * $27.5 million)

Annual Discount Rate: 10%

Expected Benefit-Cost Analysis of Adaptation (Annual Discount Rate of 10%)



Making Adaptation Affordable with Multi-Year Loans

Cost of mitigation: $1.5 million

Expected annual benefit of partial roof adaptation: $275,000 (1/100 * $27.5 million)

Annual payments from 20 year $1.5 million loan at 10% annual interest rate: $145,000

Reduction in annual insurance payment: $275,000

Reduction in annual payments due to adaptation: $275,000 - $145,000= $130,000

Everyone is a Winner

MTA :
Lower total annual payments

Insurer:
Reduction in catastrophe losses and lower reinsurance costs

Federal government:
Lower disaster relief costs

General taxpayer:
Less of their taxes going to disaster assistance

Questions for Discussion

- Would private insurers be willing to provide coverage against infrastructure damage with premiums reflecting risk?
- Could FEMA draw flood maps to reflect future flood-related damage to infrastructure?
- How does one factor in climate change in specifying risk-based premiums?
- Would communities and states favor an insurance-based program to cover losses from future disasters and encourage investments in adaptation measures to reduce future losses?
- Would the Federal Government provide low-interest loans for mitigation to communities that were financially stressed?
- What standards and regulations would be appropriate, and how would they be well-enforced?

Conclusions

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

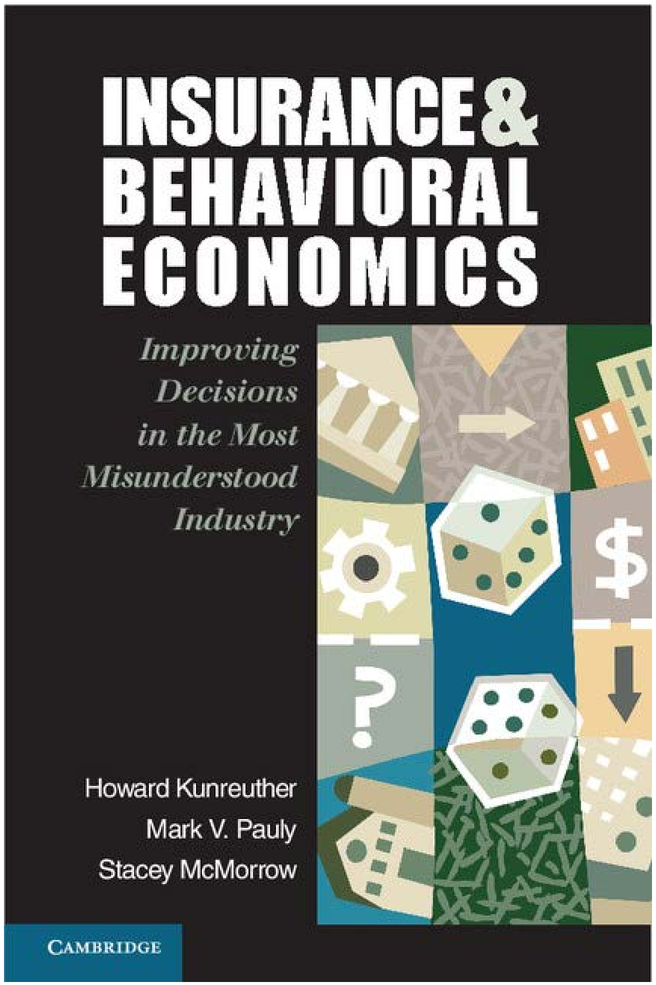
Insurers can encourage deliberative thinking for themselves and their policyholders by providing short-term incentives for acting now rather than waiting until after the next disaster.

Hurricane Sandy provides an opportunity to reevaluate the roles that insurance and adaptation measures can play in reducing future losses to infrastructure from catastrophic disasters.

The Challenges of Linking Flood Insurance with Adaptation Measures

"Jerry looked into flood insurance but says it's too darned expensive."

Insurance and Behavioral Economics: Improving Decisions in the Most Misunderstood Industry



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**