Insurance Sector Vulnerabilities to Climate Change

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Why Link Insurance & Climate Change?

• Importance
  – World’s largest industry: $3 trillion/year in revenues (= 3x “oil”)
  – Mechanism for risk averaging (financial)
  – Mechanism for risk management (physical)
  – Provides a global “observing” system
  – Complements science

• Concerns
  – Vulnerability to climate change; dangerously uses past as proxy for future
  – Increased losses threaten affordability (more uninsured)
  – Health/life risks largely unknown; unaddressed
  – Insurability/solvency in question
  – Regulation can be obstacle to “doing the right thing”
Insurance = Adaptive Capacity

• Major (and growing) means of spreading and managing the risks of extreme weather events -- today covers 20% of all weather-related damages
• Rapidly growing in developing world and economies in transition
• Availability and penetration varies widely

Premiums/capita-year highest in densely shaded areas ($5-$1000/capita-y)
Munich Re (2003)
The Type and Scale of Natural Disasters are Distributed Unevenly: 1975 to 2001

EM-DAT: The OFDA/CRED International Disaster Database (http://www.cred.be; email: cred@epid.ucl.ac.be)
Changing Nature and Structure of Events

Number of Events

1800
1600
1400
1200
1000
800
600
400
200
0

1900-1920
1930-1940
1940-1950
1960-1970
1970-1980
1980-1990
1990-2000

Natural disasters reported

1900-2000

Wind storm
Wild fire
Wave/surge
Slide
Insect infestation
Flood
Famine
Extreme temp
Epidemic
Drought

Sources: OFDA / Center for Research in the Epidemiology of Disasters (CRED) Intl database of Disasters
Spreading of Economic Costs

Weather Risks Are Spread in Five Directions

- Insurance and Reinsurers
  - Domestic
  - Foreign

- Non-Governmental Organizations and Private Donors
  - FAO
  - Red Cross
  - CARE
  - Private foundations
  - etc.

- Foreign Governments and the United Nations
  - Bilateral Aid (e.g. USAID)
  - UNOCHA
  - UNICEF
  - UNDP
  - etc.

- Individuals and Firms, as "self-insureds"
  - Householders (informally)
  - Companies (formally)

- National/Local Governments
  - Federal
  - State
  - Local
  - Village

Costs of Weather-Related Natural Disasters

- $Billion/y
- 1980-2003

- Low Income Countries
- High Income Countries

- Domestic governments & Individuals
- International Aid
- Insurers & Reinsurers

- Storm: 43%
- Flood: 40%
- Other Weather-related: 17%


- Storm: 82%
- Flood: 9%
- Other Weather-related: 9%

Source: Munich Re (2002)

The difference between total and insured losses is taken up by governments, ngo’s, self-insurers, and individuals -- insurers select risks; don’t accept all
Dynamics of Risks, Uncertainties, and Losses

Natural Phenomenon
(e.g. temperature increase)

Variability/Uncertainty
(e.g. heatwaves)

Change in Likelihood of Extreme Event
(e.g. return period)

Impact / Insured Loss
(e.g. loss of life; business interruption, etc.)
Uncertainty: Physical → Financial

“Catastrophe insurers can't simply extrapolate past experience.”

- Warren Buffett (1992)

Note: plot shows only large events and excludes health/life losses. Including small-scale events would double these numbers; health-related losses unknown

Source: Swiss Re (Sigma)
Variability

Loss amount as a percentage of the maximum annual loss

Natural Hazards

Fire

Source: Swiss Re (2002)
“CAT” Losses are Material for Insurers


<table>
<thead>
<tr>
<th>Year</th>
<th>Income (in $ million)</th>
</tr>
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<tbody>
<tr>
<td>1991</td>
<td>14,178</td>
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<tr>
<td>1992</td>
<td>5,840</td>
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<td>1993</td>
<td>19,316</td>
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<td>1994</td>
<td>10,870</td>
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<td>1995</td>
<td>20,598</td>
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<td>1997</td>
<td>36,819</td>
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<td>1998</td>
<td>30,773</td>
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<tr>
<td>1999</td>
<td>21,865</td>
</tr>
<tr>
<td>2000</td>
<td>20,559</td>
</tr>
<tr>
<td>2001</td>
<td>($6,970)</td>
</tr>
<tr>
<td>2002</td>
<td>2,903</td>
</tr>
<tr>
<td>2003</td>
<td>29,877</td>
</tr>
<tr>
<td>2004*</td>
<td></td>
</tr>
</tbody>
</table>

Sources: A.M. Best, ISO, Insurance Information Institute (Robert Hartwig)
Capital Myth: $300 Billion Available to Pay Losses

Surplus not pooled across companies. Must also back-up non-disaster related property/casualty claims and non-weather claims (e.g. terrorism). Surplus fluctuates -- sometimes significantly.

Source: Insurance Information Institute estimates based on A.M. Best Q.A.R Data. (Robert Hartwig, III)
Reinsurance Pricing Reflects Losses & Uncertainty

Losses ($B) (bars)

- 35: Typhoon Mereille, Wildfires, Drought, Hurricane Grace
- 30: Winterstorms Daria & Vivian
- 25: Northridge Earthquake
- 20: Hurricanes Opal & Lewis, Flooding, Hail, Kobe
- 15: Hurricane Georges, Typhoon Vicki
- 10: Storms, Rains, Flooding
- 5: 0

Reinsurance Price Index (curve)

- 140: Winterstorms Martin & Lothar, Typhoon Bart, Hurricane Floyd, Windstorm Anatol, Tornadoes
- 120: Hurricanes Andrew & Iniki
- 100: Northridge Earthquake
- 80: Hurricanes Opal & Lewis, Flooding, Hail, Kobe
- 60: Storms, Rains, Flooding
- 40: 0

Source: Swiss Re (2003e)
Changes in Extremes

Increase in mean and variance

(c)

Probability of occurrence

Previous climate

Less change for cold weather

New climate

Much more hot weather

More record hot weather

Source: IPCC, Third Assessment Report
Example: the 2003 European Heat Wave:
(hottest summer since 1500 AD)

- 22,000-35,000 human fatalities
- $13.6B in crop losses
- $1.7B in wildfires in Portugal alone + respiratory illness
- Nuclear power plant curtailment (insufficient cooling water)
- Unhealthy air masses (smog, particulate)

(a) Europe summer temperature anomaly with respect to 1961-1990 mean.
(b-e) Distribution of Swiss monthly and seasonal summer temperatures for 1864-2003.

Green: Fitted Gaussian distribution; Red: 2003
Source: Schar 2004 (Nature)
Vulnerabilities: Physical

• Disproportionately increasing damage functions:
  – 4x increase in wind damage for every 2x of wind speed
  – Increase in torrential precipitation: 1-in-100 year flood comes every 15 years
  – 1.4x increase in lightning for 1 deg-C increase in air temperature
  – 4x increase in wildfire damages in some areas under 2xCO2
  – *Current* warming has led to 2- to 4-times likelihood of extreme heatwaves, e.g. Europe 2003 (increase 100x in next 4 decades)
Vulnerabilities: Financial

• Underwriting
  – profitability/solvency (insufficient reserves)
  – volatility (unpredictability)
  – simultaneity (drought and flood)
  – correlation (drought-wildfire; financial markets)
  – surprise (e.g. Directors & Officers liability)

• Broader Business
  – financial market conditions
  – real estate holdings

• Market Power
  – slowed/shrinking markets (voluntary/involuntary)
  – reputation
Small-scale, Gradual, and Indirect Events Often Overlooked

- **Small-scale**
  - Subsidence, Lightning, Hail, Wildfire, Equipment Breakdown

- **Gradual**
  - Sea-level rise, Drought, Infectious diseases

- **Indirect**
  - Erosion of water quality
  - Erosion of air quality
  - Health (human, crops, etc.)
  - Amplification of poverty (slows market growth; political risk)
A/C Claims vs Cooling Degree-Days: South East

Month

Source: Hartford Steam Boiler Insurance and Inspection Co, 2001
Sea-level Rise

- Figure: 60-year coastal erosion outlook for South Bethany, Delaware -- 3 rows of homes to be lost

- 25% of homes within 150 yards of current high-tide mark at risk over next 60 years. Water quality. Wetlands.

Source: Heinz Center (for FEMA)
Health

- Heat catastrophes
- Pollen/Mold - health; liability ($5B)
- New diseases: Nipah virus - highly contagious; lethal in > 40% of cases
- Insect super-infestations
- Crop diseases
- Coral bleaching - coastal protection; tourism; fresh water salinization
Vector-born Diseases: Malaria

- Outbreaks following extreme rainfall events: more of which expected under climate change: Maputo, Mozambique

- Changes in Range: Zimbabwe

• Relevant weather-related risks include: Civil unrest, supply-chain disruption, resource-related conflict, government actions
• Level of risk tied to degree and effectiveness of post-event public-sector efforts

Source: www.aon.com/politicalrisk
Emerging Markets are the Future of Insurance, and are Particularly Vulnerable

Already over $300 billion/year in premiums

Demand growing faster than GDP

Eleven Percent of $2.9 Trillion/year Global Insurance Market is in Developing Countries and Economies in Transition: 2003

Economic Risks Rapidly Becoming Globalized

Foreign Participation in Insurance Ownership: 1998

Example: Insured losses from the 2004 Tsunami projected to fall between $5 and $10 billion
Response Options

• Reactive
  – Higher premiums
  – Higher deductibles
  – Lower limits
  – Exclusions
  – Non-renewal
  – Withdraw from markets

• Proactive
  – Building codes
  – Disaster preparedness; recovery; education
  – Public policy
  – Integrating emissions reduction and risk management
  – Science

--> Insurability is key issue
Integrating Energy Management & Risk Management

Energy-efficient torchiere lights also eliminate significant fire hazard
Where Science Meets Society (Research Needs)

• Insurers have much to offer: historical data, current exposures, actuarial techniques
• No-regrets opportunities for insurers
• Needed: better understanding of the risk management dimensions of sustainable energy technologies
• Integration of historically-based “CAT” modeling with forward-looking climate modeling --> maintain/increase insurability
Value of Coupled Models:
e.g. Permafrost Melt Hazard Potential

Settlement of several meters is possible.

Vulnerability:
- Buildings
- River terminals
- Natural gas production
- Pipelines
- Electric transmission
- Roadways/rail

More Information

http://eetd.lbl.gov/insurance