From Risk to Opportunity:
Insurer Responses to Climate Change

Evan Mills, Ph.D.
Staff Scientist
U.S. Department of Energy
Lawrence Berkeley National Laboratory

Valuation Actuary Symposium
Washington, DC
September 25, 2008
Our atmosphere is as thin -- in proportion to the Earth’s diameter -- as a film of condensation on a steel ball.
Tectonic Shifts

• “In recent years, science has deepened our understanding of climate change ... The United States takes this issue seriously.”
  - George W. Bush Administration (2007)

• “Greenhouse gases are air pollutants”
  - U.S. Supreme Court (2007)

• “Climate change and abuse of the environment is against God’s will”
  - The Vatican (2007)
For Insurers, Climate Change is an Emerging Risk to be Managed...

Insurers are....
– messengers
– integrators
– risk assessors
– risk managers

but...
– vulnerable
– flying partly blind
– selective

and....
– part of the solution
The Scientific Consensus
Nobel Peace Prize: 2007

Intergovernmental Panel on Climate Change
~1500 Authors; 1000 Reviewers
Unanimously adopted by 100 + nations (including U.S.)

IPCC Fourth Assessment Report
Co-Recipient of the 2007 NOBEL PEACE PRIZE

http://www.ipcc.ch

Warming of the climate system is unequivocal, with human activity the primary cause.

- No credible alternative theory
- Impacts observable today
- Change is accelerating
- Inaction is more costly than action
- Not “too late”: Solutions possible (and affordable)
- Must adapt and reduce emissions
Mars
Thin atmosphere
(All CO₂ in ground)
Average temperature : - 50°C

Earth
0.03% of CO₂ in the atmosphere
Average temperature : + 14°C

Venus
Thick atmosphere
containing 96% of CO₂
Average temperature : + 420°C

The Climate System

Source: Intergovernmental Panel on Climate Change, Fourth Assessment Report, WGI (2007)
Key Gases

Peak natural variability over the previous 650,000 years

Carbon Dioxide

Methane

Nitrous Oxide

Source: Intergovernmental Panel on Climate Change, Fourth Assessment Report, WG I (2007)
Net effect of cooling + warming influences...

...is warming

Source: Intergovernmental Panel on Climate Change, Fourth Assessment Report, WG I (2007)
FINGERPRINTS...
Recent Indicators of Climate Change

Global average temperature (accelerating)

Global average sea level

Northern hemisphere snow cover (accelerating)

Linear Warming Trend
Areas with a “+” significant at the 5% level

Annual Trend 1979 to 2005

Source: IPCC: grey indicates insufficient data, 18-years of data used to compute trend.
The difference between median minimum arctic ice coverage and the extent on Sept. 16, 2007 is "equal to the area of Alaska and Texas combined" (2.61 M sq. km or 1 M sq. miles). http://nsidc.org/news/press/2007_seaiceminimum/20070810_index.html
FINGERPRINTS ... Glaciers

Loss Accelerating since early 1990s

Linear Land Precipitation Trend
Areas with a “+” significant at the 5% level

Trend in Annual Precipitation, 1901 to 2005

Source: IPCC: grey indicates insufficient data. The minimum number of years required to calculate a trend value is 66 for 1901 to 2005 and 18 for 1979 to 2005. Baseline 1961-1990
There’s a consistent 50-year upward trend in every region except Oceania.
FINGERPRINTS ... Drought

Change in Palmer Drought Severity Index (PDSI) for 1900 to 2002

Proportion of land area in extreme drought predicted to increase from 1-3% to 30% by 2090s.

Drought duration expected to increase 6-fold.

The trend has been sharply upward everywhere; CO2 feedback is significant.
Overwhelming Correlations
IPCC Synthesis of Scientific Literature on Observed Changes 1970-2004

577 studies reviewed by IPCC

• 765 observed physical changes (94% consistent with warming)

• 28,671 observed biological changes (90% consistent with warming)

“Frequently Asked Questions”

- **“Why worry, aren’t we going into another ice age anyway?”**
  - Yes, but not for 10’s of thousands of years. Meanwhile, the earth is dangerously warming over a timeframe of decades.

- **“Isn’t there ‘global warming’ on Mars, too?”**
  - Not global, regional (just at south pole)
  - Caused by dust storms; cycles a lot each year
  - Sunspots change climates on any planet, but effect is swamped by CO2 on earth

- **“In geological history, didn’t CO2 increases follow temperature?”**
  - No, actually largely simultaneous.
  - Other processes (e.g. biomass die-offs, ocean circulation, Milankovitch cycles, etc.) often start a warming process, which often mobilizes CO2, which then amplifies the warming
  - In any case, we know without a doubt that last 100 years of warming has followed emissions extremely tightly, and validated models tell us this will continue

- **“Yeah, but you guys used to say we had global cooling.”**
  - Mostly northern hemisphere, not global
  - Caused by sulfate aerosols temporarily masking CO2 induced warming & suppressing hurricane activity

- **Have you read David Chrichton’s book?**
  - If I need brain surgery, I’m not going to go to a podiatrist!

Donuts Exist Despite the Holes

Source: Krispy Creme
Climate Modeling Has Become Far More Precise

1990  FAR
-500 km (T21)

1995  SAR
-250 km (T42)

2000  TAR
~180 km (T63)

2005  AR4
~110 km (T106)

Source: Intergovernmental Panel on Climate Change, Fourth Assessment Report, WG I (2007)

25x improved resolution!
Attribution

Our models predict history very well, so we are confident in their ability to project future impacts.

If we don’t alter course, we’ll end up where we’re headed

Global average surface temperature is an index of the state of the climate – and it’s heading for a state not only far outside the range of variation of the last 1000 years but outside the range experienced in the tenure of Homo sapiens on Earth

Source: John Holdren, after IPCC (2007)
Range of Predicted Warming: By Scenario and Timeframe

Extreme differences in “tails”

Source: Intergovernmental Panel on Climate Change, Fourth Assessment Report, WG I (2007)
Anticipated Insurance Losses

**Property**
- Property damage
- Marine mishaps
- Mold/moisture
- Forest products
- Agricultural losses
- Fisheries
- Business interruption
- Roadway

**Life/Health**
- Injury
- Infectious diseases
- Vector-borne diseases
- Heat stress
- Respiratory
- Pollution release
- Food safety
- Mental health
- Nutrition/water
- Roadway safety

**Liability (Casualty)**
- Products
- Negligence
- Nuisance
- Fiduciary
- Tort / BI
- Environmental
- Roadway liability insurance
US CAT Losses: 1980-2005

- This is not simply the effect of climate change
- Combined effects of demographics and warming

but.....

- **Number** of events is rising
- Trends are consistent with observed change
- Non-weather losses are growing more slowly
- Trend would be even steeper without prevention efforts


Excludes life/health losses
Changes in Extremes

Increase in mean and variance

(c) Previous climate

Less change for cold weather

New climate

Much more hot weather

More record hot weather

Source: IPCC, Third Assessment Report
Extremes Shift More Than Avg

Small changes in averages...

... but extremes are becoming normal...

... and “tails” are getting longer

Source: Alexander, et al, J. Geophysical Research, 2005
"The bottom line is that there are very real health risks associated with climate change."

- Centers for Disease Control and Prevention (CDC) epidemiologist Howard Frumkin

CDC spends less than $1 million per year on climate related programs

World Health Organization (WHO) estimates 150,000 yearly deaths from climate change (as of 2000).

Correlation of Disease Clusters with the 1997-1998 El Nino Extremes

El Nino expected to become more frequent under climate change

Source: P. Epstein, Harvard Medical School, Science
Salmonella

Figure 4.2 Relationship between mean temperature and monthly reports of Salmonella cases in New Zealand 1965 - 2000

Rare Extremes Cause Most of the Damages & Insured Losses

The European heat wave of Summer 2003

Insurance Losses:
- wildfire/property
- crop
- power sales
- health/mortality

Event was “six-sigmas” outside of norm. 16°F above average in France and Germany was a 1-in-10,000 event to 1-in-46,000 event

Change in Frequency of Extreme European Heat Waves

Change in Risk is 4x

Current

Under Human-Induced Climate Change (1.6C above 1960-1990 mean)

Source: IPCC AR4, Corresponds to 1.6C change in mean
Changes in Severe US Heatwaves

Number of Heat Waves per Decade

- Lower Emissions
- Higher Emissions
Northward Expansion of Kidney-stone “Belt”: 2000-2095

Population grows from 40% to 56% by 2050; 70% by 2095 - increase of 1.6-2.2 million cases, at cost of ~$1 billion per year.

Human Health Impacts

Respiratory Disease

- Pollen
- Mold
- Smoke and particulates
- Photo-chemical air pollution

WHO estimates 150,000 human mortalities each year due to current climate change.

Alaska: Summer 2004

Fairbanks: June 28, 2004

July 6, 2004
Temperature of Public Opinion

• In 2007, twice as many people believed climate change is here than did in 2004

• But public opinion lags scientific certainty by a significant margin

72% of the public are mostly or completely convinced

And.... diminishing differences by political party affiliation

Insurance Customers Impacted

Ski County April 1 Snowpack Loss, 1976 to 2085*

*1976 represents the average from 1941 to 1990, and 2085 represents the average from 2070 to 2090.

**Snowpack Loss:** -X%
Shareholder Climate Resolutions (United States)

Carbon Disclosure Project

Annual questionnaire on business risks and opportunities presented by climate change and greenhouse-gas emissions data from the world's largest companies

Run by Institutional Investors:

$57 Trillion under management
(major holdings in insurance)

Started in 2000, the CDP now has 385 signatory investors, including Merrill Lynch, Goldman Sachs, Morgan Stanley, AIG Investments, Barclays and HSBC are among current signatories.

Currently polling 3800 companies

Source: http://www.cdproject.net/
Insurance Regulators Recognize the Problem

“Global warming is upon us, and it poses unprecedented new threats to the insurance industry and vast segments of society that rely on insurance for peace of mind and financial security.”

Michael Kreidler
Washington Insurance Commissioner

Tim Wagner (deceased)
Nebraska Insurance Commissioner
The Business Climate is Also Changing


* Sylvie Lemmet, Division of Technology, Industry and Economics, UNEP.
## Top Concerns:
Survey of 139 Insurance Executives in 21 Countries

<table>
<thead>
<tr>
<th></th>
<th>Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Too much regulation</td>
</tr>
<tr>
<td>2</td>
<td>Natural catastrophes</td>
</tr>
<tr>
<td>3</td>
<td>Management quality</td>
</tr>
<tr>
<td>4</td>
<td>Climate change</td>
</tr>
<tr>
<td>5</td>
<td>Managing the cycle</td>
</tr>
<tr>
<td>6</td>
<td>Distribution channels</td>
</tr>
<tr>
<td>7</td>
<td>Long-tail liabilities</td>
</tr>
<tr>
<td>8</td>
<td>Actuarial assumptions</td>
</tr>
<tr>
<td>9</td>
<td>Longevity assumptions</td>
</tr>
<tr>
<td>10</td>
<td>New types of competitors</td>
</tr>
<tr>
<td>11</td>
<td>Investment performance</td>
</tr>
<tr>
<td>12</td>
<td>Managing technology</td>
</tr>
<tr>
<td>13</td>
<td>Equity markets</td>
</tr>
<tr>
<td>14</td>
<td>Risk-management techniques</td>
</tr>
<tr>
<td>15</td>
<td>Back office</td>
</tr>
<tr>
<td>16</td>
<td>Political shocks and pressures</td>
</tr>
<tr>
<td>17</td>
<td>Pricing new risks</td>
</tr>
<tr>
<td>18</td>
<td>Terrorism</td>
</tr>
<tr>
<td>19</td>
<td>Complex instruments</td>
</tr>
<tr>
<td>20</td>
<td>Retail-sales practices</td>
</tr>
<tr>
<td>21</td>
<td>Pollution</td>
</tr>
<tr>
<td>22</td>
<td>Interest rates</td>
</tr>
<tr>
<td>23</td>
<td>Corporate governance</td>
</tr>
<tr>
<td>24</td>
<td>Demographic trends</td>
</tr>
<tr>
<td>25</td>
<td>Contract wording</td>
</tr>
<tr>
<td>26</td>
<td>Capital availability</td>
</tr>
<tr>
<td>27</td>
<td>Security of reinsurance</td>
</tr>
<tr>
<td>28</td>
<td>Availability of reinsurance</td>
</tr>
<tr>
<td>29</td>
<td>Business continuation</td>
</tr>
<tr>
<td>30</td>
<td>Fraud</td>
</tr>
<tr>
<td>31</td>
<td>Merger mania</td>
</tr>
<tr>
<td>32</td>
<td>Too little regulation</td>
</tr>
<tr>
<td>33</td>
<td>Asbestos</td>
</tr>
</tbody>
</table>

Source: Centre for the Study of Financial Information and PricewaterhouseCoopers survey: 2007
Climate Change is #1 Risk, According to >70 Insurance Industry Analysts
(Ernst & Young Survey, March 2008)

1. Climate change
2. Demographic shifts in core markets*
3. Catastrophic events*
4. Emerging markets*
5. Regulatory intervention*
6. Channel distribution
7. Integration of technology with operations & strategy
8. Securities markets*
9. Legal risk*
10. Geopolitical or macro-economic shocks*

*Also influenced by climate change
Challenges for insurers

• Rising magnitude of losses; shorter return periods
• Increased variability
• Non-linear/abrupt change
• Changing geography of losses
• More correlation among losses
• Population moving into harm’s way
• Data and CAT-model blind spots
• Risks and opportunities in asset management

A future unlike the past
Erosion of insurability
Insurability

“Radical changes in natural catastrophe frequency and/or severity could eliminate certain of our markets through physical damage, price escalation, or regulatory activity... unpredictability could negate the use of actuarial techniques and undermine our ability to price and risk-manage product offerings.”

ACE Limited response to the fifth annual Carbon Disclosure Project questionnaire
Climate Change is Integral to Mainstream Insurance Issues

- Customer retention
- Corporate governance, investor relations, & disclosure
- Balance sheet strength & solvency
- Competitiveness
- Emerging markets
- Reputation & trust
- Modeling weaknesses: Past vs future
- Regulation
- Government entry into risk markets
- Macro-economic trends; security
- **Insurability**: availability & affordability

*Climate Change is a “textbook” issue for Enterprise Risk Management*
PERFECT STORM
Cincinnati Financial
Results: Q1 - 2007 and

Double-Whammy of troubled economy and high energy

fewer boat purchases
+ more repossessions
+ more time laid up

= Falling premiums and fewer customers

... but also fewer losses
Insurance Paradigm Shift

Best's Review

Growing Green

National Underwriter

Insurers Brace For GLOBAL WARMING

Top Stories of The Week

State Regulators, Legislators Close Ranks Against DFS

State regulators and legislators—then at odds over the past year—have united the barrier in a new spirit of unity; driven by the possibility the federal government could soon move into that void. Page 6, 8

Cal Plum Slams At NCOIL

State lawmakers were unable to bring a resolution supporting a national catastrophe bond bill to a vote last week, but will continue to debate the measure this summer following further industry input. Page 7

Bill To Expand RBC Act Would Include Property Risks

A bill will be introduced in Congress seeking to expand the Liability Risk-Based Capital Act to cover property insurers, according to a White House official. It is more expected to have strong support from coalitions. Page 7

Buffett: The Party's Over?

After Berkshire Hathaway Inc. reported a 19 percent drop in fourth-quarter net income, its chairman, Warren Buffett, offered sharp criticism of rating agencies, and the premium rate for insurer point estimates. Page 10

International Update

Ottawa, Legal
Changes in
First
Insurer
Foreign
Markets
Page 14

Back to
The Future

Epilepsy
Riders: Few
Little Has
 Changed
Since 2000
Page 5
From Risk ... to Opportunity

30 strategies; 422 examples
~190 parties; 26 countries ... and counting

About 40% are U.S. companies...
New Insurer Business Units

- "Office of Environment & Climate Change"
- "Advanced Energy Solutions"
- "Climate Solutions"
- "Agri-Fuels Group"
- "Green Energy Team"
- "Core Business Climate Change Project"
- "Climate Change Advisory Council"
## Insurers are innovating!

<table>
<thead>
<tr>
<th>STRATEGY</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Understanding the Problem</td>
<td>Improved data &amp; CAT modeling</td>
</tr>
<tr>
<td>2. Promoting loss prevention</td>
<td>Protecting mangroves &amp; wetlands</td>
</tr>
<tr>
<td>3. Rewarding risk-reducing behavior</td>
<td>Mileage-based auto insurance</td>
</tr>
<tr>
<td>4. Crafting innovative insurance products</td>
<td>Green-buildings products</td>
</tr>
<tr>
<td>5. Carbon risk-management and reduction services</td>
<td>Offsets bundled with insurance</td>
</tr>
<tr>
<td>6. Financing improvements</td>
<td>Loans for energy-efficiency upgrades</td>
</tr>
<tr>
<td>7. Direct investment</td>
<td>Development of wind farms, etc.</td>
</tr>
<tr>
<td>8. Engaging in public policy</td>
<td>Calling for deep emissions cuts</td>
</tr>
<tr>
<td>9. Leading by example</td>
<td>Going “carbon-neutral”</td>
</tr>
<tr>
<td>10. Carbon risk disclosure</td>
<td>Responding to Carbon Disclosure Project</td>
</tr>
</tbody>
</table>
Aligning Terms & Conditions with Risk-reducing Behavior

• Insurance discounts of up to 40% for low mileage:
  – Aioi
  – Axa
  – GMAC
  – Hollard
  – Milemeter
  – Norwich Union
  – Polis Direct
  – Progressive
  – Rheinland
  – Sompo
  – Tokio Marine Nichido
  – Unigard
  – Versicherungen

250,000 policies in Europe as of 2007; $700M revenues projected by 2010

General Motors Acceptance Corporation (GMAC) PAYD discount schedule.

<table>
<thead>
<tr>
<th>Miles/year</th>
<th>Discount offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 2,500 miles</td>
<td>40%</td>
</tr>
<tr>
<td>2,501 – 5,000</td>
<td>33%</td>
</tr>
<tr>
<td>5,001 – 7,500</td>
<td>28%</td>
</tr>
<tr>
<td>7,501 – 10,000</td>
<td>20%</td>
</tr>
<tr>
<td>10,001 – 12,500</td>
<td>11%</td>
</tr>
<tr>
<td>12,501 – 15,000</td>
<td>5%</td>
</tr>
<tr>
<td>15,001 – 99,999</td>
<td>0%</td>
</tr>
</tbody>
</table>

Some use GPS → stolen-vehicle recovery; avoids reporting fraud
Direct Investment

- **Allianz**: $15 million in the European Carbon Fund; plans to invest between $400 and $650 million in renewable energy

- **Gerling**: Sustainable Development Project operates a $100 million venture capital fund

- **ING**: Green finance - $1.16 billion

- **Sompo Japan**: $100 million green fund

- **Swiss Re**: $429 million “clean energy” venture fund; $320 million in individual investments

2008 CERA study predicts $7 trillion investment in “clean-energy technologies”.
Financing Emissions-reduction Projects

- **AIG:** $300 million lending facility for efficiency and clean energy

- **Fortis:**
  - Preferential lending rate for energy-efficiency upgrades +10% premium discount
  - $106 million “Green Bank” loans

- **HSBC:** $45 million for wind projects in India

- **Mitsui Sumitomo:** Loans for building-integrated solar systems

- **TrygVests:** $10k financing for “climate-friendly home energy upgrades” after loss.
Carbon Risk Disclosure

Carbon Disclosure Project: Annual Global Survey by Institutional Investors ($57 Trillion under management)

- AIG, Allstate, Aon, Chubb, Marsh, MBIA, Safeco, St. Paul Travelers, Unum Provident, Munich Re, others...

Source: http://www.cdproject.net/
Roles for Actuaries

1. Help your management make sense of the science, debates, and the business implications
2. Incorporate climate change effects into models & “stress-testing”
3. Understand the risk profiles of climate change responses
4. Participate in the development of “green” products & services
5. Assess comparative risks of “green” asset management strategies
“When the winds of change blow, some build walls ... others build windmills.”

- Chinese Proverb

http://insurance.lbl.gov
emills@lbl.gov
“When the winds of change blow, some build walls ... others build windmills.”

- Chinese Proverb

http://insurance.lbl.gov
emills@lbl.gov