Availability and Affordability of Insurance Under Climate Change

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* Ceres White Paper
** Climate Change Futures Study (Swiss Re/UNDP)
The Greenhouse effect

**ATMOSPHERE**

**SUN**

Some solar radiation is reflected by the atmosphere and earth’s surface

**Outgoing solar radiation:** 103 Watt per m²

Some of the infrared radiation passes through the atmosphere and is lost in space

**Net outgoing infrared radiation:** 246 Watt per m²

**GLOBE**

Solar radiation passes through the clear atmosphere.

**Incoming solar radiation:** 343 Watt per m²

Not incoming solar radiation:

246 Watt per m²

**GREENHOUSE GASES**

Some of the infrared radiation is absorbed and re-emitted by the greenhouse gas molecules. The direct effect is the warming of the earth’s surface and the troposphere.

Surface gains more heat and infrared radiation is emitted again

Solar energy is absorbed by the earth’s surface and warms it...

168 Watt per m²

...and is converted into heat causing the emission of longwave (infrared) radiation back to the atmosphere

**EARTH**
Causes of Global Warming (and Cooling)

Influences: Natural
- Solar activity
- Volcanoes
- Biological

Influences: Human
- Fossil fuels
  - GHGs
  - Particulates
- Agriculture, Cattle
- Deforestation
- Aircraft contrails

Sources and “Sinks”
Climate change leads to a range of important impacts

Physical Processes
- Air & water temperatures
- Ice
- Precipitation
- Soil moisture
- Ocean currents
- Sea level
- Permafrost
- Weather

Human Relevance

Health Impacts
- Weather-related mortality/heat stress
- Infectious diseases
- Air quality-induced respiratory effects

Agriculture Impacts
- Crop yields and commodity prices
- Irrigation demands
- Pests and weed

Forest Impacts
- Change in forest composition
- Shift geographic range of forests
- Forest health and productivity

Water Resource Impacts
- Changes in water supply and timing
- Water quality
- Increased competition for water

Coastal Area Impacts
- Erosion of beaches
- Inundation of coastal wetlands
- Costs to defend coastal communities

Ecosystem Impacts
- Shifts in ecological zones
- Loss of habitat and species
- Coral reefs threatened
The Primary Human Influence is Fossil Fuels Combustion
Fingerprint: Rise in Number and Change in Mix of Weather/Climate Disasters

Source: Center for Research in the Epidemiology of Disasters (CRED)
The Scientific Consensus on Climate Change

1300 Authors; 1100 Reviewers
Unanimously adopted by 100+ nations (incl U.S.)

National Academies of Science:
- Brazil
- Canada
- China
- France
- Germany
- India
- Italy
- Japan
- Russia
- United Kingdom
- United States of America
Natural Forcing

Natural (solar + volcanic) forcing alone does not account for warming in the past 50 years.

Anthropogenic Forcing Only

human influences alone (greenhouse gases and sulfate aerosols) brings the models and observations into pretty good agreement.

Natural and Anthropogenic Forcing

Fingerprint:
Temperatures higher than in past 1000 years, and increasing at fastest rate over this period

Prime cause of observed warming is human activity (IPCC 2001)

“Warming Commitment” is even greater:
Most of warming temporarily locked in the oceans
Fingerprint: Loss of Ice & Snow Cover

1979

1979-2003: 44% reduction in thickness

2003

• Contributes to sea-level rise
• “Darkens” Earth’s surface [undesirable feedback]
• “Freshens” northern oceans
• Melting permafrost

90 deg N
August 7, 2004
Harvard University expedition to North Pole
The Greening of Greenland

Source: Alley et al. Science (21 October 2005)
Fingerprint: Melting Land Ice

Near complete disintegration of Jackobshavn Isbrae, Greenland’s largest outflow glacier

Alley et al., Science (21 October 2005) -- Landsat
Florida under 4m Sea-level Rise
South Bethany, Delaware -- 3 rows of homes to be lost. Source: FEMA
The Ocean Conveyor Belt

In this week’s *Nature*: 1998-2004 30% reduction in observed flow at 25°NL = Heat equivalent of 500,000 power plants (Bryden et al.)
We’ll pass the 2xCO$_2$ Milestone ~2050

Air Temperatures

With increased warming, net impacts become increasingly negative

Source: NOAA (Geophysical Fluid Dynamics Laboratory)
Changes in Averages Create Even Greater 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
Small-scale, Gradual, Diffuse, and Indirect Events Often Overlooked

- Blackouts
- Crop damages
- Drought
- Equipment breakdown
- Eroded air quality
- Eroded water quality
- Hail
- Ice Storms
- Infectious diseases
- Lightning
- Mudslides
- Sea-level rise/Coastal erosion
- Sinkholes
- Subsidence
- Thunderstorms
- Tornados
- Vehicle damages/injuries
- Wildfire
- Winterstorms

Greater combined impacts than CATs in an average year.
Weather Events: Multiple Regions and Types

Inflation-Corrected U.S. Loss Trends
Disasters Not Just a “Coastal” Issue

~99% Weather Related
Health Impacts

• Human Systems
  – Heat stress
  – Respiratory disease
    • Pollen
    • Mold
    • Smoke and particulates
    • Urban air pollution
  – Infectious diseases
  – Food poisoning
  – Water quality
  – Injury/death from disasters
  – Environmental contamination

• Natural Systems
  – Crops & livestock
  – Coral reefs
  – Forest health
  – Biodiversity

The European heat wave of Summer 2003

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

WHO estimates 150,000 human mortalities each year due to current climate change
Fingerprints: Wildfire
(acres burned per fire: U.S. 1960-2004)
Projected Change in California Wildfires under a Doubling of CO$_2$

**RMS Scenario:** $4.7$ B insured loss (current climate)

Source: Fried et al, Climatic Change, using CDF models
CLIMATE CONNECTIONS: The Example of Wildfire

Climatic Factor

Temperature Increase
- Temperature leads to more rapid forest-pest reproductive cycle

Summer Drought
- Weakens trees; Dries fuel

Increased Wind; Increased Lighting
- Ignition

Extreme Precipitation
- Increased fuel load and risk of flood and mudslide

Physical Consequences

Physical Impacts

Economic & Insurance Implications

Feedback: CO₂ emissions back to atmosphere

Alaska: 2005

Timber loss; eroded property values; tourism

Smoke and particulates (ragweed pollen post-event)

Respiratory and Heart Disease

Property Loss
Alaska: Summer 2005

Unhealthful air conditions over most of state

800 miles
Wildfire & Air-Quality Links: Alaska: Summer 2004

2.5 Micron Airborne Particulate Matter - 24 hour Daily Average Values
Downtown Fairbanks, Alaska: June 15 - September 20, 2004

Date, 2004

Notes: 24 hr. average is from midnight to midnight, Alaska Standard Time, using available hours of data.
Average summertime particulate value for the Fairbanks area is 10 μg/m³.
Fingerprint: Lightning

Lightning-related damages accelerate with temperature

Examples of Losses:

State Farm: $330M/year in claims
Factory Mutual: 3-4% of claims

- 50% wildfires in western US
- >3000/year: structural, vehicle fires
- 30% of power outages
- 80% of petroleum storage accidents
- 346 incidents, 81 nuclear sites: 1990s
- $2B/year: airline operating costs
- 100,000/y: desktop computer losses
- Traffic signal outages

Source: www.lightningsafety.com
Power Outages


- Undefined Weather: 2%
- Windstorm: 26%
- Non-weather-related: 38%
- Wildfire: 3%
- Temperature Extremes: 0.3%
- Ice/Snow: 19%

U.S. total ~$80B/year

Current insured portion unknown: most are below ISO/PCS threshold for being “worth” counting

RMS Scenario: $2.7B for NY

Power outages were a factor in slowness of draining New Orleans following Katrina. Also important for contingent business interruption.
“Catastrophe insurers can't simply extrapolate past experience.”

- Warren Buffett (1992)

Non-climate factors are a factor, but...

• Trends consistent with observed climate changes
• Without prevention, losses would have been higher
• Only large events included: excludes
  - offshore; aviation
  - health/life losses
  - small-scale events

Variability is increasing

INDEX: 1980 = 1.00

Global Insured Weather-Related Losses

Increasing Faster than Premiums, Population, or GDP

2004: $44.7 billion
2005: $75 billion (est.)

Notes: All economic values inflation-adjusted to 2004 levels. Losses from Munich Re NatCat Service; premiums from Swiss Re, Sigma. Values for 2005 are LBNL estimates.
CATs Play Key Role in Profitability

P&C Combined Ratios: 1982-2004

Source: AM Best, Aggregates & Averages

Excludes effect of small weather-related events
Effected Business Segments

• Most direct lines + Reinsurance [P/C & L/H]
  – Homeowners
  – commercial multi-peril
  – business interruption
  – auto (personal/commercial)
  – inland marine
  – Aviation
  – Crop
  – offshore energy
  – equipment breakdown
  – liability (several forms)
  – life/health

• Surplus lines; Guaranty Funds; Residual Markets; Risk Retention Groups; ART; and… public-sector insurance programs

  *Emerging Markets are a major “hotspot”*
Availability Problems

- Number of Insurers in Market
- Water Damage Losses as % of Total
Why Worry? - Underwriting

• Compounds existing insurance problems
  – Mold, Respiratory Disease, Corporate Governance/Liability…
• Complicates catastrophe finance and recovery planning
  – Shorter return periods
  – Increasing variability
  – New types of (unanticipated) losses; shifting locations
  – “Cat-following-Cat” (e.g., windstorm and flood)
  – Unexpected correlation (e.g., power outage + flood)
  – Increases not necessarily predictable or gradual
• Profitability/solvency
• Flying (partly) blind
  – Seriously incomplete, and increasingly proprietary loss data
  – Financial and physical CAT models based on past outcomes

The future will not mirror the past
Why Worry? - beyond underwriting

• Asset Management
  – Weather-sensitivity of investments
  – Real estate holdings

• Operations
  – Ability to function in post-disaster settings

• Market Power
  – Slowed or shrinking market
    • voluntary - withdrawal
    • involuntary - knock-on effects
    • shift from U.S. to Europe/Asia -- where foresight is greater?
  – Reputation risk [and rising shareholder concern]

• Indirect Effects
  – “Dust-bowl plus Depression” syndrome
  – Escalating energy prices & inflation bad for insurance market
  – Impacts of climate change on insurance customers
Recommendations: Insurers

• Improve loss data collection and analysis
• Analyze implications of climate change on underwriting, investments, and customers; share the results with shareholders
• Engage in weather/climate research and modeling
• Create an industry-driven activity improving on the climate change insurance working group that was briefly active in the mid-1990s
• Promote loss prevention (e.g. building codes, preparedness)
• Lead by example in reducing corporate climate footprint
• Develop new products, policy action and technical measures to achieve greenhouse-gas emissions reductions; can have direct collateral benefits for insurance core business
It has become evident that climate change will continue to challenge insurers and state insurance regulators. Inevitably, this will pose a threat to the availability of essential insurance coverage for consumers.

NAIC (2005)
Regulator Concerns

After New Orleans, it's becoming clearer that we are experiencing more frequent and more powerful weather events that pose huge challenges for the insurance industry. … This is both a coastal issue and a heartland issue.

Tim Wagner, Director Nebraska Department of Insurance (2005)
Recommendations: Regulators

- Review the “standards of insurability” to identify new challenges, domestically and abroad
- Incorporate climate risks in solvency and consumer-impact analysis - climate change not priced into market
- Encourage insurers to collect and disclose data on applicable exposures & losses
- Improve catastrophe modeling to include climate change
- Assess exposures of insurer investments to weather extremes and adequacy of capital and surplus
- Identify and remedy undue barriers to constructive insurer activities [ranging from loss prevention to emissions reduction]
The insurance sector has a key role to play in helping to mitigate the effects of climate change by providing financial indemnification, compensation and relief against climate change events and by developing new products and solutions that can support emerging GHG [greenhouse gas] and renewable energy markets.

Marsh & McLennan Companies
"Everybody talks about the weather, but nobody does anything about it."

- Charles Dudley Warner
Hartford Courant (1897)
Source Material

• Primary Sources: Science magazine, Nature magazine, Munich Re, Swiss Re, Insurance Information Institute; PCS/ISO

• United Nations / World Meteorological Organization -- Intergovernmental Panel on Climate Change

• John P. Holdren. Presentation to 2003 UN Investors Summit entitled “Risks from Global Climate Change: What Do We Know? What Should We Do?”

• Paul Epstein, M.D., M.P.H., Harvard Medical School, Center for Health and the Global Environment, presentation entitled “Climate Change Futures” Study (Swiss Re and UNDP)
Related Presentations

- **The Science of Climate Change: Risks and Impacts**
  - (Presented to Connecticut Global Climate Change Summit: Business Risks and Opportunities for Connecticut's Insurance Industry, Hartford, CT, October 27, 2005)
  - [http://eetd.lbl.gov/emills/PRESENTATIONS/Insurance_Clima
te_Hartford.pdf](http://eetd.lbl.gov/emills/PRESENTATIONS/Insurance_Climate_Hartford.pdf)

- **Climate Change: Observed and Projected Impacts**
  - (Presented at the National Association of Insurance Commissioners Spring Meeting, Salt Lake City, March 12, 2005)
  - [http://eetd.lbl.gov/emills/PRESENTATIONS/Observed_Climat
e_Change.pdf](http://eetd.lbl.gov/emills/PRESENTATIONS/Observed_Climate_Change.pdf)