Climate Change and Disaster Losses Workshop

Understanding and Attributing Trends and Projections

25 - 26 May 2006
Hohenkammer
Germany

Center for Science and Technology Policy Research

Tyndall°Centre for Climate Change Research

Münchener Rück Munich Re

GKSS Forschungszentrum

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Table of Contents

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Workshop Agenda - Day 1

Wednesday, 24 May 2006

4:00pm WOT Executive session
7:00pm Informal evening reception

Thursday, 25 May 2006

8:45am *Gutshof-Saal Room*
Welcome, Introductions, Goals

9:00am Peter Höppe

9:15am Roger Pielke, Jr.

Part I: Trends in Extreme Weather Events

Richard J. T. Klein, Chair

9:30am Tropical Cyclones
- 5 minute perspectives
  - Faust, Knutson, Grenier

10:30am Break

11:00am Extra-tropical and Convective Storms, Floods
- 5 minute perspectives
  - von Storch, Brooks, Brazdil

12:30pm Lunch

2:00pm Discussion on Trends in Extreme Weather Events
Hans von Storch, Chair

Part II: Trends in Damage

Andrew Dlugolecki, Chair

2:45pm Tropical Storms
- 5 minute perspectives
  - Faust, Pielke, Crompton

3:45pm Break

4:30pm Extratropical and Convective Storms, Floods
- 5 minute perspectives
  - Bouwer, Ye, Kemfert, Weymann

5:15pm Discussion on Trends in Damage
Thomas Loster, Chair

6:00pm Adjourn

7:00pm Reception

7:30pm Dinner

Workshop Agenda - Day 2

Friday, 26 May 2006

Part III: Data Issues -- Extreme Weather Events and Damage

Emma Tompkins, Chair

9:00am Event Data

- 5 minute perspectives
  - Brazdil, Helminen, von Storch

9:45am Impacts Data

- 5 minute perspectives
  - Wirtz, Schmidt, Gurjar

10:30am Break

11:00am Discussion on Data Issues
Harold Brooks, Chair

Part IV: Synthesis

Peter Höppe and Roger Pielke, Co-Chairs

11:30am Initial Remarks

- 5 minute perspectives
  - Epstein, Burton, Goklany, Jun
  - Dlugolecki, Muir-Wood, Palutikof, Zapata-Marti

12:30pm Lunch

2:00pm Synthesis Forum
Peter Höppe and Roger Pielke, Co-Chairs

5:00pm Closing remarks and Adjourn

Saturday, 27 May 2006

9:30am Workshop Organizing Team Executive Session

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The Search for Trends in a Global Catalogue of Normalized Weather-Related Catastrophe Losses

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Abstract

In order to evaluate potential trends in global natural catastrophe losses it is important to compensate for changes in asset values and exposures over time. A study has been undertaken to create a Global Normalized Catastrophe Catalogue covering weather-related catastrophe losses in the principal developed (Australia, Canada, Europe, Japan, South Korea, US) and developing (Caribbean, Central America, China, India, the Philippines) regions of the world. We have attempted to survey losses from 1950 to 2005 although data availability means that for many regions even for the largest events the record is incomplete before the 1970s. After 1970 when the global record becomes more comprehensive we find evidence of an annual upward trend for normalized losses of 2% per year) that corresponds with a period of rising global temperatures. However over this same period, in some regions, including Australia, India and the Philippines normalized losses have declined. The significance of the trend in global normalized losses is dominated by the affect of the 2004 and 2005 Atlantic hurricane seasons as well as by the bias in US wealth relative to other developing regions. What is presented here provides a short summary of the global results of this study. Full results are in course of publication also covering individual peril regions and the exploration of correlations with global temperatures.

Introduction

Economic losses attributed to natural disasters have increased from US $75.5 billion in the 1960s to $659.9 billion in the 1990s (a compound annual growth rate of 8%). Private sector data also shows rising insured losses over a similar period. Both reinsurers and some climate scientists have argued that these increases demonstrate a link between anthropogenically induced global warming and catastrophe losses. However, failing to adjust for time-variant economic factors yields loss amounts that are not directly comparable and a pronounced upward trend through time for purely economic reasons.

To allow for a comparison of losses over time many previous studies have adjusted past catastrophe losses to account for changes in monetary value in the form of inflation. However in most countries far larger changes have resulted from variations in wealth and the numbers and values of properties located in the path of the catastrophes. A full normalization of losses, which has been undertaken for the United States hurricane and flood, also includes the affect of changes in wealth and population to express losses in constant dollars. These previous national US assessments, as well as those for normalized Cuban hurricane losses, have failed to show an upward trend in losses over time, but this was before the remarkable hurricane losses of 2004 and 2005.

In order to assess global trends over time we set out to compile a database of normalized economic losses attributed to weather-related catastrophes from 1950 to 2005 from a large and representative sample of geographic regions. Regions were selected which had a reasonable centralization of catastrophe loss information as well as a broad range of peril types: tropical cyclone, extratropical cyclone, thunderstorm, hailstorm, wildfire and flood. The surveyed regions also span high and low latitude areas.

Although global in scope, this study does not cover all regions. We have, for example, not included losses from Africa or South America; first because these continents are more affected by persistent climatological catastrophes (in particular drought) than sudden-onset weather-related catastrophes. Also the core economic loss data, in particular for much of Africa, is simply unavailable. However, the surveyed area includes the large majority of the world's asset exposure (and the majority of the population).

Methodology

We normalize losses to 2005 USD by adjusting for changes in wealth (GDP per capita in USD), inflation and population. This methodology is consistent with that used by Pielke and Landsea (1998) and is given below:

$NL2005 = L_y * (W2005/W_y) * (I2005)/I_y) * (P2005/P_y)$,

where normalized losses in 2005 USD (NL2005) equal the product of losses in year y and the change ratios in wealth (W), inflation (I) and population (P). Where GDP per capita is expressed in nominal terms we omit the inflation multiplier.

Data

We researched and compiled the best available economic loss data from international agencies, national databases, insurance trade associations and reinsurers as well as RMS internal figures. Data quality varies by region. Table 1 indicates coverage by region and hazard type. The final column indicates our assessment of the reliability of the estimates. In cases where the quality of insured loss data exceeds that of economic losses we have estimated economic losses based upon insurance coverage ratios for the affected region and hazard type from contemporary insurance penetration rates.

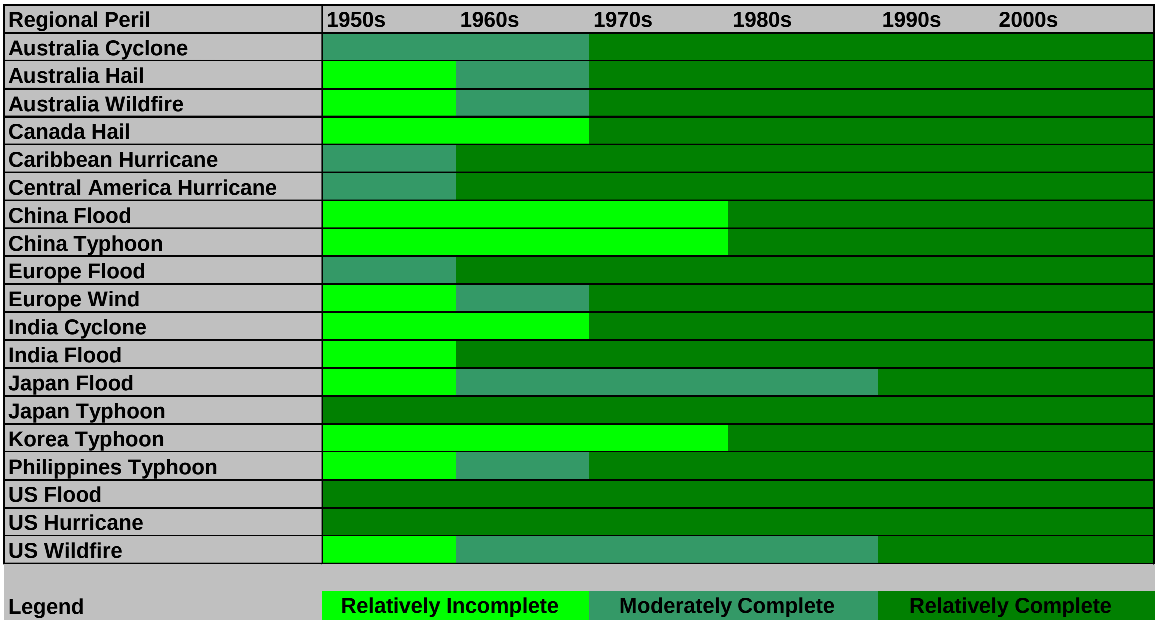
Table 1: Survey Coverage and Data Confidence

Region	Hazards	Data Confidence Level
Australia	Hail, Typhoon, Wildfire	H
Canada	Hail, Ice	M* - H
Caribbean	Hurricane	M
Central America	Hurricane	M
China	Flood, Typhoon	L* - M
Europe	Flood, Wind	H
India	Flood, Cyclone	L* - M
Japan	Flood, Typhoon	L * - M
Korea	Typhoon	L-M
Philippines	Typhoon	M
United States	Flood, Hurricane, Ice, Wildfire	H

* Data incomplete

Data sets from a number of territories are clearly incomplete through the 1950s and 1960s as shown in Figure 1 which presents relative data completeness by decade. For this reason any assessment of global trends prior to the 1970s has to omit a number of important contributory regions.

Figure 1. Data Completeness by Decade



The cumulative normalized losses for each year since 1950 are shown as a graph in Fig 1.

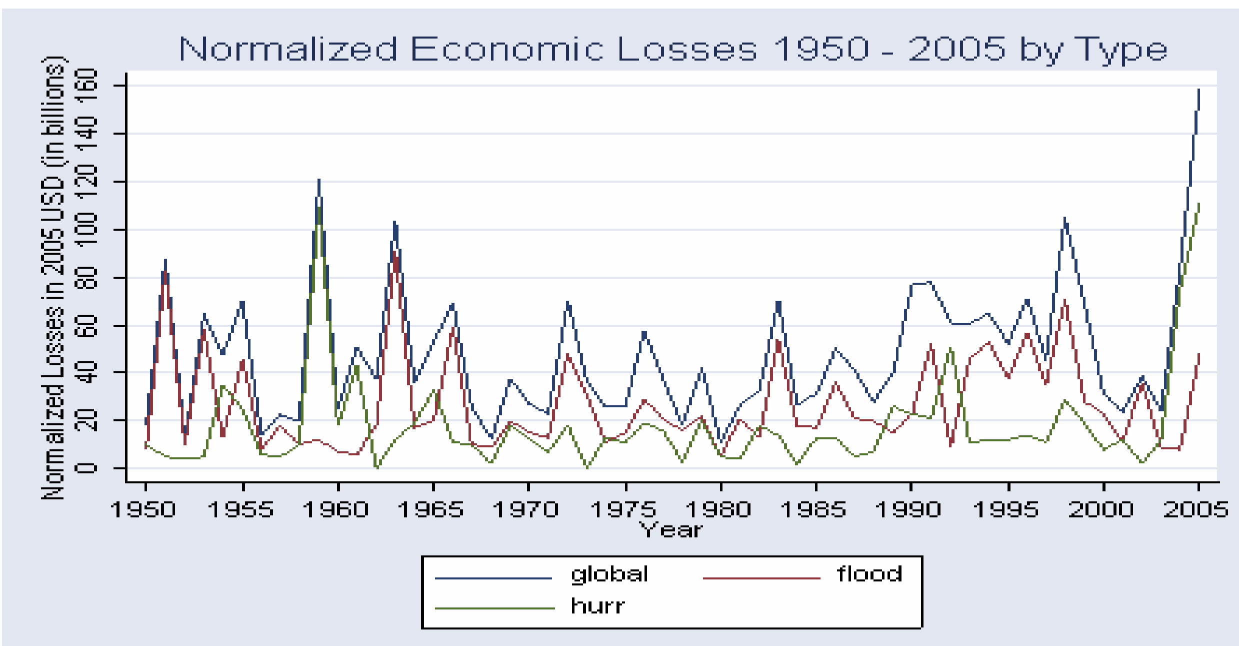


Fig 1 – Normalized economic losses for tropical cyclone, flood (storm surge and inland) and across all weather related perils, 1950-2005.

Caveats

There are four issues which merit discussion before proceeding to the results:

i) The term 'economic loss' defies precise definition and is likely to have become broader over time. Today's estimates include direct damages such as physical damage to infrastructure, crops, housing, etc. and indirect damages such as loss of revenue, unemployment and market destabilization. For example, Indonesia's losses from the 2004 tsunami include an estimated $1.53 billion USD for initial reduction in economic activity. As there is no systematic way to standardize loss estimates over time we proceed with the caveat that recent loss estimates may report a more comprehensive and therefore higher economic loss.

ii) The reporting of economic loss estimates tends to improve with the size of the event and over time. Recent losses are almost everywhere better recorded due to improvements in communications, literacy, news coverage and insurance penetration. Failing to account for the summation of small to mid-size event losses below a certain monetary threshold (e.g. $1 billion USD) will certainly affect aggregated loss estimates for most countries in earlier decades, which is why the focus here has been the largest losses.

iii) The method of normalization employed here assumes a constant vulnerability through time. For wind and hail, vulnerability reflects the susceptibility of buildings to direct damage, while for flood and wildfire it is the degree to which communities have been protected from risk (with flood defenses and fire breaks). The bias of assuming constant vulnerability is strongest where substantial adaptation (mitigation) has occurred, as for normalizing 1950s and 1960s storm surge losses in northern Europe, 1950s and 1960s storm surge and river flood events in Japan or 1970s wind loss events in Australia. However for most perils and regions, such as US hurricane, real reductions in vulnerability have been modest. The question of testing the degree to which the affects of adaptation can be demonstrated from the normalized losses is considered further in the Discussion section.

iv) The normalization methodology employed uses national statistics to compute the multipliers. Previous US normalizations use State and County level data to normalize losses. With the benefit of county level resolution in the US we can see that the population growth rate between certain coastal, hazard-prone regions such as Florida is understated by using the national average. However, we consider the large-scale migration to hazardous coastal areas seen in the US to be the exception. In the developing countries we survey, industrialization has led to migration to urban areas, which generally have lower risk profiles than rural areas. In other countries there has been a greater balance between urban and coastal migration patterns.

Trend Analysis

To test for a trend in normalized losses over time we perform a linear regression of normalized economic losses on the year. The model is given below in equation 1.

(1) $NL_y = \alpha + \beta_1 YEAR_{y} + \varepsilon_y$

Normalized losses (NL) in year y are determined by the loss year (YEAR) *y*, where ε is the error term. If time is a significant determinant of loss level we would expect the year to be statistically significant. The coefficient sign will indicate the direction of the trend.

We fit the regression twice using global normalized loss estimates as well as hazard type and regional subsets, first with data from 1950 – 2005 and then with data from 1970 - 2005.

Due to the large impact of Katrina, 2005 losses are nearly four standard deviations from the mean and exert an upward pull on the overall trend. To separate out the affect of Katrina on the overall results we ran the regression separately with Katrina losses removed.

Table 1: OLS Regression of Normalized Losses on Year

Survey Group	Time Period	
	1950 – 2005	1970 – 2005
Global Losses	379.26 (241.9)	1251.08*** (423.45)
Global Losses (Katrina Removed)	220.24 (210.62)	855.22** (330.28)

** Significant at 5%, ***Significant at 1% ^ at 0.055

When analyzed over the full survey period (1950 – 2005) the year is not statistically significant for global normalized losses. However, it is significant with a positive coefficient for normalized losses for specific regions such as Canada at 10%, Korea at 5%, and China at 1% (in all of which the earlier record is known to be incomplete). The coefficient is negative (but not significant) for Australia, Europe, India, Japan and the Philippines.

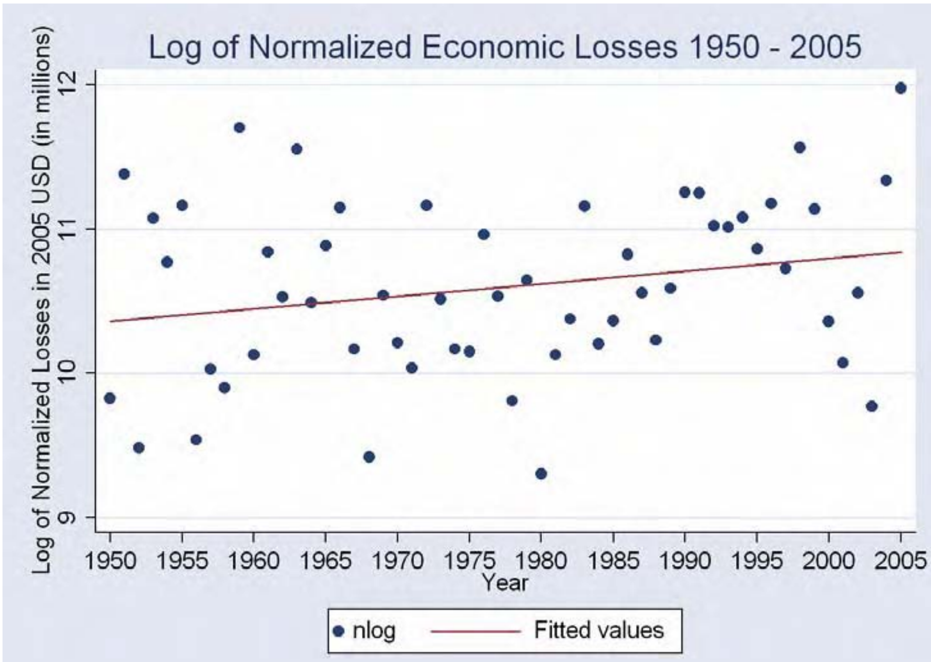


Fig 2: Trend line of Log of Normalized Economic 'Global' Losses relative to year since 1950

For the more complete 1970-2005 survey period, the year is significant with a positive coefficient for (i.e. increase in) global losses at 1% with an R2 value of 0.20 (5% with Katrina excluded), China at 1% (although again the early part of the record is likely to be incomplete), global tropical cyclones at 5% (both with and without Katrina losses) and for Caribbean losses at 10%. However, there is a decreasing trend in normalized losses for Australia at 10%, the Philippines at 5% and India at 1% (all located around the eastern Indian Ocean).

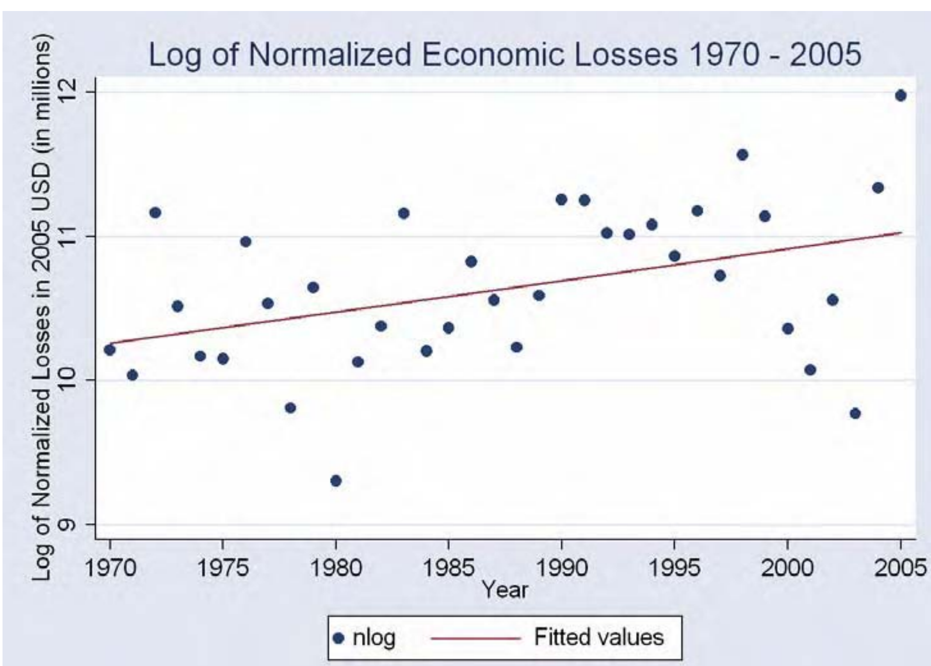


Fig 3: Trend line of Log of Normalized Economic 'Global' Losses relative to year since 1970

Discussion

Before attempting to consider the implications of these findings we should first explore potential reasons for trends within the dataset. As already noted our methodology does not normalize for changes in the vulnerability of buildings nor does our regression control for improved mitigation, as around reducing flood risk. However, there are several clear regional examples of declining loss trends since 1950 which merit comment. In Europe and Japan extensive investments in coastal flood defenses, in particular during the 1960s, have been well documented and the actual losses from events such as Typhoon Vera or the 1953 and 1962 North Sea storm surges would in consequence be significantly reduced below the normalized values if they recurred today. For flood in Europe the top three loss years all occur by 1966 and recent flood years have reached less than half the value of the high loss years in the first 20 years of the record.

While improved flood mitigation can help explain some part of the reduction of catastrophic flood losses since the 1950s other causes must be sought in explaining the upward trend in global losses seen since the 1970s.

Before concluding that these loss results demonstrate a strong rising trend in normalized catastrophe losses, we performed some simple tests to explore the sensitivity of this result.

> The first test involved exploring whether such a trend could have been identified before the 2004 and 2005 loss years, with their heavy contribution from hurricanes in the US. The results of excluding these loss years show a reduction in the significance of the trend. Had we executed this study in 2003 we would have found no evidence to suggest an upward loss trend from 1950 and weaker evidence (at 10%) from 1970 onwards.
>
> The second test involved removing the record of flood losses in China, in particular because it is likely to be incomplete prior to the 1980s. This also has the impact of the reducing the significance for a post 1970 trend in worldwide normalized losses - but which is still significant at 10%.

The importance of the contribution of the 2004 and 2005 US hurricane highlights the difficulty inherent in compounding global losses from nations with very different asset levels as wealthier nations will inevitably have higher nominal loss totals. Record years for hazard losses in a developing region would not have exerted such a strong pull on trend significance. For illustrative purposes we re-normalized each region's normalized losses by multiplying by the ratio of US GDP per capita to regional GDP per capita. This crude modification approximates a homogenous distribution of wealth. This adjustment yields results which are significant at 5% from 1950 onwards, but not significant when isolated from 1970 – 2005.

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