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CATASTROPHE LOSSES IN THE CONTEXT OF DEMOGRAPHICS, CLIMATE, AND POLICY

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ABSTRACT

Understanding trends in catastrophe losses can be difficult because there are many factors that influence losses over time. Among these are changes in population and wealth in locations at risk to extreme events and variability, as well as in the occurrence of extreme events themselves. Other factors may be important as well, such as society's risk tolerances, resilience to extremes, and policies that increase or decrease exposure. A focus on understanding trends has become increasingly significant in political debates over policy responses to human-caused climate change. This paper focuses on three issues: (i) the societal factors driving catastrophic losses; and (ii) implications for the near-term future, especially in the explosive growth in both population and wealth in urban areas, and (iii) possible actions that could be taken in the face of these trends, in the context of expected increases in the frequency and intensity of extreme events. In the coming decades, to the extent that decision makers wish to arrest the ever escalating toll of disaster losses, effective policies will require a focus on those factors most responsible for driving losses.

INTRODUCTION

In recent decades the economic costs of weather-related disasters have increased dramatically around the world prompting much discussion and debate. The recent assessments of the Intergovernmental Panel for Climate Change (IPCC) provided definitive statements to policymakers about the human influence on the climate system and its consequences, yet neglected to reflect the current scientific consensus on the causes of the increase in disaster losses from weather extremes and the practical implications of this consensus for future research and action (IPCC 2007a).

The IPCC concluded that the frequency and/or intensity of some extreme weather phenomena will very likely increase in coming decades (IPCC 2007b). At the same time the number of people at risk to weather extremes will grow (IPCC 2007a). Government and industry policymakers are concerned about how they can respond to these parallel projections which both point to ever-increasing disaster losses (Lloyds 2007, GAO 2007). In this essay we seek to fill the gap left by the recent IPCC report by describing the current scientific consensus on disaster losses and climate change, its implications for the immediate future, and steps to reduce and transfer risks associated with extreme events in support of sustainable development.

THE CURRENT CONSENSUS

According to data collected by Munich Re, global weather-related economic losses (inflation adjusted, 2006 dollars) have increased from an annual average of US$8.9 billion from 1977-1986 to US$45.1 billion from 1997-2006. However, because of issues related to data quality, the low frequency of extreme event impacts, limited length of the time series, and various societal factors present in the disaster loss record, it is still not possible to determine the portion of the increase in damages that might be attributed to climate change brought about by greenhouse gas emissions (Höppe and Pielke 2006). This conclusion is likely to remain unchanged in the near future (Höppe and Pielke 2006).

Societal change and economic development are mainly responsible for increasing losses in recent decades (Höppe and Pielke 2006), as convincingly shown in analyses of long-term records of losses. Figure 1 shows that after adjusting for societal changes, resulting time series accurately reflect documented trends (or lack thereof) and variability consistent with the observed climatological record of weather events (Höppe and Pielke 2006). This implies that the net result of the adjustments has to a significant degree successfully removed the signal of societal change from the loss record.

These examples reflect a scientific consensus on the relationship of climate change and disaster losses developed at an international workshop (Höppe and Pielke 2006) in mid-2006, summarized in the accompanying Table Box. The current consensus has implications for expectations for the immediate future and decision-making in the context of those expectations.

LOSS TRENDS

Figure 1 shows four different historical disaster loss datasets. Each curve shows the average losses over a 10-year period (i.e., for U.S. hurricanes, 1909 shows the average for 1900-1909) as a ratio of the long-term average for the entire dataset (i.e., for U.S. hurricanes 1909 shows the ratio of the 1909 value as a ratio of 1900-2005). The long-term average for each dataset is equal to 1.0 in the figure.

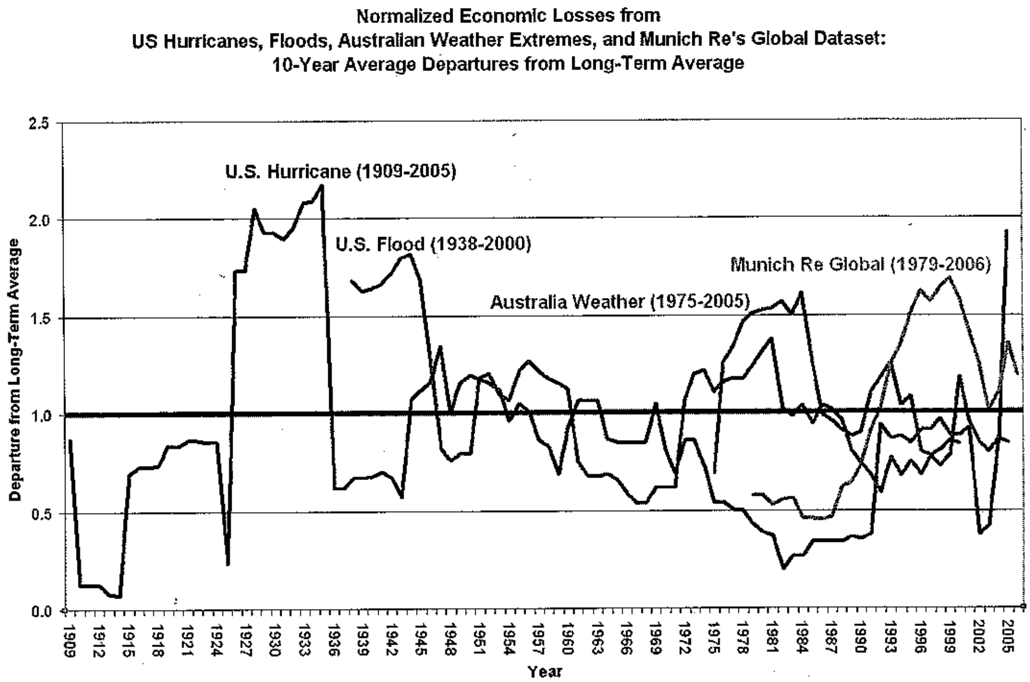

Figure 1. Normalized direct economic losses from weather-related hazards.

In Figure 1, U.S. hurricane losses (Pielke et al. in press) have been normalized to account for population growth, increasing wealth, and inflation. U.S. flood losses (Downton et al. 2005) have been adjusted for inflation and expressed as a fraction of U.S. gross domestic product (GDP) (US BEA 2007). Australian weather losses (i.e., tropical cyclones, floods, thunderstorms, hailstorms, and wildfire) are insured losses and have been adjusted for changes in dwelling numbers and nominal dwelling values (surrogates for population, inflation, and wealth) and the tropical cyclone losses adjusted for changes in building standards (Crompton and McAneney in review). Munich Re's data comes from their NatCat®SERVICE database and includes losses from designated great natural weather catastrophes (Munich Re 2007a) expressed as a ratio of global GDP (Maddison 2007). Great natural catastrophes match the criteria that an affected region's ability to help itself is distinctly overtaxed and hence interregional or international assistance is necessary, specifically defined as exceeding 10^6 x 5% of per capita GDP (developed countries) or at least US$300 million (developing countries) and/or more than a thousand fatalities, and/or more than a hundred thousand people made homeless. This dataset is generated to be homogenous since the 1970s, as it does not include smaller weather events that would be underreported earlier in the record. Annual losses in Munich Re's global dataset are highly correlated (r=0.69) with annual U.S. hurricane losses from 1970-2006.

Text Box
Consensus (unanimous) statements of the Hohenkammer workshop (Höppe and Pielke 2006):

1. Climate change is real, and has a significant human component related to greenhouse gases.
2. Direct economic losses of global disasters have increased in recent decades with particularly large increases since the 1980s.
3. The increases in disaster losses primarily result from weather related events, in particular storms and floods.
4. Climate change and variability are factors which influence trends in disasters.
5. Although there are peer reviewed papers indicating trends in storms and floods there is still scientific debate over the attribution to anthropogenic climate change or natural climate variability. There is also concern over geophysical data quality.
6. IPCC (2001) did not achieve detection and attribution of trends in extreme events at the global level.
7. High quality long-term disaster loss records exist, some of which are suitable for research purposes, such as to identify the effects of climate and/or climate change on the loss records.
8. Analyses of long-term records of disaster losses indicate that societal change and economic development are the principal factors responsible for the documented increasing losses to date.
9. The vulnerability of communities to natural disasters is determined by their economic development and other social characteristics.
10. There is evidence that changing patterns of extreme events are drivers for recent increases in global losses.
11. Because of issues related to data quality, the stochastic nature of extreme event impacts, length of time series, and various societal factors present in the disaster loss record, it is still not possible to determine the portion of the increase in damages that might be attributed to climate change due to GHG emissions
12. For future decades the IPCC (2001) expects increases in the occurrence and/or intensity of some extreme events as a result of anthropogenic climate change. Such increases will further increase losses in the absence of disaster reduction measures.
13. In the near future the quantitative link (attribution) of trends in storm and flood losses to climate changes related to GHG emissions is unlikely to be answered unequivocally.

Policy implications identified by the workshop participants

14. Adaptation to extreme weather events should play a central role in reducing societal vulnerabilities to climate and climate change.
15. Mitigation of GHG emissions should also play a central role in response to anthropogenic climate change, though it does not have an effect for several decades on the hazard risk.
16. We recommend further research on different combinations of adaptation and mitigation policies.
17. We recommend the creation of an open-source disaster database according to agreed upon standards.
18. In addition to fundamental research on climate, research priorities should consider needs of decision makers in areas related to both adaptation and mitigation.
19. For improved understanding of loss trends, there is a need to continue to collect and improve long-term and homogenous datasets related to both climate parameters and disaster losses.
20. The community needs to agree upon peer reviewed procedures for normalizing economic loss data.

Inflation-adjusted data from Munich Re indicates that the average annual losses from the period 1977-1986 to the period 1997-2006 increased at a decadal rate of about 125% (Figure 1). Over the same period annual growth in real global gross domestic product (GDP) was smaller, and averaged 35-45% between decades (OECD 2001, IMF 2006). The larger increase in disaster losses could reflect more rapid relative growth in vulnerable locations, changes in climate events (regardless of cause), or both. Median annual losses increased between the two periods by a decadal rate of about 55%. The increase in median losses is lower than the mean because the size of the largest losses increased by a greater amount. The largest annual loss in the most recent decade reached US$180.9 billion (2005) while during 1977-1986 it was US$24.1 billion. As median loss potentials increase due to changes in population and per capita real GDP so too will the potential for extreme losses as risk becomes increasingly more concentrated.

EXPECTATIONS FOR THE IMMEDIATE FUTURE

Within the next 20 years projected changes in the intensity and frequency of extreme events – depending on the timescale and hazard – remain uncertain. The most severe effects of human-caused climate change are expected in the second half of the century (IPCC 2007a). In the immediate future disaster losses will increase already as a result of societal change and economic development, independent of climate.

The challenge of disaster losses is particularly acute in developing countries where vulnerabilities are most profound and development is occurring most rapidly. Growing population and capital in mega-cities exemplify loss potential increases in the near future. Most of these cities are located in vulnerable coastal areas and river plains in developing countries. Table 1 presents the projected increase in population and economic loss potentials for the world's 10 largest cities (UN 2006, PWC 2007).

The loss potentials are the percentage changes in projected real GDP (PWC 2007), which includes UN population estimates (UN 2006). Over the coming decade, increases range from 22% (Tokyo) to 88% (Shanghai, Jakarta). In all, the loss potentials of 79 of the world's 151 largest cities, by size of their economy in 2005, are expected to grow faster than 3.5% annually, and 70 by more than 4.0% (PWC 2007). The relatively more rapid loss potential increase in cities helps to explain why disaster losses have increased faster than real global GDP. These data suggest that developing countries are repeating the dramatic increase in loss potentials observed in the U.S. Gulf and Atlantic coast counties. From 1950 to 2005 more than 130 of the 177 coastal counties saw their loss potentials increase faster than real global GDP with increases of more than 10% annually in some counties (Pielke et al. in press). The median annual increase was about 4% (Pielke et al. in press), which equates to a 48% increase over a 10-year period.

City	Population estimates (millions)[9]			Estimated GDP (US$ billion at 2005 PPPs)[8]		
	2005	2015	Change (%)	2005	2015	Increase in Loss Potential by 2015 (%)
Tokyo, Japan	35.2	35.5	0.8	1191	1452	22
Mumbai, India	18.2	21.9	20.2	126	226	79
Mexico City, Mexico	19.4	21.6	11.1	315	489	55
São Paulo, Brazil	18.3	20.5	12.0	225	336	49
New York, USA	18.7	19.9	6.2	1133	1408	24
Delhi, India	15.0	18.6	23.6	93	170	82
Shanghai, China	14.5	17.2	18.8	139	261	88
Kolkata, India	14.3	17.0	18.9	94	167	77
Dhaka, Bangladesh	12.4	16.8	35.5	52	94	81
Jakarta, Indonesia	13.2	16.8	27.3	98	184	88

Table 1. Increase in mega-city disaster loss potential from 2005 to 2015. Ranking is by population at 2015.

Increasing loss potentials will be accompanied by increasing numbers of people potentially affected by disasters. A repeat of the July 2005 floods in Mumbai in 2015 could produce approximately 80% higher losses and impact 20% more people (Table 1). The continents most prone to large numbers of fatalities in disasters – Asia, Africa, and South America – currently contain around 275 cities with more than a million people. In 10 years time this number is expected to grow to over 400 (PWC 2007). Based on these projections disaster losses and the number of people affected will continue to increase, regardless of climate change. The expected more frequent and/or intense events (IPCC 2007b) will exacerbate the effects of ever growing exposure.

RECOMMENDATIONS

The expected rapid increase in disaster losses represents a challenge but it is also an opportunity to rapidly improve adaptive capacity around the world. We offer three recommendations for how decision makers might begin to take action in the context of the current consensus on disaster losses and climate change.

Improve Data Collection on Disaster Losses

With few exceptions, records of economic disaster losses are of poor quality, inhomogeneous, and collected using a wide range of methods for different purposes, making research extremely challenging. Disaster loss data could be used to evaluate the degree of success or failure of policies; estimate losses at return periods beyond the length of the time series; identify what role other factors play in driving trends and variability over time. In particular, high quality disaster loss datasets offer the tantalizing prospect of serving as an early-warning system for changes in climate (or other aspects of the earth system), if changes in losses are non-linearly related to changes in the earth system. However, to serve this purpose the accuracy in loss data needs to be of sufficient quality to detect the impacts of geophysical signals.

Currently, the most comprehensive global disaster databases are held by reinsurance companies and are not publicly available. An open-source, peer-reviewed database that is set up according to agreed upon standards would enable the scientific community to study worldwide disaster characteristics and trends as well as contribute to assessing and improving its quality.

Explore the Role of Disaster Risk Reduction in Adaptation

The role of disaster risk reduction activities in addressing disaster losses remains poorly documented and understood. Recent studies conclude that the cost-benefit ratio of investments in disaster risk reduction range from 1:2 to 1:4 (Mechler 2005). Yet unsustainable development is increasing vulnerabilities in many places, as indicated by increasing economic losses and numbers of people affected. In particular, the inadequate pricing of adaptation costs and benefits leads to inappropriate valuation of investment and financial calculations in risk reducing measures both at the public and private sector level, particularly in developing countries (Benson and Twigg 2004).

Climate change may require a more integrated perspective on adaptive capacity than has been the case in the past. Generally, risk reduction activities are in the domain of specialized professionals such as agronomists for agriculture, engineers and hydro-meteorologists for water management, irrigation, and flood control, structural and design engineers for infrastructure and buildings, public health officials for infectious and vector borne diseases. The work of these professionals is not referred to as adaptation but may be described as plant breeding and selection, flood risk reduction, public healthcare, and so forth. Risk reduction as now being practiced is not sufficient to prevent the growth of losses from climate change, variability, and extremes, or the expected increases in vulnerability. Improving risk reduction will likely be a major challenge. But it appears that reducing vulnerabilities in the highest risk areas, such as mega-cities, could reap immediate benefits.

In the face of growing losses, decision makers might embrace more fully an alternative approach to decision making, e.g., based on no-regrets vulnerability reduction or proactive risk management. Some entry points may be available in developing countries to integrate climate adaptation in existing disaster risk reduction efforts (Few et al. 2006). More generally disaster aid is probably best spent on efforts for *ex ante* risk reduction (Linnerooth-Bayer et al. 2005). Of course, mitigation of greenhouse gas emissions should also play a central role in response to anthropogenic climate change, though it cannot decrease hazard risk for several decades. Emission reductions will influence atmospheric concentrations of carbon dioxide, and thereby reduce the potential risk of more frequent and intense extreme events in the long term, and perhaps more importantly, reduce the risk of abrupt climate changes and climate processes that could be irreversible.

Develop and Apply Innovative Mechanisms for Managing Risk

Opportunities exist to apply more widely financial tools that can transfer and reduce risks. Industries with greatest exposure, most notably insurance, have responded to the increasing risk by developing innovative products. Catastrophe (cat) bonds, developed in the late 1990s, are an alternative risk transfer mechanism used by the (re)insurance industry to transfer risk to the capital markets. The range of hazards covered by these instruments continues to expand, the most recent addition being flood risks in the UK (Allianz 2007). In the flood-prone countries of Belgium and The Netherlands previously uninsured flood risks are now being covered or are in the process of being covered through public-private insurance schemes. The viability of these systems depends on the provision of premium by the policyholders and by additional financial buffer from the national government in order to cover the risk of these low probability-high impact events.

Analysis shows that existing financing schemes for development and livelihood assurance practiced within local communities may be simultaneously utilized for the benefit of disaster risk reduction. For example, smart use of social investment funds in El Salvador aimed at improving small infrastructure have supported risk reduction (Warner et al. 2007), and community groups in India have been active in developing deficit rainfall insurance (Warner et al. 2007).

In Colombia, micro-entrepreneurs offer affordable and easy to understand life and property micro-insurance designed to protect the most vulnerable to natural disasters. Insurance is available to small banks and microfinance institutions in developing countries to protect their balance sheet and cash flow in the event of a major natural disaster. The World Bank sponsored Caribbean Catastrophe Risk Insurance Facility offers governments cover against hurricanes and earthquakes with funds available only a few days after the event providing immediate relief (Munich Re 2007b). The Munich Climate Insurance Initiative (MCII) brings together the World Bank, insurers, Non-Governmental Organizations, and the scientific community, to develop insurance-related solutions for indemnification and adaptation to climate change impacts in developing countries, and is advocated by the UN Framework Convention on Climate Change (Munich Re 2007c).

CONCLUSION

Previous IPCC assessments highlighted the importance of adaptation to weather-related disasters and the role of insurance and other financial services (Dlugolecki et al. 1996, Vellinga et al. 2001). However, the fourth assessment released in 2007 chose to focus its efforts elsewhere. Nonetheless, a strong, policy-relevant consensus does exist on disaster losses and climate change. A central element of this consensus is that increasing vulnerabilities have been the driving factors behind growing losses and loss potentials. If present trends continue, then disaster losses will keep outpacing economic growth in the future. For policymakers this means that disaster risk reduction must be the core element of climate adaptation policies. Numerous mechanisms for action exist and are being implemented in an experimental mode in many locations around the world. There remain ample opportunities to explore both the institutional and financial opportunities to integrate climate change concerns in risk reduction, as a contribution to the longer-term challenges of sustainable development.

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