

CLIMATE CHANGE AND THE INSURANCE INDUSTRY

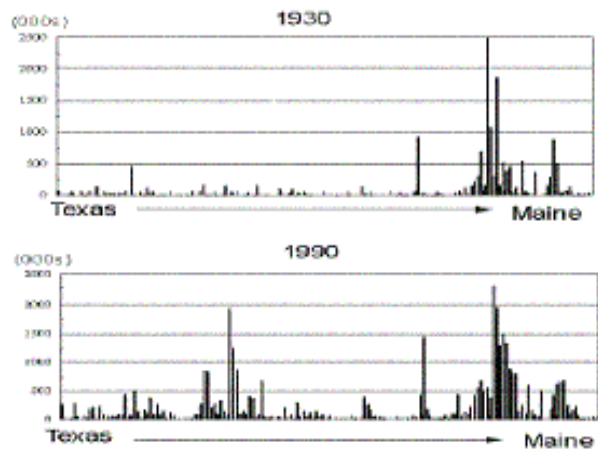
A Critical look at the Ceres report:

*Availability and Affordability of Insurance under Climate Change -
A Growing Challenge for the U.S.*

U.S. Atlantic and Gulf Coastal Counties



POPULATION BY COASTAL COUNTY



Population growth in U.S. coastal counties

(Pielke, Jr., R. A., and R. A. Pielke, Sr., 1997: Hurricanes: Their Nature and Impacts on Society. John Wiley and Sons Press: London.)

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October 28, 2005

“Mills’ analysis rests on a very thin basis of support...it is amazing...that Mills’ paper survived peer review at *Science*. It should not have. Whether *Science* has a quality control problem or an inability to question analysis that may be politically inconvenient, the publication of Mills’ paper sure does raise some questions... Shoddy science, bad peer review and a failure of the science community to demand high standards is not the best recipe for helping science to contribute effectively to policy.

“Those who perpetuate such claims, whether they are in the reinsurance industry, the UN, advocacy groups, or the scientific community, are either ill-informed or dishonest.”

-- **Roger Pielke, Jr.**

(Prometheus Weblog, 22 August 2005,
Full text in Appendix 2 below)



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CLIMATE CHANGE AND THE INSURANCE INDUSTRY

A Critical look at the Ceres report:

*Availability and Affordability of Insurance Under Climate Change -
A Growing Challenge for the U.S.*

EXECUTIVE SUMMARY

A recently released report by Ceres (self-described as a national coalition of investors, environmental organizations, and other public interest groups working with companies to address sustainability challenges such as climate change) suggests that the impacts of climate change to events such as floods, windstorms, thunderstorms, hail storms, ice storms, wildfires, droughts, and heat waves are already being felt in the United States and that their impacts will grow into the future as human activities continue to affect the atmospheric composition.

However, the Ceres report – derived from a paper by Mills published in *Science* magazine (Mills, E., 2005. Insurance in a Climate of Change. *Science*, 308, 1040-1044. August 12, 2005), - fails to make its case in a scientifically defensible manner. Its analyses are inadequate and ill-formed, and it ignores a large, robust body of literature on the subject whose conclusions run *opposite* to those found in the Ceres report.

In this analysis, we provide a basic overview of the issue pointing out the primary scientific weaknesses underlying the conclusions in the Ceres report. In addition, we also include an extensive annotated bibliography containing summaries of major scientific reviews and findings that conclude that changes in extreme weather events are not the primary factors behind the observed increases in weather-related economic losses. This bibliography includes broad overviews, as well as papers on specific extreme weather-event types. By and large, the conclusions of these papers were not included, considered, or discussed in the Ceres report--a clear indication of the inadequacies and biases inherent in the Ceres report.

Thus, the Ceres report does not fairly represent the state of knowledge on the topic of climate change and its effect on the insurance industry, and as such, should not be relied upon in decision-making processes.



ANALYSIS

Much of this critique draws heavily upon the work of Dr. Roger Pielke, Jr. (and a wide range of his colleagues), Director of the Center of Science and Technology Policy Research at the University of Colorado, who, for the past 10 years, has devoted much of his research effort to studying how the impacts of weather events have fluctuated through the years, and how observed climate patterns, variations, and changes may effect the insurance (or reinsurance) industry. Dr. Pielke has extensively published on this issue, and many of his findings, and opinions can be found on the active internet blog site Prometheus (<http://sciencepolicy.colorado.edu/prometheus/>) that is run by the Center of Science and Technology Policy Research. It is not hyperbole to observe that challenging the expertise of Dr. Pielke on this subject yields results as predictable as challenging Lance Armstrong in the Tour de France (**see Appendix II**).

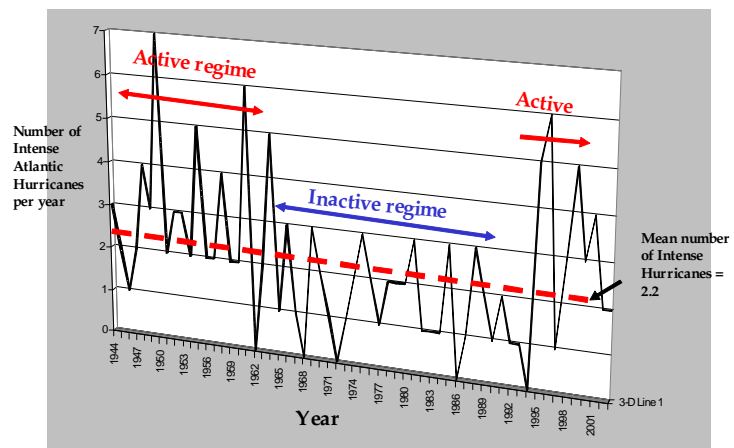
There is no scientific basis for attributing the increasing trend in disasters to changes in climate, regardless of cause.

Dr. Pielke first points out that we should not lose sight of the fact that there is a substantial *conflict of interest* when the reinsurance industry makes claims about how climate change will result in more disasters. The reinsurance industry makes money, by and large, through income that it earns on its investments, and not through the differences between what it collects in premiums and pays out for disasters. But its premiums are important from the standpoint of not just being able to pay out when disasters strike, but crucially for creating a reserve of funds that can be invested and thus generate income for shareholders. The greater the reserve the insurance industry develops, then the greater the potential income and higher stock valuation. It is pointing out the obvious that the reinsurance industry has a powerful vested interest in charging the highest rates that the market will bear for its products. And the prospect of more disasters means a basis for charging higher rates. Thus, it is also clear that when the reinsurance industry asserts that disasters *will* get worse in the future, they have an obvious conflict in interest.

But on top of this conflict of interest, claims about disasters being made by some in the reinsurance industry are simply without credible scientific support.

For instance, the bulk of the Ceres report is built upon a series of charts and data illustrating the clear fact that economic losses, even when adjusted for inflation, have increased substantially over the course of the past 50 to 100 years.

Multidecadal changes in the most intense (category 3-5) Atlantic hurricanes:
Active regime 1944-1964, Inactive regime 1965-1994, Active regime again since 1995



Source: Goldenberg et al. (2001) Science, vol. 293, 474-479; <http://www.aoml.noaa.gov/hrd/basin/index.html>

The glaring problem is that there are no accompanying charts or data as to whether or not there have been any change in the behavior of the extreme weather events that have given rise to the economic losses. Without an analysis of *the frequency and/or intensity changes* of the weather events, it is simply impossible and scientifically wrong to contend that the rising losses are due to changes in the climate. Much of the increase in economic losses has arisen from increased development in higher risk areas (e.g. coasts and floodplains).

In examining the issue in a recent article, Dr. Pielke responds to the question of whether climate change is responsible for the growth in disasters and disaster costs up to the present. The answer, as he details, is "Not at all." There is no scientific basis for attributing the increasing trend in disasters to changes in climate, regardless of cause. He points out that this is for two reasons.

First, the U.N. Intergovernmental Panel on Climate Change (IPCC) has found very little evidence for trends in weather extremes, both in its 1996 and 2001 reports.

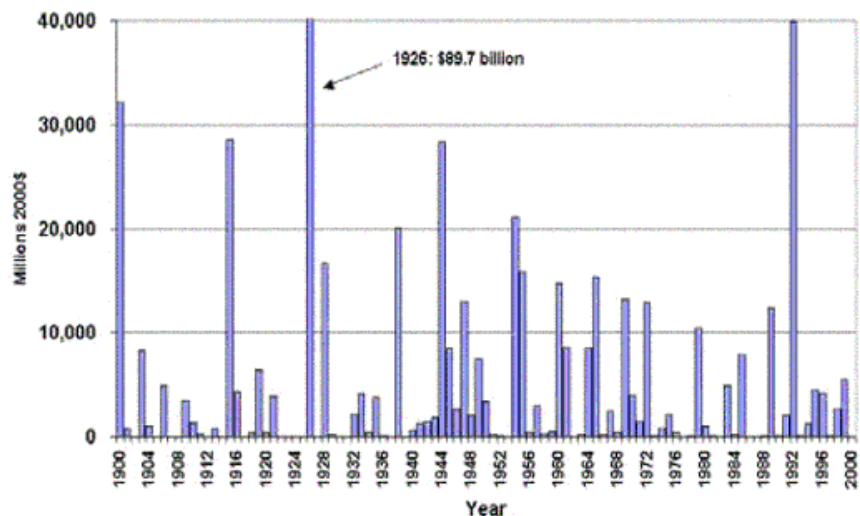
Second, given the magnitude of growth in disasters, there is clearly much going on beyond any possible changes in climate. The reason for increasing losses lies heavily with changes in *societal vulnerability* to disasters.

The IPCC stated in its *Second Assessment Report* (released in 1996) that while weather extremes varied over different times and places, it could find no coherent secular global trend of increasing extreme events:

There are inadequate data to determine whether consistent global changes in climate variability or weather extremes have occurred over the 20th century. On regional scales there is clear evidence of changes in some extremes and climate variability indicators (e.g., fewer frosts in several widespread areas; an increase in the proportion of rainfall from extreme events over the contiguous states of the USA). Some of these changes have been toward greater variability; some have been toward lower variability.

Thus, if extreme weather events were not clearly increasing in frequency or magnitude, but disasters were increasing dramatically, then the obvious explanation has to do with changes in characteristics of populations vulnerable to disasters. So Dr.

Annual Hurricane Damage: 1900 - 2000
Normalized to 2000 Values



The yearly amount of damage inflicted by hurricanes in the United States, 1900-2000 after normalizing for population growth, wealth, and inflation. (from Pielke, Jr., 2002).

Pielke initiated a range of research projects to explore the sensitivity of trends and projections in disasters to climate factors and societal factors. The results of this research have been about 20 or so peer-reviewed papers that present a consistent message: *The historical trend of growing disasters and disaster losses can be explained entirely by changes in society that create greater vulnerability to those losses.* Given that the IPCC found in 1996 that there were no apparent trends in weather extremes, this conclusion makes perfect sense.

And things have not significantly changed in the 10 years since the publication of the IPCC's *Second Assessment Report*. Losses have continued to increase, and the IPCC *Third Assessment Report (TAR)* still has not identified any secular trends in weather extremes, with only one exception. The IPCC *TAR* found no long-term global trends in tropical or extra-tropical cyclones (i.e., hurricanes or winter storms), in "droughts or wet spells," or in "tornados, hail, and other severe weather." What it did find was "a widespread increase in heavy and extreme precipitation events in regions where total precipitation has increased, e.g., the mid- and high latitudes of the Northern Hemisphere." But perhaps paradoxically, it also found "an increase (or decrease) in heavy precipitation events may not necessarily translate into annual peak (or low) river levels." While the IPCC found some changes in streamflow, it did not identify changes in streamflow extremes, i.e., floods, and concluded on a regional basis, "Even if a trend is identified, it may be difficult to attribute it to global warming because of other changes that are continuing in a catchment."

The historical trend of growing disasters and disaster losses can be explained entirely by changes in society that create greater vulnerability to those losses.

Though the picture painted by the IPCC in its 2001 *TAR* had considerable more nuance than in 1996, the underlying message changed very little. The IPCC found *no trend* in extremes that could explain any of the increasing losses related to extreme events.

While the IPCC has looked at and summarized the changes in frequencies of damaging weather events on a *global scale*, there has also been a series of analyses examining patterns of severe weather events in the United States, and how these patterns may have changed over time. Many of these studies were undertaken with the intent of determining whether the increases in losses could be related to changes in the patterns of extreme weather events. The most comprehensive analysis of this type was led by Dr. Kenneth Kunkel, who was assisted by Dr. Pielke, Jr. and Dr. Stanley Changnon. Their results were published in the *Bulletin of the American Meteorological Society* in June of 1999 (this article is referenced in **Appendix 1**). These authors did what the Ceres authors did not - that is, they examined changes in the underlying weather events to see if they mirrored the changes in economic losses. For the vast majority of events, they did not.

Again, these researchers conclude that the rising cost of weather-related damages is due primarily to changes in population demographics and not changes in the weather itself.

Researchers conclude that the rising cost of weather-related damages is due primarily to changes in population demographics and not changes in the weather itself.

The same perspective - when analysing tropical cyclones only - was offered by S. Raghavan, retired Deputy Director-General of Meteorology of the India Meteorological Department, whom had published, with colleague S. Rajesh, in the May 2003 issue of the *Bulletin of the American Meteorological Society* that:

“Increasing damage due to tropical cyclones over Andhra Pradesh, India is attributable mainly to economic and demographic factors and not to any increase in frequency or intensity of cyclones. ... There is a common perception in the media, and even in government and management circles, that [increase in property damage] is due to an increase in tropical cyclone frequency and perhaps in intensity, probably as a result of global climate change. However, studies all over the world show that though there are decadal variations, there is no definite long-term trend in the frequency or intensity of tropical cyclones.”

In a May 2005 editorial published in the Newsletter of the Indian Meteorological Society, S. Raghavan, concluded that “Unfortunately, some of the misconceptions ... are not born solely out of a lack of appreciation of meteorological science. *Misinformation is often deliberately propagated* [original emphasis].”

Much of the Ceres report is based upon an article that appeared in *Science* magazine, written by one of the Ceres report authors, Dr. Evan Mills. As with the Ceres report, his article in *Science* was an attempt to build a case for a linkage between anthropogenic climate change and increasing insurance losses. Dr. Pielke took a critical look at this paper and found it also lacking in scientific credibility. His detailed review (which is reproduced in **Appendix 2**) provides many insights into how science is twisted such that even bad science can appear in major (and usually well-respected) scientific publications. He summarized his critical review of the Mills article:

“In the end, scientific research may yet prove that anthropogenic climate change plays an observable role in disaster losses. But today, August 22, 2005, shoddy science, bad peer review and a failure of the science community to demand high standards is not the best recipe for helping science to contribute effectively to policy.”

Also, see **Appendix 3** for a further summary of all these issues.

CONCLUSION

We find Dr. Pielke’s conclusion in the entire matter of attempting to connect climate change to disaster losses convincing and sufficient:

“The bottom line is that currently there is no scientific basis for attributing any part of the global, decades-long trend of an increasing number of disasters and disaster losses to changes in climate, irrespective of the reasons for those changes. Those who perpetuate such claims, whether they are in the reinsurance industry, the UN, advocacy groups, or the scientific community, are either ill-informed or dishonest.”



FURTHER READINGS

General Surveys

Changnon S.A., Pielke Jr., R.A., Changnon, D., Sylves, R.T., Pulwarty, R., 2000: Human Factors Explain the Increase Losses from Weather and Climate Extremes. *Bulletin of the American Meteorology Society*, **81(3)**, 437-442.

Abstract

Societal impacts from weather and climate extremes, and trends in those impacts, are a function of both climate and society. United States losses resulting from weather extremes have grown steadily with time. Insured property losses have trebled since 1960, but deaths from extremes have not grown except for those due to floods and heat waves. Data on losses are difficult to find and must be carefully adjusted before meaningful assessments can be made. Adjustments to historical loss data assembled since the late 1940s shows that most of the upward trends found in financial losses are due to societal shifts leading to ever-growing vulnerability to weather and climate extremes. Geographical locations of the large loss trends establish that population growth and demographic shifts are the major factors behind the increasing losses from weather-climate extremes. Most weather and climate extremes in the United States do not exhibit steady, multidecadal increases found in their loss values. Without major changes in societal responses to weather and climate extremes, it is reasonable to predict ever-increasing losses even without any detrimental climate changes. Recognition of these trends in societal vulnerability to weather-climate extremes suggests that the present focus on mitigating the greenhouse effect should be complemented by a greater emphasis on adaptation. Identifying and understanding this societal vulnerability has great importance for understanding the nation's economy, in guiding governmental policies, and for planning for future mitigative activities including ways for society to adapt to possible effects of a changing climate.

Pielke, Jr., R.A., 2005: Climate Change and Reinsurance: Part II. http://sciencepolicy.colorado.edu/prometheus/archives/climate_change/000312climate_change_and_r.html

Conclusions

The bottom line is that there is absolutely no scientific basis for attributing any part of the global, decades-long trend of an increasing number of disasters and disaster losses to changes in climate, irrespective of the reasons for those changes. As Dan Sarewitz and I argued in *The New Republic* this week those who perpetuate such claims, whether they are in the reinsurance industry, the UN, advocacy groups, or the scientific community, are either "ill-informed or dishonest."

Pielke, Jr., R.A., 2005: Climate Change and Reinsurance: Part 2.5.
http://sciencepolicy.colorado.edu/prometheus/archives/climate_change/000321climate_change_and_r.html

Conclusions

Anyone making assertions that changes in climate (whether human caused or not) are responsible for any part of the global trend of increasing disaster losses had better provide some new scientific evidence to back up such claims. Future research may tell a different story, but my reading of the current state of science is that, today, such claims are groundless.

Pielke Jr., R.A., 2002: Statement of Roger A. Pielke, Jr. to the Committee on Environment and Public Works of the United States Senate, March 13, 2002. (http://sciencepolicy.colorado.edu/about_us/meet_us//roger_pielke/rp_senate/13_2002/testimony.pdf)

Take Home Points

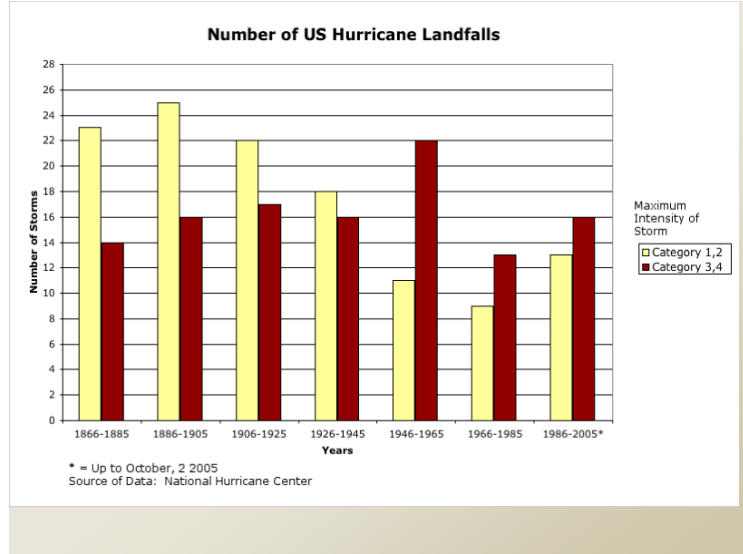
- Weather and climate have growing impacts on economies and people around the world.
- The primary cause for the growth in impacts is the increasing vulnerability of human and environmental systems to climate variability and change, not changes in climate per se.
- To address increasing vulnerability, and the growing impacts that result, requires a broader conception of "climate policy" than now dominates debate.
- We must begin to consider adaptation to climate to be as important as matters of energy policy in discussion of response options. Present discussion all but completely neglects adaptation.
- Increased attention to adaptation would not mean that we should ignore energy policies, but instead is recognition that changes in energy policy are insufficient to address the primary reasons underlying trends in the societal impacts of weather and climate.
- The nation's investments in research could be more efficiently focused on producing usable information for decision makers seeking to reduce vulnerabilities to climate. Specifically, the present research agenda is improperly focused on prediction of the distant climate future.

Hurricanes

Pielke, Jr., R. A., C. Landsea, M. Mayfield, J. Laver and R. Pasch, 2005: Hurricanes and global warming, *Bulletin of the American Meteorological Society*, in press (December 2005).

Abstract

This paper reviews recent research on tropical cyclones and climate change from the perspective of event risk – the physical behavior of storms, vulnerability – the characteristics of a system that create the potential for impacts, but independent of event risk, and also outcome risk – the integration of considerations of vulnerability with event risk to characterize an



event that causes losses. The paper concludes that with no trend identified in various metrics of hurricane damage over the 20th century, it is exceedingly unlikely that scientists will identify large changes in historical storm behavior that have significant societal implications, though scientists may identify discernible changes in storm behavior. Looking to the future, until scientists conclude (a) that there will be changes to storms that are significantly larger than observed in the past, (b) that such changes are correlated to measures of societal impact, and (c) that the effects of such changes are significant in the context of inexorable growth in population and property at risk, then it is reasonable to conclude that the significance of any connection of human caused climate change to hurricane impacts necessarily has been and will continue to be exceedingly small.

Pielke, Jr., R. A., and Landsea, C.W., 1998: Normalized U.S. hurricane damage, 1925-1995. *Weather and Forecasting*, **13**, 621-631.

Abstract

Hurricanes are the costliest natural disasters in the United States. Understanding how both hurricane frequencies and intensities vary from year to year as well as how this is manifested in changes in damages that occur is a topic of great interest to meteorologists, public and private decision makers, and the general public alike.

Previous research into long-term trends in hurricane-caused damage along the U.S. coast has suggested that damage has been quickly increasing within the last two decades, even after considering inflation. However, to best capture the year-to-year variability in tropical cyclone damage, consideration must also be given toward two additional factors: coastal population changes and changes in wealth.

Both population and wealth have increased dramatically over the last several decades and act to enhance the recent hurricane damages preferentially over those occurring previously. More appropriate trends in the United States hurricane damages can be calculated when a normalization of the damages are done to take into account inflation and changes in coastal population and wealth. With this normalization, the trend of increasing damage amounts in recent decades disappears. Instead, substantial multidecadal variations in normalized damages are observed: the 1970s and 1980s actually incurred less damages than in the preceding few decades. Only during the early 1990s does damage approach the high level of impact seen back in the 1940s through the 1960s, showing that what has been observed recently is not unprecedented. Over the long term, the average annual impact of damages in the continental United States is about \$4.8 billion (1995 \$), substantially more than previous estimates. Of these damages, over 83% are accounted for by the intense hurricanes (Saffir–Simpson categories 3, 4, and 5), yet these make up only 21% of the U.S.-landfalling tropical cyclones.

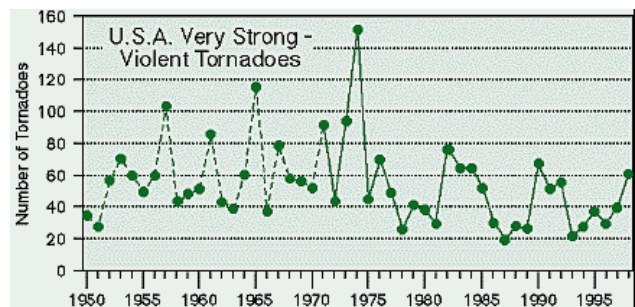
Thunderstorms/Hailstorms

Changnon, S., 1997: Trends in hail in the United States. *Workshop of the Social and Economic Impacts of Weather*, R. A. Pielke Jr., Ed., National Center for Atmospheric Research, 19–33. (<http://sciencepolicy.colorado.edu/socasp/weather1/index.html>)

Conclusions

Several results presented reveal that the growth of population, or property at risk, with increased urban targets, increased population in storm-prone areas, and higher property values per unit area have been the major factors behind the ever growing hail losses to both crops and property in the United States.

When these data are normalized to area/density at risk, the time distributions do not reveal increases since 1950, but rather level 50-year distributions interspersed with occasional periods of high losses.



Droughts

Pielke, Jr., R.A., 2005: Climate Change and Reinsurance: Part 2.5. http://sciencepolicy.colorado.edu/prometheus/archives/climate_change/000321climate_change_and_r.html

Conclusions

A recent NCAR study argues that one measure of drought shows a significant increase in areal extent over the past 20 years. But a connection to societal impacts remains to be made.

There is a lot that we don't know about global trends in the impacts of droughts. There may be robust trends in the incidence of drought that are global in nature. Better data on impacts will be useful from around the world. But clearly there is no evidence that would allow for a connection to be made between trends in drought and their societal impacts. I'll stick with my hypothesis that any trends in impacts are the result of increasing societal vulnerability and ask for falsification.

Floods

Pielke, Jr., R.A., 2005: Flood Damage and Climate Change: Update. http://sciencepolicy.colorado.edu/prometheus/archives/climate_change/000523flood_da_age_and_cli.html

Conclusions

What does this mean? There is presently no scientific basis for attributing worldwide or regional trends in flood damage to greenhouse gas emissions. None. While scientists may report something different in the future, today it is clearly a misuse of science to allege a connection between greenhouse gases and flood damages. The trend of increasing flood damage is overwhelmingly the result of societal changes.

Pielke, Jr., R.A., and M.W. Downton, 2000: Precipitation and Damaging Floods: Trends in the United States, 1932-97. *Journal of Climate*, **13(20)**, 3625-3637.

Abstract

The poor relationship between what climatologists, hydrologists, and other physical scientists call floods, and those floods that actually cause damage to life or property, has limited what can be reliably said about the causes of observed trends in damaging floods. It further limits what can be said about future impacts of floods on society based on predicted changes in the global hydrological cycle. This paper presents a conceptual framework for the systematic assessment of the factors that condition observed trends in flood damage. Using the framework, it assesses the role that variability in precipitation has in damaging flooding in the United States at national and regional levels. Three different measures of flood damage—absolute, per capita, and per unit wealth—each lead to different conclusions about the nature of the flood problem. At a national level, of the 10 precipitation measures examined in this study, the ones most closely related to flood damage are the number of 2-day heavy rainfall events and the number of wet days. Heavy rainfall events are defined relative to a measure of

average rainfall in each area, not as absolute thresholds. The study indicates that the growth in recent decades in total damage is related to both climate factors and societal factors: increased damage is associated with increased precipitation and with increasing population and wealth. At the regional level, this study reports a stronger relationship between precipitation measures and flood damage, and indicates that different measures of precipitation are most closely related to damage in different regions. This study suggests that climate plays an important, but by no means determining, role in the growth in damaging floods in the United States in recent decades.

Heat Waves

Davis, R.E., Knappenberger, P.C., Novicoff, W.M., and P.J. Michaels, 2003. Decadal changes in summer mortality in the U. S. cities, *International Journal of Biometeorology*, 47, 166-175.

Abstract

Recent studies suggest that anthropogenic climate warming will result in higher heat-related mortality rates in U.S. cities than have been observed in the past. However, most of these analyses assume that weather/mortality relationships have not changed over time. We examine decadal-scale changes in relationships between human mortality and hot, humid weather for 28 U.S. cities with populations greater than one million. Twenty-nine years of daily total mortality rates, age-standardized to account for underlying demographic changes, are related to afternoon apparent temperatures (Ta) and organized by decade for each city. Threshold Ta values, or the Ta at and above which mortality is significantly elevated, are calculated for each city, and the mortality rates on days when the threshold Ta was exceeded are compared across decades. On days with high Ta, mortality rates were lower in the 1980s and 1990s than in the 1960s and 1970s in a majority of the cities. Regionally, northeastern and northern interior cities continue to exhibit elevated, albeit reduced, death rates on warm, humid days in the 1980s and 1990s, while most southern cities do not. The overall decadal decline in mortality in most cities is probably because of adaptations: increased use of air conditioning, improved health care, and heightened public awareness of the biophysical impacts of heat exposure. This finding of a more muted mortality response of the U.S. populace to high Ta values over time raises doubts about the validity of projections of future U.S. mortality increases linked to potential greenhouse warming.

Davis, R.E., Knappenberger, P.C., Michaels, P.J., Novicoff, W.M., 2003. Changing heat-related mortality in the United States. *Environmental Health Perspectives*, **111**, 1712-1718.

Abstract

Heat is the primary weather-related cause of death in the United States. Increasing heat and humidity, at least partially related to anthropogenic climate change, suggest that a long-term increase in heat-related mortality could occur. We calculated the annual excess mortality on days when apparent temperatures—an index that combines air temperature and humidity—exceeded a threshold value for 28 major metropolitan areas in the United States from 1964 through 1998. Heat-related mortality rates declined significantly over time in 19 of the 28 cities. For the 28-city average, there were 41.0 ± 4.8 (mean \pm SE) excess heat-related deaths per year (per standard million) in the 1960s and 1970s, 17.3 ± 2.7 in the 1980s, and 10.5 ± 2.0 in the 1990s. In the 1960s and 1970s, almost all study cities exhibited mortality significantly above normal on days with high apparent temperatures. During the 1980s, many cities, particularly those in the typically hot and humid southern United States, experienced no excess mortality. In the 1990s, this effect spread northward across interior cities. This systematic desensitization of the metropolitan populace to high heat and humidity over time can be attributed to a suite of technologic, infrastructural, and biophysical adaptations, including increased availability of air conditioning.



APPENDIX 1

Kunkel, K.E., Pielke Jr., R.A., Changnon, S.A., 1999. *Temporal fluctuation in weather and climate extremes that cause economic and human health impacts: A review. Bulletin of the American Meteorological Society*, **80**, 1077-1098.

[Full paper at:

http://sciencepolicy.colorado.edu/admin/publication_files/resource-75-1999.11.pdf]

doi: 10.1175/1520-0477(1999)080<1077:TFIWAC>2.0.CO;2

Bulletin of the American Meteorological Society: Vol. 80, No. 6, pp. 1077–1098.

Temporal Fluctuations in Weather and Climate Extremes That Cause Economic and Human Health Impacts: A Review

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ABSTRACT

This paper reviews recent work on trends during this century in societal impacts (direct economic losses and fatalities) in the United States from extreme weather

conditions and compares those with trends of associated atmospheric phenomena. Most measures of the economic impacts of weather and climate extremes over the past several decades reveal increasing losses. But trends in most related weather and climate extremes do not show comparable increases with time. This suggests that increasing losses are primarily due to increasing vulnerability arising from a variety of societal changes, including a growing population in higher risk coastal areas and large cities, more property subject to damage, and lifestyle and demographic changes subjecting lives and property to greater exposure.

Flood damages and fatalities have generally increased in the last 25 years. While some have speculated that this may be due in part to a corresponding increase in the frequency of heavy rain events, the climate contribution to the observed impacts trends remains to be quantified. There has been a steady increase in hurricane losses. However, when changes in population, inflation, and wealth are considered, there is instead a downward trend. This is consistent with observations of trends in hurricane frequency and intensity. Increasing property losses due to thunderstorm-related phenomena (winds, hail, tornadoes) are explained entirely by changes in societal factors, consistent with the observed trends in the thunderstorm phenomena. Winter storm damages have increased in the last 10–15 years and this appears to be partially due to increases in the frequency of intense nor'easters. There is no evidence of changes in drought-related losses (although data are poor) and no apparent trend in climatic drought frequency. There is also no evidence of changes in the frequency of intense heat or cold waves.



APPENDIX 2

Comments by Dr. Roger Pielke, Jr. on the Science Magazine article written by Evan Mills, upon which the Ceres report heavily drew.

These comments were originally posted on the *Prometheus blog* on August 22, 2005 (http://sciencepolicy.colorado.edu/prometheus/archives/climate_change/000537the_other_hockey_sti.html).

The Other Hockey Stick

Disaster losses have increased dramatically in recent decades. Yet as discussed here frequently there is no scientific evidence showing that any part of this increase can be attributed to changes in climate, whether anthropogenic in origin or not. This is a long post on this subject. It contains a lot of gory detail on what I consider to be a major misuse of science in the climate debate, viewed through the lens of a recent paper in *Science*. I focus on this issue mainly because this is an area where I have considerable expertise, and in this context my work is often mis-cited or ignored. This misuse of science is pretty much overlooked by scientists (here is one exception) advocates on either side of the debate, and the media (here is one exception). A number of colleagues and I have a letter on this subject coming out in the November Bulletin of the American Meteorological Society (I'll post

a pre-publication version of this soon). Also, in partnership with Munich Re we are organizing a major workshop on attribution of causes underlying the observed trend of ever-escalating disaster damages. Munich Re seems very supportive of rigorous science on this topic. So clearly, I intend to pursue this subject.

Some important things to say before proceeding -- As I have written often on these pages, I accept the IPCC WGI consensus position on climate change and I am a strong advocate for policy action on climate change. I am also quite concerned by the role of science and scientists in the highly politicized context of climate.

I have titled this post "The Other Hockey Stick" drawing on some comments made by Hans von Storch in a talk at NCAR last month. The "other hockey stick" refers to the graph used by the IPCC based on Munich re data to show increasing disaster costs and has been widely used to argue for evidence of a climate change signal in disasters. Such claims are made by prominent scientists (such as Rajendra Pachauri and John Houghton) and can be found frequently in the scientific literature. The motivation for the present discussion is a paper in the 12 August 2005 issue of Science. Evan Mills, a scientist at Lawrence Livermore National Laboratory. Wrote in the essay,

"According to the latest Intergovernmental Panel on Climate Change (IPCC) assessment, climate change has played a role in the rising costs of natural disasters." And on the "relative weights of anthropogenic climate change and increased exposure" in the loss trend Mills concludes "quantification is premature." Mills uncritically accepts the IPCC statement, which as I show below is based on a pretty weak source and he is simply wrong on the latter point. Mills either ignores or is unaware of a robust literature on this subject (see here and here and here). Mills' analysis rests on a very thin basis of support. For reasons discussed below, it is amazing to me that Mills' paper survived peer review at Science. It should not have. Whether Science has a quality control problem or an inability to question analyses that may be politically inconvenient, the publication of Mills' paper sure does raise some questions.

Mills has a section of his paper focused on attribution of causes explaining recent trends in disaster losses. Let's take a close look at ten of the sources he cites in that section to support claims of a climate change signal in the damage record:

Kunkel et al. 1999. Mills cites this paper, (on which I am a co-author) to support this claim, "Socioeconomic and demographic trends clearly play important-and likely dominant-roles in the observed upward loss trends." Here is what Kunkel et al. concluded, "the results of the review strongly suggest that the increasing financial losses from weather extremes are primarily due to a variety of societal changes." Perhaps a slightly different characterization than the paper suggests, but lets move on.

Changnon and Demissie, 1996. This paper says nothing about trends in flood damage. What it does say is that in a comparison of urbanizing and rural river basins, there were large societal influences on streamflow in the urbanizing basins. This paper provides no basis for asserting anything related to flood damages.

Zhang et al. 2005. This paper is about the relationship of coastal erosion and sea level rise. It says nothing about trends in disaster losses.

Easterling et al. 2000. This paper states, "Most of the increase has been due to societal shifts and not to major increases in weather extremes. The growth of population, demographic shifts to more storm-prone locations, and the growth of wealth have collectively made the nation more vulnerable to climate extremes." This paper originated in a workshop held in Aspen that I participated in and I was originally a co-author on early drafts of this paper. I dropped off because I thought that the paper's conclusions were not supported by the evidence. In this case, there is an important difference in the cited sentence between the words "Most" and "All". "Most" happens to be grammatically correct, but in this case is synonymous with "All". My concern was that the paper would be mis-cited to assert an attribution when none was found. Here is a good example.

Karl and Trenberth 2003. This paper calls for the development of a global observing system. It says nothing about trends in disasters.

Next the paper asserts that "Global weather-related losses in recent years have been trending upward much faster than population, inflation, or insurance penetration, and faster than non-weather-related events (Fig. 2D). By some estimates, losses have increased by a factor of 2, after accounting for these factors plus increased density of insured values."

It cites 2 references to make this claim. The first reference is to a talk by Howard Kunreuther. I have known Howard for a while and respect him and his work a great deal. I emailed him to ask his source for this claim and interestingly he referred me to the second source cited by Mills. So Mills is citing the same source twice, using two apparently different sources. Not good.

The second source is a 2000 report by Munich Re on catastrophes. The relevant sections of the report can be found at pp. 79-81. Here Munich Re accurately cites my work to correctly argue for the normalization of historical loss data to account for societal changes. Then Munich Re provides some summary data following a black box calculation of changes in disaster damages after normalizing for societal changes. Munich Re finds that global disasters cost an adjusted \$636 billion in the 1990s compared with \$315 billion in the 1970s, and concludes, "Mills 'factor of 2' comes from this calculation (i.e., 636/315). Methodologically the calculation is suspect for a number of reasons. First, Munich Re provides neither their methods nor data. Second, Munich Re admits that data on changes in wealth are not available

around the world and changes in GDP are not always a good proxy for data on wealth. Third, Munich Re's data apparently includes weather and non-weather events (e.g., see figure "d" on page 81, which refers to earthquake damages).

But let's assume that all of these issues raised above can be overcome and in the end there remains a 2 to 1 ratio. The fact is that the large decadal variability in normalized losses makes it quite dodgy to assert a trend between two different ten-year periods over a period of 30 years. Let me illustrate this with an example from our database of normalized hurricane losses. If we adjust the hurricane loss data to 2004 values and then compare decades we see some interesting things. First the ratio of the 1990s:1970s is quite similar to the Munich Re analysis, 2.1 (\$91B/\$43B). But if we look at other decadal comparisons, the picture looks quite different, 1990s:1940s = 1.0 (\$91B/\$90B) and 1990s:1920s = 0.6 (\$91B/\$154B). Bottom line: The Munich Re analysis tells us nothing about attribution.

The Munich Re analysis may prove correct in the end from the standpoint of disasters in the 1970s compared to the 1990s. But all that it would allow us to say is that the 1990s had more costly disasters than the 1970s, and provides absolutely no basis for attribution of the causes of the differences. At a minimum, analyses such as Munich Re's should be submitted for peer review in the scientific literature to allow for an open discussion of data and methods.

Back to the papers cited by Mills:

Association of British Insurers, 2004. Mills cites this report as follows, "The Association of British Insurers states that changes in weather could already be driving UK property losses up 2 to 4% per year (7) owing to increasing extreme weather events."

The executive summary of the AIB report does claim, "Weather risks are already increasing by 2 - 4 % per year on the household and property accounts due to changing weather." But if you read down just a bit further (on p. 8) the executive summary says something a little different "On reasonable projections of extreme events, the pure risk rate for weather catastrophes is already rising at an unseen rate of 2 - 4 % per year." It has now raised the issue of projections. And if you take a look at the Technical Annex to the report, you find something different still, "Thus on the basis of the Foresight Programme view of future flood risk, realistically the risk of flood damage is projected to increase by between 2.1% and 3.9% per annum, or a range of two to four percent per year."

There are two important points here. First, the 2%-4% per year increase in damages is a projection made out over the next 80 years. Second, we discussed the Foresight project quite favorably here last year. The Foresight project was notable because it considered both climate and societal factors in its projections. The 2%-4% number is not based on climate factors alone. Mills' statement is thus incorrect in

two ways - the increase in damage is projected, not observed, and it is the consequence of societal and climate factors, not an observed increase in extreme events.

Mills next cites the *IPCC WGII, Chapter 8* to justify the claim "According to the latest Intergovernmental Panel on Climate Change (IPCC) assessment, climate change has played a role in the rising costs of natural disasters." If you go to the IPCC you see that the single basis for this claim is the Munich Re 2000 report discussed above. This is the third different reference to the same analysis. At best this is sloppy citing. At worst it appears as if there is an attempt to portray a broader intellectual base of support for these claims than there actually is.

Shoddy science, bad peer review and a failure of the science community to demand high standards is not the best recipe for helping science to contribute effectively to policy.

Lastly in this section, *Mills et al. 2002* discuss the relationship of lightning claims and temperature, which makes sense as lightning tends to be associated with thunderstorms and thunderstorms occur in summer not winter. As they state "An additional issue is that peak lightning periods occur in summer, when electricity reliability problems are likely to cause other business interruption losses, as suggested by the illustration." There is no data here relevant to understanding historical trends in disasters (or insurance claims).

So here is my tally:

3 sources are each traced back to a single non-peer reviewed source, Munich Re 2000, that raises some serious questions of methods and interpretation.

4 papers are cited but are not at all relevant to the issue of disaster losses or attribution.

1 paper (AIB) is mis-cited, which is easy to see if you actually look beyond the first page of its executive summary. (Ironically, the Foresight report which forms the basis for the AIB claims actually makes a good case for the overwhelming dominance of societal factors in future flood losses in the UK.)

1 paper is cited accurately, *Easterling et al.*, but in my opinion this paper plays fast and loose with language to allow a mis-interpretation of its results.

1 paper *Kunkel et al.* is cited accurately, though I might take issue with the spin, it is probably within the bounds of appropriateness.

Of 10 citations, 9 are highly questionable. And this is Science magazine. (Emphasis added)

The bottom line is that the issue of attribution of trends in disaster losses rests on the thin reed of a single citation in the *IPCC WG2 Chapter 8* to a 2000 Munich Re report that seems to be cited over and over again. Through citing this report several times via different secondary sources, the citing of multiple irrelevant sources and the careful parsing of two papers, Mills comes to the conclusion that climate change is responsible for some part of the observed trend in losses. There is a much, much larger literature on this subject that Mills does not cite.

These are not characteristics that one expects to see in a paper in *Science*, arguably one of the two most influential publications on science in the world. I have submitted a brief comment in the form of a letter to *Science* on this paper referencing some of this broader literature. Let's see what happens.

In the end, scientific research may yet prove that anthropogenic climate change plays a observable role in disaster losses. But today, August 22, 2005, shoddy science, bad peer review and a failure of the science community to demand high standards is not the best recipe for helping science to contribute effectively to policy.



APPENDIX 3

These comments have just appeared in the *Bulletin of the American Meteorological Society* (DOI:10.1175/BAMS-86-10-1481, October 2005, 1481-1483).

Clarifying the Attribution of Recent Disaster Losses: A Response to Epstein and McCarthy

The December 2004 issue of *BAMS* contains an article warning of the threats of abrupt climate change (Epstein and McCarthy 2004, hereafter EM04). The article seeks to raise awareness of the risks of an abrupt change in climate related to human influences on the climate system, but, in doing so it repeats a common factual error. Specifically, it identifies the recent growth in economic damages associated with weather and climate events, such as Hurricanes Mitch and Jeanne and tornadoes in the United States, as evidence of trends in extreme events, arguing "the rising costs associated with weather volatility provide another derived indicator of the state of the climate system . . . the economic costs related to more severe and volatile weather deserves mention as an integral indicator of volatility." Although the attribution of increasing damages to climate changes is but one of many assertions made by EM04, the repetition of this erroneous claim is worth correcting because it is not consistent with current scientific understandings.

The rising costs of disasters are important, and so too is human influence on climate. Policy makers should, indeed, pay attention to both issues. But a robust body of research shows very little evidence to support the claim that the rising costs

associated with weather and climate events are associated with changes in the frequency or intensity of events themselves.¹ Instead, the research that has sought to explain increasing disaster losses has found that the trend has far more to do with the nature of societal vulnerability to those events. This conclusion is borne out in literature from the natural hazards community (e.g., Mileti 1999; Tierney 2001) and the societal impacts of the climate community (e.g., Glantz 2003; Changnon et al. 2000), and is consistent with the findings of the most recent assessment of the Intergovernmental Panel on Climate Change (IPCC) (Houghton et al. 2001; McCarthy et al. 2001). Emanuel (2005) reports a change in recent decades in the intensity of tropical cyclones in the North Atlantic and North Pacific. However, there has been no similar trend of increasing damage. AMERICAN METEOROLOGICAL SOCIETY OCTOBER 2005 | 1481 DOI:10.1175/BAMS-86-10-1481 Nonetheless, misperceptions persist (e.g., Harvard Medical School 2004, Munich Re 2004).

In particular, research on the societal dimensions of disasters shows that over recent decades the impacts of disasters on society do show an increase, whether measured by economics (Munich Re 2004) or people affected (International Federation of the Red Cross 2004). The primary reasons for these increases lie with underlying societal trends—demographic, economic, political, social, etc.—that shape our vulnerability to impacts (Adger et al. 2003; Kunkel et al. 1999; Smit et al. 2000; Changnon et al. 1997; Easterling et al. 2000; Changnon 2003; Pielke and Downton 2000; Pielke and Landsea 1998; Raghavan and Rajesh 2003).

Concern about the possibility of abrupt climate change, whether human caused or not, is well justified (Alley et al. 2003). However, to connect the economic and other human impacts of disasters that have occurred in recent years and decades to climate changes (human caused or not) is not supported by the robust peer-reviewed literature in this area. Advancing such unsupported connections not only can create inefficiencies in disaster policy (Sarewitz and Pielke 2005), but can also open the door to an “overselling” of climate science and a resulting criticism of advocacy efforts regarding climate change (e.g., von Storch and Stehr 2005). Both science and policy will be better served by aligning the justifications advanced for action with current scientific understandings. Future research may yet reveal a connection between climate change and trends in disaster costs, but at present it is premature to attribute trends in disaster costs to anything other than characteristics of and changes in societal vulnerability.

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¹ Emanuel (2005) reports a change in recent decades in the intensity of tropical cyclones in the North Atlantic and North Pacific . However, there has been no similar trend of increasing damage.



END
