Climate change and extreme weather events: Is there a connection?

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In this special commentary to Cicerone*, Heather Tompkins explores the link between extreme weather events and climate change.*

Turn on the television and you might just catch a story about the weather. Weather has always been a popular topic but in the past decade it has sparked more interest and debate as the public has become more concerned about unforeseen changes in our climate. Over the 20th century the average temperature of the earth has increased 0.4–0.8 °C. This increase is expected to continue, and by 2100 the average global temperature is likely to be 1.4–5.8 °C warmer. One of the anticipated effects of climate change is the possible increase in both frequency and intensity of extreme weather events, such as hurricanes, floods, and droughts. The warming of the earth may fuel interactions between the ocean and atmosphere that will amplify the frequency and intensity of extreme weather events. The question now being asked is – are extreme weather events becoming more frequent, and is this linked to climate change?

To provide some background, weather events can be classified as extreme through various factors such as the impact the event has economically (insurance costs), socially (loss of life) and environmentally (destruction of habitat). The reinsurance firm Swiss Re assembled a list of the top 40 deadliest and costliest events for 1970–2001. Presented below are the top five extreme weather events taken from that list. The table shows that in economic terms extreme weather events have been felt the most in the developed world. On the other hand, the deadliest extreme weather events often occur in developing countries where people live in vulnerable, marginalized areas. Moreover, the costliest extreme weather events are not necessarily the most deadly. Hurricane Andrew, which tops the list in the most costly category, had only 38 victims, while Tropical Cyclone Gorky, the second most deadly weather event, accounted for only three billion USD in insured losses – about one seventh of the losses of Hurricane Andrew.

Table 1. Top five costliest extreme weather events 1970-2001*

Rank	Victims[1]	Insured loss[2]	Date	Event	Country
1	38	20,185	23.08.92	Hurricane Andrew	US, Bahamas
2	51	7,338	27.09.91	Typhoon Mireille	Japan
3	95	6,221	25.01.90	Winterstorm Daria	France, UK et al.
4	80	6,164	25.12.99	Winterstorm Lothar	France, Ch et al.
5	61	5,990	15.09.89	Hurricane Hugo	Puerto Rico, US et al.

Table 2. Top five deadliest extreme weather events 1970-2002*

Rank	Victims[1]	Insured Loss[2]	Date	Event	Country
1	300,000	N/a	14.11.70	Storm & Flood	Bangladesh
2	138,000	3	29.04.91	Tropical Cyclone Gorky	Bangladesh
3	15,000	106	29.10.99	Cyclone 05B	India (Orissa), Bangladesh
4	15,000	N/a	01.09.78	Flooding following monsoon	Northern India
5	10,800	N/a	31.10.71	Flooding	India (Orissa), Bay of Bengal

Scientifically speaking, global warming is expected to be accompanied by changes in temperature and precipitation extremes. The Intergovernmental Panel on Climate Change (IPCC) outlined in its Third Assessment Report the likelihood of the occurrence of such extremes in the 21st century. Simple extremes, such as higher maximum land temperatures and more intense precipitation, are projected to be very likely, that is, to have a 90-99% chance of occurring. These amplified simple extremes could lead to extreme weather events like drought and flooding. Current trends in one-day and multi-day precipitation events are revealing. There is now a tendency to have more days with heavier 24-hour precipitation, even if some of these areas are experiencing a decrease in total annual rainfall.

The case of India is interesting when looking at extreme weather events. For a country that has more than 70% of its population relying on agriculture directly or indirectly, the impact of extreme weather events is critical. In the last decade India has been repeatedly battered by successive monsoons, flooding and droughts. For example, for the last 100 years in the state of Orissa, 49 years have experienced floods, 30 have had droughts, and 11 faced

* Adapted from Swiss Re Sigma report "Natural catastrophes and man-made disasters in 2001: Man-made losses take on a new dimension" (No. 1/2002)
[1] Dead and missing
[2] In USD millions, indexed to 2001

cyclones. These extreme weather events are not mutually exclusive. It is not unusual for a year to have a combination of droughts, floods and cyclones. In addition, the number of villages in India experiencing drought is increasing. For example, in the state of Gujarat, only 2000 villages experienced drought in 1961, but by 1988, over 145,000 villages were affected. With respect to cyclones, India is particularly vulnerable because of the relatively large percentage of the population living in coastal districts that often lie in the path of cyclones. Protective measures, such as early warning systems, storm shelters and dikes, are not as common in India as in developed countries. Loss of life in India due to extreme weather events is frequently high. In 1999, 15,000 people were killed by super cyclone 05B. Some studies have been conducted to determine whether the frequency of monsoon rainfall and droughts is undergoing a change. However, the results have been inconclusive or contradictory.

There is considerable evidence that economic damages caused by extreme weather events have been increasing noticeably over the last few decades. Munich Re, the world's largest reinsurance firm, compared economic losses in the 1960s with losses in the 1990s and concluded that a significant portion of the increase in losses was due to a change in the frequency of extreme weather events. In 1998 alone, extreme weather events accounted for 89 billion USD worth of damages, an increase of 50% from the previous record set in 1996. In 1999 there were over five weather events that resulted in losses over a billion dollars. Two of these events include storms Lothar and Martin, whose hurricane-force winds occurred within a day of one another and caused more than six billion USD in combined losses to Central Europe. Certain factors must be taken account when considering the significance of economic losses. First, economic losses are expected to increase over time as people move into more vulnerable areas. The more people that live in a vulnerable are, the more infrastructure, homes and business that are susceptible to damage as well, adding to insurance losses. Second, inflation also drives up economic losses since buildings and materials increase in price as time goes on. Therefore the perception that the increase in economic losses intuitively means an increase in extreme weather events is misleading.

It's hard to escape the perception that extreme weather events are increasing. Ask anyone and they are likely to recall a storm, flood, heat-wave or drought that was the worst in *their* recent memory. Our televisions and newspapers almost daily carry weather related stories and images such as the unprecedented 1998 ice storm that crippled much of eastern Canada and the United States. Not that this coverage isn't merited in some cases. The ice storm was the most destructive weather related event ever to hit Canada and one of three weather related billion dollar (USD) losses for that year. However, extensive press coverage on extreme weather events may be prejudicing our perception of the issue. One study based in the United States examined whether the enhanced media attention was in fact biasing the public's perception (see Easterling et al., 2000). In the case of the United States, media coverage on extreme weather events appears to be more extensive than in other parts of the world. In the case of land-falling Atlantic hurricanes, the study found that the public's perception of an increase in frequency was actually the opposite of reality.

Natural phenomena that might explain a possible increase in extreme weather events do exist. For example, El Niño and La Niña are known to precipitate extreme weather events. El Niño and La Niña are extreme phases of a naturally occurring climate cycle known as the

Southern Oscillation. The El Niño Southern Oscillation (ENSO) encompasses a large-scale change in sea surface temperatures (SST) in the eastern tropical Pacific. The change in SST alters atmosphere–ocean interactions, altering weather patterns worldwide. During an El Niño year, weather patterns are reversed from the norm. Possible impacts of an El Niño year include decreased rainfall in countries such as Indonesia, Malaysia, Australia, and India, as well as more storm activity in Canada, Alaska and the northern US. The uncommonly strong El Niño of 1997–98 is credited with contributing to the aforementioned ice storm of 1998. Conversely, a La Niña year emphasizes normal weather patterns, so wetter areas get wetter (i.e., floods), drier areas get drier (i.e., droughts). Also during a La Niña year, the trajectory of severe weather (e.g., tornadoes and hurricanes) is moved further north and west. In fact, the probability of occurrence of more than one billion USD in damages is 0.77 in a La Niña year, 0.32 in El Niño years and 0.48 in neutral years.

Also, one must take into account whether an extreme event is truly *extreme*. The natural variability of extreme weather events is still to some extent unknown since most historical records on events can only stretch back a couple of hundred years. The cycles that extreme weather events undergo may be on a time scale that is longer than our records, thus making them difficult to foresee. For example, statistically speaking, the probability of an annual precipitation event of 1 in 1000 years still falls within the range of a "normal" climate. An event that may seem extreme to us may be a purely random variation or part of the natural variability of the earth's climate.

How can the public be better informed about extreme weather events? Historical records do provide some reliable insight into the frequency and intensity of extreme weather events. Yet, as mentioned before, these records are insufficient to give an accurate picture of what to expect. Predictive climate models have been utilized to analyze extreme weather events, but the unpredictability of extreme weather events is impeding the process. However two new studies published in the January 2002 edition of the journal *Nature* have improved our confidence in estimating the risk of flooding and extreme precipitation. Milly et al found that the frequency of severe floods in large river basins has increased during the 20th century. They established that the likelihood of this increase arising from natural climate variability is small. The other study, by Palmer and Raisanen, analyzed the output of 19 climate models, predicting that wet winters will be five times more likely in northern and central Europe over the next century. They also estimated that the Asian monsoon region will experience an increase in wet summers of a similar scale, escalating the risk of flooding in already flood-prone areas.

So the debate continues. No clear consensus exists linking the frequency and intensity of extreme weather events to changes in climate patterns, but it would be reckless to not expect that climate change will have some impact on extreme weather events. Today there are over six billion people living on the earth, often in areas that are known to be vulnerable to extreme weather events. The potential for catastrophic damage and lost of lives is enormous. There is urgent need for a better understanding of the changing climate patterns and how they affect extreme weather events. Further study, especially on the natural variability and cycles of extreme weather events as well as data on a smaller (i.e., local) scale is required.

References

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