

Prof. Dr. Peter Hölpe

Head of Geo Risks Research, Munich Re Group, Munich, Germany

Risk analyses: Is global warming increasing the costs of damage caused by natural disasters?

Some of you may be asking yourselves why the insurance industry or Munich Re is so interested in climate change. The easy answer is that we have to pay for part of the damage that climate change is already causing. I will show you some examples and some evidence that this is already a reality. As for my department: Munich Re has a long tradition of analyzing natural disasters and their trends, having recruited its first two scientists back in 1974. Now the department has a staff of 25, two of them based in our office in Princeton, and two in Hong Kong, so we have a large team with experts in geophysics, meteorology, geography, hydrology and all fields of relevance to natural disasters.

I would now like to show you just a few examples of natural disasters from the last few years, because these last years, especially 2004 and 2005, broke records in terms of the intensity and frequency of the disasters and the damages and losses they incurred. I will start with 2002. This was the year in which the "flood of the century" occurred in Eastern Germany: you can see here an aerial view of the old part of Dresden (chart 4). This flood caused huge economic losses – 16 billion euros in total, of which 3.4 billion euros had been insured. Then, just one year later – Professor Levermann already showed you a different picture of this – came the extreme summer of 2003 (chart 5). This was without doubt the most severe humanitarian catastrophe to hit Europe for centuries, killing more than 35,000 people, most of them in France, where the highest heat stress occurred. You can see an index here – of the so-called perceived temperature – indicating the heat stress. The next year was also a record year, with four hurricanes making landfall in Florida (chart 6). This was the highest number in Florida since records began in 1850, and also represented a record in terms of total economic losses: US\$ 62 billion from just the four hurricanes in Florida, with insured losses of about half of this figure, i.e. US\$ 31.5 billion. Then, in March 2004, we had the first hurricane in the Southern Atlantic. We saw the highest-ever 24-hour precipitation measured in India – 944 mm, which is more than the annual average for most of the cities here in Germany. This resulted in the deaths of more than 1,000 people, and caused economic losses of US\$ 5 billion and US\$ 770 million insured losses (chart 8). Next we saw the most expensive natural disaster ever recorded in Switzerland, namely the flooding in August 2005. The resulting economic loss for Switzerland alone amounted to US\$ 2.1 billion - the total amount was US\$ 3 billion, of which a little over half was insured (chart 9). Then came the largest loss incurred by a single event in history, Hurricane Katrina. Never before had a single event cost so much money in terms of both economic and insured losses. Economic losses are estimated to be US\$ 125 billion, from just this one hurricane. The insured loss came to US\$60 billion (chart 10).

From a meteorological point of view Katrina was the sixth strongest hurricane since records began. In the same season we also had the strongest hurricane ever, when Wilma hit Mexico, the USA and the Caribbean and caused huge economic and insured losses (chart 11). We also had the fourth strongest hurricane, which was Rita. In other words, the strongest, the fourth strongest and the sixth strongest hurricanes all occurred during the course of just one season. There was also the first

real hurricane system to approach Europe, when hurricane Vince showed up close to Madeira and made its way into Spain and Portugal (chart 12). This is a totally new phenomenon, where hurricanes are generated so far north and east that they end up drifting to the east. This means Europe can no longer be said to be hurricane-free. The storm didn't reach the coasts of Europe at hurricane strength, because the waters in-between are still too cold, but it is just conceivable that this could happen in the near future. A second tropical storm also came close to Europe, making landfall in Morocco after it had passed over the Canary Islands and caused damage to the tune of US\$ 375 million there. This was the first time the Canary Islands had ever documented a tropical storm – a new phenomenon once again. As you can see, last year was a real record season in terms of hurricanes, with old records being broken by six of the named tropical storms and three of the hurricanes.

Munich Re has one of the world's largest databases on natural catastrophes, and I would like to provide you with some detail about its contents (charts 15-18). So far, we have documented 22,000 individual natural events which have caused disasters on a global level; I would like to show you just a few results of the statistics from this database. What you see here is the number of major natural disasters, i.e. those which kill thousands of people and cause billions of dollars of damage. As you can see, they are broken down into the different types: flood, windstorm, earthquake, tsunami, volcanic eruption and other types of events which are also related to weather. As you can see here, starting from the 1950s we had about two of these per year on a global level – this number has now increased to about seven.

The major part of this trend is driven by weather-related events. This shows only the geophysical events – the slight upward trend is due without doubt to population growth: some of the disasters in the 1950s were not major disasters because the population was smaller so fewer people were killed or injured. Most of the trend, therefore, is due to weather-related disasters. These are the costs of these great weather disasters; they have already been adjusted to take account of inflation, so this is all in 2005 values. You can clearly see the exponential increase in both economic losses, shown by the green bars, and insured losses on a global level, shown by the blue bars (chart 18). As you can see, 2004 was a record year - never before had the losses been as high as in 2004, yet 2005 topped this record year by a factor of two. What we are seeing here is a dramatic development in weather-related disasters. There are certainly many reasons for the increases in losses incurred by these great disasters (chart 19). We have more people living in areas which are affected, we have a higher standard of living which means that property of higher value can be affected, we have people living in mega cities which are especially vulnerable, and we have more and more people settling in areas like Florida, which have a high hurricane risk. Our societies have also become more vulnerable, which in many ways also increases the insured losses.

Nonetheless, we are quite sure that none of these factors can fully explain the overall increase in total losses, and definitely not the increase in the numbers of events, because socio-economic developments do not have such a large influence on this. For a PhD thesis, we are planning to assess the quantitative effects of all the socio-economic causes in order to see what is left over and can be attributed to environmental changes like global warming. There is increasing scientific evidence now that there is a causal link (chart 20): we know for sure that climate has been changing, and we know for sure that there has been an increase in large-scale

weather disasters. Although this does not necessarily mean that there is a causal link between the two trends, we are finding more and more evidence for such a link. The first is a British study which was published in Nature in 2004 showing that human influence has already at least doubled the risk of a heat wave exceeding the magnitude of the European heat wave in 2003. We also have a study which modeled the effects of climate change on hurricanes and found that maximum wind speed and precipitation in hurricanes will increase until 2050 as a result of climate change and global warming. There has already been an increase in the number of major tropical storms, both in the Atlantic and Pacific region. This is what we have learnt from the studies of Emanuel and Webster published last year. Another very interesting fact is that there is now evidence that sea surface temperatures have already increased by about 0.5 degrees Celsius (chart 21) as a result of climate change. One of the studies was published just two weeks or so ago. Another study carried out by Webster showed that of all the factors that drive a major tropical storm only the steady increase in sea surface temperatures over the last 35 years can account for the rising strength of storms in six ocean basins around the world, not only in the Atlantic Ocean.

In other words, we have learnt that global warming has raised the sea surface temperature, and that this increase is the only explanation of the rise in the intensity of these hurricanes. The logical conclusion, therefore, is that anthropogenic climate change has already produced an increase in the intensity of the hurricanes. In chart 21 you can see the proof for a general trend towards higher sea surface temperatures in almost all ocean basins: in the Northern Atlantic Ocean, the Northern and Southern Indian Ocean and the Western Pacific Ocean.

In another study we did, we analyzed the total number of tropical storms in the Northern Atlantic using data provided by the NOAA since 1850 (chart 22). The figures were broken down into the different phases of the multi-decadal Atlantic oscillation, and we can observe some natural cycles in the Atlantic Ocean – the so-called cold and warm phases with colder and warmer sea surface temperatures. We calculated the annual average number of destructive hurricanes, i.e. the major hurricanes in Saffir-Simpson classes three to five, and found, as you can see, that there were always fewer of them during the cold phases. This is very plausible, and just what we would expect. During the warm phases, on the other hand, we see much higher numbers – factors of two and more. But what we also see is an increase in the number of major storms if we compare the two warm phases – the current one which started in 1995 and the preceding one around the 1950s. Thus, comparable natural cyclical phases show differences, and this can only be explained by the steady increase in sea surface temperature due to global warming.

To sum up, we have both a natural effect, namely the multi-decadal Atlantic oscillation, and an effect caused by the steady warming of the sea surface temperature. Rough estimates conclude that about one third of the increased intensities and frequencies that we have seen during the last few years may be due to climate change. If you translate this into costs, you see that more than US\$ 50 billion last year could perhaps already be attributed to global warming.

Chart 23 shows the sea surface temperature anomaly and adjusted losses, not only adjusted for inflation, but also for development of population and values. You can see two different figures: one based on our Munich Re NatCat Service Data, and the

other on Roger Pielke's data, who has developed methods for such adjustments. There is hardly any difference between the two: the colder the sea surface temperature was, the less damage occurred. There is a clear relationship between sea surface temperature and annual market losses. If the sea surface temperature rises further due to global warming, we will have to expect larger damages. Furthermore, there are also health effects. We are seeing an increased rate of heat mortality in some regions, we should expect higher UV radiation, and there will be effects on food safety and diarrheal diseases, as well as infectious diseases.

I would like to conclude by saying that natural disasters, especially weather-related events, are increasing dramatically in number and magnitude, and loss potentials have reached new dimensions. Climate change is already happening and can no longer be stopped, but at best attenuated. There is more and more scientific evidence of a causal link between global warming and the increasing frequencies and intensities of natural catastrophes. Climate change also increases the risk of injuries and fatalities resulting from extreme events and changing patterns of disease. We will have to adapt to the changing risks, and attempt to mitigate greenhouse gas emissions. The insurance industry is quite a powerful force in supporting climate protection, and Munich Re has done a lot in this respect. I would like to show you just a few recent examples. We have published a book and a board game which teaches players about how climate change works and what you can do to combat it. We have been very active in many groups promoting climate protection like the Climate Group, the Global Round Table on Climate Change, the European Climate Forum etc. Within the so-called Munich Climate Insurance Initiative, we have worked together with the World Bank, PIK and IIASA to develop insurance solutions to protect developing countries against increasing damages caused by weather-related disasters, and we offer insurance cover for renewable energy plants, e.g. for a geothermal energy plant in Unterhaching close to Munich. One of our most recent products is the Kyoto Multi-Risk Policy to cover Kyoto processes like CDM and JI projects. This new product, which we are now offering, helps to make these projects feasible, because investors are keen to have at least part of their risks insured. This completes my presentation, and I am now looking forward to the discussion with you. Thank you for your interest.