Knowledge series

Topics Geo
Natural catastrophes 2006
Analyses, assessments, positions

Münchener Rück
Munich Re Group

Contents

Cover:
In the early hours of 27 May 2006, the densely populated region to the south of Yogyakarta was shaken by an earthquake of magnitude 6.3, which rendered a million people homeless in a matter of seconds. More than 5,700 were killed.

Below:
Just weeks after the Yogyakarta earthquake, Java was hit by another catastrophe. A strong earthquake some 200 km off the coast triggered tsunami waves of up to seven metres in height. The population was not alerted since the region had no viable early-warning system at the time. As a result, more than 650 people lost their lives in this tragic event.

Analyses – Assessments – Positions

For the past 13 years, we have presented the results of our annual worldwide survey of natural catastrophes in Topics Geo. Long-standing readers will notice that the approach is different this year. The new format, starting with the subtitle, Analyses – Assessments – Positions, reflects this change of emphasis. Instead of constituting an essentially statistical study of natural catastrophes, the focus is now on providing background analyses that are of practical application.

Winter Storm Kyrill, which struck in mid-January 2007, presented the insurance industry with a loss of several billion dollars and confirmed our prediction that an exceptionally warm winter, like the one we are experiencing this year, would entail a particularly high storm risk. This year has again shown that there will be a long-term increase in weather extremes in Europe as well as elsewhere. Winter storms, in particular, are likely to increase in severity.

It is true that, compared with the record losses of 2004 and 2005, the natural catastrophe situation could have been far worse in 2006. In fact, the unexpectedly weak 2006 hurricane season gives rise to a considerable number of underwriting issues. Should we revise last year's estimates? What were the factors behind the fall in the number of hurricanes in 2006? What can we expect in the years to come? The article "Lull in the North Atlantic?" on page 5 provides detailed answers and explains Munich Re's standpoint.

The catastrophe portraits analyse the significance of individual major events for the insurance industry: Europe's exceptional snowfalls, Australia's probably most severe cyclone on record and the Indonesian earthquake in which several thousand people lost their lives. We discuss how to determine what constitutes an event in the context of Europe's snow pressure losses, consider possible cyclone scenarios for Brisbane, and examine the loss potential of an earthquake in Jakarta.

A chapter on climate and climate change looks at the implications of the many scientific studies published in 2006 and the political debate on climate change for the insurance industry.

The issue is rounded off with the latest frequently-quoted worldwide statistics from NatCatSERVICE.

It contains great deal of information that I am sure will be of practical use in your professional life and I wish you, accordingly, an interesting read.

Munich, February 2007

Dr. Torsten Jeworrek
Member of the Board of Management
Corporate Underwriting/Global Clients

In focus

2006 hurricane season – Why were the forecasts wrong? Most experts believed that Katrina and the other 2005 hurricanes were a sign of above-average storm activity to come. Why did it not happen? What will next season bring? Scientists have been examining the implications whilst the insurance industry has been reviewing its storm models.

Between 24 August and 1 September 2006, the Caribbean was pounded by Hurricane Ernesto, which subsequently swept northwards along the east coast of Florida. This photograph taken in Cuba gives some idea of the ease with which hurricanes are able to wrest buildings from their foundations and toss cars around like toys. Ernesto caused damage amounting to US$ 500m, half of which was insured.

Lull in the North Atlantic?

Following record hurricane insured losses in 2004 (some US$ 40bn) and 2005 (around US$ 80bn), one fact in particular stands out when we look back at the 2006 North Atlantic hurricane season: we did not experience the high levels of activity forecast by all the reputed institutes. There were only ten named tropical storms, five of which reached hurricane force.

The following aspects are especially striking:

- This is in line with the average over the past 56 years. During this period, there have been around ten named cyclones per year, including six of hurricane force (i.e. with wind speeds exceeding 118 km/h).

- If we look at the high-activity phase (Atlantic warm phase) since 1995 in isolation, the 2006 hurricane season was well below par. In the period 1995–2006, there were on average more than 14 named storms per year, of which eight reached hurricane force.

- With only two hurricanes of category 3 or more (i.e. with wind speeds of over 178 km/h), 2006 was below the 1900–2006 average (three) and well below the average for 1995–2006 (about four).

- The number of US landfalls in 2006 was below the average, totalling four (all below hurricane force). During the preceding high-activity phase, the annual average was around five, two of hurricane force.

The main issue for the insurance industry is whether, in the light of 2006, we are justified in adjusting our risk management to reflect loss frequencies since 1995 (the onset of the Atlantic warm phase). To answer that question, we need to examine the cyclones that occurred in the North Atlantic in 2006 and conduct a scientific analysis of the reasons for the below-average level of activity.

Tropical cyclones in the North Atlantic in 2006

Three tropical storms made landfall on US territory; Atlantic cyclones also hit Haiti, Cuba, Bermuda and the Azores (Fig. 1).

- Alberto struck Adams Beach, Florida, on 13 June; Tropical Storm Beryl swept across Nantucket Island, Massachusetts, on 21 July.

- Chris weakened to a tropical depression and only brought precipitation to Cuba on 5 August.

- Ernesto grazed southwest Haiti on 27 August and struck Cuba (Playa Cazonal) the following day as a tropical storm. It maintained this force when it reached Florida (Plantation Key) on 30 August and North Carolina (Long Beach) on 1 September. It caused insured losses in the order of US$ 250m in the Caribbean and North America, but overall losses were double that figure.

- Florence, which hit Bermuda on 11 September, was a Category 1 storm.

- A notable feature following on from Hurricane Vince (October 2005) and Tropical Storm Delta (November 2005), which had moved eastwards towards Europe making landfall on the Spanish mainland and Canary Islands the previous year, was the track of Hurricane Gordon in September 2006. One of two storms to reach force 3 that year, it moved into the West Drift three days after it had formed, striking the Portuguese autonomous region of the Azores as a Category 1 hurricane on 20 September.

2006 hurricane losses were low compared with previous years and there were few deaths (see Chronicle page 50). Particularly noteworthy was the fact that the tracks of most of the cyclones did not lead close to the US mainland. Instead, they described a typical northward and eastward curve, well to the east of the Caribbean and American coasts, in the open Atlantic – similar to the most frequently occurring pattern in the period 1995–2003.

Scientific reasons for the low level of activity

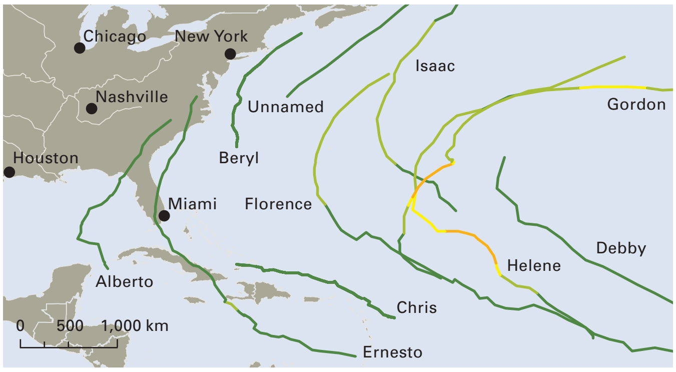
Sea surface temperature

Following all-time highs between June and October 2005, with a deviation of +0.85°C from the 1961–1990 average, sea surface temperatures in the main hurricane breeding ground of the tropical North Atlantic – and in particular the central area of the tropical North Atlantic – were lower in 2006. However, they were nonetheless high, the deviation (+0.59°C) being the third-highest since the beginning of the period under observation (see Fig. 2). This is in keeping with the phase of high ocean temperatures going back to 1995. The maximum fluctation range in water temperatures over the past 12 years has been approximately 0.8°C, and the differences year on year have been substantial. Furthermore, sea temperatures in 2006 were high enough to have triggered an extremely active season. Accordingly, to find the reasons for the lower level of activity, we need to look elsewhere.

Dryness

The main reasons for the small number of cyclones were widespread atmospheric dryness over the tropical North Atlantic and the effect of El Niño in the Pacific, which developed rapidly in the period between August and October. The dry, warm layer of air increases the energy barrier that must be overcome to allow warm, moist air to rise up from the surface of the water, where it can subsequently produce tall thunderclouds and result in cyclones. The air over the sea therefore required more convective energy in order to rise up through this layer. This hampered the formation of clouds and storms.

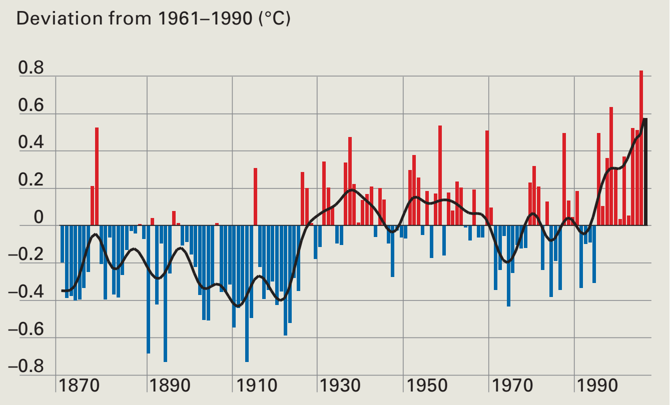
Fig. 1 North Atlantic tropical cyclone tracks in 2006



Source: NOAA, NHC, Miami

Wind speed in km/h
(SS: Saffir-Simpson Hurricane Scale)
— Tropical storms (< 118 km/h)
— SS 1 (118–153 km/h)
— SS 2 (154–177 km/h)
— SS 3 (178–209 km/h)
— SS 4 (210–249 km/h)
— SS 5 (≥ 250 km/h)

Fig. 2 Average June–October sea surface temperatures in the tropical North Atlantic



June–October average sea surface temperature deviations from the 1961–1990 mean in the tropical North Atlantic for the area 10°N–20°N, 80°W–20°E.
Black curve: smoothed curve.

Source: HadISST, Hadley Centre/
Met Office, UK

This dryness is caused by high concentrations of mineral particles in the atmosphere. They absorb solar radiation, thus warming the surrounding layer of air and making it drier. This concentration of particles, which can span the entire Atlantic from Africa to Central America, is caused by sand blown from the Sahara.
El Niño is another phenomenon which has a drying effect on the air. Over the Caribbean and tropical Atlantic in particular, displacement of the circulation patterns can bring about a downward motion. As the air sinks, it becomes warmer and drier. Analyses show that, between June and November 2006, the moisture content of the middle atmosphere over the tropical North Atlantic was consistently below the long-term average. Indirect evidence of this is an above-average water vapour brightness temperature due to a lack of water vapour in the atmosphere (see Fig. 4).

Vertical wind shear

A further mechanism plays a major role in the formation of hurricanes: different wind forces in the upper (approximately 12-km altitude) and lower (approximately 1.5-km altitude) atmosphere. The greater the difference in wind force and direction, the lower the propensity for tropical cyclones to develop. This is also referred to as vertical wind shear. It is a factor whose annual cycle affects the typical course of the hurricane season. In September, vertical wind shear is at a minimum whilst activity, on average, is at a maximum. Wind shear is a very effective means of controlling cyclone activity. Typically, it increases from October onwards, bringing the hurricane season to a close. The very high sea temperatures in the equatorial Pacific which accompany El-Niño events increase wind shear over the tropical Atlantic.

Distribution of the different mechanisms at play across the season

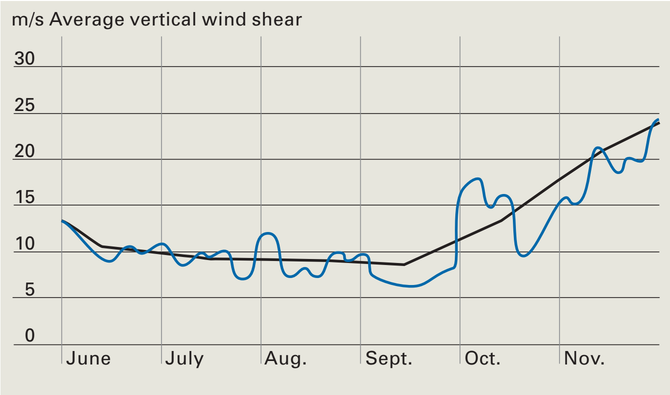
The season got off to an early start, the first named tropical storm forming on 11 June. According to the long-term average for 1944–2005, the season would normally start a month later (on 10 July). In June and July, sea surface temperatures were 0.5–1.0 °C cooler and the air over the eastern tropical Atlantic drier than in 2005. Accordingly, activity in those two months was far less pronounced than in 2005 (with three storms compared with seven) and in keeping with the 1995–2006 average.

In August 2006, there were three storms – well above the long-term average but below the average for the previous 12 years (3.8). This was mainly due to the effect, as described above, of mineral particles swept up from the sand of the Sahara, producing warm, dry air. Vertical wind shear was also high at the beginning and towards the end of the month, a factor not conducive to cyclones.

In September, activity increased to just below the mean for the previous 12 years, vertical wind shear in the tropical Atlantic and Caribbean being below average. Probably the main driving force, it was not outweighed by the continuing dryness of the atmosphere.

The North Atlantic hurricane season ended relatively early, at the beginning of October, westerly winds in the upper atmosphere having strengthened due to the rapid development of El Nino; wind shear had accordingly increased sharply. Fig. 3 shows that, at the beginning of October, there was a steep rise in the difference between wind forces near the ground and at altitude.

Fig. 3 Vertical wind shear over the tropical North Atlantic

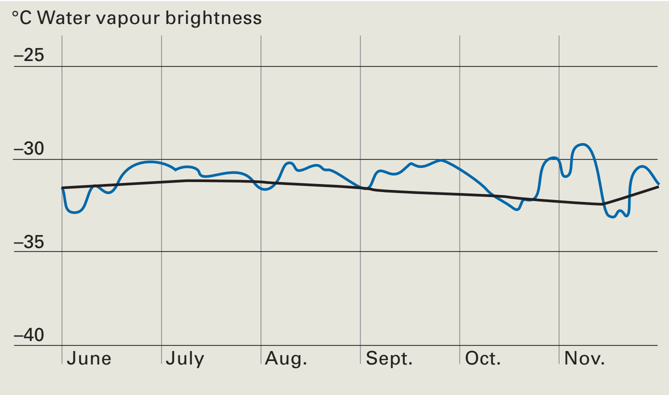


Differences in wind speed and direction by altitude (12 km vs. 1.5 km) during June–November 2006 for the area 15°W–60°W, 0°N–20°N.

Source: NOAA, Satellite Services Division, Tropical Products.

— 2006 smoothed, schematised curve.
— Long-term average (climatology).
Cyclone formation is favoured by deviations below and impeded by deviations above climatology.

Fig. 4 Water vapour brightness temperatures over the tropical North Atlantic



Middle atmosphere water vapour brightness temperatures during June–November 2006 for the area 15°W–60°W, 0°N–20°N.

— 2006 smoothed, schematised curve.
— Long-term average (climatology).
Deviations above climatology indicate drier and below climatology moister than average air.

The development of El Niño had the opposite effect in the Northeast Pacific (Mexican Pacific coast, Baja California, Hawaii), reducing wind shear and thus creating conditions more favourable to the formation of cyclones. Fig. 6 shows that wind shear was generally below average between June and November in those parts of the Northeast Pacific where cyclones form. Accordingly, activity in the region exceeded the 1949–2004 long-term average with 19, compared with 16, named storms.

Effect of climate conditions

Many scientific papers published last year provided further evidence that sea surface temperature is one of the main parameters of storm activity in the North Atlantic.

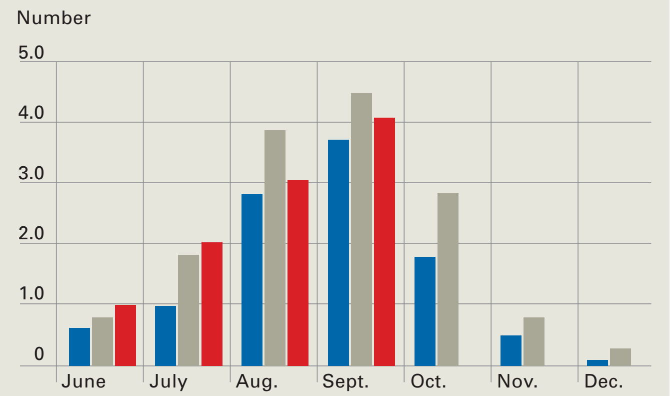
Recent research also shows, however, that the degree of vertical wind shear over the Atlantic, a further factor which increases or reduces activity, falls whenever the tropical Atlantic becomes exceptionally warm, thus promoting the formation of hurricanes (Latif, 2006). This has been the case since the mid-1990s, the temperature of the North Atlantic having increased by more than the average for sea surfaces between 60°N and 60°S throughout the intervening period. In the North Atlantic, the temperature increase triggered by the transition to the warm phase of the naturally occurring Atlantic multidecadal oscillation (AMO) from the mid-1990s is coupled with the global temperature trend caused by anthropogenic climate change. Since 1994, both components have contributed more or less equally on average to the increase in temperature, which has been more pronounced in the North Atlantic than in other seas. During this period, wind shear has tended to be lower, promoting the development of hurricanes. The same situation was observed in the periods 1920–1940 and 1950–1960. In 2006, as in 1997, El Niño temporarily counteracted the effects of reduced wind shear.

The 2006/2007 El Niño event drew to a close at the end of February 2007. Leading meteorological institutes forecast that the La Niña event will start in 2007, thus tending to increase hurricane exposure.

Assessment of current risk measurement

Following the dramatic hurricane losses of 2004 and 2005 and analysis of their causes, there was a shift in risk assessment focus – both in the insurance industry and among consultancy and modelling firms.

Fig. 5 Average number of North Atlantic tropical storms

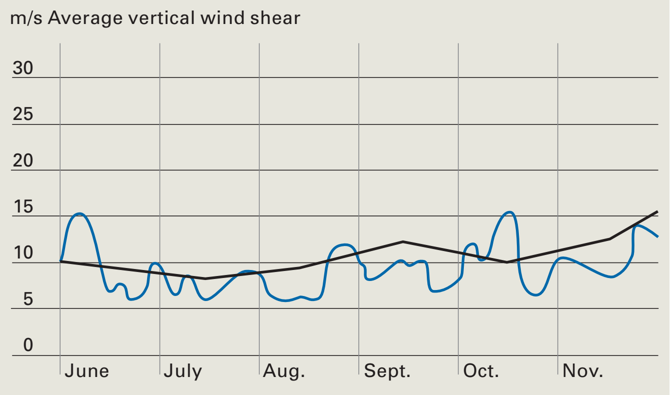


Comparison of June–December monthly averages for 1950–2006 (blue), 1995–2006 (grey) and 2006 (red)

🟦 1950–2006 averages
◼ 1995–2006 averages
🟥 2006

Source: NOAA, UNISYS

Fig. 6 Vertical wind shear over areas of the tropical Northeast Pacific in 2006



Differences in wind speed and direction by altitude (12 km vs. 1.5 km) during June–November 2006 for the area east 110°W, north 0°N.

— 2006 smoothed, schematised curve.
— Long-term average (climatology).
Cyclone formation is favoured by deviations below and impeded by deviations above climatology.

Source: NOAA, Satellite Services Division, Tropical Products.

As well as climatological aspects, new insights into the specific loss dynamics of major catastrophes such as Hurricane Katrina were taken into account. That event led to the widespread breakdown of economic life in the region affected (for instance, access to some parts of New Orleans was barred), and a reduction in manpower, businesses, consumers and purchasing power. Looting and arson further aggravated the losses, whilst shortages of labour and materials and delays in assessing the damage added to the costs. In addition, business interruption (BI and CBI) assumed exceptional proportions.

The yardstick for changes to Munich Re's assessment of climatological risk was the distribution of losses during the warm phase of the AMO. Due to their extreme variability, warm or high-activity phases always include spells of below-average activity and can only be identified from the long-term average and not on the basis of individual years.

- During the current warm phase this was the case in 1997, an El Niño year, when only one Category 1 hurricane reached the US mainland.
- In 2000 and 2001, there were just two and three landfalls respectively, all being of hurricane force.

This shows that, despite the low landfall frequency of severe storms in 2006, the current warm phase, and its greater hurricane risk, persist.

Our standpoint

We factor varying climate parameters into our risk measurement in accordance with the latest scientific studies. The 2006 hurricane season, with its below-average landfall activity, does not affect that measurement. Fluctuations between high-activity and below-average activity years are characteristic of warm phases.

Alberto was the first tropical storm of the 2006 season. It swept across Cuba, making landfall in Florida on 13 June. Fortunately, damage was minimal. Roads were flooded and a number of cars were washed away. Some 30,000 residents had to be evacuated from the affected areas.

Catastrophe portraits

Winter damage in Europe, storms in Asia and Australia, earthquakes and tsunami in Indonesia – just some of last year's catastrophes. Below, we analyse these events, assess loss susceptibilities and determine potential loss scenarios.

There were similar scenes across much of Europe throughout the winter of 2005/2006 as residents, emergency services and troops desperately shovelled snow to prevent roofs from collapsing.

Winter 2005–2006 in Europe – An exception?

Compared with the long-term average, parts of central Europe experienced exceptionally cold temperatures and heavy snow during the winter of 2005/2006. Southern and eastern Germany and much of Austria, the Czech Republic and Poland in particular faced record amounts of snow. One characteristic was an unbroken snow cover lasting for well over 100 days in some places. Frequent and sometimes heavy falls alternated with short thaws, accompanied by rainfall, and lengthy frosts, so that successive layers of snow accumulated over the months. This resulted in unusually deep snow and snow pressure losses in the order of US$ 1bn, of which about half was insured.
No cold spell had brought similar conditions to central Europe since the winter of 1978/1979, when vast areas of northern Germany and Denmark were virtually buried beneath huge quantities of snow.

Chronology of events

November 2005

Following a very warm, dry autumn, winter began in about mid-November 2005 with a cold advection and the first snows. Between 25 and 28 November, a low-pressure system (Thorsten) remained almost stationary over the Netherlands. This brought heavy snowfalls to the Münsterland and Bergisch Land regions, covering wide areas with new wet snow that was 20–25 cm and, in places, as much as 50 cm deep. With wind speeds reaching 80–100 km/h, overhead power lines became encased in a thick layer of frozen snow. Battered by storm gusts, many pylons buckled under the heavy load, leaving more than 200,000 households in the Münsterland region without electricity – in many cases, for days.

December 2005 to January 2006

After an average, although in central Europe somewhat cold and generally wintry December, the turn of the year brought a low-pressure system and large quantities of snow in the eastern Alpine Foreland. In Bavaria and Austria, roofs collapsed under the weight of snow. The most dramatic event was the collapse of the roof of an ice rink in the town of Bad Reichenhall, Germany, on 2 January 2006. In all, 15 people were killed and 34 injured, in some cases severely. The catastrophe triggered a debate about the safety of large buildings, halls and stadiums. Further to a period of more settled weather, the situation deteriorated from mid-January, with fresh precipitation – mainly in the form of wet snow, sleet or freezing rain on lower ground. However, the absence of a widespread, large-scale thaw and the subsequent prolonged frosty spell made the snow even harder. A factory building collapsed in Passau, Germany. The roof of the town hall fell in at Mariazell, Austria, and 65 people died in Katowice, Poland, when an exhibition hall collapsed.

February 2006

Following this frosty period, the situation was further aggravated by renewed heavy snowfalls between 6 and 10 February. More roofs collapsed, many public buildings were temporarily closed. Parts of Austria were declared disaster areas. Much time and effort was spent clearing exposed roofs of snow, in some cases with the help of soldiers. In the latter part of February, somewhat milder weather with precipitation reached central Europe but this did not herald the onset of a major thaw.

March 2006

At the beginning of March, a depression over the Adriatic brought prolonged heavy snow, the third large fall of the winter. It triggered several avalanches and more buildings collapsed under the additional snow load. After a frosty mid-March with unseasonably low temperatures, a general thaw finally set in around 20 March. Rain further added to the weight of the snow, temporarily increasing the avalanche and snow pressure risks again.

April 2006

At the end of March and beginning of April 2006, snowmelt and repeated bouts of heavy rain caused flooding on the River Elbe in the Czech Republic and Germany followed by one of the worst floods of recent decades on the Danube between Austria and the Black Sea. Flood-prevention measures in Budapest proved their worth when the Danube rose to its highest level for 120 years. There was widespread flooding along the Danube in Romania and Bulgaria. The areas affected were sparsely populated and had low insurance penetration.

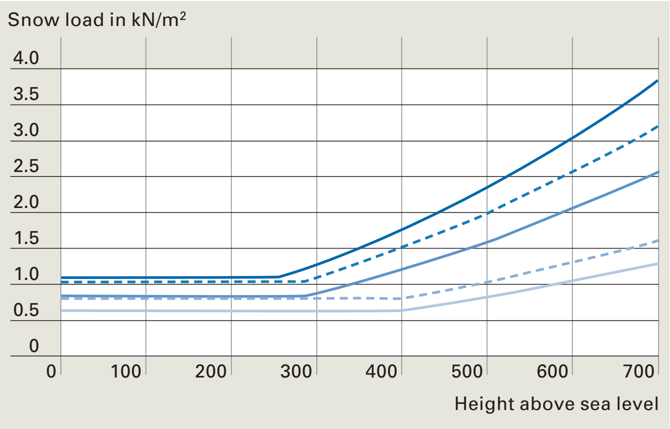
Loss prevention

When there are successive falls of snow with no major intervening thaws, the snow load on roofs gradually increases. If it reaches a critical level, a normal fall of snow is enough to trigger a collapse.
Expected snow load is crucial when calculating the static load capacity of a building and, in particular, the roof. In Germany, the specified snow load depends on three factors:

- Local climate zone: Local climate zones are recorded on snow load zone maps, which reflect historic maximum snow intensities (Fig 1).
- Topographic height: Topographic height takes into account the increased snow risk on higher ground. Figure 2 shows minimum snow load expressed as a function of snow pressure zone and topographic height.
- Roof pitch: A factor taken into account by means of a form coefficient which calculates the snow load for a given roof. The flatter the pitch of the roof, the greater the loadbearing capacity of the building needs to be.

Fig. 1 Snow load zones in Germany in accordance with DIN 1055-5

Fig. 2 Characteristic snow load values as a function of topographic height and snow load zone



Maximum snow load increases with elevation above sea level (and also varies according to snow load zone).

Source Fig. 1 and 2: DIN Deutsches Institut für Normung e. V.

Loss analysis

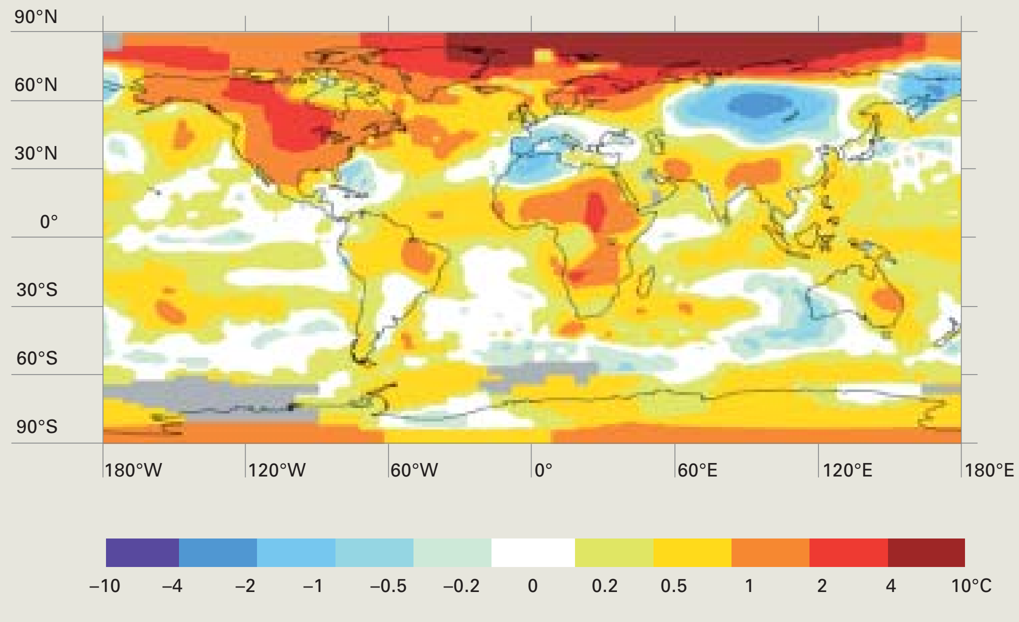
The overall loss in Europe for the 2005/2006 winter was around US$ 1bn, half of which was insured. In Austria alone, the market loss came to around US$ 400m. One of the biggest single losses was the collapse of the exhibition hall in Katowice on 28 January 2006, in which 65 people died and about 170 were injured. Although triggered by the snow load, it was largely due to design faults and the insufficient load-bearing capacity of the building's main supports.
Another key event was the collapse of the ice rink in Bad Reichenhall. When a day's abundant snowfall followed heavy rains, the roof of the ice rink, built in the 1970s using laminated wooden beams, collapsed under tons of snow. However, snow load was not the only factor involved. Subsequent investigations showed that the roof had been built in line with the applicable DIN standards. According to press reports, however, it had not been adequately maintained. Furthermore, some of the building materials were not state of the art so that, for instance, the glue used in the wooden construction absorbed moisture and lost its adhesive properties.

This is backed by surveys carried out on other buildings that had collapsed or were liable to collapse. Although the trigger was the excessive weight of ice and snow, the real causes were as a rule defective design, workmanship and materials or inadequate maintenance.

Assessment and prognosis

All in all, the 2005/2006 winter with its abundant snow largely stands out because of its short-lived, superficial thaws. The overall impression of an exceptionally hard and prolonged winter is reinforced by the fact that accumulations of snow on that scale have become something of a rarity over the years. In recent decades, average winter temperatures in the northern hemisphere have increased more than average summer temperatures. Fig. 3 shows the deviation in winter surface temperatures from the long-term average.
Whilst the global climate is warmer, variability has increased and negative extremes such as cold winters with heavy snow are still liable to occur. A further reason for the current, albeit temporary, increase in the risk of snow pressure losses is that climate change is expected to increase precipitation in the winter half-year, resulting in more snow. Moreover, that snow will be wet and correspondingly heavy. Unless global warming were so advanced that winter precipitation fell mainly in the form of rain, higher precipitation would be the major factor. In the longer term, global warming is likely to reduce the snow pressure risk but, at the same time, increase the risk of floods.

Fig. 3 Surface temperature deviation December 2005–February 2006



Deviation from the equivalent long-term (1960–1990) average temperature in the 2005/2006 winter. Only central and southern Europe and Siberia experienced an unseasonably cold winter; almost everywhere else temperatures were above average.

Source: NASA GISS

How are snow pressure losses (re)insured?

How do we deal with large-scale snow pressure losses in reinsurance treaties? The issue arises if snow pressure is a peril covered under the original policy and there is corresponding cover under reinsurance treaties.

Cover under insurance policies

In Austria, snow pressure is included under windstorm insurance.
In Italy, it is also normally covered under the windstorm peril in standard fire policies (eventi atmosferici).
In Germany, on the other hand, snow pressure is covered in the extended natural hazards policy (flood, heavy rain, backwater, earthquake, subsidence, landslide, snow pressure, avalanche) whilst, in the French insurance market, there is a difference between personal lines business and commercial clients. Cover for the former is provided in homeowners' package policies. Commercial customers, however, need to purchase an extension of cover which is only available in conjunction with hail insurance.

How snow pressure losses are dealt with in reinsurance

Reinsurance treaties respond to snow pressure events in different ways.

Under a proportional treaty, insurer and reinsurer share (theoretically with no limit) each and every snow-pressure loss in accordance with the treaty provisions. However, since snow pressure losses are accumulation events, reinsurers normally insist on a limit per event. This comprises a definition of the event and the actual liability limit which determines the maximum amount the reinsurer will assume for the individual liabilities constituting an accumulation event. (Strictly speaking the concept of a limit per event contradicts the principle of proportionality underlying proportional treaties. Where accumulation events are concerned, the basic rule according to which insurer and reinsurer share each and every loss no longer applies with no limit.)

Per risk excess of loss treaties are similar. Again, insurer and reinsurer share each individual loss as laid down in the treaty (provided the priority is exceeded). Here too, the reinsurer has to decide how to deal with accumulation events such as snow pressure. Typically, event limits also apply.

The situation with regard to catastrophe XL treaties is different. For that reason, the liability limit in respect of cumulative events is characteristic of the basic catastrophe-XL treaty concept and always included in such treaties from the outset. In addition a definition of event is required which describes what the limit of liability applies to.

Although event definitions have different functions depending on treaty type, they are always central to the issue of reinsurer liability in accumulation situations. Standard event definitions contain causal, geographical and/or temporal criteria. Although it should normally be relatively easy to

Summary and definition of accumulation event and cause

Various standard definitions (including LPO 98a and Munich Re's definition of event) require that the common cause of individual snow pressure losses be one event. This means that all the individual losses must have a common cause. In addition, that cause must be considered an "event" (in its everyday meaning) by the objective observer. Only then can individual snow pressure losses be aggregated to constitute an accumulation event.

The cause itself is difficult to define in the case of snow pressure losses (does it mean the last snowfall or total snowfall during the season?). From a scientific perspective, it is the total weight of all the preceding snowfalls that causes roofs to collapse. The decisive factor is that volumes of snow which have accumulated in the course of various meteorological events essentially remain on the roofs. If the weight of the snow reaches a critical level, "normal" snowfalls are sufficient to result in the collapse of a roof. Quite apart from this, the alternative "last snowfall as cause" approach is not in the insurer's interest because loss events so defined are numerous and small, and potentially below the priority of a cat XL treaty.
The next issue is the additional requirement regarding event. The only thing that can probably be said with any certainty is that a hard winter with a large amount of snowfall and prolonged cold is more appropriately deemed a state rather than an event. However, beyond this bare assertion, the event issue is itself difficult to resolve. Would a single snowfall of 3 cm be regarded as an event simply because a given roof collapsed under the resulting 103 cm of snow or is a fall of 3 cm not, on the contrary, relatively insignificant and, for that reason, not an event?

Clauses which require only a common cause (rather than an event) for all individual snow pressure losses do not dispel this legal uncertainty. Even if, from the insurer's perspective, the use of such a clause is regarded as having a slight advantage over the standard clauses referred to above, it does not resolve the issue: should the general weather pattern be seen as the common cause or do the individual snowfalls each constitute respective (common) causes of a part of the roof collapse.

determine whether or not any geographical and temporal criteria have been met, causality (the causal criterion) presents greater difficulty – partly because, since it can never be determined objectively, there are usually valid arguments one way or the other. Furthermore, in the situation described insurers and reinsurers are likely to be pursuing opposing interests. Consequently, disagreements between the two sides are far from uncommon.

Possible reinsurance covers

For really unequivocal solutions, the only admissible event definitions are those that do not include the causal criterion but constitute a combination of certain phenomena (in this instance, roofs that have collapsed under the weight of snow) within a given time-frame and specific geographical area, regardless of which individual fall of snow led to the collapse. There are two options, as described below.

1. Winter aggregate XL treaty

Stand-alone aggregate XL cover (coverage period from 1 October to 1 April) for all losses due to winter perils (e.g. snow pressure, frost, avalanche, snowmelt), i.e. all perils where attribution of the cause of loss presents similar problems.

Conclusion: It gives the contracting parties clarity regarding cover and price and uses a more consistent method than the solution outlined below because the system of reinsurance treaties with no aggregate character is not broken by the integration of aggregate elements.

2. Extension within the event clause

Aggregate cover for snow pressure and other winter perils is provided under existing reinsurance treaties in an additional section, even if such treaties do not have an aggregate character. This can be achieved by an extension to the event definition. In this case cover should be without temporal limits, i.e. all individual losses due to the winter perils referred to under item 1 are combined into one event with no time limit.

Conclusion: This form of extension can easily be included in an existing treaty but additional account has to be taken of it in the pricing. This approach is systematically less consistent than the first because it applies an aggregate method, a technique not otherwise used in the reinsurance treaty, to winter perils.

Solutions based on defined periods of time are liable to cause problems if, as is typically the case with snow pressure scenarios, it is no longer possible to determine when the loss occurred. Days or weeks may pass before the damage is discovered (e.g. if the building is in a remote situation) and the loss reported. In such cases, the precise date of loss is a matter of conjecture. Arrangements that provide for all the losses of one winter to be accumulated into a single event avoid these almost inevitable uncertainties and resultant disputes.

Tragedy struck on 2 January when the roof of an ice rink collapsed at Bad Reichenhall. Among the 15 people killed were 12 children.

Cyclone Larry struck the north coast of Australia on 20 March 2006, leaving a trail of devastation in the Innisfail region. More than 10,000 homes were damaged or destroyed, over 120,000 households were deprived of electricity and there was major damage to roads, bridges and port installations. Larry caused damage in the region of US$ 1.3bn, of which US$ 450m will be met by the insurance industry.

Stormy times down under

The relative calm on Australia's cyclone front was finally broken after many years when Tropical Storm Larry caused major damage in 2006, rekindling memories of the 1974 catastrophe. Munich Re is in the process of calculating possible loss potentials.

Larry – Australia's most destructive tropical storm since 1974

On 20 March 2006, Cyclone Larry, Australia's worst tropical storm since records began (mid-19th to the mid-20th century, depending on the region) made landfall on the Queensland coast, close to the town of Innisfail. With 290 km/h gusts and a central pressure of 959 hPa, Larry was a Category 4–5 storm on Australia's Tropical Cyclone Severity Scale (see Fig. 3). Two other severe tropical storms have struck Australia's north in the recent past: Ingrid (category 4 on the cyclone intensity scale at landfall) in March 2005 and Monica (Category 3 and Category 5 landfalls) in April 2006.

Larry and Ingrid were the first major cyclones (intensity equal to or greater than 3) to hit Queensland's east coast since 1999 – Larry was probably the northeast's first Category 5 storm since 1918. The long list of devastating storms on Australia's east coast has been meticulously researched by the Bureau of Meteorology. However, the region has suffered few large-scale catastrophes by global standards on account of its low population density and value concentration. Larry, in meteorological terms a major event and probably the strongest cyclone to make landfall in Australia for a hundred years, struck the town of Innisfail (9,000 inhabitants) and left a trail of devastation in the surrounding area.

The Innisfail region had suffered 22 tropical storms since 1870, accompanied in a number of cases by severe storm surges and inland floods. According to the relevant building standard, Innisfail is in wind region C (see Fig. 1). More stringent standards have applied to new properties since the 1980s.

Larry, Monica and Ingrid focused the attention of the population and the insurance industry on the threat that hangs over the northern part of the continent. Since 1900, three to four storms have crossed the coast per year on average.

Larry's trail of devastation in figures

Region	Scale of damage
Mareeba/Eacham/ Millaa Millaa	93 damaged properties
Babinda	80% of buildings damaged
Flying Fish Point	15% of homes damaged
Innisfail	50% of homes damaged 35% of private industry damaged 25% of government buildings damaged (schools, etc.)
Etty Bay	40% of homes suffered roof damage
East Palmerston	70% of homes damaged
Silkwood	Worst-affected location 99% of homes lost roofs or suffered structural damage
Kurrimine Beach	30% of homes damaged 15% of private industry damaged
El Arish	30% of homes damaged 50% of private industry damaged
Bingil Bay	30% of homes damaged
Mission Beach	30% of homes damaged 20% of private industry damaged 40% of caravan park damaged
South Mission Beach	20% of homes damaged 20% of private industry damaged
Jappoonvale	Possible tornado damage

Source: Australian Government, 2006, NatCatSERVICE

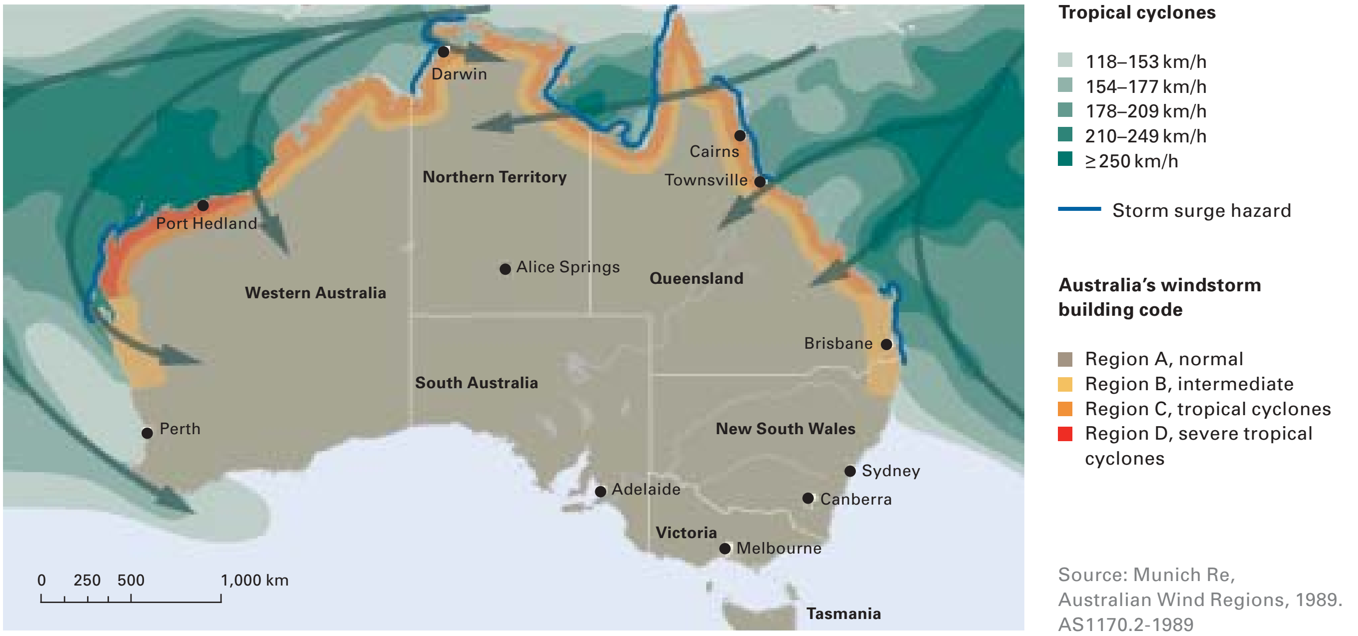
The table shows how vulnerable the region's buildings are to severe tropical storms. Additional research by Munich Re has provided the following data:

- More than 10,000 buildings in the cyclone's path were damaged or destroyed.
- 120,000 homes were hit by power cuts.
- The area extending from the Tablelands, located north of Innisfail, to Tully in the south and Herberton in the west sustained heavy agricultural losses – fruit, cereals and sugar cane being the worst affected crops. 80% of the banana plantations were destroyed along the cyclone's 40–50-km-wide track.
- Sugar mills were damaged in Babinda, Mourilyan and Johnstone.

Loss figures
Total amount of loss: US$ 1,300m, including destruction of banana and sugar cane plantations in the order of US$ 400m

Insured loss: US$ 450m

Fig. 1 Storm hazard and building code zones



Source: Munich Re, Australian Wind Regions, 1989. AS1170.2-1989

Cyclone Tracy 1974 – The last "direct hit"

The last time a severe storm struck a major city in the Australian tropics was over 30 years ago: on 24 December 1974, Darwin (1974 population: 48,000) was virtually flattened by Cyclone Tracy (a Category 4 storm). No part of the city escaped. 90% of the buildings suffered major roof damage and of the 9,000 houses damaged, 50% were practically total losses. Only 400 houses and 1,500 apartments remained habitable. Based on 1974 values, the overall loss amounted to some US$ 800m, of which US$ 300m were insured.

The cost of potential hits

Darwin scenario

Between 1974 and 2005, Darwin's population had risen from 48,000 to more than 105,000 and insured values had increased tenfold by 2006. Even though Darwin is less vulnerable to damage following reconstruction, a Category 5 cyclone (of similar force to Larry) making landfall in the area today could cause insured losses of more than US$ 1.5bn.

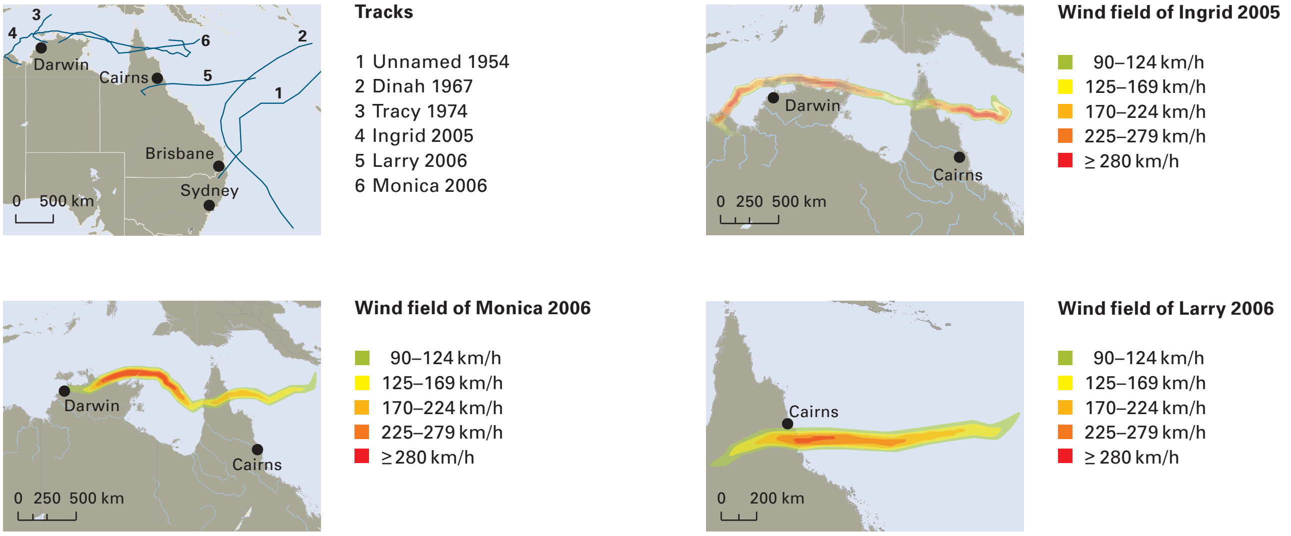
Brisbane scenarios

However, even in 2006, Darwin still ranked as a relatively small city. By comparison, populations and values in regions like Cairns and the Brisbane conurbation with its Gold Coast and Sunshine Coast tourist centres in particular have soared in recent decades. Our analyses show that the area has Australia's highest exposed values in terms of the tropical cyclone peril. In the event of a cyclone catastrophe, it would suffer the highest accumulated losses.

The Brisbane, Gold Coast and Sunshine Coast region lies towards the southern end of the tropical cyclone zone along the east coast. Water temperatures are lower than in the north due to the influence of ocean currents from the Antarctic. These also account for the area's shortened cyclone season – December to March. The season typically runs from November to April in the South Pacific. This is shown both by meteorological records of tropical cyclones in the Brisbane area dating back to the 1950s and by historical documents going back as far as 1890.

Of 14 tropical storms whose centre passed within 200 km of Brisbane between 1950 and 2006, two (an unnamed one in 1954 and Dinah in 1967) had reached cyclone strength (with wind speeds in excess of 120 km/h) when they were closest to the city.

Fig. 2 Tracks and wind fields



Tracks

Wind field of Ingrid 2005

Wind field of Monica 2006

Wind field of Larry 2006

Source: Munich Re

Cyclone Dinah loss figures

- Heron Island: Severe damage caused by high winds and inundation.
- Sandy Cape: Central pressure of 944.8 hPa and high water, 10 m above normal.
- Sunshine and Gold Coast: Storm surge, wind losses – roofs blown off and trees uprooted.
- Tweed Coast: Damage to cereal and banana crops.
- Emu Park, Yeppon, Maryborough/Bundaberg region: Damage and erosion caused by storm surge.
- Sandgate: Storm surge – flooded houses (1.5 m deep).
- Water lapped the decking of the Jubilee Bridge (1.5 m above the highest astronomic tide).

Historic events show that tropical cyclones are a threat to Brisbane. However, it is extremely difficult to estimate the return periods of accumulation loss potentials in this region, an issue fraught with uncertainty, as can be seen from the range of loss potential estimates provided by commercial models. The PMLs of these models diverge by a factor of about ten, given a 250-year return period and an identical portfolio, and even a 1,000-year return period is subject to a divergence factor of three. The spread is even wider if accumulation estimates undertaken for specific studies are included. Furthermore, none of the models published to date takes account of the additional potential losses if the Brisbane, Gold Coast and Sunshine Coast area were struck by a storm surge. In order to highlight the possible risks, we examined the two potential scenarios: Brisbane and Brisbane/Gold Coast/Sunshine Coast.

Neither of the above constitutes a worst-case scenario for South Queensland either from the meteorological perspective or in terms of relative accumulation PML assumptions. According to a US Naval Research Laboratory study, one possible worst-case scenario for Brisbane is as follows: a strong cyclone makes landfall just north of Brisbane and sweeps across the western part of the city. On this track, Brisbane would find itself to the left of the cyclone, and thus exposed to the highest wind speeds, the maximum storm surge risk and the heaviest precipitation. The storm would abate somewhat as it pursued its inland course, but only to a limited extent since it would continue to draw energy from the nearby ocean.

Munich Re scenarios: Cyclone Brisbane/Gold Coast/Sunshine Coast

The following approach gives the insured market loss and scale of possible loss potentials for the Cyclone Brisbane accumulation scenario. It is not possible to infer accumulation PMLs for individual portfolios from these figures.

Scenario 1: Category 3 cyclone on the Australian Tropical Cyclone Severity Scale (with peak gusts of 170–224 km/h on landfall; Brisbane is directly in its path (excluding the Gold Coast and Sunshine Coast):

- Market liabilities for Brisbane – CRESTA zone 1: (residential buildings, commercial and industrial properties – material damage only, excluding business interruption): approximately US$ 100–125bn
- Relative accumulation PML (ratio of insured losses to total sum insured, wind and storm surge in the Brisbane/Moreton Bay area): 6–8%
- Absolute loss potential: Insured losses of US$ 6–10bn

Scenario 2: Category 3 cyclone; comparable to Dinah in 1967, but with a track some 100–150 km further south; the accumulation loss region is Brisbane, the Gold Coast and the Sunshine Coast:

- Market liabilities for Brisbane, the Gold Coast and the Sunshine Coast – CRESTA zones 1–3: (residential buildings, commercial and industrial properties – material damage only, excluding business interruption): approximately US$ 150–200bn
- Relative accumulation PML (wind and storm surge in the Brisbane, Gold Coast and Sunshine Coast region): 5–7%
- Absolute loss potential: Insured losses of US$ 8–14bn

The photos show the high value concentrations on the coast – a storm surge would cause heavy losses.

We also consider such an event – combined with high wind speeds – to be a potential megacatastrophe scenario which could involve losses of more than US$ 20bn for the insurance industry. In general, however, tropical cyclones move along the coast so that Brisbane is on their right, where it escapes the worst of the conditions.

Fig. 3 Saffir-Simpson and Australian Tropical Cyclone Severity Scales compared

	Saffir-Simpson Scale	**Australian Tropical Cyclone Severity Scale**
Wind parameter Starting point	1-minute wind average from hurricane force (> 118 km/h)	Peak gusts exceeding storm force (> 90 km/h)
Category 1	118–153 km/h	90–124 km/h
Category 2	154–177 km/h	125–169 km/h
Category 3	178–209 km/h	170–224 km/h
Category 4	210–249 km/h	225–279 km/h
Category 5	> 250 km/h	> 280 km/h

Larry hit Australia's sugar crop hard – it is the world's third-largest cane sugar exporter after Brazil and Thailand – and losses in the banana plantations were catastrophic, with almost the entire crop being wiped out. In terms of crop losses and replanting costs, the total is estimated to amount to some US$ 200m. Virtually no one has crop insurance.

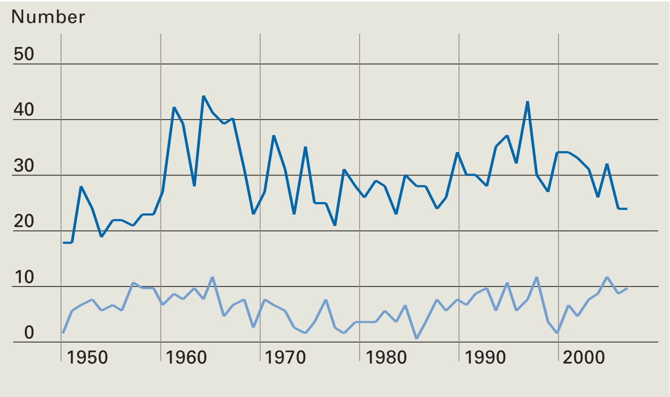
The Northwest Pacific typhoon season proved costly for insurance industry and economy in 2006. The overall loss from the season's 19 typhoons was just under US$ 12bn. Insurers were left with a bill of US$ 1.5bn. 2,500 people lost their lives as a result of torrential rain and mudslides.

2006 typhoon season in the Northwest Pacific

2006 was marked by an above-average number of typhoons of category 4–5 on the Saffir-Simpson Scale, namely ten, compared with an average of seven since 1950. There were 24 named tropical storms in the Northwest Pacific in 2006 – slightly below the long-term average of approximately 29. (Fig. 1).

Many of these severe typhoons made landfall, primarily affecting the Philippines, China, Vietnam and Japan.

Fig. 1 Number of Category 4 and 5 typhoons in the Northwest Pacific 1950–2006



Source: Joint Typhoon Warning Center (JTWC)

The season got off to a spectacular start with Typhoon Chanchu (Caloy). This was the strongest typhoon ever recorded in May in the South China Sea. It crossed the Philippines between 11 and 13 May, subsequently strengthening to category 4 over the South China Sea before abruptly changing course and heading north. It had weakened to category 1 by the time it crossed the south China coast on 18 May, where it missed Hong Kong. Economic losses in the Philippines and China were in the order of US$ 1.5bn. More than 100 people were killed.

On 10 August, Typhoon Saomai made landfall in China between the cities of Fuzhou and Wenzhou, with wind speeds of 210 km/h (JTWC). It was China's strongest typhoon since Wanda in 1956. Economic losses amounted to approximately US$ 2.5bn and 450 people died.

On 17 September, Typhoon Shanshan lashed the island of Kyushu in southern Japan with winds of up to 140 km/h and heavy rainfall (72 mm/h). Despite being of only moderate strength (category 2 on the Saffir-Simpson Scale) it caused insured losses of over US$ 1.2bn.

Last year, the Philippines were particularly hard hit, with six typhoons in all (Chanchu, Xangsane, Cimaron, Chebi, Durian, Utor). On 28 September, Manila was struck by Xangsane (Milenyo), the severest typhoon to hit the capital since Angela in 1995, although it had weakened to category 1. It certainly lived up to its name: Xangsane is the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TO SKYWAY
KEEP RIGHT

Laotian word for elephant. The typhoon damaged some 500,000 buildings and caused widespread power cuts lasting up to ten days.

However, the worst was yet to come for the Philippines. On 29 October and 11 November, typhoons Cimaron (Paeng) and Chebi (Queenie), categories 3 and 4 respectively, made landfall in the province of Aurora in Northern Luzon. Then, on 30 November, the province of Albay in the Bicol region was hit by Durian (Reming), a Category 3–4 typhoon. Over 200 mm of precipitation triggered mudslides on the slopes of Mount Mayon, a volcano, burying dozens of villages. More than 800 people were killed and hundreds were reported missing. Just two weeks later, Typhoon Utor swept across the Philippines at speeds of up to 140 km/h, on a somewhat more southerly course than Durian. As a result, tens of thousands of houses were severely damaged or destroyed, hundreds of boats capsized and 50,000 people were left homeless.

The 2006 season was a reminder of the high typhoon exposure of countries on the northwestern seaboard of the Pacific. Although last year's typhoons left their mark as far as the insurance industry was concerned, there was no catastrophe on the scale of Katrina in terms of insured losses, because some storms weakened before they reached major cities like Manila whilst others, such as Saomai, although powerful, made landfall in less-developed regions (Fig. 3).

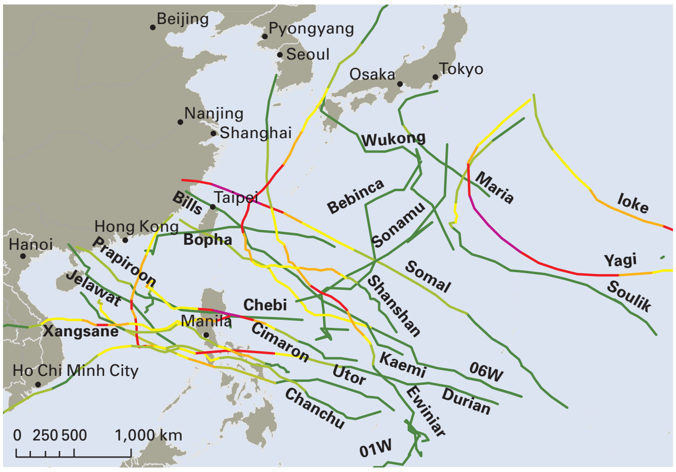
Assessment of the loss potential

Saomai showed the need to take very seriously the prospect of a Category-4-plus storm making landfall in the Shanghai area.

The moderately weak Shanshan, which battered the country between 17 and 19 September, inflicted a market loss of US$ 1.2bn, confirming the vulnerability parameters which Munich Re's geoscientists had calculated for storm-exposed insured risks in Japan on the basis of previous typhoon catastrophes. The event again demonstrated that a direct hit on a major conurbation such as Osaka, Nagoya or Tokyo by a Category 4–5 typhoon carries a loss potential which is a multiple of that figure.

This would have corresponding implications for the insurance industry. According to analyses undertaken using our typhoon simulation model, market losses in Japan resulting from rare but nonetheless meteorologically possible storm and storm-surge catastrophes could be in the fifty billion dollar range.

Fig. 2 Tracks of all Northwest Pacific tropical cyclones in 2006

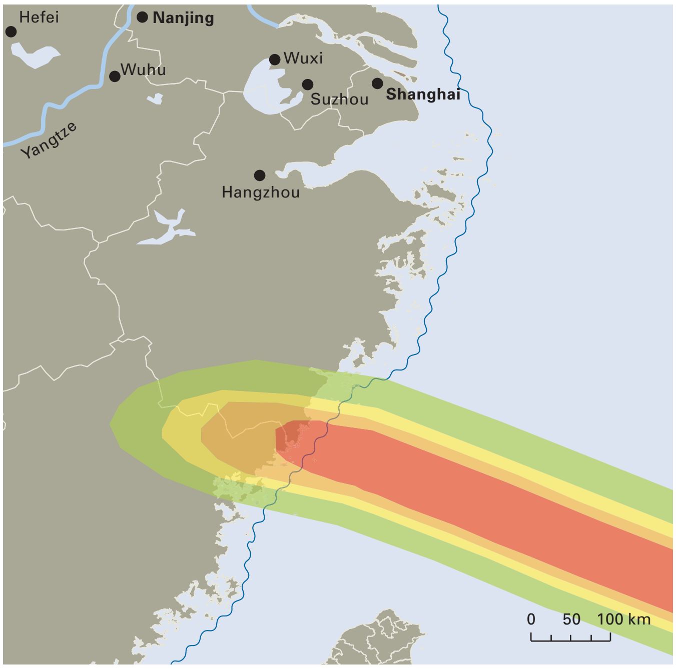


Source: Munich Re

Wind speed

🟩 Tropical storms (<118 km/h)
🟩 SS1 (118–153 km/h)
🟨 SS2 (154–177 km/h)
🟧 SS3 (178–209 km/h)
🟥 SS4 (210–249 km/h)
🟪 SS5 (≥250 km/h)
— Storm surge hazard

Fig. 3 Cyclone Saomai's wind field



Source: Munich Re

Loss potentials for China, in contrast to those of Japan, are still difficult for the insurance industry to determine. It is true that, from the scientific perspective, relatively comprehensive records of storm and storm-surge events going back some 50 years illustrate the high exposure in growth regions like Shanghai and the Yangtze Delta or Hong Kong and the Pearl River Delta. However, there is a granularity problem (in terms of geographical resolution and line-of-business split) with regard to the liability information used for modelling loss simulations. It is currently reported on a province basis (Fig. 4).

This causes considerable uncertainty with regard to estimated loss potentials, wind and storm-surge exposure being significantly higher on the coast than in the hinterland. However, the risk models have to make assumptions about the spatial distribution of insured values within a province. This can only remedied with the aid of a more detailed view of the insured risks in the more exposed coastal regions, e.g. based on four-digit postcodes (Fig. 5).

According to our risk studies, potential market losses from typhoon catastrophes in China are still well below the values for the scenarios US hurricane, European winter storm or Japanese typhoon. As the Chinese economy is rapidly growing (at some 10% p.a.) and growth is mainly concentrated on conurbations like Shanghai and Hong Kong, there is likely to be a disproportionate increase in loss potentials in China.

Looking ahead

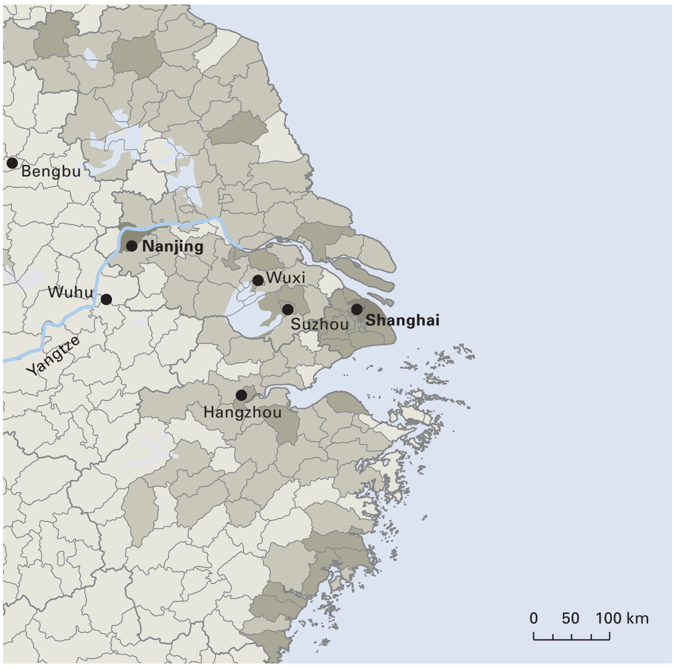
In view of soaring insured liabilities and, as yet, relatively imprecise risk information, there is urgent need to identify China's changing typhoon frequencies and intensities (due to natural climate factors or anthropogenic causes) as soon as possible. According to the latest scientific analyses, it is not possible to be as categorical about changing storm exposures in the Northwest Pacific as in the North Atlantic. The main reasons for this are that the time series are shorter, the readings differ from one meteorological service to another, and current research is focusing on the North Atlantic. However, a number of studies indicate that the average Northwest Pacific typhoon season has lasted longer in recent decades, whilst various data series show that the annual number of Category 2–5 cyclone days – i.e. the total duration of individual cyclones within this range – has risen considerably in the course of the last 30 years.

Fig. 4 Province view

Source: Munich Re

Low ■ ■ ■ ■ ■ High

Fig. 5 Same portfolio, but with a four-digit postcode view



Source: Munich Re

Low ■ ■ ■ ■ ■ High

Walls collapsed at the Saphir Square Shopping Mall in the north of Yogyakarta. Horizontal displacements between the different floors can clearly be seen.

The Yogyakarta earthquake

This 6.3-magnitude quake struck the densely populated and economically less-developed region to the south of Yogyakarta (Indonesia), causing more than 5,700 deaths. The medium-strength event again shows how important it is to minimise the vulnerability of housing and public buildings.

Economic losses are in the order of US$ 3bn; the insured market loss is very low, amounting to some US$ 35m, which is in stark contrast to the scale of the human disaster. This underscores the need for non-traditional insurance solutions, above all for less developed regions, to avoid the threat to the livelihoods of those concerned that is often associated with such natural catastrophes.

Scientific analysis

The earthquake struck in the early hours of 27 May 2006, at 5.56 a.m. local time, approximately 20 km to the south of Yogyakarta. The location of the epicentre is not precisely known. It seems likely that the earth ruptured along a fault running north-eastwards from the coast. This is where stress that builds up as the Australian Plate subducts beneath the Sunda Plate is released. Whilst subduction proceeds at a rate of 6 cm per year, fault movements within the Sunda Plate are much slower. For that reason, earthquakes of this type are in fact relatively rare. Nevertheless, an even stronger quake occurred at the same site in 1867, which was also felt in Jakarta, some 500 km away and caused extensive damage in Yogyakarta.

The regional intensity distribution of the 2006 earthquake was determined by local ground conditions. The greatest damage occurred not directly in the assumed epicentral area but along the eastern edge of a valley running from Yogyakarta to the coast. The valley's volcanic sediments are a mixed blessing since, whilst providing fertile farmland, they greatly amplify the shaking of an earthquake. The closer to Yogyakarta, the shallower the layer of sediment and the less severe the damage – so that the city remained by and large undamaged on this occasion. A number of houses collapsed in the southern part of the city but there was hardly any damage in the northwest. Damage in the northeast was confined to the valleys of a few streams. None of the intensity maps published shortly after the earthquake even remotely reflected these ground effects correctly. Although there are no readings from the epicentral area, it would appear that the ground acceleration of approximately 20% of the earth's gravitational force (which has an expected return period of 500 years) was exceeded over a limited area only.

Immediately after the earthquake, the Merapi Volcano tripled its already increased activity so that there was acute risk of a sizeable eruption, particularly since the lava dome at the volcano's funnel was inclined towards the southeast and unstable. However, following a moderately severe eruption on 13 June 2006, volcanic activity at Mount Merapi decreased considerably.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Catastrophe for those affected

According to official figures, 5,749 lives were lost as a result of the quake and about a million people were rendered homeless within a matter of seconds. 154,000 homes were destroyed and another 260,000 damaged. The overall economic loss is around US$ 3.1bn. After a slow start, direct aid was well organised in the weeks immediately following the quake. However, reconstruction was delayed due to the lack of a long-term emergency plan and the fact that promised government compensation has been paid in only a few cases. According to press reports, when the rainy season started at the end of October 2006, some six months after the earthquake, 600,000 were still homeless.

Vulnerability of the buildings

Many homes had thin walls made of rudimentary bricks rendered with mortar which had a high sand content. The connections to the natural stone foundations and the roofs proved inadequate and had certainly not been designed to withstand the severe lateral loads of an earthquake. In some places, up to 80% of the buildings collapsed and thousands were buried under the weight of the heavy roofs. The construction standard of schools, universities and administrative buildings was particularly poor. Fortunately, since the quake struck very early in the morning, there were few deaths in these locations.

Even older buildings made of better-quality materials came through the earthquake for the most part with little, mainly non-structural, damage – and this included structures in the epicentral area.

One surprising fact was that new-style acrylic paints increased much of the damage to dwellings. This is because they hermetically seal the underlying mortar which gradually becomes less elastic and more brittle. The paints that had previously been used allowed the mortar to absorb sufficient moisture during the annual rainy season.

Many of the buildings affected in the city of Yogyakarta were modern, multi-storey blocks including, for instance, the shopping malls, many mainly modern hotels and also the airport terminal – all of which were purportedly built in accordance with current building codes. They were not as badly damaged as buildings in rural areas, the tremors in the city having been much weaker. Nevertheless, this yields significant information about the potential losses that a more severe earthquake could cause. In many cases, the buildings were damaged by horizontal rotation of the floors against one another. The Malioboro Shopping Mall and the Ibis Hotel, which are located in different parts of the same complex, bore typical signs of pounding damage (which occurs when adjacent structures of different heights pound against one another). The minor tremors produced in this instance would not normally be expected to cause damage on such a scale. Furthermore, the brick infill fell out on a number of buildings. One of the city's newest constructions, the Saphir Square Trade Mall, which had opened just before the earthquake, suffered the most spectacular damage. The exterior walls tilted outwards on many floors. Most of the buildings are now being reconstructed using rubble taken from the ones that were destroyed, due to the lack of viable alternatives and financing. This situation bodes ill for the future, bearing in mind that a stronger earthquake could strike in the region.

Underwriting assessment

Yogyakarta is Indonesia's intellectual and cultural centre and has little industry. Hotels, shopping malls and small businesses producing crafts for the tourist market make up the bulk of the insured values. Only a small percentage of

This warehouse collapsed in the epicentral area. Many of the insured losses concerned similar risks.

Typical total loss in the worst affected region. The thin walls collapsed under the weight of the heavy roof.

residential buildings are insured against earthquakes. Despite its high population density, the region accounts for only 1% of sums insured for the country as a whole. Compared with the rest of the country, it is therefore less significant in insurance terms. Human disaster and insured losses must accordingly be dealt with as separate issues. Most of the insured damage was concentrated on Yogyakarta, and most of that on only one building, the Sheraton Hotel, where the luxuriously appointed reception area collapsed. The insured market loss is around US$ 35m, just 1% of the economic loss.

What lessons can be learnt from this?

The data provided by the earthquake on the vulnerability of buildings in Indonesia and comparable countries in Southeast Asia is both important and disquieting. Insured losses would have been higher had it not been for the low insurance density in the area affected. Although the ground movements were relatively minor, potential insurance risks such as warehouses, hotels and shopping malls proved very vulnerable. This indicates that these risks are far less safe than previously thought, despite Indonesia's sound building codes. Consequently, a detailed assessment of major properties is strongly recommended. The insurance industry should also make tools available designed to monitor compliance with building standards more effectively. This could reduce losses considerably.

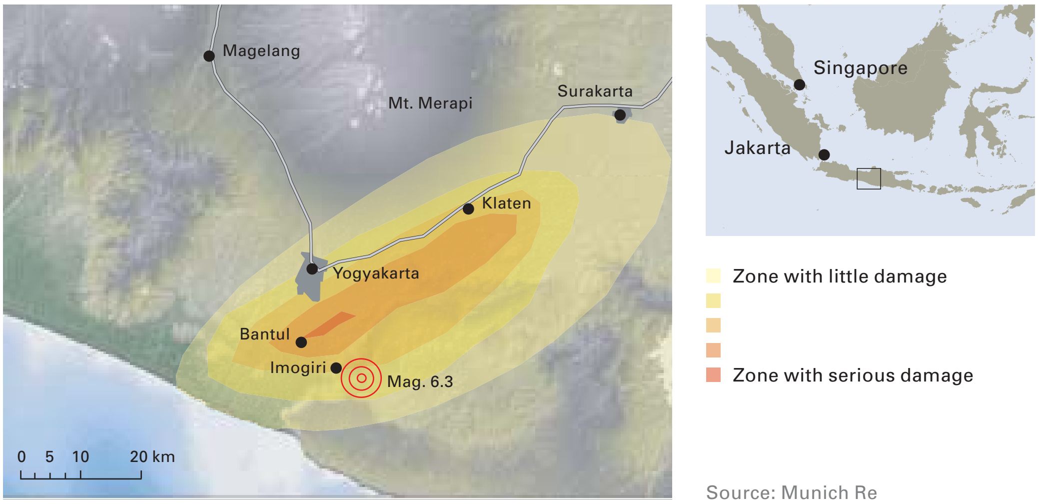
This earthquake again confirms what has been shown on a number of occasions in the recent past (e.g. Buhj 2001, Bam 2003, Kashmir 2005): the insurance industry needs to do more to protect the livelihoods of people in less developed regions. The industry has to treat this as a matter of urgency if it is to fulfil its social role as a provider of risk compensation solutions, particularly in the wake of natural catastrophes. The past has shown traditional insurance to be unequal to this task. It is time to consider pool solutions or non-traditional insurance products. However, the insurance industry also needs to promote loss prevention if the risks are to be insurable. One obvious and technically feasible solution would be to apply rates based on the use of simple measures that will improve stability. Soaring population figures, particularly in Southeast Asia's huge conurbations with their high natural hazard exposure (Manila, Djarkarta or Kathmandu, for instance), call for urgent, concrete and effective measures.

Implications for the risk model

Indonesia has suffered an exceptionally large number of natural catastrophes in recent years. This does not mean that there will be a return to calm in the region in the immediate future. There is still pent-up seismic energy waiting to be released in the zones around the major quakes of December 2004 and March 2005. Japanese researchers believe that this also applies to the area around the fracture face of the July 2006 quake (see article p. 32). In addition, they believe there could be a major quake along the Sumatra Fault between Sumatra and Java, which evidently extends further than previously thought into the strait that divides the two. As around 40% of Indonesia's insured values are concentrated in the Jakarta region and neither the ground conditions in Jakarta nor the quality of the buildings is appreciably better than in Yogyakarta, such a quake is a real threat both in human terms and for the insurance industry. According to Munich Re's internal model, the insured market loss is liable to be between US$ 1.3bn and US$ 2bn.

The Yogyakarta quake findings will be incorporated directly in Munich Re's new probabilistic earthquake risk model which will be unveiled in 2007.

Yogyakarta earthquake: Location of the epicentre



Source: Munich Re

People were caught unawares when a tsunami struck Central Java on 17 July 2006. The photograph shows all that remains of buildings on the shore; further inland, the damage was less severe.

Tsunami strikes Java

Since the tsunami disaster of December 2004, a great deal of time and money has been invested in research. Countries are virtually competing with one another for the honour of being the first to install an early-warning system. It is therefore, on the face of it, all the more dramatic that 650 people lost their lives in 2006 when another tsunami struck the island of Java – with no advance warning. What went wrong?

An earthquake occurred at 3.19 p.m. on 17 July 2006, some 200 km off the coast of Central Java. The national authorities and various other institutions, including the Geo Research Centre in Potsdam, Germany, recorded a magnitude of 5.6. However, the US Geology Service registered a magnitude of 7.2. On the strength of this assessment, the Pacific Tsunami Warning Center on the island of Hawaii automatically issued a local tsunami warning at 3.36 p.m. for the area located within 100 km of the epicentre. The possibility of a destructive tsunami on a major scale was ruled out. If a wave were to reach the coast, this would probably occur at around 4 p.m. local time according to the warning, allowing people a margin of 24 minutes to reach safety.

Since Indonesia’s geophysics institute considered Central Java tsunami-free (there had been no such event there for more than 200 years according to an article in the Jakarta Post on 19 July 2006), it was initially assumed that no action was necessary. However, as the number and severity of the aftershocks were not typical of a 5.6 quake, the relevant Indonesian ministries were nevertheless advised, although at what time this was done is not clear. They decided not to pass the warning on to the region concerned. The official reason given for this was to avoid causing unnecessary alarm among local residents by raising what seemed likely to be a false alert, and bringing discredit on the early-warning system even before its launch. Apart from this, it was by no means clear how people could have been warned in the limited time available. At that juncture, there was no viable scheme and a projected SMS chain-letter system then being tried out was, in any case, too slow.

The quake was barely perceptible at the coast, so that few people sought refuge on higher ground. The tsunami struck the coast of Java at approximately 4 p.m. The 6–7 m waves in Ciamis Bay and at Widara Payung far exceeded predictions. Even on the beach at Parangtritis, some 150 km further east, a popular resort close to Yogyakarta and outside the area included in the advance warning, three people were killed by 2 m waves. In all, the tsunami is believed to have claimed 668 lives along a 200 km stretch of coast. They were the victims of a fateful miscalculation.

What we now know

It later emerged that the earthquake had a moment magnitude of 7.7. The scale is important here, since no two earthquakes are alike. Each has a different rupture mechanism, direction and speed. In this particular case, the rupturing of the earth’s crust, and particularly the uppermost part,

directly below the ocean bed, was a relatively slow process. When, in addition, the motion is primarily vertical, ground displacements are more effectively transmitted to the water column directly over the fracture surface than is the case with normal earthquakes. Scientists therefore refer to this type of slow earthquake as a tsunami quake. In addition, the energy generated is in the longer-wave range. Consequently, readings taken using relatively short-wave scales of magnitude tend to greatly underestimate such tremors. This explains the huge discrepancies in initial assessments of magnitude.

Tsunami quakes often have catastrophic effects. This was the case in Nicaragua (1992), East Java (only 600 km to the east of this year's earthquake, 1994), Peru (1996) and Papua New Guinea (also on 17 July 1998 – where the impact of the tsunami was probably reinforced by a submarine landslide just off the coast). The Sumatra quake on 26 December 2004 should presumably also be included in the list of tsunami quakes. Originally, the name tsunami quake was coined following investigations into the 1896 earthquake at Sanriku in Japan. Such quakes occur frequently in the Kurile and Aleutian Islands. Major earthquakes, fairly common in these regions, have to be monitored very closely because they could trigger pan-Pacific tsunamis.

Our standpoint

The 2006 tsunami in Java graphically demonstrated how important it is to install an early-warning system which directly measures tsunami waves generated by an earthquake as quickly as possible. Given the uncertainty surrounding the available data in this instance, the reasons for the decision taken by the Indonesian authorities are understandable, but the resulting miscalculation had dramatic consequences. However, events have also shown that it is not enough merely to establish a network of buoys and set up a data centre to collate all the information. Clear, effective and transparent decision-making processes are indispensable.

This earthquake occurred some 200 km off the coast but there is not always 30 minutes' advance notice of a tsunami. If an earthquake occurred under the Mentawai Islands in Sumatra, a fairly probable scenario, the inhabitants of the towns of Bengkulu and Padang would have far less time to take refuge from what could prove to be a much stronger tsunami.

Outlook

An early warning system will shortly be installed in Indonesia. Although it will not have any major effect on the insurance industry, it is to be hoped that it will help to ensure that any future natural catastrophe does not become a human catastrophe.

Indonesian tsunami: Affected stretch of coast

Source: Munich Re

Above: The waves destroyed thousands of homes; the mass of water left the isolated remains of buildings and trees in its wake. Many people sifted through the rubble looking for precious rebuilding materials.

Below: Waves with a height of up to seven metres lashed a 200-km stretch of coast, bringing large-scale devastation. More than 650 people lost their lives and thousands were injured.

Climate and climate change

Europe experienced its warmest autumn, the USA suffered record-breaking forest fires, the Arctic ice is melting more rapidly than predicted. 2006 will go down in climate statistics as a record year. Munich Re is involved in numerous initiatives and working alongside many experts to devise strategies designed to mitigate the effects of climate change.

Huge fires affecting many US states ravaged a total of some 38,000 square kilometres of forest – more than ever before. The fires killed at least 20 people, most of them firefighters. Tens of thousands of homes were destroyed by the flames. The insured loss totalled about US$ 500m.

The economic sector and climate change

The capital markets have not been spared the consequences of increasingly frequent and violent natural catastrophes. On the contrary, results and share prices are affected by resulting raw materials shortfalls, damage to production sites and business interruption. In addition, sectors such as agriculture, tourism and healthcare are starting to feel the gradual effects of climate change. Ultimately, economic performance as a whole suffers. The macroeconomic effects have long been under discussion. Now, however, Sir Nicholas Stern's climate review has provided the first comprehensive quantitative analysis of the consequences of climate change and possible courses of action.

Stern Review

In October 2006, Sir Nicholas Stern, former Chief Economist and Senior Vice President of the World Bank, presented a review commissioned by the British government on the economics of climate change. One of his central themes is that climate change constitutes the greatest market failure the world has ever seen. Sir Nicholas predicts that, by the middle of this century, climate change will account for a loss of at least 5% in global growth (US$ 2,200bn at current values) each year. If we also take its impact on environment and health and knock-on effects into account, it could be as much as 20% of annual global GDP (around US$ 9,000bn). By contrast, the review argues, the cost of taking action would be as little as 1% of global GDP per year (US$ 445bn). That action would enable us to avoid entering a critical threshold area where average global temperatures were 2°C higher than pre-industrial levels.

To achieve this target, we would have to stabilise the concentration of greenhouse gases in the atmosphere at or below 550ppm CO_{2e} (climate gases are expressed in terms of CO_2 equivalent). Global emissions would need to peak in the next 10–20 years and subsequently fall by 1–3% per year to around 25% below current levels by 2050. If we compare the costs of action with the costs of inaction, there is only one choice as far as the economy is concerned: we have to protect the climate.

The role of the insurance industry

As well as preventing future emissions, we must also provide the financial means for adapting to those effects that can no longer be avoided. If we follow the Stern Review's line, this is an area where the insurance industry has a key part to play by providing insurance solutions to counter the financial losses. Munich Re regards climate change as a major issue and, as co-founder of the Munich Climate Insurance Initiative, is devising appropriate insurance-based tools. The project targets those countries and regions which are worst affected.

World climate summit in Nairobi

The political discussions at the world climate summit in Nairobi should also be seen in the light of the Stern Review. They, too, highlighted the need to finance adaptation. However, the main item on the agenda was the post-2012 phase of the Kyoto Protocol (Kyoto Plus), which the world community has to decide on by 2009 at the latest. To meet this deadline, negotiations must begin in 2007. The conference paved the way for this by giving the go-ahead for a review of the Kyoto Protocol's effectiveness (Article 9 of the Protocol). Now it is up to heads of government to officially launch the negotiations. The G8 + 5 Climate Change summit and the European Union, under German presidency for the first six months of 2007, would be appropriate forums for giving a clear direction.

Measures to help those regions most affected have been stepped up and poorer countries will now receive aid from an Adaptation Fund. This is financed by means of a 2% levy on Certified Emission Reduction permits generated by CDM (Clean Development Mechanism) projects, a practical device for helping to finance adaptation in developing countries. The steady growth in the number of CDM projects should boost resources considerably. However, this is no more than a first step (which will amount to around US$ 250–300m by 2012). The EU plans to launch a risk capital fund promoting the use of climate-friendly energy technologies in Africa. It will contribute €80m to the fund over the next four years and mobilise environmentally sound investments in the order of €1.25bn

Munich Re's Kyoto Multi Risk Cover can also be seen in the context of these measures. Its object is to compensate entities which invest in CDM and JI (Joint Implementation) projects (such as banks, funds, and project sponsors) for losses sustained if a project fails to deliver the agreed number of emission rights.

Global Roundtable on Climate Change

Although progress has been moderate on the political front, climate change is certainly being treated seriously by the economic sector. This is shown by the impact of the Stern Review as well as the Global Roundtable on Climate Change, initiated by Jeffrey Sachs, a renowned economist from Columbia University in the city of New York. The Roundtable, of which we have been a member since inception in 2005, comprises more than 150 leading international representatives from the economic, political and research sectors, together with non-governmental organisations. Its aim is to develop a global perspective of and global solutions to the challenges of climate change, taking due account of the economic, scientific and technical issues involved. A Roundtable statement, due to be issued in the first quarter of 2007, calls on the economic sector to promote more efficient, greenhouse-gas-neutral energy in order to maintain CO_2 levels in the atmosphere at or below 560 ppm. As emission and development levels vary from country to country, the Roundtable applies the principle of common but differentiated responsibility. In order to meet the objective, carbon dioxide emissions will have to carry a world market price, along similar lines to the European Union's Emission Trading Scheme. This would open up the door to new products, markets and investment sectors for the finance and insurance industries: renewable energy, new energy technologies such as carbon capture and storage, the financing and insuring of Kyoto mechanisms and public-private partnerships, to name only a few.

Climate protection provisions in the USA

In 2005, seven states on the east coast of the USA signed the Regional Greenhouse Gas Initiative (RGGI), under which they agreed to maintain their individual energy emission budgets at a constant level during the period 2009–2014. From 2015, they will be reduced by 2.5% per year. Thus, emissions will be 10% lower in 2019 than in 2009, and 35% less than they would have been without such an undertaking. At the same time, a regional CO_2 emissions trading system will be set up. Other states have launched similar initiatives. In September 2006, Arnold Schwarzenegger, Governor of California, signed an act calling on the state, the world's 12th largest CO_2 producer, to cut its emissions to 1990 levels by 2020 – a reduction of 25%. Furthermore, by 2050, emissions are required to be 80% lower than in 1990. California and the RGGI states account for roughly a quarter of the USA's population and approximately 30% of the US economy.

International workshop on loss trends

The insurance industry is directly affected by losses due to climate change. At an international workshop entitled "Climate Change and Disaster Losses: Understanding and Attributing Trends and Projections", which we organised together with the University of Colorado, 32 eminent experts from 13 countries examined the following issues:

- What factors account for increasing costs of weather-related disasters in recent decades?
- What are the implications of these understandings, for both research and policy?

Participants were drawn from the scientific sector (including the DIW, PIK, Tyndall Center and Harvard Medical School), consultancy firms (RMS, Risk Frontiers), the American Meteorological Service, the WMO and the insurance industry (Swiss Re, Axa Re). The conference was held at Hohenkammer, near Munich. A paper outlining the consensus reached by the participants identifies climate change as a factor which contributes to losses. Details of the consensus together articles written by the participants can be downloaded from the following website:

http://sciencepolicy.colorado.edu/sparc/research/projects/extreme_events/munich_workshop/workshop_report.html

Recognising the dangers and adjusting course

The Stern Review, the Global Roundtable, insurance loss analyses as well as the outcome of the Nairobi summit and the US climate regulations show that the economic sector is taking climate change seriously. Political endeavours are gradually emerging which will provide the appropriate legislative framework. At the same time, there are clear opportunities for new economic options. To consolidate these developments and maintain the necessary impetus, the politicians now have to reach agreement on Kyoto Plus. The insurance sector needs to take account of climate change in risk measurement and adjust its products accordingly. This view is gaining ground at European level and a study on climate change published by the European Insurance and Reinsurance Federation (Comité Européen des Assurances), which draws on a number of our analyses, was presented to the European Parliament in January 2007 (www.cea.assur.org). This is one of a number of insurance industry initiatives aimed at increasing policymakers' awareness of the economic effects of climate change.

At the 12th world climate summit in November 2006, then UN Secretary-General Kofi Annan warned the international community that climate change had to take its place alongside the threats of conflict and poverty. Achim Steiner, Executive Director of UNEP, called for a quantum leap forward in commitment to climate protection.

Data, facts, background

According to the World Meteorological Organization (WMO), 2006 was one of the warmest years on record (i.e. since 1861). Provisional estimates indicate that 2006 will prove to be the fourth-warmest year ever recorded in the northern hemisphere, with a deviation of +0.56°C compared with the average for the climate normal period 1961–1990 (14.6°C). Globally, 2006 is likely to go down in history as the sixth-warmest ever, with a deviation of +0.42°C from the climate normal average (14.0°C). The last six years would then rank among the seven warmest ever recorded – in the northern hemisphere and globally – underlining the fact that climate change marches inexorably on.

A number of extremes stand out on the different continents. In Europe, following 2003's very hot summer, June and July 2006 broke a further record, July being the warmest ever recorded in Europe, with a +2.7°C deviation from the 1961–1990 average for the comparable period. The United States also suffered heatwaves in July and August, with air temperatures in many places exceeding +40°C. A late-summer heatwave in Australia, followed by the warmest autumn on record, brought extreme drought to many areas. Agricultural production fell by more than a third in 2006.

These individual heat events can be seen in a wider context. Globally, the number of days with temperatures in the upper ranges and the maximum duration of warm episodes are increasing (see Fig. 2 and 3). The heat is a threat to the health of elderly city-dwellers lacking appropriate facilities, and is the cause of many deaths. During periods of drought, production may come to a standstill at factories which rely on rivers for cooling water or transport purposes. Agricultural production in countries such as Spain and Portugal, for instance, has been hit by heat and drought in recent years. In the United States, fires destroyed a record 3.8 million hectares of forest in 2006. The trend has been rising since the 1990s (see Fig. 1).

In the autumn months of September to November, temperatures in many parts of Europe north of the Alps were more than 3°C above the average for the reference period in 1961–1990. As a result, World Cup ski races were cancelled, winter resorts remained uncharacteristically green and the winter sports industry sustained losses. Scientific studies show that such developments are characteristic of climate change in Europe, with a later average onset of winter and higher mean autumn temperatures.

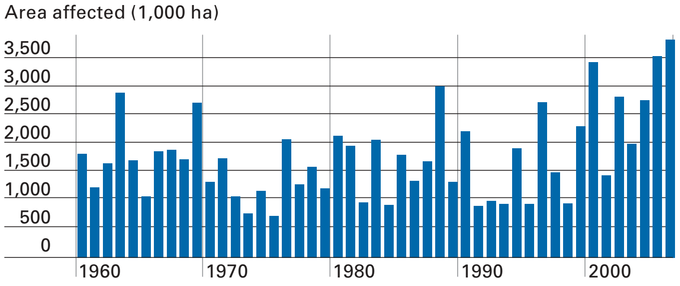
In the Horn of Africa heavy precipitation caused devastating floods in Ethiopia, Kenya and Somalia in October and November – the region's heaviest rains for 50 years. During the Indian monsoon season, 24-hour precipitation readings broke records at many weather stations.

The flood events can also be seen in a wider context. Global warming intensifies the hydrological cycle, resulting in an increase in the number of days worldwide with heavy precipitation and a higher ratio of heavy to total annual precipitation (see Fig. 4 and 5).

The ice in the Arctic Ocean receded still further in the summer of 2006 as a result of global warming. The average loss is around 9% per decade or 60,000 km^2 per year – an area the size of Ireland. As the Greenland Ice Sheet retreats, it exposes a growing expanse of water, a more effective medium for absorbing heat during the summer months than ice. This could speed up the rate at which the Ice Sheet melts in the 21st century, so that sea levels may rise by as much as 20–60 cm by 2050, exceeding current predictions.

This would, in turn, increase the risk of storm surge for cities like London, Hamburg, New York, Shanghai and Tokyo as well as many other coastal regions in future decades, bringing a corresponding rise in loss potentials.

Fig. 1 Total wildland fires USA

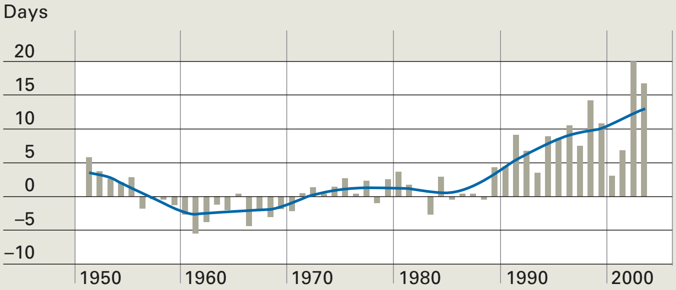


Source: National Interagency Fire Centre, www.nifc.gov and press reports

Our standpoint

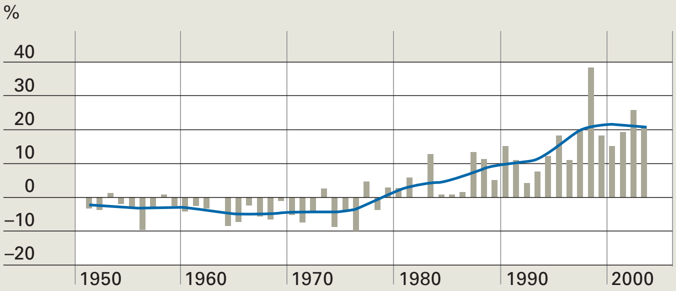
The fourth report of the IPCC (Intergovernmental Panel on Climate Change) published in February 2007 corroborated the findings of earlier climate change analyses and prognoses and confirmed our own estimates, which are essentially based on worldwide loss data. In view of continued global warming, we anticipate a long-term increase in severe, weather-related natural catastrophes. Coming in the wake of 2006, when there were comparatively few such catastrophes, Winter Storm Kyrill, which struck in January 2007, was a reminder of the loss potential of extreme weather events in Europe. Even if Kyrill cannot be directly attributed to its effects, scientific studies forecast that climate change will lead to an intensification of winter storm activity. Climate change is a fact. All we can do now is to limit global warming; it can no longer be stopped or reversed in the present century. We expressly welcome calls by the EU Commission to reduce greenhouse gas emissions in order to limit the overall increase in temperature to 2°C. To that end, a follow-up agreement to the Kyoto Protocol, with consistent reduction targets, is indispensable.

Fig. 2 Warm spell duration indicator



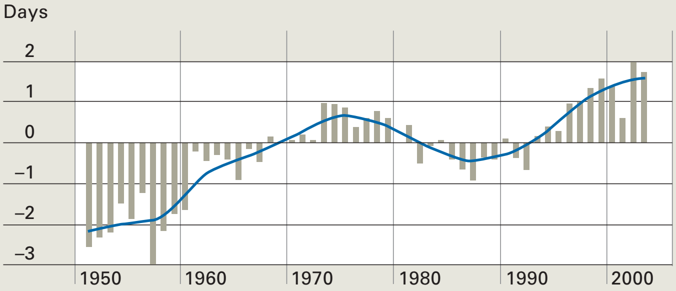
Annual consecutive periods of days (minimum 6) worldwide on which maximum temperatures were equivalent to the top 10% daily maxima for the climate normal period 1961–1990.

Fig. 3 Warm days worldwide



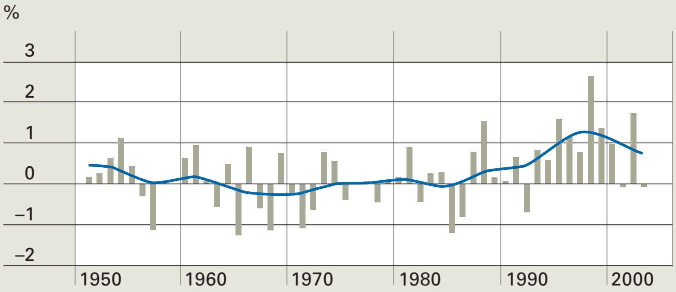
Annual days per year on which the maximum temperature was equivalent to the top 10% daily maxima for the climate normal period 1961–1990.

Fig. 4 Strong precipitation days (> 10 mm)



Global days per annum with minimum 10mm precipitation (relative to the 1961–1990 average).

Fig. 5 Percentage contribution of heavy precipitation days to total precipitation



Worldwide annual ratio of heavy precipitation days (top 5% for the climate normal period 1961–1990) to total annual precipitation (relative to the 1961–1990 average).

Source: L. V. Alexander et al. (2006), Global observed changes in daily climate extremes of temperature and precipitation, JGR, VOL. 111, D05109, doi: 10.1029/2005JD006290

NatCatSERVICE

NatCatSERVICE is the central element of Munich Re's Geo Risks Research. Founded in 1974, it is now one of the most comprehensive natural catastrophe databases in existence.

Each year, we analyse and document some 700 natural hazard losses. The database currently has more than 23,000 entries. It contains data on the major catastrophes of the last 2,000 years and all post-1980 loss events.

The only way to ensure accurate analyses and hazard assessments is to systematically document all details in full. At a time when natural catastrophe losses are steadily increasing worldwide, NatCatSERVICE is a major resource for clients, international organisations and research institutes.

You can download the latest data, analyses and charts from our website at www.munichre.com/geo.

The year in figures

The number of loss events due to natural hazards documented in 2006 was far higher than in previous years, totalling 850 compared with a ten-year average of some 700. Fortunately, fatalities, overall and insured losses were relatively low. The reason for this was that only about a quarter of the losses were, by definition, severe or devastating natural catastrophes, the remainder being classed as small loss events.

Number of events

91% of the losses were weather-related whilst 9% were due to earthquakes and volcanic eruptions. The percentage split between the main types of loss occurrence is in line with the average over the last ten years.

Fatalities

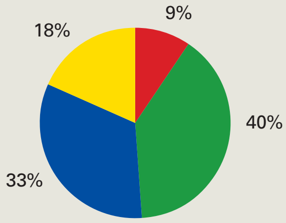
Fatalities in 2006 were roughly in line with the long-term average, in stark contrast to the previous two years' major catastrophes: the South Asia tsunami in 2004 and the Pakistan earthquake in 2005, where the death tolls had been much higher. Nevertheless, thousands of lives were lost in a number of catastrophic events:
- Indonesia: The earthquake on 27 May and the tsunami on 17 July claimed 6,500 lives.
- Philippines: More than 800 died in the most serious windstorm event, Typhoon Durian.
- Africa: Record precipitation caused major floods in August and September, in which more than 1,400 people lost their lives, most of them in Ethiopia.
- Europe's July heatwave claimed 2,000 lives, the Netherlands being worst hit (1,000 deaths) followed by Belgium (more than 800).

Overall losses and insured losses

Overall losses were moderate last year, amounting to some US$ 50bn – the lowest figure since 2000. Severe monsoon floods in India ranked among the costliest economic catastrophes, causing a loss of approximately US$ 3bn. In August, thousands of villages were under water in the state of Gujarat. In Surat, a city with a population of over a million, more than 100,000 cars and motorcycles were damaged, factory production lines were halted and life came to a standstill. Insured loss: US$ 400m. For the insurance industry, this was the region's second major event in just 12 months.

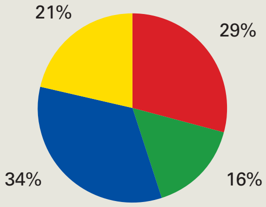
Windstorms were the main cause of insured losses, accounting for 79% or US$ 13bn. In the USA, two tornado outbreaks caused damage amounting to more than US$ 3bn in April, whilst Typhoon Shanshan brought losses of US$ 1.2bn to Japan.

850 loss events



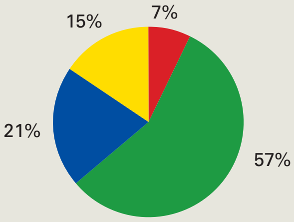
Percentage distribution worldwide

20,000 fatalities



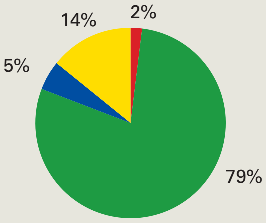
Percentage distribution worldwide

US$ 50bn overall losses



Percentage distribution worldwide

US$ 15bn insured losses



Percentage distribution worldwide

🟥 Earthquake, tsunami, volcanic eruption
🟩 Windstorm
🟦 Flood
🟨 Temperature extremes (e.g. heatwave, drought, wildfire); mass movements (e.g. landslide)

Great natural catastrophes 1950–2006

In 2006 only one loss event caused by natural hazards qualified as a “great natural catastrophe” in accordance with the criteria we use for our long-term analyses. This was a 6.3 magnitude earthquake which rocked the area around Yogyakarta, Indonesia, on 27 May 2006, causing the loss of more than 5,700 lives.

Approximately half of last year’s events fall into category 1 of our classification system and a third into category 2. Accordingly, the remaining 20% are split between the categories severe, great and devastating.

When we compare 2006 with 2005 the following features stand out:

- A sharp rise in small-scale loss events (category 1): over 400 compared with 150 in 2005.
- Severe (category 3) catastrophes were slightly less than half of the previous year’s figure.
- There were 30 devastating loss events in 2006 as against 15 in the preceding year – a 50% increase. They included severe floods in Ethiopia in which 1,400 people lost their lives, a tsunami in Indonesia with a death toll of over 660 and a series of tornadoes which hit the USA in April, inflicting a loss of more than US$ 4bn.
- On the positive side, there was only one great natural catastrophe in 2006 compared with six in the previous year, which had been marked by disastrous hurricanes – Katrina, Rita, Stan und Wilma – and the Pakistan earthquake, in which more than 88,000 people were killed.

Definition

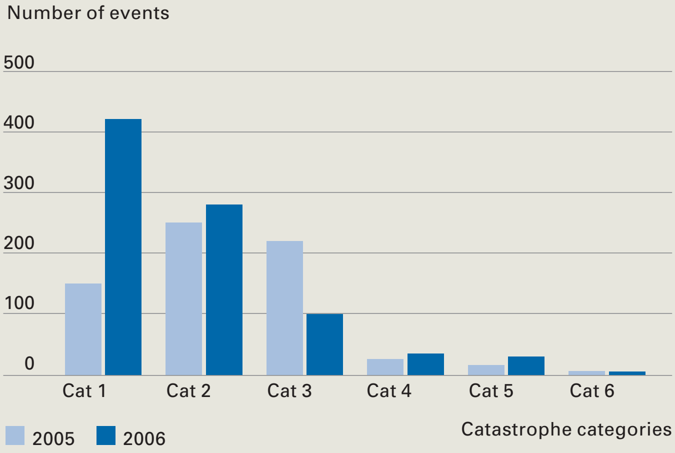
In line with United Nations definitions, natural catastrophes are classified as “great” if the affected region’s ability to help itself is clearly overstretched and supraregional or international assistance is required. As a rule, this is the case when there are thousands of fatalities, when hundreds of thousands of people are left homeless, or when overall losses – depending on the economic circumstances of the country concerned – and/or insured losses are of exceptional proportions.

Outlook

Since 1950, there has been a long-term upward trend in the number of events and the amount of economic and insured losses. Approximately two great catastrophes occurred per year throughout the 1950s. From 2000 onwards, the figure had risen to seven, most being weather-related. The increase in geological catastrophes (earthquakes, tsunamis and volcanic eruptions) has been much less pronounced – from approximately one per annum in the 1950s to about two today.

Many of the factors contributing to the steady increase in losses are of a socioeconomic nature (increasing value concentrations, population growth and the settlement and industrialisation of exposed areas). However, in our view, the main driver of future loss developments will be climate change, and this is expected to lead to a higher incidence of major weather events.

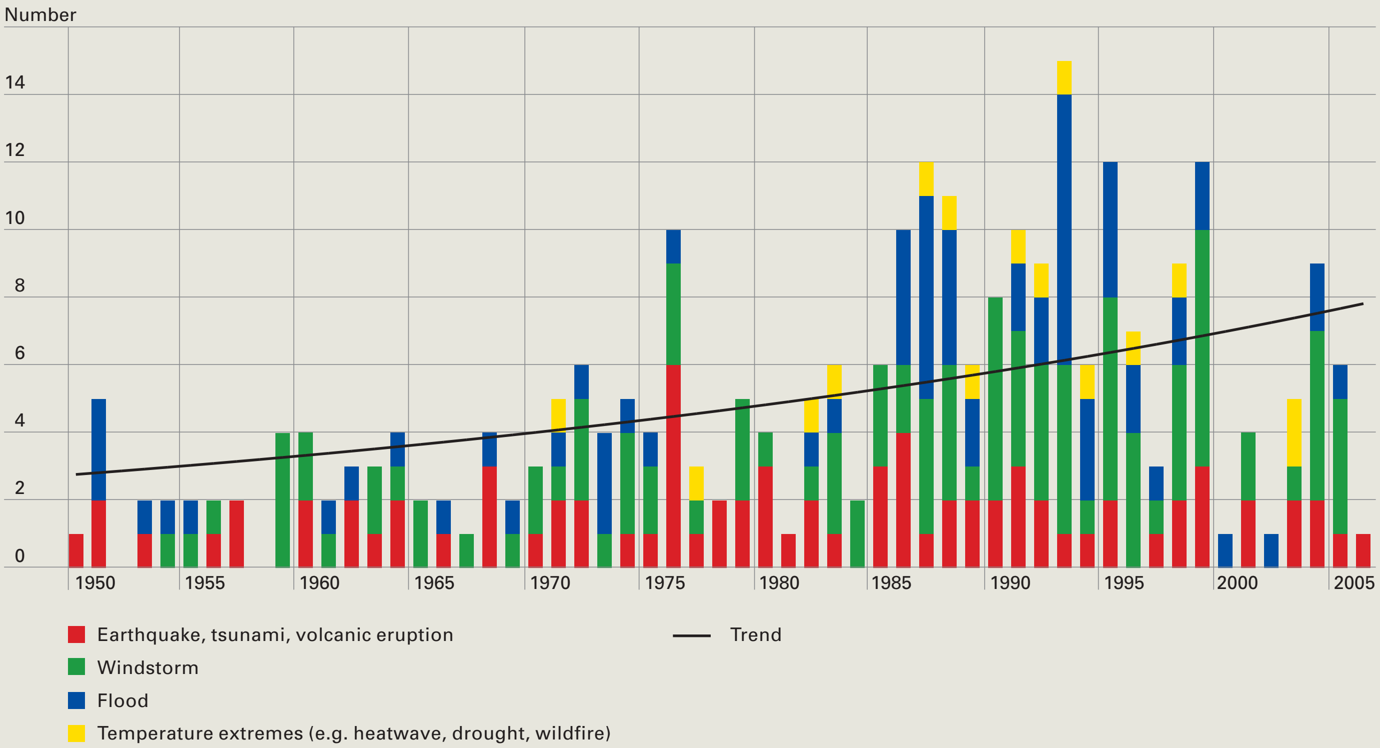
Natural catastrophes 2006 – Breakdown into six catastrophe categories



Cat 1	**Small-scale loss event** (1–9 deaths and/or hardly any damage)
Cat 2	**Moderate loss event** (10–19 deaths and/or damage to buildings and other property damage)
Cat 3	**Severe catastrophe** (More than 20 deaths, overall loss of more than US$ 50m)
Cat 4	**Major catastrophe** (More than 100 deaths, overall loss of more than US$ 200m)
Cat 5	**Devastating catastrophe** (More than 500 deaths, overall loss of more than US$ 500m)
Cat 6	**Great natural catastrophe** (See definition above)

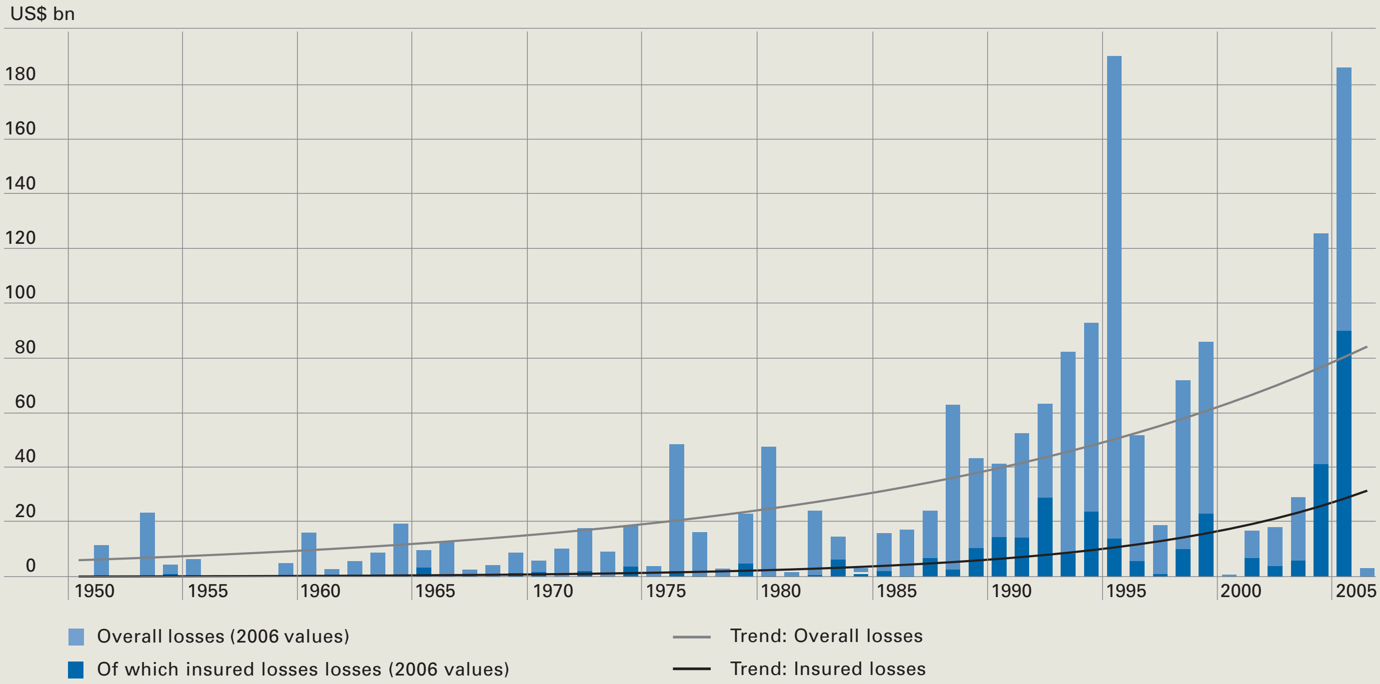
Number of events

The chart shows the number of great natural catastrophes for each year, divided according to type of event.



Overall losses and insured losses – Absolute values and long-term trends

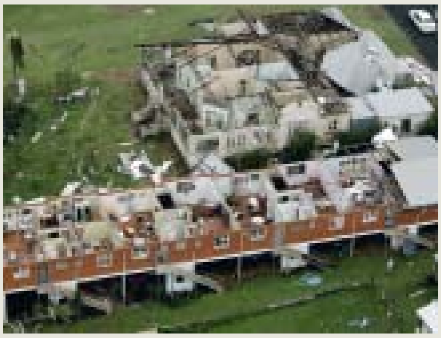
The chart presents the overall losses and insured losses – adjusted to present values. The trend curves confirm an increase in catastrophe losses since 1950.



Pictures of the year

January–March
Cold wave, winter damage: Europe
Overall losses: US$ 1,000m
Insured losses: US$ 500m
> 900 fatalities

17 February
Landslide: Philippines
154 fatalities



20 March
Cyclone Larry: Australia
Overall losses: US$ 1,300m
Insured losses: US$ 450m

27 March
Tornadoes: Germany
Overall losses: US$ 5m
Insured losses: US$ 3m
Two fatalities

6–8 April
Tornadoes, hailstorms: USA
Overall losses: US$ 1,600m
Insured losses: US$ 1,280m
12 fatalities

27 May
Earthquake: Indonesia
Overall losses: US$ 3,100m
Insured losses: US$ 35m
5,749 fatalities

Summer
Wildfires: USA
Overall losses: > US$ 700m
Insured losses: US$ 500m

17 July
Tsunami, earthquake: Indonesia
668 fatalities

29 July
Earthquake: Tajikistan, Afghanistan
Overall losses: US$ 17m
5 fatalities

July
Drought, heat wave: Europe
Overall losses: US$ 800m
2,000 fatalities

July–August
Floods: India
Overall losses: US$ 3,300m
Insured losses: US$ 400m
Over 900 fatalities

10–16 August
Typhoon Saomai: China, Philippines
Overall losses: US$ 1,400m
Insured losses: US$ 200m
440 fatalities

15–17 August
Volcanic eruption: Ecuador
Overall losses: US$ 150m
Four fatalities

28 September–3 October
Typhoon Xangsane: Philippines, Vietnam
Overall losses: US$ 710m
Insured losses: US$ 7m
239 fatalities

November–December
Floods: Ethiopia, Kenya, Somalia
300 fatalities

30 November–5 December
Typhoon Durian: Philippines, Vietnam
Overall losses: US$ 1,485m
813 fatalities

7 December
Tornado: London
Overall losses: US$ 6m
Insured losses: US$ 3m

18 December 2006–22 January 2007
Floods: Malaysia, Indonesia, Singapore
210 fatalities

2006 hurricane and typhoon chronicle

2006 North Atlantic hurricane season

Name	Date	Maximum category on Saffir-Simpson Scale	Maximum wind speeds	Affected areas	Fatalities	Estimated overall losses (US$ m)	Estimated insured losses (US$ m)
Tropical Storm Alberto	10–14 June		110 km/h	Cuba. USA: Fl, NC, SC	1		
Tropical Storm (unnamed)	17–18 July		85 km/h				
Tropical Storm Beryl	18–21 July		90 km/h				
Tropical Storm Chris	1–5 Aug		100 km/h				
Tropical Storm Debby	21–27 Aug		85 km/h				
Hurricane Ernesto	24 Aug–1 Sept	1	120 km/h	Cuba. Dominican Republic. Haiti. USA: DE, FL, MD, NC, NJ, NY, SC, VA	14	500	245
Hurricane Florence	3–12 Sept	1	150 km/h	Bermudas. Canada			
Hurricane Gordon	11–20 Sept	3	195 km/h				
Hurricane Helene	12–24 Sept	3	205 km/h				
Hurricane Isaac	27 Sept–2 Oct	1	140 km/h				

2006 typhoon season

Name	Date	Maximum category on Saffir-Simpson Scale	Maximum wind speeds	Affected areas	Fatalities	Estimated overall losses (US$ m)	Estimated insured losses (US$ m)
Tropical Storm 01W	4–7 Mar		65 km/h				
Super Typhoon Chanchu (Caloy)	8–18 May	4	250 km/h	China. Philippines. Taiwan. Vietnam	> 90	1,500	
Tropical Storm Jelawat	26–29 June		85 km/h				
Super Typhoon Ewiniar	29 June–10 July	4	240 km/h	China. South Korea	574	350	
Tropical Storm Bilis (Florita)	9–14 July		100 km/h	China. Philippines. Taiwan	> 600	1,900	
Tropical Storm 06W	18–19 July		65 km/h				
Typhoon Kaemi (Glenda)	22–25 July	2	160 km/h	China. Philippines. Taiwan	36	1,000	
Typhoon Prapiroon (Henry)	31 July–3 Aug	1	130 km/h	China. Philippines	83	670	
Super Typhoon Saomai	4–10 Aug	5	260 km/h	China. Philippines	> 440	1,400	200
Typhoon Maria	5–9 Aug	1	120 km/h				
Tropical Storm Bopha (Inday)	6–10 Aug		95 km/h	Philippines	2		
Tropical Storm Wukong	12–19 Aug		95 km/h	Japan	3		
Tropical Storm Sonamu	13–16 Aug		85 km/h				
Super Typhoon Ioke	27 Aug–5 Sept	5	260 km/h	USA: Wake Island, Johnston Atoll			
Typhoon Shanshan	10–17 Sept	4	220 km/h	Japan. South Korea	10	2,500	1,200
Super Typhoon Yagi	17–24 Sept	5	260 km/h				
Super Typhoon Xangsane (Milenyo)	25–30 Sept	4	230 km/h	Philippines. Vietnam	> 239	710	> 7
Tropical Storm Bebinca	1–6 Oct		85 km/h				
Tropical Storm Rumbia	4–6 Oct		85 km/h				
Typhoon Soulik	9–15 Oct	2	165 km/h				
Super Typhoon Cimaron (Paeng)	27 Oct–4 Nov	5	260 km/h	Philippines	23	9	
Typhoon Chebi (Queenie)	9–14 Nov	4	215 km/h	Philippines	1		
Super Typhoon Durian (Reming)	26 Nov–5 Dec	4	250 km/h	Philippines. Vietnam	> 813	1,485	
Typhoon Utor (Seniang)	7–14 Dec	3	185 km/h	China. Philippines	30	15	

Source: NHC, Joint Typhoon Warning Center, NatCatSERVICE

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