

Knowledge series

Topics Geo

Natural catastrophes 2007

Analyses, assessments, positions



Münchener Rück
Munich Re Group



Contents

2 In focus

- 5 The monsoon – Between a curse and a blessing
- 10 North Atlantic hurricane activity in 2007

14 Catastrophe portraits

- 17 January: Winter Storm Kyrill in Europe
- 20 April: Nor'easter in the United States
- 22 June: Cyclone Gonu in Oman
- 24 June: Severe weather events in Australia
- 26 June and July: Floods in the UK
- 30 July: Earthquake in Japan
- 32 October: Wildland fires in California

34 Climate and climate change

- 37 World Climate Conference in Bali smooths the way for the successor to the Kyoto Protocol
- 39 Living with climate change – The strategic repositioning of the Munich Re Group
- 41 Data, facts, background

44 NatCatSERVICE

- 45 The year in figures
- 46 Pictures of the year
- 48 Great natural catastrophes 1950–2007

Cover:

2007 was the wettest summer in England and Wales for many years: it generated insured flood losses amounting to US\$ 6bn, making it the costliest flood event ever for the insurance industry. The picture shows a flooded street in Catcliffe in northern England on 26 June 2007.

Below:

At the end of October and the beginning of November 2007, southern California was hit by the worst wildland fires in the state's history. More than 2,000 km² of wildland was burnt and over 2,000 buildings. Overall losses came to US\$ 2.7bn, with insured losses totalling US\$ 2.3bn.



Climate awareness is increasing

“Munich Re is a pioneer in climate change research and one of the first corporate groups to promote the idea of global counter-measures”: these were aspects underlined by the jury in November 2007 when the Eco-Manager of the Year prize was awarded to Dr. Nikolaus von Bomhard, Chairman of Munich Re’s Board of Management, by the environmental foundation WWF Deutschland and the business magazine Capital.



The publication of the new IPCC report last year finally made policy-makers, business, and society at large fully aware of climate change. It is in the nature of things that we, as a global reinsurer, have concerned ourselves with climate change and its effects over the past thirty years and more, analysing the loss potentials and developing insurance solutions to cope with them: after all, as an “insurer of last resort”, we often have to carry the lion’s share of insured losses following great natural catastrophes. In 2007, the insurance industry had to foot a bill of approx. €9bn solely for the losses caused by Winter Storm Kyrill in January and the UK floods in June and July. The trends we have been analysing for years clearly indicate that the losses – mainly from atmospheric perils – will continue to increase in coming decades.

The country portrait is a new feature of Topics Geo: this issue focuses on India. With a population of more than a billion, India is one of the fastest growing newly industrialising countries. It is an interesting market for business and especially for insurance, promising high growth potential in the long term. At the same time, the risks of change are mounting there too: the concentrations of values are growing, but so is the severity of the monsoon rains to which they are exposed. Country studies for selected markets will be a regular feature of future issues.

A further innovation is intended to satisfy the growing information needs of our cedants throughout the world: we have prepared additional topics and statistics of local relevance for the United States, Asia, and Australia; these are enclosed in the respective editions and are also available for download from Munich Re’s website.

I hope you find this issue of Topics Geo interesting, with plenty of information that will be of practical use in your day-to-day work.

Munich, April 2008

A handwritten signature in black ink, appearing to read 'Torsten Jeworrek'. The signature is fluid and cursive, with a large initial 'T'.

Dr. Torsten Jeworrek

Member of the Board of Management
and Chairman of the Reinsurance Committee





In focus

India is gradually becoming a focal point for companies with global operations. At the same time, monsoon activity is changing significantly. This has repercussions for the insurance industry.

With 15 named storms in the North Atlantic, 2007 was way above the long-term average, but there were no major losses.

Heavy monsoon rains have brought large-scale floods to India again and again in recent years, causing billions in losses and thousands of fatalities. During the 2007 monsoon season alone, over 3,000 people died and more than one million homes were damaged or destroyed. In the year before, the industrial region around Surat in Gujarat State had been hit particularly hard: the photo shows a flooded textiles factory in Surat in August 2006.

The monsoon between a curse and a blessing

The significant increase in extreme monsoon rainfalls, a burgeoning of insured values, and fiercer price competition are major challenges for the insurance industry in India. The market is currently going through a complex process of liberalisation and adjustment.

The monsoon is as much a part of India as the country's extensive dry seasons. Producing about 80–90% of the country's annual precipitation, the summer monsoon (June–September) is a source of life to India, regulating, as it does, the gigantic country's water balance. It is particularly crucial for the agricultural sector, which accounts for about a fifth of India's gross domestic product and provides work for around two-thirds of the population. But the monsoon itself has changed. The frequency and intensity of extreme rainfall have both increased considerably, whilst exceptional rainfall levels have given rise to serious floods and ensuing damage in recent years. In 2005, the highest level of precipitation ever measured on a single day in India was recorded in Mumbai. In 2007, the effects of the summer monsoon were extremely intense for the third year in succession.

Losses caused by floods

	2005	2006	2007	Average 1980–2004
Overall losses	5,400	6,200	750	1,150
Insured losses	850	410	n/a	5
Fatalities	1,650	1,100	2,000	1,100

Losses in US\$ m, 2007 values.

The annual overall loss due to flood in the years 2005–2007 averaged roughly US\$ 4bn, three to four times higher than the average for the period 1980–2004. Escalating concentrations of values in exposed regions like Mumbai combined with growing insurance awareness caused insured losses to soar during this period. Is this latest development merely an outlier or the herald of a long-term change in monsoon activity?

Climate change as the cause

Scientific studies show that monsoon activity in central India has changed significantly (Goswami et al. 2006). The daily variability of monsoon rainfall, i.e. the range between severe and less severe daily rainfall events, has increased markedly in the last 50 years. In central India, the number of intense precipitation events per day (at least 100 mm/day) has increased by about a third since 1950. The figure is even more dramatic in the case of extreme precipitation events, involving levels of at least 150 mm/day. It has roughly doubled since 1950 – a highly significant increase in scientific terms. At the same time, there were considerably fewer instances of moderate precipitation events in the observation period. Although these opposing trends mean that average rainfall has not changed, this is not good news. On the contrary: whilst the moderate monsoon is important for India's water balance, especially for the agricultural sector and the supply of drinking water, intense and extreme rainfall have a major bearing on losses. What is more, the majority of models quoted by the Inter-

governmental Panel on Climate Change in its report assume that the total rainfall depths of the summer monsoon will increase in future. Even if there are large deviations between the individual scenario calculations, there is no doubt about the outcome: Indian summer monsoons are very likely to become more extreme.

And this is due to global warming. Sea surface temperatures in the tropical Indian Ocean, for instance, have risen by about 0.5°C over the last 50 years. This results in more moisture reaching India with the monsoon.

It is a risk of change that is difficult to quantify and the Indian insurance industry must give greater attention to devising appropriate solutions – particularly as the values to be insured are rapidly increasing.

Losses increase – Premiums come under pressure

In India, the natural perils of windstorm and flood (STIF) are automatically included in any property insurance policy. Weather risks, particularly monsoon rainfall, have always constituted a major threat. The process of global warming has made it more and more difficult to forecast the beginning and magnitude of annual monsoon rainfall. Between 1980 and 2007, weather disasters (floods, storms, droughts) caused overall losses amounting to US\$ 53bn (2007 values). The main peril is flood, which accounted for about 77% of the overall losses and 66% of the insured losses over the said period.

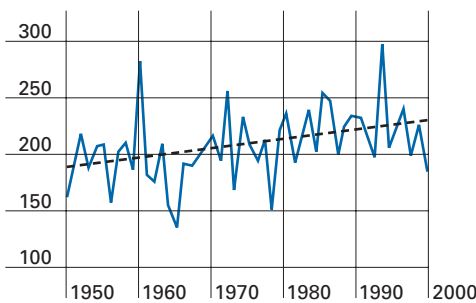
The summer floods in 2005 (Mumbai Floods) exhausted nearly all the market players' cat XL programmes for the first time ever. Due to the agreed net retentions, some of them had large losses that were not covered. There is already a broad consensus in the market that the rates, especially for flood risks, have to be adjusted substantially. Some insurers are considering the possibility of quoting separate premium rates, but this is not to be expected in the short term due to the shortage of claims statistics and especially to the fact that as of 1 January 2008 pricing controls have been removed in all lines of property insurance except motor third-party liability.

Climate change and summer monsoons in India

Summer monsoon activity (June–September) in central India has changed significantly in the past 50 years. The extremes have increased.

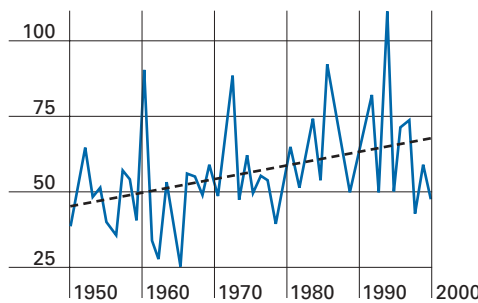
1. Variability is rising

Variance (mm/day)²



2. Heavy rainfall events are increasing

N (R ≥ 100 mm/day)



Central India (74.5°E–86.5°E; 16.5°N–26.5°N)

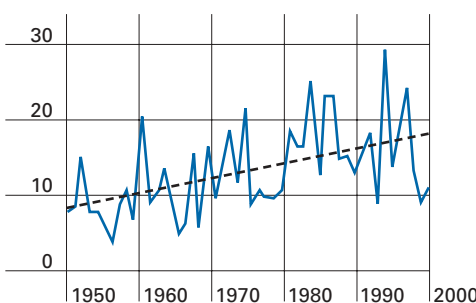
1. Variability of daily rainfall anomalies in the summer monsoon
Broken line: Linear trend.

2. Number of heavy rainfall events per day (at least 100 mm/day)
Broken line: Linear trend.

3. Number of extreme rainfall events per day (at least 150 mm/day)
Broken line: Linear trend.

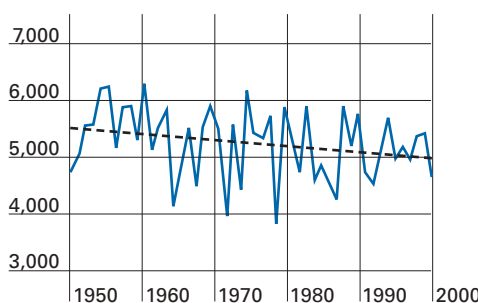
3. Extreme rainfall events are increasing

N (R ≥ 150 mm/day)



4. Moderate rainfall events are decreasing

N (5 ≤ R < 100 mm/day)



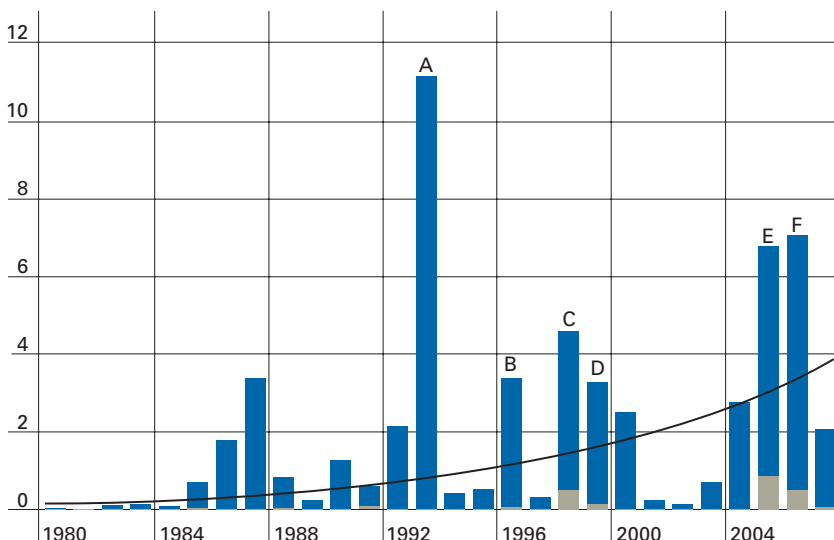
4. Number of moderate rainfall events per day (between 5 and 100 mm/day)
Broken line: Linear trend.

Source: Goswami, B. N. et al. (2006), Science 314

Weather-related natural catastrophes in India from 1980 to 2007

Overall losses and insured losses

(US\$ bn, 2007 values)



Losses from weather-related catastrophes have risen strikingly since the early 1990s. The largest insured loss was generated by the Mumbai Floods in 2005 (US\$ 770m). The highest overall losses were caused by the floods in Gujarat and Punjab in northern India in 1993.

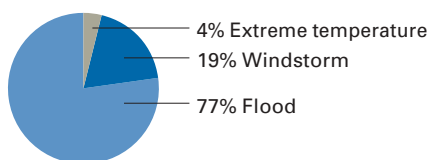
Largest events

- A: 1993: Flood, Gujarat, Punjab
- B: 1996: Cyclone, Andra Pradesh
- C: 1998: Cyclone, Gujarat, Kandia
- D: 1999: Cyclone, Orissa
- E: 2005: Flood, Mumbai
- F: 2006: Flood, Surat

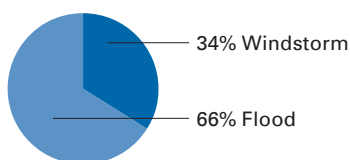
■ Overall losses
■ Insured losses

Source: NatCatSERVICE, Geo Risks Research, Munich Re

Overall losses US\$ 53bn



Insured losses US\$ 2bn



Market and market players in a learning process

For the insurance industry, the question is how the Indian insurance market will develop in the medium to long term. If there are no major loss events with large insured losses, pricing pressure will certainly be maintained for some time. Moreover, companies have in the past compensated underwriting losses with high returns on India's booming stock exchange. Reinsurance capacity is generally available in good measure.

At present, however, India is going through a process of learning and adjustment. The market has yet to encounter a phase with a scarcity of reinsurance capacity that necessitates risk-based pricing. Generally speaking, the private insurance industry should in the long term offer coverage concepts, such as a pool solution with compulsory insurance for natural hazards. These require both technical know-how and financial resources, however. International reinsurers could provide both, but the scope for efficient risk transfer in India is limited at present. Reinsurance is mainly provided by the General Insurance Corporation of India (GIC Re), to which non-life insurers must currently cede 15% of their cessions.

Low market penetration – High growth potential

The socio-economic transformation of India presents its insurance industry with great challenges. Forecasts suggest that the country's insurance market will increase to some €100bn, five times its current volume, over the next ten years. This growth will be driven above all by rising demand from India's middle class, currently numbering some 300 million people, and the improvement and expansion of the infrastructure.

Freedom of establishment for foreign insurers is limited at present to joint ventures with a maximum foreign capital share of 26%. The government is currently examining the possibility of increasing this share to 49%. At present, 17 property insurance companies and 17 life insurers are licensed to do business.

These figures vividly illustrate how much the insurance industry has already profited in recent years from the opening of India's market as well as from the country's high rate of economic growth. Between 2001 and 2006, the annual increase in premiums averaged roughly 24% in life and 11% in non-life. In an international comparison based on total population, market penetration is still comparatively low in what is the second most heavily populated



Water as a risk factor – Soil sealing and glacial lake outburst flood

Floods and inundation are influenced not only by the intensity of the precipitation but also by the characteristics of the area on which the rain falls. Is the terrain flat or sloping? Are there narrow or wide valleys in the region? What about the discharge capacity of river courses? How big are the retention and storage capacities? The degree of sealing determines how much water can seep into the ground. This involves not only artificial sealing, resulting from road-building and urban development, but also natural sealing, which depends on the type of soil and the amount of precipitation involved. In the case of prolonged and intensive rainfall, the ground becomes so satur-

ated that sooner or later it cannot absorb any more water. Further precipitation then quickly leads to floods.

Artificial sealing, on the other hand, is usually a result of urbanisation. In many of India's urban areas, upgrading of the sewage and drainage systems cannot keep up with the rapid pace of urban development. The systems are overloaded, there is backwater, and the ground is flooded.

Further perils emerge when glacial lakes burst and permafrost melts. The main factors for the advance or retreat of glaciers in the Himalayas are the volume and type of summer precipita-

tion. In the wake of global warming, the zero-degree border rises, glaciers receive less snow and more liquid precipitation, and what were once giant masses of ice shrink. At the same time, the frozen slopes (permafrost) melt at an increasing rate at higher levels. Lakes that have been formed by glaciers and moraines burst, destabilising the sides of hills and mountains and dragging down loose material and debris flows. With the volumes of rain increasing, there is also a mounting danger of soil erosion. Moreover, debris, gravel, and sand add to the sediment carried in rivers, creating problems at reservoirs and hydro-power stations.

country in the world. With an average premium volume as a percentage of GDP, market penetration is about 0.6% (non-life) and 4% (life). In the non-life sector, it is estimated that 90% of the Indian population have no insurance protection whatsoever. In terms of absolute premium volume, however, the country already ranks fifth in Asia after Japan, South Korea, China, and Taiwan and fifteenth in the world (2006). And experts agree that the speed of expansion will continue to be high in the years to come.

Positioning ourselves selectively as a reinsurer

Munich Re has 50 years of experience on the Indian insurance market; it knows the market players and local customs and practice. We opened an office in Kolkata in 2000 and a representative office in Mumbai the following year. We enjoy the confidence of the Indian insurance market and, on the strength of our long-standing business relations, are recognised as a reliable reinsurance partner.

In the current market phase, we are looking beyond our traditional reinsurance business, positioning ourselves as a global reinsurer particularly in niche markets and in sectors where quite specific, individual solutions are required. For example, we are stepping up our involvement in renewable energy projects. With a view to offering attractive insurance solutions in rapidly growing emerging markets, we developed a new product last year: the Kyoto Multi Risk Policy (more on this in Topics 2007/2 and our website www.munichre.com).

We also make available our risk knowledge and financial strength in connection with large and very large risks – a segment that is continuously gaining in importance in the dynamically growing economy of India. We not only provide our capacity but also make an important contribution to the development of risk awareness.

We intend to do everything in our power to support India in the reinsurance sector. To ensure the stability of its strongly expanding insurance market, deregulation must be extended from India's primary insurance market to include international reinsurance business as well. We intend to open a reinsurance branch as soon as the legal framework permits.

Heavy monsoon rain in India from June to September 2007 caused major losses affecting agriculture, livestock, infrastructure, and commerce. Thousands of towns and villages were swamped. This flooded street is in Kheda, approx. 40 km from Ahmadabad.

From 17 to 23 August 2007 Hurricane Dean raged in the Gulf of Mexico, causing the worst damage in Guadeloupe, Martinique, Jamaica, and Mexico. Overall losses came to US\$ 1.5bn, with insured losses totalling US\$ 450m. This picture of damaged landing stages was taken in Fort de France, Martinique, on 17 August.

North Atlantic hurricane activity in 2007

In 2007, the National Hurricane Center (NHC) in Miami assigned names to a total of 15 systems: in other words, there were 15 storms with wind speeds of at least 63 km/h last year. Six of them were classified as hurricanes, i.e. they had a peak wind speed exceeding 118 km/h. Generally speaking, there was a distinct shift towards the southwest. Following the devastating hurricane events on the US mainland 2004 and 2005, it was now mainly the Caribbean that was hit by intensive cyclones.

Outstanding hurricane events

- The Atlantic hurricane season made an early start when a subtropical storm named Andrea formed off the west coast of Florida on 9 May – three weeks before the beginning of the official hurricane season on 1 June. Andrea did not make landfall.
- The first tropical storm of the hurricane season was Barry, which made landfall at Tampa on 2 June. Because of its low intensity, this cyclone caused only minor damage.
- Hurricane Dean hit the Yucatan peninsula on 21 August with wind speeds of up to 270 km/h, thus reaching the highest of five categories on the international Saffir-Simpson Hurricane Scale. Shortly before making landfall on the Mexican peninsula at Majahual, Dean had a central pressure of 906 hPa – making it the third strongest hurricane ever to reach land from the Atlantic. After leaving a trail of destruction on the peninsula, Dean grew in intensity again in the Gulf of Campeche and, on 22 August, reached the Mexican mainland for the second time, this time as a Category 2 hurricane at Tecolutla. The oil rigs in its path had to stop production. Dean also grazed Jamaica and some islands of the Lesser Antilles. Altogether, it caused an insured loss of US\$ 450m.
- It was followed only two weeks later by Hurricane Felix, a Category 5 hurricane whose track ran further south than Dean's. This cyclone and the attendant heavy rain reached Nicaragua at Puerto Cabeza on 4 September. The effects in the city were catastrophic: 90% of the buildings were destroyed, 8,000 people had to be evacuated, and more than 133 were killed.
- September 2007 was a month of above-average activity. Another of the hurricanes was Humberto, which formed in the Gulf of Mexico off the coast of Texas. It grew in intensity from 55 km/h to almost 140 km/h in 18 hours – the fastest growth in intensity ever recorded (Klotzbach and Gray, 2007¹). This development is attributable to a combination of favourable conditions, warm sea



surface temperatures and the hurricane's structure, which was very compact for a tropical cyclone. When Humberto hit the coast of Texas at High Island, it was a Category 1 hurricane. The insured loss to property is estimated at US\$ 30m.

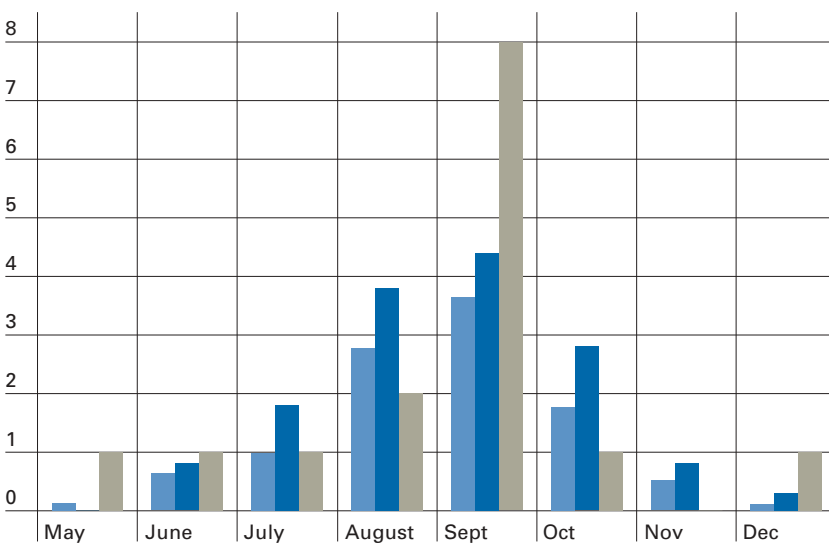
- Even before reaching hurricane strength, Noel brought substantial falls of rain to the Dominican Republic, Haiti, and Cuba. The result: more than 25,000 buildings destroyed by floods, landslides, and flash floods. On its path towards the north-east, Noel gained in intensity and developed into an extratropical storm. Even when it finally reached the mainland in Nova Scotia, Canada, it was still carrying hurricane-force winds and heavy rain.
- The 2007 cyclone season came to an extremely late end with Subtropical Storm Olga. Classified as a tropical storm on 11 December, Olga moved westwards along the north coast of Puerto Rico. 79,000 people were affected when heavy rain resulted in the electricity grid collapsing; 144,000 had no access to the public water supply. On 11 December, the Yaque del Norte River burst its banks near Punta Cana in the Dominican Republic. Faced with the threat of the Tavera Dam collapsing, the authorities consequently decided to open the flood gates. The subsequent flooding claimed the lives of 35 people.

Assessment of the 2007 season in terms of the hurricane climatology of the North Atlantic

The number of named storms in the 2007 hurricane season (15) is much higher than the long-term climatological average (1950–2006: 10.6 named storms) and roughly equal to the average of the current warm phase (1995–2006: 14.6 named storms). Nevertheless, as only two of last year's hurricanes counted as intense storms (Categories 3–5 on the Saffir-Simpson Scale), the 2007 season should really be classified as being below average – at least compared with the current warm phase as a whole. The average for warm phases is 3.9 such storms. A further indicator is the accumulated cyclone energy (ACE), defined as the sum total of the squares of the maximum wind speeds over the entire duration of all storms. The value for the 2007 season was only 69, compared with an average of 150 in the current warm phase. The fairly small ACE index reflects both the short duration of some storms (e.g. Ingrid, Melissa, Karen, and Humberto) and their relatively low intensity.

There are many reasons for this: relatively low water temperatures and exceptional upper air flows are sure to have played a part. Average surface temperatures in the tropical Atlantic were lower in 2007 than in 2006, for example; between April and September 2007, the Atlantic cooled down by 0.5 °C. The reason most often proffered is the content of mineral Sahara dust in the atmosphere, which partially absorbs the sun's rays and partially reflects them into space. It was higher in June/July 2007 than at any time since 1999 (Evan, 2008²). The transition from neutral to La Niña conditions, which governed the year 2007, did not increase hurricane activity. Although in September, the climatological peak of the season, vertical wind shear in the tropical Atlantic and the Gulf of Mexico was slightly

Average number of named tropical storms in the North Atlantic

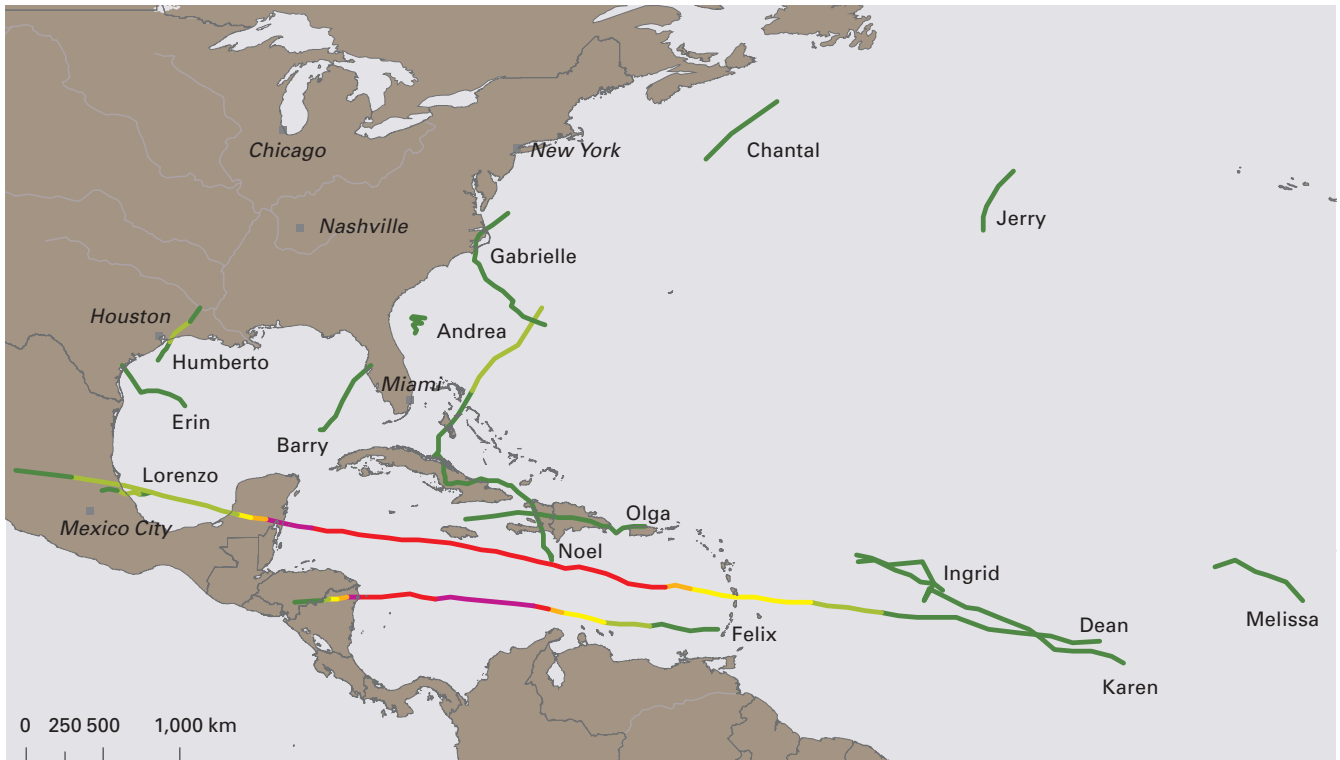


Comparison of May–December monthly averages in the periods 1950–2006, 1995–2006, and 2007.

■ 1950–2006 average
 ■ 1995–2006 average
 ■ 2007 average

Source: NOAA, UNISYS

North Atlantic tropical cyclone tracks in 2007



In 2007, 15 tropical cyclones developed in the Atlantic, six of which reached hurricane force with wind speeds exceeding 118 km/h.

Wind speeds in km/h (categories on the Saffir-Simpson Hurricane Scale)

- Tropical storm (63–117 km/h)
- Cat. 1 hurricane (118–153 km/h)
- Cat. 2 hurricane (154–177 km/h)
- Cat. 3 hurricane (178–209 km/h)
- Cat. 4 hurricane (210–249 km/h)
- Cat. 5 hurricane (≥ 250 km/h)

Source: NOAA, NHC, Miami

reduced by the La Niña conditions, resulting in an exceptionally large number of named storms (8), upper low pressure zones and associated west winds prevented some storms (Ingrid, Karen, Melissa) from intensifying to a dangerous degree. Other storms (Humberto, Lorenzo) formed so near the coast that they hardly had any chance to intensify over the water. In October, the reduction in wind shear, again driven by La Niña, was overcompensated by the large-scale primarily cyclonal conditions in the upper air flow, which counteracted the formation and development of tropical cyclones.

In the current AMO warm phase, 2007 is the fourth year after 1997, 2002, and 2006 to display average or below-average activity compared with the years 1950–2000. This is contrary to all expectations. In May 2007, Klotzbach and Gray (2007¹) had forecast nine hurricanes, five of which would be major ones. But the effects of La Niña were overcompensated above all by the cool water temperatures and the upper air flow conditions. The remarkable feature of the 2007 season was its exceptional length, since it began in May and did not end until December (as in 2005).

The 2007 season makes one thing very clear: hurricane activity is always determined by a combination of factors, and these vary from year to year. As far as the long-term average is concerned, for example, sea surface temperature is the most important parameter, but this is far from being always the case when the focus is on individual seasons. On account of the persisting warm phase, tropical sea surface temperatures must be expected to remain above average for some years to come.

¹ Klotzbach and Gray, 2007: Summary of Atlantic Tropical Cyclone Activity and Verification of the Author's Seasonal and Monthly Forecasts. <http://typhoon.atmos.colostate.edu/forecasts/>

² Evan, 2008: http://cimss.ssec.wisc.edu/clavr/amato/dust_record/2008_forecast.htm.





Catastrophe portraits

Europe was hit particularly hard by natural catastrophes in 2007. The claims the insurance industry had to pay just for Kyrill in January and the UK floods in the summer came to roughly €9bn. The largest overall losses, however, were caused by an earthquake in Japan.

On its way through Europe, Kyrill caused severe damage to buildings and infrastructure and devastation in forests. The forestry industry had to cope with more than 50 million cubic metres of windthrow.

January: Winter Storm Kyrill in Europe

As a result of climate change, the 21st century will bring a distinct increase in annual loss ratios due to winter storms in many countries of Europe. This is borne out by scientific studies. Kyrill cannot be classified as an isolated or exceptional case.

Meteorological trend and characteristics

Winter Storm Kyrill was the climax of the 2006/2007 winter storm season. It developed from a low-pressure system that formed over the central North Atlantic on 17 January 2007. With maximum gusts of 135 km/h, it swept over England and the North Sea before heading for southern Denmark. On 18 January, peak gusts exceeding 100 km/h were registered in the Netherlands, Belgium, Luxembourg, and Germany. Many regions were hit by hurricane-force gusts of over 120 km/h, the strongest of which was recorded on Mount Wendelstein in Germany (202 km/h). Thunderstorms, some of them violent, formed in the cold-front area and were accompanied by hailstorms. Damage was also caused by tornadoes in eastern Germany.

Owing to the storm's high forward speed, it did not lose intensity until it had travelled an unusually long way eastwards. On the night of 18/19 January, it reached wind speeds of 140 km/h in Poland, the Czech Republic, and Austria, showing that these regions, too, are exposed to winter storms.

Kyrill and historical major windstorm events in Europe – A comparison

If we look at the wind fields of historical storms, we find that Kyrill is difficult to compare with other storms. In terms of the wind speeds and the regions affected, Kyrill most closely resembles Winter Storm Daria (1990), which cost the insurance industry €4.4bn (original values), a good half of this in the UK. The largest share of the €4.5bn insured loss from Kyrill, on the other hand, was in Germany (€2.4bn).

Lothar (1999) had a completely different geographical focus (France, especially Paris, Switzerland, southwestern Germany). Costing €5.9bn in real terms, it was the most expensive winter storm loss in Europe ever for the insurance industry. Taking Germany in isolation, Kyrill could also be compared with Jeanett (2002: insured loss of €1.2bn in Germany, €1.7bn in Europe). But Kyrill had much higher wind speeds in Germany, central England, Poland, the Czech Republic, and Austria.

Underwriting aspects

According to the latest IPCC Assessment Report on the effects of climate change in Europe (IPCC, 2007), winter storm activity – expressed in the generally positive winter index value of the North Atlantic Oscillation – will remain constant on average in the coming decades and will even increase in the long term. The expectation that winter storm activity will be increased by climate change is substantiated by a number of global climate models, including those devised by the Max Planck Institute for Meteorology in Germany and the Hadley Centre in England. According to these models, it is mainly the intensity that will increase and not the number of storms.

According to analyses using ensemble runs of the latest global climate model developed by the Max Planck Institute in Hamburg, the average annual loss ratios from winter storm events in the individual countries will have increased as follows by the end of the 21st century: Germany 40%, UK 43%, France 11%, Norway and Sweden 7%.¹ These results do not take into account any structural alterations made in adapting to the change in the wind climate. According to a Swiss study, the increase will be even more extreme: 100% in Germany and Denmark and 95% in Sweden.²

Conclusion

In the light of these analyses, we do not class Kyrill as an isolated or exceptional case. Although it generated what was by far the largest insured loss ever caused by a winter storm event in Germany, we will have to be prepared for further events costing as much and even more. We expect winter storm activity to increase – particularly in the long term – as a result of climate change.

Kyrill had one further outstanding feature: it was the strongest winter storm ever to hit eastern Europe as well – above all Poland and the Czech Republic – and thus provided striking evidence of the windstorm exposure in this region.

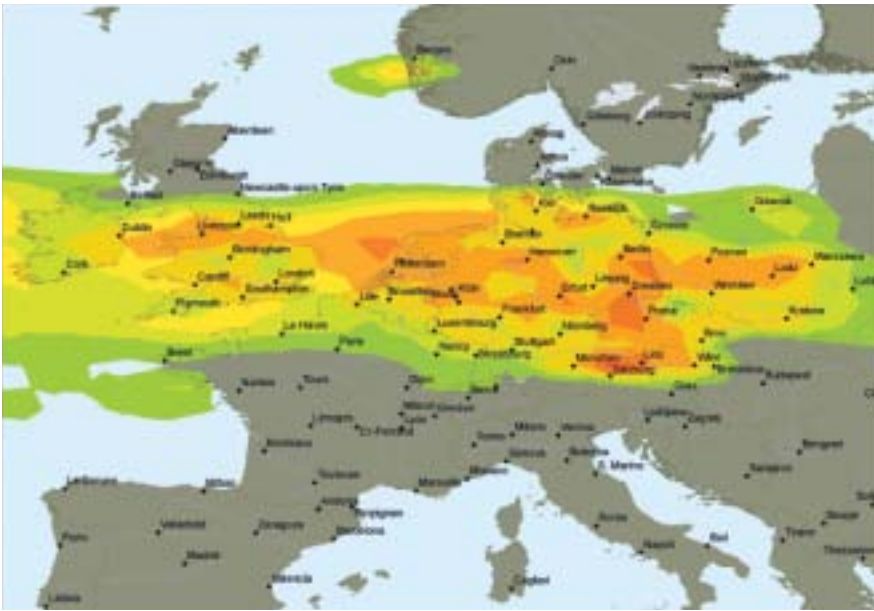
What does this development mean for the insurance industry? It will no longer be sufficient just to consider the experience of the past. Equal attention must be given to factoring in changes in exposure due to climate change. Prospective underwriting, which considers long-term changes in exposure, will consequently gain in significance. And the importance of insurance protection as a whole will become clear, coupled with necessary and judicious deductibles and loss prevention concepts.

¹ Pinto, J. G. et al. (2007), Changing European storm loss potentials under modified climate conditions according to ensemble simulations of the ECHAM5/MPI-OM1 GCM, *Nat. Hazards Earth Syst.* 7, p. 165–175.

² Schwierz, C., et al. (2007), Modeling European winter wind storm losses in current and future climate, submitted to *Climatic Change*.

Loss figures

Countries mainly affected	Overall loss		Insured loss		Fatalities
	€m	US\$ m	€m	US\$ m	
Belarus	10	13	n/a	n/a	0
Belgium	350	450	215	280	2
Germany	4,200	5,500	2,400	3,120	13
France	200	250	100	130	3
United Kingdom	900	1,200	515	670	14
The Netherlands	430	550	330	425	6
Austria	300	400	200	260	0
Czech Republic	115	150	30	35	4
Europe as a whole	7,800	10,000	4,500	5,800	49



Kyrill's wind field

Kyrill's wind field shows that wind speeds of over 100 km/h were recorded in large parts of the UK, the Benelux countries, Germany, Poland, the Czech Republic, and Austria.

Gusts in km/h

80-90
90-100
100-110
110-120
120-130
120-140
> 140

Source: Munich Re



Kyrill caused severe damage to the power network throughout Europe, leaving millions of households with electricity for some of the time. This downed electricity pylon was seen near Magdeburg in Germany.



Gale-force gusts and heavy rain damaged buildings, vehicles, aircraft, and ships in the UK. Road, rail, air, and shipping services came to a standstill in large parts of the country. This is a picture of the Thames in London, stirred up by the storm.

April: Nor'easter in the United States

A strong winter storm hit the Atlantic coast of North America and parts of the southern US Gulf states in April 2007 with a mixture of thunderstorms, snowfall, and excessive rain. The insured market loss, including losses under the National Flood Insurance Program (NFIP), amounted to US\$ 1.5bn. Although this is minor compared with hurricane losses of the past, the loss potential inherent in such storms is enormous due to their vast territorial extent.

Origin and development

The storm started in the southwestern United States as an upper-level disturbance in the jet stream, triggering several tornadoes and bringing strong winds and hail to Northern Texas on 13 April. The next day, after rapidly growing in intensity due to the powerful jet stream, the storm moved through the southeastern states, bringing heavy rainfall and increased thunderstorm activity with straight-line winds, hail, and tornadoes to the states of Louisiana, Missis-

sippi, and Georgia. The system's track then shifted northeast, moving across North and South Carolina towards the Atlantic Ocean, where it rapidly intensified into a major Nor'easter, reaching at the peak of its development a central pressure of approximately 960 hPa, equivalent to a moderate Category 3 hurricane. After raging near New York City on the morning of 16 April, it then moved out to sea, where it eventually weakened over the next few days. The result was a combination of high wind speeds, heavy snow, intense rainfall, and consequential inland and coastal flooding in the northeastern United States and eastern Canada. This was the first major winter storm to occur since the 1991 Halloween Nor'easter, popularly known as the "Perfect Storm", and another major Nor'easter in 1992, which resulted in an insured market loss of about US\$ 1bn (in original values).

Loss figures

Insured losses in the United States, not including NFIP

Region/State	Insured loss (US\$ m)	Percentage of insured loss
Northeast	661	49%
Connecticut	56	4%
Massachusetts	36	3%
Maine	67	5%
New Hampshire	55	4%
New Jersey	160	12%
New York	180	13%
Pennsylvania	42	3%
Rhode Island	23	2%
Vermont	42	3%
Mid-Atlantic states	259	19%
District of Columbia	12	1%
Delaware	14	1%
Georgia	20	1%
Maryland	30	2%
North Carolina	90	7%
South Carolina	30	2%
Virginia	63	5%
Gulf states	430	32%
Louisiana	20	1%
Mississippi	10	1%
Texas	400	30%
Total	1,350	100%

Source: PCS

In April 2007, a winter storm with snow, wind, and rain brought chaos to the Atlantic coast from the United States to Canada and in parts of the US Gulf states. Flights were cancelled, rail traffic came to a partial standstill, and highways were closed. Insurers received more than 300,000 claims. This house was torn from its anchoring in Ferry Beach, Maine.



Losses

The worst cases of flooding were in the states of New Jersey and New York, including the New York City metropolitan area. In Central Park, 192 mm of rain fell within 24 hours on 15 April, the second heaviest rainfall since records began in 1869. Airports had to cancel over 500 flights, and train services were disrupted by delays and cancellations due to flooded railway lines. In New Jersey, most major highways were closed on 15 and 16 April, when most of the major rivers, such as the Raritan and Millstone rivers, exceeded their flood stages with record levels.

Locations at higher elevations from upstate New York to eastern Canada were crippled by heavy snowfall. With power lines downed, Ottawa and Montreal and surrounding areas were hit by black-outs, affecting more than 175,000 Canadian homes. Further south, over a quarter of a million US homes, mainly in New York and Pennsylvania, were without electricity as a consequence of strong winds.

The areas most severely affected by gale-force winds and associated storm surges were the coastal regions of the New England states, especially Maine and Massachusetts, but surges were also reported in sections of Virginia and New Jersey. Although spring tide conditions were prevalent in the New York City area on 16 April, there was no serious flooding because the storm surge reached its peak at about 2 m during low tide.

Of the total insured loss from the storm event in the United States, 49% or US\$ 661m came from the northeastern states, led by New York and New Jersey. Additional loss contributions costing US\$ 259m (19% of total insured losses) came from adjoining coastal states southward from Delaware to Georgia, whilst US\$ 430m (corresponding to 32% of total insured losses) came from the states of Texas, Mississippi, and Louisiana.

Conclusion

The 2007 Nor'easter demonstrated that a weather system does not have to be a hurricane to cause widespread damage over vast areas in just a few days. In this case, after all, a large number of states in the United States and provinces in Canada were affected.

Although the storm cost less than Hurricane Floyd, which, in 1999, generated an insured market loss of about US\$ 2.4bn (original values), a Nor'easter of this type could have produced far greater losses under different circumstances, such as in winter time with more frozen precipitation, or in the middle of the working week, when it would have caused more business interruption, or if the peak storm surge in New York City had coincided with high tide rather than low tide.

Though such storms are usually regarded as a single natural event, the ensuing insured losses commonly result from a combination of perils, such as wind, hail, snow load, and inland and coastal flooding, which presents both risk modellers and loss adjusters with a very complex task.

Given the multifaceted disaster potential of such super-regional events, underwriting staff should give due consideration not only to adequate pricing but also to accumulation control.

June: Cyclone Gonu in Oman

Cyclone Gonu was the most intense storm ever recorded in the Arabian Sea and the heaviest tropical cyclone with a track leading into the Gulf of Oman, where it caused severe devastation on 5 and 6 June 2007.

Scientific aspects

Gonu formed on 1 June from an area of persistent convection (rising air movement) in the eastern Arabian Sea. Favourable meteorological conditions allowed it to intensify to 260 km/h after 48 hours, a wind speed equivalent to the highest category on the five-stage Saffir-Simpson Scale, which had never been recorded in this region before. Shortly before reaching the Gulf of Oman, Gonu weakened to a Cat. 2 storm owing to interaction with the land surface. Although the eye of the cyclone never made landfall on its way through the Gulf of Oman, the coastal area was hit by high wind speeds and heavy rain with a depth of more than 200 mm. In the mountain range behind the coastline, dams that were not designed for such volumes of water were breached and flooded large parts of the coastal zone, particularly Muscat, the capital of Oman. The highest wind speeds were recorded in Ras al Hadd, northeast Oman: 170 km/h, compared with a maximum of 100 km/h in Muscat.

Loss and damage and their effect on the insurance market

The worst losses to the economy as a whole involved the destruction of roads and flood prevention facilities on the northeast coast of Oman and in Muscat; these were not insured, however. The majority of insured losses were in Muscat. A car depot, for example, with more than a thousand cars was completely destroyed by floods and mudslides. Once the water had evaporated, the vehicles were stranded in a sea of sand. The extent of loss took the local insurance market completely by surprise. Measures designed to limit the risk are imperative, the first step being a study to assess the flood risk. Concrete underwriting measures are also to be implemented, including adequate deductibles primarily for windstorm and flood, combined with limits of liability based on location, type of risk, and flood hazard. The best starting point would be to have the object to be insured undergo an assessment by internal and external engineers. The situation can also be improved by clear guidelines for underwriters in concert with a structured underwriting process.

Implications for adjacent regions

Exposure in the United Arab Emirates with the focus on Dubai is particularly significant due to the high concentration of liabilities there. A cyclone with a track reaching the Dubai area is less probable than was the case with Gonu. Also, it would have to cross the northern part of the UAE, which has the effect of reducing the intensity of tropical cyclones considerably, so that wind exposure is not very significant. On the other hand, Dubai could be affected by heavy rain, but since there are no mountains in the region, there is no danger of orographic lifting as on the north coast of Oman.

Loss figures

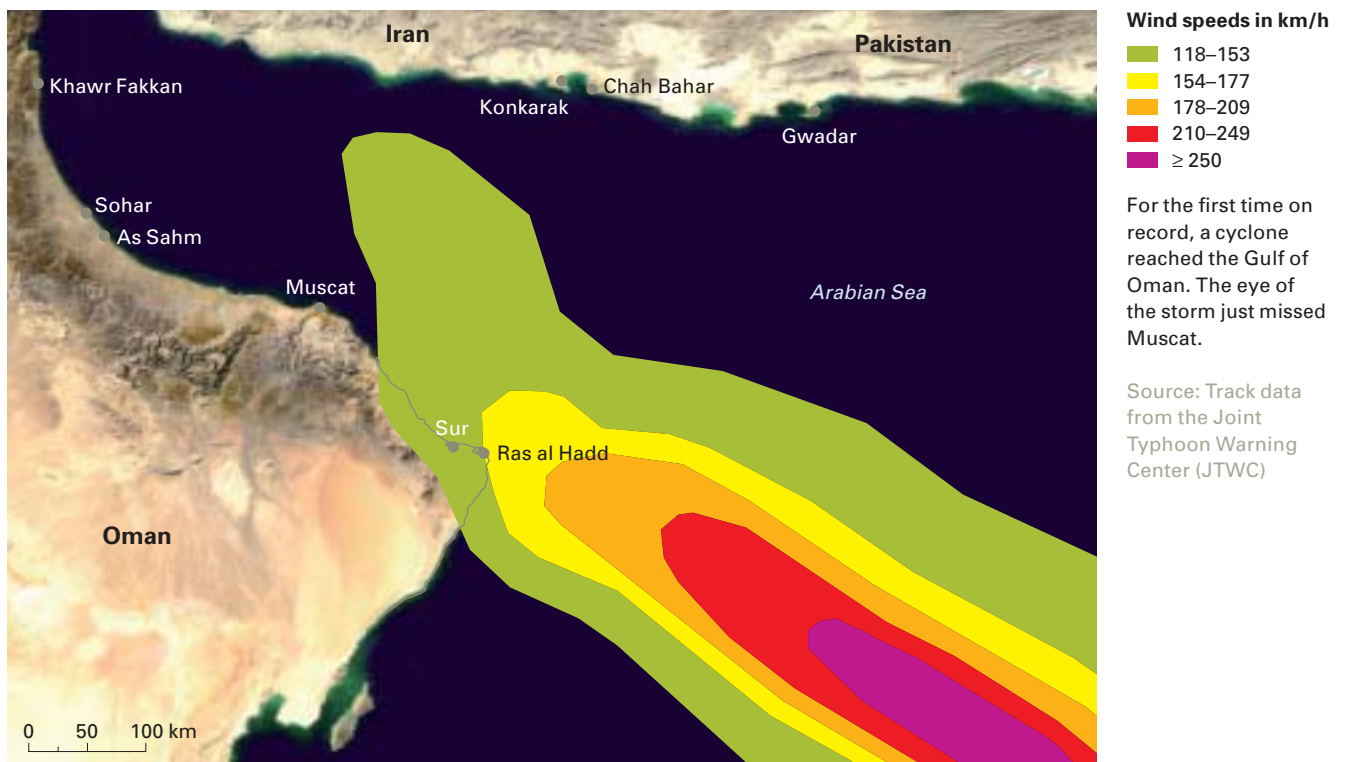
Fatalities	70
Overall losses (US\$ m)	3,900
Insured losses (US\$ m)	650

Nevertheless, there have been many intense storm events in the Emirates and the Arabian Peninsula. These usually form in conjunction with low-pressure systems approaching from the northwest and cause intense rain, sometimes accompanied by storm gusts and hailstorms. In 1989, for example, wind speeds of 170 km/h were recorded in Qatar. The highest value ever recorded in Dubai was 124 km/h – in May 1981 during a severe storm with hailfall. The maximum 24-hour rainfall in Dubai was 171 mm, recorded on 18 February 1988. The values quoted here are similar to those recorded during Gonu and clearly demonstrate how severely the region is exposed to meteorological/hydrological extreme events.



With wind speeds of 170 km/h and heavy rain, Cyclone Gonu caused large insured losses. These two pictures show a car depot that was devastated by a mudflow. The majority of the vehicles were a total loss.

Cyclone Gonu's wind field



June: Severe weather events in Australia

In June 2007, Australia’s eastern seaboard was hit by a series of five storms, meteorologically referred to as East Coast Lows (ECLs). They caused heavy rain, strong winds, and high waves. In terms of their intensity, they were comparable with the storm that hit the same region in 1974. Large parts of the coastal region in New South Wales were declared a disaster area on 8 and 9 June 2007. This weather event is one of the four costliest insured losses in Australia’s history.

Meteorological background and characteristics of East Coast Lows

ECLs are very intense low-pressure systems which can occur throughout the year but are more common during the southern hemisphere autumn and winter months, with maximum frequency in June. They intensify rapidly, representing a major loss potential for Australia. Typical features include gale-force winds along the coast, heavy rainfall leading to flash floods or river flooding, and very rough seas and heavy swells in both coastal and ocean waters. While maximum wind speeds are lower than in severe tropical cyclones, a gust of 165 km/h associated with an ECL was recorded at the Newcastle station in 1974. A series of five ECLs as in 2007 is rare but not unprecedented (e.g. June 1967, June 1950).

There appears to be a correlation between the occurrence of ECLs and changes in the sea surface temperatures in the Pacific Ocean. There is a tendency for ECLs to occur particularly when an El Niño phase is followed by a La Niña phase, which was the case in 2007.

In terms of rainfall and associated weather conditions, the 2007 lows were very different:

- 8–9 June: The time of the most destructive storm, resulting in widespread damage in the Hunter and Newcastle areas and all along the coast up to Sydney from sustained heavy rain, strong winds, and large waves.
- 15–16 June: A smaller and weaker storm, which saw the Illawarra district record the highest rainfall totals. Up to 30 cm of snow fell between Canberra and Braidwood, resulting in roads being closed.
- 19–20 June: The most intense storm in terms of minimum central pressure, which saw rain fall in areas already soaked, enough to give rise to a second set of flood waves along the Hunter River and the streams that feed into it.
- 26–27 June: A complex low-pressure system which moved along the east coast from the north to the south, bringing flooding to the East Gippsland area of Victoria.
- 28–29 June: A storm similar to the previous one in that it brought further rainfall and flooding to East Gippsland, where rainfall totals greater than 300 mm were recorded over four days. There was major flooding on several rivers with some flood peaks the highest on record.

Loss figures

Period	June 2007	
Region	Newcastle, Hunter Valley, and Central Coast	
Cause	Five East Coast Lows, with windstorm, heavy rain, floods, high waves	
Fatalities	9	
Estimated number of claims	90,000	
Overall losses	1,270m US\$	1,500m A\$
Insured losses	680m US\$	800m A\$

The Queen's Birthday Weekend Storm on 8–9 June

The Queen's Birthday weekend storm was the first of a series of ECL weather systems to affect the eastern seaboard from Newcastle to Sydney.

A low-pressure system north of Newcastle had become so intense on Thursday evening (7 June) that gale-force southeasterly winds drove the Pasha Bulker carrier aground at Nobby's Beach near the city centre of Newcastle the following morning (8 June). Afternoon thunderstorms over Newcastle and northern parts of Lake Macquarie caused flash flooding. They also affected areas along the coast and the Hunter Valley, rapidly putting many of Newcastle's suburbs under water and stranding thousands of motorists on their way home for the long weekend.

Peak wind speeds of 135 km/h at Norah Head and 124 km/h at Newcastle were measured in the early hours of Saturday morning (9 June), whilst a second small-scale low crossed the coast over Newcastle. This second low weakened slightly as it moved inland, but a line of heavy showers and thunderstorms moved to the south, bringing torrential rain along the whole of the coastal region before losing strength over the northern suburbs of Sydney during Saturday morning.

The Hunter and Newcastle areas were severely affected, with rainfall depths of 250–300 mm being recorded on Friday, 8 June. The extent and depth of flash flooding that swept across the City of Newcastle during the early evening hours were unprecedented and, for many in the community, unexpected. The resulting flood in Hunter Valley led to the worst flooding in the cities of Singleton and Maitland since 1971. As a precaution, some 4,000 people were evacuated in Maitland in case the levees were overtopped or failed.

By Monday afternoon (11 June), the state emergency service had logged around 20,000 calls for assistance, triggering the second largest response operation in the history of Australia after the 1999 Sydney hailstorm. A natural disaster was declared in 19 local government areas.

Local infrastructure was severely affected, with interruptions to power, water, and gas supplies, sewerage system failures, and rail line damage. Many roads were made impassable by flood water, fallen trees, downed power lines, and abandoned cars.

Subsequent analyses indicated that flash flooding had been exacerbated by storm water channels being blocked by numerous abandoned vehicles and by a shipping container wedged into a storm water channel entrance to the harbour in the Newcastle Central Business District.

The first of the five events caused the highest losses, with an insured market loss estimated at US\$ 680m, representing over half of the overall amount. Had the storm event occurred either a week earlier or a week later, it would have coincided with the spring tide and would have resulted in significantly larger losses.

Impact on the insurance industry

Flood insurance in general, has not been offered for residential buildings in Australia to date, although storm water runoff and (in some cases flash flooding) is covered.

As far as the storm on 8 and 9 June was concerned, the main issue for insurance companies and their assessors was initially whether the damage had been caused by storm gusts, heavy rain with resulting flash flooding, and/or flooding caused by rivers and creeks. Depending on the policy wording, the majority of claims were settled as either storm, storm water runoff, or flash flooding damage. However, there were some claims which were not paid because they fell under the flood exclusion.

Due to the recurring problem of floods in Australia, insurance companies, together with the Insurance Council of Australia, have developed a voluntary definition for inland (riverine) flooding consistent with current wordings used within the market for residential policies. The challenge for insurance companies is to provide affordable coverage for consumers while ensuring adequate returns.

June and July: Floods in the UK

Meteorological causes and background

The months of May, June, and July 2007 in England and Wales were the wettest for over 200 years. Between the beginning of June and the end of August, total rainfall was more than 360 mm (see map on page 27), with central and northeast England receiving almost twice the average amount in this period. The month of May had already seen exceptionally large amounts of rain, with swollen rivers and brooks and increased surface runoff due to the ground being waterlogged.

These weather anomalies were mainly due to the position of the jet stream, a band of strong winds at a height of 11 km which plays an important part in the formation of low-pressure systems and their tracks across Europe. While the jet stream's position is far to the north in normal summers, it was much further south for most of 2007 and was also stronger than usual. This resulted in frequent low-pressure systems over the UK, carrying large amounts of moisture and thus an abundance of rain.

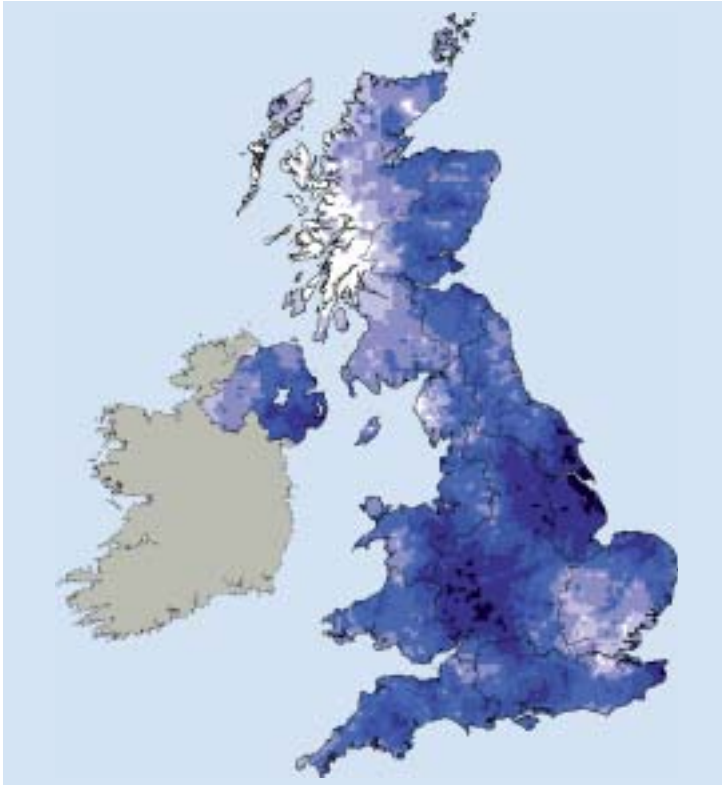
June floods

Between 15 and 21 June, heavy rain and thunderstorms brought local flooding to Yorkshire and central England, but there was no major damage. However, the volume of rain prepared the ground for ensuing events. On 25 June, a stationary low-pressure system drew moist air masses to the UK from the North Sea, with intense rain over long periods from the northeast of England to Wales. Many areas recorded as much rain in 24 hours as in an average month (June). The regions affected were Humberside, Yorkshire, Lincolnshire, and central England, with damage occurring particularly in Hull, Sheffield, Barnsley, and Doncaster. Since the ground was so saturated that it could not absorb any more rain, the water ran off on the surface and collected in lower-lying areas, and although such rivers as the Don (Sheffield) and Idle (Doncaster) burst their banks, the Environment Agency said that five times as many homes and businesses were inundated by surface runoff (flash floods) and standing water as by overflowing rivers. The municipal drainage system in Hull was overwhelmed by the volume of water: 17,000 homes were damaged by the resulting flood waters.

Loss figures

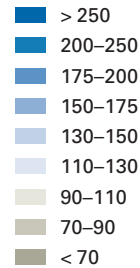
The costliest floods in the UK (losses in original values)

Period	Areas affected	Overall losses (US\$ m)	Insured losses (US\$ m)
June 2007	England: Yorkshire, Hull, Humberside, Sheffield, Worcestershire, Rotherham, Wakefield, East Riding, Doncaster, Lincolnshire	4,000	3,000
July 2007	England: Worcestershire, Oxfordshire, Gloucestershire. Wales	4,000	3,000
Oct–Nov 2000	England: Kent, Tonbridge, Yalding, Maidstone, East Sussex, Lewes, Uckfield, Plumton, Surrey, Selsey, Kent, Dover, London. Wales. Ireland	1,500	1,100
9–13.4.1998	England: Midlands, East Anglia, Northamptonshire, Warwickshire, Oxfordshire, Worcestershire, Cambridgeshire. Wales: Skenfrith	400	250
July–Sept 1985	Scotland	250	175
1–6.1.2003	England: Berkshire, Oxfordshire, Essex, Bewdley, Worcester, Gloucester. Wales	150	100
26.12.1993–10.1.1994	England: Cornwall, Norfolk, Suffolk, Essex, Sussex, Kent, Hampshire. Wales	120	75
10–13.12.1994	Scotland: Strathclyde, Glasgow	155	47



The graph shows the precipitation depths from June to August 2007 compared with the long-term mean (1971–2000). The two centres are clearly visible in the southwest and northeast of England with above-average rainfall – and these were also the areas with most losses.

Percentage deviation from the 1971–2000 mean.



Source: <http://www.metoffice.gov.uk/corporate/pressoffice/2007/pr20070831.html>

July floods

A similar weather constellation followed just three weeks later. Again an almost static depression poured large volumes of rain over the British Isles, this time especially in western, central, and southern England and Wales. The Avon, the Severn, and the Thames, and their tributaries, which were already swollen with the water from the last rain period, burst their banks, resulting in flood control structures being overtopped in some places. Residential areas in Gloucestershire, Oxfordshire, Berkshire, and parts of central England were hit particularly hard. Some areas in Lincolnshire were flooded for the second time in a month. The town of Tewkesbury (Gloucestershire), situated at the confluence of the Avon and Severn, was completely cut off from the outside world. 350,000 homes had to go without

fresh water for more than 10 days when the Mythe water treatment plant was flooded. Gloucester narrowly escaped disaster when the Severn flood wave peaked just a few centimetres below the main wall protecting the city. Although parts of Oxfordshire had been inundated by the Thames and its tributaries, the flood wave had fallen by the time it reached Reading and London so that no major losses were recorded there.

Losses

The flood events in June and July both caused insured losses totalling US\$ 3bn, thus exceeding – together and as separate events – the previous largest insured flood loss for a single year (2000: US\$ 1.4bn at today's values).

Impact on the insurance industry

The main reason for the enormity of the insured loss is the high market penetration of flood insurance in the UK, where flood is included in the standard cover of most residential and commercial policies. In its Statement of Principles on the Provision of Flood Insurance, the Association of British Insurers underlines its willingness to offer flood cover as far as possible, but also calls on the state to provide efficient risk management. However, the 2007 floods showed that many safeguards (like dykes) and drainage systems are not designed to cope with rain events of these dimensions. The debate on adequate financing for the construction and upgrading of flood control structures was rekindled – especially because at the same time it was revealed that the government had plans for three million new homes to be built between now and 2020, many of them in areas known to be flood-prone.

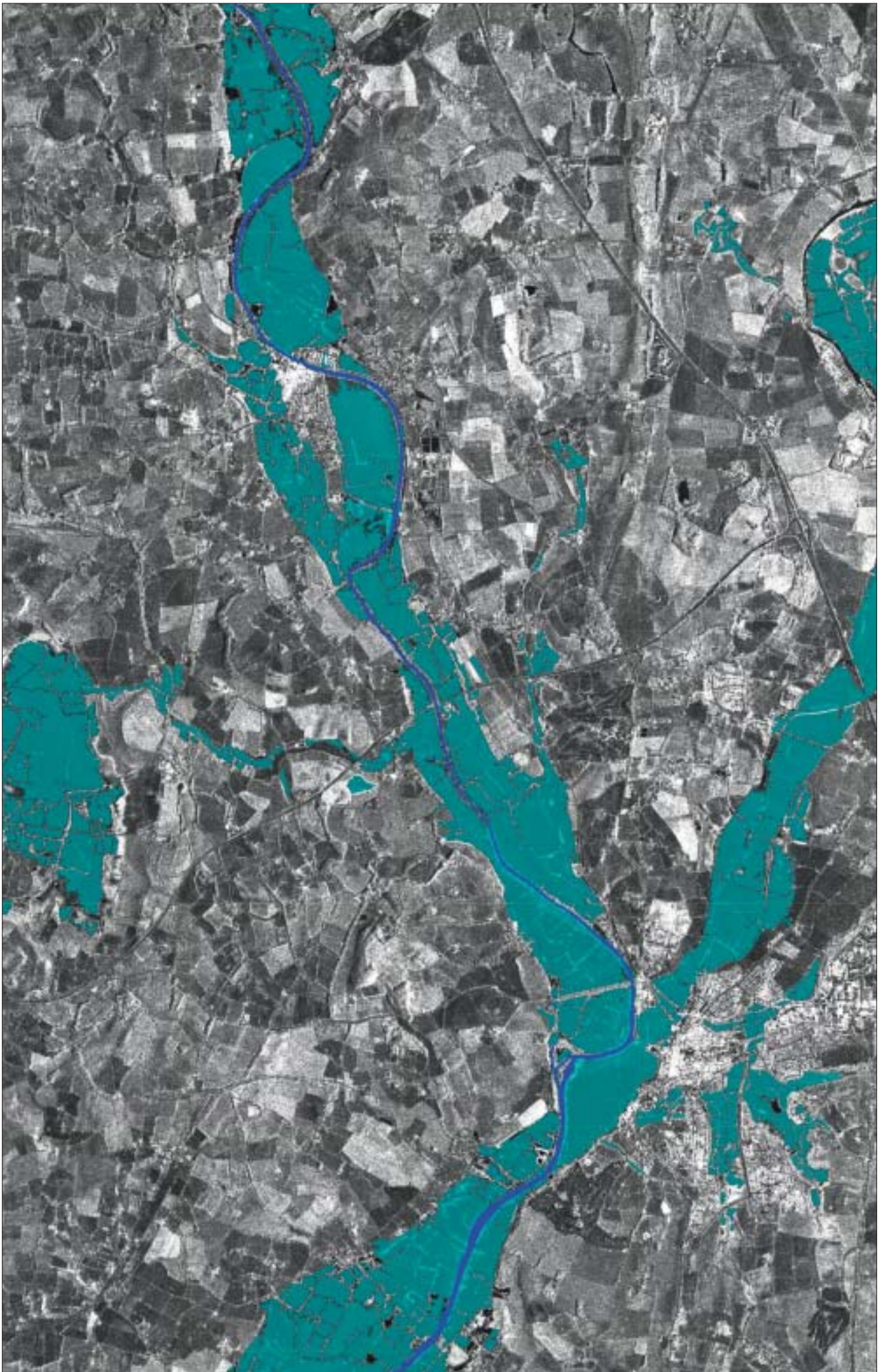
The losses were mainly carried by primary insurance companies as only a relatively small proportion was covered by reinsurance. For one thing, the hours clauses laid down in the wordings clearly defined the floods as two separate events, so that the majority of primary insurers had to carry their retention twice. Another factor is that the retentions in UK cat programmes have been rising continuously in recent years, with the result that reinsurance only attaches following really major catastrophes and losses with extended return periods. It remains to be seen whether this development will continue in the future or whether there will be growing interest in covers for small loss events with a high occurrence probability or covers like annual aggregate or stop-loss covers.

Prospects

Last summer's floods raise the question of whether climate change is already perceptible and what developments are to be expected in the future. The latest IPCC report predicts that Britain will become warmer, with more winter precipitation and hence a higher flood risk. Summer rain levels will decrease, but rainfall could be more intense than today since a warmer atmosphere can absorb more moisture and can thus carry more potential precipitation. The distribution of summer precipitation is still unknown, however. The summer of 2006 was one of the driest on record, 2007 the wettest. Although individual events or years are not to be seen as an indication of long-term developments, series of extremes in close succession are likely to be more common in the future. The fact that insured losses are increasing is largely due, however, to an increase in values, particularly in flood-prone areas. This will continue to have a profound impact on flood losses for the insurance industry.

This map shows the extent of the floods at the confluence of the Avon and Severn on 26 July 2007. The flooded areas are marked light-blue, the normal extent of the rivers dark-blue. The severely affected town of Tewkesbury is in the southeast. The map is a composite image using radar data (Envisat) and optical satellite images (Landsat 7 ETM+).

Source: http://www.zki.dlr.de/applications/2007/england2/138_en.htmlAt dolore



July: Earthquake in Japan

On 16 July 2007, Niigata Prefecture was hit by a moderate earthquake. This was the third earthquake to strike in a short time, although the exposure in this region is not particularly high. It damaged the world's largest nuclear power plant and brought production in Japan's automobile industry to a temporary halt, thus revealing the economy's extreme vulnerability to natural catastrophes.

Scientific aspects and features

The Mw 6.6 earthquake was triggered 14 km below the surface at 10.13 local time. The epicentre was to the north of Kashiwazaki, a coastal city about 70 km from the city of Niigata with a population of 800,000 and 250 km from Tokyo. Although there is nothing surprising about a quake of this magnitude in Japan, the accumulation of such events in this zone in recent times is striking. In 2004, a quake 50 km further south caused overall losses of approx. US\$ 30bn, and in March 2007, it was the turn of the Noto peninsula 140 km to the west. The question is whether the area is going through a phase of elevated activity and whether further quakes will follow in the years to come. There is no scientific evidence of this, however. The epicentre was on the northeast edge of the rupture zone running parallel to the coastline north of Kashiwazaki, with maximum ground accelerations of more than 0.8 g (g = acceleration of gravity) in some places. Whilst there was strong ground motion in the coastal region along the rupture zone and its extension to the southeast down to Joetsu, the effect of this ground motion diminished quickly in a northeast direction towards Niigata.

Losses

Losses were largely concentrated in the cities of Kashiwazaki, Nagaoka, and Joetsu. Roads, railway lines, and harbour facilities were damaged all along the coastal strip. The world's largest nuclear power station was in the direct vicinity of the epicentre and was also damaged. One of the transformers caught fire. Small quantities of radioactive substances were also released. At the time of the quake, four of the plant's seven units were in operation. The recorded ground motion exceeded the values assumed in the building regulations by a factor of three. The fact that there was no major structural damage to the facility is doubtless due to the safety margins required in plants of such significance. Owing to the repair work, the lengthy inspections, and the essential earthquake-resistant structural improvements, the facility has not gone back into operation yet (March 2008); this has resulted in billion-dollar business interruption losses, which are not insured. There is no information on when the plant will go back on grid. All in all, the question is whether Japanese nuclear power stations are adequately designed to cope with earthquakes.

Loss figures

Fatalities	11
People injured	2,000
Buildings (destroyed, badly damaged)	4,000
Buildings (slightly damaged)	30,000
Overall losses (US\$ m)	12,500
Insured losses (US\$ m)	300

An engine components manufacturer and auto industry supplier was affected, causing production to stop at all large Japanese automobile firms. Hundreds of engineers commissioned by car manufacturers got production going again within a week – thanks to the modest scale of the damage. The loss in production involved about 120,000 vehicles. The business interruption losses were either not insured or were within the companies' deductibles.

Since there are not many industrial facilities in the affected region, the insured losses were relatively small compared with the overall losses. These mainly affected residential buildings insured under state covers or cooperatives. And: the city of Niigata was just outside the area affected.

Although, as might be expected after a quake of this magnitude, there were short interruptions in the gas, electricity, and water supplies, and the infrastructure was damaged, in some instances extensively, the Japanese authorities had the situation under control very quickly. Japan's crisis management system seems to work well – at least when the repercussions of natural catastrophes are moderate. The experience gained with the recent quakes in the region was certainly beneficial.

Conclusion

In spite of insured losses being comparatively small, these two examples turn the spotlight on the enormous loss potential of major industrial facilities. Even moderate damage can stop production and cause billion-dollar losses at sensitive facilities like nuclear power plants. A further risk is to be seen in the fact that entire fields of industry are reliant on individual suppliers and that many manufacturers no longer keep stocks in warehouses. If the supply chain is interrupted, production has to be stopped after only a couple of days. Complete destruction of the supplier's factory would have had drastic implications for the Japanese auto industry. Complex losses caused by the interaction of different factors are a real challenge to the automobile and other industries. Assessing these risks is difficult and fraught with uncertainties. Although business interruption losses are usually excluded or subject to strict limits in new policies, comprehensive accumulation control is of crucial significance for policies that are already in force.

Niigata Earthquake: Position of the epicentre



The losses were mainly along the coastal strip in which the Kashiwazaki nuclear power station is located. To the north of the epicentre, in the direction of Niigata, there was hardly any damage.

October: Wildland fires in California

In late October 2007, southern California experienced a series of severe wildland fires. The first fire started on 20 October, followed by almost two dozen more over the next two days.

A combination of dry vegetation and strong winds fuelled the fires, creating ideal conditions for them to spread. The firefighters were not able to contain them until the weather conditions changed. By the time the last fire was extinguished on 9 November, the conflagrations had scorched over 2,000 km² of wildland and destroyed over 2,000 buildings.

Scientific aspects and features

Large wildland fires in southern California require two meteorological ingredients: dry atmospheric conditions and high winds. The months leading up to the 2007 fires had been unusually dry, with some locations in southern California experiencing the most severe drought on record, making local vegetation extremely flammable. The second ingredient, high winds, would come in late October, when high pressure over the western United States triggers what is known as the Santa Ana winds. These dry, westerly winds from the desert warm up as they descend from the high altitudes inland to the coast. They also increase in velocity as they are funnelled through mountain passes and canyons, resulting in hot, dry winds with peak speeds in excess of 140 km/h.

Losses

A total of 23 fires occurred across seven counties, of which San Diego County was the most severely impacted. The Witch or Witch Creek fire in San Diego County was the largest fire to occur, both in terms of size and damage to property. It was started by downed power lines on October 21, burning more than 800 km² of land and destroying more than 1,100 mostly very expensive homes, resulting in an estimated insured loss of US\$ 1.3bn, averaging US\$ 1m per home and contents. Elsewhere in San Diego County, the Harris, Rice, and Poomacha fires scorched an additional 604 km² of brush and forest and 597 homes. Other notable fires outside of San Diego County include the Slide and Grass Valley fires in San Bernardino County, which destroyed 446 homes, the Santiago fire in Orange County, and the Canyon fire near the city of Malibu in Los Angeles County, which ruined a number of expensive buildings.

As with all wildland fires, the majority of insured losses were due to destroyed or damaged residential buildings at or near the wildland-urban interface. Hardest hit were residential subdivisions in the towns of Ramona, Poway, Escondido, and incorporated sections of the city of San Diego in the Witch fire, the town of Fallbrook in the Rice fire, and some small, unincorporated towns southeast of San Diego in the Harris fire. As a result of concerted fire-fighting efforts, major town centres were protected from the fire, minimising the damage to commercial properties.

Loss figures

Period	21.10.–9.11.2007
Overall losses (US\$ m)	2,700
Insured losses (US\$ m)	2,300

Loss probabilities

Period of analysis	1970–2007	1990–2007
Loss expectancy value (= average annual insured loss)	236	454
Annual exceedance probability of 0.2 (return period: 5 years)	150	1,000
of 0.1 (return period: 10 years)	1,000	2,400
of 0.04 (return period: 25 years)	2,800	4,000

Annual losses in US\$ m, 2007 values.



California was the scene of hundreds of destructive wildland fires from late October to early November. The fires destroyed more than 2,000 houses and thousands of cars in seven counties. Eight people were killed, 133 were injured. The last fire was extinguished on 9 November 2007.

Due to the rapid spread and size of the fires and the difficult fire-fighting conditions in terms of inaccessible terrain and limited fire-fighting resources, many residential properties were totally destroyed. Only a very small number of buildings affected by the large fires sustained repairable damage. In the smaller fires, a greater proportion of impacted homes were salvageable. The loss pattern also varied substantially. In some neighbourhoods, entire blocks of homes burned down; in others, it was common to see a burned house next to an unscathed building. This was the result of several factors: the type of construction, the susceptibility of the buildings' exterior and landscaping to fires, the fire protection measures in place, and the fire-fighting resources and tactics.

Results

Residential communities across the United States are continuing to expand into wilderness areas, so that, with the danger of wildland fires increasing, the detrimental effects on society and property are growing. Historically speaking, the exposure is highest in coastal California, but other parts of the state are also susceptible. One recent example was the Angora fire in June 2007 near Lake Tahoe, which destroyed over 300 buildings and caused US\$ 141m in insured losses. Other states, particularly in the western and southeastern United States, are also vulnerable to wildland fires as well, though large fires occur with less frequency there.

Over the past 38 years (1970–2007), annual aggregate insured property losses in California due to wildland fires averaged approx. US\$ 236m, adjusted for inflation and population. This value has been exceeded seven times over the period – and six times since 1990 alone. The largest annual loss from wildland fires in California was recorded in 1991, with a total insured loss of US\$ 2.9bn (2007 values; original values: US\$ 1.7bn).

By applying a least-squares logarithmic curve fitting to the adjusted industry loss data, we can determine the probability of exceedance of different loss thresholds.

The extent to which such distribution functions – and hence the results of estimating loss exceedance probabilities – depend on the period chosen is shown by the table of loss probabilities on page 32.

The loss probabilities from wildland fires in California have changed noticeably in recent years. The main reason appears to be the steep increase in construction activity in the wooded areas on the periphery of major West Coast cities. A definitive evaluation, at least in quantitative terms, of the role also played by other weather patterns (volume and seasonal distribution of precipitation; El Niño and La Niña events) is not yet possible.

The decisive factor is that changing loss statistics (non-stationary loss distributions) must be considered in insurers' risk assessments. On account of this risk of change, the losses of the past 18 years (1990–2007, adjusted for inflation and population growth) are likely to give a better impression of current loss probabilities than those of the longer period since 1970. Given a changing environment, the further development of suitable methods for a commensurate evaluation of risks of change will be absolutely essential for a stable risk partnership between policyholders, insurers, and reinsurers.

Loss minimisation measures

Although the loss potential in areas exposed to fire is generally growing, losses can be limited by preventive measures, chief among them being the use of non-combustible materials particularly for the exterior walls and the roof covering. Keeping the property clear of highly combustible vegetation within a radius of 15 to 30 m would also greatly reduce the risk of fire. Roofs, gutters, and eaves should be kept clear of vegetative debris. These solutions can greatly reduce the societal and economic impacts from future fire events.





Climate and climate change

Climate change was the omnipresent topic of last year. As a global reinsurer we continue to steadfastly promote solutions: in the international debate, in our products, and in our own business operations.

Extremely dry weather and record temperatures in the summer of 2007 provided favourable conditions for forest and wild-land fires in the south and southeast of Europe. In August, Greece experienced its worst fires for decades, with overall losses amounting to roughly US\$ 2bn. This is a view of Mandelieu-La-Napoule in the south of France, against a wall of flames on 4 July 2007. 3,000 inhabitants were evacuated, but the fire services were able to contain the fire, and there was no major damage.

World Climate Conference in Bali smooths the way for the successor to the Kyoto Protocol

Climate change was the main focus of political and public discussion in 2007. The highlights of the climate debate were the awarding of the Nobel Peace Prize to the IPCC and Al Gore and, in December, the World Climate Conference (COP 13) held in Bali.

In 2007, an extremely mild winter followed by an unseasonably warm spring in many parts of Europe and the United States combined with an unusual profusion of political events turned the spotlight on the issue of climate change as never before. The publication of the IPCC's 4th Assessment Report in particular attracted much coverage in the media. Published at six-year intervals, the IPCC's report was presented in four stages in 2007, which had a powerful public relations impact.

Milestones

In March, the European Council came to an agreement on ambitious climate protection targets. CO₂ emissions are to be reduced by 20% in relation to 1990 levels by 2020, and by as much as 30% if other countries agree to similar targets. In the same period, energy efficiency is to be improved by 20% and renewable energy's share of primary energy production increased to at least 20%.

In June 2007, the German Advisory Council on Global Change (WBGU) published a report entitled *World in Transition – Climate Change as a Security Risk*. The conclusion it reaches is that climate change could lead to international conflicts and overtax international security systems. One of the year's highlights was the G8 summit at Heiligendamm, Germany, in June 2007, which ended with the US committing itself to negotiations on a successor to the Kyoto Protocol under the auspices of the UN. In October, the Nobel Peace Prize was awarded to the Intergovernmental Panel on Climate Change and to Al Gore, giving a clear signal of how important it is to combat the effects of global warming. Munich Re has attended all the climate summits from the very beginning and has been involved as an author or reviewer in all the IPCC's reports.

MCII in close cooperation with UNFCCC

The year ended with the UN's 13th World Climate Conference (COP 13) held in Bali in December. Munich Re was represented in side events, the most significant of which was staged by the Munich Climate Insurance Initiative (MCII), an initiative launched by Munich Re, the World Bank, non-governmental organisations, and scientific institutes (further information at www.climateinsurance.org). The aim is to develop and offer insurance solutions for increasing losses in developing countries that cannot adapt adequately to the effects of climate change and do not have a function-

ing insurance market to provide protection against these risks. The delegates attending the main conference welcomed the objectives set by the MCII, which will act in an advisory capacity during the post-Kyoto negotiations. MCII's central aim was included in the Bali Roadmap, the action plan issued at the climate summit.

- "... taking into account the urgent and immediate needs of developing countries that are particularly vulnerable to the adverse effects of climate change.
- ... risk management and risk reduction strategies, including risk sharing and transfer mechanisms such as insurance."

The Munich Re Foundation was also represented in Bali, unveiling its new project „Climate change and justice“, which it is carrying out in conjunction with the Potsdam Institute for Climate Impact Research, Misereor, and the Institute for Social and Development Studies at the Munich School of Philosophy.

The Bali results in detail

The climate conference got off to a successful start when the Kyoto Protocol was ratified by Australia, one of the two remaining non-signatories among the industrial nations. The negotiations were tough because of the obstructive stance adopted by some of the countries. But all the same, there were some notable results in the end:

- Successor to the Kyoto Protocol: The countries agreed to negotiations under the auspices of the United Nations in the next two years with the aim of signing a successor to the Kyoto Protocol in Copenhagen at the end of 2009. Countries that have not yet ratified the Kyoto Protocol or have not set any targets like the US, China, and India, will take part in these negotiations, too.
- Emissions: No agreement was reached on a generally binding reduction of greenhouse gas emissions, but the signatories to the Kyoto Protocol intend to commit themselves to a measurable and verifiable emissions reduction of 25–40% in relation to 1990 levels by 2020. Developing and emerging countries are also called on to take appropriate measures.
- Technology transfer: More financial support and investments for environmentally sound technologies in emerging and developing countries.

- Climate fund: The climate fund for the benefit of developing countries is to be topped up substantially.

- Rain forest protection: As of 2013, the poorer countries of the world are to be granted permission to trade in the CO₂-storage capacity of their forests by selling emission allowances to industrial countries. This will help prevent deforestation, since it will be more lucrative to preserve forest areas than to destroy them.

How are these resolutions to be evaluated?

Political acceptance of the general process of reducing CO₂ globally under the auspices of the UN Framework Convention has certainly increased. The Bali roadmap is a clear signal for the financial market: emissions trading on an international scale and the CDM – involving sustainable technology transfer from industrial countries to developing countries – are to be maintained and continued beyond 2012. The emissions reduction targets will be tightened. It was also decided to hold negotiations on risk management and risk reduction strategies and on risk sharing and risk transfer.

Conclusion

The Bali conference increased the chances that new legally binding reduction targets for the period beyond 2013 will be set in 2009 with the support of all the relevant emitters.

Munich Re is vigorously promoting a successor to the Kyoto Protocol with ambitious targets and is contributing its expertise in political decision-making processes. And we are setting a good example: our business operations at the Munich site will be carbon neutral by 2009, and in the International Organisation by 2012.

Living with climate change – The strategic repositioning of the Munich Re Group

Climate change is one of the greatest risks facing mankind. In recent years, the insurance industry – and Munich Re in particular – has been instrumental in ensuring that this message is received loud and clear by politicians, industry, and society as a whole. Now we are going one step further and are turning our knowledge into even more action – with the aid of an all-embracing strategic approach – in the areas of “risk management”, “product development”, and “capital market management”.

Over the past thirty years and more, we have put much effort into investigating climate change. Our high-quality data provides strong evidence that the effects of climate change are already to be seen and that adaptation measures need to be taken without delay.

Expert network: science – technologies – finance

Prompted by our responsibility as a global player to take a proactive stance towards new social questions and in response to dramatic loss trends, we are adopting resolute measures to counter the loss factors stemming from human activity. The Munich Re Group is pooling its activities on this subject through a network of experts from all its business areas affected by climate change. We quantify risks

by way of risk-adequate premiums and provide decision-makers with arguments for effective preventive action. Linking our expert network to the underwriting expertise in our operational units enables us to develop coverage concepts and to implement them in practical insurance solutions which include enterprise risks and other risks that have hitherto been considered „exotic“. Also featured are covers for new CO₂-reduction technologies and measures designed to assist adaptation to climate change.

Knowledge and innovation capacity as a driving force in new fields of business

Investments in adaptation measures designed to deal with the effects of climate change and in the reduction of greenhouse gas emissions pay off: that is a view also shared by the former chief economist of the World Bank, Sir Nicolas Stern. One of the core messages in The Stern Review, published in autumn 2006 and recognised throughout the world as a visionary work, is as follows: Climate change is the greatest market failure of all time – the only economically reasonable solution: take action immediately!



The Munich Re Group is one of the market leaders in the insurance and reinsurance of offshore wind power plants – during both construction and operation phases. The use of renewable energy is an indispensable factor in reducing CO₂ emissions.

That means:

- meeting the ambitious CO₂ targets by initiating concrete legislative procedures and specifying energy production and efficiency requirements,
- implementing new energy production technologies and new energy-saving construction methods,
- employing new mechanisms to (further) develop carbon emissions trading.

These developments present investors with completely new risks. They open up new fields of business for professional risk carriers that have extensive knowledge of new technologies and experience with the risks of change. For a successful and sustainable development of these business fields, two additional components are needed: capital strength and innovation capacity – both of which are established strengths of the Munich Re Group.

Wind and solar power are indispensable elements in reducing CO₂ emissions. Other technologies like geothermics, hydrogen technologies, and solar chimney, tidal, and wave power plants will play an important role in the future. The systems technology is still new, however, and both investors and operators need the security provided by new risk transfer solutions. This will open up extraordinary economic opportunities in a dynamic growth sector.

Two examples

- Since 2001, Munich Re has supported the construction and operation of offshore wind power plants as both insurer and reinsurer. On account of the high risks and technical challenges associated with German sites, this type of green electricity has so far only been available abroad – and Munich Re is one of the market leaders in insuring such business.
- Volcanoes, geysers, hot springs: in some places on the surface of the earth the colossal energy hidden within its depths is particularly evident. Modern technologies make it possible to exploit the climate-friendly and regenerative resource of geothermal heat. The greatest hurdle for investors has been the productivity risk – but Munich Re has developed an insurance solution for this.

Synergies between reinsurance and insurance and asset management

In the future, reinsurance will only be required to cover risks from new technologies that are very complex or involve high sums insured. In other words, following the initial phase, a substantial proportion of special insurance solutions will eventually be adapted for inclusion in extended standard products on the primary insurance market. For this reason, the primary insurance companies in our Group, such as ERGO and Midland Insurance, have access at all times to the knowledge on the subject of climate change that has been built up in our reinsurance business. As a result, Victoria has established itself as a pioneer with modern coverage concepts in the field of green electricity. Knowledge is also shared in connection with investment products: the climate strategy fund set up by Munich Re's asset management subsidiary MEAG invests in water treatment and supply, renewable energy, energy efficiency, and recycling. In addition, it takes into account companies likely to benefit from measures intended to mitigate climate change.

Munich Re declared the topic of climate change a strategic topic and follows a holistic strategic approach. Analysing the prospects of climate change in the near future and its sectoral repercussions is therefore of great significance and culminates in concrete business strategies.

Data, facts, background

The conclusions drawn in the 2007 global climate report were unequivocal: the UN's Intergovernmental Panel on Climate Change sees human activity as the most probable cause of climate change.

The IPCC's findings are contained in the following publications (www.ipcc.ch):

- Part 1: Physical Science Basis (February 2007)
- Part 2: Impacts, Adaptation and Vulnerability (March 2007)
- Part 3: Mitigation of Climate Change (May 2007)
- Synthesis Report (November 2007)

The IPCC warns: Global warming is getting faster

According to the IPCC, there is a more than a 90% probability that, since the middle of the 20th century, global warming has largely been due to the anthropogenic increase in the concentration of greenhouse gases in the atmosphere. The linear warming trend in the hundred years between 1906 and 2005 is 0.74°C, whilst the rate of warming over the last fifty years is, at 0.13°C per decade, almost twice as high. In other words, global warming is getting faster all the time.

The results of global warming include the following:

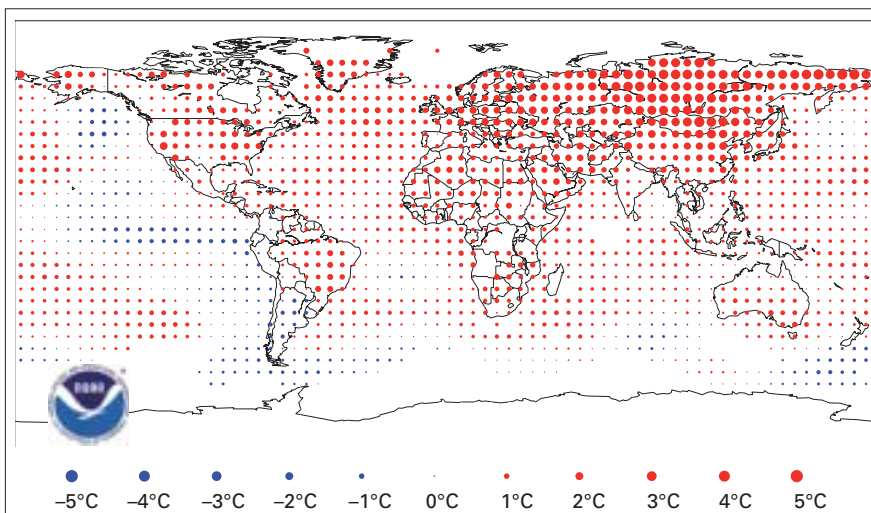
- Sea levels are rising due to thermal expansion and inland ice melt. In the 20th century, sea levels throughout the world rose by an average of 1.7 mm/year; since 1993, however, a rise of 3.1 mm/year has been recorded.
- The summer minimum sea ice cover in the Arctic has been receding by about 7.4 % per decade since the 1970s.

The trends derived from measurements of extreme atmospheric phenomena also correlate with global warming: more

- warm days/nights over land areas,
- hot spells and drought areas,
- heavy rain in many regions, and
- tropical cyclones in the North Atlantic

The IPCC expects the majority of the trends already observed to continue. Over the next twenty years, the mean global temperature will increase by about 0.2°C per decade. Even if all emissions stayed at their 2000 levels, it would still increase by about 0.1°C per decade. Many changes will only affect certain regions. Semi-arid areas like the Mediterranean region, western North America, southern Africa, and southwestern Australia will have less and less water. The large-scale Atlantic circulation which drives the Gulf Stream and is responsible for Europe's relatively mild winters is now considered unlikely to change abruptly in the course of the 21st century.

Regional deviations of mean annual temperature in 2007 from the 1961–1990 mean



This chart shows the deviations of annual mean surface temperatures in 2007 from the 1961–1990 mean according to the US National Climatic Data Center/NESDIS/NOAA. Red dots stand for positive anomalies, blue dots for negative anomalies, their size reflecting the degree of variation. The comparatively large positive temperature anomalies in Eurasia are clearly evident.

Source: <http://lwf.ncdc.noaa.gov/oa/climate/research/2007/ann/global.html>

The socioeconomic sectors must adapt to the now unavoidable change in climate; a dangerous anthropogenic interference with the climate system (UNFCCC Art. 2) must be countered by a long-term reduction in greenhouse gas emissions. IPCC model studies show that if we set ourselves a target of limiting the greenhouse gas concentration at the end of the 21st century to 550 ppm CO_{2eq}^{*}, thus keeping the rise in global temperature to a maximum of 3°C compared with pre-industrial levels, the price for emitting one tonne of carbon dioxide would, according to the IPCC, have to be US\$ 20–80 in the year 2030. This would provide a sufficient incentive for the necessary minimisation measures. To limit the value to 550 ppm CO_{2eq}, the IPCC projects costs amounting to 0.2–2.5% of global GDP in 2030.

Data and facts on the climate in 2007

The year 2007 confirms the persisting trend of anthropogenic warming.

In large parts of the northern hemisphere, the mean temperature in 2007 was 2–4°C above the mean for 1961–1990. Winter and spring in 2007 were among the warmest ever observed in Europe. Hence, 2007 was the northern hemisphere's second warmest year since the start of the time series in 1850; provisional analyses put 2007 eighth in global terms with a deviation of +0.40 °C (Climate Research Unit, University of East Anglia).

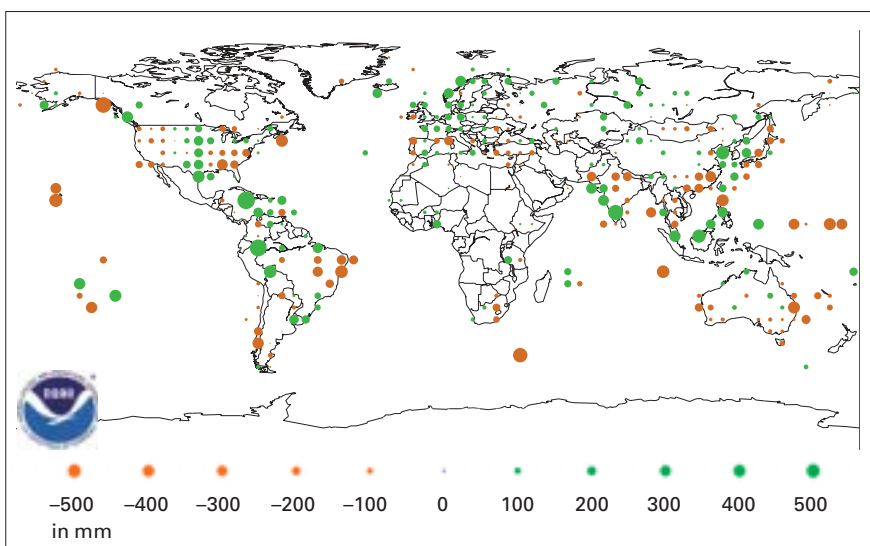
Heat extremes with dry warm spells occurred in May, June, and July in western Russia and south-east Europe. Temperatures in Bulgaria climbed to 45°C, resulting in numerous forest fires. The forest fires that raged through Greece in August were the worst in Europe for decades.

Western Australia sweltered in a heatwave from January to March. In August, central and south-eastern parts of the United States were also hit by a severe heatwave; it was the second warmest August since recording began 113 years ago. 2007 thus fits into the pattern of increasing hot weather episodes throughout the world that began some twenty years ago (cf. Topics Geo 2006, p. 43). The heat was accompanied by extreme dryness in Australia and North America, and it was extremely dry in China (Gansu, Henan) too. In the United States, this led to wildland fires similar in scale to the ones in the record-breaking year of 2006.

But opposite extremes – catastrophic heavy rainfall events – also occurred in 2007. A strong south-west monsoon caused severe damage due to local flash floods in western and central Africa and the Horn of Africa from July to September, affecting more than 1.5 million people. In Latin America, flood catastrophes hit Bolivia, Argentina, Uruguay, and Mexico. In Asia, some parts of Jakarta were inundated by as much as 3.7 m following heavy rain in February; severe floods hit southern and southeastern China in June and July, affecting more than 13 million people. Thousands were killed when there were extreme monsoon downpours in India, Pakistan, Bangladesh, and Nepal. In Europe, England and Wales suffered major flooding, with 415 mm of rain making it the wettest May–July period since recording began in 1766. Although detailed analyses for 2007 are still continuing, the trend appears to have been confirmed: the share of heavy rain in annual precipitation (Topics Geo 2006, p. 43) is growing throughout the world, adversely affecting the risk of flooding.

* The CO₂ equivalent level (CO_{2eq}) is the amount of CO₂ that would be required to give the same global mean radiative forcing near the earth's surface as the sum of a basket of all forcings, including CO₂, CH₄, N₂O, CFCs, ozone, sulphate aerosols, black carbon and others.

Regional deviations of mean annual precipitation in 2007 from the 1961–1990 mean



This map shows the deviations of annual precipitation in 2007 from the 1961–1990 mean according to the US National Climatic Data Center/NESDIS/NOAA. Green dots stand for positive anomalies, orange dots for negative anomalies, their size reflecting the degree of variation. Exceptional precipitation deficits are clearly identifiable in parts of North America, China, and Australia.

Source: <http://lwf.ncdc.noaa.gov/oa/climate/research/2007/ann/global.html>

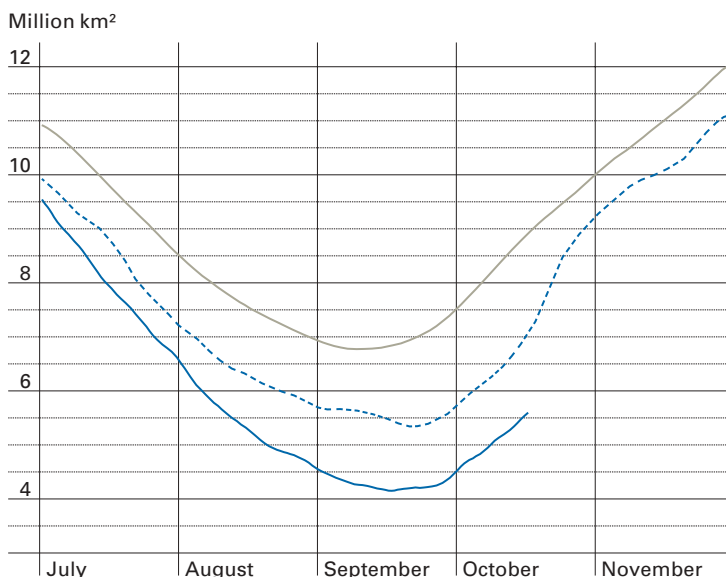
One result of the northern hemisphere warming in 2007 was the extremely low Arctic sea ice extent in September. Covering an area of 4.28m km², it was 39% below the 1979–2000 mean and 23% below the last record minimum of 2005. For the first time in centuries, the Canadian Northwest Passage was free of ice for vessels (without the help of icebreakers) for about five weeks; the Northeast Passage around Siberia was not far from becoming passable.

A corresponding decrease in the extent of northern hemisphere snow cover in springtime has also been observed – likewise a direct effect of climate change. The negative effect of this is a shorter tourist season in skiing regions; but there are also two positive effects: less need for winter services and fewer injuries caused by accidents.



The Canadian Northwest Passage was free of ice for about five weeks in 2007. This is a photo of the research ship Polarstern on a North Pole expedition.

Sea ice extent in the northern hemisphere



This chart shows the development of the surface covered by sea ice in the northern hemisphere before and after the typical September minimum. The 1979–2000 mean is shown as a grey curve, the two recent record years 2005 as a dotted curve and 2007 as a blue curve. The gigantic loss in area of the September minimum in 2007 compared with the record minimum just two years previously is very distinctive. The graph uses data from the US National Snow and Ice Data Center.

— 2007
 - - 2005
 — 1979–2000 average

Source: <http://lwf.ncdc.noaa.gov/oa/climate/research/2007/ann/global.html>

NatCatSERVICE

NatCatSERVICE is a central element of Munich Re's Geo Risks Research and is one of the world's most comprehensive databases of natural catastrophes.

There were 960 natural catastrophes throughout the world in 2007. This is the highest figure Munich Re has ever registered since it began keeping a systematic record of catastrophes in its NatCatSERVICE database. The year was marked above all by weather-related catastrophes, with more than three-quarters of all loss events being windstorms or floods. In 2007, the insurance industry again had to cope with natural catastrophe losses that far exceeded the exceptionally low level of the previous year.

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

The year in figures

Overall losses from 960 natural catastrophes in 2007 came to US\$ 82bn (2006: US\$ 50bn). At just under US\$ 30bn, insured losses were almost double the figure for the previous year.

Number of events

The trend towards increasing numbers of catastrophes continued in 2007. By way of comparison: 400 events occurred on average in the 1980s, 630 in the 1990s, and 730 in the last ten years.

Fatalities

16,000 people died throughout the world as a result of natural catastrophes. The worst human disaster was caused in mid-November by Cyclone Sidr, which devastated coastal areas of Bangladesh. The result: 3,300 people killed, 50,000 injured, and 3 million homeless. Bangladesh had already suffered large-scale monsoon flooding in July and August with a death toll of more than 800. There were a further 1,500 fatalities in India and Nepal – also victims of the monsoon floods. The most catastrophic earthquake occurred in Peru in August. The city of Pisco in western Peru was almost totally destroyed, and 595 people were killed in this magnitude 8 earthquake.

Overall losses and insured losses

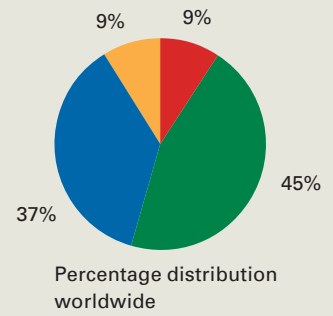
The percentage distribution of overall losses was in line with the average of the last ten years. The two costliest events in 2007 were the Chetsu earthquake in Japan (16 July) with overall losses amounting to US\$ 12.5bn and Winter Storm Kyrill, which cost US\$ 10bn as it swept over Europe in January. Please refer to the catastrophe portraits on pages 17 and 30.

The percentage distribution of insured losses was quite different to previous years.

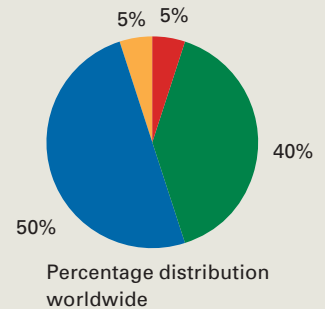
– Flood losses accounted for 26% of the insured losses, which was far above the long-term average of 7%. This was due to the two floods in the United Kingdom in June and July, with a total insured loss of US\$ 6bn.

– At continental level, the loss impact was most severe in Europe, where almost half of all insured losses were incurred – roughly US\$ 13bn. It is also noticeable that Australia/Oceania accounted for 7% of the losses (US\$ 1.8bn), which was much higher than the average of the last 10 years (1.5%). This was primarily due to the hail events in Canberra in February and Sydney in December and to the windstorms and floods that hit New South Wales in June.

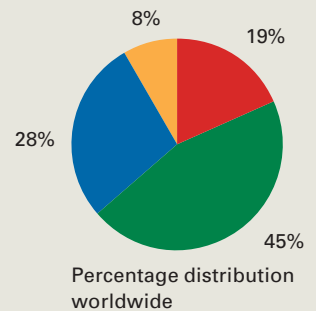
960 events



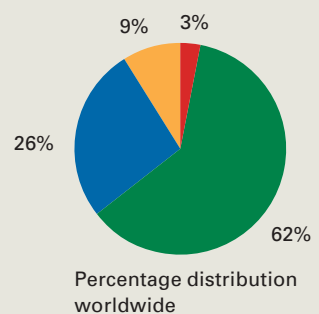
16,000 fatalities



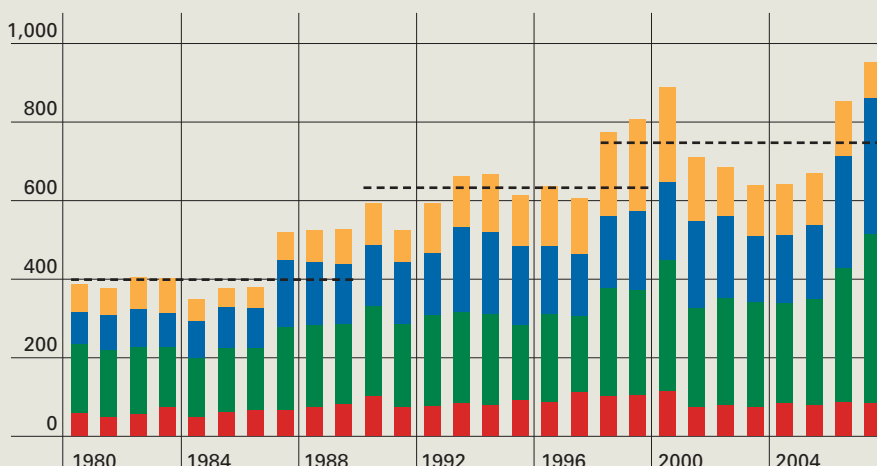
Overall losses: US\$ 82bn



Insured losses: US\$ 30bn



Number of natural catastrophes 1980–2007



- Geophysical events
Earthquake, volcanic eruption
- Meteorological events
Tropical storm, winter storm, severe weather event, hail, tornado, local storms
- Hydrological events
Storm surge, river flood, flash flood, mass movement (landslide)
- Climatological events
Freeze, wildland fire, drought
- Ten-year mean

Pictures of the year



18–20 January
Winter Storm Kyrill: Europe
Overall losses: US\$ 10,000m
Insured losses: US\$ 5,800m
Fatalities: 49



1–11 February
Floods, flash floods: Indonesia
Overall losses: US\$ 1,700m
Insured losses: US\$ 410m
Fatalities: 90



6 March
Earthquake: Indonesia
Overall losses: US\$ 200m
Insured losses: US\$ 5m
Fatalities: 70



18 April
Landslide: Canada



4–8 May
Severe storms, tornadoes, floods: USA
Overall losses: US\$ 350m
Insured losses: US\$ 260m
Fatalities: 14



4–8 June
Tropical Cyclone Gonu: Oman, Iran
Overall losses: US\$ 3,900m
Insured losses: US\$ 650m
Fatalities: 70



8–10 June
Severe storms, floods: Australia
Overall losses: US\$ 1,300m
Insured losses: US\$ 680m
Fatalities: 9



June and July
Floods: United Kingdom
Overall losses: US\$ 8,000m
Insured losses: US\$ 6,000m
Fatalities: 5



16 July
Earthquake: Japan
Overall losses: US\$ 12,500m
Insured losses: US\$ 335m
Fatalities: 11



**July–September
Floods: Sudan**

Overall losses: US\$ 300m
Fatalities: 150



**15 August
Earthquake: Peru**

Overall losses: US\$ 600m
Insured losses: US\$ 200m
Fatalities: 595



**7–16 August
Floods: India**

Overall losses: US\$ 50m
Fatalities: 106



**23 August–5 September
Wildland fires: Greece**

Overall losses: US\$ 2,000m
Fatalities: 67



**28 October–6 November
Floods, landslides: Mexico**

Overall losses: US\$ 2,500m
Insured losses: US\$ 350m
Fatalities: 22



**15–17 November
Cyclone Sidr, storm surge:
Bangladesh, India**

Overall losses: US\$ 3,700m
Fatalities: 3,500+



**3 November
Hailstorm: Colombia**



**11–13 December
Tropical Storm Olga: Puerto Rico,
Dominican Republic, Haiti**

Fatalities: 48



**16–17 December
Winter storm: Canada**

Overall losses: US\$ 12m
Insured losses: US\$ 8m

Great natural catastrophes 1950–2007

The long-term analysis of great natural catastrophes provides one of the most important and most stable sets of statistics when it comes to global loss trends. Reporting is getting better all the time – although there have always been comprehensive records of such major events, representing excellent sources for historical research even today. In addition, Munich Re’s archive of losses gives access to original information on all the losses that have occurred since the company was founded in 1880.

Since 1990, the journal of great natural catastrophes has been regularly updated in our annual reviews. This issue of Topics Geo also includes a breakdown of the various hazards and the geographical areas affected.

Analyses go back 58 years

Since 1950, the definition of „great natural catastrophes“ has applied to 283 natural hazard events (see below). This definition ensures that the statistics contain not only events with high overall monetary losses but also events with a large human impact – reflecting the numbers of people killed and made homeless.

The breakdown of events by natural hazard – earthquake and volcanic eruption, windstorm, flood, drought – was as follows: earthquakes and volcanic eruptions (80) accounted for approx. 30% of all the events, windstorms (115) 40% – including no fewer than 90 tropical cyclones – and floods (72) just under 30%. Only 15 events were in the drought, wildland fire, heatwave, and freeze category, accounting for only 5% of the total.

Fatalities

Almost two million people have died in major catastrophes since 1950. In 1970, a storm surge claimed 300,000 lives in Bangladesh. In 1976, an earthquake in northeast China killed 240,000 and flattened the city of Tangshan. With a death toll exceeding 220,000, the South Asian tsunami of 26 December 2004 was the third deadliest great catastrophe since 1950.

As far as the geographical distribution is concerned, the large majority of fatalities (80%) were in Asia (1.5 million people). The American continent accounted for 12% (7% or 133,000 in South America, 5% or 94,500 in North America, Central America, and the Caribbean).

Overall losses and insured losses

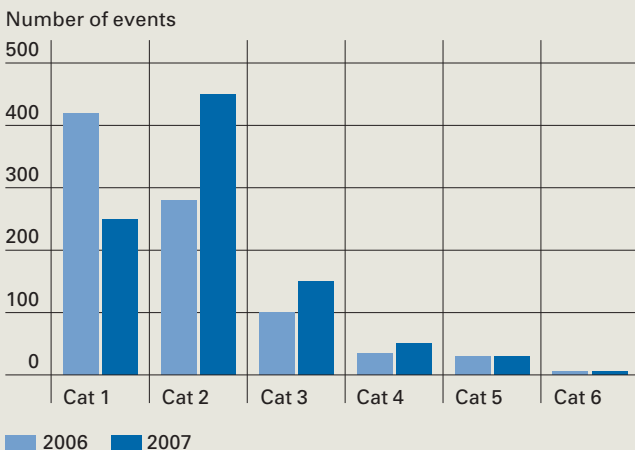
Overall losses totalled US\$ 1,800bn in current values. The two most expensive individual events were the earthquake of 17 January 1995 in the Japanese city of Kobe (US\$ 140bn) and Hurricane Katrina in the United States (25–30 August 2005), which cost US\$ 138bn (2007 values for both losses).

Insured losses totalled US\$ 240bn (current values). Three-quarters of the losses were in North America (including Central America and the Caribbean). Europe followed with 15% and Asia 10% (see chart on page 50). In the breakdown by individual hazard, windstorm events were by far the most common (81%).

The two following aspects are clearly reflected in the list of the 15 most expensive events for the insurance industry (page 50):

- Apart from the Northridge earthquake (United States, 1994), they were all windstorm events. The two most expensive events were both hurricanes, Katrina (2005) and Andrew (1992) – with almost identical tracks!

Natural catastrophes in 2007 – compared with 2006 Breakdown into six catastrophe categories



Category 1 Small-scale loss event

1–9 deaths and/or hardly any damage

Category 2 Moderate loss event

10–19 deaths and/or damage to buildings and other property damage

Category 3 Severe catastrophe

More than 20 deaths and/or overall loss of more than US\$ 50m

Category 4 Great catastrophe

More than 100 deaths and/or overall loss of more than US\$ 200m

Category 5 Devastating catastrophe

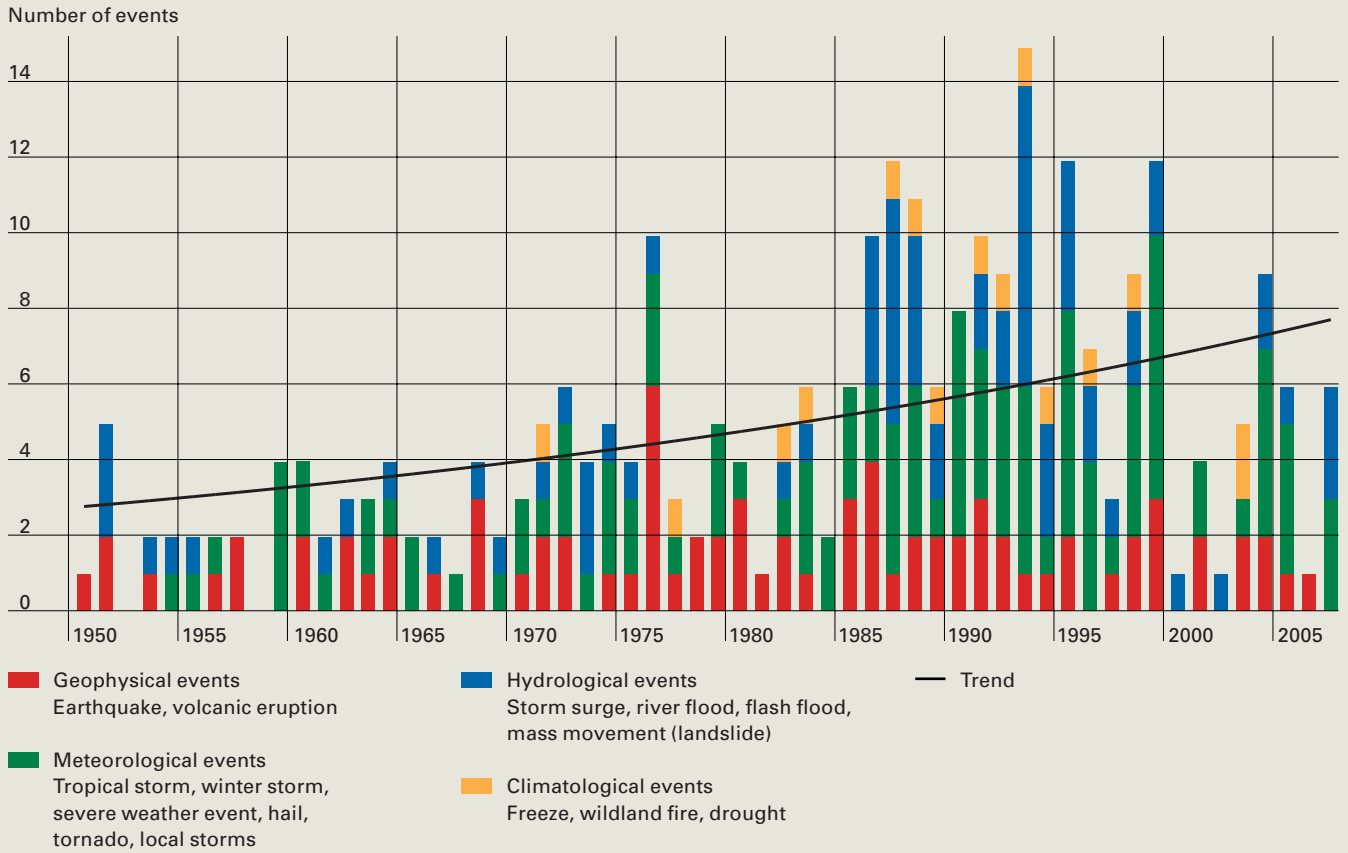
More than 500 deaths and/or overall loss of more than US\$ 500m

Category 6 Great natural catastrophe

Region’s ability to help itself clearly overstretched; supraregional/international assistance required; thousands of fatalities and/or hundreds of thousands of people left homeless; overall losses and/or insured losses of exceptional proportions

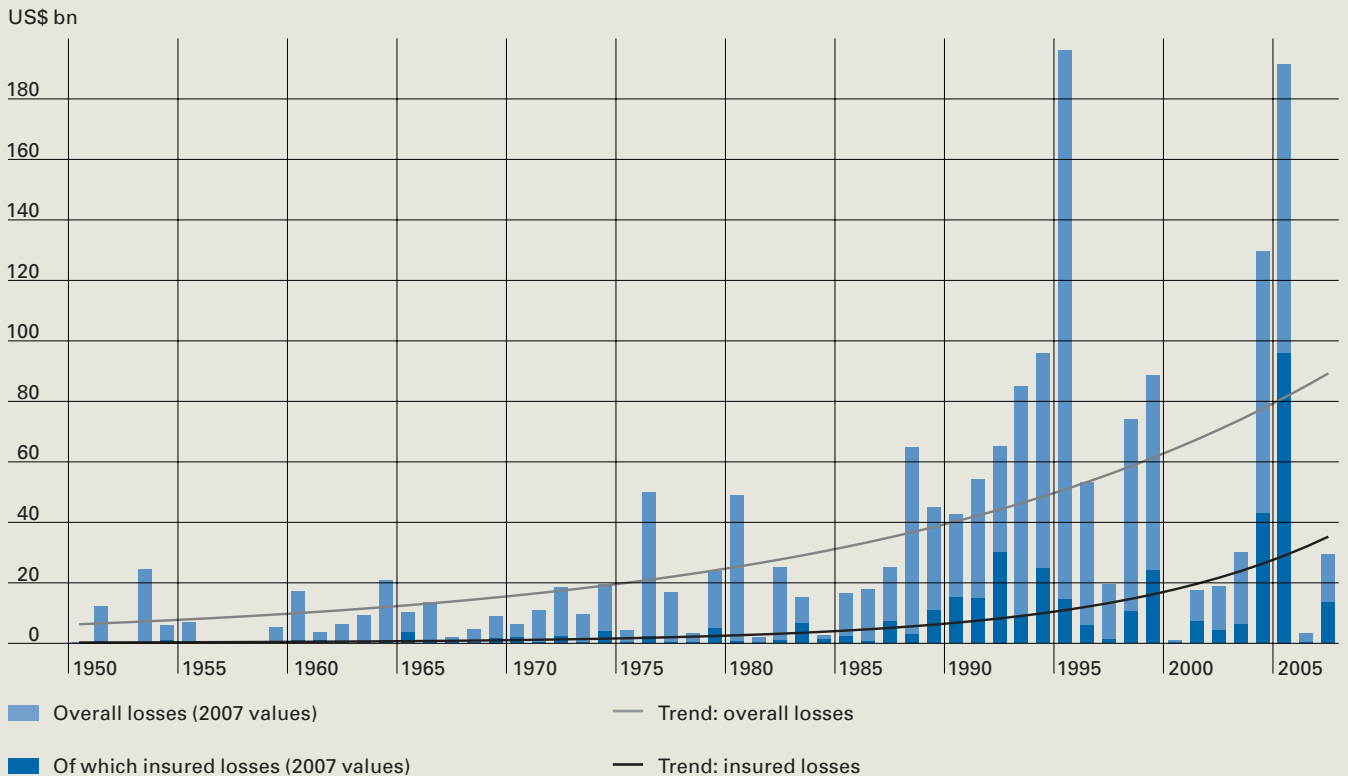
Great natural catastrophes: Number of events

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



Great natural catastrophes: 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 verify the increase in catastrophe losses since 1950.



- Ten of these 15 most expensive catastrophes occurred in North America, two in Japan, and three in Europe.

Analysis of 2007

We analysed 960 events altogether last year and allocated them to Munich Re’s catastrophe classes (cf. chart, page 48).

There were six catastrophes in 2007 that complied with the definition of great natural catastrophes and they were all weather-related events. Europe was hit extremely hard in 2007, with three great natural catastrophes.

- Winter Storm Kyrill, which crossed large parts of Europe in January, caused insured losses amounting to US\$ 5.8bn.

- Two flood events in short succession hit the United Kingdom in June and July, giving rise to an overall figure of US\$ 6bn in insured losses.

- In June, Cyclone Gonu crossed the Arabian Sea to Oman, where it destroyed infrastructural installations and caused large losses in car depots. Insured losses of US\$ 650m are indicative of the enormous loss potential in this booming region.

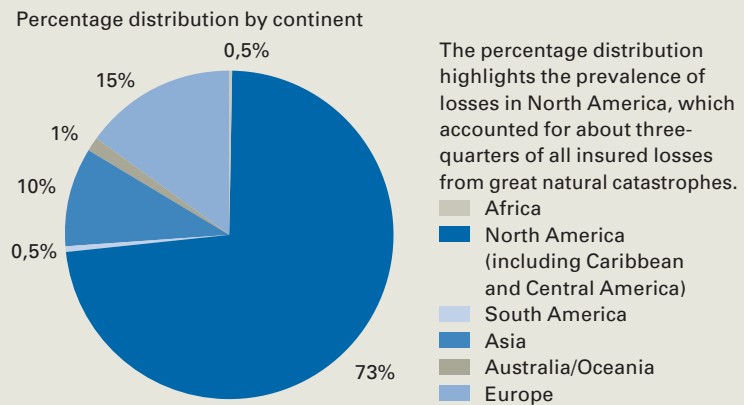
- In November, the Mexican state of Tabasco and large parts of Chiapas suffered their most devastating floods in 50 years. The Mexican authorities declared a state of emergency. About a million people were made homeless and lost all their possessions.

- November also saw Cyclone Sidr devastate long strips of coast in Bangladesh, with a tragic death toll of 3,700.

Conclusion

Last year again confirmed the long-term trend. The overall analysis since 1950 shows that throughout the period as a whole, the heaviest losses were caused by windstorms – particularly hurricanes and typhoons – and that North America recorded the largest number of events and the largest losses. A few individual years deviated from this pattern, however: in 2007, for example, there were three great natural catastrophes in Europe, whilst Oman recorded its first such event, Cyclone Gonu.

Great natural catastrophes 1950–2007
Insured losses: US\$ 240bn



The 15 most expensive natural catastrophes for the insurance industry

Year	Region	Event	Overall loss	Insured loss
2005	USA	Hurricane Katrina	138,000	67,700
1992	USA	Hurricane Andrew	45,700	26,000
1994	USA	Northridge earthquake	63,300	22,000
2004	USA, Caribbean	Hurricane Ivan	26,000	15,600
2005	USA, Mexico	Hurricane Wilma	22,000	13,400
2005	USA	Hurricane Rita	17,500	12,400
1991	Japan	Typhoon Mireille	16,000	11,100
2004	USA, Caribbean	Hurricane Charley	20,300	9,050
1990	Europe	Winter Storm Daria	11,400	8,550
1989	Caribbean, USA	Hurricane Hugo	15,800	7,900
1999	Europe	Winter Storm Lothar	14,600	7,500
2004	USA, Caribbean	Hurricane Frances	13,500	6,800
2007	Europe	Winter Storm Kyrill	10,000	5,800

Losses in US\$ m, 2007 values.

© 2008
Münchener Rückversicherungs-Gesellschaft
Königinstrasse 107
80802 München
Germany
Telefon: +49 (89) 38 91-0
Telefax: +49 (89) 39 90 56
<http://www.munichre.com>

Supervisory Board

Dr. Hans-Jürgen Schinzler (Chairman),
Herbert Bach (Deputy Chairman),
Hans-Georg Appel, Holger Emmert,
Ulrich Hartmann, Dr. Rainer Janßen,
Prof. Dr. Henning Kagermann, Prof. Dr. Hubert
Markl, Wolfgang Mayrhuber, Kerstin Michl,
Prof. Karel Van Miert, Ingrid Müller,
Prof. Dr. Heinrich v. Pierer, Dr. Bernd
Pischetsrieder, Dr. Jürgen Schimetschek,
Dr. Albrecht Schmidt, Dr. Ron Sommer,
Wolfgang Stögbauer, Josef Süßl,
Judy Vö

Responsible for content

Corporate Underwriting
GeoRisksResearch

Contact

Angelika Wirtz
Telefon: +49 (89) 38 91-34 53
Telefax: +49 (89) 38 91-7 34 53
E-Mail: awirtz@munichre.com

Order numbers

German 302-05698
English 302-05699
French 302-05700
Spanish 302-05701
Italian 302-05702

Download

www.munichre.com >> publications

Printed by

WKD-Offsetdruck GmbH
Oskar-Messter-Strasse 16
85737 Ismaning
Germany

Picture credits

Cover: AP Photo/Dave Thompson
Inside front cover: AP Photo/Mike Meadows
pp. 2/3: AP Photo/Ajit Solanki
p. 8: AP Photo/Ajit Solanki
p. 11: AP Photo/Brennan Linsley
pp. 14/15: picture-alliance/dpa
p. 19: picture-alliance/dpa
p. 21: AP Photo/Robert F. Bukaty
p. 23: Helga Weindl, München
p. 33 left: AP Photo/Mark J. Terrill
p. 33 right: Reuters, Berlin
pp. 34/35: Reuters, Berlin
p. 39: Reuters, Berlin
p. 43: Sandra Schuster, Sydney
p. 46 (1): Reuters, Berlin
p. 46 (2): Reuters, Berlin
p. 46 (3): AP Photo/Achmad Ibrahim
p. 46 (4): AP Photo/Tara Brautigam
p. 46 (5): AP Photo/Charlie Riedel
p. 46 (6): Reuters, Berlin
p. 46 (7): Newspix
p. 46 (8): AP Photo/Kirsty Wigglesworth
p. 46 (9): Reuters, Berlin
p. 47 (1): AP Photo/Abd Raouf
p. 47 (2): AP Photo/Ricardo Mazalan
p. 47 (3): Reuters, Berlin
p. 47 (4): Reuters, Berlin
p. 47 (5): Reuters, Berlin
p. 47 (6): AP Photo/U.S.Navy-Marine Corps, Sgt. Ezekiel R.
Kitandwe
p. 47 (7): Reuters, Berlin
p. 47 (8): Reuters, Berlin
p. 47 (9): AP Photo/The Canadian Press, Ryan Remiorz

The broad range of Munich Re's geoscientific knowledge may be found at www.munichre.com/geo. Besides supplying basic scientific and insurance information on the subject of natural hazards, it presents analyses of topical loss events and interactive hazard maps for all regions of the world.

© 2008
Münchener Rückversicherungs-Gesellschaft
Königinstrasse 107
Germany
80802 München

Bestellnummer 302-05699