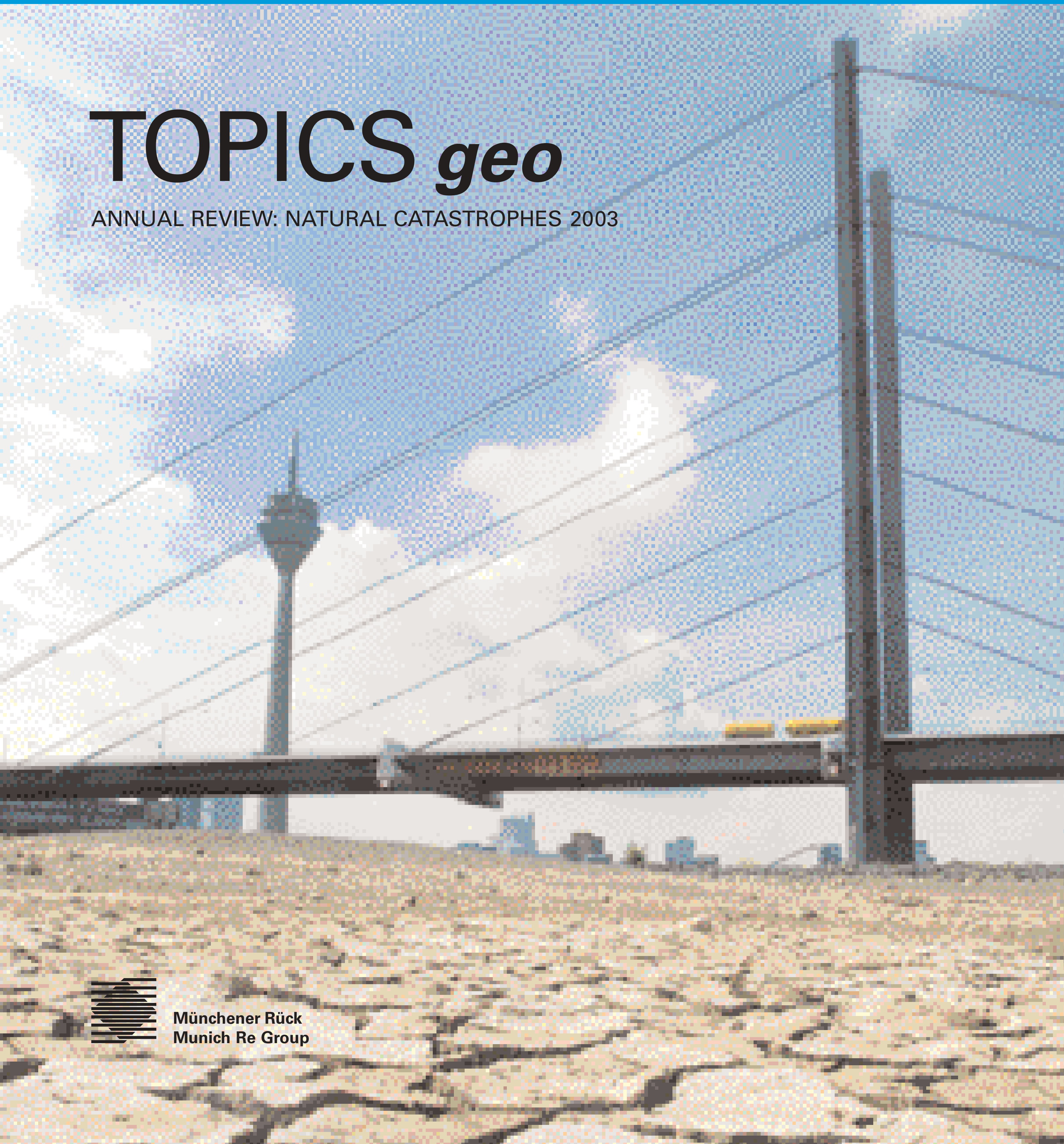
11th year · 2004

Natural catastrophes in 2003 | Trends of great natural catastrophes since 1950 | Hot summer in Europe – The future has already begun | The California wildland fires | The Bam earthquake in Iran | Geographical underwriting – Applications in practice | The climate summit 2003 in Milan

TOPICS *geo*

ANNUAL REVIEW: NATURAL CATASTROPHES 2003



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Inserts
World Map of Natural Catastrophes 2003
MRNatCat*POSTER* Natural catastrophes in 2003

Cover:
01 In the summer of 2003, weeks and weeks of heat and drought led to historically low levels in many important shipping routes throughout Europe. The picture on the front cover shows the Rheinkniebrücke, a bridge that crosses the Rhine River in Düsseldorf: there was so little water at many places that transportation was severely impaired.

Left:
02 After the heat came the flood: after the drought, the autumn brought strong thunderstorms to central Europe. Almost the entire Rhône region of southern France was under water at the beginning of December after torrential rain.

Natural catastrophes in 2003 Review – Outlook

01

The overall balance of catastrophes in 2003 was again clearly dominated by atmospheric events and weather-related natural catastrophes. The greatest sadness and grief, however, was caused around the globe by the severe earthquake in Iran at the end of the year, which claimed the lives of some 40,000 people and was thus the natural catastrophe with the largest number of victims last year. As in the previous year, the statistics were also marked by an extreme weather event of historical dimensions: the great heat wave that hit central and southern Europe in the summer of 2003, which killed at least 20,000 people and generated economic losses far exceeding US$ 10bn.

Loss figures

More than 75,000 died throughout the world as a result of natural catastrophes. The number of natural hazard events came to around 700 and thus reached the same level as 2002. Economic losses rose to over US$ 65bn (2002: US$ 55bn). Droughts and forest fires in Europe and the United States – but also floods in Europe and Asia – had a major impact. Insured losses totalled US$ 15.8bn (previous year: US$ 11.5bn; 5-year average US$ 16bn).

Storms and floods

300 of the approx. 700 events recorded were windstorms and severe weather events. They accounted for two-thirds of the insured losses.

– Two devastating series of severe weather events and tornadoes destroyed buildings and infrastructure in the US Midwest. More than 400 single tornadoes were counted in just one tornado outbreak in May. A massive hailstorm in Texas will go down in US insurance history after generating insured losses of over US$ 1bn.

– In mid-September, Maemi, a strong typhoon, tore across South Korea (insured loss: around US$ 500m).

– At almost the same time, Hurricane Isabel was battering the US East Coast, where it damaged more than 360,000 homes (economic loss: US$ 5bn; insured loss: US$ 1.7bn). Although the hurricane season in the Atlantic was of average severity on the whole, there were two further events which deserve particular mention, Hurricane Fabian and Hurricane Juan. Fabian, which generated losses of US$ 400m at the beginning of September, was the severest hurricane in the history of the Bermudas. In October and thus relatively late in the season, Hurricane Juan developed off the US East Coast, moved an unusually long way northwards (44.5°N), and hit large parts of eastern Canada (economic loss: US$ 100m; insured loss: US$ 60m).

Europe was largely spared severe storms and other extreme weather events this year, although there was quite a blustery start to the year. At the beginning of January, Winter Storm Calvann swept over France, Switzerland, and Germany. It only caused moderate damage, however.

Altogether, there were about 200 sizeable flood events around the world.

– Heat waves with temperatures of up to 50°C were followed by severe floods in many Asian countries in May and June. As in previous years, this was the result of an extremely wet monsoon. In China, the swollen waters of the Huai and Yangtze flooded hundreds of thousands of homes and caused an economic loss of almost US$ 8bn.

– Many places in the Rhône region of southern France were under water at the beginning of December when numerous rivers flooded their banks after extreme rainfalls of up to 300 mm in 24 hours in some places (insured losses: approx. US$ 1bn).

Hot summer in Europe – A taste of things to come

The outstanding event of the past year in Europe was the extreme heat and drought in the summer. Initial climatological analyses indicated that – in statistical terms – the event as a whole was to be expected much more seldom than once in 450 years. (We refer you to our documentation beginning on page 20.)

Nevertheless, the burden imposed on insurers by, for example, drought-related losses was relatively small because reduced yields in the agricultural sector as a result of heat waves and dry weather are – for the most part – not yet covered in the European Union. On the other hand, economic losses were extraordinarily high at approx. US$ 13bn.

Devastating wildfires raged on nearly all continents of the earth in 2003. The year had hardly begun when bush fires heading straight for Canberra (Australia) hit the headlines. Thousand of firefighters and volunteers were engaged for weeks in an untiring battle against huge fires in Italy, France, Portugal, and Spain, where more than 5,000 km^2 of forest burned down. Western Canada saw its worst fires since the beginning of the 20th century. In October and November, thousands of homes in California were destroyed by fires, which presented the insurance industry with a bill of some US$ 2bn.

Serious earthquakes in Algeria and Iran

There were 70 loss-producing earthquakes around the globe last year, generating economic losses of some US$ 6bn, about US$ 100m of which was insured. In February, the northwest of China was shaken by a quake with a magnitude of 6.4, the worst in the region for 50 years. 70,000 buildings were destroyed or damaged. In May, an earthquake with a magnitude of 6.8 rocked Algeria near the capital, Algiers, and claimed the lives of at least 2,200 people. A disturbingly severe earthquake occurred off the Japanese island of Hokkaido on 26 September, but in spite of its magnitude of 8.0, it only caused slight damage owing to the position of its hypocentre.

Despite a magnitude of 6.5, the earthquake that caused parts of California to tremble on 22 December did not cause any dramatic damage because it fortunately occurred in a thinly populated region about half-way between Los Angeles and San Francisco. However, its proximity to those two megacities underlines the extremely high risk in the event of future strong quakes.

Finally, early in the morning on 26 December an earthquake with a magnitude of 6.5 devastated the region around the city of Bam in the southeast of Iran. The majority of the mud-brick houses in this city – situated on the legendary Silk Road and with a population of approx. 100,000 – collapsed, burying tens of thousands beneath the debris. The authorities counted more than 40,000 people killed and approx. 30,000 injured. We refer you to the article beginning on page 32.

Outlook

Along with 2002 and 1998, 2003 was one of the warmest years ever recorded. The hot summer in Europe was a demonstration of just how serious the effects of climate change can be. The results of research performed by climate scientists indicate that even slight changes in temperature have a tremendous impact on the corresponding extreme values. It is to be feared that extreme events which can be traced to climate change will have increasingly grave consequences in the future. This means that we must reckon with new types of weather risks and greater loss potentials. All this will be a challenge in every respect. Neither human beings, buildings, and infrastructure nor the agricultural and livestock sectors are prepared for such extremes. In accordance with the precautionary principle, we would be well-advised to prepare ourselves for dramatic changes.

The 9th Conference of the Parties, which took place in Milan at the end of 2003, produced, to all intents and purposes, no new results. What did emerge, however, was that climate protection will shortly enter a new dimension, even if Russia does not ratify the Kyoto Protocol immediately. Great expectations are being placed on emissions trading, which will begin in the European Union in 2005. This will create for the first time a real chance of influencing developments with an eye to the future and thus alleviating the adverse effects of climate change (cf. our article on this subject beginning on page 50).

03 2003 was a year of extremes. Europe experienced its most extreme heat wave in centuries. But other continents suffered under the sweltering sun for weeks too. In India, water wells and reservoirs dried up and the people had to walk miles just to fill a couple of vessels with the precious liquid. In the wake of global climate change, water shortages will become a central problem in many regions of the earth this century.

Pictures of the year

04

15–17 July
Hurricane Claudette, United States

In the United States last year, whole areas were devastated on repeated occasions by tornadoes, and losses were also caused by hurricanes. The damage shown in this photo was caused by Hurricane Claudette, which, after sweeping through the Gulf of Mexico, had its main impact in Texas. The cyclone tore boats and yachts from their anchorage and damaged oil rigs as well as houses and infrastructure. Altogether, 15,000 claims were lodged with insurers.

05

July–August
Forest fires, Portugal

2003 was a year of fires. There were extensive forest fires in Australia, North America, and Europe. This inferno was photographed in the Açor Mountains, Central Portugal. The country had to cope with historic conflagrations, in which 10% of its forest area burned down completely.

06

12–13 September
Typhoon Maemi, South Korea

With wind speeds of up to 215 km/h and record rainfall of 500 mm, Maemi was one of the strongest typhoons in the history of South Korea. Thousands of buildings and bridges were destroyed, whole streets turned into raging torrents in next to no time and became impassable. Insured losses came to US$ 0.5bn.


07

25 September
Earthquake, Japan

Two submarine earthquakes in short succession with magnitudes of 8.3 and 7.4 rocked the eastern part of the North Japanese island of Hokkaido. A major fire broke out in an oil refinery, and there were power outages and severe damage to the infrastructure. The quake also triggered a sea wave that reached a height of 4 m but fortunately did not cause any major flooding.

08

2–4 December
Floods, France

Following the heat wave in the summer, December 2003 brought extreme torrential rain to the South of France, affecting the entire southern part of the Rhône valley. 300 mm of rain fell within a space of 24 hours, an amount that normally takes several months to accumulate. This is a picture of an industrial estate in Arles.


09

22 December
Earthquake, United States

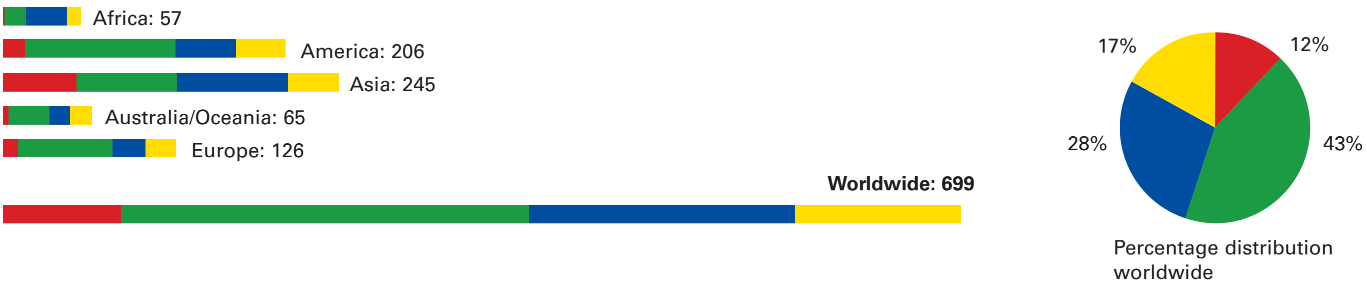
An earthquake between Los Angeles and San Francisco caused a stir shortly before the end of the year. Houses and a historic tower in Paso Robles collapsed. The epicentral area was sparsely populated, seven people were killed, 50 were injured. The quake with a magnitude of 6.5 highlighted once again the enormous earthquake hazard in California.

Statistics of natural catastrophes in 2003

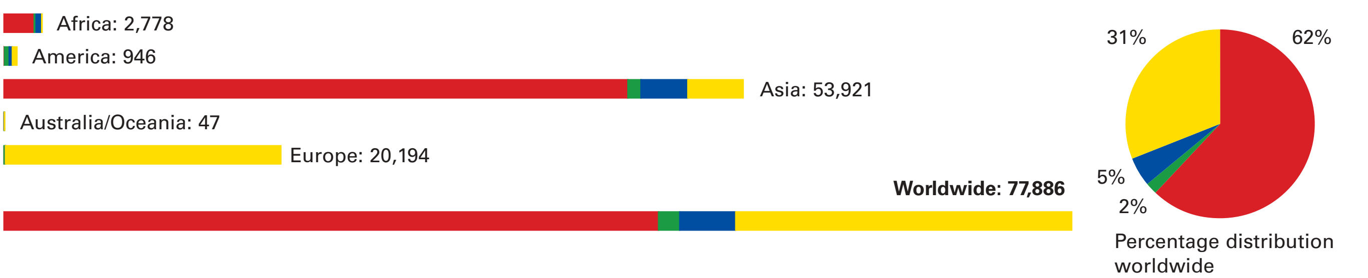
Loss events and fatalities

Approx. 700 natural hazard events were registered in 2003. Compared with previous years, the distribution of the various types of event (earthquake, windstorm, flood, others) is nothing out of the ordinary. Unlike the fatalities: this figure is largely due to the earthquake in Bam (Iran) and the summer heat wave in Europe.

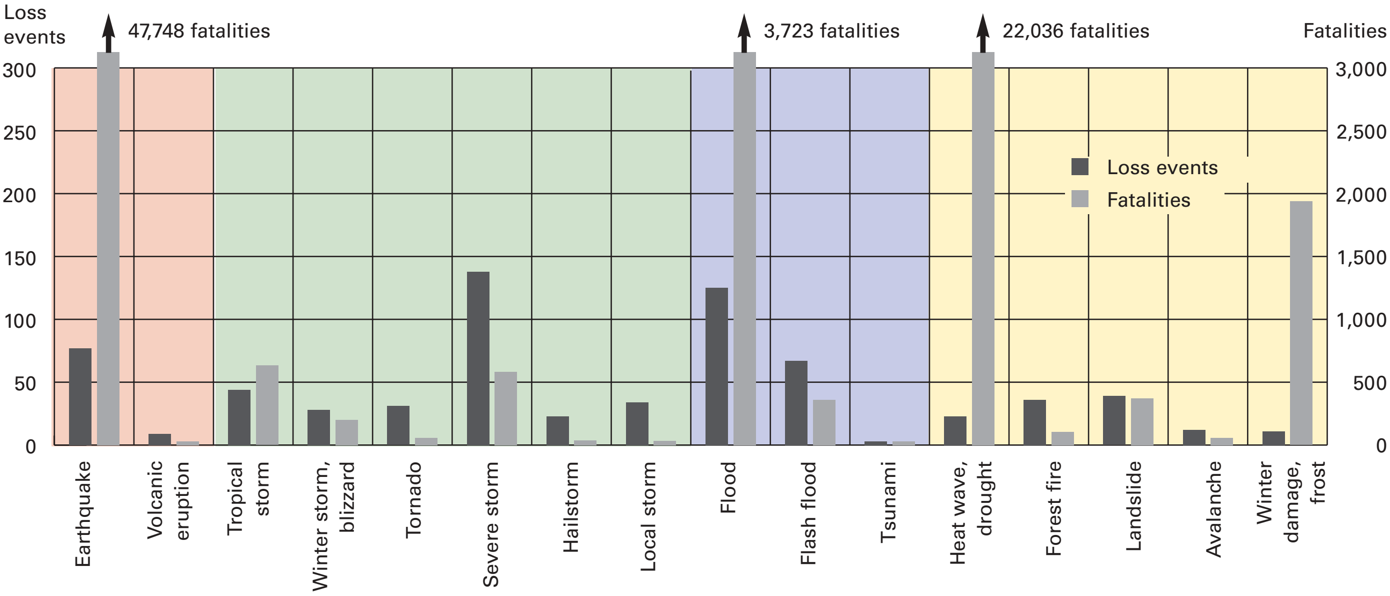
Number of loss events: 699



Number of fatalities: 77,886



Breakdown by type of event



- Earthquake, volcanic eruption
- Windstorm
- Flood
- Others

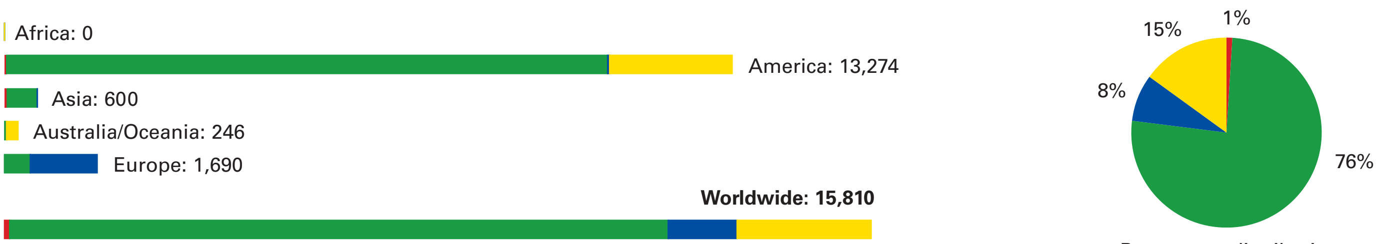
Economic and insured losses

In 2003, other events (heat waves, forest fires) were very prominent. The drought in Europe accounted for almost a third of the economic losses, whereas the wildland fires in California generated a large proportion of the insured losses. Otherwise, it was the picture that has become customary over the years: the statistics are dominated by windstorm losses.

Economic losses: US$ 64,604m

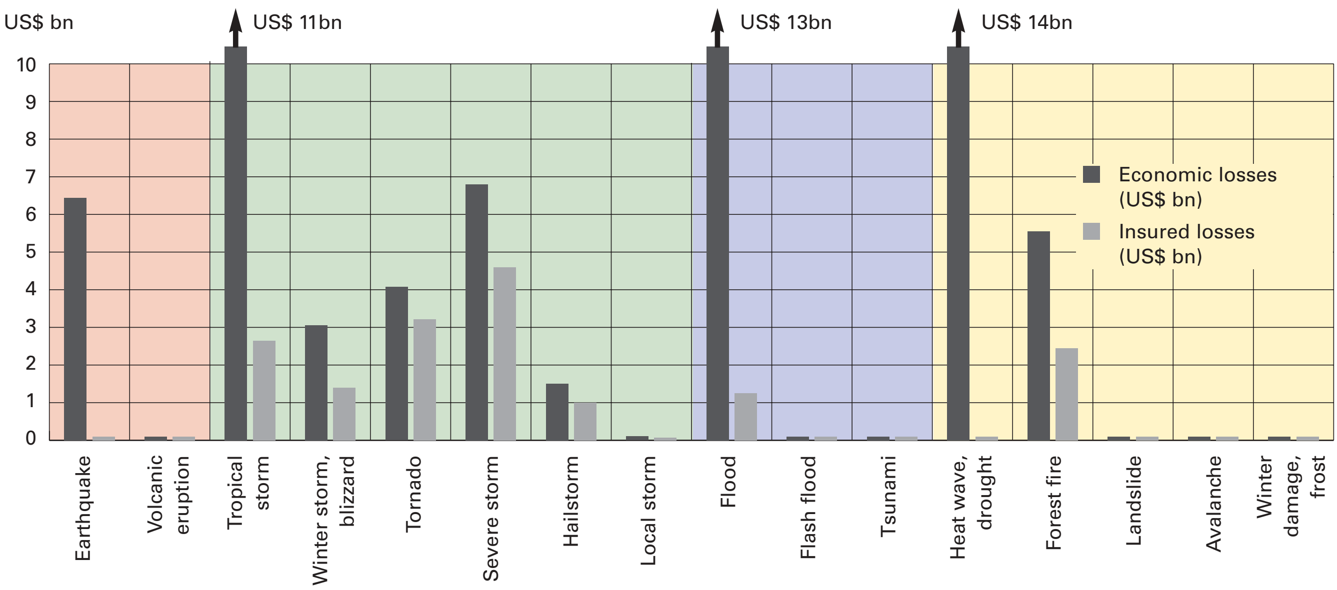
Percentage distribution worldwide

Insured losses: US$ 15,810m



Percentage distribution worldwide

Breakdown by type of event



Major engineering and fire catastrophes in 2003

02

A large number of spectacular engineering catastrophes, explosions, and arson attacks occurred again in 2003. However, the extent of the losses caused by these events was much smaller than that due to natural catastrophes and they claimed fewer lives. There follows a selection of significant events:

10

29 January, United States
Explosion in a pharmaceutical factory

11

1 February, United States
Space shuttle Columbia explosion

12

18 February, South Korea
Arson attack on underground train

13

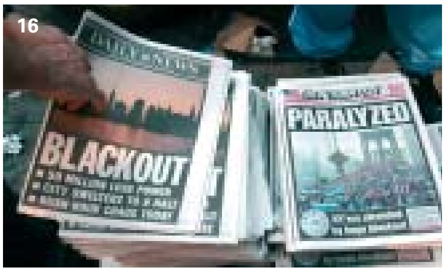
20 February, United States
Inferno in a nightclub

14

3 June, Spain
Collision between an express and a goods train

15

8 July, Bangladesh
Ferry accident on the Meghna

16


14 August, United States and Canada
Power outage

17

19 September, outer space
Failure of a Telstar 4 satellite

18

23 December, China
Natural gas accident during drilling operations

Date	Region	Loss event
29 January	**United States,** North Carolina, Kinston	**Explosion in a pharmaceutical factory** An explosion in a pharmaceutical factory in North Carolina triggered a fire in which six people were killed and more than thirty injured. The explosion had probably been caused by fine plastic dust used in the manufacturer of rubber.
1 February	**United States,** sky over Texas	**Space shuttle Columbia explosion** The US space shuttle Columbia exploded during re-entry into the earth's atmosphere. This is thought to have been caused by a small piece of insulation material that had damaged the left wing during the launch phase. All seven members of the crew were killed in the accident.
18 February	**South Korea,** Daegu	**Arson attack on underground train** An arsonist ignited a carton of flammable material in a packed underground train in the centre of Daegu. The flames spread in a matter of seconds and set fire to a second train coming in the opposite direction. 138 people suffered severe burns, 120 died in the blaze.
20 February	**United States,** Rhode Island, West Warwick	**Inferno in a nightclub** A pyrotechnic device got out of control and set fire to the stage curtain and interior of a nightclub during a rock concert. The club was not equipped with sprinklers, so that the fire was able to engulf the entire building in just a few minutes, with the result that 100 people were killed.
3 June	**Spain,** near Albacete	**Collision between an express and a goods train** The signals on a single-line track were green when an express train crashed head-on with a goods train at a speed of 200 km/h. 27 people were killed in the accident. The catastrophe would not have happened if there had been an automatic safety system installed on the line.
8 July	**Bangladesh**	**Ferry accident on the Meghna** More than 650 people were drowned when an overloaded triple-deck ferry on the Meghna river hit turbulent waters and sank. Accidents of such dimensions are almost regular occurrences because the number of passengers taken on board often greatly exceeds the permitted limit. The photo shows the situation encountered daily on passenger ferries in this region.
14 August	**United States and Canada,** East Coast	**Power outage in the northeast of the United States and Canada** 50 million people in this densely populated region were without electricity for as long as 24 hours. The entire traffic network, communications, and large sections of economic life came to a standstill. The economic loss is estimated to be US$ 6bn. The power outage in North America was just the first in a succession of incidents that affected various countries including the United Kingdom (28 August), Malaysia (1 September), Sweden and Denmark (23 September), and Italy (28 September).
19 September	**Space**	**Failure of a Telstar 4 satellite** A short circuit in the power supply led to the total loss of a satellite that had been launched in 1995. As all contact was cut off, it was of no further use. This Telstar 4 telecommunications satellite was insured for approx. US$ 140m.
23 December	**China,** Chongqing	**Natural gas accident during drilling operations** During drilling operations at a gas field in the southwest of China, there was a toxic gas blowout. 10,000 people had to be treated for severe poisoning and chemical burns, more than 200 were killed. It took several days to close the burning well.

19 A strong earthquake with a magnitude of 6.8 on the Richter Scale wreaked enormous devastation near the capital of Algeria. The photo shows a typical damage pattern, which is known as the soft-storey problem and is a concern to construction engineers throughout the world. The lack of adequate support leads to entire floors collapsing. 2,200 people died in this major natural catastrophe in May.

Great natural catastrophes

03

Great natural catastrophes 1950–2003

For risk managers in the insurance industry it is important not only to look at loss events in isolation but also and above all to keep track of identifiable trends.

Hundreds of natural hazard events occur around the world year in, year out. For risk managers it is of decisive importance not only to look at the individual events but also to consider in particular future developments. Long-term trends can be derived from major natural catastrophes, because only these can be researched far back into the past. The last four years in our long-term statistics should not make us forget that both the number of events and the monetary losses have increased perceptibly in recent decades. This becomes clear particularly in the case of the decade comparisons (cf. table on p. 15).

Definition of great natural catastrophes:

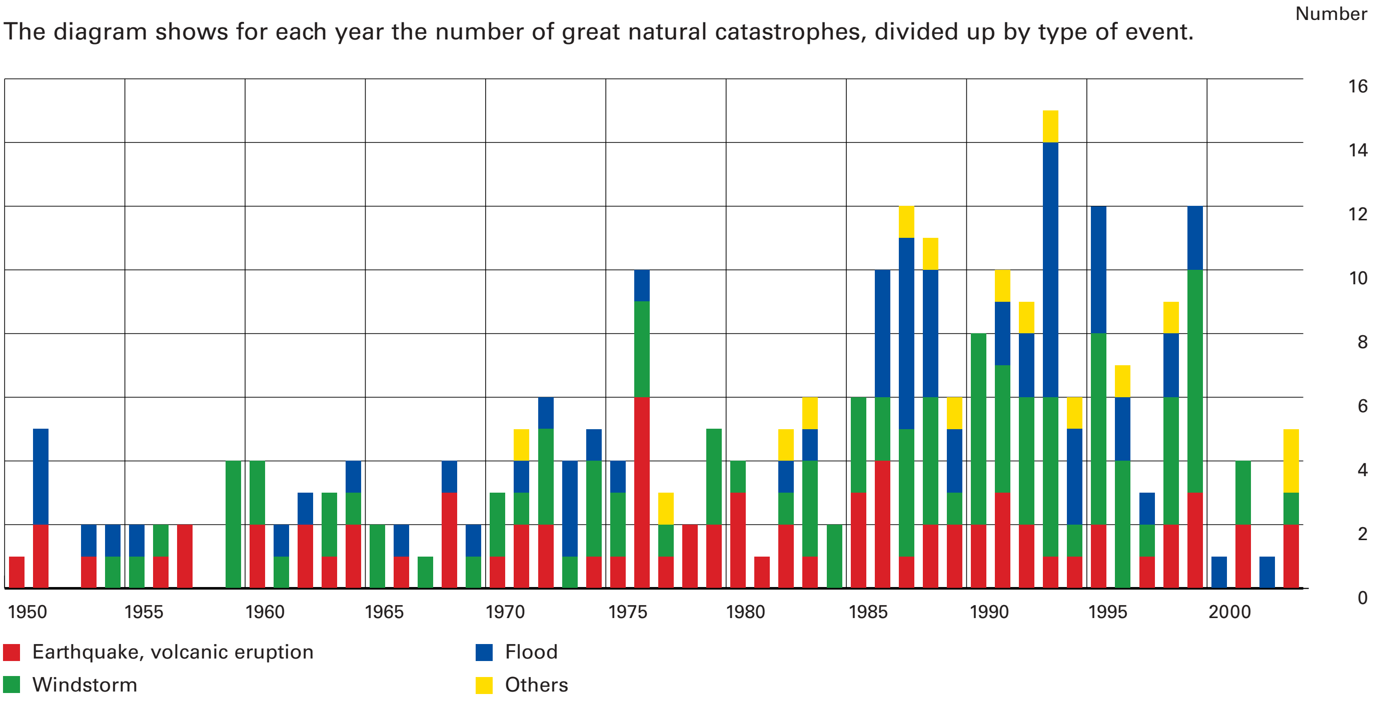
Natural catastrophes are classed as great if the ability of the region to help itself is distinctly overtaxed, making interregional or international assistance necessary. This is usually the case when thousands of people are killed, hundreds of thousands are made homeless, or when a country suffers substantial economic losses, depending on the economic circumstances generally prevailing in that country.

A total of 700 loss events due to natural hazards were registered last year and from these we have selected the "great" natural catastrophes on the basis of the above definition.

– Tornadoes, severe storms, United States (May)
– Earthquake, Algeria (May)
– Heat wave, forest fires, Europe (July–August)
– Heat wave, drought, forest fires, United States (October–November)
– Earthquake, Iran (December)

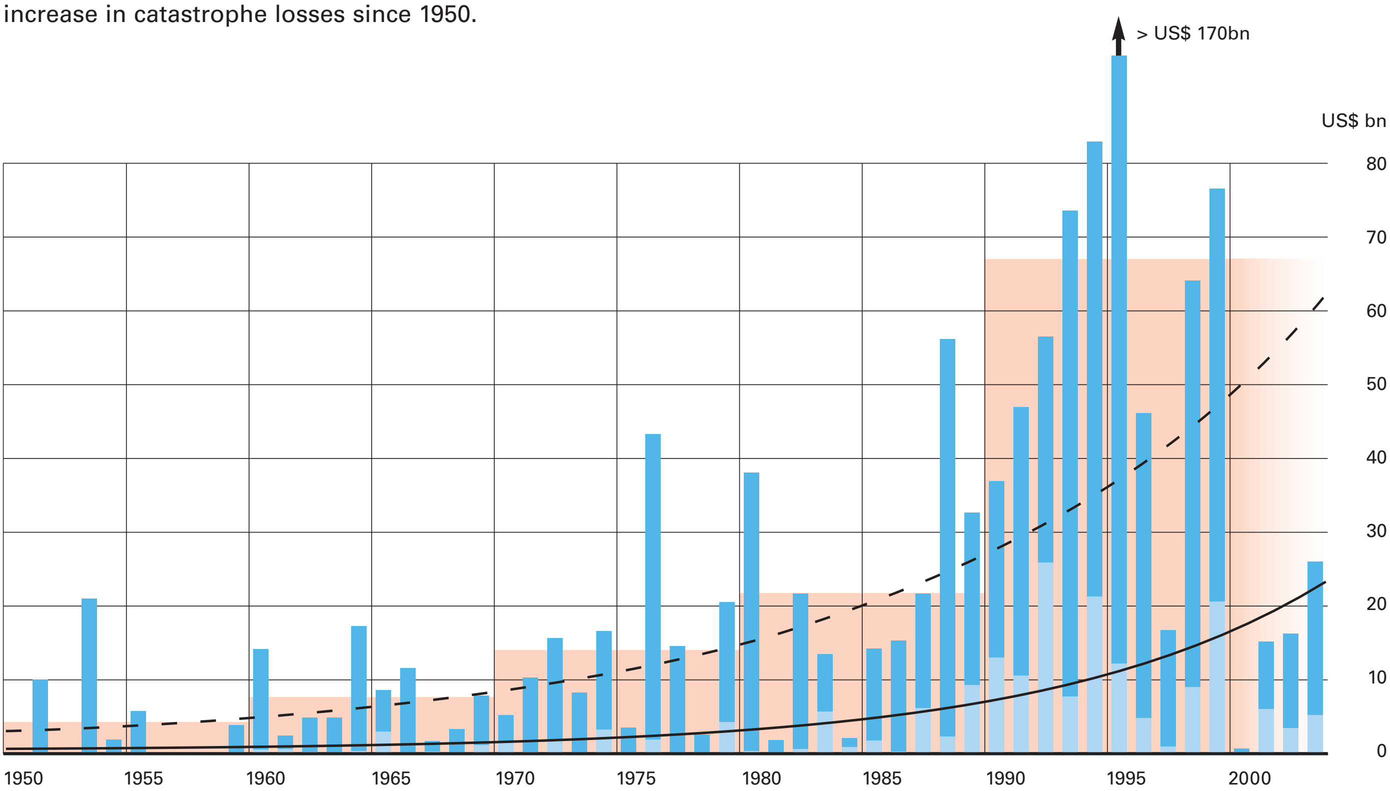
Number of events

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



Economic and insured losses with trends

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



Economic losses (2003 values)
of which insured losses (2003 values)
Average economic losses per decade
Trend of economic losses
Trend of insured losses

Decade comparison 1950–2003

The table allows a comparison of the aggregate loss figures of recent decades. Comparing the last ten years with the 1960s makes the increase in natural catastrophes particularly clear. This applies both to the number of events and to the extent of the losses incurred.

Decade	1950–1959	1960–1969	1970–1979	1980–1989	1990–1999	Last 10 years
Number of events	20	27	47	63	91	60
Economic losses	42.7	76.7	140.6	217.3	670.4	514.5
Insured losses	**–**	**6.2**	**13.1**	**27.4**	**126.0**	**83.6**

Losses in US$ bn (2003 values)

The comparison of the last ten years with the 1960s shows a dramatic increase.

Last 10:60s
2.2
6.7
13.5

NatCat*SERVICE*-Information

Weather-related natural catastrophes in the insured and uninsured world

04

Weather-related natural catastrophes repeatedly affect both well-developed and less-developed insurance markets and countries. Against this backdrop the same questions regularly arise: "Are weather-related natural catastrophes still insurable in the long term? Are all regions of the earth insurable in fact?" and "What is to be done about the millions and millions of people who are not insured?"

The year 2003 brought the United States devastating tornadoes and China severe floods. In 2002 there were hundred-year floods in central Europe and at the same time floods in India with more than 1,200 fatalities. In 1992 Hurricane Andrew generated billion-dollar losses in Florida with insured losses of US$ 17bn, in 1998 Hurricane Mitch caused a humanitarian disaster with some 10,000 fatalities. Mitch hit Honduras, where there is little insurance coverage, and paralysed the comparatively poor national economy for years to come. In the following article we examine the insurance penetration in various markets and the effect of weather-related natural catastrophes.

Uneven insurance penetration around the globe

While industrial countries may be said to be relatively well to very well insured, the people in developing countries are more or less poorly insured. But what is the yardstick on which this statement is measured? There are various ways of calculating property insurance premiums. The total premium income of individual countries cannot be used as a criterion as this leads to considerable distortions in particularly highly populated and large countries. The best approximation for the percentage of insured people or households is obtained using the paid property insurance premiums per capita.

Given this extreme simplification, there is one important aspect that is obviously not to be overlooked: even in countries where sufficient insurance premiums are paid on average, there will be a large number of people who cannot afford any coverage at all and remain uninsured.

Our analysis is based on a breakdown into seven country groups corresponding essentially to the following key:

– Uninsured (property insurance premiums US$ 0–5 per person and year): material assets not or inadequately insured
– Basically insured (property insurance premiums from US$ 5 to 50 a year): most vital basic insurance just about provided
– Adequately to well insured (property insurance premiums exceed US$ 50, 100, 500, or 1,000 a year): material assets (households) adequately to well insured

– In Africa there are only seven countries with an annual property insurance premium exceeding US$ 5 per person. Of these, South Africa is the only country with a well-developed insurance market.

– The largest and most highly populated countries of Eurasia, China, India, and Russia, are in different groups. Nevertheless, it must be borne in mind that the picture will be distorted by the not inconsiderable sums insured for industrial plants and international construction projects or businesses (e.g. international hotel chains). Also, the size and distribution of the population lead to extreme regional differences, e.g. between urban and rural populations. And the much-cited "emerging markets", especially India and China, are developing so rapidly that the insurance penetration may look very different in just a few years.

– It is interesting to note that in South America the average property insurance premium is without exception above US$ 5 a year, i.e. in the basically insured group. This means that – at least in purely statistical terms – there is "basic protection" for the population's assets.

– In the wealthy industrial countries of North America and western Europe and in Japan, South Korea, Australia, and New Zealand, a sum far exceeding US$ 100 per person per year is spent on average for property insurance protection. As a rule, each household takes out several insurance policies; the people are considered to be well to very well insured.

Analysis of weather-related natural catastrophes by country group

If we look at the global effects of weather-related natural catastrophes that have occurred since 1980 in this world classified in terms of insurance protection, we will notice the following:

- Windstorms, severe weather, floods, drought, and other weather-related natural catastrophes occur throughout the world, regardless of whether the regions concerned are well or poorly insured.

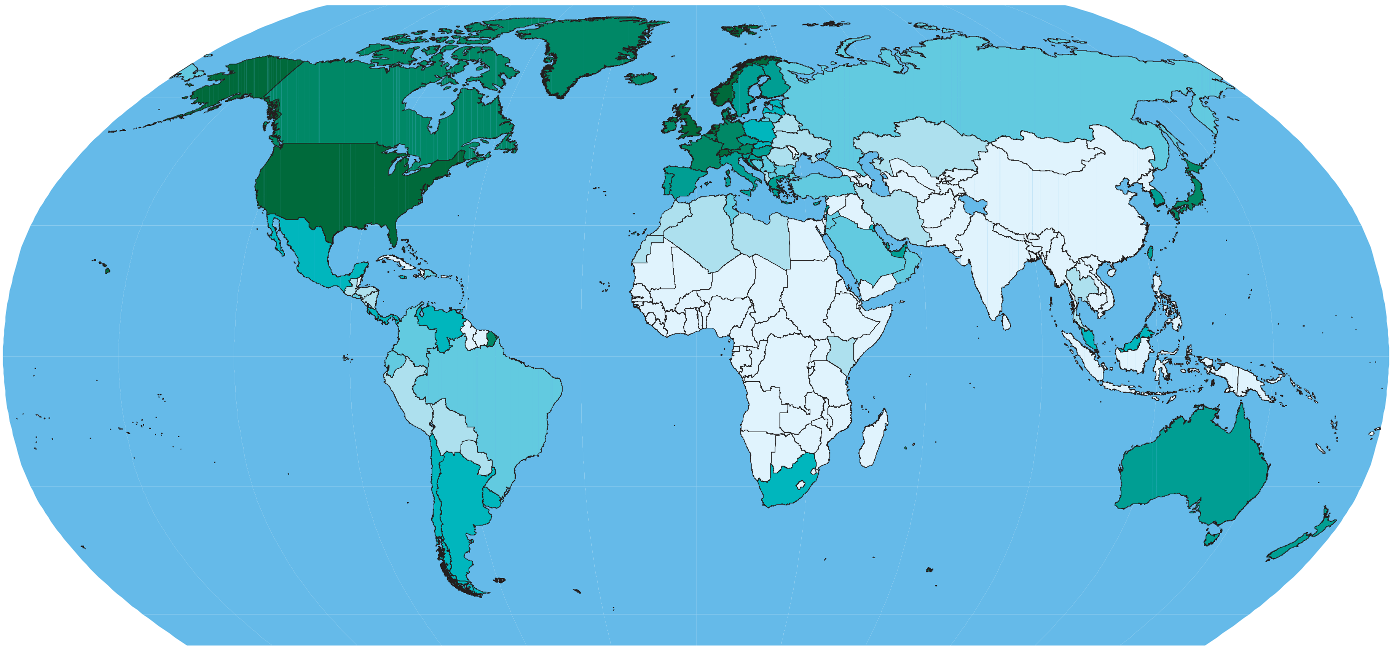
- Approx. 80% of all fatalities (more than 700,000 people) were in the uninsured group in the period under examination.

- As a result of the high level of industrialisation and the comparatively high standard of living, a disproportionate majority of the total economic loss (60%) was caused in the rich industrial countries. Even so, the economic loss incurred by those without insurance far exceeded US$ 300bn (roughly a third).

- The overwhelming majority of insured losses (95%) was inevitably paid out in the countries with good insurance penetration; a sum of more than US$ 200bn. There are no major changes to be expected in this distribution in the foreseeable future.

Will these losses continue to be insurable in the future?

In the light of this development, what are the limits of insurability of frequently affected markets or regions? There is no generally valid answer. In the medium to long term, it could be that the insurance industry will have to withdraw from individual regions and zones that are regularly and almost predictably affected by weather-



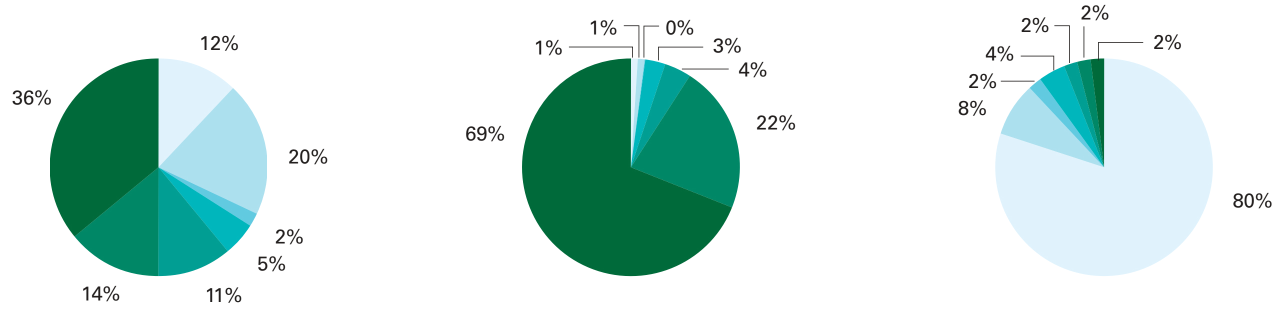
Uninsured group
- US$ 0–5

Basically insured group
- US$ 6–25
- US$ 26–50

Well insured group
- US$ 51–100
- US$ 101–500
- US$ 501–1,000
- US$ 1,000+

Property insurance premium (non-life including health) per capita per year in US$
Source: MR Economic Research/NatCat*SERVICE*®

Weather-related natural catastrophes 1980–2003: percentage distribution among insurance markets at various stages of development



Economic losses: US$ 1,000bn

Insured losses: US$ 225bn

Fatalities: 930,000

- US$ 0–5
- US$ 6–25
- US$ 26–50
- US$ 51–100
- US$ 101–500
- US$ 501–1,000
- US$ 1,000+

Property insurance premium per capital per year in US$
Source: MR Economic Research/ NatCat*SERVICE*®

related natural catastrophes. This will apply in particular to areas along individual sections of river that are regularly flooded so that the basic premise of insurance (sudden and unforeseen occurrence of an event) is no longer valid. It is a different situation when large regions or countries are concerned. Here the instruments available to the insurance industry will suffice for decades to come, insofar as at least some of the conditions specified below continue to be met. For example, a rigorous implementation of just the first three of the following measures will enable the insurance industry to cope with even huge loss potentials :

- Risk-adequate premiums, prospective underwriting
- Substantial deductibles geared to the degree of exposure
- Accumulation control
- Loss prevention and loss avoidance (heightening of awareness, motivation)
- Change in forms of cover from proportional to non-proportional excess of loss covers
- Limits of indemnity, going as far as the exclusion of particularly exposed areas (as already sketched out for flood) or of specific perils

Solutions for the poorly insured or uninsured world

For years now international organisations like the United Nations and the World Bank have been endeavouring to find solutions for uninsured or inadequately insured people, communities, and countries. An example of this was the International Decade for Natural Disaster Reduction (IDNDR), whose work spanned the world in the 1990s and is being continued by its successor organisation, the International Strategy for Disaster Reduction (ISDR). The aim of these endeavours is, and was, to save human lives, reduce losses from natural catastrophes, and to minimise their effects. We have selected a few examples to illustrate this:

- In conjunction with the insurance industry, the World Bank has devised concepts for some countries (e.g. India) in order to ensure the provision of reliable insurance protection against natural hazards.

– Financing catastrophe funds (Cat Bonds) is one way of making provisions before natural catastrophes occur. In the event of a loss, speedy payments make it possible to rebuild factories and restore damaged infrastructure in a short time.

– Micro-finance and micro-insurance solutions can even reach individual households in poor countries and promote welfare and economic development even in the smallest of communities.

Of course, the state insurance concepts that have already been set up in some industrial countries to address specific problems (e.g. in France, Spain, Switzerland, and the United States) must continue to be observed closely. Such state insurance concepts may be an effective solution in certain countries.

Public-private partnerships as a model

Roughly one-half of all the people on earth are de facto without adequate insurance protection (in our analysis, the lowest class with US$ 0–5 per person per year). At the same time, natural catastrophe losses will reach dimensions that are quite new – as a result of global climate change, for example. This makes it necessary to look for practicable and adaptable concepts. Also, a topic that is being discussed more and more often at the Conference of the Parties' meetings on climate protection is whether, and how, the industrial countries, in other words the countries that are mainly responsible for man-made climate change, can be held liable for weather-related and climate-related losses in the uninsured world.

It will only be possible to rise to the challenges we will be facing in our ever more complex world if politics, the insurance industry, and the people in the regions that are being affected more frequently all contribute towards that solution. The often called-for public-private partnerships (PPPs) which are based upon this concept are a very promising start in the right direction.

20 A heat wave held central Europe in its grip for weeks on end in the summer. It caused severe damage particularly in the agricultural sector, with losses exceeding US$ 10bn, and destroyed the entire harvest in many places.

Documentation:

Hot summer in Europe – The future has already begun

05

Summer 2003: Weeks and weeks of extreme temperatures above the 30°C mark made the people in Europe sweat. Are the extreme weather-related events of the recent past still atypical occurrences or do they already reflect the normality of global warming?

Not only the floods in August 2002, but also the summer heat of 2003 were real "hundred-year" events – as meteorologists have now definitely established. In 2002, Saxony had recorded local precipitation amounts of over 300 l/m^2 within a period of 24 hours, the likes of which had never come anywhere near to appearing in the region's climate statistics up until then. In 2003, the meteorological summer (June to August) presented Germany with mean temperatures no less than 3.4°C above the average for the period 1961–1990. According to an analysis performed by the Frankfurt University Institute for Meteorology and Climatology (Prof. Schönwiese), this corresponds to an occurrence probability of once in approx. 450 years. But this does not even take into account the fact that the months of May and September were also unseasonably warm or that the heat wave affected not only Germany but also large parts of central, western, and southern Europe. Consequently, the event is an even more weighty and extreme "outlier" in the climate statistics.

But are these two extreme weather-related events really as unusual today as they would have been in past decades and centuries? Or do they already reflect the changes that global warming brings with it?

All in all, precipitation amounts increase if the earth gets warmer because more water evaporates and the atmosphere can hold more water vapour. The water cycle becomes more intense as a result and the probability of torrential rain rises substantially. Given an average increase in temperatures of 2°C, as is to be expected in many regions by the middle of this century, the return periods of extreme daily precipitation may be reduced to a third, and given a – not unimaginable – increase of 4°C to even an eighth, e.g. from 100 to 12 years.

The same applies to temperatures and, generally speaking, to other climate parameters as well. Even a relatively moderate shift in averages will lead to an inordinate increase in the exceedance probability of uncommon threshold values. The Frankfurt meteorologists' analyses show, for instance, that the probability of a hot summer like the one in 2003 has increased by a factor of twenty in the past two decades alone, which in terms of the temperature were in themselves quite exceptional. In accordance with the rules of statistics, this means that, in only a few decades, hundred-year events can turn into what are basically quite normal occurrences that may be expected every couple of years. An additional danger is that such rapid and enduring changes may cause unexpected feedback effects and irreversible phase transitions in the complex "atmosphere – earth – ocean – ice" system (e.g. changes in ocean currents) and may thus make all prognoses worthless.

In accordance with the precautionary principle, we would be well-advised to be prepared for dramatic changes. It is essential to consider trends that are already recognisable today when defining design values for buildings (e.g. for thermal or windstorm loads), or when designating high-risk zones in which land use is prohibited, or when calculating the risk premiums for natural hazard covers on a prospective basis.

Regrettably, the experience gained from last year's hot summer has confirmed in full what Munich Re's Geo Risks Researchers have been predicting for many years: 1. The risk of pronounced and prolonged periods of heat and drought is increasing dramatically in large parts of Europe. 2. The potential effects on the economy and the insurance industry are completely underestimated or even ignored. 3. There has been a ruinous neglect of precautions for adaptation to such situations.

Indeed, the heat and drought in the summer of 2003 had some remarkable features, as the following key data impressively demonstrate:

- Size of the affected area: several million square kilometres
- Countries most severely affected: France, Spain, Portugal, Italy, Germany, Switzerland, Austria; England, Benelux, Poland, Slovakia, Romania, and Hungary.

- Duration of the heat period without extended interruptions: approx. 3 months (mid-May–mid-August)
- Number of fatalities: over 20,000 (see table)
- Property damage, especially in agriculture and as a result of forest fires: US$ 13bn

Other grave effects on the economy:

- Inland shipping (low water: cancellations and losses in cargo transportation and tourism)
- Industry, power plants (river water too warm, problems with cooling: production bottlenecks)
- Stark reduction in worker efficiency (resulting in an economic loss that is substantial but still very difficult to quantify in monetary terms)

A particularly critical aspect for many sectors of the economy was the extremely low water level of numerous European rivers, in which the lowest values of all time were often measured. This meant that normal shipping was impossible for a long time. Above all, however, numerous electricity-generating plants had to cut back on their output because there was either not enough “water power” or not enough cooling water to stay within the discharge temperature limits. Electrical power was therefore in short supply and the price rose; occasionally the power supply failed altogether.

Even in sectors that usually profit from nice summers like open-air entertainment and tourist attractions, there was a shortfall in daytime receipts because it was just too hot to make the effort and go. The owners of cafés, ice parlours, garden restaurants, beer gardens, and swimming baths did a roaring trade though.

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At the peak of the heat wave, water had to be sprayed onto the outside surfaces of numerous power plants above ground (as here in Fessenheim, France) as the cooling systems were no longer working efficiently due to the heated rivers and the shortage of water. Some power plants had to reduce their output, some had to be shut down altogether.

The effects of the exceptional heat on the people

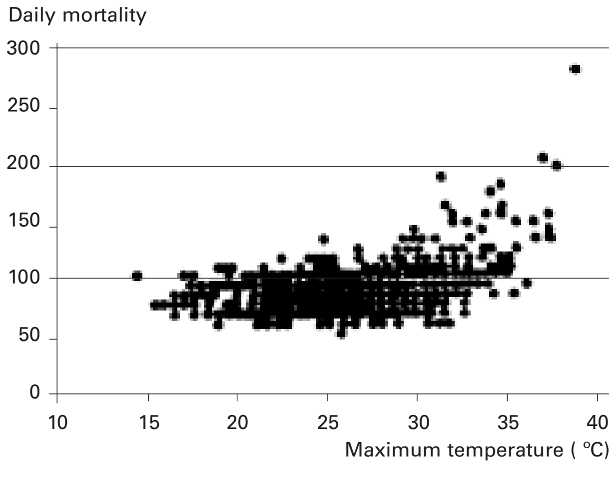
The thermal climatic conditions are among the environmental factors that have the strongest impact on personal well-being and health.

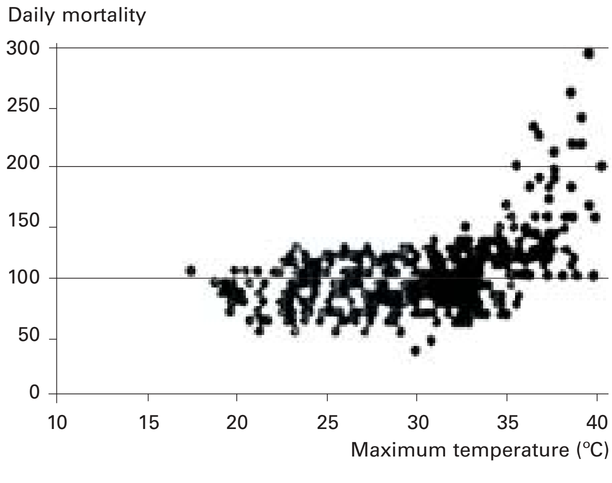
The human organism reacts in many ways to changing temperature conditions, in order to keep up its internal regulating system, in which maintaining a constant body core temperature has top priority. In hot weather the blood pressure falls, the heart has to beat faster, and the body loses large amounts of liquid through perspiration. These stresses and strains may be too much for the cardiovascular system especially in the infirm and may cause death. Many studies prove that there are definite links between the number of fatalities and the thermal conditions on any one day. In New York and Shanghai, for example, three times as many people die on extremely hot days as on normal warm days – and these are two cities in two completely different regions of the earth (cf. the graphs below).

As the strain exerted on the body is influenced not only by air temperature but also by humidity, wind speed, and irradiation conditions, all these complex influences are taken into account in the more recent biometeorological analyses. Of paramount importance therefore is perceived temperature, which many meteorological services have been using for some years now.

The analysis of nine different heat waves shows that perceived temperature and the number of fatalities run more or less parallel in time. The number of fatalities drops below the average expectancy value once a heat wave has ended. This phenomenon is called the "harvesting effect" in the field of epidemiology. It means that the elevated mortality during heat waves is to some extent due to the time of death being advanced by no more than a few days. In the majority of heat-mortality studies, however, modern epidemiological analyses point not only to this "harvesting effect" but also to fatalities that would not have been expected in the subsequent few weeks without the effects of the heat, in other words to a real increase in mortality over a relatively long period of time.

Temperature and mortality in New York and Shanghai.





The graphs show the number of fatalities as a function of the maximum temperature. At elevated temperatures, the numbers of deaths increase enormously. Source: McMichael, A. J., et al., 1996. Climate Change and Human Health, WHO/WMO/UNEP.

The heat in the summer of 2003 claimed the lives of more than 20,000 people in Europe (see table). And the distribution of the heat victims correlates strikingly with the analyses of thermal stress performed by the German Weather Service (DWD) (see map of Europe below).

The death rate in France in August 2003 was more than twice as high (25 cases per 100,000 inhabitants) as the temperature-related fatality rate in Chicago during the 1995 heat wave (12 deaths per 100,000 inhabitants, totalling 514); in Ile-de-France and Centre, the regions most severely affected, the rate was no less than four times as high.

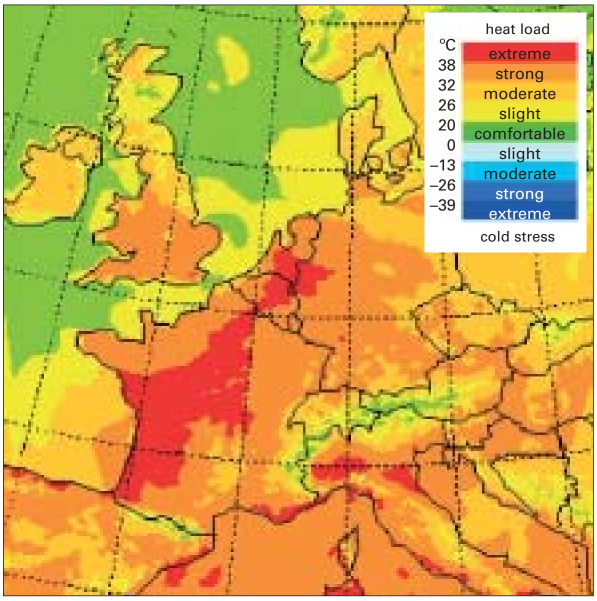
The effects of the summer heat wave on morbidity due to the consumption of spoilt food (e.g. salmonella poisoning) cannot be quantified. The WHO estimates, however, that throughout the world about 2.4% of all diarrhoea cases are the result of higher temperatures due to climate change in recent decades.

For the experts, it is not only the maximum daytime temperatures that are important but also the night-time temperatures. They influence the quality of sleep and hence a person's heat tolerance on the following day. Particularly in the concrete jungles of the megacities, night cooling is reduced considerably by the heat island effect. The negative effects of heat waves may thus be considerably aggravated.

Correlations: weather, health, accidents

A recent study performed at the University of Munich looked into the connections between the number of road accidents and various meteorological parameters. There were significant correlations not only with primary weather influences like storms, rain-soaked roads, and black ice, but also with thermal conditions. The scientific analysis of daily accident figures and weather factors revealed that there were 18% more road accidents on the hottest days than on cool days. Even in countries where heat load is common like Saudi Arabia (Riyadh), there is a positive correlation between the frequency of road accidents and air temperatures.

Map of perceived temperatures in Europe on 8 August 2003



Service: German Weather Service

Victims of the hot summer of 2003 in Europe

	Fatalities
France	14,800
Spain	2,000
Portugal	1,300
Italy	4,000
Germany	3,500
United Kingdom	900
Netherlands	500

Snapshot of perceived temperatures in Europe on 8 August at the peak load time (1 p.m.). Paris was in the extreme zone for days and recorded by far the largest number of victims. The figures published on numbers of victims varied widely from country to country and were not always easy to verify. The figures quoted in the table reflect the best estimates of ministries and state statistical offices at the end of the year.

Occupational health studies reveal that heat load increases the number of occupational accidents and reduces productivity. Air temperatures above 27°C reduce cognitive performance (e.g. perception, reaction times, concentration).

There is also evidence that heat is capable of raising the level of aggression and the incidence of violent acts. A current study on the effects of the weather shows that the rescue services are called out to deal with acts of violence up 75% more often on hot days than on cool days.

The direct negative effects of climate change on humans are not so much the result of slow and continual increases in the temperature as the increasing frequency of extreme events like the summer of 2003 in Europe.

The hot summer in 2003 was also indirectly responsible for the frequent exceedance of ozone threshold values in western and southern Europe. This may also affect the health of the population and have a negative impact on agriculture and forestry. The increase in forest damage in central Europe in the summer of 2003 was attributed to the elevated ozone values as well as to moisture stress.

During the summer months, record temperatures were recorded in many regions of Europe. This thermometer in Alicante shows an unprecedented temperature of 64°C – which represents a new dimension even for southern Spain.

Summary

To sum up: heat waves not only cause a distinct increase in the mortality of the elderly but also leave their marks on national economies: more accidents occur, agriculture and forestry suffer, and labour productivity declines.

Chronicle:

The California wildland fires of 2003

06

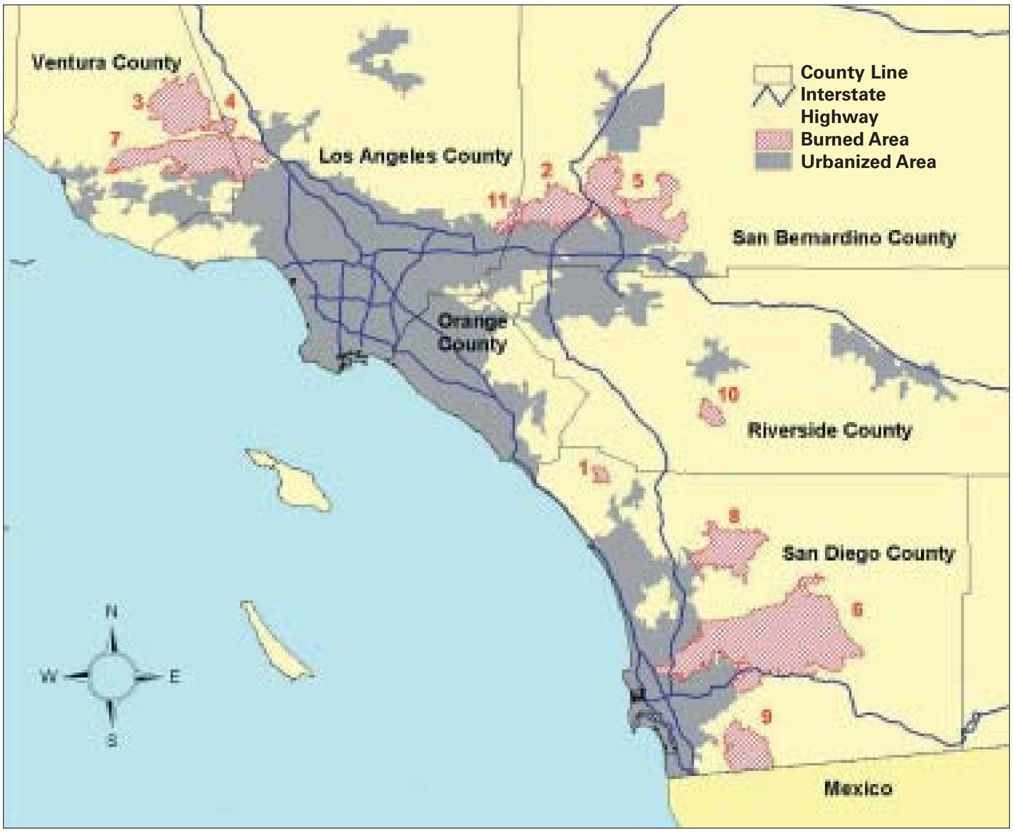
23 Natural forests, like most forests, are not usually insured for fire, but large losses are often to be expected if buildings or entire settlements are caught in the blaze. In California, where more than 4,000 buildings went up in flames, the insurance industry paid more than US$ 2bn to the homeowners.

In late October 2003, southern California experienced an unusually active period of wildland fires. The first fires in this episode were ignited on 21 October.

Several additional fires started during the following week, fuelled by dry vegetation and fanned by strong Santa Ana winds (warm, dry, offshore blowing winds), before a combination of vigorous fire-fighting activities and more cooperative weather conditions (cool, damp, onshore blowing winds) started to whittle them down. The late-October fires in southern California destroyed more than 3,600 homes and damaged a few hundred more. The fires also destroyed or damaged several hundred automobiles, trailers, and boats. The counties of San Bernardino and San Diego were the worst hit, but the fires did also affect Ventura, Los Angeles, and Riverside counties. A total of 22 deaths have been attributed to these fires. Estimates of total insured losses from all fires combined are around US$ 2.2bn, and economic losses have been projected on the order of US$ 3.5bn.

The fires of October/November 2003

The Cedar fire in San Diego County is the largest wildland fire in California's history. It burned more than 270,000 acres (110,000 hectares) and destroyed over 2,200 homes. It is believed that the Cedar fire was ignited by a distressed hunter sending up a signal flare. The Old and the Grand Prix fires have both been blamed on arson. The fires merged on 26 October, separated only by Lytle Creek. The so-called Padua fire was merely the



Location and extent of the October 2003 wildland fires in southern California.

Summary of the October 2003 wildland fires in southern California
(data as of December 2003)

No.	Fire	Cause of ignition	Date started	Date contained	Area km²	Deaths	Destroyed structures		
							Commercial	Residential	Outbuildings
1	Roblar	Under investigation	21 Oct.	28 Oct.	35	0	0	0	0
2	Grand Prix	Arson	21 Oct.	8 Nov.	241	0	1	135	60
3	Piru	Under investigation	23 Oct.	10 Nov.	259	0	1	1	6
4	Verdale	Arson	24 Oct.	28 Oct.	35	0	0	0	1
5	Old	Arson	25 Oct.	5 Nov.	370	6	10	993	0
6	Cedar	Accident	25 Oct.	4 Nov.	1,107	14	22	2,232	566
7	Simi	Spot fire from (4)	25 Oct.	1 Nov.	438	0	0	22	278
8	Paradise	Accident/arson	26 Oct.	6 Nov.	230	2	2	221	192
9	Otay	Under investigation	26 Oct.	28 Oct.	186	0	0	1	5
10	Mountain	Under investigation	26 Oct.	29 Oct.	42	0	0	21	40
11	Padua	West end of (2)	27 Oct.	2 Nov.	42	0	0	0	0
			Total:		**2,985**	**22**	**36**	**3,626**	**1,148**

The number of the fire (No.) in the table refers to the fire's number on the map.
Outbuildings refer to detached garages, sheds, pools, fences, and the like.

western flank of the Grand Prix fire, the portion of it that was on the Los Angeles side of the county line. The whole conflagration (Old/Grand Prix/Padua) in San Bernardino County burned over 160,000 acres (65,000 hectares) and destroyed more than 1,100 homes. As of December 2003, the causes of all the Californian fires have not been determined, but the Verdale fire has been blamed on arson, the Paradise fire has been attributed to human activity (either an accident or arson), and the Simi fire has been attributed to spot fires from the Verdale fire. The causes of the Roblar, Piru, Mountain, and Otay fires are still under investigation.

Wildfire history

The continuously expanding wildland-urban interface in the south-western United States is susceptible to disastrous fire losses. Recent examples include the Rodeo-Chediski (Arizona) conflagration in June 2002, which caused an estimated US$ 125m in insured property losses (all historical losses are reported in 2003 dollars, adjusted for inflation using the Consumer Price Index), and the Cerro Grande (New Mexico) fire in May 2000, which caused an estimated US$ 150m of insured property losses. Historically, however, the state of California has been hit the hardest. The most costly fire in the state's history, in terms of insured property losses, is the Oakland Hills firestorm in October 1991, which caused an estimated US$ 2.3bn in insured property losses. In 1993, which is the third costliest wildland fire year in California's history (after 1991 and 2003), two fires in southern California (Laguna Canyon in October and Malibu-Topanga in November) caused a total of US$ 930m in insured property losses.

Return period approaches

Based on data on insured losses during the past 34 years (1970 to 2003), annual aggregate property losses in California from wildland fires have averaged approximately US$ 180m, adjusted for inflation. It is interesting to note that in this 34-year period, the annual average has only been exceeded four times. Applying a simple, least-squares logarithmic curve fitting to the inflation-adjusted California wildfire loss data (annual aggregates) yields an estimated return period of five years (the reciprocal of the annual frequency of exceedance) for US$ 100m, ten years for US$ 650m, and a return period of 25 years for an annual aggregate industry loss of US$ 2bn. Extrapolating this curve, which is not a recommended practice, generates an estimate of US$ 2.8bn

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The local fire-fighting teams were completely at the mercy of natural forces. Firemen are powerless in the face of a gigantic ball of fire in Simi Valley, northwest of Los Angeles, where an area of more than 400 km² burned down.

for the 50-year industry gross loss on an annual aggregate basis from California wildland fires.

The estimated losses and return periods mentioned above are only given here for rough reference; they are not based on a probabilistic risk model. While the insured wildland fire losses incurred over the past one third of a century have been adjusted for inflation, they have been corrected neither for increased exposure nor for overall growth in wealth and property values during the period. Since the increase in exposures has disproportionately taken place at the wildland-urban interface, it is very likely that the empirical loss estimates mentioned above are lower than the actual, present-day probabilistic loss estimates would be.

The wildland fire risk in the United States in general, and in California in particular, is on the rise, due to increasing urbanisation and an ongoing population shift towards the south and the west. Homeowners and owners of other property located at or near the wildland-urban interface would be well advised to take all reasonable measures to reduce the fire hazard. The recommended actions include, but are not limited to, creating and maintaining a clear fire break surrounding the property, using non-combustible roofing and wall cladding material, and keeping the roof, gutters and eaves clear of debris.

Insurance and reinsurance aspects – Fire event issues

Since a fire known as the Padua fire merged with a fire known as the Grand Prix fire and subsequently merged with the Old fire (PCS Cat 98), the above-mentioned list of eleven fires has to be reduced. Munich Re Group therefore consider that the California fires of October 2003 consisted of several fires or events. This consideration also maintains a consistency with the 1993 wildfires, where each of the 27 different fires had a separate origin and each was considered to be a separate event. We are aware that the intention of this paper is to describe the events physically. But the commitment of Munich Re finally depends of the definition of "event" in both the direct policy wording and the reinsurance wording.

Therefore, Munich Re recommend the following:

a) Review the respective wordings
b) Define the number of events based on the respective wordings
c) If necessary, revise the claims estimations/amounts based on the findings of the number of events

Earthquake report:

The Bam disaster in Iran

07

On 26 December, shortly before the end of the year, an earthquake below the city of Bam in the southeast of Iran highlighted once again the lethal connection between poor building quality and large numbers of victims: 40,000 people died.

Scientific aspects, features of the quake

The strong earthquake with a magnitude of 6.5 occurred at 5.26 a.m. local time. The hypocentre was only 8 km below the city of Bam, some 180 km south of Keman, the provincial capital, and just under 1,000 km south of Teheran.

Scientists were surprised neither by the strength of the quake nor by its location. Iran is located in the pressure zone of the Arabian and Eurasian plates, which are moving towards each other at a speed of some 3 cm a year. This plate movement has caused strike slip and thrust faults throughout Iran, a region of high seismic activity. The Bam Fault with a north-south horizontal displacement runs almost directly through Bam. It was on this fault that the quake on 26 December 2003 occurred (see Fig. 2). As the seismic hazard map for Iran shows, there is an elevated earthquake hazard throughout the country. The city of Bam is in intensity zone 3, corresponding to an expected earthquake intensity of at least VIII (MM scale) on average once in just under 500 years (see Fig. 1).

Historical records give no indication that Bam or its immediate environs had ever been hit by a quake of such magnitude before. This is why the city's 2,000-year-old citadel had never fallen victim to an earthquake. In 1981, however, two strong earthquakes with magnitudes of 6.9 and 7.3 shook the region some 100 km north of Bam, claiming the lives of several thousand people. The list of devastating historical earthquake catastrophes in Iran is particularly long. In the last century alone, seven quakes with over 5,000 victims were registered, the last being in 1990, when 40,000 people were killed in the Rasht region on the Caspian Sea.

One distinct feature of the Bam earthquake was the relatively small size of the heavily affected area around the Bam Fault activated in the earthquake and in particular around the epicentre. Severe damage was only reported in Bam itself and a few villages in the immediate vicinity. This is due to what was – by global standards – a moderate magnitude of 6.5 and to the low focal depth of 8 km. The maximum intensity recorded in Bam, which lay in the epicentral area, was IX on the EMS scale (see Fig. 3).

Losses

The people of Bam were still sleeping when the earthquake struck, claiming the lives of at least 40,000, injuring more than 30,000, and making 100,000 homeless. The city now presents a scene of total destruction, with 70% of the houses having collapsed at least partially. Besides the unfortunate time of the quake and its position directly beneath the town, the main reason for the large number of fatalities was the generally poor construction quality. Traditional buildings of mud-brick construction and heavy roofs are particularly unsafe when earthquakes strike. The binding material is poor to non-existent so that the unreinforced masonry possesses hardly any resistance against the ground motion in strong earthquakes. With little tensile and shear strength, the walls are unable to resist dynamic earthquake loads, which is why the majority of the buildings in the epicentral area collapsed. The comparatively loose construction of the mud-brick walls prevented the creation of cavities which would have given the inhabitants some protection from the falling masses of stone and given them the chance of being rescued alive. Consequently, the 44 international relief teams with 1,500 staff and some 20,000 Iranian volunteer helpers were only able to rescue about 3,000 people. Three days after the earthquake, only 20 survivors were pulled from the ruins.

Situated on the legendary Silk Road, Bam is famous for its 2,000-year-old citadel Arg-e-Bam. This fortified settlement is one of the country's most important cultural monuments and was badly damaged in the earthquake. The destruction of Bam and its citadel will cripple tourism in the region for years, if not decades. The area has thus been robbed of an important economic pillar.

25 The collapsing mud-brick buildings form compact heaps of rubble which create hardly any cavities and thus make it almost impossible to survive under the debris for any length of time.

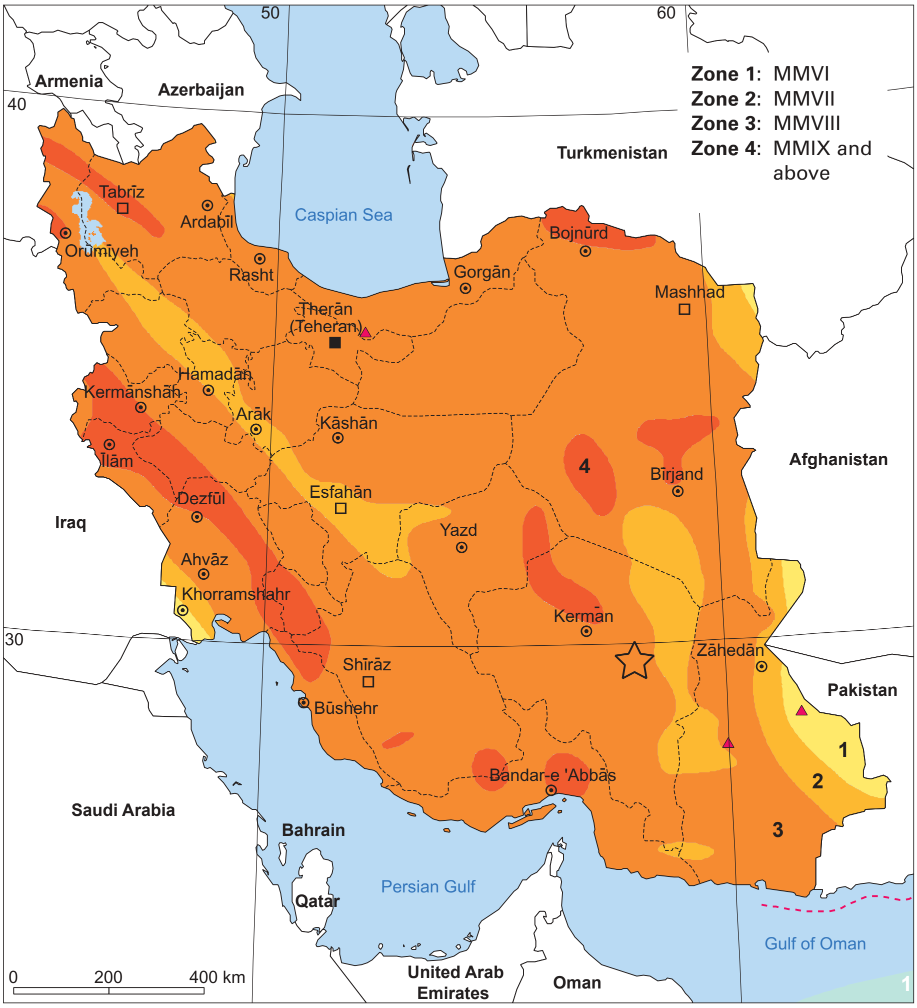

Fig. 1: Seismic hazard map of Iran and the position of the epicentre.

Insurance aspects

On average, only 10 to 15% of the houses in Iran are insured for fire. Earthquake cover is not automatically included but has to be purchased separately.

- The insurance penetration in the region around Bam is likely to be much lower – on account of the low standard of living there.
- Although many of the country's large oil or gas industrial plants are covered by insurance, none of them are located in Bam. Insured losses are therefore expected to be small. The economic effects will have to be borne mainly by the impoverished population itself. Besides having to cope with the immeasurable human tragedy, the region thus also faces complete economic collapse.
- By far the highest concentration of liabilities anywhere in the country is to be found today in the capital, Teheran. In the event of a strong earthquake, the insurance industry would have to reckon with losses amounting to several hundred million dollars.

Accumulation control and possibly the introduction of limits of indemnity are techniques that can make the risk acceptable even in such extremely exposed regions.

Cities in danger

Millions of people in Iran live in buildings that would collapse in a strong earthquake; throughout the world it is several hundred million. It is to be feared that the future will bring more tragedies like the quakes of Gujarat (India, 2001) and Izmit (Turkey, 1999), with death tolls of some 20,000. In fact, it is only a matter of time before a strong quake occurs again directly beneath a city with over a million inhabitants and claims the lives of several hundred thousand people, as in Tangshan (China) in 1979. Owing to the rapid growth of many Third World metropolises in highly-exposed regions, such a scenario has become distinctly more probable in recent decades in spite of the possibilities provided by modern earthquake engineering. Experts fear that if a strong quake were to be triggered beneath Teheran, which has a population of twelve million and has already been destroyed on several occasions in the course of its history, as many as one million people could die.

Munich Re has long been involved in a series of global initiatives set up by the United Nations aimed at disaster reduction; in this way, it makes a substantial contribution in its own field of competence to the sustainable economic and social development of countries in the Third World.

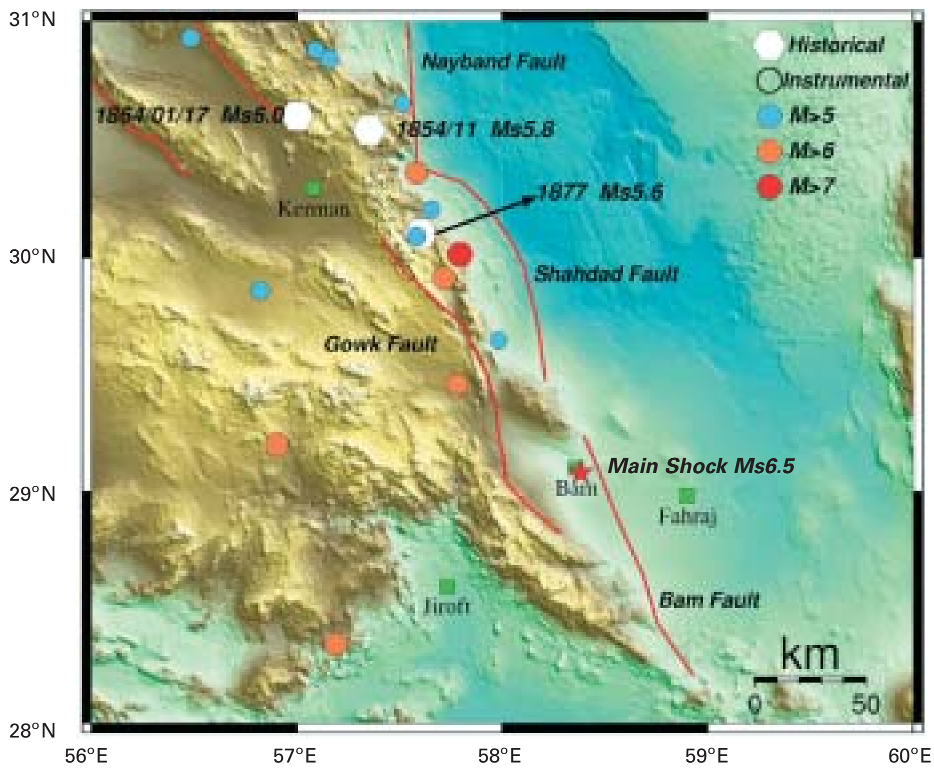

Fig. 2: Historical survey of earthquake activity in the region (Source: International Institute of Earthquake Engineering and Seismology, Iran).

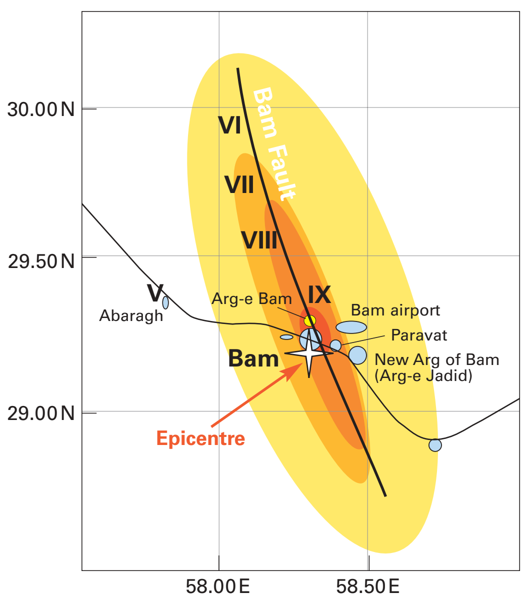

Fig. 3: Earthquake intensity map (EMS scale) of the earthquake on 26 December 2003 (Source: International Institute of Earthquake Engineering and Seismology, Iran).

Source: International Institute of Earthquake Engineering and Seismology, Iran.

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26, 27 The 2,000-year-old citadel in Bam – in 1975 (left) and after the earthquake.

Summary

The quake on 26 December 2003 devastated 70% of the city of Bam; more than a third of its inhabitants were killed. The reason for this horrific scene was the poor quality of the buildings. What makes it all the more tragic is that the region had been classified as a highly exposed zone even before the earthquake, so that the buildings should have been of safer construction.

The catastrophe demonstrates once again the connection that exists around the world between a low standard of development and a high number of fatal victims. Even if the hazard is known, the people in such regions simply do not have the money to build earthquake-resistant houses as a means of cushioning or avoiding catastrophes.

The ten most devastating earthquakes in Iran in the last one hundred years

Date	Region	Magnitude	Fatalities
23.1.1909	Borujerd	7.3	6,000
1.5.1929	Kopet Dagh	7.4	3,330
2.7.1951	Demavend		3,000
1.9.1962	Buyin-Zara, Quazvin	7.3	12,225
31.8.1968	Khorasan, Dasht	7.3	12,000
10.4.1972	Fars, Firuzabad, Ghir	7.0	5,044
24.11.1976	Northwest, area on border to Russia	7.3	5,000
16.9.1978	Tabas	7.7	20,000
20/21.6.1990	Gilan Province, Manjil-Rasht	6.2	40,000
26.12.2003	Bam	6.5	40,000+

Rare events?

08

Tropical cyclones in 2003 caused exceptional losses in the Bermudas, Korea, and Canada. The tropical cyclone season presented a mixed picture in the meteorologists' and insurers' statistics.

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Wind and storm surge damage at a hotel complex in the Bermudas. The damage caused by Hurricane Fabian reached from the roof of this complex to its foundations.

As in the years 1998–2002, windstorm activity in the Atlantic (US/Caribbean) was, with a total of 16 tropical cyclones, well above the long-term average of just under 10 (reference period: 1950–2002). On the other hand, the seven hurricanes (tropical cyclones in the Atlantic with wind speeds above 118 km/h, i.e. at least stage 1 on the 5-stage Saffir-Simpson Hurricane Scale [SS]) were more or less average.

In the Northwest Pacific (Southeast Asia), the year ended with 22 observed tropical storms (17 of typhoon force, corresponding to at least SS1). Windstorm activity in this region was thus below average in 2003; by way of comparison: the averages in the period 1950–2002 were about 26 for tropical storms and 20 for typhoons.

Tropical cyclones did not cause any outstanding losses for the insurance industry in 2003. With insured losses of US$ 1.7bn, the costliest event of the year was Hurricane Isabel, which attracted intense media coverage because of the very high wind speeds over the Atlantic (at times SS5) and the associated threat to the US East Coast. Fortunately, the hurricane weakened considerably just before landfall in North Carolina and hit the region around Cape Hatteras, where the population density and concentration of values are both comparatively low.

Nevertheless, the insurance industry was hit by losses in 2003 that meant new record highs for the areas affected:

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The storm surge whipped up by Hurricane Fabian washed sand and rubble into numerous buildings near the shore. Even if high wind-load standards are incorporated in the building code, they will not reduce such losses to any substantial degree.

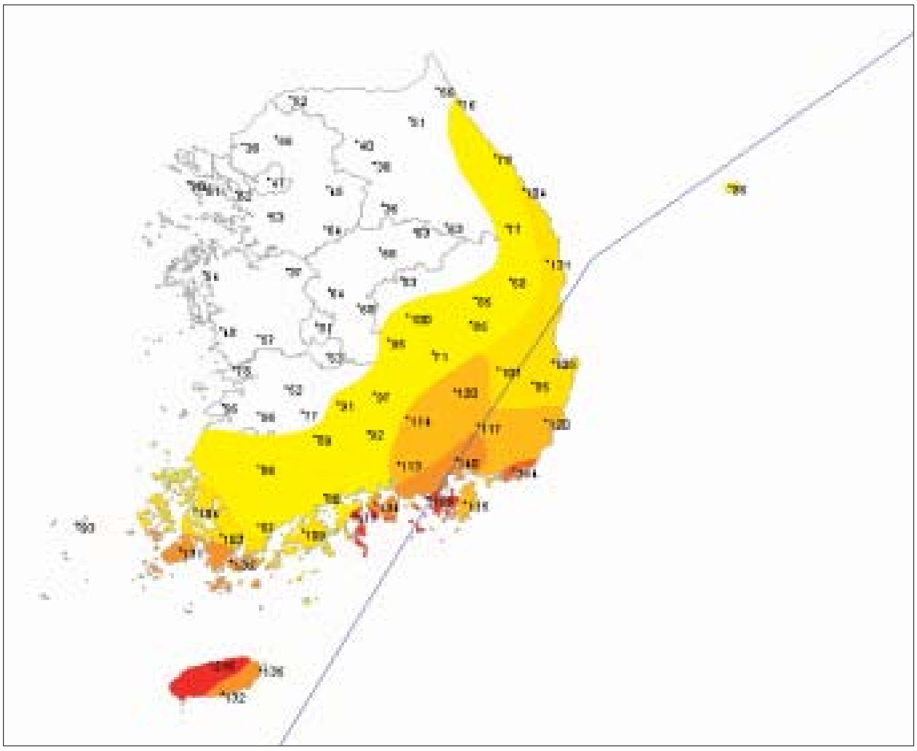
Hurricane Fabian:
Insured losses in the Bermudas: US$ 300m.
Largest hurricane insured loss on the Bermudas to date: Hurricane Emily in 1987 with US$ 35m

Fabian hit the Bermudas on 5 September 2003 at wind speeds of 195 km/h (10-minute mean). With an intensity of 3 on the Saffir-Simpson Scale, this was the strongest hurricane since 1926 on these islands, which in the last decade have developed into a significant offshore financial centre. In addition to the losses directly caused by the wind throughout the islands, there were also losses in the coastal regions due to storm surge and wave impact. The sea level rose by as much as 7 m, especially in the south of the main island. There are no dependable estimates on the extent to which water damage contributed to the overall loss. But the analysis of insured losses reveals that hotels and coastal resorts were affected more severely on average than residential buildings and other commercial risks.

The average loss ratio in the country as a whole (the ratio between the overall insured loss and the overall sum insured) was in the lower single-digit percentage range. There were some risks – especially hotels with business interruption cover – where the individual loss ratio was much less favourable, however, with values exceeding 20%. How does this vulnerability compare with the experience derived from hurricanes in the United

States and windstorms in Europe? The answer is indisputable: given a certain wind speed, the vulnerability of building and contents values in the Bermudas is much lower than in the coastal areas of the United States but somewhat higher than in Europe. This is partially due to the difference between tropical cyclones and extratropical storms in terms of the secondary hazards of torrential rain and storm surge. However, the main reason for the overall low vulnerability in the Bermudas is the generally meticulous attention to constructing buildings and roofs with solid materials.

Hurricane Fabian was another clear demonstration that if construction methods take the hazards into account, they can reduce the claims burden from catastrophe events considerably. This has a positive effect on the risk premiums. There is one thing that should not be forgotten, however. Fabian was only an SS3 hurricane in the Bermudas and thus far from being a potential accumulation scenario. If the islands had been hit by Hurricane Isabel (2003) with its intensities of up to SS5, it would have potentially been a probable maximum loss (PML) scenario.



The figures show the highest peak gusts (in km/h) recorded during Typhoon Maemi. The 10-minute average wind speeds are approx. 20% lower in each case (source: Korea Meteorological Administration; cartographic processing: Geo Risks Research Dept., Munich Re).

Typhoon Maemi:
Insured loss in South Korea: US$ 500m.
Largest insured typhoon loss in South Korea to date: Typhoon Rusa in 2002 with US$ 170m

Maemi, the tropical cyclone that was called a super-typhoon in many reports, crossed parts of South Korea on 12 September 2003 and presented the insurance industry with a bill that was more than three times as high as the record established the previous year.

In meteorological terms, Maemi was anything but an exceptional event, though. Only one weather station on the island of Cheju off the Korean mainland actually recorded a record wind speed of 216 km/h (in peak gusts). All the other 70 wind speed recordings (two of which were also made on Cheju) were in the 110–180 km/h range. In Pusan, the top reading was 154 km/h, a value that had already been reached or exceeded on two occasions since 1950. The position in Ulsan was quite similar: in the previous 50 years there had been three events in which Maemi's top speed of 120 km/h was exceeded.

Unlike Typhoon Rusa in 2002, Maemi was a relatively dry storm. In the exposure centres of Pusan and Ulsan, the 24-hour precipitation depths were 64 and 99 mm respectively (corresponding to a return period of less than one year). Only the southern coastal regions registered values of 200–300 mm/24 h and locally of up to 410 mm/24 h.

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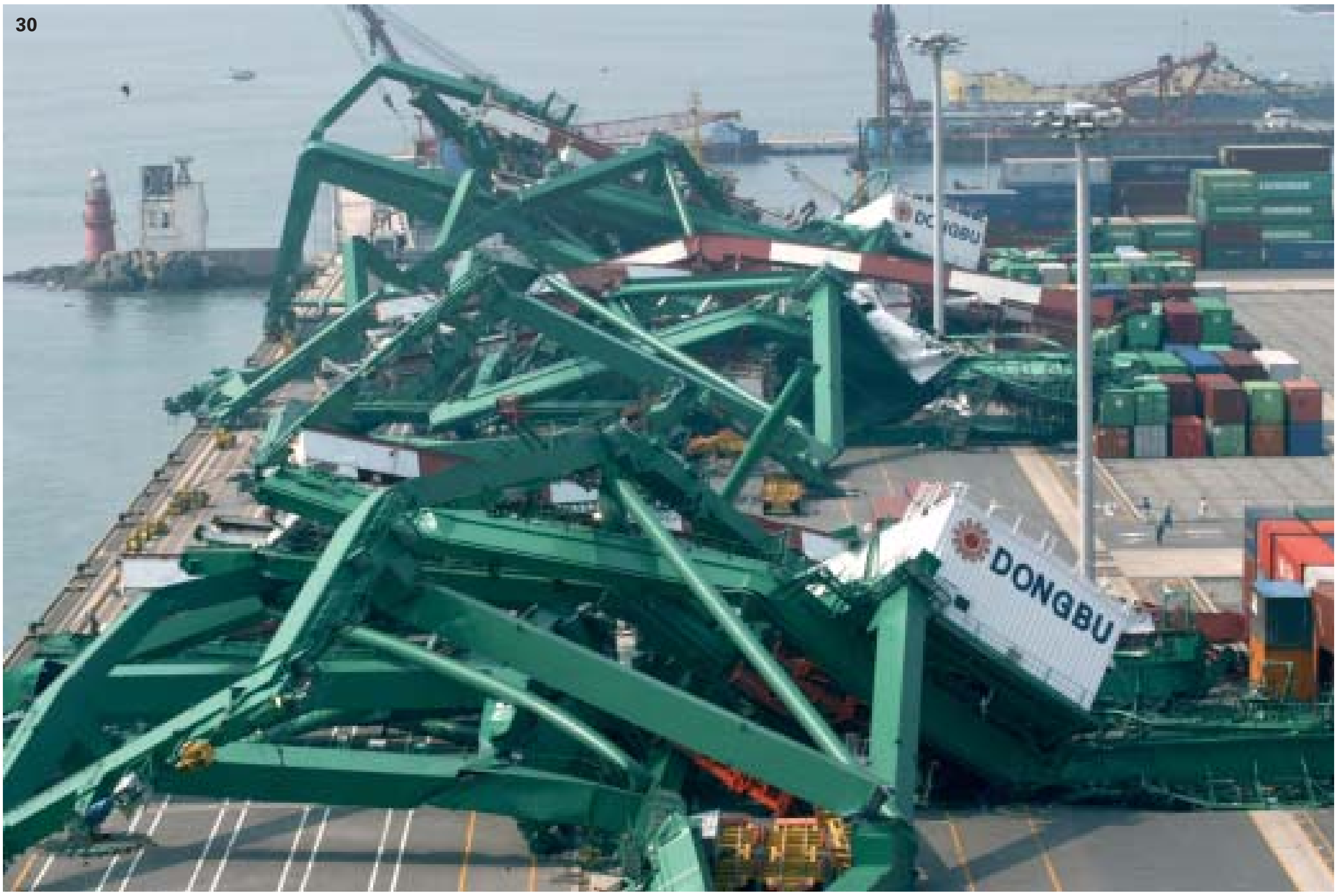

A loading crane toppled by the wind in the port of Pusan.

If the geographical distribution of insured values in Korea – essentially commercial and industrial risks – is taken into account, the following overall assessment of the Maemi loss emerges:

– The vulnerability to (windstorm) damage of the risks currently covered by insurance is reduced by the existence and monitoring of building codes. The local building codes for Pusan and Ulsan are geared to a wind speed of 144 km/h. On Cheju the minimum requirements are 162 km/h.

– Compared with the loss experience from tropical cyclones in the United States and extratropical storms in Europe, Maemi is to be considered – in terms of its intensity over the Korean mainland – as "medium". The average loss ratio (cf. Hurricane Fabian in item 1) was below the experience values for hurricanes with landfall in the United States, but clearly above the empirical values of gales in Europe in recent years (e.g. Lothar, 1999).

Hurricane Juan:
Insured loss in Canada: US$ 60m. Largest hurricane loss to date: Hurricane Hazel in 1954 with US$ 100m (total economic loss, original value at that time); since 1950, no insured loss from a topical cyclone has been higher than US$ 5m.

Although the loss burden was generally moderate, Juan was an exceptional hurricane. What made it exceptional was its meteorological data: when Juan reached the Canadian

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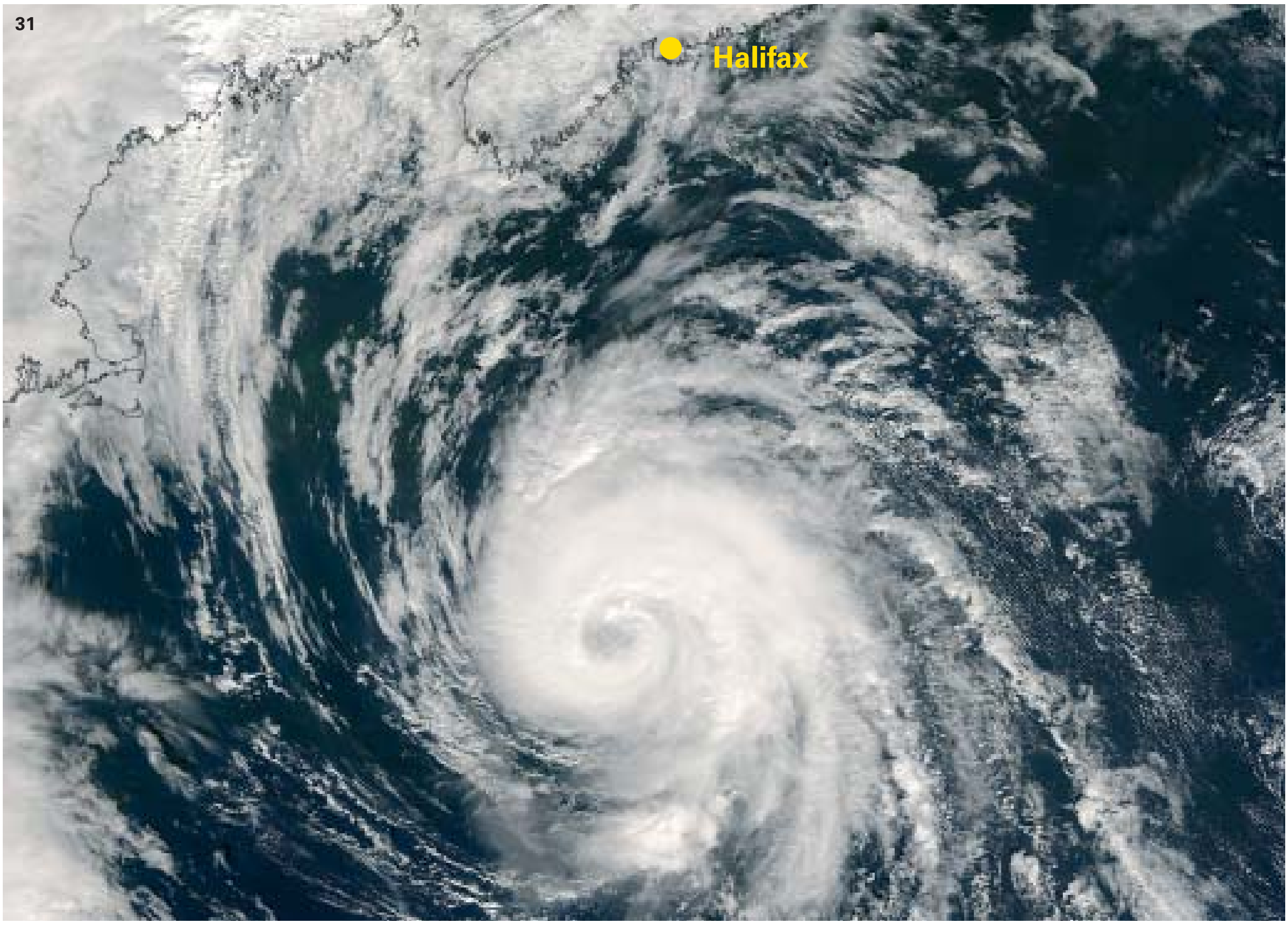


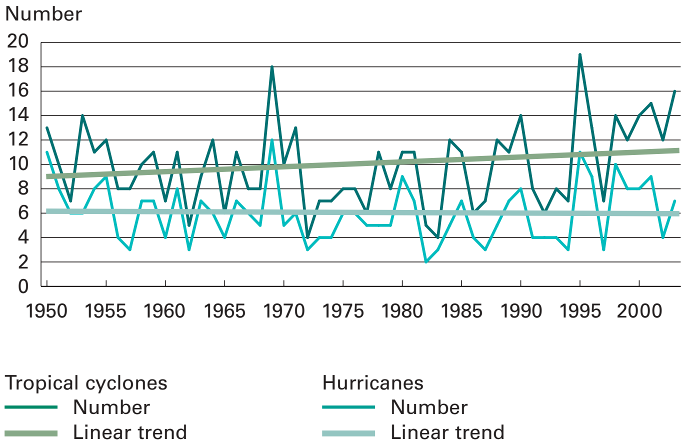
Satellite image of Hurricane Juan shortly before it reached the Canadian mainland near Halifax on 29 September 2003. In spite of the surface temperature of the North Atlantic already being quite cool at this high geographical latitude, the typical spiral structure of the hurricane vortex remained completely intact until landfall.

coast near Halifax at a latitude of about 44.5°N, it was a full-blown tropical cyclone with an intensity of SS2 and wind speeds of up to 158 km/h (in gusts). The region had not been hit by a hurricane of comparable strength in 40 years. Even Hazel – the most damaging tropical storm in Canada up to that time – had reached peak gusts of only 115 km/h over Canada. Extreme flooding on account of copious rainfall with values of up to 225 mm/24 h caused 83 deaths and an (uninsured) loss which – in current terms – would probably have come to more than US$ 1bn.

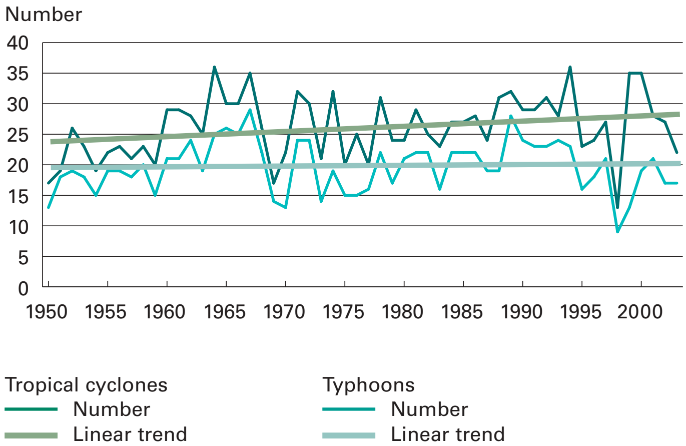
Windstorm activity in the North Atlantic and the Northwest Pacific 1950–2003

Statistics on tropical cyclones in the North Atlantic and the Northwest Pacific reveal an increase in windstorm activity in the period 1950–2003.

It is noticeable that in both regions the increase only relates to less extreme events. There is no change in the average number of hurricanes and typhoons. The reasons for the increase in the frequency of less extreme events are still unclear. For the time prior to 1970 at least – when complete monitoring of tropical cyclones became possible with the aid of satellites – changes in the observation methods could influence the quality of the data. But in recent decades there has been an increase in the expanse of sea areas with water temperatures exceeding 26°C – a precondition for the growth of tropical cyclones – and this could also raise the frequency of this type of storm.



The annual number of tropical cyclones and hurricanes in the period 1950–2003 in the North Atlantic (including the Caribbean). The 54-year average is 10 for tropical storms (including hurricanes) and 6 for hurricanes.



The annual number of tropical cyclones and typhoons in the period 1950–2003 in the Northwest Pacific. The 54-year average is 26 for tropical storms (including typhoons) and 20 for typhoons.

Geographical underwriting – Applications in practice

09

Creating transparency in the underwriting process is prerequisite to sustainability and long-term efficiency in risk management. The key to success is provided by a new method and technique: geographical underwriting.

The process of geocoding
The insurance companies' portfolio and/or loss data are geocoded on the basis of different levels of spatial detail. This is crucial for analyses of specific portfolios, computer models, and scenario calculations. These ultimately provide an essential basis for underwriting and risk management decisions.

Natural hazard business in property insurance calls for increasingly precise estimates of threat potentials (e.g. terrorism) and their interrelations. The only way to ensure success in the long term is to project appropriate prices for current and future risks. The hallmark of quality in the dealings of insurers and reinsurers is first-class risk management, because it guarantees the sustainability of business relations.

In order to meet the requirements of sustainable risk management, Munich Re's Geo Risks Research Dept.(GEO) has developed a new method designed to ensure in the long term that the complex business of insurance remains calculable and profitable: this method is called geographical underwriting.

In our last issue of topics – Natural Catastrophes, we presented the theoretical approach behind this method; in this issue, we will describe the initial experience we have gained through applying it in practice. We will also sketch out the steps that need to be taken prior to implementing the new processes in the management of natural hazards and man-made risks and in the course of loss analysis.

The process of geocoding

The starting point for future-oriented control and optimisation of portfolios with regard to natural hazards and man-made risks is to know as precisely as possible the geographical location of the risks concerned (georeferencing). Anonymised client portfolio and loss data provide the basis for this. Many companies in the insurance industry are already in a position to supply this important information.

The geocoding of portfolios of liabilities and losses (georeferencing) makes it possible to produce analyses and computer models in accordance with the geographical underwriting method.

Geocoding may be performed using various levels of detail (addresses, municipalities, postcodes) (Fig. 1). In view of the precision and quality required in the future, coarse geocoding, e.g. at country or state level, is no longer sufficient. The spatial definition (risk allocation) on the basis of CRESTA zones (cf. www.cresta.org) often used today in property insurance must be refined and made more transparent for important core markets and risk types.

The level of detail required in the geocoding process depends on the hazard for which the risk exposure is being examined. Given the modelling and simulation programs available nowadays, a distinction can be made between three levels of spatial detail (resolutions):

Coarse: Data with a coarse resolution usually only relate to regions, countries, federal states, or very large postcode units. Such a resolution may be used for large-scale hazards or scenarios (e.g. the effects of climate change, environmental influences) but it is of limited value as far as many other (natural) hazards are concerned.

Medium: If data of medium quality are available – precise postcode units, municipalities, and local authority

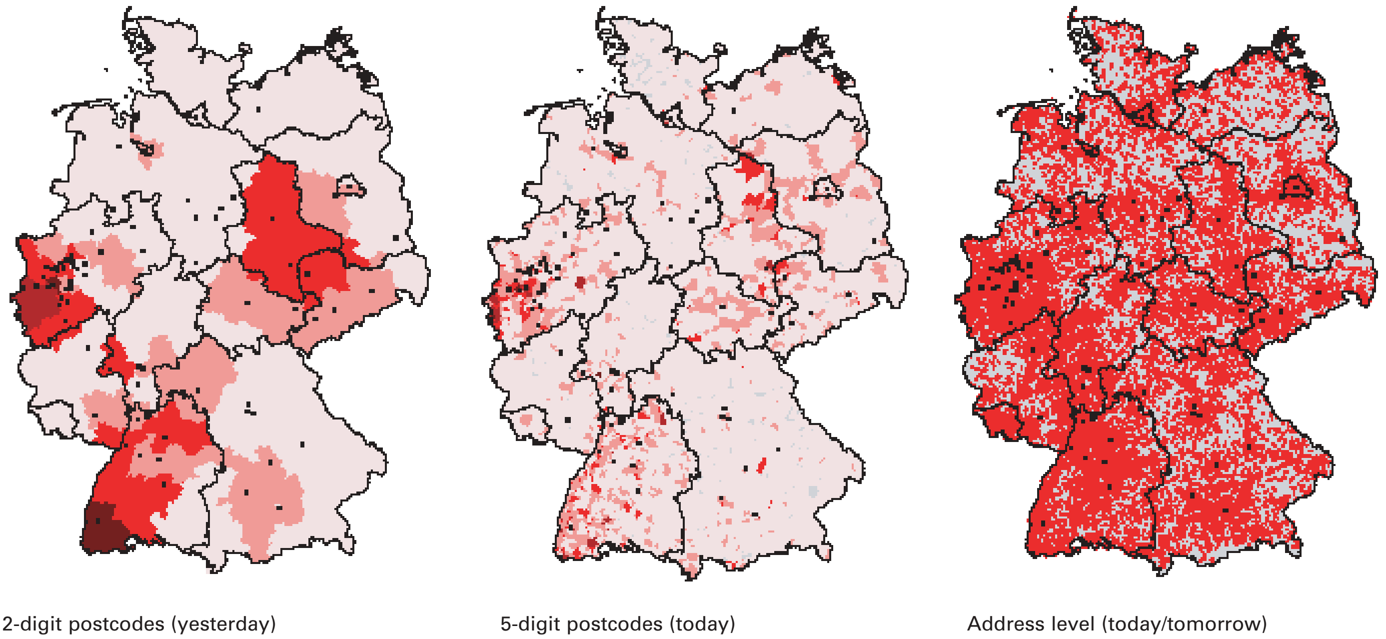


Fig. 1: **Risk allocation with varying levels of detail**
Using a simulated client portfolio as an example, the input datasets (e.g. liabilities) are visualised in various resolutions. The different colour intensities reflect the different liability concentrations. In Germany referencing is performed almost exclusively on the basis of 5-digit postcodes (in line with CRESTA). The address level result – in this case a property treaty with about one million addresses – gives an idea of how much better analyses can be if this level of resolution can be attained. Switching from 2-digit postcodes to data based on specific addresses increases a portfolio's transparency quite considerably.

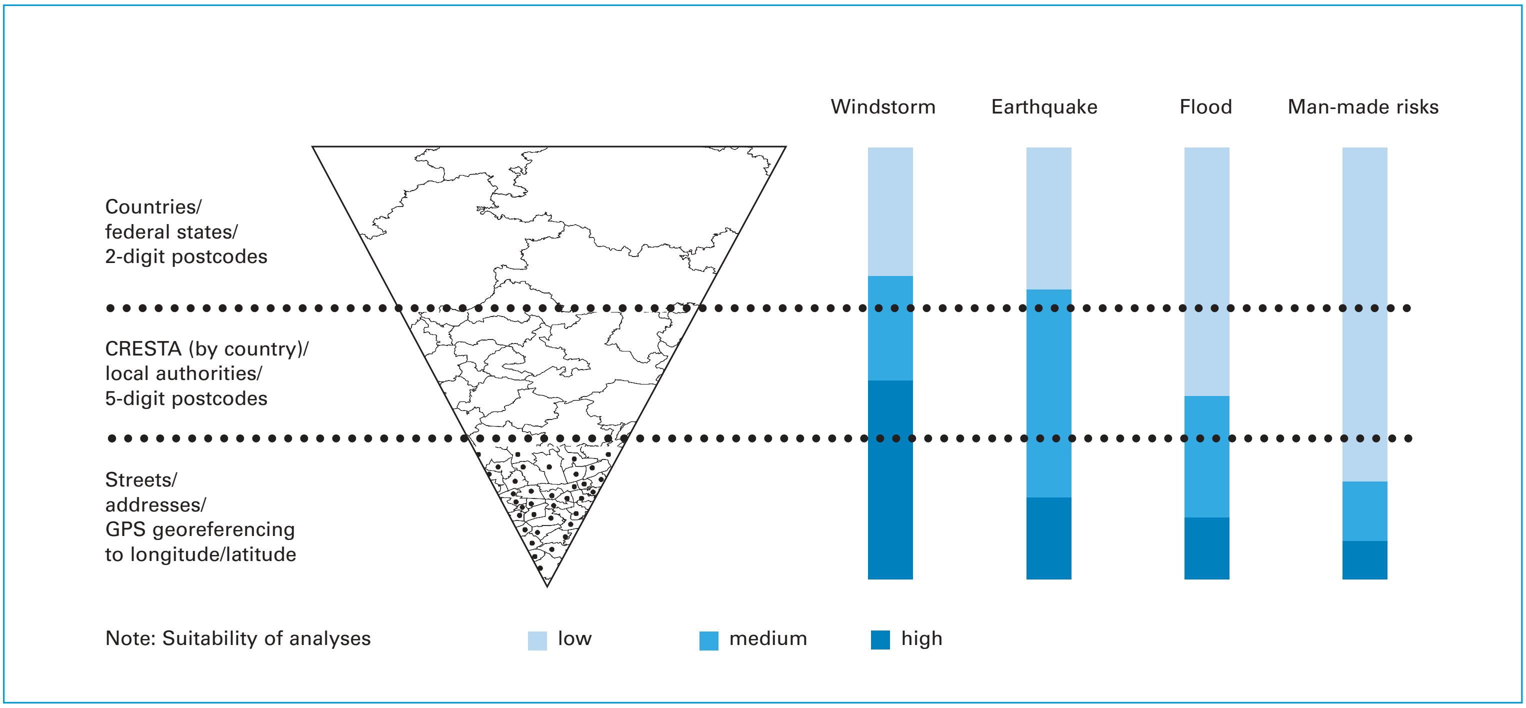


Fig. 2: **Levels of detail and their suitability for computer modelling and simulation**
Ideally, as much liability information as possible should be available with a high geographical resolution. It is then possible to aggregate to the most suitable level of detail, depending on the issues and objectives involved. This only functions from a lower to a higher level, however, i.e. from addresses (individual coordinates) to the next aggregation level upwards (postcodes, countries).

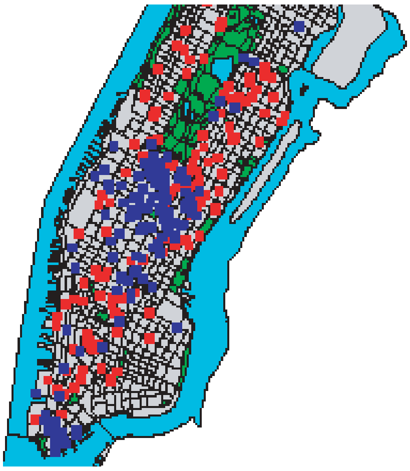


Fig. 3: Detailed accumulation and spread effects from several individual portfolios (red, blue: insured risks from two different portfolios).

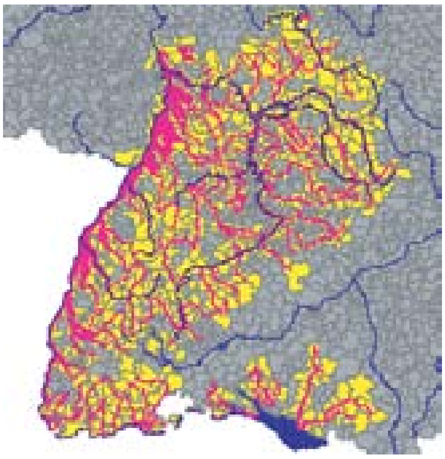


Fig. 4 a: Postcode areas potentially exposed to flood (yellow).

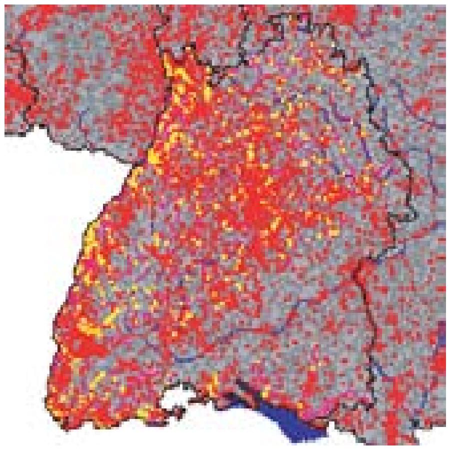


Fig. 4 b: Individual risks exposed to the flood hazard (yellow) on the basis of data with exact addresses (red: all risks).

boundaries – it is possible to produce quite realistic analyses for certain natural hazards like windstorm or earthquake. The majority of CRESTA zones are based on this classification.

Fine: If the focus of the hazards to be analysed is on small areas (as is the case with terrorist attacks and industrial accidents, for example) or if the question as to whether damage occurs or not depends on a difference of only a few metres (floods, hail), it will be necessary to work with more detailed geodata. This means the kind of information provided by individual addresses and GPS (Global Positioning System), which yield exact results down to a few metres.

The current position of geocoding

All geocoding services at address level are currently based on data collected for vehicle navigation and route planning purposes. At present there are two large firms whose offerings are used by all downstream service providers. These services are called location based services (LBS) in the trade and may be combined with the spatial analysis tools of Geographical Information Systems (GIS).

The data have a high level of coverage particularly in the important industrial countries. These countries are mainly the core markets in the insurance sector; the US market and Europe are very well covered. They will soon be joined by the Asian markets.

Geocoding is technically quite mature nowadays and has been tested sufficiently for it to be used in practice. What is more, external services can be used via the internet or integrated in a company's own IT landscape.

From the insurance point of view, not only risk analyses but also clients' master file data can be examined to ensure their postcodes are correct and can thus be used for efficient geo-marketing activities.

From the underwriting point of view, geocoding can be used in both treaty and facultative business when it has been enhanced to address level. To this end, a preliminary series of feasibility studies was performed in which real portfolios were analysed and their technical and operative viability verified.

In the following sections we present applications (computer models, scenarios) used in risk management that are possible on the basis of geocoding.

Case study: Holistic accumulation study

For the purposes of "transparency", visualising the spatial exposure distribution or the spread of risks is be-

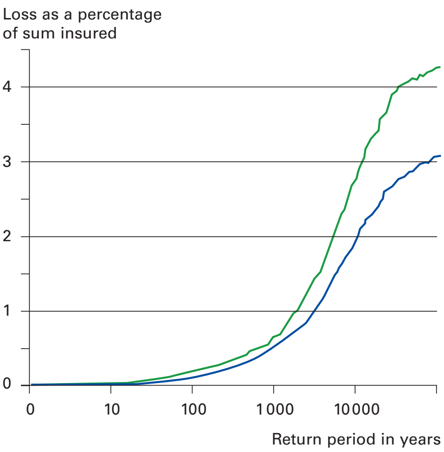


Fig. 5: Levels of detail and their possible effects on PML calculations.

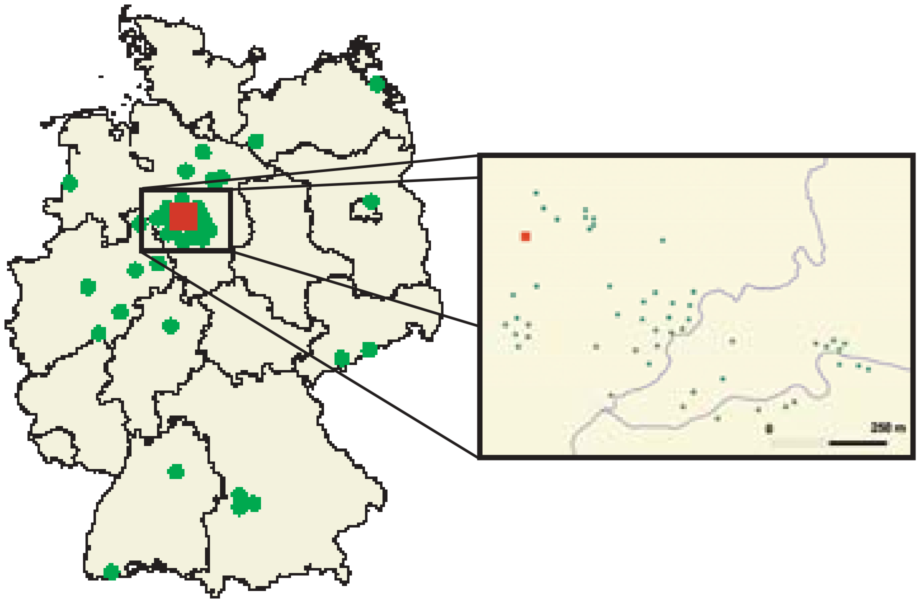


Fig. 6: The multi-location problem (overview and detail; red: address of the multi-location policy; green: actual location of the risks).

coming increasingly important. As the example of Manhattan demonstrates, centres of accumulation can be displayed precisely on the basis of addresses. In this example, the blue and red dots represent two portfolios, thus revealing spatially cumulative effects and the spread of risks. The ability to spatially analyse and visualise a complete accumulation, which may comprise several separate portfolios or client accounts, is of particular importance in this connection (Fig. 3).

Case study: Levels of detail and their effect in connection with accumulation

In order to calculate and analyse the property PML (probable maximum loss) in, for instance, areas prone to flooding, it is a great advantage to have exact knowledge of the risk (risk situation). The example (Fig. 4) shows how various levels of spatial detail influence the PML calculations on the basis of coarse and fine observations. The violet area in the diagram on the left is the area prone to flooding; the yellow areas are postcode areas that could be affected by a flood. As entire postcode areas are only flooded in exceptional cases, determining the areas that really will be affected is very difficult and prone to error. The reason for this is that the risks are not distributed evenly but have additional points of concentration (e.g. trading estates, built-up areas). Exact addresses were used for the data in the right-hand map. All the yellow dots coincide with the flood-prone area.

How strong an impact the level of detail may have on the PML calculation will depend on the composition and spread of the portfolio. In this specific example (Fig. 5) the PML derived from the postcode calculation (green line) is almost one-third higher than the address-based PML (blue line).

There are likely to be similar correlations for many portfolios, although divergent shifts are also conceivable.

Case study: The multi-location problem

Many portfolios contain multi-location policies, which are difficult to identify and analyse exactly – especially in the case of treaty business. These often involve housing associations or chains of companies, where the address quoted only refers to the headquarters while the policy actually includes many other risks at different locations as well. This can lead to a situation in which existing exposures are not identified or are incorrectly evaluated. This may prove to be a drawback both for insurers and for reinsurers.

In this example of a multi-location risk (Fig. 6), the known situation (red dot) would not lead one to expect an ex-

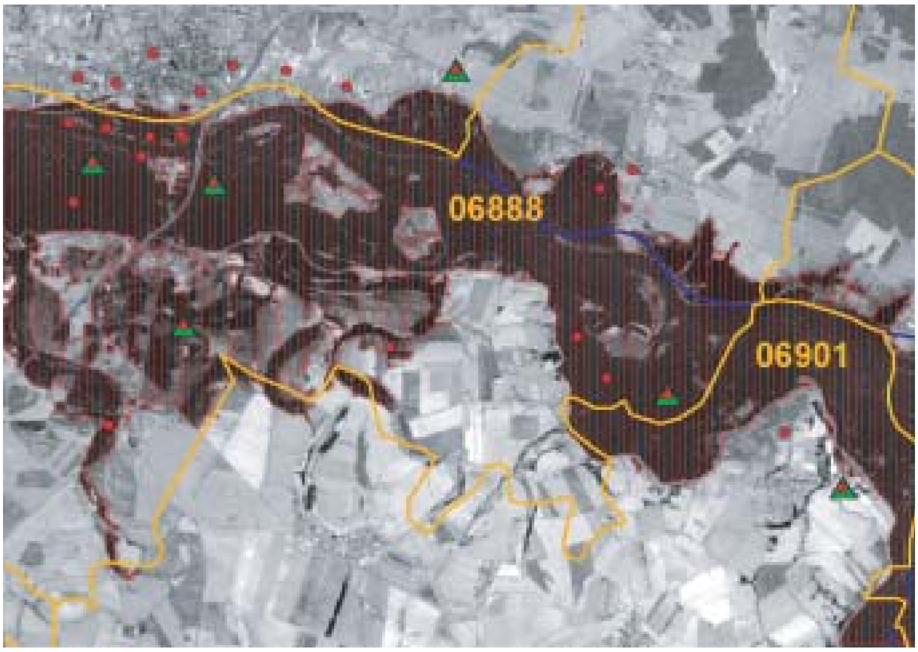


Fig. 7: Loss management can be improved considerably by linking up portfolio data with current weather or flooding information.

posure to flood. If all the individual risks subsumed under this policy are observed, however, it turns out that a not inconsiderable number of these individual risks are highly exposed. This frequently encountered problem can be solved if all the individual risks collected together in one multi-location policy are available with their address and the corresponding indemnity limit.

Case study: Improved loss management

A small section of the August 2002 floods in Germany reveals the enormous potential for analyses if datasets with exact addresses are used (Fig. 7). The area that has been flooded is marked on the basis of satellite data (cross-hatched in red). The yellow borders and captions relate to postcode areas and clearly show how coarse this "grid" is for this kind of analysis. The individual risks are shown as red dots. A clear distinction between risks that are affected and those that are not is both possible and important in order to be able to estimate loss potentials after an event. With the help of loss advices (green triangles) certain loss patterns may be derived which can be used for such purposes as claims handling. Claims relating to risks located outside the derived loss zones can be identified accurately so that any cases of doubt can be clarified.

Case study: Proactive underwriting

The expected risks of change (e.g. due to climate change) will very probably lead to an increase in natural catastrophes and extreme events.

Experience gained in the past is therefore of limited value as an indicator of the future. For this reason, proactive underwriting is required in which the, in all probability, higher losses of the future are appropriately considered.

The same applies to man-made hazards, the intensity and frequency of which do not follow scientific patterns. If these altered conditions in risk management are to be visualised, all possible scenarios must be taken into account and underwriting tools must be developed to deal with them.

Geocoding may also be used for the purposes of proactive risk control (risk clearance). This is the case, for example, with a Munich Re rating tool for facultative risks (Fig. 8): the risks in question are geocoded interactively on the basis of their addresses (red dots) and compared online with risks that have already been written and geocoded (triangles). On the basis of these data, the maximum loss amount in the direct vicinity of the new risk(s) is modelled (violet circle, all risks within this circle). In this way, an undesirable accumulation situation can be identified and calculated in advance, and if necessary avoided.

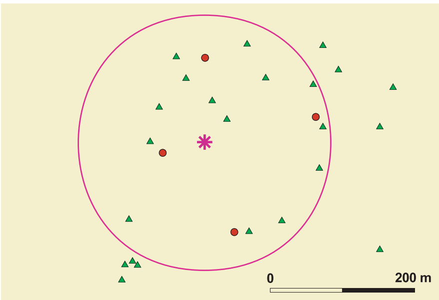


Fig. 8: Timely identification of accumulation situations by means of proactive risk control. The circle denotes the area of the maximum loss amount.

Next steps

We will only be able to manage the risks we assume to best advantage if we can assess them as accurately as possible. The advantage of the method outlined above is that accumulative effects are identified in good time, allowing underwriting options and risk control to be activated quickly and effectively for the purposes of sustainable portfolio management.

The following conditions must be met:

– The flow of data between insurer and reinsurer must be further intensified and optimised. Examples from the US market show that this is possible.

– In order to evaluate portfolios better, the data must be available at least in medium and preferably in fine detail. Only the latter makes it possible to conduct an analysis using any geographical spatial pattern desired. Until this step can be performed by all market players autonomously, service providers or reinsurers can fill the gap.

– Models already in place for natural hazards need to be further refined. Models for other hazards (e.g. terrorism) still have to be developed.

These approaches have already been realised successfully in a number of areas at Munich Re. The establishment of a geo-data platform is one of the central components; many applications will be able to access this analysis potential. It is essential that full advantage be taken of these enhanced geo-information services in the future.

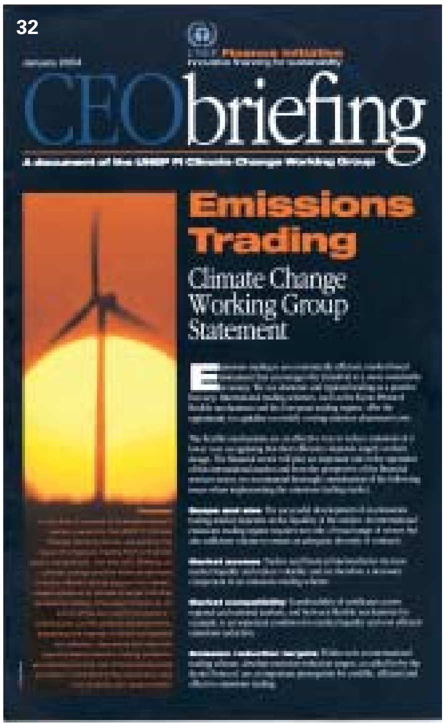
The 2003 climate summit and the Kyoto Protocol – Can we wait for Russia? 10

"Climate change remains the most important global challenge to humanity, and its adverse effects are already a reality in all parts of the world" – this was a key message in the final agreement of the climate summit in Milan. Even so, it would seem the 9th Conference of the Parties did not achieve very much. Or did it?

From 1 to 12 December 2003, some 5,000 experts from almost 200 countries – including politicians from 180 countries – gathered in Milan for this year's climate summit. The Conference of the Parties (COP) has the objective of establishing globally binding, effective climate protection measures.

The central issue of the discussions is the much-cited 1997 Kyoto Protocol, which sets out emission limits for a large number of countries. The Protocol is not only supported by all the major emerging and developing countries (e.g. Brazil, South Africa, India, China) but has also been ratified by 120 countries, including large industrial nations like the EU member states, Japan, and Canada. Australia, Russia, and the United States are still missing from the list – but the arrangements are that the Kyoto Protocol can become globally binding international law as soon as it has been ratified by either the United States or Russia.

The US government accepts climate change as a fact – but is still looking for alternative ways of dealing with it. It is calling for even more evidence that environmental change is attributable to human activity and is concentrating its efforts on research into new climate protection technologies. This is the policy increasingly being followed by Australia too. Against this backdrop it was clear that the whole world and particularly the media would concentrate on the stance adopted by Russia and so reporting focused on the question: Will Russia ratify – yes or no? In the months prior to the meeting, the signals from Moscow – even from individual ministries – were sometimes positive, sometimes negative. The ratification issue will probably continue to cause heated debate; but experts and insiders still expect the Kyoto Protocol to be signed and sealed in the foreseeable future.



On time for the climate summit in Milan, the banks and insurers that are taking part in the UNEP Finance Initiatives published a paper explaining their position with regard to emissions trading. It presents the most important aspects in clear terms.

What subjects did the negotiations in Milan address?

- The climate conference in Milan closed further important gaps in the provisions that shape the Kyoto Protocol. This included defining the modalities for the recognition of afforestation and reforestation projects in developing countries. Such projects must not only be designed to absorb CO_2 permanently, they must also be scrutinised and performed in accordance with ecological and socio-economic criteria.

- It was also important to settle what is to happen with reforestation projects and plantations that have been destroyed after being recognised as CO_2 sinks. If a forest has been cleared or has burned down, it makes sense to take this fully into account and deduct the certified emission reductions that have been granted.

- Another topic addressed was the future of the climate convention "after Kyoto". There was a discussion of the issues and obligations the community of states should be aiming for after the first commitment period (2008–2012).

- One particularly pleasing outcome of COP 9 was that a number of countries committed themselves to developing their renewable energy sources. These included numerous Arabian and African countries (Egypt, Djibouti, Morocco, Syria, and others).

Is Russia alone the key to climate protection?

Reporting directly from Milan, the BBC said, "Russia holds climate key". Although the Kyoto Protocol and its ratification represent the first and hence one of the most important global steps towards climate protection, there is no sense in simply waiting for ratification to happen. There are other important developments running parallel that also promote climate protection.

- The banks and insurers taking part in the UNEP Finance Initiatives programme have stepped up their dialogue with the politicians – for the following reason: a good basis for cooperation is necessary because the Kyoto Mechanisms specified in the Protocol will generate many environmental projects throughout the world and these will depend on support from financial services providers.

- At the beginning of June 2004, Germany will host a major world conference on renewable energies (Renewables 2004). It is being organised by the federal government, which gained further support for this initiative at the Milan summit. "Renewables 2004" will undoubtedly have a stimulating effect – also on the economy. The significance of renewable energies will be given a further boost.

- 2005 sees the start of international emissions trading in the EU member states. Approx. 12,000 industrial facilities in such sectors as energy, steel, and minerals will be given clearly delineated emission allocations and limits. Energy efficiency ought then to be seen relatively quickly as an economic opportunity, which will promote the implementation of climate-friendly and ecological technologies. In this context, Munich Re is investigating possible new fields of business for the insurance industry.

A further question is whether the no fewer than 120 countries that have already ratified the Protocol should not forge ahead with their climate protection commitments parallel to the Kyoto process. After all, these countries have more than underlined that they intended to implement an earnest climate protection policy. Then why wait for Russia?

"Climate change remains the most important global challenge to humanity, and its adverse effects are already a reality in all parts of the world" was one of the final statements made by ministers and representatives from 188 nations around the world at COP 9 in Milan. As the effects of global climate change become more and more noticeable, every possible effort must be made to save the climate – and without delay.

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33 A waterspout near Limassol on the south coast of Cyprus on 27 January.

Münchener Rückversicherungs-Gesellschaft
Königinstrasse 107
80802 München
Germany
Tel.: +49 (0) 89/38 91-0
Fax: +49 (0) 89/39 90 56
http://www.munichre.com

Responsible for content
Corporate Underwriting/Global Clients,
Geo Risks Research Dept.

Persons to contact
Thomas Loster
Tel.: +49 (0) 89/38 91-52 87
Fax: +49 (0) 89/38 91-7 52 87
E-mail: tloster@munichre.com
Angelika Wirtz
Tel.: +49 (0) 89/38 91-34 53
Fax: +49 (0) 89/38 91-7 34 53
E-mail: awirtz@munichre.com

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