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Summary

Man-made losses take on a new dimension

USD 34.4bn in insured losses (property and business interruption)

At USD 34.4bn, the burden on property insurance due to catastrophe losses was extremely high in 2001, with an estimated USD 19bn incurred by property and business interruption losses arising from the terrorist attack of 11 September. Furthermore, the insurance industry is having to cover liability and life insurance losses related to the attack which are estimated at USD 16.5-39bn (cf List on page 8 and Figure 3 on page 9). As regards property and business interruption losses, which we deal with on the following pages, 2001 was only just surpassed as the worst in insurance history by 1992 (Andrew) and 1999 (winterstorms in Europe, eg Lothar).[1] While in 1992 and 1999 the record losses were due to natural catastrophes, in 2001 it was the man-made losses that weighed heaviest on the insurers' books.

Man-made disasters cause USD 24.4bn in insured losses, natural catastrophes USD 10.0bn

Of the USD 34.4bn in insured losses, USD 24.4bn was attributable to man-made and USD 10.0bn to natural events. Without the 11 September terrorist attack, 2001 would have been just an average loss year: the storm-related losses amounted to about USD 7.2bn, those caused by earthquakes lay around USD 0.6bn, while losses due to flooding totalled a mere USD 0.07bn. Not counting the terrorist attack, fire and explosion losses amounted to USD 3.7bn, aerospace losses to USD 1.1bn.

33 000 fatalities, high economic losses due to major events

In the 315 events recorded by *sigma,* more than 33 000 people lost their lives; the earthquake in Gujarat (India) in January alone accounted for at least 15 000 fatalities, the terrorist attack of 11 September over 3000. Apart from the 11 September attack, the total financial loss from which is difficult to quantify, further events caused economic losses in the billions – among them tropical storm Allison (USD 5.0bn), the Gujarat earthquake (USD 4.5bn) and the Code Red computer worm (USD 2.6bn).

Natural catastrophes: reinsurers and investors mitigate fluctuation in the loss burden

In the long term, it is especially storms, floods and earthquakes that impact the insurance industry – for this reason, it is crucially important for reinsurers and investors alike to be able to diversify the natural catastrophe risk. An analysis of historical *sigma* data indicates that geographic diversification significantly reduces the risk, but that diversification with investment portfolios can help to diminish the risk still further.

Large-scale terrorist attacks call for new approaches in insurance – trend towards higher losses continues

In the light of the risk factors in evidence worldwide – increasing population densities, higher concentrations of values especially in exposed regions – the trend towards higher losses continues unabated. Add to this the new dimension of large-scale terrorist attacks with their high and complex loss potentials. Direct insurers and reinsurers have taken up the challenge and have developed new approaches: re-assessing insurability and offering special terrorism covers with initial government involvement.

[1] The reference for this study is the period since 1970; all the losses in this study have been calculated at 2001 prices; for the selection criteria used in *sigma* see pages 4/5.

Terms and selection criteria

Terms

Natural catastrophes

The term "natural catastrophe" is taken to mean an event caused by natural forces. Such an event generally results in a large number of individual losses involving many insurance policies and insured parties. The scale of the losses resulting from a catastrophe depends not only on the severity of the natural forces concerned, but also on man-made factors such as building design or the efficiency of disaster control in the afflicted region. In the present study, natural catastrophes are broken down into six categories:

– floods
– storms
– earthquakes (including seaquakes and tsunamis)
– drought, bush fires (including heat)
– cold waves, frost
– other (including hail and avalanches)

Man-made disasters

This study categorises as "man-made" or "technical" disasters major events associated with human activities. Generally a large object in a very limited space is affected which is covered by a small number of insurance policies. The study subdivides man-made disasters into seven categories:

– major fires, explosions
– aviation and space disasters
– shipping disasters
– road/rail disasters
– mining accidents
– collapse of buildings/bridges
– miscellaneous (including terrorism)

Loss figures

"Losses" comprise all insured losses except liability. Leaving aside the liability losses on the one hand allows a relatively swift assessment of the insurance year but on the other tends to under-state the cost of man-made disasters. A figure identified as a "total loss" or "economic loss" includes all damage, whether insured or not.

Selection criteria

sigma has been publishing tables listing major losses since 1970. In order to maintain comparability of the selection criteria over the course of time, the minimum threshold for inclusion of losses is adjusted annually to compensate for inflation in the US. Thresholds with respect to casualties – numbers of dead, missing, severely injured, homeless – also make it possible to tabulate events in regions where the insurance penetration is below average.

Limits in 2001

For the 2001 reporting year, the lower loss thresholds were set as follows:

Insured losses:	Shipping	USD 14.1m
	Aviation	USD 28.3m
	Other losses	USD 35.1m
or		
Economic losses:		USD 70.2m
or		
Casualties:	Dead or missing persons	20
	Injured	50
	Homeless	2 000

Adjustment for inflation and correction of the loss amounts

sigma converts all losses for the occurrence year not given in USD into USD using the end-of-year rate. To take account of inflation, these USD values are extrapolated using the US consumer price index to give current (2001) values.

Example of adjustment for inflation

As an illustration, here are the property loss figures from the explosion on the Piper Alpha oil rig in the North Sea on 6 July 1988:

Insured loss in 1988 prices: USD 2.0bn
Insured loss indexed to 2001: USD 3.0bn

Changes to past data

If changes to the loss amounts of previously published events become known, *sigma* takes these into account. Such changes do affect the data on past events held by *sigma,* but only become evident where an event appears in the table of the 40 most costly insured losses or of the disasters with the most fatalities since 1970 (Tables 9 and 10, pages 23/24).

Sources

Newspapers, direct insurance and reinsurance periodicals, specialist publications (in printed or electronic format) and reports from insurers and reinsurers provided the sources for the choice of events for inclusion.[2] Although all the information used in this study was taken from reliable sources, Swiss Reinsurance Company does not accept any responsibility for the accuracy or comprehensiveness of the details given. The information provided is for informational purposes only and in no way constitutes Swiss Re's position. In no event shall Swiss Re be liable for any loss or damage arising in connection with the use of this information. (See also the copyright information on page 2).

[2] Natural catastrophes in the US: those sigma figures which are based on estimates from the Property Claims Service (PCS), a unit of the Insurance Services Office, Inc. (ISO), are given for each individual event in ranges defined by the PCS. The estimates are proprietary to ISO and may not be reprinted nor used for any purpose, including use as a component in any financial instruments, without the express written consent of ISO.

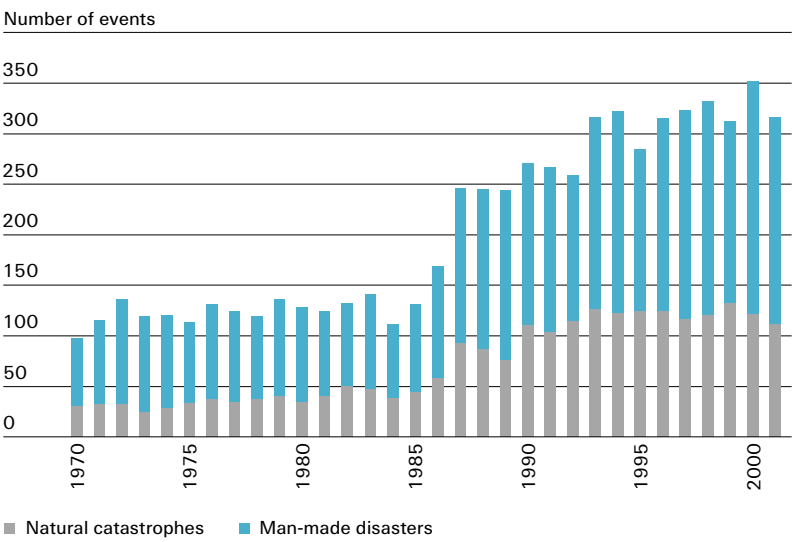
Catastrophes in 2001: record losses in property insurance, over 33 000 fatalities in all

Number of catastrophes running high since 1987

315 catastrophes in 2001

Since the late 1980s, the number of catastrophes has been high at more than 250 natural catastrophes and man-made disasters per year.[3] A major part of these are road and shipping accidents, major fires and aerospace incidents. In the year under review, *sigma* reported 315 major losses; of these, 111 were attributable to natural catastrophes and 204 to man-made disasters. (cf Table 6, List of major losses in 2001 according to loss categories, page 21.)

Figure 1
Number of events 1970–2001



Billion-dollar economic losses in 2001

Were it not for 11 September, the economic losses of the year 2001 would have been below the average of the costly loss years since 1987. (The overall economic loss due to the terrorist attack is not taken into consideration here, as its indirect adverse consequences are extremely difficult to quantify.) Economic losses in the billions were caused by tropical storm Allison in the US (USD 5.0bn), by the earthquake in India (USD 4.5bn), the drought in Iran (USD 2.5bn) and the earthquakes in El Salvador (USD 1.5 bn) and in the US (USD 1.0bn). Man-made events likewise caused economic losses in the billions, for instance, the Code Red computer worm (USD 2.6bn) or the explosion on an oil rig (USD 1bn).[4]

[3] The improving availability of information distorts the statistics especially for developing countries, eg with regard to road accidents.

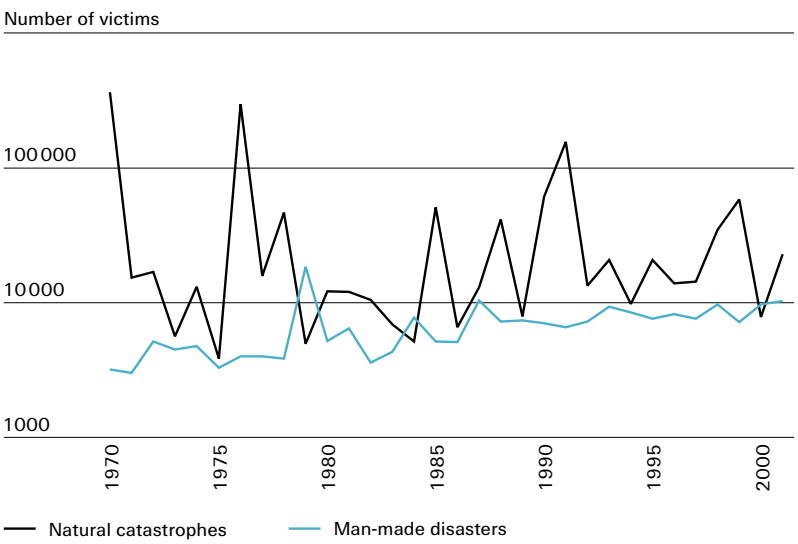
[4] The chronological list of loss events is not included, for copyright reasons. For a pdf file or a print-out, please contact *sigma*@swissre.com or the editors listed on page 2.

High death toll – the earthquake in Gujarat in January 2001 alone claimed 15 000 fatalities

Over 33 000 deaths due to earthquakes, floods and terrorism

Over 33 000 people lost their lives in the events recorded by *sigma.* The terrorist attack on 11 September claimed over 3000 victims. But as in previous years, natural catastrophes again took a high toll: more than 16 000 people died in 13 earthquakes, 15 000 in the Gujarat (India) quake alone. Almost 4000 people perished in floods and over 2 000 were killed in storms. (cf Table 8, The 20 worst catastrophes in terms of victims in 2001, page 22.)

Figure 2
Number of victims 1970–2001



The number of fatalities in 2001 is slightly lower than the average of the past 15 years. It should be noted, however, that the number of catastrophe victims varies considerably from year to year; for instance the high fatality levels of the years 1970, 1976 and 1991 were mainly attributable to two tropical cyclones in Bangladesh and an earthquake in China. (cf Table 10, The 40 worst catastrophes in terms of victims 1970–2001, page 24.)

Insured losses in 2001: a new record in man-made disasters

Insured losses of over USD 34bn

The insured loss caused by large-scale events in 2001 amounted to USD 34.4bn – of which USD 10.0bn were due to natural catastrophes and USD 24.4bn to man-made disasters. The property and business interruption losses caused by the terrorist attack of 11 September – not to mention the liability and life insurance losses – are estimated at USD 19bn, which makes the terrorist strike the highest property loss ever in the history of insurance. For the sake of comparison, the previous most costly man-made property losses were: the explosion on the Piper Alpha oil rig in 1988 (USD 3.0bn) and an explosion in a petrochemicals plant in Texas in 1989 (USD 2.9bn; both figures indexed to 2001). For the first time since the 1990s, when natural catastrophe losses

clearly decided the worldwide property insurance balance, the technical losses tipped the scales in 2001 with a share of well on 70%. (cf Table 7, The 20 most costly insurance losses in 2001, page 22.)

The loss estimates in connection with the terrorist act of 11 September vary widely. Here are some of the published estimates which, by contrast with the *sigma* statistics, also include liability and life insurance losses:

Insured loss (all lines) from the terrorist act of 11 September

Estimates of the insured loss (all lines) from the terrorist attack of 11 September:[5]

Line of business	Range, in USD bn
Property	10.0 – 12.0
Business interruption	3.5 – 7.0
Workers' compensation	3.0 – 5.0
Aviation	3.0 – 6.0
Liability	5.0 – 20.0
Other non-life	1.0 – 2.0
Life & health	4.5 – 6.0
Total	30.0 – 58.0

Regional focus of insured losses in 2001: US and Europe

The US accounted for four-fifths of all insured losses worldwide, precisely because of 11 September and tropical storm Allison. For Europe the figure was just on 9% – mainly due to an explosion in a fertiliser factory in France. Asia bore about 6% of the insurance burden – especially because of the typhoons Nari and Danas (Taiwan, Japan) but also as a result of a major fire in Taiwan. The Asian region was once again the region with the highest proportion of victims, accounting for approximately 70% of the total; but the US also recorded a large number of disaster victims in the year.

Table 1
Catastrophes in 2001 by region or country

Region/country	Number	as %	Victims	as %	Insured loss in USD m	as %
Europe	35	11.1 %	761	2.3 %	2,869	8.3 %
America	65	20.6 %	5,731	17.3 %	28,489	82.8 %
US	29	9.2 %	3,451	10.4 %	27,614	80.3 %
Asia	157	49.8 %	23,093	69.9 %	1,982	5.8 %
Africa	50	15.9 %	2,951	8.9 %	190	0.6 %
Oceans/space	8	2.5 %	514	1.6 %	861	2.5 %
World total	315	100.0	33,050	100.0	34,392	100.0

[5] Source: Tillinghast Towers Perrin, status on 31 January 2002.

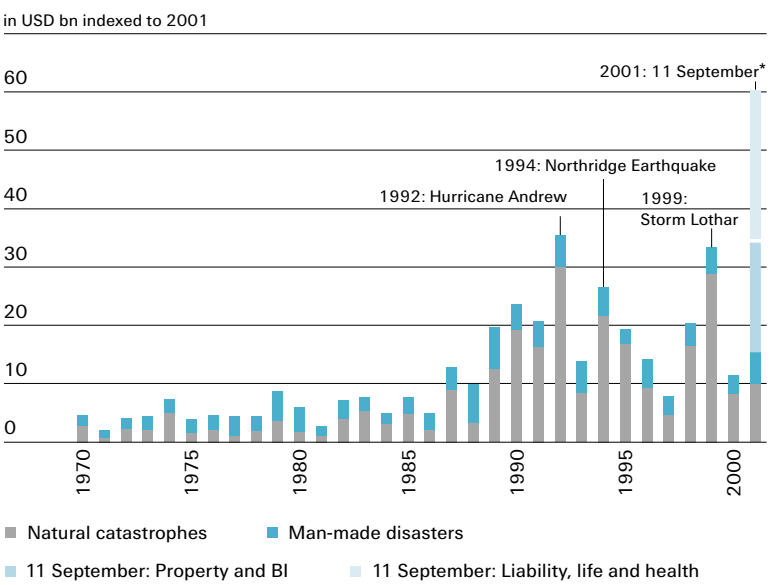
Insured losses: trends since 1970

Series of record-loss years since 1987

At USD 34.4bn, the total amount of losses incurred in the year under review is way above the inflation-adjusted average of the record-loss years since 1987. However, the period 1987–2001 is striking on account of the extraordinarily strong fluctuation in the claims burden: at an average insured loss of USD 20.2bn per year, the standard deviation amounts to no less than USD 9.0 bn.[6]

In terms of man-made major losses, 2001 is a record year with USD 24.4bn, by comparison with the 15-year average of USD 5.9bn. As regards natural catastrophes, by contrast, the insured loss of USD 10.0bn is less than the 15-year average of USD 14.3bn. (cf Table 9, The 40 most costly insurance losses 1970–2001, page 23.) Figure 3 puts into perspective the estimated liability and life and health insurance losses of 11 September when compared with the property and business interruption losses incurred for the whole of 2001.

Figure 3
Insured losses 1970–2001
(property and business interruption)



* Estimate of the total insured loss (all lines of business, incl. liability as well as life and health): USD 30–58bn.

Data in Figure 3: The data are available in the *sigma* chartroom on the Swiss Re Portal www.swissre.com/portal – free of charge and round the clock.

Natural catastrophes the most serious cause of loss in the long term

Averaging USD 8.9bn per year, storms have been the most serious cause of loss since 1987, followed by earthquakes (USD 1.6bn) and floods (USD 0.8bn). However, the losses of USD 0.07bn attributed to flooding in the year under review appear to be particularly low. This is because floods often occur in the wake of a storm, so that the losses they cause are attributed to the storm itself – for example, in the case of tropical storm Allison in the US, where the

[6] Around two-thirds of insured losses due to catastrophes lie in the range "mean less standard deviation" to "mean plus standard deviation"

secondary flooding caused about 90% of the insured loss. The absence of further billion-dollar insured losses due to natural catastrophes in 2001 is completely fortuitous.

Outlook

Increasingly devastating catastrophes – more people and properties in exposed areas

The scale of the natural catastrophes and man-made disasters recorded by *sigma* has been on the increase since 1970 and reflects the growing loss potential due to

- higher population densities
- more insured assets in exposed areas
- higher concentrations of values worldwide.

Though the rise in insured losses is being curbed by preventive measures and higher deductibles, the *sigma* statistics nevertheless show that these mitigating measures are still being outweighed by loss-increasing factors.

More losses in the billions

Precisely these billion-dollar losses due to natural catastrophes and man-made disasters are a crucial factor impacting on the insurers' loss burden. What is more, the scope of these exposures has been enlarged by the new dimension of the terrorist attack of 11 September, and in future allowance will have to be made for such large-scale attack in threat scenarios. But direct insurers and reinsurers have taken up the challenge and have developed new approaches (cf the section on "Terrorism", pages 16–20).

Geographic diversification

Geographic diversification of storm, flood and earthquake risks

On average over the years, storms, floods and earthquakes are the most costly catastrophes – this holds true even taking into account the high man-made losses of the year 2001. Storms, floods and earthquakes are the result of physical causes that are independent of each other: atmospheric pressure differences, uncontrollable masses of water, and geophysical forces, respectively. The only instance in which some limited interdependence can be observed is in the case of floods, which frequently follow storms that have been accompanied by heavy precipitation. From the geographic aspect, too, natural catastrophes are independent of each other, provided sufficiently broad regional terms of reference are defined. For this reason, natural catastrophe risks can be relatively well diversified on a global scale. This applies to only a limited extent to the insured portion of natural catastrophe losses, as the insured values are spread extremely unevenly by region. International reinsurers are able to balance out a major part of the fluctuation in the loss burden due to natural catastrophes over the years. For example, in a given year the worldwide reinsurance premiums for natural catastrophes may be used to pay for a high loss in the US; in another year these premiums are available to pay for a catastrophe in Japan.

Extremely costly loss years rarely affect more than one broad region

It is virtually impossible to empirically verify the options available for diversification on the basis of loss data alone, because precisely the largest natural catastrophes occur very rarely and are thus underrepresented in the longest series of historical loss data. On the basis of examples taken from the *sigma* loss data, which date back to 1970, it can be shown, however, that above-average insured losses due to natural catastrophes have only very rarely occurred simultaneously in different regions of the world. For the purposes of the following analysis, extreme years are defined as years in which the insured losses due to the three natural perils storm, flood and earthquake exceed USD 500m (indexed to 2001). If the broad regions Africa, America, Asia, Europe and Oceania are defined, the following picture is obtained:

Table 2
Years with simultaneous extremely high insured losses in the period 1970–2001
(Africa, America, Asia, Europe and Oceania)

Number of regions with simultaneous extreme years	Number of years	Specific years
3	7	89, 91, 93, 95, 98, 99, 00
2	10	72, 74, 82, 83, 84, 87, 90, 94, 97, 01
1	12	70, 73, 75, 76, 78, 79, 80, 85, 86, 88, 92, 96
0	3	71, 77, 81

Only seven out of 32 years exhibit extremely high losses in three regions at the same time

Since 1970, above-average high natural catastrophe losses have never occurred in more than three of the five regions at the same time. Only seven of the 32 years were counted as extreme years in three of the five regions at the same time. In most of these cases, it was North America, Asia and Europe that were simultaneously affected, because the loss threshold of USD 500m tends to be exceeded more often in markets of this size. More frequently, two (in ten out of 32 years) or only one of the five regions (in twelve out of 32 years) experience extreme losses in any year. In three of the 32 years, no region recorded insured losses of more than USD 500m.

Geographic diversification also pays off in terms of the mean variation of the loss ratios.[7] The mean loss ratio due to natural catastrophes has nearly doubled since 1990 compared with the previous period (1970–1989); for this reason, Table 3 shows only the values since 1990. The mean loss ratio due to natural catastrophes is highest in America at 2%, followed by Asia and Europe. This is related to the higher concentrations of insured values in these regions, but is also a consequence of the greater exposure of these values in high-risk areas.

Table 3
Insured natural catastrophe losses[8] 1990–2001

Average, in USD bn Indexed to 2001	**Africa**	**America**	**Asia**	**Europe**	**Oceania**	**World**
	0.042	9.196	1.995	2.963	0.035	14.231
as % of non-life premiums						
Average	0.6 %	2.0 %	1.3 %	1.0 %	0.2 %	1.5 %
Standard deviation	1.7 %	1.7 %	1.9 %	1.6 %	0.4 %	0.8 %
Variation coefficient[9]	3.14	0.87	1.47	1.60	1.77	0.56

Variation of the loss burden due to natural catastrophes higher per region than in a global insurance portfolio

The mean variation of the loss burden due to natural catastrophes is significantly higher in the individual regions than in the case of an insurance portfolio that spans the whole world. While in such a global portfolio the variation of the natural catastrophe loss ratio amounts to only 56% of the mean (a variation coefficient[10] of 0.56), in America the relative variation is as much as 87% of the mean, and in the other regions it even exceeds the mean by a clear margin. These statistics show that international diversification of the natural catastrophe risk, as practised by international reinsurers, can significantly reduce the fluctuation in the loss burden from year to year. As international reinsurance only has to make available as much capital as is required for the global portfolio, its relative capital cost is lower than that for regional or single-country reinsurance solutions.

Accumulation potential due to natural perils limits the scope for geographic diversification

However, the natural perils harbour an enormous accumulation potential, as the loss peaks in the years 1992 and 1999 impressively show (see Figure 4). The various insurance markets are too different in size to permit, for example, the risk capital required for the American market to be reduced by diversification with insurance portfolios in Africa or Oceania. Cross-compensation between the larger regions of America, Asia and Europe works better, but still suffers from the fact that average losses in America in the past twelve years were three times higher than in Europe and more than four and a half times as high as in Asia. This indicates that the potential for geographic diversification also has its limits.

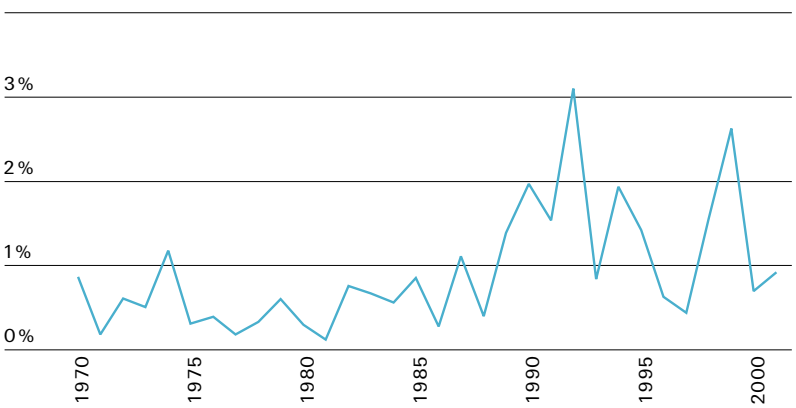
[7] Insured catastrophe losses divided by the premium volume from the respective region, giving a kind of "catastrophe-loss ratio".
[8] Here comprising only the three most important perils: storm, flood and earthquake.
[9] Defined as standard deviation / mean.
[10] The variation coefficient is the most familiar measure of relative variation and is defined as the standard deviation divided by the mean. The standard deviation is not suitable for cross-comparisons, as it depends on the mean: in regions with a high mean, the standard deviation is likewise high, and vice versa.

Absorption of fluctuation worldwide

Investment portfolios absorb the remaining fluctuation

Further options for balancing risk in the worldwide portfolio are diversification over time or diversification with investment portfolios which include not only insurance but also other risks. In the case of diversification over time, a few years' premiums added together are sufficient to pay for the losses. However, there must be enough capital available to cope with fluctuation from year to year. Diversification with non-insurance risks is based on the fact that there is hardly any correlation between natural catastrophes losses and financial market parameters: whether a natural catastrophe causes a loss has little or nothing to do with a stock exchange index or interest rate levels.[11] Because this is the case, the variation of a portfolio of stocks and bonds can be reduced by mixing in catastrophe risks. For this reason, cat bonds – and other similar financial instruments – are an ideal addition to an investor's portfolio and can serve as a complement or a hedge for international reinsurance. At present, however, the cost of such capital market instruments is higher in most cases than that of traditional reinsurance, mainly because investors are not yet very familiar with these instruments and insurance risks appear to be far from transparent enough for the capital market. For this reason, cat bonds are being increasingly linked to objective (parametrical) indices based on economic values; this makes it easier for the investor to assess the mostly quite minor probability of default.

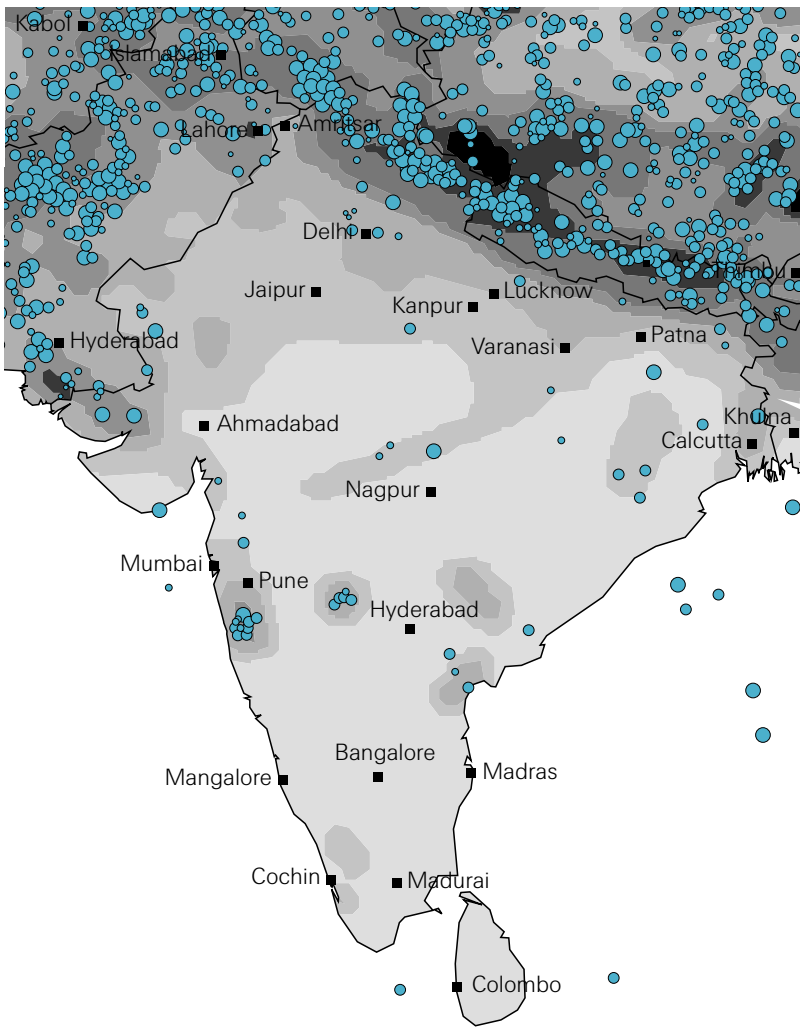
Figure 4
Insured natural catastrophe losses[12] as % of non-life premiums, 1970–2001



[11] For example, the New York Stock Exchange showed hardly any response to the USD 20.2bn loss caused by Hurricane Andrew on 23 August 1992: on Monday, 24 August, the S&P500 index dropped 1% by comparison with Friday, 21 August, only slightly more than the normal day-to-day fluctuation range; at year-end 1992, the index was 3.8% higher than on the day before the hurricane.

[12] Here comprising only the three most important perils storm, flood and earthquake.

Figure 5
Example of a CatNet map image of earthquake risk in India



Assessment of the natural catastrophe risk made easy thanks to CatNet

CatNet offers loss data on natural catastrophes, an interactive atlas of natural perils, insurance information on specific countries, and lots more besides.

CatNet – a new online tool for assessing natural perils

CatNet is a new instrument for specialists dealing with natural events and their loss potentials. It offers rapid access to data on natural perils. The search function gives a choice of 500 000 place names. Map displays provide information on earthquake hazards, wind speeds, flood and CRESTA zones. CatNet helps the user to estimate losses due to potential catastrophe scenarios and enables him to call up insurance policy terms from various countries. It also contains *sigma* loss data on natural catastrophes.

CatNet in brief:

- Global overview: information on natural catastrophes worldwide, even on unfamiliar regions.
- Speed: check the exposure of your portfolio or assess facultative risks related to earthquake, storm or other natural perils at a glance.
- Flexibility: the application is accessible round the clock.

Contact addresses

CatNet is available to Swiss Re clients free of charge. For further information on CatNet, visit the Swiss Re Portal (http://www.swissre.com/portal) or ask Swiss Re Client Services:

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Immeasurable terrorism risk

The devastating attacks on the World Trade Center in New York and the Pentagon in Washington on 11 September 2001 abruptly forced the insurance world to address the urgent issue of international terrorism. The attacks demonstrated that this type of threat has become virtually immeasurable in terms of both the severity and frequency of exposure – making it difficult for the private insurance industry to adequately cover this risk. While insurers and reinsurers are already willing and able to provide limited cover for terrorism risk, they are also examining a viable long-term approach. Experience with other extraordinary risks – natural catastrophes such as earthquakes or floods – provides valuable guidance on how to cope effectively with the terrorism risk.

Terrorism and terrorism risk

The phenomenon of terrorism is difficult to define in unambiguous terms. The definition Swiss Re currently uses in its reinsurance treaties focuses more on the effects than on the motives of this phenomenon:

Definition

Terrorism means an act or threat of violence or an act harmful to human life, tangible or intangible property or infrastructure with the intention or effect of coercing any government or putting the public or any segment of the public in fear.

Terrorism and natural catastrophes – numerous parallels

History and loss experience show that terrorism is in no way a novelty for the insurance sector. However, 11 September has brought to light a new dimension of international terrorism, with a staggering, previously inconceivable scale of threat scenarios and loss potentials. Terrorism risk in many ways closely parallels natural catastrophe risks such as earthquakes, storms and floods. In both cases, enormous inherent loss potentials make diversification difficult to achieve; individual events can affect entire economies and many different lines of insurance business. And yet, there are also significant differences: unlike terrorist attacks, natural hazards occur randomly and without intent, and their probabilities and consequences can be modelled with scientific data and methods.

Terrorism risk insurance before 11 September

Government-backed or pool arrangements in highly-exposed countries

Historically, fire insurance covered fire and explosion damage regardless of its cause, with the exception of damage caused by war, civil war or civil commotion. Since, in most countries, terrorism was not mentioned in war exclusion clauses, fire or explosion damage resulting from a terrorist attack was covered. Special regulations or pool solutions with governmental support are in place to cover terrorism risk, but only in a few particularly exposed countries: UK, Spain, South Africa and Israel. Tables 4 and 5 provide an overview of terrorism losses between 1970 and 2001.

Table 4
The 10 most costly insured losses due to terrorist attacks

Insured loss (in USD m, indexed to 2001)	Victims	Date	Event	Country
19 000	at least 3 000	11.09.2001	Terror attack against WTC, Pentagon and other buildings	USA
907	1	24.04.1993	Bomb explodes in London's City (near NatWest tower)	UK
744	–	15.06.1996	Bomb explodes in Manchester	UK
725	6	26.02.1993	Bomb explodes in garage of WTC	USA
671	3	10.04.1992	Bomb explodes in London's financial district	UK
398	20	24.07.2001	Suicide bombing at Colombo International Airport	Sri Lanka
259	2	09.02.1996	Bomb attack on London's South Key Docklands	UK
145	166	19.04.1995	Bomb attack on government building in Oklahoma City	USA
138	270	21.12.1988	PanAm Boeing 747 crashes at Lockerbie due to bomb explosion	UK
127	–	17.09.1970	Three hijacked passenger airplanes dynamited in Zerga	Jordan

Table 5
The 10 most deadly terrorist attacks

Victims	Insured loss (in USD m, indexed to 2001)	Date	Event	Country
at least 3 000	19 000	11.09.2001	Terror attack against WTC, Pentagon and other buildings	USA
300	–	23.10.1983	Bombing of US Marine barracks and French paratrooper base in Beirut	Lebanon
300	6	12.03.1993	Series of 13 bomb attacks in Mumbai	India
270	138	21.12.1988	PanAm Boeing 747 crashes at Lockerbie due to bomb explosion	UK
253	–	07.08.1998	Two simultaneous bomb attacks on US embassy complex in Nairobi	Kenya
166	145	19.04.1995	Bomb attack on government building in Oklahoma City	USA
127	45	23.11.1996	Hijacked Ethiopian Airlines Boeing 767-260 ditched at sea	Indian Ocean
118	–	13.09.1999	Bomb explosion destroys apartment block in Moscow	Russia
100	–	04.06.1991	Arson in arms warehouse in Addis Ababa	Ethiopia
100	6	31.01.1999	Bomb attack on Ceylinco House in Colombo	Sri Lanka

The new challenge after 11 September 2001

Insured losses (all lines of business) due to 11 September are set to far exceed those caused by Hurricane Andrew

Total insurance losses from the 11 September attack on the World Trade Center are still difficult to quantify. The resulting loss total is certain to be much higher than that incurred by Hurricane Andrew, now only the second largest insurance event in history, which hit Florida in 1992 causing insured losses to the tune of some USD 21bn. These dimensions illustrate that both the severity and frequency of loss exposure have become virtually immeasurable. The potential scale of fatal and disruptive effects is compounded by various factors. Modern technology and extremely effective and lethal weapons – including chemical, biological, or hazardous nuclear materials – are available to terrorists. Further, terrorists are ready to sacrifice their own lives to maximise damage, disruption, horror and the number of fatalities. The size, complexity and vulnerability of certain targets – such as densely overbuilt downtown areas or economic centres – enable perpetrators to achieve staggering consequences with relatively simple but concentrated attacks.

New terrorism and insurability

Terrorism covers: rising demand and dwindling supply

Before 11 September, terrorism loss potentials appeared to be manageable by the private insurance industry. Accordingly, terrorism risk was largely covered on a private basis. Since that date, new dimensions of terrorism have prompted a surge in genuine and legitimate demand for insurance protection against this type of threat. At the same time, the insurance industry is having to fundamentally review its risk acceptance position, and to reduce and limit coverages granted to avoid incurring unmanageable exposures in the future.

The question whether terrorism risk is insurable at all must be thoroughly reviewed. The criteria for the insurability of risks in general first need to be examined:

Criteria for insurability of risks

1. Assessibility: the probability and severity of losses must be quantifiable.
2. Randomness: the time at which the insured event occurs must be unpredictable, and the occurrence itself must be independent of the will of the insured.
3. Mutuality: numerous persons exposed to a given hazard must join together to form a risk community within which the risk is shared and diversified.
4. Economic feasibility: private insurers must be able to charge a premium commensurate with the risk.

Terrorism risk challenges the traditional criteria for insurability

Obviously, terrorism risk does not readily satisfy all of these criteria. The data available from past events gives little indication of the future risk. Although terrorists do not act randomly, but strike by surprise and deliberately maximise effects, their attacks are fortuitous for their victims. Mutuality is difficult to achieve, given the major differences in terrorist hazard exposure between landmark risks and most other buildings. The tremendous loss potentials and the risk of co-ordinated terrorist actions throughout the world hamper diversification. And, finally, the evident uncertainties regarding risk quantification make the economic feasibility of the business extremely doubtful.

State involvement

In view of such difficulties, a quick answer – and an understandable instant response by insurers to the shock of 11 September – is to exclude terrorism from insurance policies altogether. This could make the government step in to provide cover, as is currently the case in the UK, Spain, South Africa, Israel and (since January 2002) France.

The state as the insurer of last resort – a remedy with immediate effect

Some major hurdles to insurability can be overcome through state involvement. The state as the insurer of last resort is in a better position to deal with extreme loss potentials than are private insurance companies with their limited capital and capacity. Governments can make terrorism insurance mandatory and spread the risk throughout an entire society. Pricing is not a major issue, since premiums can be easily adjusted to loss experience in the course of time. At the same time, this approach generates significant funds, permitting even large future losses to be covered. Solutions of this kind are both feasible and effective. They are commonly applied in many markets for natural catastrophe risks such as earthquakes or floods.

Private insurance solutions take time to build up capacity

On a purely private basis and without state involvement, terrorism risk can be insured to a certain extent. However, accumulating the necessary private insurance capacity does take time. For example, we expect the private insurance industry in the US to develop – over the next three to four years – the means to cover terrorism, using an approach similar to its current practice regarding natural catastrophe risks.

Combination of state and private resources for a transition period

In the case of acute incompatibility between supply and demand for terrorism risk insurance – as is currently in evidence in the US market – temporary solutions permitting an efficient combination of private and public resources are appropriate, based on the following principles:

1. Mandatory direct insurance: all property risks are automatically covered against terrorism, the aim being to finance and provide affordable cover for highly exposed risks.
2. Levy on current property premiums: this surcharge should generate sufficient premiums to enable the international reinsurance market to participate.
3. Sharing the loss burden: this important aspect should be combined with efforts to align the interests of all parties involved, ie insured parties, direct insurers, reinsurers and government:

- Insured parties carry a significant deductible.
- Direct insurers retain a certain share of the premium and cede the remainder into a "terrorism pool".
- Losses in a bottom layer per event are paid by the direct insurer, while losses beyond this layer are paid out of the pool.
- Beyond a given deductible, the pool is reinsured on a non-proportional, per event basis by private reinsurers, and in excess of that amount jointly by reinsurers, capital markets, and the government.

Solidarity helps overcome capacity shortages

In this situation, the government would be in the dual function of establishing rules to impose the solidarity required to overcome the insurance capacity shortage, and itself acting as an insurer of last resort by providing financial capacity for very large loss events that exceed private insurance capacity. Government involvement can be significantly reduced or phased out over time as private insurance capacity accumulates.

Consequences for insurers and reinsurers

New threats have to be assessed in accordance with established standards

Regardless of the degree of state involvement, the challenge of terrorism calls for an appropriate response by the insurance and reinsurance sector. Terrorism risk must be treated on the basis of the established principles of risk assessment and management: identify threats, accurately define perils and covers, limit exposures, quantify risks, price risks adequately, grant cover separately or exclude terrorism risk altogether, if these criteria cannot be fulfilled.

Premiums commensurate with the risk are indispensable

Terrorism cover can be offered only on a limited, selective basis and against payment of an additional premium which reflects the individual risk. Unless solidarity is imposed through some form of state involvement, landmark risks will inevitably carry higher premium rates. Cover conditions – ie deductibles and cover limits at the direct insurance and reinsurance level – must ensure that risk sharing among the insured, direct insurers and reinsurers is well-balanced, and that overall exposures are kept within defined limits.

Insurers and reinsurers who are willing to assume terrorism risk must re-implement or revise some established insurance principles and tackle a new set of topical issues in the following areas:

Topical issues for insurers and reinsurers

1. Coverage conditions, wordings, and clauses: update the definition of risk, covered perils, excluded perils. Apply sublimits and specify named perils to restrict the scope of cover.
2. Pricing and underwriting: develop more refined pricing methods and procedures, adjusted to risk type, country, region, loss experience and expectancy.
3. Risk and capital management. For example: extend scenarios and capacity management procedures to make allowance for possible terrorist attacks, enhance analysis for correlations between lines of business and between underwriting/investment/credit/operational risks, develop alternative risk transfer products and systems addressing terrorism risk.

Table 6
List of major losses in 2001 according to loss category*

	Number	as %[13]	Victims[14]	as %[13]	Insured loss[15] (in USD m)	as %[13]
Natural catastrophes	**111**	**35.2%**	**22 803**	**69.0%**	**10 010**	**29.1%**
Floods	47		3 972		70	
Storms	37		2 077		7 165	
Earthquakes	12		16 273		645	
Droughts, bush fires	4		127			
Cold, frost	7		349			
Other natural catastrophes	4		5		2 130	
Man-made disasters	**204**	**64.8%**	**10 247**	**31.0%**	**24 381**	**70.9%**
Major fires, explosions	**40**	**12.7**	**921**	**2.8%**	**3 748**	**10.9%**
Industry, warehouses	17		371		2 086	
Oil, gas	7		11		1 161	
Hotels	1		78			
Department stores	2		1		140	
Other buildings	6		144		286	
Other fires, explosions	7		316		75	
Aviation disasters	**17**	**5.4%**	**785**	**2.4%**	**1094**	**3.2%**
Crashes	10		666		87	
Explosions, fires						
Damage on ground	2		119		71	
Air collisions						
Space	5				936	
Other aviation accidents						
Shipping disasters	**22**	**7.0%**	**1 609**	**4.9%**		
Freighters	2		65			
Passenger ships	19		1 523			
Tankers	1		21			
Drilling platforms						
Other shipping accidents						
Road/rail disasters	**75**	**23.8%**	**2 061**	**6.2%**		
Buses, trucks	62		1 813			
Trains	12		247			
Major pile-ups	1		1			
Other traffic accidents						
Mining accidents	**18**	**5.7%**	**959**	**2.9%**	**68**	**0.2%**
Collapse of buildings/bridges	**5**	**1.6%**	**156**	**0.5%**		
Miscellaneous major losses	**27**	**8.6%**	**3 756**	**11.4%**	**19 472**	**56.6%**
Terrorism, social unrest	4		3 165		19 398	
Other major losses	23		591		74	
Total	**315**	**100.0%**	**33 050**	**100.0%**	**34 392**	**100.0%**

[13] Percentage share of event group in total
[14] Dead and missing
[15] Excluding liability losses

* The chronological list of loss events is no longer included, for copyright reasons. For a pdf file or an (English) print-out, please contact *sigma*@swissre.com or the editors listed on page 2.

Table 7
The 20 most costly insurance losses in 2001

Insured loss[16] (in USD m)	Victims[17]	Date	Event	Country	Non-life premium volume (in USD m, indexed to 2001)	Loss as % of NL-premium volume
19 000	3 000	11.09.2001	Terrorist attacks on WTC, Pentagon and other buildings	US	463 481	4.1 %
3 150	33	05.06.2001	Tropical storm Allison; rain, floods	US	463 481	0.7 %
1 900[18]	–	06.04.2001	Hailstorms, floods, tornadoes	US	463 481	0.4 %
1 357	30	21.09.2001	Explosion in fertiliser factory; 4000 homes destroyed	France	38 336	3.5 %
600	103	06.09.2001	Typhoon Nari; floods, landslides	Taiwan, Japan	–	–
500	1	03.08.2001	Storm Hartmut, hail; winds of up to 112 km/h	Germany	69 623	0.7 %
500	11	15.03.2001	Explosion on board Petrobras drilling platform P-36	Brazil	10 745	4.7 %
485	–	30.04.2001	Violent thunderstorms, hail and tornadoes	US	463 481	0.1 %
398	20	24.07.2001	Rebels destroy aircraft of Sri Lankan Air	Sri Lanka	–	–
335	–	09.06.2001	Heavy thunderstorms and hail	US	463 481	0.07 %
320	–	07.09.2001	Loss of power in Hughes-702 satellite	Space	–	–
305	1	28.02.2001	Earthquake (moment magnitude 6.8)	US	463 481	0.07 %
300	5	10.09.2001	Typhoon Danas, winds of up to 108 km/h	Japan	105 800	0.3 %
286	–	12.05.2001	Fire in Asia Pacific Design Centre	Taiwan	7 301	3.9 %
285	–	06.05.2001	Thunderstorms, floods, hail	US	463 481	0.06 %
253	–	06.09.2001	Panamsat PAS-7 loses power capacity	Space	–	–
215	–	23.10.2001	Severe cold front, thunderstorms	US	463 481	0.05 %
200	25	06.07.2001	Storms over western Europe	France et al.	–	–
190	5	24.02.2001	Thunderstorms, tornadoes	US	463 481	0.04 %
n.a.	–	14.08.2001	Explosion in refinery	US	463 481	n.a.

[16] Excluding liability losses
[17] Dead and missing
[18] Figures for natural catastrophes in the US by courtesy of the Property Claims Service (PCS)

Table 8
The 20 worst catastrophes in terms of victims in 2001

Victims[19]	Insured loss (in USD m)[20]	Date	Event	Country
15 000	100	26.01.2001	Earthquake (moment magnitude 7.7) in Gujarat	India, Pakistan
3 000	19 000	11.09.2001	Terrorist attack on WTC, Pentagon & other buildings	US
886	–	10.11.2001	Torrential rainfalls, severe flooding	Algeria
844	180	13.01.2001	Earthquake (moment magnitude 7.7), landslide	El Salvador, Guatemala et al.
396	–	15.08.2001	Heavy rain causes Mekong river to burst its banks	Vietnam, Cambodia
360	–	25.07.2001	Typhoon Toraji causes landslides and flash floods	Taiwan, China
350	–	20.10.2001	Boat carrying illegal immigrants capsizes	Indonesia
350	–	10.08.2001	Floods; damage to farmland, forests, infrastructure	Iran
320	–	07.11.2001	Tropical typhoon Lingling	Philippines
302	–	27.08.2001	Flash floods	Nigeria
291	–	29.12.2001	Explosion in fireworks shop	Peru
281	–	16.07.2001	Tin mine flooded	China
277	–	31.07.2001	Fierce storm triggers floods and landslides	Indonesia
274	–	13.02.2001	Earthquake (6.1. Richter scale)	El Salvador
265	44	12.11.2001	American Airlines Airbus 300 crash shortly after take-off	US
196	–	04.07.2001	Typhoon Utor with unusually large radius (350 km)	Philippines, Taiwan, China
178	–	18.06.2001	Floods; 2400 buildings damaged	China
177	–	10.08.2001	Typhoon Usagi; floods	China, Vietnam, Thailand
169	100	24.06.2001	Typhoon Chebi; rains, floods, landslides	China, Taiwan, South Korea
146	–	07.09.2001	Floods in Eastern India	India
145	60	23.06.2001	Earthquake (8.3 moment magnitude); tsunami	Peru, Bolivia

[19] Dead and missing
[20] Excluding liability losses

Table 9
The 40 most costly insurance losses 1970–2001

Insured loss[21] (in USD m, indexed to 2001)	**Victims**[22]	**Date**	**Event**	**Country**	**Loss as % NL-premium volume**[23]
20 185	38	23.08.1992	Hurricane Andrew	US, Bahamas	5.0 %
19 000	3 000	11.09.2001	Terrorist attack on WTC, Pentagon etc.	US	4.1 %
16 720	60	17.01.1994	Northridge earthquake	US	4.0 %
7 338	51	27.09.1991	Typhoon Mireille	Japan	6.5 %
6 221	95	25.01.1990	Winterstorm Daria	France, UK et al.	–
6 164	80	25.12.1999	Winterstorm Lothar over Western Europe	France, CH et al.	–
5 990	61	15.09.1989	Hurricane Hugo	Puerto Rico, US et al.	–
4 674	22	15.10.1987	Storm and floods in Europe	France, UK et al.	–
4 323	64	25.02.1990	Winterstorm Vivian	Western/Central Europe	–
4 293	26	22.09.1999	Typhoon Bart hits south of country	Japan	3.9 %
3 833	600	20.09.1998	Hurricane Georges	US, Caribbean	–
3 150	33	05.06.2001	Tropical storm Allison; rain, floods	US	0.7 %
2 994	167	06.07.1988	Explosion on platform Piper Alpha	UK	5.5 %
2 872	6 425	17.01.1995	Great-Hanshin earthquake in Kobe	Japan	1.9 %
2 551	45	27.12.1999	Winterstorm Martin over south-west France and Spain	France, E, CH	–
2 508	70	10.09.1999	Hurricane Floyd; heavy downpours, flooding	US, Bahamas	–
2 440	59	01.10.1995	Hurricane Opal	US et al.	–
2 144	246	10.03.1993	Blizzard, tornadoes	US, Mexico, Canada	–
2 019	4	11.09.1992	Hurricane Iniki	US, North Pacific	–
1 900[24]	–	06.04.2001	Hail, floods and tornadoes	US	0.4 %
1 892	23	23.10.1989	Explosion in petrochemicals plant	US	0.5 %
1 834	–	12.09.1979	Hurricane Frederic	US	0.6 %
1 806	39	05.09.1996	Hurricane Fran	US	0.4 %
1 795	2 000	18.09.1974	Tropical cyclone Fifi	Honduras	–
1 743	116	03.09.1995	Hurricane Luis	Caribbean	–
1 665	350	10.09.1988	Hurricane Gilbert	Jamaica et al.	–
1 594	20	03.12.1999	Winterstorm Anatol	Western/Northern Europe	–
1 578	54	03.05.1999	Series of over 70 tornadoes in the Midwest	US	0.4 %
1 564	500	17.12.1983	Blizzards, cold wave	US, Canada, Mexico	–
1 560	26	20.10.1991	Forest fires spread to urban areas, drought	US	0.4 %
1 546	350	02.04.1974	Tornadoes in 14 states	US	0.7 %
1 475	–	25.04.1973	Flooding on the Mississippi	US	0.6 %
1 461	–	15.05.1998	Wind, hail and tornadoes (MN, IA)	US	0.4 %
1 428	63	17.10.1989	Loma Prieta earthquake	US	0.4 %
1 413	31	04.08.1970	Hurricane Celia	US, Cuba	–
1 386	12	19.09.1998	Typhoon Vicki	Japan, Philippines	–
1 357	30	21.09.2001	Explosion in fertiliser factory; 4000 homes destroyed	France	3.5 %
1 337	46	05.01.1998	Cold spell with ice and snow	Canada, US	–
1 319	21	05.05.1995	Wind, hail and flooding (TX, NM)	US	0.3 %
1 300	2	29.10.1991	Hurricane Grace	US	0.3 %

[21] Excluding liability losses
[22] Dead and missing
[23] Premiums in 2000, calculated at 2001 prices
[24] Figures for natural catastrophes in the US by courtesy of the Property Claims Service (PCS)

Table 10
The 40 worst catastrophes in terms of victims 1970–2001

Victims[25]	Insured loss (in USD m, indexed to 2001)[26]	Date	Event	Country
300 000	–	14.11.1970	Storm and flood catastrophe	Bangladesh
250 000	–	28.07.1976	Earthquake in Tangshan (8.2 Richter scale)	China
138 000	3	29.04.1991	Tropical cyclone Gorky	Bangladesh
60 000	–	31.05.1970	Earthquake (7.7 Richter scale)	Peru
50 000	156	21.06.1990	Earthquake in Gilan	Iran
25 000	–	07.12.1988	Earthquake in Armenia	Armenia, ex-USSR
25 000	–	16.09.1978	Earthquake in Tabas	Iran
23 000	–	13.11.1985	Volcanic eruption on Nevado del Ruiz	Colombia
22 000	233	04.02.1976	Earthquake (7.4 Richter scale)	Guatemala
19 118	1 063	17.08.1999	Earthquake in Izmit	Turkey
15 000	100	26.01.2001	Earthquake (moment magnitude 7.7) in Gujarat	India, Pakistan
15 000	106	29.10.1999	Cyclone 05B devastates Orissa state	India, Bangladesh
15 000	–	01.09.1978	Flooding following monsoon rains in northern parts	India
15 000	530	19.09.1985	Earthquake (8.1 Richter scale)	Mexico
15 000	–	11.08.1979	Dyke burst in Morvi	India
10 800	–	31.10.1971	Flooding in Bay of Bengal and Orissa state	India
10 000	234	15.12.1999	Flooding, mudslides, landslides	Venezuela, Colombia
10 000	–	25.05.1985	Tropical cyclone in Bay of Bengal	Bangladesh
10 000	–	20.11.1977	Tropical cyclone in Andrah Pradesh and Bay of Bengal	India
9 500	–	30.09.1993	Earthquake (6.4 Richter scale) in Maharashtra	India
9 000	543	22.10.1998	Hurricane Mitch in Central America	Honduras, Nicaragua, et al.
8 000	–	16.08.1976	Earthquake on Mindanao	Philippines
6 425	2 872	17.01.1995	Great Hanshin earthquake in Kobe	Japan
6 304	–	05.11.1991	Typhoons Thelma and Uring	Philippines
5 300	–	28.12.1974	Earthquake (6.3 Richter scale)	Pakistan
5 000	1 044	05.03.1987	Earthquake	Ecuador
5 000	426	23.12.1972	Earthquake in Managua	Nicaragua
5 000	–	30.06.1976	Earthquake in West-Irian	Indonesia
5 000	–	10.04.1972	Earthquake in Fars	Iran
4 500	–	10.10.1980	Earthquake in El Asnam	Algeria
4 375	–	21.12.1987	Ferry Dona Paz collides with oil tanker Victor	Philippines
4 000	–	30.05.1998	Earthquake in Takhar	Afghanistan
4 000	–	15.02.1972	Storms and snow in Ardekan	Iran
4 000	–	24.11.1976	Earthquake in Van	Turkey
4 000	–	02.12.1984	Accident in chemical plant in Bhopal	India
3 840	6	01.11.1997	Typhoon Linda	Vietnam et al.
3 800	–	08.09.1992	Flooding in Punjab	India, Pakistan
3 656	327	01.07.1998	Flooding along Yangtze River	China
3 400	1 063	21.09.1999	Earthquake in Nantou	Taiwan
3 200	–	16.04.1978	Tropical cyclone	Réunion

[25] Dead and missing
[26] Excluding liability losses

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