Society and politics

Efforts to mitigate anthropogenic climate change and adjust to its unavoidable impacts constitute an enormous challenge for science and society. Topics Geo highlights the past year's major scientific, political and industrial developments.

Ernst Rauch

Efforts to gain a better understanding of the anthropogenic and natural causes of climate change and its impacts constitute a huge challenge to scientists, civil society, industry and policy makers. Since our current understanding of the physical science basis of global warming was substantially confirmed by climate research in 2012, there have increasingly been calls to formulate socially acceptable and economically viable strategies. However, there has been little evidence of a political will to reduce greenhouse gas emissions. Risk carriers in the private sector and society are faced with the task of establishing their individual exposures and taking appropriate action. Where the insurance sector is concerned, this primarily involves evaluating the portfolio-based risk of change. Increasingly, the technology sector is coming up with proposals for containing climate change. The insurance industry can support this trend by providing innovative risk transfer solutions.

The IPCC Special Report *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (SREX) publishes new scientific analyses of the impact of ongoing warming on extreme weather events and sea levels. Studies show that, in recent years, the rate of sea level rise has been faster than predicted by the models.

SREX: Report on climate change and extreme events

New scientific analyses of the impact of ongoing warming on extreme weather events and sea levels were published in the full version of the IPCC Special Report *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (SREX: http://www.ipcc-wg2.gov/SREX/). Studies show that recent sea level rise has been more rapid than projected in IPCC Fourth Assessment Report models in 2007. Moreover, climate change has already resulted in regional changes in heatwaves, heavy precipitation and other extreme weather events. The SREX Report analyses the future evolution of extreme weather events on the basis of scientific studies and categorises them into region, type of hazard and current research findings.

Increase in greenhouse gas emissions

Provisional estimates indicate that greenhouse gas emissions (CO_2 equivalent) increased by 3% to around 32 gigatonnes in 2012, but this was subject to considerable regional variations. Emissions in the European Union (EU-27), for instance, were roughly 2% lower than in the previous year. With a total reduction of an estimated 17% by 2012 in relation to 1990, the base year, this means that the EU is on target to reach its political goal of a 20% reduction by 2020. The EU has offered to increase this to 30% provided other countries with high CO_2 emission levels also set more ambitious targets.

Doha climate summit: Few tangible results

Since acute financial and economic problems currently dominate the international political agenda, measures to adjust to the consequences of climate change faded into the background at the climate change conference (COP18) held in Qatari capital, Doha, in late 2012. Agreement on global greenhouse gas (GHG) reductions was again deferred. There was little sign of a political will to lead and shape a decisive reaction to the challenges of anthropogenic climate change. The following resolutions were adopted under the Doha Climate Gateway:

- On 1 January 2013, the Kyoto Protocol's second commitment phase, due to end in 2020, began. This involves 37 countries, including all the EU member states. The existing EU goal of a 20% reduction in GHG emissions over the base year 1990 by 2020 was officially adopted.

- The delegates agreed on a timetable for the negotiation process under the umbrella of the UNFCCC (United Nations Framework Convention on Climate Change). It is hoped that this will culminate in a climate change agreement between all countries in 2015.

- Songdo in South Korea was selected as the headquarters of the Green Climate Fund. With US$ 100bn per year in funding from the international community of states by 2020, it will be a key element in the financing of climate mitigation and adaptation projects. What is not clear, however, is whether the industrialised nations will actually deliver on the promises made in 2009.

- Loss analyses and the development of adaptation strategies are to be stepped up within the framework of the Loss and Damage programme launched by UNFCCC to deal with climate change losses in developing countries. Risk transfer mechanisms – and the relevant financing programmes – were explicitly acknowledged to be part of any adaptation strategy. As in previous years, however, the conference failed to pass a detailed resolution on a multinational or global compensation pool for extreme weather losses, even though suitable concepts, based on Munich Climate Insurance Initiative (MCII) proposals, for example, are already available.

On a more positive note, the Doha Climate Gateway will at least ensure that the global climate change negotiating process will continue until 2020. However, it must be pointed out that GHG emissions are still rising steadily throughout the world, despite almost 20 years of climate change summits. The requisite decisions are often deferred and minor advances towards a global agreement on climate protection are all too often nullified by subsequent retreats. Far fewer countries have agreed to the second commitment phase of the Kyoto Protocol, for instance, and they account for only 15% of total global GHG emissions. Without further fine-tuning and critical analysis, the current negotiating concept could ultimately prove counter-productive. On the other hand, there are no ready solutions when it comes to improving the negotiating process. Binding targets for the international community of states can only be reached under United Nations auspices. However, solutions negotiated directly between a smaller group of countries could be the key to a voluntary spearhead movement aimed at achieving a sustainable climate policy.

Industry – Focus on technical solutions

Private-sector climate protection products concentrate on preventing GHG emissions by exploiting renewable energy sources and using heating and cooling technology to make buildings more energy-efficient. The amount of money invested in renewable energy projects worldwide rose from US$ 40bn in 2004 to some US$ 250bn in 2011. Provisional figures indicate that 2012 global investment in this sector is likely to have been on a par with that of the previous year.

Insurance industry – Coverage programmes

The insurance industry is increasingly developing risk transfer products specifically designed to support climate change and GHG adaptation and mitigation. They aim to take account of changing natural catastrophe loss patterns. Reinsurers have offered nat cat frequency covers in response to regional changes in loss frequency for some years now. Innovative renewable energy insurance covers have also been launched. For example, Munich Re's option cover insures photovoltaic system operators against the risk of a solar module manufacturer being unable to discharge its warranty obligations due to insolvency – for instance, following an unexpected fall in output. Such financial protection facilitates the implementation of photovoltaic projects and, without it, bank loans may only be granted on much less favourable terms.

In 2012, Munich Re also became the first insurance group to offer serial loss cover on offshore wind turbines. Under this further addition to its renewable products range, Munich Re meets the cost of repairing or replacing defective turbines or individual components in the event of a loss affecting a series of components in the gear mechanism, rotor or tower, for instance. In addition, the often substantial cost of chartering the necessary purpose-designed ships is covered. The five-year cover also includes the cost of retrofits to systems in which a defective component is incorporated, even though there has been no loss or damage.

The 18th UN climate conference was held at Doha, capital of the Arab emirate of Qatar, from 26 November to 8 December. The photo shows Emir Sheikh Sabah al-Ahmad al-Sabah at the opening ceremony.

Facts, figures, background

The prolonged heatwave and drought that affected vast areas of the USA, record-breaking minimum Arctic sea ice cover during the northern hemisphere's summer months and New York's highest storm surge in over 100 years, triggered by Hurricane Sandy, were the most striking global weather and climate phenomena in 2012.

Eberhard Faust and Ernst Rauch

Provisional figures released by the World Meteorological Organisation (WMO) indicate that 2012 is likely to be among the ten warmest years on record since 1850. As in the period August–December 2011, El Niño Southern Oscillation Index (ENSO) values were negative from January to May 2012. In June, this La Niña phase moved towards more neutral ENSO conditions before subsequently settling on the borderline between neutral and El Niño conditions, with simultaneous warming of the equatorial eastern Pacific off the coast of South America. Thus, on average, 2012 can be regarded as a neutral year.

With regard to worldwide precipitation in 2012 (land-based data only), two regions displayed an extensive and relevant negative deviation from the annual base period (1961–1990) mean, as defined by the US National Oceanic and Atmospheric Administration (NOAA). For several months – and particularly during the growth period – rainfall was well below the long-term average not only in the USA but also in the Mediterranean region as far as the Caspian Sea. Agricultural production of corn and other cereals was primarily affected. Since multiple peril crop insurance is widespread in the USA, this resulted in the highest ever public-private-sector agricultural insurance loss (see article on page 16).

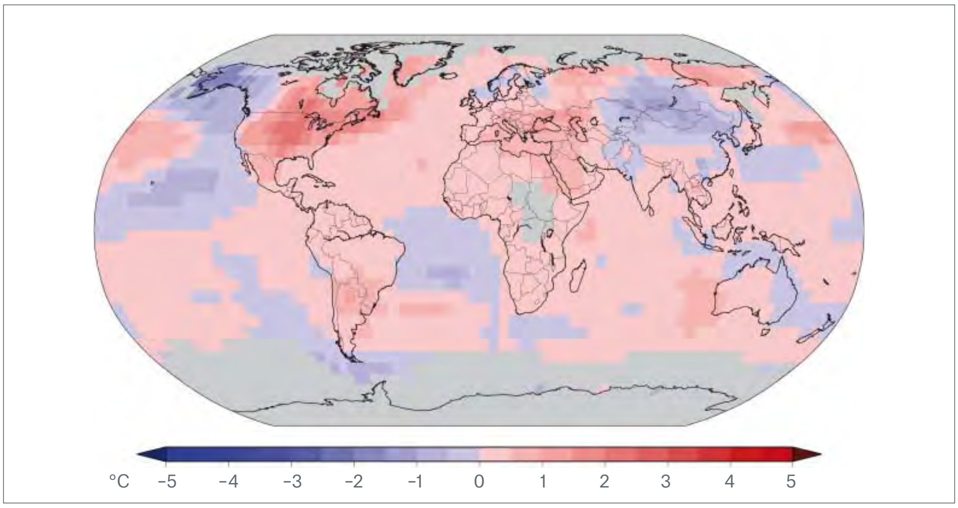
January/February: Strong frost in Europe – Mild temperatures in North America

Due to the negative phase of the Arctic Oscillation (AO) prevailing at the time, much of central and eastern Europe experienced a major cold spell in the last week of January and first two weeks of February. In parts of eastern Europe, the air temperature dropped to –40°C (–40°F), but elsewhere also, including in Germany, temperatures were below –25°C (–13°F) for several days in succession. Rome (Italy) was covered in snow for the first time in 26 years on 4 February. More or less at the time Europe was experiencing severe frost, temperatures in Canada were well above the seasonal average. Also due to the negative AO phase, Winnipeg (Manitoba), for example, recorded its third warmest January and highest January daytime temperature (around +7°C or 45°F) since records began in 1873.

March to September: Heatwave, drought and wildfires in the USA

Much of the USA – and particularly the Midwest Corn Belt – experienced month-long heat and drought in the spring and summer of 2012, causing record US crop insurance claims. From March onwards, the combination of persistent above-average temperatures and below-average precipitation triggered a series of forest and bush fires in the USA and Canada. In the USA alone, 3.7 million hectares (9.2 million acres) were ravaged by flames in the 2012 fire season, the third highest figure since wildfire statistics began in the early 1960s (2006: 4 million hectares/9.9 million acres, 2007: 3.8 million hectares/9.3 million acres). July 2012 was the warmest month ever in the USA and the year as a whole the country's warmest since US records began in 1895.

Regional mean temperature anomalies for 2012 with respect to a 1981–2010 base period

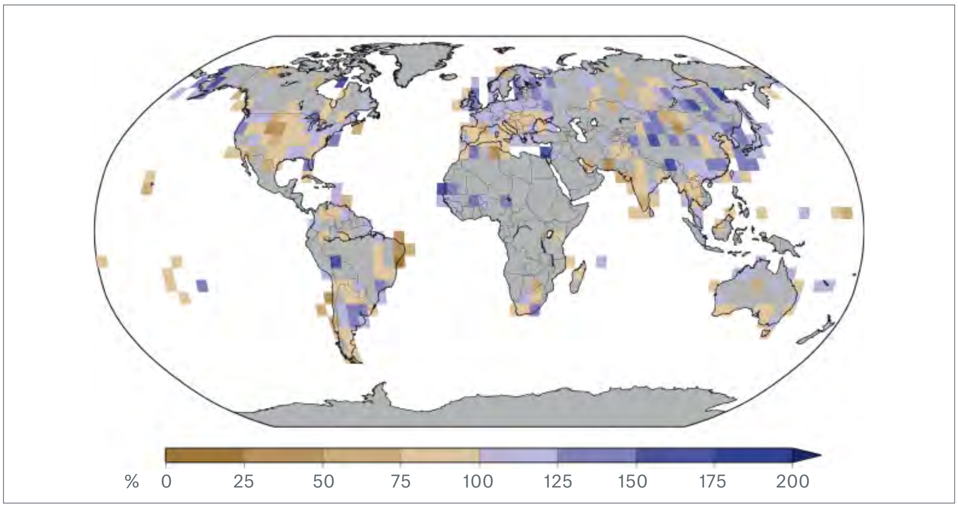


Over much of America, Europe and Africa, 2012 was too warm compared with the reference period. On the other hand, average annual temperatures in Alaska and some parts of Asia were below the long-term average. Globally, 2012 was one of the ten warmest years since 1850.

■ Warmer
■ Cooler

Source: NCDC/NESDIS/NOAA

Regional anomalies in annual precipitation in 2012 with respect to a 1961–1990 base period

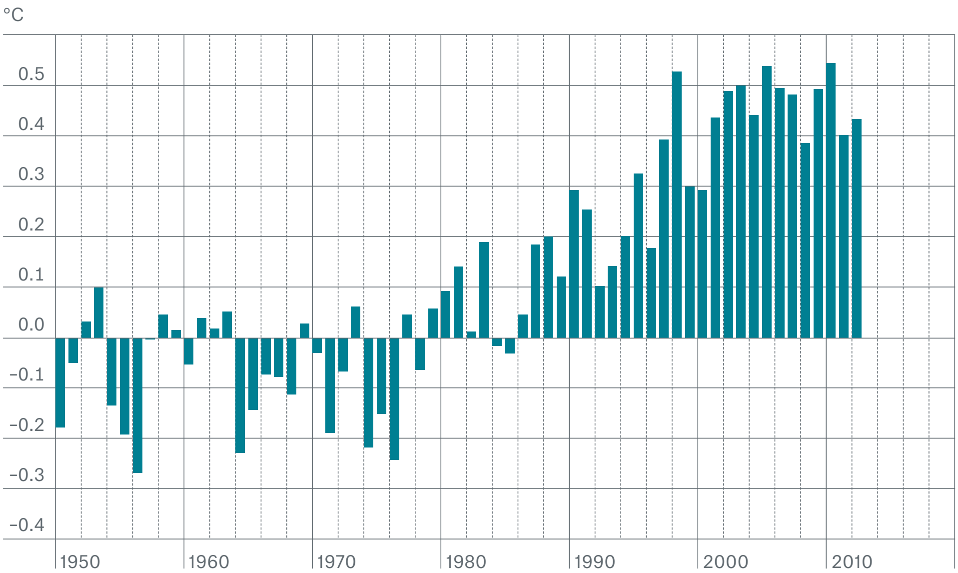


Regional annual precipitation anomalies in 2012 with respect to a 1961–1990 base period. This clearly shows the precipitation deficit over much of the USA.

■ Drier
■ Wetter

Source: NCDC/NESDIS/NOAA

Annual global average temperature anomalies 1950–2012 with respect to a 1961–1990 base period



The ten warmest years in the climate record period 1850–2012 were all subsequent to 1998. The time series starts in 1850. The chart relates to the period from 1950–2012.

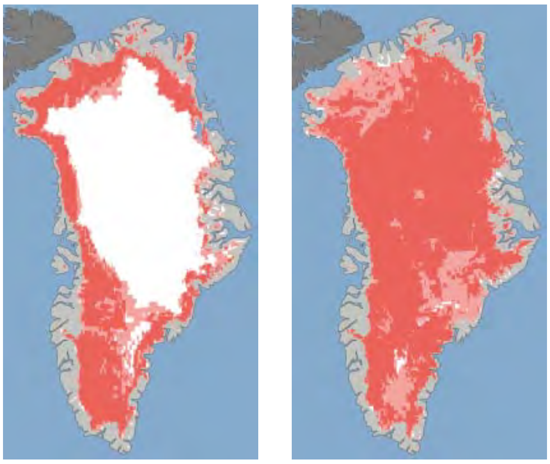
Source: HadCRUT4, Met Office/Climate Research Unit of the University of East Anglia (2013). 2012 is based on HadCRUT4, the update to HadCRUT3

Extent of ice sheet melt in Greenland

Satellite images show the extent of surface melt over Greenland's ice sheet on 8 July 2012 (left) and 12 July 2012 (right). Surfaces are classified as "melt" if at least two satellites detected surface melting. If the data have been detected by only one satellite, the areas concerned are classified as "probable melt".

- Ice/snow free
- Probable melt
- Melt
- Ice and snow

Source: http://www.nasa.gov/topics/earth/features/greenland-melt.html



Scientific assessment

Several years ago, a study by A.L. Westerling et al. (2006) showed that climate change had substantially increased the risk of wildfires of more than 400 ha in the mid-altitude mountain regions of the western USA. A comparison between the periods 1970–1986 and 1987–2003 shows that, during the latter period, fire outbreaks were four times more frequent, the area ravaged by fire was six times larger and the wildfire season was more than half as long again. This is primarily due to higher spring and summer temperatures bringing increasingly early snowmelt, and a growing soil moisture deficit, especially in mountain regions in late summer. According to a projection based on climate models (D.V. Spracklen et al. 2009), the average annual area burned by fire in the western USA will increase by more than 50% over the next 40 years. This does not take account of changes relating to cause of fire, lightning frequency or duration of fire season. The Pacific Northwest and Rocky Mountain regions are likely to be primarily affected, with increases of 80% and 180% respectively. The devastating fires of 2012 thus underline the tendency towards a long-term increase in wildfire risk in populated areas.

With regard to the western USA in particular, wildfire hazard and the observed increase in dry periods can already be causally linked with anthropogenic climate change (T.P. Barnett et al. 2008, G.M. MacDonald et al. 2008). A study based on climate models projects a future increase in heatwaves and associated droughts for the USA as a whole. According to this projection, the threshold value of the hottest season in the reference period 1951–1999 will be exceeded at least seven times over much of the West in the decade from 2030–2039. This will be due to more pronounced high-pressure conditions and substantial soil moisture and precipitation deficits over much of central and eastern USA – i.e. roughly corresponding to the area affected by drought in 2012 – compared with current average summer conditions (N.S. Diffenbaugh and Ashfaq 2010). Thus, 2012 can be interpreted as a year anticipating the projected changes. In North America, the summer drought risk is more likely to increase than decrease in the years to come.

June to July: Heatwave and drought in parts of Russia and Kazakhstan – Exceptionally low temperatures in northern Europe and southern hemisphere

In much of southern Europe and Asia, the summer began with major temperature contrasts: above-average temperatures in northern and western Asia, on the one hand, and cold waves in Sweden and the southern hemisphere, on the other. New record minimum temperatures were set in some places in South Africa, Australia and New Zealand. As in 2010, parts of Russia and Kazakhstan experienced a prolonged drought that caused considerable agricultural losses.

July: Greenland shelf ice at record minimum

Greenland ice melt was the highest since satellite observations began in 1979. While only about 40% of the inland ice cover was affected on 8 July 2012, temperatures of up to 23°C caused 97% of the surface to melt just four days later. Even at the highest elevation of 3,000 metres above sea level, the ice melted on 11 and 12 July. Both observations are unique in the history of systematic recording, which began in 1889. However, scientific analysis of ice cores from the region shows similarly intensive melt events have occurred previously in Greenland.

The exceptionally warm 2012 Arctic summer and rapid melting of the inland ice masses were due to a series of stable high-pressure systems over Greenland between May and July. They led to the formation of heat islands with rising temperatures.

September: Record minimum Arctic/maximum Antarctic sea ice extent

On 16 September 2012, the Arctic sea ice extent measured 3.4 million km², the lowest reading since systematic satellite observations commenced in 1979. As recently as the early 1980s, Arctic sea ice extent was 7–8 million km² during the season when it was at its minimum. This is equivalent to an average decrease in the area covered by ice of 11.3% per decade. During the same period, the maximum annual winter sea ice extent also fell by 2.5% per decade. At roughly 15.3 million km², the figure was about the same in 2012 as in 2010, and more than 2011's record minimum of 14.7 million km².

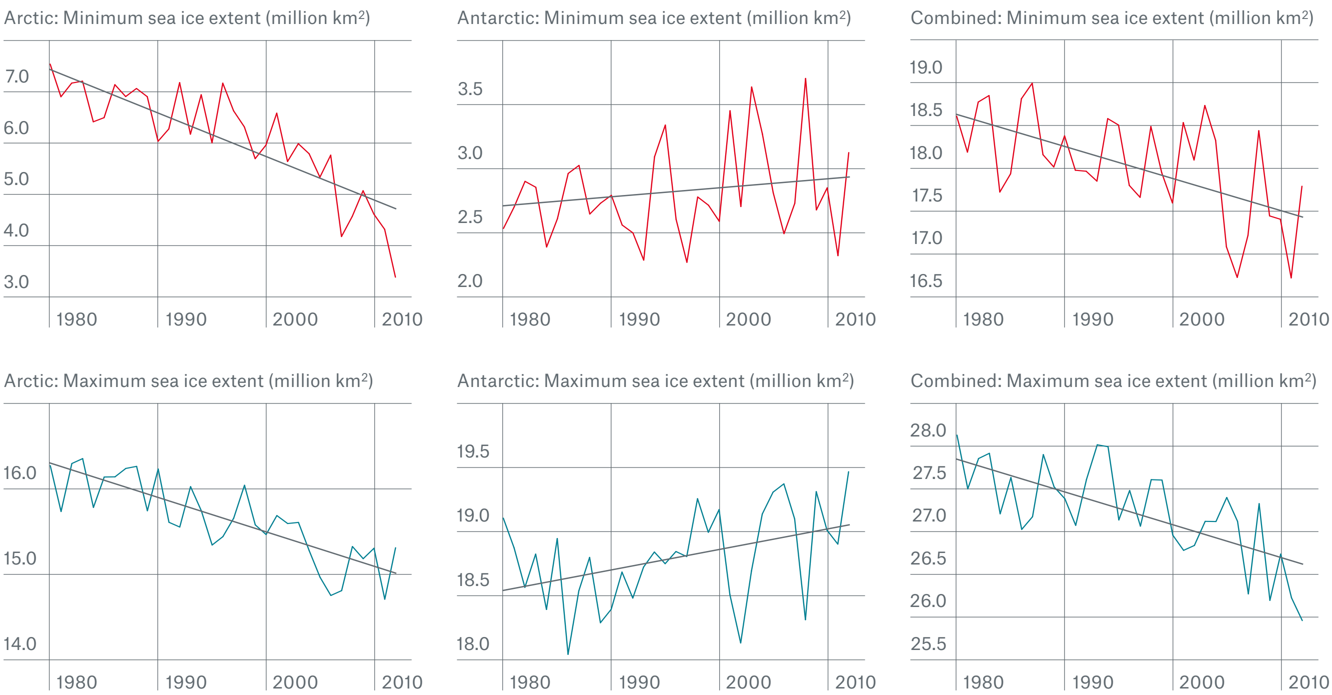
The opposite applied in the southern hemisphere, where both maximum annual Antarctic sea ice extent (excluding inland ice masses) and minimum annual sea ice extent increased between 1979 and 2012. The ice sheet grew by 0.9% per decade during the Antarctic winter. In relation to the trend, the ice sheet increased from around 18.5 million km² in the early 1980s to a maximum of some 19 million km² in September 2012. During the same period, the minimum sea ice extent measured during the Antarctic summer increased by 2.8% per decade from roughly 2.7 million to almost three million km² (trend values). At 3.1 million km², the minimum sea ice extent observed in 2012 was above the trend value and substantially more than the previous year's 2.3 million km².

A closer look at the combined development of Arctic and Antarctic sea ice extent since systematic satellite measurements started shows the following: the annual minimum ice cover (summer months in the respective hemispheres) has declined by 2.0% and annual maximum ice covers (winter months in the respective hemispheres) by 1.4% per decade

Scientific assessment

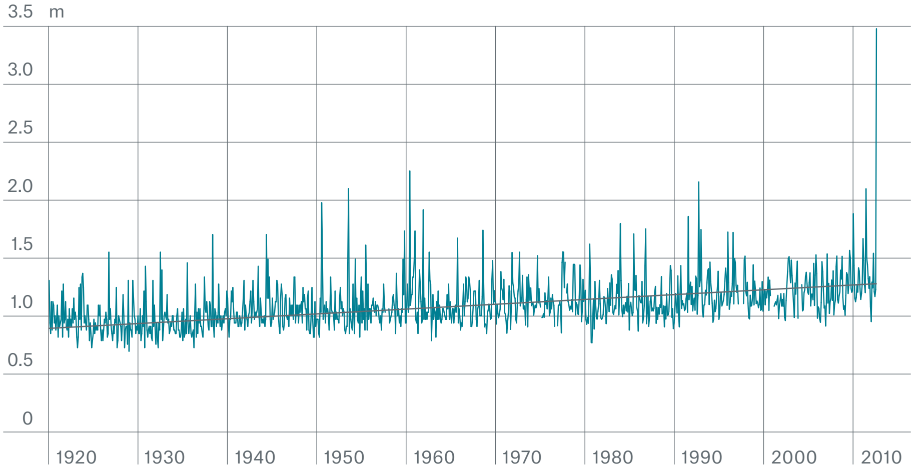
Three records were set in 2012 in the realms of ice and snow: the smallest Arctic sea ice extent in September since the start of the satellite era (3.4 million km²), Greenland's largest surface melting in July since 1889 and the largest sea ice extent ever observed in the Antarctic in September (19.5 million km²). Is there a common climate denominator underlying this trend?

Arctic and Antarctic annual sea ice extent with trend 1980–2012



Annual minimum and maximum Arctic and Antarctic sea ice extent with trend and combined extent of the two polar sea ice sheets. Satellite data have been continuously available since 1979. The data for the combined extent were calculated by totalling the daily ice extent values and may deviate from the annual maximums/minimums.

Source: National Snow and Ice Data Center 2012



Deviation in monthly maximum sea levels in New York (in relation to mean sea level)

The mean sea level recorded at the Battery Park tide gauge, on the southern tip of Manhattan, rose by some 35 cm in the (93-year) period 1920–2012 (an average increase of around 3.8 mm per year).

Source: Center for Operational Oceanographic Products and Services (2012)

A recent study by the Max Planck Institute of Meteorology (D. Notz and Marotzke 2012) investigated the factors behind the significant fall in Arctic sea ice extent during the summer months. Higher carbon dioxide concentrations and the greenhouse effect were identified as being the most probable cause among potential natural and anthropogenic candidates. Researchers also showed that the properties of the upper air flow have changed in the last 30 years as a result of Arctic sea ice melt and self-amplifying temperature rise at higher latitudes. Upper-level air flow follows a wave pattern in the mid-latitudes and governs the sequence of high and low-pressure systems. As a result of the changes, high-pressure systems extend on average much further north in autumn, winter and summer while, at the same time, the west to east flow in the wave structure and weather systems is slowing down. This encourages the development of stable weather conditions with extreme consequences (Francis and Vavrus 2012) such as surface melting over 97% of Greenland in July 2012. This resulted from a series of warm high-pressure systems and the fact that the high-pressure pattern persisted. Ice cores indicate that the last time a similarly record-breaking melt occurred was in 1889. Research also shows that warmer atmospheric conditions over Greenland in summer since 2000 have changed the reflective properties of lower-altitude surfaces by fostering the formation of larger ice grains. The resulting somewhat darker areas absorb more solar energy and heat up more easily, so that more ice melts (J.E. Box et al. 2012).

The winter processes that change the extent of Antarctic sea ice are due to an interaction between continent and ocean. Evidence shows that Antarctica is also getting warmer as a result of climate change, although more slowly than northern regions. The winds around the South Pole are being strengthened by the increasing north-south temperature gradient in the southern hemisphere. Thus, they are tending to blow the sea ice further out into the ocean in some parts of Antarctica and less far in others (P.R. Holland and Kwok 2012). As a result of these changes, overall sea ice extent has increased in recent winters and this year's figure is a record. Climate change is thus also affecting Antarctic sea ice development in the winter months, making it the most likely common denominator behind 2012's various ice and snow records and changes. Since the changes in sea ice extent in the Arctic and Antarctic are attributable to different factors, they cannot be used as an argument against climate change.

October: Record-breaking storm surge in New York due to Hurricane Sandy

Hurricane Sandy was the outstanding loss event of 2012 for the insurance industry. It made landfall in the New York/New Jersey region on the eastern seaboard of the USA in late October, with wind speeds on the borderline between tropical cyclone and hurricane strength. A storm surge of almost 3.5 m above mean sea level was measured at the Battery Park tide gauge at the southern tip of New York's Manhattan Island. Several factors accounted for the height of this storm surge. Firstly, it was due to Sandy's vast size combined with its near-perpendicular landfall. Secondly, there was a full moon, so that landfall coincided with a spring tide. Thirdly, the increase in water level was also due to a steady rise in sea level over a number of decades (roughly 35 cm in 93 years on this gauge).

Scientific assessment

Cyclones that occurred in the distant past can be identified by analysing sediment from salt marshes and lakes near the coast. Such geological analyses have yielded evidence of four major landfalling hurricanes associated with high storm surges in the New York area: in 1693, 1788, 1821 and 1893. The water levels that would have been reached at the southern tip of Manhattan given present-day conditions can be calculated for the last three. This indicates maximum surge heights of roughly 3 m plus a few decimetres above today's mean sea level (Scileppi and Donnelly, 2007). Hurricane Sandy, which occurred in October 2012, was the first storm since these hurricanes to exceed the three-metre mark, with a maximum surge height of almost 3.5 m. A further factor in the case of Sandy was the effect of a 0.5–0.8 m spring tide. Since New York's current flood protection system has a maximum height of 2.5–3 m, the above events would also cause loss or damage today. In the past three centuries, New York has experienced storm surges on this scale at intervals of between 119 and 33 years.

In future, however, events like Sandy, with levels of around 3.5 m, are to be expected far more frequently, according to a recent study into the development of storm surge risks due to climate change, based on climate models (Lin et al., 2012). By the end of the 21st century, this frequency will have increased three- to 33-fold, depending on the model. In addition to the greater intensity and scale of major storms, this increase will primarily be due to sea level rise. In other words, Hurricane Sandy was just a foretaste of what the inhabitants of New York and other parts of the northeast US coast can expect to face more often in the future.

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Most comprehensive nat cat database

In recent decades, natural catastrophe losses have developed in different ways depending on region and hazard. However, in most cases, the trend is clearly upward.

The extent to which the loss trends are due to population growth, increased prosperity and other socioeconomic factors as opposed to increases in the frequency and severity of natural hazard events is of crucial importance in natural hazard risk assessment. A good database is essential so that past loss data can be correctly ranked by order of magnitude. Munich Re's natural catastrophe database, which now contains more than 31,000 entries, is the most comprehensive source of natural catastrophe data in the world. It is the cornerstone that underlies a wide range of information, tools and services in the field of risk management and risk research. In 2012, 905 loss-related events were recorded in the database, considerably exceeding the 820 registered in 2011 and the ten-year average of 800. All natural hazard events that result in property damage or personal injury are recorded in the NatCatSERVICE database. Based on monetary and humanitarian impact, events are attributed to one of several categories, ranging from minor losses to major natural catastrophes.

The latest analyses, charts and statistics are available as free downloads from the Touch Natural Hazards section of our website: www.munichre.com/touch.

In 2012, some 60 earthquakes worldwide caused significant material damage and personal injury. The photograph shows the ruins of a house in Rovereto sulla Secchia, which was destroyed in the series of earthquakes that hit northern Italy in May 2012.

The year in pictures

5 to 6 January
Winter storm Andrea: Europe
Overall losses: US$ 720m
Insured losses: US$ 440m
Fatalities: 5

24 January to 11 February
Floods: Australia
Overall losses: US$ 225m
Insured losses: US$ 140m
Fatalities: 2

2 to 4 March
Severe weather, tornadoes: USA
Overall losses: US$ 5,000m
Insured losses: US$ 2,500m
Fatalities: 41

5 to 8 April
Severe weather: Argentina
Overall losses: US$ 10m
Fatalities: 18

10 to 24 May
Floods: China
Overall losses: US$ 2,500m
Fatalities: 127

20/29 May
Earthquakes: Italy
Overall losses: US$ 16,000m
Insured losses: US$ 1,600m
Fatalities: 18

26 June to 31 July
Floods: Bangladesh
Fatalities: 131

June to September
Drought, heatwave, wildfires: USA
Overall losses: >US$ 20,000m
Insured losses: >US$ 15,000m
Fatalities: 102

July to October
Floods: Nigeria
Overall losses: US$ 500m
Fatalities: 431

8 to 9 August
Typhoon Haikui: China
Overall losses: US$ 1,500m
Insured losses: US$ 230m
Fatalities: 16

11 August
Earthquake: Iran
Overall losses: US$ 500m
Fatalities: 306

24 to 31 August
Hurricane Isaac: Caribbean, USA
Overall losses: US$ 2,000m
Insured losses: US$ 1,220m
Fatalities: 42

3 to 27 September
Floods: Pakistan
Overall losses: US$ 2,500m
Fatalities: 455

7 September
Earthquake: China
Overall losses: US$ 1,000m
Insured losses: US$ 45m
Fatalities: 89

24 to 31 October
Hurricane Sandy: Caribbean, USA
Overall losses: US$ 65,000m
Insured losses: US$ 30,000m
Fatalities: 210

10 to 14 November
Floods: Italy
Overall losses: US$ 15m
Fatalities: 4

11 November
Earthquake: Myanmar
Fatalities: 26

4 to 5 December
Typhoon Bopha: Philippines
Overall losses: US$ 600m
Fatalities: 1,100

The year in figures

Petra Löw, Angelika Wirtz

Following record losses in 2011, 2012 counts as a moderate year. However, overall losses worldwide from 905 events totalled US$ 170bn, which is just above the ten-year average. At US$ 70bn, insured losses were also higher than the ten-year average (US$ 50bn). Fatalities (9,600) were substantially below the ten-year average (106,000).

The worst catastrophe of 2012 was Typhoon Bopha in the Philippines, with more than 1,100 fatalities. The most costly event was Hurricane Sandy, which primarily affected the US states of New Jersey and New York. It caused economic losses of around US$ 65bn and insured losses of US$ 30bn.

Number of events

Of the 905 documented loss events, 840 (93%) were weather-related, i.e. storms, floods and climatological events such as heatwaves, cold waves, droughts and wildfires. The remaining 7% were caused by earthquakes (63 in all) and two volcanic eruptions. This distribution deviates from the 1980–2011 average of 86% weather-related and 14% geophysical events.

On the other hand, the breakdown by continent was approximately in line with the long-term average. The only exception was Africa, where the total of 99 loss events in 2012 was well above the long-term average (56). Most of the natural catastrophes occurred in Asia (334) and America (285). There were 132 in Europe and 54 in Australia.

Fatalities

Of the 9,600 fatalities, almost 30% resulted from only five events:

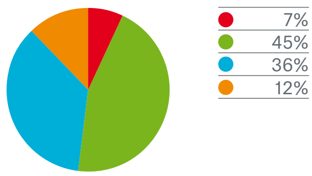
- December: Typhoon Bopha, Philippines, 1,100 fatalities
- January: Cold wave, eastern Europe, 530 fatalities
- September: Floods, Pakistan, 455 fatalities
- July–October: Floods, Nigeria, 431 fatalities
- August: Earthquake, Iran, 306 fatalities

Losses

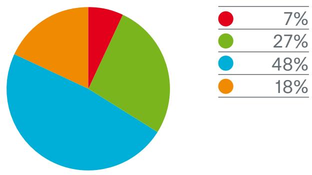
Around two-thirds of the overall losses of US$ 170bn and 89% of the insured losses of US$ 70bn were due to weather-related events in the USA. This was where the five most costly events occurred from an insurance industry perspective.

- October: Hurricane Sandy, USA and Caribbean, US$ 30bn
- June–September: Drought, USA, US$ 15–17bn
- March: Severe weather/tornadoes, USA, US$ 2.5bn
- April: Severe weather/tornadoes, USA, US$ 2.5bn
- June: Severe weather, USA, US$ 2bn

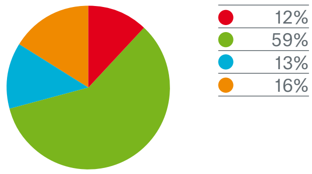
905 events
Percentage distribution worldwide



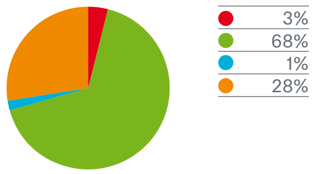
Fatalities: 9,600
Percentage distribution worldwide



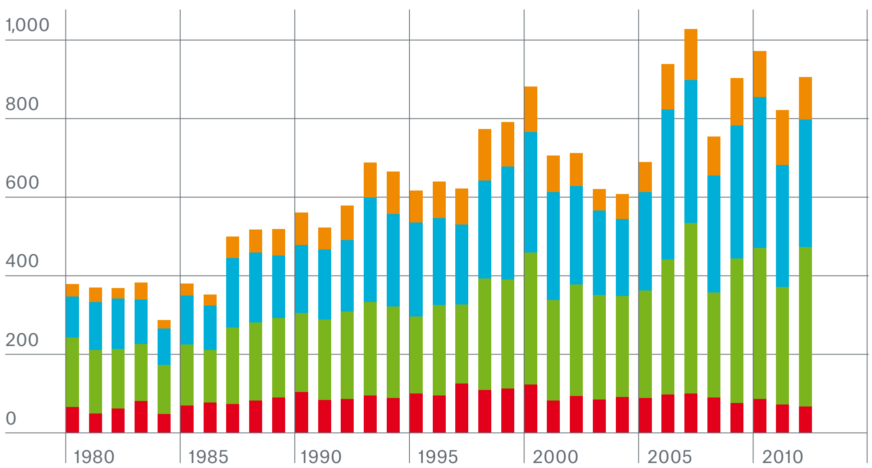
Overall losses: US$ 170bn
Percentage distribution worldwide



Insured losses: US$ 70bn
Percentage distribution worldwide



Number of natural catastrophes 1980–2012



Geophysical events: Earthquake, tsunami, volcanic eruption

Meteorological events: Tropical storm, winter storm, severe weather, hail, tornado, local storm

Hydrological events: River flood, flash flood, storm surge, mass movement (landslide)

Climatological events: Heatwave, cold wave, wildfire, drought

A series of earthquakes in Italy's Emilia Romagna province proved exceptionally expensive. With insured losses of some US$ 1.6bn, this series emerged as the insurance industry's costliest earthquake loss ever in Italy. Overall losses totalled US$ 16bn.

Asia was again hit by major floods in 2012. Torrential rainfall in mid-June caused heavy losses in northeast and southeast China. Insurance claims for Beijing alone were in the order of US$ 150m. The overall loss is estimated to be around US$ 8bn.

Losses in Australia/Oceania were relatively low compared with previous years, with the notable exception of two flood events in Australia: one in Queensland during January and February, and the other in New South Wales during February and March. They resulted in insured losses of US$ 280m and overall losses of around US$ 500m.

A breakdown of the losses between the four main perils reveals a number of substantial deviations from the long-term average. Around 59% of overall losses are attributable to windstorms, compared with the long-term average of 39%. The opposite applies in the case of earthquakes. Earthquakes accounted for 12% of overall losses in 2012, which is only half the 1980–2011 average.

With regard to insured losses, a particularly striking feature in the "climatological events" category is that droughts accounted for a 28% share. This is well above the long-term average of 7%, and was due to the severe drought that primarily afflicted the US Midwest during the summer, causing immense agricultural losses.

Once again, windstorm events accounted for the largest share of insured losses (68%). The loss drivers – Hurricane Sandy in October and a number of tornadoes in the spring – all related to the USA. The most severe tornado outbreak (on 2–4 March) alone caused insured losses of US$ 2.5bn, with Tennessee the worst hit state.

OUR EXPERTS

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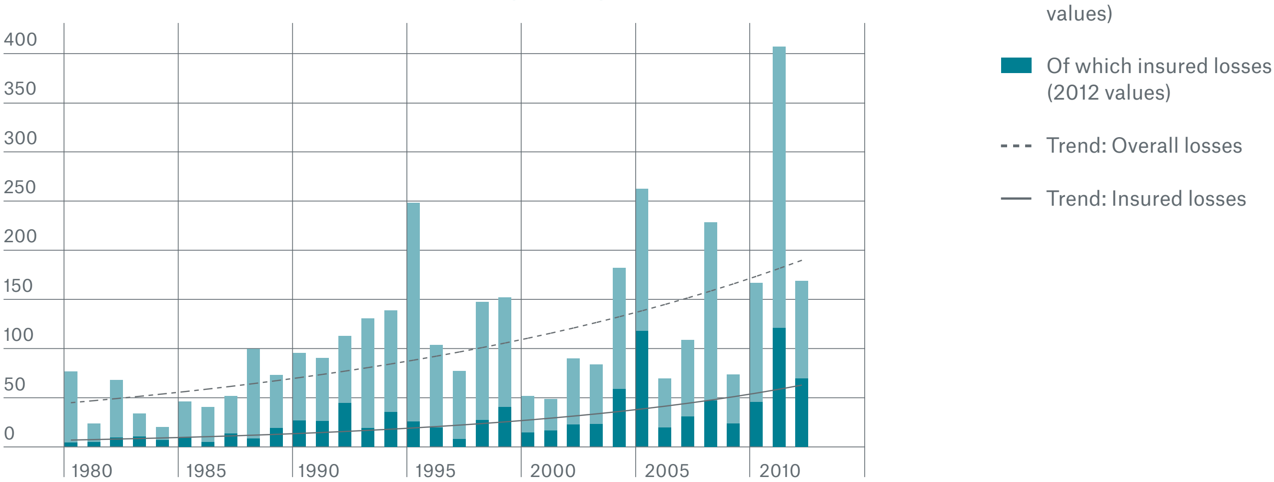
Overall losses and insured losses 1980–2012 (US$ bn)



Natural catastrophes 1980–2012

Breakdown by continents and perils

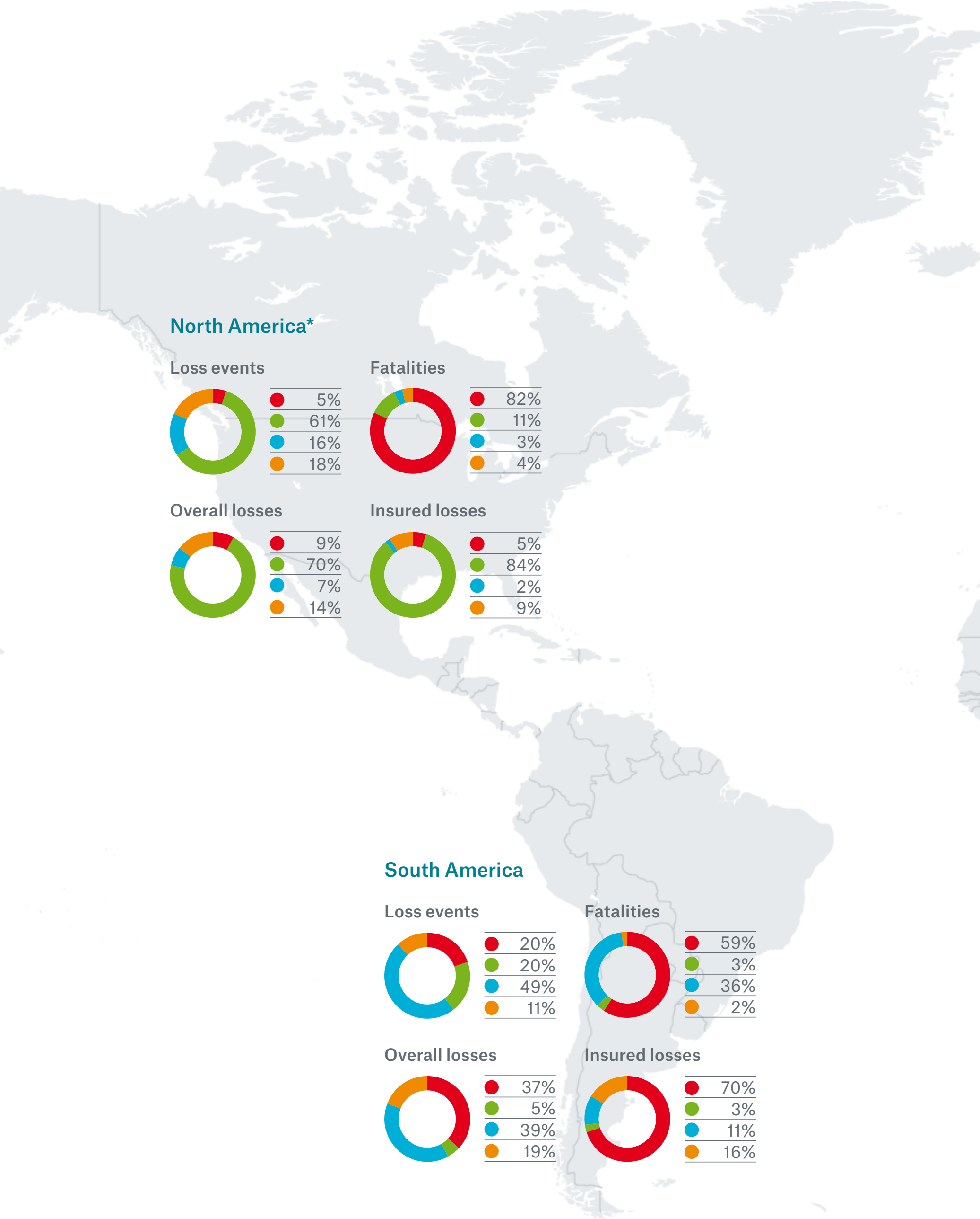
Between 1980 and 2012, some 21,000 loss-related events were recorded in Munich Re's NatCatSERVICE. The chart provides a breakdown by continent and sub-continent and shows the percentages attributable to each of the following main perils:

- **Geophysical events:** Earthquake, tsunami, volcanic eruption
- **Meteorological events:** Tropical storm, winter storm, severe weather, hail, tornado, local storm
- **Hydrological events:** River flood, flash flood, storm surge, mass movement (landslide)
- **Climatological events:** Heatwave, cold wave, wildfire, drought

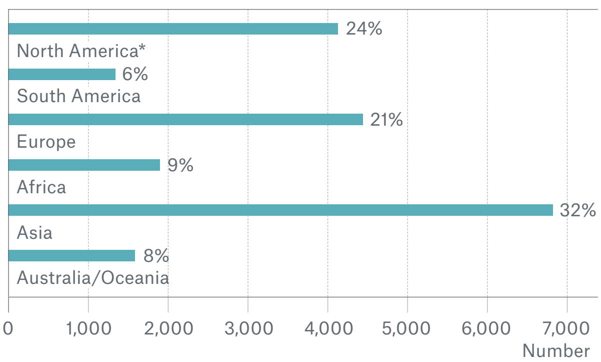
* North America = North America, Central America, Caribbean

Overall losses and insured losses, 2012 values.

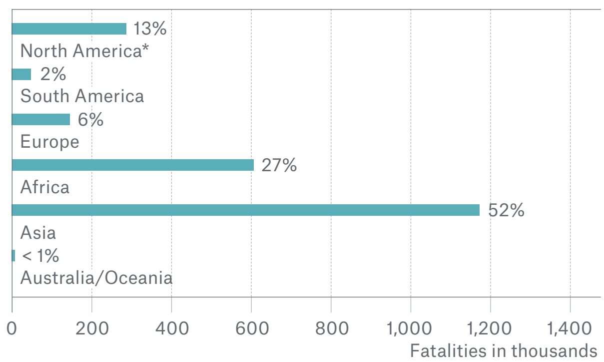
Source: Munich Re, NatCatSERVICE

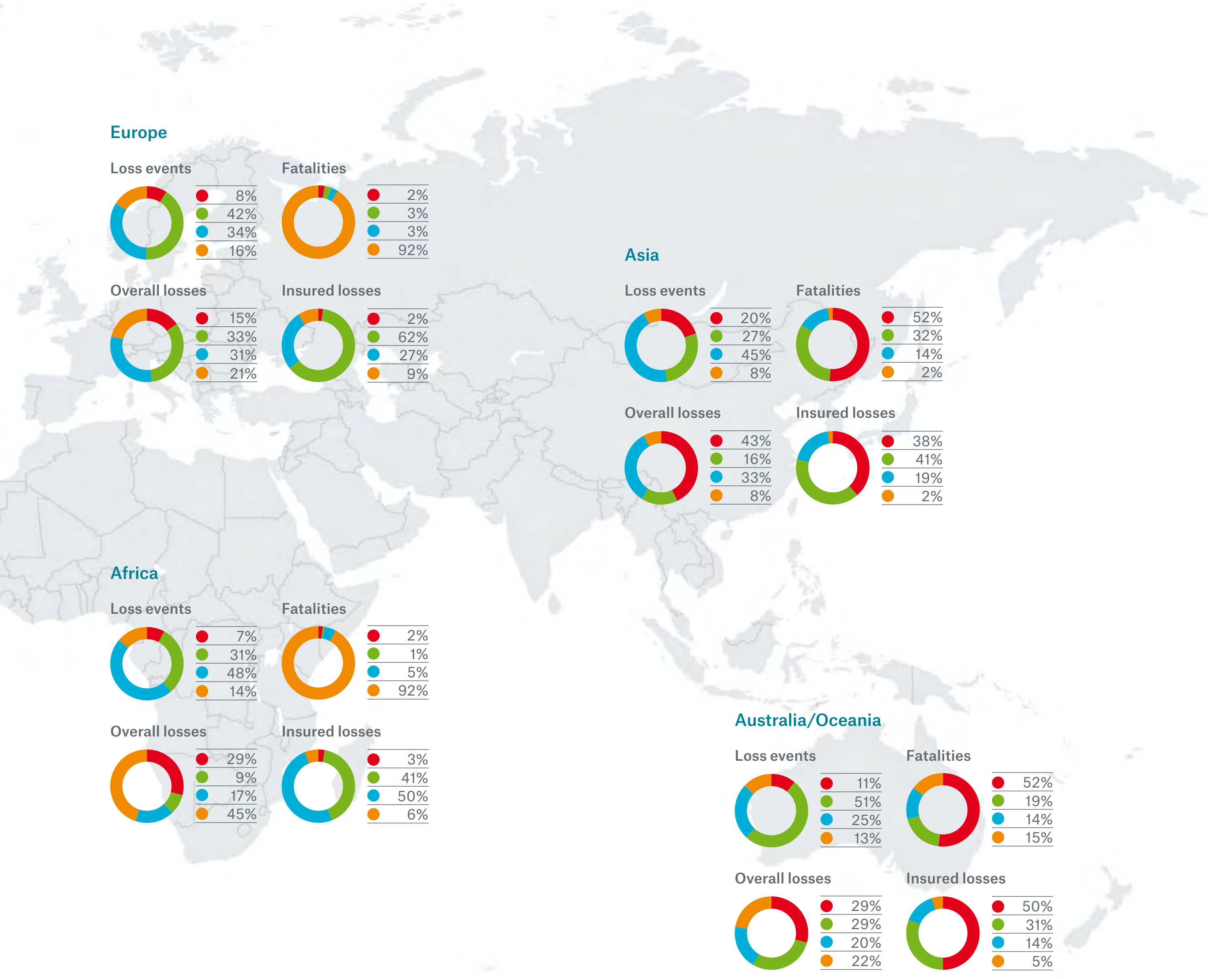


Number of events: 21,000

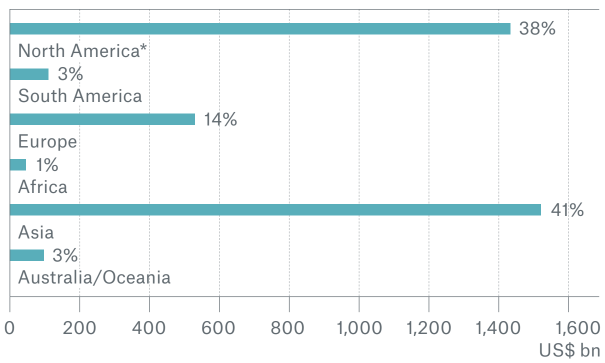


Fatalities: 2.3 million

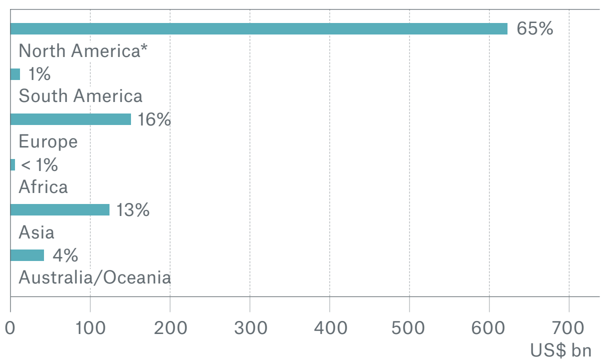




Overall losses: US$ 3,800bn



Insured losses: US$ 970bn



Loss trends – How much would past events cost by today's standards?

In recent decades, natural catastrophe losses have evolved in different ways depending on the region and the hazard. In most cases, it is clear that the trend is upwards, but the factors behind this trend are less clear.

Jan Eichner

We live in an ever-changing world, where circumstances that applied until recently may now be obsolete. This can lead to problems when it comes to nat cat risk assessment, for instance when calculating loss return periods, because such assessments rely on data taken from the past. To be able to compare past and present-day losses, the former would, in theory, have to be repeated under current conditions – which is impossible. We therefore need a standard which enables losses incurred at a given point in time to be set in the current context. Referred to as normalisation, this can only be achieved using proxy data, i.e. approximate indications of how socio-economic values have developed in the course of time.

Risk factors and loss drivers

Risk and the loss amounts potentially associated with it are determined by three factors: the destroyable assets (exposure), their susceptibility to damage (vulnerability) and the intensity and frequency of the natural hazard (hazard). Where insured losses are concerned, exposure also includes insurance penetration. The different factors involved change in the course of time, and usually to different extents, depending on region. Such changes play a major role in any comprehensive risk assessment.

Exposure is closely linked to socio-economic developments such as population growth, wealth, economic growth and the development of natural areas formerly considered, often not without cause, to be waste land. These are factors which increase on average in the course of time, so that the losses also increase.

No clear trend is evident where vulnerability is concerned. On the one hand, building code improvements have been introduced to ensure that roofs are more resistant to storm damage, for instance, and that dams afford protection against specific flood levels. Effective warning systems are another positive development, ensuring speedy deployment of preventive and protective measures. But, on the other hand, vulnerability has also increased due to factors such as the installation of photovoltaic systems on roofs or the use of fragile materials as cladding for façades.

The natural hazards themselves can also change in the course of time but the natural variability commonly referred to as a "whim of nature" is not a matter of mere chance. Atlantic warm and cold phases, for instance, influence hurricane activity on a scale of several years. The same is true of the quasi-periodic ENSO (El Niño, La Niña) phenomenon in the Pacific. As well as influencing Atlantic hurricane activity, ENSO can cause heavy precipitation in South America and affects severe thunderstorm activity over North America. Over long time scales, climate change is also partly responsible for shifts in, and the intensification or even, in some cases, moderation of some natural hazards. Regional climate models and medium-term projections indicate the extent of such changes.

Proxy values and data

To be able to compare past and current losses, one needs to account for inflation and exposure increase over time. Increases in value are positively correlated with population development and values in a given region. Indeed new assets tend to be more readily created in areas that already have an extensive infrastructure. Key macroeconomic data such as national economic output and total income can be used as proxies to reflect such developments. The national figures have to be broken down into local units so that the generally limited dimensions of natural phenomena can be more effectively mapped. Otherwise, the results obtained from normalising individual loss events may be very approximate. However, aggregating a number of events reduces the degree of imprecision, regional overestimates and underestimates virtually balancing each other out.

Miami Beach 1914: Low-risk, despite high hurricane exposure.

Miami Beach 2012: High loss potential due to intense development.

The following data combinations summarise sociological and economic developments. They are now established as proxies of exposure development in normalisation analysis.

Local GDP = GDP per capita x Number of people affected

Total economic added value is normally expressed as gross domestic product (GDP) or, less commonly, gross national income (GNI). A proxy for local GDP is obtained by multiplying national GDP per capita by the number of inhabitants within the given region. Other methods divide national GDP into equal-sized cells weighted to reflect the percentage of overall population located in each one. This produces a kind of gross cell product. All the cells located in a region exposed to natural hazards must be added together to obtain a proxy for the region in question.

One of the disadvantages of using GDP data, especially in the western world, is that they now include a substantial proportion of intangible assets (e.g. related to the service sector) that may not be directly affected by natural catastrophes. Normalisation may thus result in a slight but systematic overstatement of past losses.

A far better approximation of actual destructible assets is obtained from estimates relating to building stock and increase in prices and to

Value of local building stock = Average housing price x local building stock

national or regional index of construction and repair costs. The value of the local building stock is the average price of the buildings multiplied by the building stock, and only applies to buildings. It does not take account of the value of contents and vehicles, which may account for a more or less equivalent proportion of the overall amount in the event of a loss.

Although useful for loss normalisation purposes, data of the requisite quality are currently available for just a few industrialised nations and cannot be used for international analyses. Since GDP figures are readily available, they are now accepted for normalisation at global level, despite the inaccuracies involved. More detailed figures are only available for a few regional analyses, primarily in the USA and a number of western European countries.

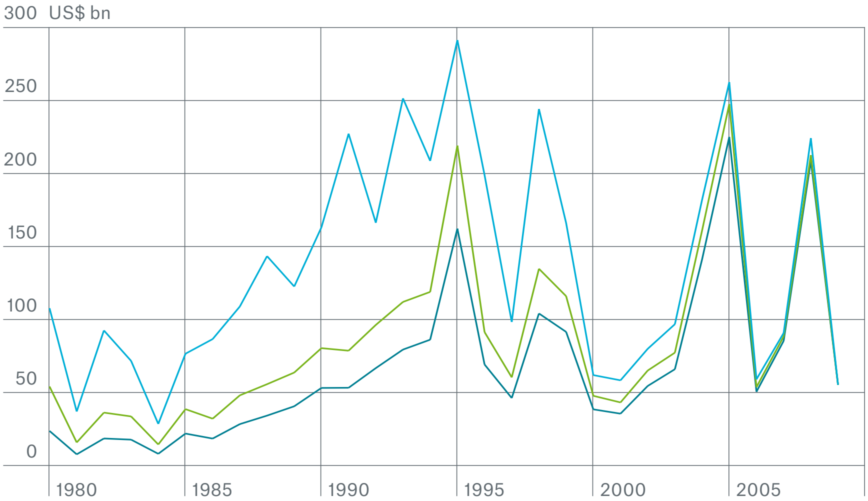
Where precise GDP figures are not available for the country concerned, national income classes can be compiled from World Bank statistics, for example, and a proxy GDP or GNI value calculated by assigning the country to the appropriate class. Although the results may be very approximate in some cases, this method is still better than adjusting loss data for inflation only, for comparison purposes.

Normalisation methods and results

In mathematical terms, normalisation is based on the assumption that the loss and the proxy value develop proportionally and that the quotient of loss value and exposure proxy is constant over time. A formula is then derived for normalised loss at present-day values:

$$\text{Loss today} = \text{Loss in year X} \times \frac{\text{Proxy today}}{\text{Proxy in year X}}$$

Overall economic loss from all natural catastrophes worldwide 1980–2009



The diagram shows global overall nat cat losses since 1980 in original values, adjusted for inflation and normalised on the basis of GDP data.

- Original values
- Adjusted for inflation (2009 values)
- Normalised on the basis of GDP data per country (2009 values)

Source: Diagram based on Fig. 3 in: E. Neumayer and F. Barthel, *Normalizing economic loss from natural disasters: A global analysis,* in Global Environ. Change (2010), Vol. 21 (1), p. 13–24, doi: 10.1016/j.gloenvcha.2010.10.004.

In studies by the Grantham Research Institute of the London School of Economics (LSE) in which loss data from Munich Re's NatCatSERVICE were analysed, the following combination of proxies was chosen to normalise global overall losses in the countries concerned: inflation, gross domestic product per capita and number of people affected by the catastrophe, or:

Proxy = Inflation* x *GDP per capita* x *No. of people affected

One finding established in an LSE analysis into the increase in global nat cat losses is illustrated in the above graph. Due to socio-economic growth, normalising the data has the effect of substantially reducing the trend observed in the case of annual losses in original values. The LSE researchers' cautious linear estimate of the residual trend indicates a mean increase of US$ 1.7bn per year for the past 30 years in present-day values. That is equivalent to an increase of about 50% over the period as a whole. However, the diagram also shows that the trend features phases of greater and lesser loss activity rather than being linear.

A second LSE study analysed insured losses from meteorological and climatological loss events, primarily severe thunderstorms, in the USA. Here, insurance penetration has to be taken into account. The authors of the study use two different methods to compare the effects of different socio-economic proxies on insured losses. The first is based on inflation, insurance penetration, GNI per capita and number of people affected. The second substitutes value of local building stock for the last two values.

Proxy = Inflation* x *GNI per capita* x *No. of people affected* x *Insurance penetration

Proxy = Inflation* x *Building stock value affected* x *Insurance penetration

The results are shown on page 59. Again, the virtually exponential rise in original values is weaker following normalisation. This is also depicted in linear form, both methods resulting in an increase of approximately US$ 750m per year for weather-related events. Even disregarding the outlier Hurricane Katrina in 2005, the trend still indicates an increase of some US$ 450m per year. The increase for severe thunderstorms alone is in the order of US$ 100m per year. The fact that similar results are obtained even though different proxies are used can be taken to indicate the stability of the results.

OUR EXPERT

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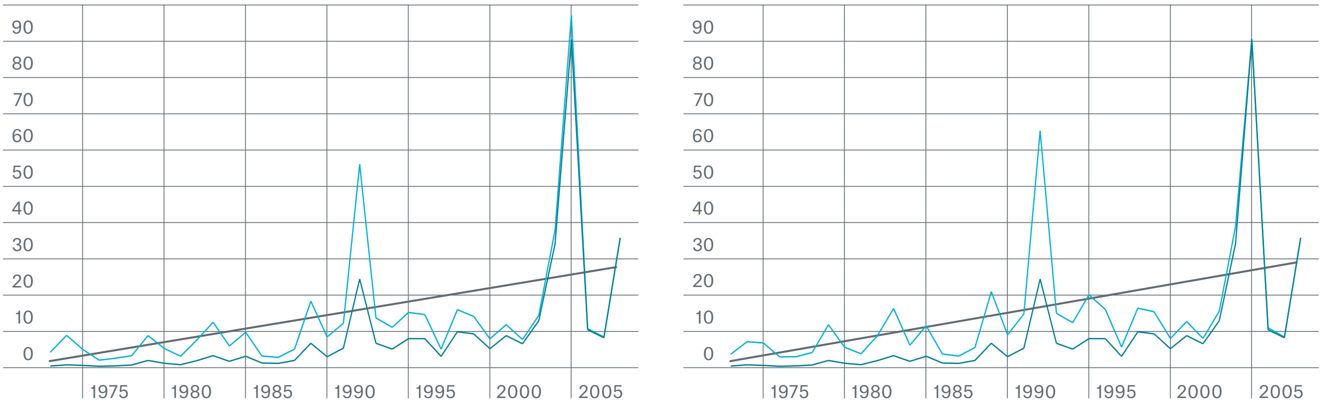
Natural catastrophes in the USA 1973–2009
Insured losses

Weather-related events*

Normalised on the basis of income development | Normalised on the basis of building stock development

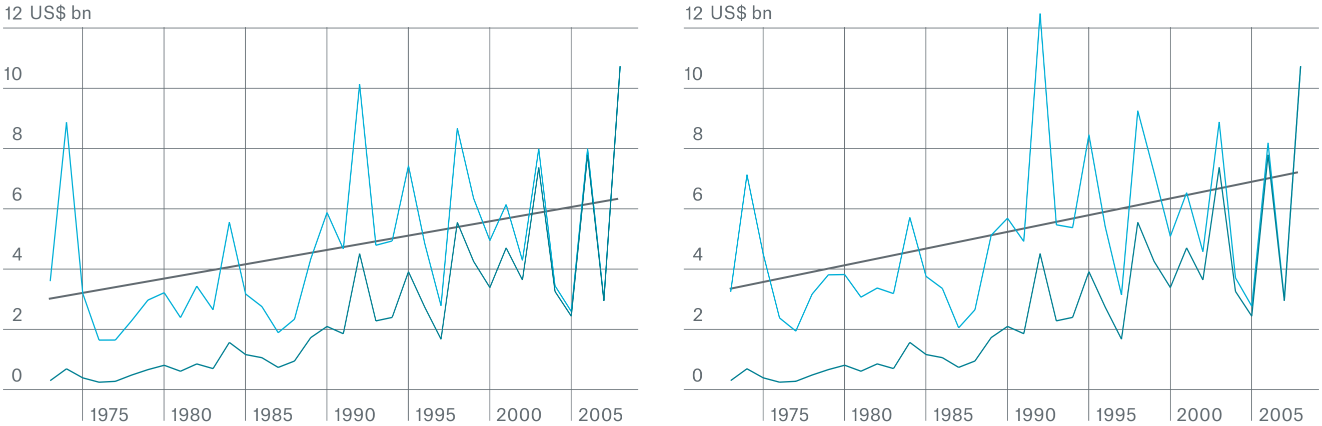


* Weather-related events: Meteorological events (storms), hydrological events (floods) and climatological events (heatwave, cold wave, wildfire, drought)

■ Original values ■ Normalised – Trend

Convective storms**

Normalised on the basis of income development | Normalised on the basis of building stock development



** Convective storms: Severe thunderstorms with flash floods, hail, tornado, lightning

■ Original values ■ Normalised – Trend

Insured losses are shown in original values and normalised on the basis of income development (left) and building stock development (right), bearing in mind changes in insurance density.

Source: Based on Fig. 8(a) and (b) in F. Barthel and E. Neumayer, *A trend analysis of normalized insured damage from natural disasters* in Climatic Change (2012) 113: 215–237, DOI 10.1007/s10584-011-0331-2

Conclusion

Once the loss increases have been adjusted to eliminate socio-economic effects, the residual trend can essentially be attributed to changes in vulnerability and in the frequency and intensity of natural hazards. What part the two remaining factors play cannot (yet) be conclusively established. However, if the development is essentially due to changes in the natural hazards, future increases are to be expected as a result of climate change. Munich Re's NatCatSERVICE will also provide normalised loss time series as a standard service from 2013 onwards. The normalisation methods used will be presented in detail in the next issue of Topics Geo.

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Topics Geo – World map of natural catastrophes 2012

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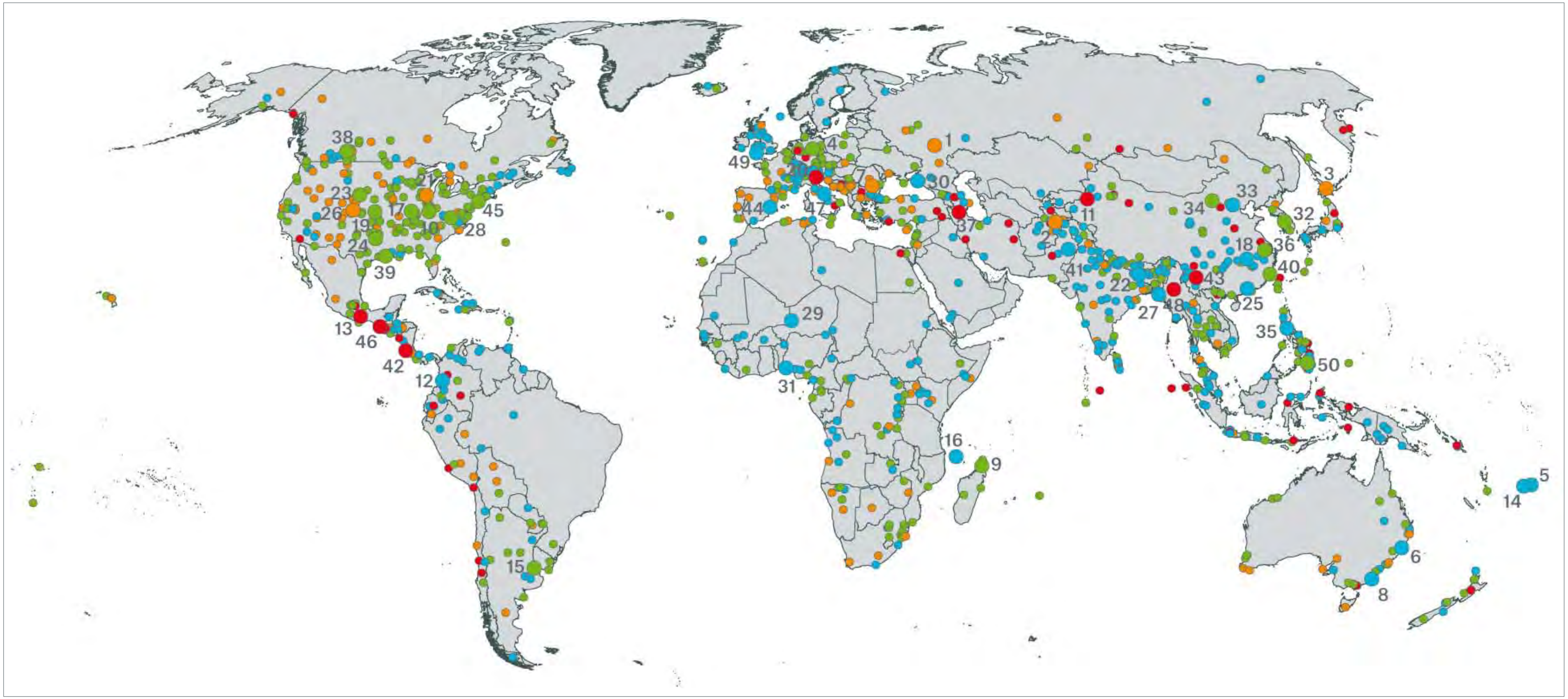

905 natural hazard events, thereof

○ 50 major events (selection)

- **Geophysical events:** Earthquake, tsunami, volcanic eruption
- **Meteorological events:** Tropical storm, winter storm, severe weather, hail, tornado, local storm
- **Hydrological events:** River flood, flash flood, storm surge, mass movement (landslide)
- **Climatological events:** Heatwave, cold wave, wildfire, drought

Topics Geo – 50 major events in 2012

No.	Date	Loss event	Country/Region	Deaths	Overall losses US$ m	Insured losses US$ m	Explanations, descriptions
1	1.1.–7.2.	Cold wave, winter damage	Russian Federation	215			High wind speeds. Infrastructure and crop losses.
2	January–March	Cold wave, avalanches	Afghanistan	250			Coldest winter for 15 years, heavy snowfall, large avalanches. Areas cut off. Livestock deaths.
3	1.1.–10.2.	Winter damage, snowstorms	Japan	83			Blizzards, gusts up to 130 km/h, avalanches. Bridge collapsed, highways, roads blocked.
4	5.–6.1.	Winter Storm Andrea	Western, northern and eastern Europe	5	720	440	High wind speeds, heavy snowfall (up to 60 cm). Power outages. Property and infrastructure losses.
5	21.–25.1.	Floods, landslides	Fiji	11	20		Tropical depression, heavy rain (400 mm/48h). >50 bridges damaged, 55% of export crop destroyed.
6	24.1.–11.2.	Floods, flash floods	Australia	2	225	140	Torrential rain. Thousands of houses, vehicles damaged. Coal mines affected, cattle losses.
7	25.1.–13.2.	Cold wave, winter damage	Eastern, southern and western Europe	541	850		Snowdrifts up to 8 m, extreme frost and low temperatures (–39°C). River navigation suspended. Pipes burst. Power outages. Livestock losses.
8	24.2.–16.3.	Floods	Australia	2	230	140	Towns cut off. Thousands of houses/vehicles caught in flood waters. Infrastructure and agriculture losses.
9	26.2.–4.3.	Tropical Storm Irina, floods	Madagascar, South Africa, Mozambique	88			Thousands of houses damaged. Bridges, roads damaged. Losses to agriculture.
10	2.–4.3.	Severe storms, tornadoes	USA	41	5,000	2,500	>30 tornadoes up to EF4 (Enhanced Fujita Scale), large hail. Losses to property and industry.
11	9.3.	Earthquake	China		80		M_w 5.8. >8,600 houses damaged or destroyed. Losses to infrastructure.
12	15.3.–1.6	Floods, flash floods	Colombia	55	300		Heavy seasonal rains. >25,000 houses flooded. 5 bridges, 11 aqueducts damaged.
13	20.3.	Earthquake	Mexico	2	320	160	M_w 7.4. >15,000 buildings damaged/destroyed. Communications disrupted, power outages.
14	28.3.–3.4.	Floods, flash floods	Fiji	4	72		Hundreds of houses damaged. Power and water supply disrupted.
15	5.–8.4.	Severe storms	Argentina	18	10		>32,000 houses, many schools and businesses damaged. Power and water supply disrupted.
16	19.4.–13.5.	Floods	Comoros	4	5		Landslides, rockslides. Villages cut off. >9,300 houses damaged or destroyed. Losses to agriculture and livestock.
17	28.–29.4.	Severe storms	USA	1	4,600	2,500	Two waves of supercell thunderstorms, tornadoes, large hail (7cm in diameter). Thousands of houses and businesses damaged or destroyed. >50,000 cars damaged. Power outages.
18	10.–24.5.	Floods, landslides	China	127	2,500		Severe storms, hail. 200,000 houses, hospitals, schools damaged/destroyed. >14,000 km^2 of cropland severely damaged or destroyed.
19	25.–30.5.	Severe storms, hailstorms	USA		3,400	1,700	Thunderstorms, tornadoes, hail (up to 11 cm in diameter). Losses to buildings, industry and agriculture.
20	20.5/29.5.	Earthquakes	Italy	18	16,000	1,600	Series of earthquakes up to M_w 5.9. Major losses to houses and historic buildings. Losses to food industry and infrastructure.
21	June–September	Drought, heatwave	USA	100	20,000	15,000–17,000	Severe lack of rain, extreme temperatures (>40°C). Major crop losses (esp. soybeans and corn). Low water levels in rivers, reservoirs, wells.
22	June–September	Floods, landslides	India	600	150		Heavy monsoon rains. 4,500 villages flooded. Infrastructure damaged. Heavy losses to agriculture fisheries and livestock. More than two million displaced.
23	6.–7.6.	Severe storms, tornadoes	USA		1,400	1,000	Large hail, flash floods. Thousands of houses and vehicles damaged. Losses to infrastructure.
24	11.–13.6.	Severe storms, hailstorms	USA		1,900	950	Hail up to 7cm in diameter. >3,000 houses, 8,000 vehicles damaged. Power outages.
25	20.6.–8.7.	Floods	China	70	800		>100,000 houses damaged or destroyed. Losses to agriculture. More than 160,000 people displaced.
26	23.6.–10.7.	Wildfires	USA	2	600	450	Waldo Canyon fire, gusts up to 95km/h. Hundreds of houses burnt. More than 34,000 people evacuated.
27	26.6.–31.7.	Floods	Bangladesh	131			Torrential rain (400 mm/12h), landslides. >250,000 houses destroyed. Power and communication lines disrupted. Losses to infrastructure.
28	28.6.– 2.7.	Severe storms	USA	18	4,000	2,000	Super derecho. Thousands of houses, mobile homes, businesses, vehicles and boats damaged. >2.4 million without electricity.
29	July–September	Floods	Niger	91			24,000 houses destroyed. Bridges, roads destroyed. Losses to crops and livestock. Outbreak of epidemic diseases.
30	6.–8.7.	Flash floods	Russian Federation	172	400	32	Heavy rain (>300 mm/few hours), tornadoes. Thousands of houses damaged. Major losses to infra-structure.
31	July–December	Floods	Nigeria	431	500		Torrential seasonal rain. 600,000 houses, churches, schools damaged/destroyed. Drinking water supply disrupted. Losses to crops and livestock. Displaced: 2.2 million.
32	18.–29.7.	Tropical Storm Khanun (Enteng)	North and South Korea	89	100		Torrential rain. Tens of thousands of houses flooded or destroyed. Bridges, roads washed away. Losses to agriculture.
33	21.–24.7.	Floods	China	151	8,000	180	200,000 houses damaged or destroyed. 50 bridges, 750 km of roads destroyed. Major losses to agriculture and livestock (170,000 farm animals killed).
34	2.–6.8.	Typhoon Damrey, floods	China	10	370		Torrential rain. Dam collapse. >35,000 houses damaged/destroyed. 240 bridges damaged. Crops destroyed.
35	5.–17.8.	Floods	Philippines	109	70	3	Torrential monsoon rain. >13,000 buildings damaged or destroyed. Financial markets closed. Losses to crops and livestock.
36	8.–9.8.	Typhoon Haikui, floods	China	16	1,500	230	Heavy rain. 40,000 houses damaged or destroyed. Losses to factories. Roads, bridges damaged. Evacuated: >2.1 million,
37	11.8.	Earthquakes	Iran	306	500		Twin earthquakes, up to M_w 6.4. 12,000 houses destroyed. Communications disrupted. Injured: >3,000.
38	12.8.	Hailstorm, severe storm	Canada		1,050	530	Thousands of houses, businesses, vehicles damaged. Trees downed. Power failures.
39	24.–31.8.	Hurricane Isaac	Caribbean, USA	42	2,000	1,220	Category 1 hurricane, heavy rain (500 mm). Buildings, vehicles, boats damaged. Oil platforms, gas production, refineries affected. Losses to agriculture and fisheries.
40	25.–30.8.	Typhoon Bolaven, storm surge	Japan, North and South Korea, China	100	950	450	Torrential rain. Thousands of houses destroyed. Losses to businesses, industry and infrastructure. Major losses to crops and fish farms.
41	3.–27.9.	Floods	Pakistan	455	2,500		>600,000 houses damaged or destroyed. Irrigation systems damaged. Losses to agriculture and livestock. More than 300,000 displaced.
42	5.9.	Earthquake	Costa Rica	2	45	32	M_w 7.6. Hundreds of houses damaged. Losses to infrastructure. Power outages.
43	7.9.	Earthquake	China	89	1,000	45	M_w 5.6. >6,500 houses destroyed, 430,000 damaged.
44	28.9.	Flash floods, tornado	Spain	10	260	130	Villages cut off. Homes, commercial properties damaged. Two bridges destroyed.
45	24.–31.10.	Hurricane Sandy, storm surge	Caribbean, USA, Canada	210	65,000	30,000	Category 2 hurricane. Record storm surge in New York City. Severe flood losses. Major losses to infrastructure. Power supply disrupted, in some cases for weeks.
46	7.11.	Earthquake	Guatemala	44	200		M_w 7.4. Damage recorded in 21 (out of 22) states. >30,000 houses/vehicles damaged/destroyed.
47	10.–14.11.	Floods	Italy	4	15		Rivers burst their banks. Houses, business damaged, vehicles washed away. Bridges destroyed.
48	11.11.	Earthquake	Myanmar	26			M_w 6.8. Hundreds of houses, hospitals, schools, religious buildings, government offices damaged.
49	21.–27.11.	Floods	UK	4	15		Villages cut off. >1,400 houses flooded.
50	4.–5.12.	Typhoon Bopha	Philippines	1,100	600		Torrential rain. >167,000 houses damaged/destroyed. Communication, power and water supply disrupted. Bridges destroyed. 400,000 displaced.

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NOT IF, BUT HOW