TOPICS GEO

Natural catastrophes 2012
Analyses, assessments, positions
2013 issue

The great drought

USA experiences the worst drought catastrophe of recent decades. PAGE 16

Hurricane Sandy
Record storm surge along US East Coast

In Focus
Russia – A land of extremes

NatCatSERVICE
Overview of natural catastrophes 1980–2012

Munich RE

EDITORIAL

Dear Reader,

First Irene then Sandy: the two tropical cyclones struck the northeast coast of the USA in consecutive years. Whilst Irene had caused moderate losses in 2011, Sandy, a late-October storm, graphically demonstrated the destructive power of hurricanes. Sandy ranks alongside Hurricanes Andrew (1992) and Katrina (2005) as one of the costliest storms in terms of insured losses. Power outages lasting several days in some areas also showed just how vulnerable modern society is, despite all the preventive measures.

Overall, the natural catastrophe statistics for 2012 were largely dominated by atmospheric events, with no catastrophic earthquakes. Due to a number of major weather-related catastrophes, including severe tornado outbreaks in the spring and a record drought in the US Midwest, the USA accounted for an exceptionally high proportion of natural catastrophes. However, Russia also experienced unusually hot, dry conditions, and vast tracts of land were devastated by wildfires. In view of climate change, it is to be feared that Russia will be increasingly affected by disastrous natural hazard events. Our "In Focus" section presents an analysis of the situation and explores the consequences for the insurance industry.

There has been a clear upward trend in natural catastrophe losses for some decades now. Topics Geo examines the extent to which this is due to population growth, increased prosperity and other socio-economic factors and the extent to which it is attributable to an increase in the frequency and intensity of natural hazard events. This plays a key role in natural hazard assessment, for instance when calculating loss return periods. Such risk assessments will only provide valid results if data from past events can be classified correctly.

For the first time, Topics Geo includes both the 2012 World Map of Natural Catastrophes and a continent-by-continent breakdown of events recorded in our NatCatSERVICE database since 1980.

I sincerely hope that this issue of Topics Geo will provide useful support for your day-to-day work, and wish you an informative read.

Munich, February 2013

Dr. Torsten Jeworrek
Member of Munich Re's Board of Management
Chairman of the Reinsurance Committee

NOT IF, BUT HOW

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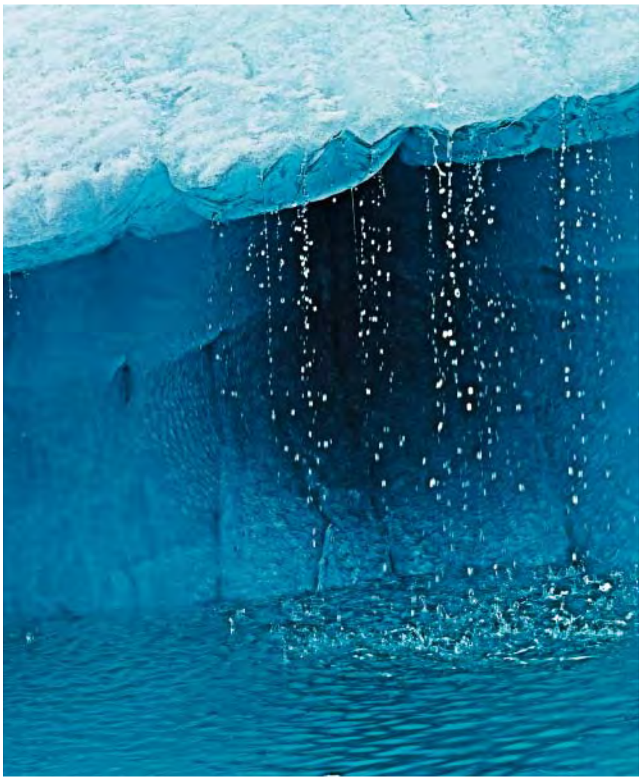

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CLIMATE RISK INDEX

Thailand and Cambodia suffer most

The annual Global Climate Risk Index (CRI) published by Germanwatch shows the extent to which countries have been affected by extreme weather like floods, storms and heatwaves. This is based on Munich Re's NatCatSERVICE database together with demographic and economic data provided by the International Monetary Fund. In 2011, the list was headed by Thailand, Cambodia and Pakistan. In the period between 1991 and 2011, Honduras, Myanmar and Nicaragua ranked highest in terms of losses and fatalities.

>> Further information is available at:
www.germanwatch.org

DISASTER RESEARCH

Disaster loss data working group formed

IRDR (Integrated Research on Disaster Risk), a programme of the International Council for Science, has set up the DATA (Disaster Loss Data) Working Group. At its first meeting, in October 2012, 12 participants from universities, governments, UN and EU organisations and the insurance industry set the agenda for the next 12 months. The aim is to standardise the terminology and classification of natural disasters so that databases are globally comparable. A further step involves work on an international numbering system for natural catastrophes. This will improve transparency and facilitate data analysis.

>> Further information can be found at:
www.irdrinternational.org

PUBLICATION

Study on weather risks in the USA and Canada

Weather-related natural catastrophes are increasing at a much faster pace in North America than on any other continent. Our latest study, "Severe weather in North America", analyses different weather phenomena and their consequences. We examine the reasons behind the increase in weather risks, including climate variability and climate change, and recommend risk mitigation and prevention measures designed to deal with extreme events. It is planned to extend the weather risks series to other regions.

>> Details on how to order the study are available at:
www.munichre.com/touch/publications

News in brief

MCII now in operation: **Munich Climate Insurance Initiative** proposes insurance solutions within the framework of the COP climate negotiations. More information on this and the current pilot project is available at: **www.climate-insurance.org**.

The normalised data recorded in Munich Re's NatCatSERVICE database have been further enhanced with effect from January 2013. Analyses, graphs and statistics are available as free downloads at: **www.munichre.com/touch>>NatCatSERVICE Downloadcenter**

Dr. Anselm Smolka, who is in charge of the section Corporate Underwriting Geo Risks, retires from Munich Re on 30 September 2013. Munich Re's Geo Risks Research Department was built up by Dr. Smolka and Dr. Gerhard Berz, for many years its head. Dr. Smolka was responsible for producing the insurance industry's first probabilistic earthquake risk model in 1987. He will be succeeded by his current deputy, Alexander Allmann, a geophysicist.

CRESTA zones using France as an illustration

Digital CRESTA zone maps are the basis used for natural hazard modelling, accumulation control and mapping. In future, high resolution (see diagram on the right) and low resolution versions will be available.

CRESTA reform promises greater risk transparency

CRESTA, an independent initiative whose main goal is to establish a uniform, global system for the accumulation risk control of natural hazards, was founded some 30 years ago. In 2013, CRESTA's current zoning standard will be overhauled.

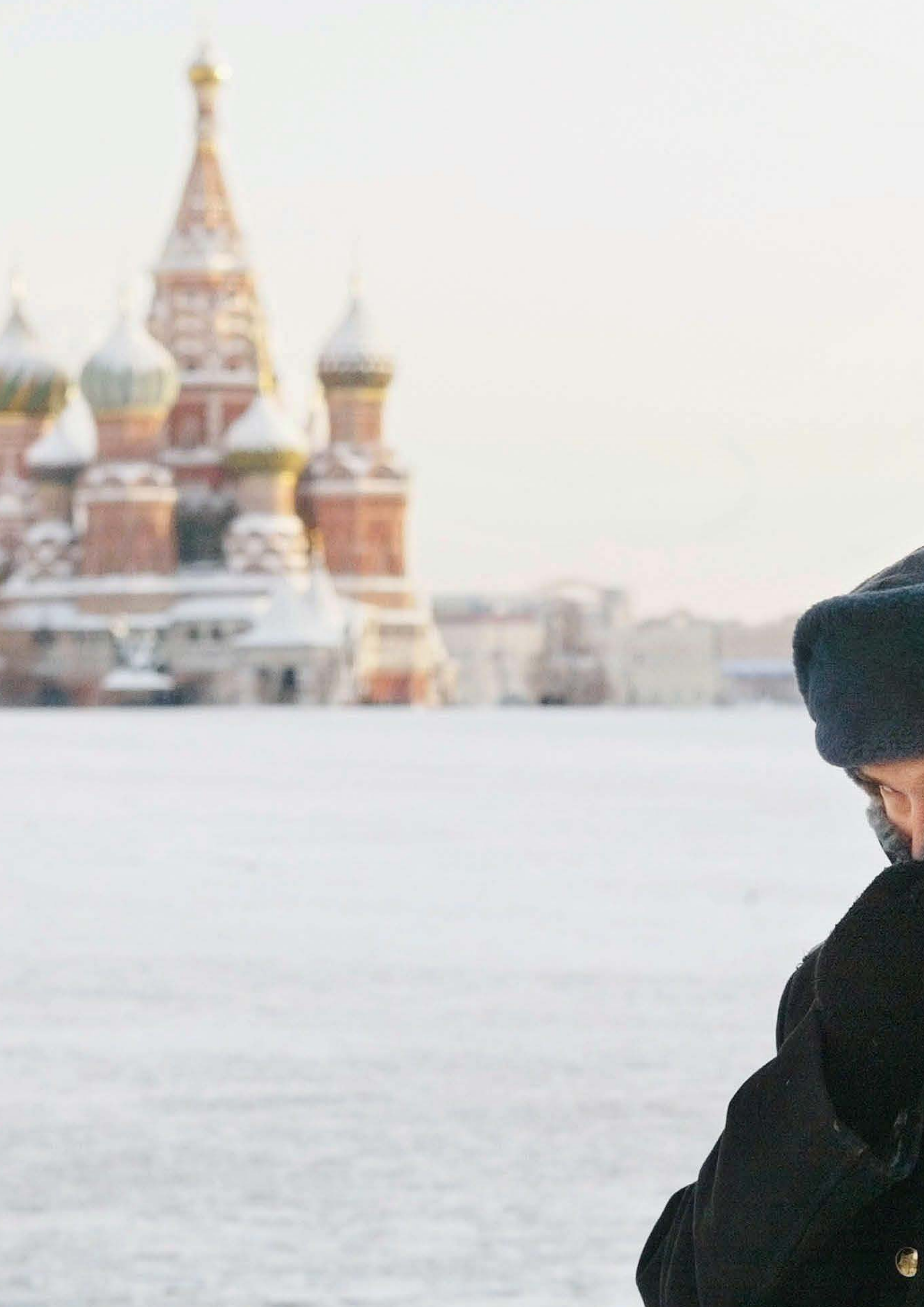
CRESTA zones – the acronym stands for Catastrophe Risk Evaluating and Standardizing Target Accumulations – give primary insurers and reinsurers a system that enables them to transfer aggregated exposure data. Currently, there are zones – and in some cases subzones – for 86 countries.

To give insurers an even better service, CRESTA zones will in future be based on official boundaries rather than perils, since postcodes and administrative zones are generally simpler to use and easily accessible. There will be high resolution and low resolution versions of the CRESTA zones. The high resolution version is designed for data transfer and natural hazard modelling. The low resolution version can be used for accumulation risk control and to visualise aggregated insured values on maps. In addition, a further 49 countries will be added to the database, so that there will be 250,000 high resolution zones worldwide instead of the present 43,000. The official supplier of the special worldwide CRESTA zone maps is GfK GeoMarketing.

To facilitate the changeover to the new system, users will initially be able to access both the new and the old zones, subzones and maps. Conversion tables will be available so that the old zones can be linked with the new ones. Users will still be able to visualise aggregated sums insured per CRESTA zone – in schedule form or in detail – by uploading the ACORD (Association for Cooperative Operations Research and Development) standard table. Another new key function available at no additional cost will allow users to establish CRESTA zones for their insured risks for any given coordinates in just a few short steps.

The task of running the CRESTA secretariat is traditionally performed in alternate years by Munich Re and Swiss Re. In 2013, the secretariat will be headed by Dr. Jürgen Schimetschek, Geo Risks Manager in Munich Re's Corporate Underwriting/Accumulation Risks unit.

>> Further information is available at: **www.cresta.org**



Russian Federation – A land of extremes

Russia is the site of major geological and hydro-meteorological events, weather extremes and other grandiose natural phenomena. Although vast stretches of the country are very thinly populated, natural hazards are a growing challenge for Russian insurance companies and their reinsurers.

Peter Müller

With a land mass extending from the Baltic to the Sea of Japan, and from the Caucasian Mountains to the Arctic glaciers, the country's "vital statistics" are truly impressive: with an area of more than 17 million km^2, the Federation's coastline is more than 37,000 km long, it is crossed by some 120,000 rivers and more than two million lakes dot the landscape. Almost all climate and vegetation zones are found in Russia: the Mediterranean climate, deserts, steppes, tundra, endless ice, permafrost terrain and seemingly never-ending taiga. Major earthquakes, active volcanoes, gale-force winds and severe flooding regularly unleash their destructive forces. Its huge forests also make the Russian Federation an important factor in global climate development.

Jack Frost? Russia covers the full range of climate zones except tropical, but it has a predominantly subarctic and humid continental climate.

Drought causes billions in losses

The statistics of Munich Re's NatCatSERVICE show that, since 1980, roughly 500 natural hazard events have caused macroeconomic losses of US$ 20bn and insured property losses of US$ 760m, both in today's values. Russia captured public attention in the summer of 2010, when the country was ravaged by wildfires during a heatwave and a drought, both worse than any experienced in the past. It is not uncommon for fires to break out in Russia's huge forests. This time, however, toxic smoke covered not only much of the countryside, but also the capital, Moscow. The agricultural sector was badly hit by the drought and farmers experienced considerable production losses. Crops were totally destroyed over an area of around 13 million hectares. The economic loss amounted to several billion US dollars. The government even imposed a ban on cereal exports on account of the disastrous harvest.

Two years on, in 2012, Russia again hit the headlines. This time, wildfires – some caused by arson – raged in the federal districts of the Ural Mountains, Siberia and the Far East, devastating large stretches of land. More major disasters are to be expected in the future. Recent years have already seen a sharp increase in the number of wildfires and wildfire losses. Area-wide forest and peat fires can now be expected roughly every ten years in and around Moscow. A dramatic situation arose even in 2002, when – as in 2010 – the flames nearly reached Moscow's orbital motorway. At the same time, the village of Shiryaevo in the Shatursky District burned down completely. The whole of Moscow was shrouded in smog and visibility was reduced to a mere 50 metres at times.

Ruinous natural calamities on the rise

A completely different kind of disaster occurred on 8 July 2012, when continuous rain and storms caused severe flooding and landslides in Russia's Black Sea region. Thousands of homes were inundated, and 171 people lost their lives. A state of emergency was declared in several towns and cities as railway lines and roads were washed away or rendered impassable. Worst hit was Krymsk, some 1,200 km south of Moscow, where a raging three-metre flood wave fed by the waters of three mountain rivers swept aside everything in its path. The consequences for Krymsk were devastating, with one house in three destroyed by the flood.

The situation is likely to intensify in the future. Russia's Ministry of Civil Defence certainly expects the climate changes observed in Russia in past decades to increase the probability of ruinous natural disasters. Since the devastating wildfires, better technical equipment has been developed to fight catastrophic fires, but major progress is hampered by the sheer size of the territory, uncertainties over who owns the forests, the multifarious interests of lobby groups and the fact that administrative efficiency still has room for improvement.

Insurance market with potential for expansion

Government action is called for following natural catastrophes like that suffered in Krymsk in 2012 because few homeowners are insured against such losses. The insurance products are not yet available and the fact that insurance company branch networks are essentially limited to larger towns and cities also makes life more difficult for potential policyholders. But the situation is gradually changing. For example, the Russian government is considering the reintroduction of obligatory natural hazard insurance for all property owners, as in the Soviet era. At that time, the owners of privately owned individual houses had to purchase state insurance against certain natural hazards, while cover was not obligatory for blocks of flats.

The state's influence has largely been modified to market economy intervention today, although it also intervenes directly. When the state insurance monopoly was dismantled in the early 1990s, a proliferating market emerged, with more than 3,000 insurers jostling for business. The supervisory authorities gradually imposed more stringent capital requirements to stabilise the market, the most recent in January 2012. As a result, many companies closed but the industry's consolidation is by no means complete. Only half of the 600 or so companies currently in the market are expected to remain in operation.

Although a law similar to Germany's Insurance Contract Act (VVG) has been enacted and regulation of the reinsurance market is also liberal, the Russian insurance market still lags behind markets in other former socialist countries in eastern Europe. Political, financial and administrative barriers are still impeding progress. Even now, the two former state insurance companies still play a major role. One has changed its name from Gosstrakh to Rosgosstrakh, while the other – Ingosstrakh – continues to operate under the same name. This can easily give rise to misunderstandings, even among Russian policyholders, because "gos" means state. Indeed, the state has not withdrawn entirely from the insurance industry, and still owns a number of smaller company shareholdings, although they are up for sale. In addition, several of the most important insurers, including SOGAZ, VTB I.C. and Selkhosbank I.C., are run as private companies, in which, however, the state is the major shareholder.

Russia's nascent middle class

With a gross domestic product (GDP) of US$ 1.86tn, Russia ranked ninth in the world in 2011. Despite its economic strength, however, insurance penetration is relatively low. For one thing, even now a large percentage of the population does not own enough property to make insurance worthwhile. At the same time, daunted by a lengthy and frequently turbulent claims settlement process, many people do not see any point in buying a policy. Moreover, many simply lack the financial resources to purchase insurance cover. And the growing numbers of super-rich often dispense with insurance entirely.

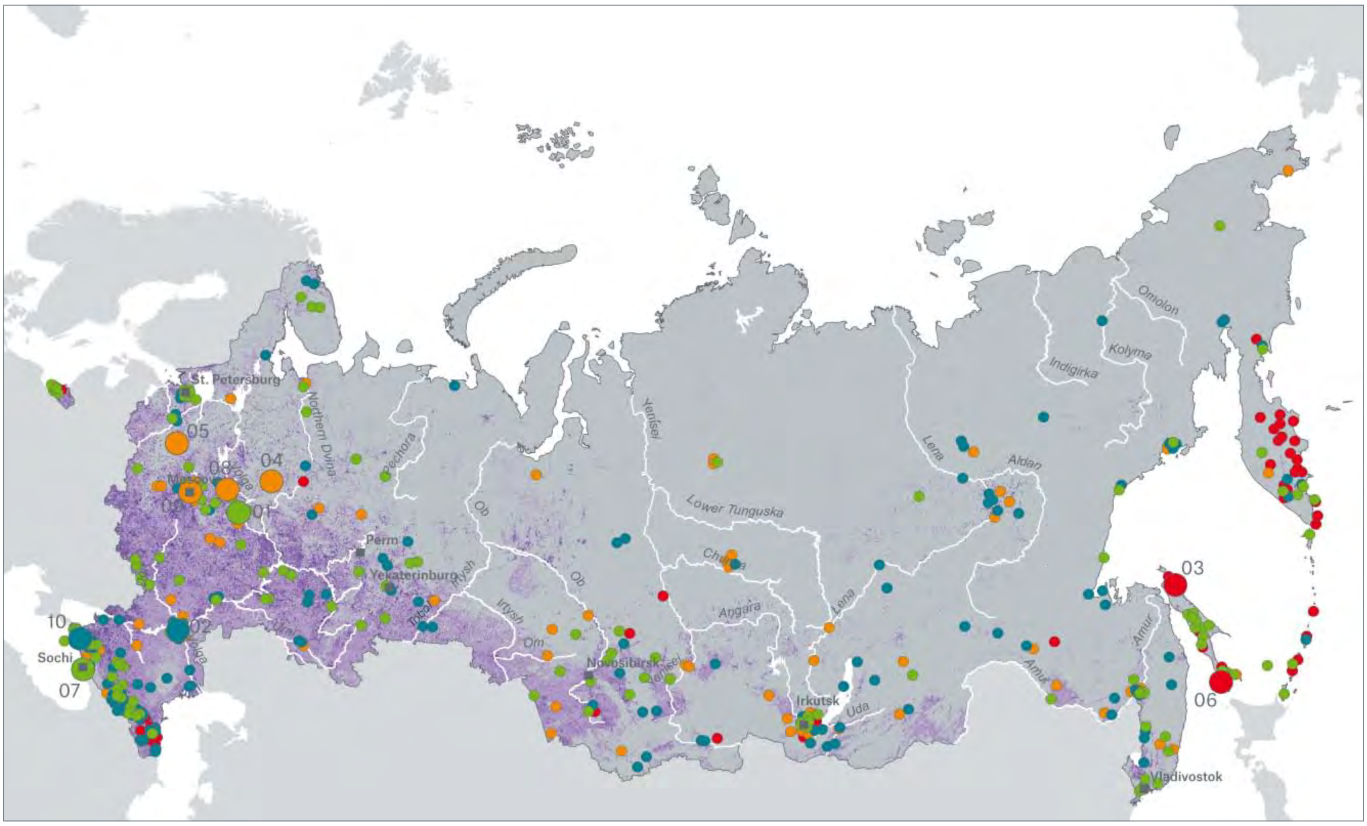
A wealthy middle class with a corresponding need for insurance cover is gradually emerging, mainly in the large conurbations, which offer it greater potential. Roughly three-quarters of Russia's 142 million inhabitants live in cities. In fact, one-quarter lives in the 14 cities with more than one million inhabitants. Moscow, with roughly 12 million inhabitants, and St. Petersburg are the biggest cities. The latter's population recently surpassed five million again, following a wave of emigration in the early 1990s. Unofficially, the population of Moscow is much higher.

The drought and fire catastrophe in 2010 have again raised the question of the function and role of private insurance. Insurance, long considered unnecessary in Russia, is now expected to cover every risk as far as possible. Yet the role of insurance is often misunderstood in this debate. Although it can help to reduce financial burdens, it will never be able to shoulder all economic losses.

To improve market penetration, attention is increasingly focusing on insurers' payment practices, the quality of their products and policyholder satisfaction. However, the government's aim of introducing mandatory natural hazard cover for property owners is the subject of much controversy. The demand for and supply of stand-alone nat cat policies is low but natural hazards are frequently covered under industrial policies (e.g. property, CAR/EAR).

From July to September 2010, much of Russia was caught in the grip of an extreme heatwave and dry conditions. This led to a large number of wildfires and the Moscow region was covered with a dense toxic blanket of smoke. The 30,000 fires caused 130 deaths.

Natural catastrophes and population density in the Russian Federation (1980–2012)



The map shows the population density in Russia together with natural catastrophes documented since 1980. In all, there were some 500 loss-related events with overall losses of US$ 20bn and insured losses of US$ 760m (2012 values). The ten main catastrophes are shown in the table and numbered in order of occurrence.

Source: Munich Re and data from LandScan (2009) TM Population Data Set/UT-Battelle, LLC/U.S. Department of Energy

- ○ Natural catastrophes
- ◯ Significant loss events

- Geophysical events (earthquake, volcanic eruption)
- Meteorological events (windstorm)
- Hydrological events (flooding, mass movement)
- Climatological events (temperature extremes, drought, wildfire)

Population density (2009) per km²

- < 1
- 1–9
- 10–49
- 50–199
- ≥ 200

No.	Year	Event	Town/region	Overall losses in US$ m*	Insured losses in US$ m*	Fatalities
1	1984	Tornadoes	Volga region	25	3	400
2	1991	Floods	Volgograd	500	15	
3	1995	Earthquake	Sakhalin	100	5	1,989
4	2002	Wildfires	Esp. Moscow region	500		
5	2006	Cold wave	Esp. Moscow region	400		116
6	2007	Earthquake	Sakhalin	465		4
7	2009	Winter storm, storm surge	Krasnodar, Sochi	60	30	
8	2010	Heatwave, drought, wildfires	Esp. Moscow region	3,600	450	56,130
9	2010	Ice storm	Moscow	60	55	
10	2012	Flash floods	Krasnodar, Krymsk	400	32	172

* Original values

Earthquake hazard in the Russian Federation

Earthquake hazard

- □ Zone 0: MM V and lower
- ■ Zone 1: MM VI
- ■ Zone 2: MM VII
- ■ Zone 3: MM VIII
- ■ Zone 4: MM IX and higher

Probable maximum intensity (MM: Modified Mercalli Intensity Scale) with a 10% probability of being exceeded in 50 years (corresponds to a return period of 475 years) and average subsoil conditions.

Wildfire hazard in the Russian Federation

Wildfire hazard

- □ No hazard near water and settlement areas and on soil without vegetation
- ■ Zone 1: Low
- ■ Zone 2: ↓
- ■ Zone 3: ↓
- ■ Zone 4: High

Excluding the effect of wind, fires started deliberately and fire-prevention measures.

According to optimistic forecasts, the Russian Ministry of Finance expects the insurance market to grow strongly in the coming years, with the insurance sector's share of GDP increasing from 1.3% to 5%. Per capita premium income is projected to rise from RUB 5,690 (US$ 190) to RUB 26,770 (US$ 890) by 2020, although how these targets are to be achieved is not clear. In addition to suitable products, more autonomy, better regulation and the planned obligatory covers are expected to stimulate the market.

New agricultural insurance law

The disastrous harvest following the 2010 drought prompted the Russian government to focus on crop insurance. Efforts to revise the existing agricultural insurance law were stepped up in order to achieve agricultural policy objectives, namely self-sufficiency in food production and the exploitation of global export opportunities. Munich Re was actively involved in drafting the new version. The agricultural insurance law lays the foundations for a public-private partnership between the state, the insurance industry and the agricultural sector. The budget needed to support crop insurance is provided by the government. The funds are included in the multi-year agricultural development programme and therefore available in the long term. The same is true of government-aided livestock insurance. Based on the new agricultural insurance law, it will be available from January 2013.

Despite these efforts, however, crop insurance density has not increased (assuming a density of 20% on the basis of insurable acreage), mainly because the insurance industry does not meet the structural and organisational criteria required for the law to be implemented. The investments needed to develop specialty crop insurance have not been forthcoming and there is insufficient know-how to systematically provide a scientifically validated basis for product development, premium calculation and claims settlement. The government knows that the law's practical implementation is not ensured. Further implementation guidelines will have to be drafted – a task which will mainly fall to the National Association of Agricultural Insurers (NAAI). In this respect, the NAAI will have an important coordination function under the agricultural insurance law.

Market crop insurance premium volume, which was around RUB 15bn (US$ 500m) in 2011, is expected to fall in 2012. Crop insurance premiums amounted to only about RUB 7bn (US$ 230m) in the first six months of 2012.

Crop insurance will become more attractive to primary insurers and reinsurers if the public-private partnership develops along the lines of SystemAgro (the sustainable crop insurance programme based on Munich Re's global experience). However, uniform terms of insurance must be established for all market players and the government will have to co-finance insured catastrophe losses. Greater acceptance in Russia's agricultural community would substantially increase insurance density and give farmers an effective risk management tool in the event of further disasters like those of 2010 and 2012. For Russia, this would be a major step towards achievement of its agricultural policy objectives.

Climate change brings opportunities and risks

Until recently, climate change did not loom large in the public mind nor feature particularly in political debate, but the situation is changing as natural catastrophe losses increase. Rising temperatures will lead to more frequent floods, storms and wildfires, while road and rail infrastructure and buildings will also sustain considerable losses as permafrost thaw leads to unstable ground conditions.

On the other hand, climate change will also have positive effects. The Northern Sea Route will one day be commercially viable if the ice cover in the Arctic Ocean is reduced. The melting of the ice caps will also make it easier to drill for raw materials in the Arctic. Russia has already laid claim to the rich oil, gas and ore deposits believed to lie beneath the ice.

Russia entered a new phase of economic development when it became a member of the World Trade Organisation (WTO) in August 2012. Raising the previous limit on foreign shareholdings will also have an impact on the insurance market. Munich Re was represented in Russia in the period 1887/88 to 1914, and played an active part in insuring the monumental Trans-Siberian Railway project. We have had a representative office in Moscow since 1991 and played a pivotal role in developing insurance programmes for new infrastructure, industry and urban development projects. A growing primary insurance market is crucial to further business development. Where natural catastrophes are concerned, Munich Re's positive international natural hazard insurance experience will help the country establish its own sector. Munich Re has acquired a wealth of expertise and will be pleased to assist with the development of viable coverage programmes and rates.

OUR EXPERT

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Facts on climate change in Russia

Jan Eichner and Swenja Surminski

Since all except tropical climate zones are found in Russia, climate change will have a range of consequences. Changes are already evident. Due to its geographic location, with many regions extending into the far north, the temperatures have already risen by more than the global average over the past 100 years.

Russia has a predominantly subarctic, damp continental climate due to the very northerly, polar location of much of Siberia. Permafrost is an important feature. The climate has principally given rise to tundra, taiga and steppe vegetation, with vast forests and extensive grasslands and peat moors. Russia's boreal (mainly birch) forests are the world's largest by acreage and second only to the Brazilian rainforest in terms of CO_2 absorption. Most rivers run from south to north, flowing into the Arctic Ocean and normally freezing over in winter.

In the past 100 years, temperatures in Russia have risen by 1.5°C on average, which is almost twice the global average (0.8°C), even rising by more than 2°C in more northerly regions. The reasons for these major deviations from the global average are complex, one being Russia's geographical location and subarctic continental climate. Due to the cooler temperatures prevailing there, the atmosphere absorbs less water vapour. Supplying energy to the atmosphere generally acts in two ways, increasing both the sensible heat, i.e. air temperature, and the latent heat, i.e. water vapour content. The warmer the air, the more water vapour it can absorb. Since temperatures in Russia are typically lower than in other regions, less atmospheric energy is transformed into latent heat and more into sensible heat, i.e. changes in temperature. This accounts to a large extent for the above-average rise in summer and winter temperatures.

The implications for permafrost regions are considerable. The higher the temperatures in summer, the greater the thaw depth. Thermokarst forms as the permafrost thaws. It is characterised by small lakes, depressions and hummocks caused by ground subsidence. Over the past two decades, some parts of Siberia have subsided by up to 20 cm per year, impacting regional eco-systems, buildings and infrastructure. The stability of roads, power lines, pipelines and railway tracks depends on the stability of the permafrost subsoil. In mountainous regions, landslides may even be triggered as the ground becomes softer. The number of days on which vehicles can cross the tundra on frozen farm tracks and gravel roads has decreased considerably over the decades. Scientists expect this thaw process to continue, leading to a decline in the total permafrost area in the Arctic and subarctic regions.

One dramatic side effect of thermokarst formation is that organic substances, such as rotting plants trapped in the frozen soil for tens of thousands of years, can now thaw. As decomposition resumes, large amounts of carbon dioxide and methane are released, powerful greenhouse gases that further warm the atmosphere.

A positive economic effect expected to result from the reduced Arctic sea ice extent in summer is that the Northern Sea Route will regularly open, giving shipping a shorter route between Europe and Asia while the ice is at its minimum. This will doubtless cut transport costs and permit easier access to mineral and other natural resources. Together with permafrost thaw, however, sea ice retreat is increasing coastal erosion and making it more difficult to plan the investment needed for essential infrastructure like ports and roads.

Although even more directly affected by the rise in temperature, the situation in western and southern Russia is completely different. Extreme heatwaves and droughts, and widespread forest and peat fires have become more frequent and intense, causing serious damage on several occasions in recent years. In the summer of 2010, a heatwave combined with a prolonged drought and poor forest management resulted in devastating wildfires.

For some time now, Russian scientists have observed a change in exposure here – partly due to climate changes. For instance, the average annual number of forest and peat fires and the area affected by fire have more than doubled since 1985. Forecasts project a 50% increase in the number of days with a high wildfire risk in southwestern Russia by 2025. The latest Special Report on Extremes (SREX) by the Intergovernmental Panel on Climate Change (IPCC) also expects further temperature increases in northern Asia. As a result, heat events with a current return period of 20 years will recur every five years by mid-century. A similar pattern can be seen with heavy precipitation (the main cause of flash floods). What are now 20-year extreme events could occur twice as

The Russian Federation's rail network comprises 85,000 km of track and is the longest in the world. It was primarily constructed in the period from 1920 to 1991. Many lines were laid on permafrost, and suffer major damage when the ground thaws and softens, no longer providing firm support.

often in future, and it is no contradiction in terms that the same regions are becoming more arid. Even if total annual precipitation decreases, the probability of extreme cloudbursts can still increase. The desertification of cultivated land is due to increasing aridity in southern Russia. This in turn has repercussions for regional climate, vegetation and water resources – and consequences for agriculture and industry.

Implications for the insurance industry

Even if the complex interactions and uncertainties involved make it impossible to predict exactly how climate change will affect insurance demand, we can at least surmise what factors will lead to a change in demand. Munich Re and the London School of Economics are working on a research project (*Evaluating the Economics of Climate Risks and Opportunities in the Insurance Sector*) which has identified five main determinants of insurance demand within the context of climate change: economic growth, the willingness to pay for insurance, political conditions, the insurability of natural catastrophe risks, and possibilities of adjusting to the impacts of climate change. The base scenario assumes a 7.1% p.a. rise in non-life premium volume in the period from 2010 to 2020. Climate change is expected to have relatively little effect on short- and medium-term growth. In Russia and the other BRIC economies, the annual effect of climate change on income is likely to change by less than 0.4%. This slight but not insignificant effect could intensify, however, if the politicians introduce regulatory mechanisms to counter climate change, such as obligatory insurance, state-subsidised insurance products or the imposition of stricter solvency capital requirements. The same also applies if new business opportunities arise following measures designed to reduce greenhouse gas (GHG) emissions or adapt to climate change. Based on these assumptions, two scenarios can be developed as regards insurance demand in Russia:

Optimistic scenario with a substantial increase in demand

Thanks to decisive action, it will be possible to reduce greenhouse gas emissions so that the costs of climate change will be relatively moderate. The government's proactive adaptation policy and a gradual increase in natural catastrophe risks and losses increases awareness of the advantages of insurance. The government therefore creates a more favourable environment for insurers and reinsurers, and people are more willing to purchase insurance cover. The insurance industry responds favourably to the growing risks and offers products supporting the adaptation process. Confidence in insurers grows and the industry is regarded by the public and the politicians as implicit to a solution to the problems of climate change. A range of adaptation and GHG-reduction measures creates rapid growth in the market for new insurance products.

Pessimistic scenario with little increase in demand
Government measures to reduce the risks of climate change fall short of the mark. Losses increase, adaptation measures and steps to reduce GHG emissions lose momentum. The insurance industry fails to anticipate the full implications of the deterioration in the risk situation and reacts with dramatic price hikes. More and more companies become insolvent, insurers withdraw from some market segments. In some high-risk regions, cover becomes unaffordable and is subsequently no longer available. This has a detrimental effect on the resilience of the local population and on economic development. Public and political confidence in the insurance industry dwindles and the regulatory situation deteriorates. This leads to price regulation and a shift towards more state-sector products in a number of market segments. A more lax global climate policy ultimately leads to a stagnating market for renewable energy cover and a fall-off in demand for GHG-reduction and climate-change-adaptation products. In the medium to long term, global failure to deal with climate change causes increasing economic instability, with higher inflation and lower growth. This adversely affects the insurance market.

Many factors that might cause the pendulum to swing towards either the optimistic or the pessimistic scenario are beyond the insurance industry's control. Nevertheless, a number of factors hinge on the industry's response to the challenges. There are various ways of weighting the trend in favour of the optimistic scenario. They include promoting risk awareness, providing the information needed to keep the climate debate alive, and supporting GHG-reduction and climate-change-adaptation measures. Moreover, changes in the risks must be adequately reflected in underwriting and risk management.

Literature: Nicola Ranger and Swenja Surminski – *A preliminary assessment of the impact of climate change on non-life insurance demand in the BRICS economies*, International Journal of Disaster Risk Reduction.

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Drought in the US Midwest

Following the drought in Texas and neighbouring states in 2011, the USA experienced yet another period of extreme dryness in 2012.

Markus Steuer and Maximilian Strobl

2012 was an exceptionally warm year in the USA. In all of the Midwestern states, where most of the main US crops (corn and soybeans) are grown, and many others, the first six months were the warmest since records began in 1895. Above-average temperatures accompanied by increased evaporation rates caused the soil to dry out. In addition, following an abnormally warm and dry 2011/2012 winter, there had been a relatively thin snow cover on the mountains in the spring, so that there was little meltwater to moisten the ground.

From May 2012 onwards, the situation was further aggravated by below-average rainfall in the interior of the country. June and July also failed to bring the abundant rainfall eagerly awaited by farmers, as almost the entire United States came under the influence of high-pressure systems. The resulting drought conditions, which were exacerbated by extremely high temperatures during the warmest July on record since 1895, persisted throughout the subsequent months. The consequences for agriculture were devastating, since weather conditions from June to August play a very important part in the development of corn, soybeans and other crops.

The dryness and heat that prevailed in the US Corn Belt in 2012 primarily affected corn and soybean production. But barge traffic and power production also suffered significant losses.

Based on the Palmer Z Index readings (this index depicts moisture anomalies), a drought of this magnitude in the Primary Corn and Soybean Belt has a return period of 30–35 years. Since 1895, this intensively farmed region had experienced a worse situation only during the Dust Bowl years of 1934 and 1936, and in 1988. Initial model runs by Munich Re assign an agrometeorological return period of 35–45 years to the 2012 drought.

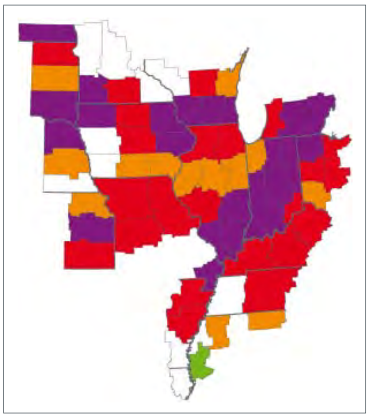
The Palmer Z Index is monthly based and can be used to measure deviations in soil moisture conditions from the long-term average. The duration and geographical extent of very prolonged droughts can be more effectively assessed by the Palmer Drought Severity Index (PDSI), which also takes account of moisture deficits in the preceding months. Based on the PDSI, 39% of the contiguous USA experienced severe or extreme drought in August 2012. This area extended from Nevada to Ohio and from northwestern Texas to North Dakota.

Crop and livestock losses

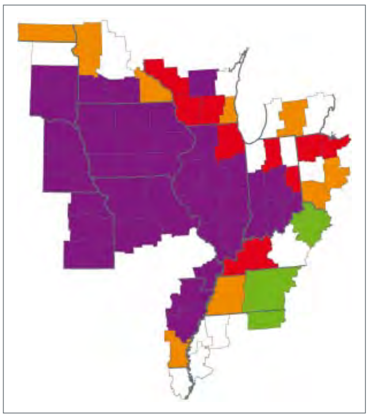
The USA is the world's largest producer of corn and soybeans and also ranks first and second, respectively, in global exports of these products. In 2012, some 40 million hectares (97 million acres) of land were planted to corn and more than 30 million hectares (77 million acres) to soybeans. This corresponds to almost 70% of total grain acreage in the USA. By far the lion's share of these crops is grown in the Primary Corn and Soybean Belt. According to the US Department of Agriculture (USDA) definition, more than 20% of corn and soybeans were rated as being in poor or very poor condition in late June. That share rose to almost 50% (corn) and 40% (soybeans) in July, due to low precipitation and high temperatures. By the time the crops were harvested, the soybean situation had improved slightly, but the condition of the corn crop remained at the same level. Sorghum was affected almost as much as corn.

Prices for crops, especially corn and soybeans, rose considerably in view of the impending losses. Between spring and harvest, the price of soybeans increased by more than 20% and the price of corn by over 30%. Since corn is a very important ingredient in animal feed, livestock producers were particularly hard hit by the higher prices. To make matters worse, between 50% and 60% of the pastures and rangelands were rated as being in poor or very poor condition from July onwards. The price rises also impacted the food processing industry, most of the vegetable oil used for food production being made from soybeans. Soybean meal is also an important source of protein in livestock husbandry and corn is used in the manufacture of industrial products, and primarily ethanol.

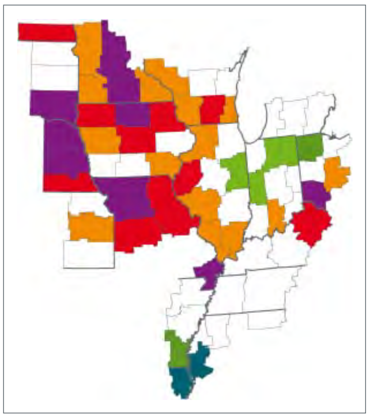
Dryness in June, July and August 2012 in the Primary Corn and Soybean Belt



June 2012



July 2012



August 2012

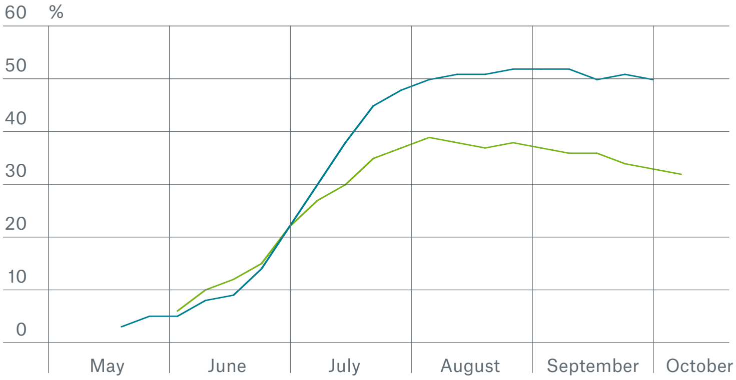
The Palmer Z Index indicates regions in which monthly ground moisture deviates significantly from the long-term average. The rapidly intensifying drought in the Primary Corn and Soybean Belt from June to July was especially devastating for corn because the plants were then at a growth stage particularly crucial to yield.

Palmer Z Index

- Extreme drought (–2.75 or less)
- Severe drought (–2.74 to –2.00)
- Moderate drought (–1.99 to –1.25)
- Normal conditions (–1.24 to 0.99)
- Moderately moist (1.00 to 2.49)
- Very moist (2.50 to 3.49)
- Extremely moist (3.50 or more)

Source: National Climatic Data Center (NCDC), NOAA

Corn and soybeans in poor or very poor condition (2012)



According to the USDA's definition, crops are in poor condition if there is a heavy degree of loss of yield potential. Their condition is deemed to be very poor if there is an extreme degree of loss to yield potential, complete or near crop failure.

— Corn
— Soybeans

Source: National Agricultural Statistics Service (NASS), USDA

As a result of the 2012 drought, stocks of corn and soybeans dropped to historically low levels in the USA and worldwide. Additional production losses due to a continuation of the 2012 conditions would lead to a further deterioration in the supply situation in 2013 and could trigger a drastic rise in food prices throughout the world.

Impact on agriculture in a historical context

During the last severe drought in the Midwest, in 1988, total production of all grains declined by 33% compared with the three-year average. Corn, with a drop of 45%, suffered much more than soybeans (production down by 26%). The overall loss to agriculture totalled US$ 15bn. Farmers were severely hit by the drought, only some 20% of farms and an area of around 23 million hectares (56 million acres) being insured. A total of US$ 1bn was paid in indemnities. The government gave another US$ 4bn in Federal Disaster Assistance.

The 2012 drought proved far costlier for crop insurers, more crops being harvested now than in 1988 and, at the same time, insurance density and total liability covered by crop insurance being much higher. In 2012, farmers had purchased cover for almost 115 million hectares (more than 281 million acres), or 86% of the insurable area. Due to the high exposure and extreme dryness, the losses covered by the public-private multiple peril crop insurance programme will be a record US$ 15–17bn, which translates into a net loss ratio for insurers ranging from around 105% to 135%. In contrast to 1988, many policies link the indemnity not only to yield but also to crop prices paid at harvest time. In this way, the higher prices directly impact the insured losses.

The US crop insurance system is based on a sharing of risks between the private insurance industry and the government. The private insurance industry reported payments higher than at any time in the past, even though the amount of liability is capped by the government.

US droughts since 1900

Period	Main loss area	Overall losses* (US$ m)	Insured losses* (US$ m)	Area percentage (severe to extreme drought)**
1930s Dust Bowl				63% (July 1934)
1951–1956	Great Plains			50% (Sept. 1954)
1988	Midwest	15,000	1,000	36% (July)
2002	Great Plains	10,000	2,000	39% (July)
2011	Texas	8,000	2,400	25% (August)
2012	Midwest	> 20,000	15,000–17,000***	39% (August)

* Losses in agriculture (original values)
** Share of the contiguous USA, based on the Palmer Drought Severity Index
*** Losses covered by the public-private multiple peril crop insurance programme. In average years insured losses are around US$ 9bn.

The table compares the impact of various droughts on agriculture. In terms of duration, intensity and geographical extent, the 1930s series was the severest event. At that time, dust storms caused severe soil erosion in Colorado, Kansas, Oklahoma and Texas, hence the name given to this natural disaster: the Dust Bowl. Overall losses are very hard to quantify, however. It is estimated that US$ 1bn (approx. US$ 16bn in 2012 values) was paid out in governmental aid at that time.

A tough year for farmers and insurers

The drought in the Midwest had severe consequences for farmers. Topics Geo interviewed Derick Warren of Warren Farms and Greg Mills, Chairman of the Crop Insurance and Reinsurance Bureau (CIRB) and President of ADM Crop Risk Services.

***Topics Geo:** The 2012 drought was one of the worst on record for the US agricultural industry. Mr. Warren, your farm grows corn and soybeans in Illinois, a state that suffered extensively under the drought. How did it affect your yields?*

Warren: Up until this last harvest, we'd been averaging about 180 bushels of corn per acre (115 dt/ha) and 55 bushels of soybeans (35 dt/ha). And back in the spring, just a month after planting, it looked like we were going to have our best output ever. The growing conditions were wonderful, and nothing had to be replanted. We were expecting to see as much as 250 bushels of corn per acre (160 dt/ha). But then, in June, it started going steadily downhill. We stopped getting rain and temperatures rose. By 6 July, our soil moisture dropped down to 0%. When it was time, the grain just wouldn't fill the ears, and we had to start aborting kernels. In the end, our corn crop took the biggest hit, with about a 35% loss. Our soybean yields fared better with only about a 10% reduction, thanks to the rain we finally got in August.

Have you experienced a drought of this magnitude before?

Warren: No, nothing close to it. My father has been farming this land for more than 50 years and I started in 1982. Even the drought we had in 1988 didn't destroy as much of our harvest as this one. And until 2012, we never had a problem with alfatoxin either, a toxic fungus that thrives in drought conditions. The corn we did harvest couldn't be stored in our containers; it had to be taken straight to the elevator in town to prevent the risk of contamination.

What makes the 2012 drought so much different than the one in 1988?

Mills: For starters, the 1988 drought was focused more to the north and wasn't nearly as far-reaching. We also didn't see such high temperatures back then. With the 2012 drought, temperatures climbed to around 5° to 15°F (3° to 8°C) higher than normal and lingered. This had an especially devastating affect during the pollination period for corn. On the other hand, many of the crop varieties used today are genetically superior and more drought-resistant than what was planted in 1988. So losses could have been much higher.

Are these genetically modified, drought resistant varieties something your farm uses?

Warren: We've never had the need to plant drought-resistant corn because we've always had enough soil moisture to get us through in this area. But, as it stands right now, we're about 10 inches (25 cm) short of the water we need. So the next few months are critical. Unless we get about one good rain a week or a decent snowfall, we could very well have problems going into the next growing season. If we don't get enough subsoil moisture, it will be another difficult growing season. So, yes, if the drought continues, then it could be something we'd have to look into for the future.

Derick Warren (right) with his son Brody at the family's farm in Illinois. The farm produces mainly corn and soybeans.

Greg Mills, a US crop insurance specialist, is Chairman of the Crop Insurance and Reinsurance Bureau (CIRB) and President of ADM Crop Risk Services.

In the US, the Multiple Peril Crop Insurance (MPCI) programme was created by the government to regulate insurance prices and coverage. It also subsidises farmers' premiums, while still allowing private insurance companies to administer and service the policies. What are the objectives behind this public-private partnership?

Mills: Before the US government created MPCI, a lot of farmers would be completely wiped out after a major natural catastrophe. And, many times, the government would have to go in after the fact and provide emergency relief funds. The objective of MPCI is to give the farmer a backstop in an environment that would otherwise be too risky. And this safety net is increasingly critical in today's agricultural industry; input costs are rising, land is becoming more expensive and the overall risks are higher. Offering farmers yield and revenue protection not only brings a degree of economic security to rural America but also helps stabilise the world's food and biomass energy supplies.

Are American farmers adequately insured to counter the risks and cope with catastrophe?

Mills: About 85% of farmers buy crop insurance under MPCI. MPCI's most efficient coverage is called Revenue Protection. It offers protection against all natural perils and price fluctuations at different guarantee levels. Now, whether they have bought sufficient coverage is another story. But I think that, after this year's drought, we'll see not only a growth in participation but also an increase in coverage levels.

Mr. Warren, your farm is protected under MPCI. What level of coverage do you typically select?

Warren: I've always gone for the full 85% coverage level, and the subsidy helps make it affordable. But my father and I have separate policies. Just one year before the drought hit, I convinced him to increase his coverage as well – a decision we're both thankful for now. I think all farmers should get insured to lock in their revenue. Without it, I'd have lost a considerable amount of income because of the drought. The policy also serves as collateral with my bank, which makes it easier to take out the loans we need for the following year's farming supplies.

Mr. Mills, what was the biggest operational challenge facing the crop insurance industry as a result of the drought?

Mills: The initial administrative processes were a huge hurdle. When you've got, say a million policies and suddenly about 80% have a loss, it's a challenge to get all those claims processed quickly.

How was the crop insurance industry able to handle the increased volume?

Mills: When we started to see how severe the drought could become, some companies began calling up farmers and giving them a heads-up to prepare the necessary documentation. The more organised and prepared a farmer is, the quicker adjusters can assess and process the claim. Technology also plays a pivotal role in how efficiently an insurer can respond. All our loss adjusters at ADM Crop Risk Services are equipped with laptops and smart phones instead of clipboards and pencils. Being able to enter loss information on the spot cut our processing time almost in half.

What was your claims experience like?

Warren: As long as you have your fields separated and your paperwork, like delivery sheets and bin documentation in order, it all runs smoothly. In my case, the adjuster from ADM Crop Risk Services came out and we sat down together to go through all the information. He came up with the number and it was all taken care of right then and there. It took less than 30 days before I received compensation.

What sort of loss ratio are you expecting to be felt in the crop insurance industry?

Mills: I'd say we're looking at a 105% to 120% loss, with some companies facing as much as 130%. And if it wasn't for the August rains that saved a good portion of the soybean crops, it'd be even higher. As part of the MPCI programme, the US government offsets part of the insurers' losses, as do reinsurance companies like Munich Re. But 2012 was still a tough year for many farmers and insurers alike.

The losses to be borne by reinsurers are on a scale normally encountered only after major storms, floods or earthquakes. The 2012 drought showed that, assuming high insurance penetration, private-sector funding of multi-peril crop insurance at current premiums would be economically feasible only in the framework of a public-private partnership. The decisive point in Munich Re's view is that the government's role must not be confined to premium subsidisation, but also include co-financing a substantial share of the catastrophe losses. This is because the main hazards in agriculture are systemic and have wide-scale impact.

Favourable conditions for wildfires

The drought also led to an above-average fire risk in many regions. In Colorado, for instance, June 2012 was the warmest and second driest on record. The Waldo Canyon fire, which raged in the mountains northeast of Colorado Springs in June and July, destroyed almost 350 homes in the wildland-urban interface. This was 2012's most damaging wildfire and the costliest ever in Colorado's history. It resulted in an overall loss estimated at US$ 900m, half of which was insured. The fire was man-made, although it is not clear whether it was caused by arson or carelessness.

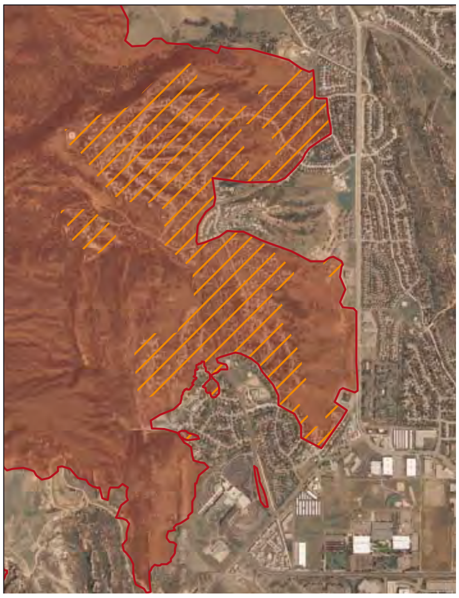
On a nationwide average, the area destroyed in the 2012 wildfire season was the third largest since systematic records began in the 1960s. An above-average number of fires occurred in grasslands and open scrublands. Fire can spread more rapidly in these areas, so that the area affected is on average greater than in the case of forest fires.

Disruption of waterway traffic

Since late spring, navigation had been more difficult on the Mississippi river system due to low water levels. In places, navigable channels had narrowed to such an extent that shipping was held up or able to move one way only. Vessels were no longer able to carry full cargoes and there were numerous groundings. Consequently, fewer goods were transported and there were delays and increased freight costs. Shipping on the Mississippi had already been badly hit by the 1988 drought and the transport of bulk commodities (coal, petroleum and grain) declined by 50% that summer. In several places barge traffic was stopped for four weeks. The industry suffered a loss of at least US$ 200m due to the 20% drop in turnover.

Utility companies cut back production

The drought also affected the power industry in the Midwest. One plant had to be shut down when its cooling water source fell below the plant's intake. At another, output had to be reduced because the cooling water was too warm to be discharged. The eco-system is likely to suffer if the temperature of the river or lake into which the water is discharged exceeds certain limits. The temperature in the cooling pond of a nuclear power plant in Illinois also rose above the permitted 100°F (38°C). Special permission was granted for the plant to continue operating, although the temperature reached 102°F (39°C).



Over 90% of the insured losses from the Waldo Canyon fire were accounted for by personal lines of business, most of the buildings in the area concerned being residential. The photograph shows houses ablaze to the northeast of Colorado Springs. The map indicates the perimeter of the fire in July 2012 (red area) and affected residential areas (hatched).

- Perimeter of the fire in July
- Affected residential areas

Source: Munich Re, based on data from USGS Rocky Mountain Geographic Science Center (perimeter) und ESRI, i-cubed (satellite image)

Risk, Liability & Insurance

Our "Risk, Liability & Insurance" series explores fundamental issues of liability law and its significance for the insurance industry. Analysing the effect social influences have on insurance and tort law practice is an important part of this process.

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NOT IF, BUT HOW

These examples show that extreme drought can jeopardise the power supply and this can have huge loss potential. In addition to cooling restrictions, a further problem encountered by fossil-fuelled power plants is that coal and petroleum supplies may run out if barge traffic is affected. Hydroelectric power production may also decline due to lack of rainfall.

However, the entire system is subject to stress, not only because less power is generated but also because more power is consumed by cooling and air-conditioning systems during heatwaves. Additional power has to be fed into the system to maintain the balance between generation and consumption. In the event of an imbalance, the point may be reached where some power plants have to be taken out of service to prevent major damage and malfunctions.

In the USA, the additional power required can be met to a certain extent by producing electricity in natural gas plants, which normally only operate at 25% to 50% of their full capacity. If they also have cooling problems or spare capacity is not available in a particular region, power shortages have to be offset between different regions. However, if much of the country is affected by drought for a significant period and several regions are facing the same problems simultaneously, widespread power failures cannot be excluded.

OUR EXPERTS

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Conclusion

The 2012 drought showed that this natural hazard can cause losses in many different sectors. It affected barge traffic and power generation and caused heavy losses due to wildfires, the ignition and spread of which were favoured by the dry conditions. Agriculture was by far the worst hit. The US agricultural insurance system proved its worth and saved the vast majority of farmers from financial distress or even bankruptcy. The agricultural banks did not suffer substantial loan defaults, so that farmers can still avail themselves of low-cost loans. Agricultural loans play an important part in financing ongoing production in the USA. They are used to offset the negative cash flows resulting from the high up-front costs incurred for crops which are harvested and sold at a much later point in time. In addition to these advantages, subsidised premiums have also helped boost acceptance of the crop insurance programme. Around 86% of agriculturally used land was insured in 2012.

This system of providing cover against natural hazards in the US agricultural sector is far more efficient than the state relief generally paid elsewhere following disasters. It ensures that cover and indemnity are tailored to the farmer's individual risk situation, and provides fast claims settlements. However, it also benefits the state because farmers pay much of the premium themselves, whereas aid payments are funded entirely by taxpayers. Public-private partnerships of this type also eliminate the need for a state-run disaster relief infrastructure, this being provided by the private-sector insurance industry.

Munich Re regards the US crop insurance system as an exemplary form of risk management for natural catastrophes in the agricultural sector and a model for other countries. It ensures that production levels quickly return to normal following a natural catastrophe and thus plays an important part in ensuring secure food supplies and preventing major price fluctuations. Based on experience acquired worldwide over many years, Munich Re has analysed the success factors that ensure sustainable crop insurance and given it a name: SystemAgro.

>> Detailed information on SystemAgro can be found on Munich Re's website at:
www.munichre.com/systemagro

Impact on global food security

Drought – An underestimated natural hazard

Prof. Dr. Peter Höppe, Head of Munich Re's Geo Risks Research/Corporate Climate Centre
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The year 2012 was marked by a series of catastrophic droughts, Munich Re's NatCatSERVICE registering no fewer than 26 loss-related events in all. The main event (with a 40-year return period) was the major drought in the US Midwest, which caused agricultural losses totalling billions of dollars. Meanwhile, Russia, the Ukraine and Kazakhstan, all of which account for a significant proportion of the world's cereal production, also experienced extremely dry conditions. World cereal prices spiralled following disastrous harvests in the regions concerned. According to an analysis by the KfW banking group, prices rose 17% to unprecedented levels in July alone. Some products, such as corn, were subject to even more dramatic increases, prices rising by 25%.

Harvests in agricultural export regions like Texas (USA) and Russia had already been affected by drought in 2011 and 2010. In 2010, Russia experienced unprecedented heat and drought, prompting the government to impose a temporary export ban to safeguard domestic food supplies. The 2011 famine in Somalia was also triggered by a severe drought.

NatCatSERVICE data show a clear long-term trend towards more droughts. The incidence of droughts has doubled from ten loss-related events worldwide in the 1980s to roughly 20 in recent years.

Droughts differ from natural hazards such as storms and earthquakes. They develop gradually and may last months or even years. They are therefore less "spectacular" than tornadoes or flash floods, and less newsworthy and we often become aware of them only when they have caused a famine or a dramatic hike in food prices on world markets. Thus, keeping accurate records of drought data in natural catastrophe databases is a challenge.

"Droughts will be one of the most catastrophic natural hazards in coming decades."

Munich Re sponsored research by a geography Masters student into ways of improving our NatCatSERVICE drought records by basing them on more objective data. Clear criteria were established for determining the duration of an event and the losses. All 500 drought events registered in the database since 1980 have been re-assessed and we now have an even better basis for providing high-quality reports on drought losses and loss trends.

This will be even more crucial in future. In its 2012 report on extreme events (SREX), the Intergovernmental Panel on Climate Change (IPCC) predicted more heatwaves accompanied by droughts in many parts of the world. By mid-century, heatwaves that now have a 20-year return period are likely to occur every two to three years in the US Midwest and central Europe, and as much as every one to two years in Southeast Asia. Thus, droughts will be one of the most catastrophic natural hazards in coming decades, posing a huge threat to world food supplies.

The situation will be further aggravated by the fact that the global population will have grown to some nine to ten billion by mid-century and demand for animal-based foods will increase in countries with rapidly growing wealth, such as China. Agricultural production will have to be stepped up and more land will be needed to meet the growing demand. However, more intensive production will mean the agricultural sector is more susceptible to the increasingly variable weather conditions and similarly to increasing development of farmland in regions ill-suited to agricultural production.

The recent droughts and their implications for food prices are therefore to be seen as precursors of a phenomenon that will be increasingly prevalent in coming decades. Appropriate preventive measures include climate protection, steps to curb population growth, using more resistant types of crop and reducing meat consumption.

Earthquake series in Emilia Romagna, northern Italy

From mid-May to mid-July 2012, the Emilia Romagna region was shaken by a series of earthquakes. Despite the relatively low magnitudes, losses ran into the billions.

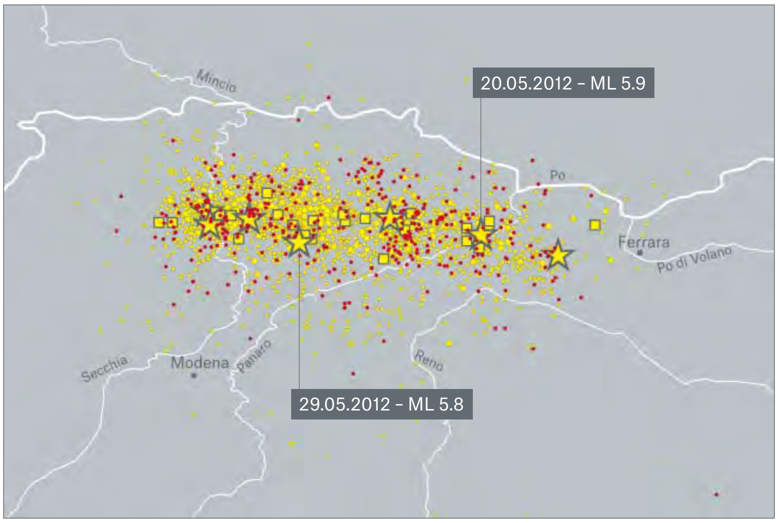
Anselm Smolka and Marco Stupazzini

Seismic activity in the northern foothills of the Apennines is related to continuing orogenic activity that generates northward shear stress. Overall, such activity can be considered moderate, comparable with the regions of stronger activity in central Europe, north of the Alps. The last major damaging earthquake occurred here in 1570, although the epicentre then lay slightly to the east of the area affected in 2012. The series of earthquakes began on 19 May with a number of magnitude-4.1 tremors that culminated in the quakes on 20 May (M=5.9) and 29 May (M=5.8). In all, seven magnitude ≥5 events were registered between 20 May and 20 July 2012, the epicentres moving from east to west. Intensities along an epicentral zone roughly 50 km long reached maximum values of VII–VIII on the European Macroseismic Scale.

Strong ground motions

The acceleration values of the earthquake on 29 May were recorded by three different networks, and the data are of very good quality. The maximum ground acceleration measured by the seismic recording station at Mirandola, closest to the epicentre, was 0.3g in a horizontal direction and 0.9g in a vertical direction. What was particularly striking and very unusual for a relatively low magnitude quake of this nature were the long-period velocity impulses. They are attributable to the directivity of the westward rupture process combined with the highly irregular basement topography beneath the young sediments of the Po Valley. When the observed acceleration spectra are compared with the design spectrum of the current Italian seismic building code, the values measured are found to have a return period of roughly 1,000 years. The value for oscillation periods of more than 1.5 s is prob-

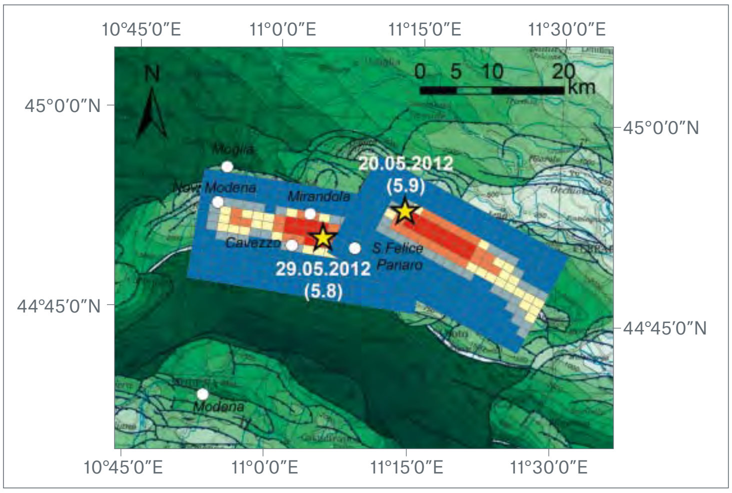
Seismic sequence 19 May–20 July 2012



Epicentres of the earthquake series in the Emilia Romagna region between 19 May and 20 July 2012. The yellow stars represent magnitude ≥5 events.

- < M. 3.0
- ≥ 3.0–3.9
- ≥ 4.0–4.9
- ≥ 5.0
- Events from 19 May–20 June
- Events from 21 June–20July

Source: ISIDe Working Group (INGV, 2010), Italian Seismological Instrumental and Parametric Database: http://iside.rm.ingv.it



Rupture planes of the quakes on 20 and 29 May 2012

The diagram indicates the approximate extent of the rupture planes for the quakes on 20 and 29 May. The colour of the smaller squares represents the different displacement amounts.

- High
- ↓
- ↓
- Low

Source: C. Smerzini, personal information, 2012

ably closer to 2,500 years. As is customary, buildings are designed to withstand events with a return period of 475 years.

Seismic building codes in Italy

Italy has had guidelines on earthquake-resistant construction for many decades but their scope and requirements have changed considerably over the years:

- 1927: "Regio decreto": Only applied to the area affected by the Messina/Reggio quake in 1908
- 1974: National building code with special regulations governing earthquake-zone construction
- 1980: Decree of the Ministry for Public Buildings
- 2003: New seismic zoning system
- 2005: Implementation of the zoning system in new construction regulations, mandatory from 2009 onwards

Epicentral parameters of the quakes on 20 and 29 May 2012

	20 May 2012	29 May 2012
Magnitude ML	5.9	5.8
Focal depth (km)	6.3	10.2
Coordinates	44°53′24″N 11°13′48″E	44°51′0N 11°5′10E

A comparison of the situation before and after 2003 (see maps on p. 28) shows that the zones with special earthquake regulations have been considerably extended. Interestingly, Emilia Romagna, where the earthquakes occurred, was not classified as seismically active before 2003.

Losses

The Emilia Romagna quakes form part of the series of earthquake disasters that have occurred throughout the world since the Haiti quake in January 2010, despite their relatively low magnitudes. According to figures published by the Italian Civil Defence Ministry, the overall loss totals €13bn (US$ 16bn), of which roughly €5bn is accounted for by buildings, 25% of which were insured. On a global scale, the building losses sustained in Italy are high because the country has a unique stock of historical buildings, which are extremely prone to earthquake damage. Although the significant losses to historical buildings were not particularly unexpected, many factory buildings were also extensively damaged. This is because most of the industrial buildings were constructed before 2003, i.e. prior to the introduction of a special building code for this earthquake zone.

Insurance aspects

With an estimated cost of €1.3bn (US$ 1.6bn, as at December 2012), the Emilia Romagna quakes produced Italy's highest ever insured earthquake losses. This is surprising, considering that major cities like Modena, Bologna, Ferrara and Mantua were little affected. Although the area where the biggest losses occurred is predominantly rural, all sizeable communities have industrial zones, so that in all several thousand industrial buildings are located here. The main industries are cheese production, including Parmesan and Grana Padana, food processing and medical technology.

Commercial buildings, some of which were completely destroyed, accounted for a significant proportion of the insured losses. Hundreds of thousands of cheeses were lost due to storage racks tipping over. The second major loss item concerns municipal policies for public buildings and covers for water management companies. Public authorities are frequently housed in damage-prone historical buildings, and municipal policies are much more common in this region than in central and southern Italy, for example.

After a somewhat slow start, claims settlement subsequently progressed well. As with other recent quakes, especially Christchurch in New Zealand, the key factors proved to be adequate replacement values and under-insurance clauses, rigorous accumulation control and risk geocoding, and contingency plans for claims settlement following major events. One of the main problems is assessing the restoration value of historical buildings.

The earthquake series in the Emilia Romagna region showed that even moderate quakes have enormous loss potential. A similar situation could also arise in Italy's industrial corridor between Turin and Venice. However there are other regions in central Europe, outside Italy, with similar seismicities and comparable building codes, including the Basle conurbation, southwest Germany, the Lower Rhine Basin and the Vienna Basin.

OUR EXPERTS

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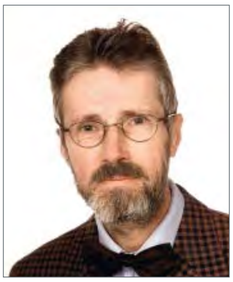

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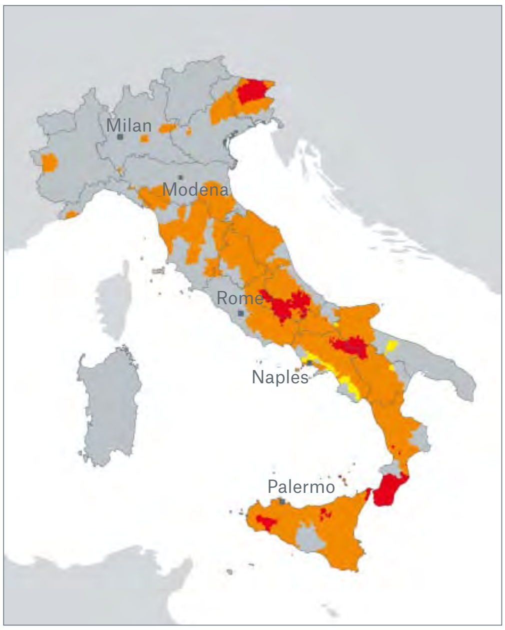
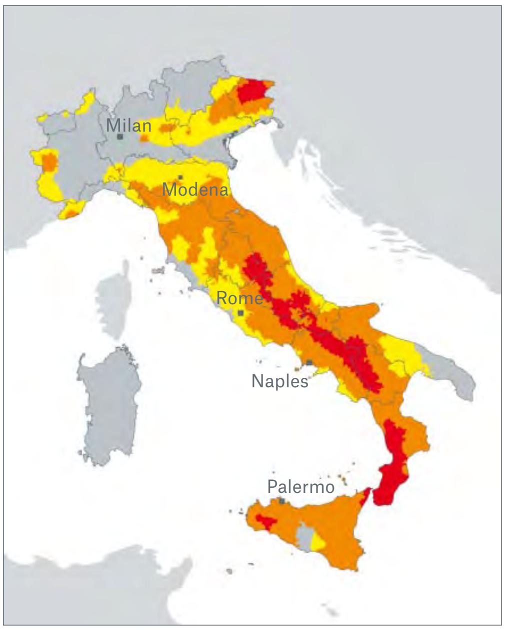
Earthquake zones based on Italian building codes

1980 to 2003



After 2003 onwards



Introduced some decades ago, Italy's guidelines for earthquake-proof construction have since undergone several updates.

1980 to 2003
- Zone 1
- Zone 2
- Zone 3
- No classification

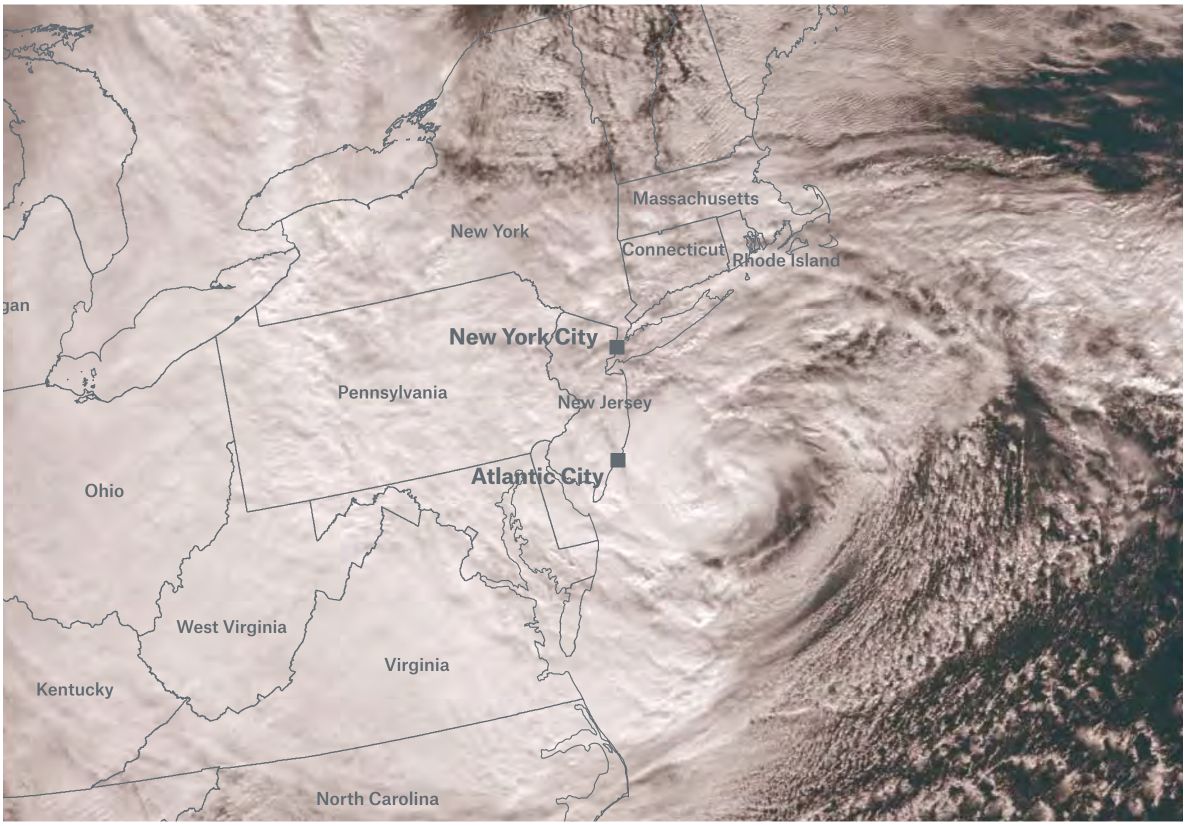
After 2003
- Zone 1
- Zone 2
- Zone 3
- Zone 4

Source: Dipartimento della Protezione Civile, www.protezionecivile.gov.it

The Emilia Romagna region in northern Italy suffered considerable damage in the May 2012 earthquake series. Thousands of buildings, including a number of historical monuments, sustained severe damage. The photograph shows the damaged clock tower in Finale Emilia.

Hurricane Sandy impacts US East Coast

On 29 October, Hurricane Sandy slammed into the New Jersey coastline, leaving behind an unprecedented level of devastation. Sandy was the most destructive hurricane encountered in the northeastern USA since the great storm of 1938.



Hurricane Sandy was an extremely large system – its wind field covered an area of 1.5 million km². Sandy caused losses in 15 US states.

Source: NASA/NOAA/
U.S. Department of Defense

Mark Bove

Hurricane Sandy was the second last hurricane of the 2012 season. It began as Tropical Depression 18 in the central Caribbean on 22 October, then became a tropical storm that strengthened as it moved north, reaching hurricane intensity and passing over Jamaica on 24 October with winds of 130 km/h (80 mph). Sandy then intensified, with sustained winds of 175 km/h (110 mph), before making landfall next morning in Cuba, as a strong category 2 storm on the Saffir-Simpson hurricane damage potential scale. After weakening slightly, the hurricane passed over the Bahamas and then, on 27 October, turned firstly northeast ahead of a strong cold front approaching the eastern United States, and then back to the northwest. Sandy made its final landfall at 8 p.m. local time on 29 October on the North American continent near Atlantic City, New Jersey, with sustained winds of 130 km/h (80 mph).

Meteorological conditions

Among the most unusual aspects of Hurricane Sandy were its northwestward motion before landfall in New Jersey and the vast size of its wind field, which covered an area of 1.5 million km^2 (560,000 square miles). Both features were caused by Sandy interacting with other low-pressure systems, highlighting the impact of extratropical transition.

Over half of all Atlantic tropical cyclones undergo extratropical transition, a process in which a tropical cyclone's structure changes from a warm-core to a cold-core system. Many different factors can influence transition, but typically they involve the tropical storm interacting with a jet stream, extratropical cyclone, or colder, drier air mass. During transition, the previously radially symmetrical tropical cyclone starts to become more asymmetric. The wind field broadens as shear and dry air masses inhibit thunderstorm activity in the tropical cyclone's core. This can trigger the development of warm and cold fronts, helping the storm obtain energy from temperature gradients. In contrast, warm-core tropical cyclones obtain energy when water vapour condenses, releasing latent heat.

Hurricane Sandy went through two distinct periods of extratropical transition, leading it to be dubbed a "Frankenstorm" or "Superstorm" by the US media The first started as Sandy exited Cuba, as shear and dry air from an upper-level low disrupted its core. The storm's wind field broadened substantially, and frontal features started to develop. Sandy began to regain some of its tropical characteristics as it moved north of the Bahamas, away from this low. It then went through another period of extratropical transition as it began to interact with a large area of low pressure over the USA a couple of days later. This time, Sandy completed its transition and became fully extratropical just before landfall. Sandy's two periods of extratropical transition are also probably one of main reasons why the hurricane's wind field grew to near-record size.

The second feature, Sandy's northwestward motion before landfall, was caused by its transition to an extratropical storm and a phenomenon known as the Fujiwhara effect: two low-pressure systems sufficiently close to one another rotate counter-clockwise around each other (in the northern hemisphere), and are slowly drawn together. Occasionally, the two systems merge to form a larger, single circulation. This is what occurred with Sandy in the 24 hours before landfall, as the hurricane and low pressure to its southwest began to interact and rotate around each other, pushing Sandy back to the west before the two systems eventually merged into a very large extratropical cyclone just off the coast of New Jersey.

Comparison with the 1938 Great New England Hurricane

Due to the magnitude of loss, Sandy will inevitably be compared to the Great New England hurricane of 1938. Due to the limited observational data in the 1930s, it is not possible to accurately compare all aspects of the two storms. However, the similarities between the two storms include undergoing extratropical transition, large storm surges that occurred near high tide, similar minimum central pressures, and a large wind field that penetrated deep inland.

Aside from landfall location, the 1938 hurricane was a much more intense storm at landfall than Sandy. If the hurricane of 1938 had occurred today, it would probably cause significantly more damage than Hurricane Sandy. The New England hurricane had reached Saffir-Simpson category 5 intensity while north of the Bahamas and, although it weakened before landfall, its rapid forward motion of 100 km/h (60 mph) limited the amount of weakening and added significantly to the wind speeds on the right-hand side of the storm.

The 1938 New England hurricane was one of the strongest to strike the northeast US coast. Losses were reported in New York State, Rhode Island, Connecticut, Massachusetts and as far north as New Hampshire, Vermont and Maine. The photo shows the scene of devastation left by a ten-metre wave at Island Park.

Although Sandy's winds were less strong than those of the 1938 hurricane, its exceptionally large wind field caused losses in 15 US states. Many boats were destroyed in marinas like this one at Staten Island, New York.

And while extratropical transition had begun to affect the event, it is likely that transition was not complete before landfall. This means that the core of the 1938 hurricane, containing the strongest winds, was largely intact at landfall, whereas Sandy's core had completely collapsed before landfall, resulting in a broader, but generally weaker, wind field.

In the 1938 storm, sustained winds in excess of 200 km/h (120 mph) and gusts above 290 km/h (180 mph) were observed. In Sandy, only a few observing stations had sustained winds above hurricane force, and maximum wind gusts only reached 180 km/h (110 mph). Since wind damage increases exponentially in relationship to wind speed, the 1938 storm was much more potent than Sandy. Similarly, storm surge heights with the 1938 hurricane are estimated to have reached 10 metres (30 feet), about twice the maximum surge heights seen with Sandy.

Nevertheless, some aspects of Sandy had a greater potential to cause large losses. Sandy's landfall was located along the New Jersey and New York coastline, a more densely populated area than Long Island, the location of the 1938 landfall. It also put New York City on the stronger side of the storm's circulation, increasing loss potentials. Sandy's path and large wind field also allowed for a much larger area of coastline to be impacted by surge flooding than during the 1938 storm, especially around the New York Bight, where Sandy's persistent easterly winds funnelled water into New York Harbor and reached record levels. Sandy's extensive wind field produced losses from Indiana to Nova Scotia, a distance of over 1,600 km (1,000 miles), far exceeding the area that sustained damage in the 1938 hurricane.

Loss aspects: Wind

In general, wind damage from Sandy was relatively light but spread across the northeastern USA. Strong gusts, were observed during Sandy at only a few locations along the New Jersey and Long Island coastlines. In these areas, there was loss of roof covering as well as broken windows and subsequent water damage. In Manhattan, the façade of a small building collapsed and a crane on top of a skyscraper under construction was partially toppled. In the Breezy Point neighbourhood of Queens, winds fuelled a residential fire that spread rapidly, destroying 111 homes. Storm surge flooding at the time of the fire also limited the ability of firefighters to contain it.

Further inland, wind speeds were typically not strong enough to cause direct damage to well-built structures. Instead, most wind damage was caused by collapsing branches and power lines that crashed into buildings and vehicles, and also led to widespread power outages. They covered parts of 15 states, including 2.7 million homes and businesses in New Jersey and 2.2 million in New York. Surge flooding was also responsible for some of the outages in New York City and other coastal regions. In some locations, power was not restored for several weeks.

Loss aspects: Storm surge

The combination of Sandy's large wind field, persistent easterly winds, and a high tide at landfall produced a record storm surge in parts of New York, Connecticut, and the New Jersey shore. Surge heights reached 3.5 metres (11.48 feet) above mean sea level at Battery Park in Lower Manhattan, exceeding the previous high water mark set by Hurricane Donna in 1960 by almost 1.3 metres (4 feet). Surge heights also exceeded 3 metres (10 feet) along western sections of Long Island Sound and 4.5 metres (15 feet) at some locations in New Jersey.

The entire length of the Jersey Shore was affected by Sandy's coastal flooding, storm surge and large waves washing over dozens of coastal communities. Thousands of homes and businesses and critical infrastructure were destroyed. In some locations, like the small town of Mantoloking, the storm surge ripped houses from their foundations. Residents here and at other locations had to abandon their homes for weeks.

Dozens of marinas and thousands of boats were also damaged, and the tourist industry was hit. Boardwalks up and down the New Jersey coast were destroyed, and several piers filled with amusement park rides suffered partial or total collapse. Some of the casino resorts in Atlantic City were forced to shut down for several days, resulting in a large loss of revenue. Container ports and vehicle terminal and loading facilities suffered heavy losses, producing the largest ever marine insurance loss: approx. US$ 2.5 to 3bn.

Hurricane Sandy's vast wind field drove powerful water masses onto the coast and coincided with a high tide, producing record sea levels. The map shows the areas affected by Sandy's storm surge.

- ■ Flooded area
- – State boundary

Source: PERILS, SERTIT 2012, http://sertit.u-strasbg.fr

Water flowing into New York Harbor caused severe flooding to communities along the Raritan Bay, including Union Beach, Sayreville and Perth Amboy. Further north, the surge flooded the Meadowlands and caused the Hudson River to burst its banks, inundating Jersey City, and Hoboken. Tens of thousands of Hoboken residents were stranded for several days and had no electricity due to flooded electrical substations. Flood waters also poured into the entrances of Port Authority Trans-Hudson (PATH) train stations, flooding a number of platforms and two rail tunnels connecting New Jersey and New York City.

In Manhattan, the Hudson and East Rivers flooded. Large areas of the New York financial district and Battery Park City were affected, as well as significant areas of the Lower East Side, SoHo, Tribeca and Chelsea. Thousands of buildings, ranging from modern skyscrapers to single family homes, sustained water damage as flood waters poured into ground floors and basements, damaging or destroying personal property, insulation and electrical equipment. Over ten million square feet of office space was closed in the financial district alone, forcing companies to relocate their employees until repairs had been carried out and creating the potential for large business interruption losses. The construction site surrounding the World Trade Center complex and art galleries in the neighbourhood of Chelsea were also flooded.

The infrastructure below Manhattan was similarly hard hit. Flood waters poured into subway entrances, inundating five stations and seven rail tunnels that cross under the East River. The surge forced the shutdown of the entire New York subway system for three days. Below 34th street, it remained closed for several more days as water was pumped out and electrical equipment checked for damage. Water also had to be pumped out of the Holland, Brooklyn-Battery, Queens-Midtown and several other road tunnels. Parts of the city's power grid were also damaged as flood waters shorted out substations and underground wiring. Con Edison, the utility provider for New York City, had to cut power to most of Lower Manhattan during the height of the storm to prevent further damage to its systems.

The outer boroughs of Manhattan also sustained heavy flood damage. In Staten Island, the Midland Beach neighbourhood along the island's southeast coast endured some of the most severe flooding, where homes were swept from their foundations by the surge. Coney Island in Brooklyn and the Rockaway Peninsula of Queens were completely inundated, and the runways at John F. Kennedy and LaGuardia airports were submerged for several days, forcing thousands of flight cancellations and snarling US air traffic.

Even coastal areas of Connecticut, New York's neighbouring state, were affected by storm surge as high winds pushed water westward into Long Island Sound.

Loss aspects: Precipitation

Unlike other recent northeastern hurricanes, Sandy did not cause any significant instances of inland flooding due to rainfall. The heaviest precipitation occurred over the Delmarva Peninsula, where rainfall amounts averaged around 18 cm (7 inches), but due to the low-lying, marshy nature of the regions, only isolated incidences of flood damage were reported. Further west, Arctic air caused Sandy's precipitation to fall as snow, creating blizzard conditions in West Virginia and Kentucky. Up to 1 metre (3 feet) of heavy, wet snow accumulated, downing trees and power lines and causing buildings to collapse.

Underwriting aspects

As with all US hurricanes, as a result of Sandy, insurers and reinsurers will examine and, where necessary, revise their underwriting and models, bearing in mind the following points in particular:

Application of hurricane deductibles

In the aftermath of unprecedented losses from Hurricane Andrew in 1992, insurance companies that wrote business in Florida began to institute hurricane deductibles in their policies. Usually expressed as a percentage of the property value, hurricane deductibles are typically several times larger than a standard fire deductible. The implementation of hurricane deductibles accomplished two goals desired by both insurers and state governments. The first was to help reduce the cost of insurance to homeowners by making them pay a larger share of the loss for rare, but potentially severe, hurricane events. The second was to partially mitigate the amount of loss incurred by insurers due to hurricanes, as insured losses from Hurricane Andrew led to the insolvency of 11 insurance companies. Since then, hurricane deductibles have gained wider acceptance by the industry and regulatory agencies and have been implemented by insurers in 18 different hurricane-exposed states.

However, hurricane deductibles have not worked exactly as anticipated by the insurance industry. The first reason for this is that the trigger for a hurricane deductible can be based on many different storm and geographic metrics that can vary by state. Hurricane deductible triggers could be tied to wind speeds, watches and warnings issued by the National Hurricane Center, Saffir-Simpson Scale category, or whether the storm has been "named" by a government agency. In some cases, hurricane deductibles only apply if certain storm criteria are met and the hurricane makes landfall over the state in question.

Furthermore, in some states the department of insurance determines what combination of criteria triggers the hurricane deductible, while other states allow individual insurance companies to determine their own triggers. The different criteria in each state can lead to situations where citizens of one state have to pay hurricane deductibles and citizens of another do not, even if both states experience hurricane-force winds, diminishing their effectiveness.

The second reason why hurricane deductibles have not worked as expected is that state governments may not allow their application in situations where there is uncertainty about a storm's intensity or status as a tropical cyclone at landfall. For example, Hurricane Irene's (2011) intensity dropped below hurricane status just before its transit of New Jersey, New York, and Connecticut. As a result, the governments of these states did not permit the application of hurricane deductibles for this event. In the case of Hurricane Sandy, the National Hurricane Center reported that the storm had become "post-tropical" just prior to landfall in New Jersey. Even though the storm produced hurricane-force winds over the state, Sandy's reclassification enabled New Jersey and other states to prohibit the use of hurricane deductibles for the event.

As seen after Irene and Sandy, state governments will often prevent hurricane deductibles from taking effect in cases where a storm's status as a "hurricane" is uncertain at landfall. However, many insurers and reinsurers typically model hurricane risk using the assumption that hurricane deductibles will be triggered, even in borderline category 1 events or in the case of extratropical transition. Since this is not always the case in reality, it means that actual losses to insurers from events like Irene and Sandy end up being higher than anticipated. In light of this, the insurance industry will probably reconsider the modelling assumptions to reflect the fact the hurricane deductibles may not be applicable for all events.

Flood exposure data and modelling

Although flooding is a major source of insured loss from tropical cyclones, the ability of insurers (and reinsurers in particular) to quantify and assess the amount of flood-exposed risks within a portfolio remains limited. There are two primary reasons why this is the case: the first is the complex mix of public and private insurance in the USA for the peril of flood, and the second is a lack of consistent capturing and reporting of flood exposure data by the industry.

Flood coverage is not normally included in personal lines policies in the USA. Instead, flood insurance offered by the National Flood Insurance Program (NFIP) within participating communities. However, since NFIP coverage for residential buildings is capped at US$ 250,000, much less than the value of many homes, some personal lines writers do offer flood insurance in excess of the NFIP coverage. NFIP flood coverage is also available for small businesses, while private insurers offer flood coverage for various types of commercial and industrial risks.

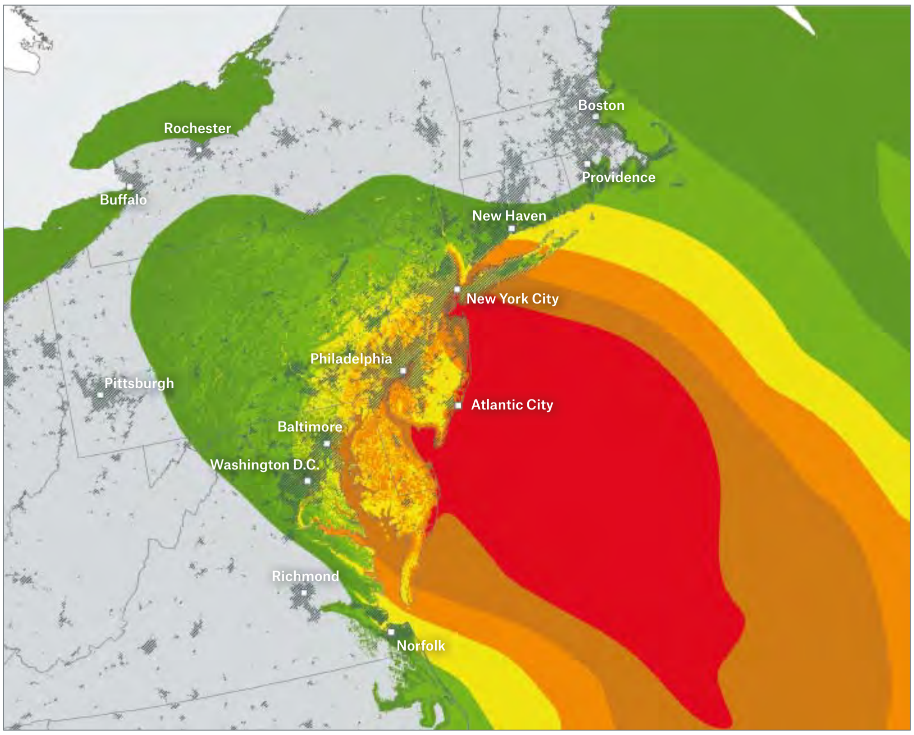
Wind field of Hurricane Sandy

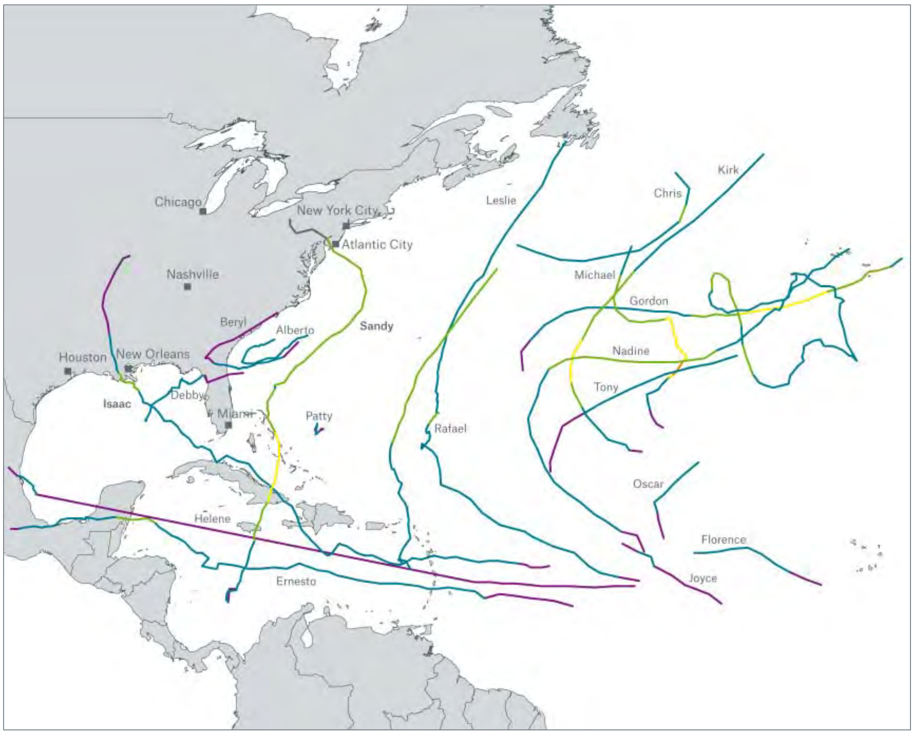
On 29 October 2012, Sandy's huge wind field impacted the US East Coast. It reached Atlantic City, New Jersey, at 8 p.m. local time, with winds of 130 km/h (81 mph).

Gusts (km/h)
- 80–90 (50–56 mph)
- 91–100 (57–62 mph)
- 101–110 (63–68 mph)
- 111–120 (69–74 mph)
- 121–130 (75–80 mph)
- 131–140 (81–86 mph)

Populated areas

Source: Munich Re, based on National Hurricane Center, Hurricane Research Division, National Weather Service





Atlantic tropical storm tracks in 2012

The map shows all North Atlantic tropical storm tracks in 2012. There were 19 tropical storms in all, seven of which made landfall. Storm activity began with Alberto (19 May) and Beryl (26 May) which preceded the official start of the hurricane season, on 1 June.

Wind speeds (km/h, mph)
(SS: Saffir-Simpson Scale)

- Tropical depression (< 63 km/h, < 39mph)
- Tropical storm (63–117 km/h, 39–73mph)
- SS 1 (118–153 km/h, 74–95mph)
- SS 2 (154–177 km/h, 96–110 mph)
- SS 3 (178–209 km/h, 111–129 mph)
- SS 4 (210–249 km/h, 130–156 mph)*
- SS 5 (≥ 250 km/h, ≥ 157 mph)*
- Post-tropical

* No category 4 and 5 wind speeds were recorded on the Saffir-Simpson Scale in 2012.

Source: Unisys

Since only a limited amount of flood insurance in the USA is written by the private sector, the demand for statistical catastrophe models to assess flood risk has historically been much lower than for other perils. Due to low demand and the considerable amount of time and resources required to create such a model, catastrophe model vendors have not developed robust US flooding model tools, particularly for inland flooding. It should be noted that hurricane models have included storm surge flooding for many years, but the modelling of this component has historically been viewed as relatively simplistic in nature compared to the wind component.

All catastrophe models rely on vast amounts of detailed policy data – location, value, construction, deductibles, etc. – to estimate losses. Although, over the past 20 years, insurers have made considerable progress in capturing these data to improve the quality of model output and reduce uncertainty in results, information on flood coverage is often not captured by US insurers. Part of this is due to the fact that there are no models for the peril, so flood-related policy data is often not captured, even in cases where flooding is modelled, such as storm surge. Another limitation is that flood and wind coverage may have different deductibles and limits within the same policy. This is problematic because many hurricane models currently cannot handle different peril-based deductibles and limits. Instead, the models typically use the hurricane deductible for all sources of loss, reducing the accuracy of modelled loss results.

Another important aspect of flood exposure data that should be captured by insurers is how contents are distributed within a building. This is particularly true of larger commercial risks, like high-rise office buildings, where significant amounts of electronic equipment like generators and computer servers are often kept in basements, creating potential for large contents losses from flooding, as seen in the New York financial district during Sandy and in Houston, Texas, following torrential rains from Tropical Storm Allison in 2001.

Due to the lack of high-quality flood exposure data, many insurers and reinsurers are left with great uncertainty as to the amount of flood risk in their portfolios. To reduce this uncertainty, the insurance industry needs to consistently capture flood exposures with greater accuracy and detail to allow for proper actuarial and underwriting analysis. And as flood models for the USA become available over the next couple of years, these detailed flood data, in conjunction with wind policy data, should give insurers a more comprehensive view of hurricane risk to a portfolio and reduce uncertainty in loss results.

OUR EXPERT

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Conclusions

Although only a category 1 hurricane before undergoing extratropical transition and making landfall, Sandy shattered loss records for the northeastern USA.

Insured losses, including payments under the National Flood Insurance Program, stand at US$ 30bn (as estimated in February 2013), although this figure could change, since not all claims have been settled. The record losses, despite Sandy being a relatively weak storm, were due to the huge geographic area impacted by its vast wind field, as well as record surge flooding along the heavily populated coasts of New York, New Jersey, and Connecticut. Overall losses are likely to exceed US$ 65bn, making Sandy the second most costly natural disaster in US history, in terms of original dollar loss.

The impacts of Sandy are a much better indication of what a severe hurricane can do to the northeast USA than any other storm in the past 70 years. Although one of the worst natural disasters in the history of New York City and New Jersey, Sandy was far from being a worst-case hurricane scenario for the region. A stronger hurricane, like the 1938 Great New England hurricane that travelled along a similar path to Sandy, would easily cause more severe levels of wind damage and larger storm surges. The lessons learned from Sandy, particularly its storm surge impacts in New York City, should be used to lessen the potential of similar losses from future hurricanes in the region.