

EARTH 270 – DISASTERS AND NATURAL HAZARDS (v. 2018)



Kesennuma City, Miyagi Prefecture, Japan, March 2011

PROFESSOR S.G. EVANS, PhD, PEng (Room 303, Earth Science
and Chemistry (ESC) Building)

UNIVERSITY OF
WATERLOO

ECONOMIC LO\$\$E\$ - 3 MAJOR COMPONENTS



1. **DIRECT LOSSES** – actual replacement value of damaged/destroyed property/infrastructure
2. **INSURED LOSSES** – insurance claims paid out to policy holders to cover a percentage of damage in 1
3. **INDIRECT LOSSES** – additional/downstream costs (e.g., economic disruption, loss of production, medical and emergency services, rebuilding)

TOTAL ECONOMIC LO\$\$E\$ = (1-2)+2+3

2016



Munich, 04 January 2017

Press release

Natural catastrophe losses at their highest for four years

Contact
Media Relations Munich,
Stefan Straub
Tel.: +49 (89) 3891-9898
Fax: +49 (89) 3891-79898
sstraub@munichre.com

Münchener Rückversicherungs-Gesellschaft
Aktiengesellschaft in München
Media Relations
Königinstraße 107
80802 München
Germany
Letters: 80791 München

www.munichre.com
<http://twitter.com/munichre>

A number of devastating earthquakes and powerful storms made 2016 the costliest twelve months for natural catastrophe losses in the last four years. Losses totalled US\$ 175bn, a good two-thirds more than in the previous year, and very nearly as high as the figure for 2012 (US\$ 180bn). The share of uninsured losses – the so-called protection or insurance gap – remained substantial at around 70%. Almost 30% of the losses, some US\$ 50bn, were insured.

"After three years of relatively low nat cat losses, the figures for 2016 are back in the mid-range, where they are expected to be. Losses in a single year are obviously random and cannot be seen as a trend", said member of the Board of Management Torsten Jeworrek. "The high percentage of uninsured losses, especially in emerging markets and developing countries, remains a concern. Greater insurance density is important, as it helps to alleviate the financial consequences of a catastrophe for more people. With its risk knowledge, the insurance industry would in fact be able to bear a much greater portion of such unpredictable risks."

Earthquake in Japan most expensive natural catastrophe of 2016

The costliest natural catastrophes of the year occurred in Asia. There were two [earthquakes on the southern Japanese island of Kyushu](#) close to the city of Kumamoto in April (overall losses US\$ 31bn; proportion of insured losses just under 20%), and [devastating floods in China](#) in June and July (overall losses US\$ 20bn; only some 2% of which were insured).

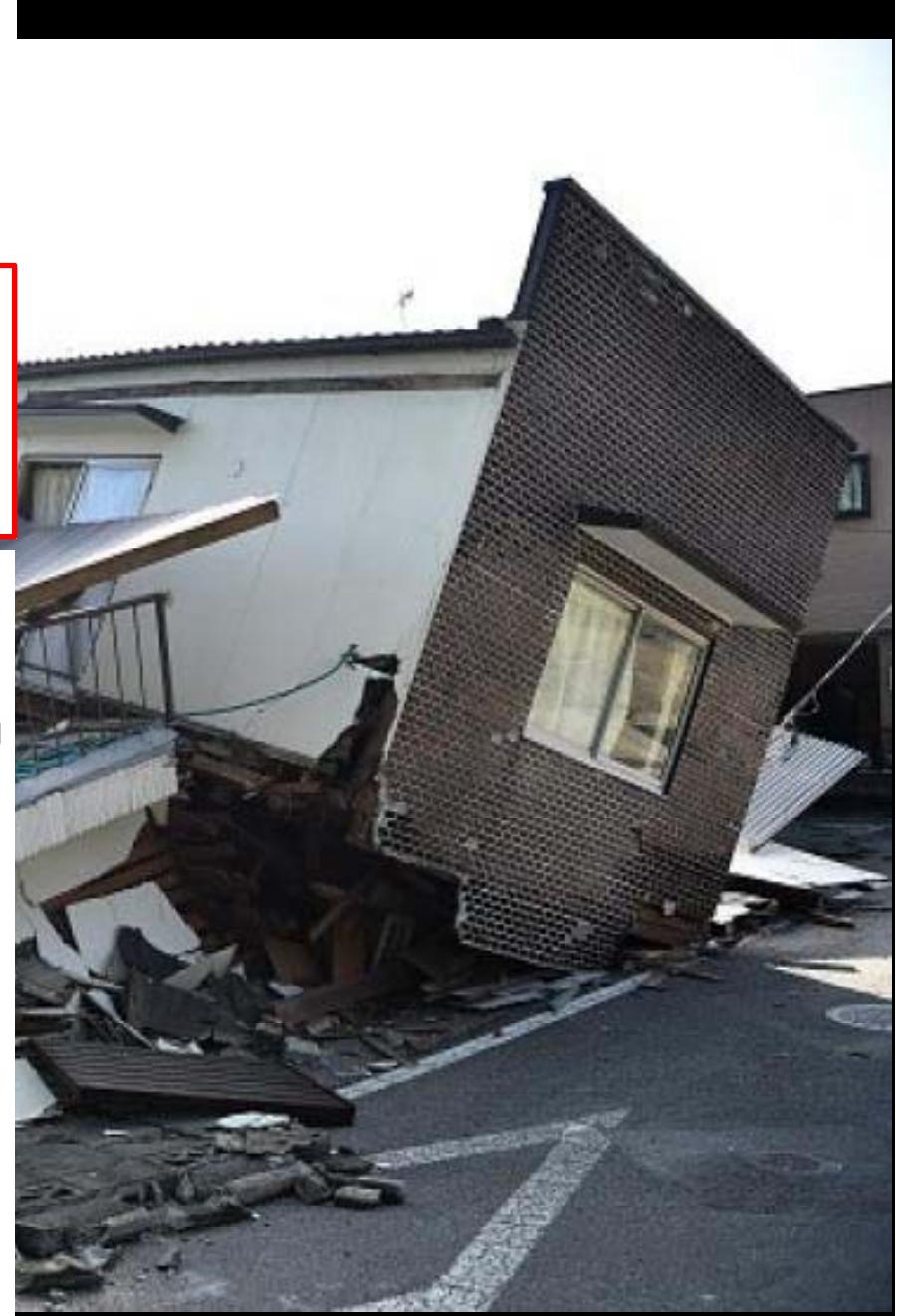
North America was hit by more loss occurrences in 2016 than in any other year since 1980, with 160 events recorded. The year's [most serious event here was Hurricane Matthew](#). Its greatest impact was in the Caribbean island nation of Haiti, which was still struggling to recover from the 2010 earthquake. Matthew killed around 550 people in Haiti, and also caused serious damage on the east coast of the USA. Overall losses totalled US\$ 10.2bn, with over a third of this figure insured.

Series of storms in Europe, wildfires in Canada

North America was also impacted by other extreme weather hazards, including [wildfires in the Canadian town of Fort McMurray](#) in May, and [major floods in the southern US states](#) in summer. In Canada, the mild winter with less snow than usual, and the spring heatwaves and droughts which followed, were the principal causes of the devastating wildfires that hit the oil-sand-producing region of Alberta, generating overall losses of US\$ 4bn. More than two-thirds of this figure was insured. In August, floods in Louisiana and other US states following persistent rain triggered losses totalling US\$ 10bn, around a quarter of which was insured.

There was a [series of storms in Europe](#) in late May and early June. Torrential rain triggered numerous flash floods, particularly in Germany, and there was major flooding on the River Seine in and around Paris. Overall losses totalled some US\$ 6bn (approximately €5.4bn), around half of which was insured.

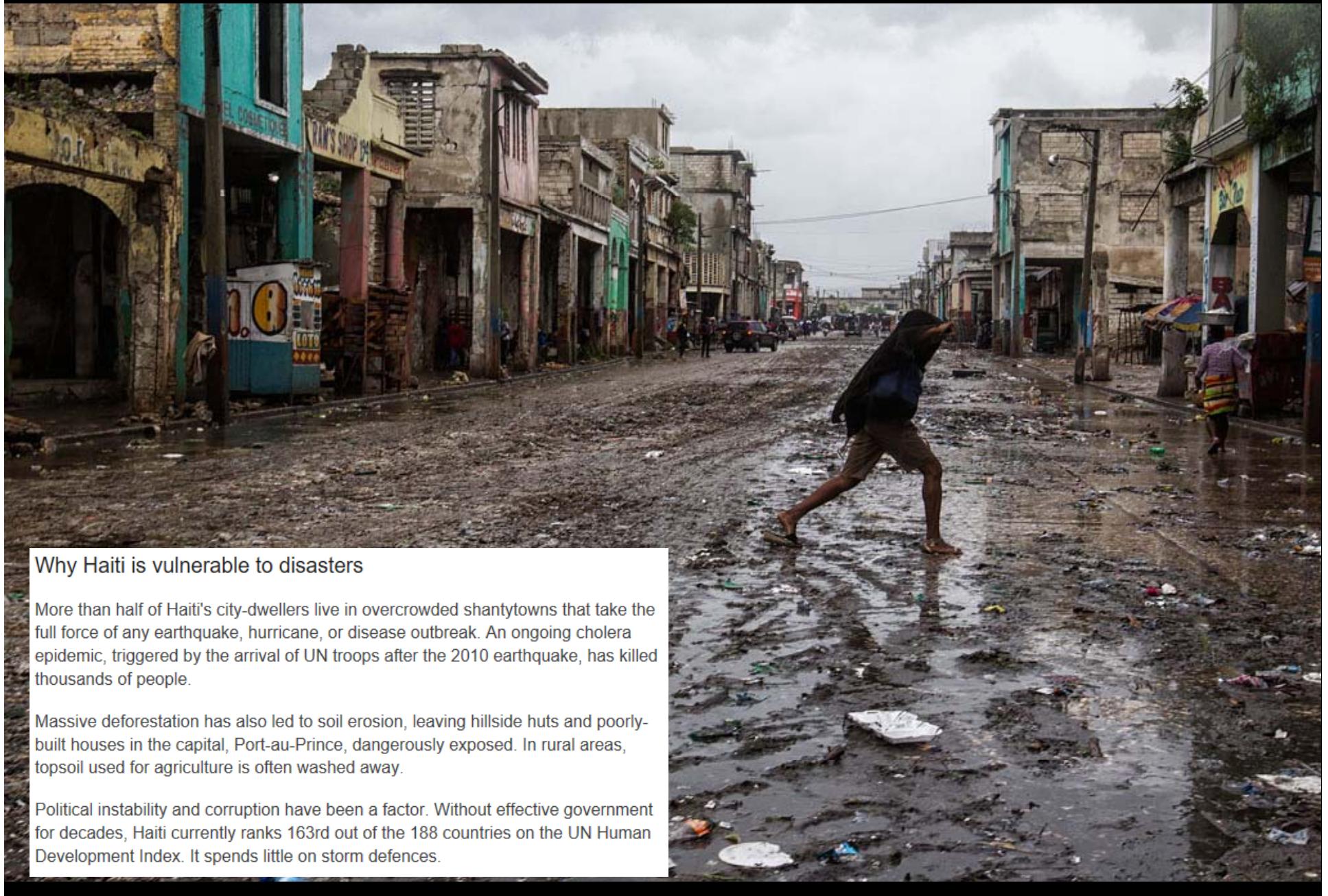
"A look at the weather-related catastrophes of 2016 shows the potential effects of unchecked climate change. Of course, individual events themselves can never be attributed directly to climate change. But there are now many indications that certain events – such as persistent weather systems or storms bringing torrential rain and hail – are more likely to occur in certain regions as a result of climate change", explained Peter Höpke, Head of Munich Re's Geo Risks Research Unit.



HURRICANE MATTHEW OVER HAITI - October 4, 2016



THE QUESTION OF HAITI



Why Haiti is vulnerable to disasters

More than half of Haiti's city-dwellers live in overcrowded shantytowns that take the full force of any earthquake, hurricane, or disease outbreak. An ongoing cholera epidemic, triggered by the arrival of UN troops after the 2010 earthquake, has killed thousands of people.

Massive deforestation has also led to soil erosion, leaving hillside huts and poorly-built houses in the capital, Port-au-Prince, dangerously exposed. In rural areas, topsoil used for agriculture is often washed away.

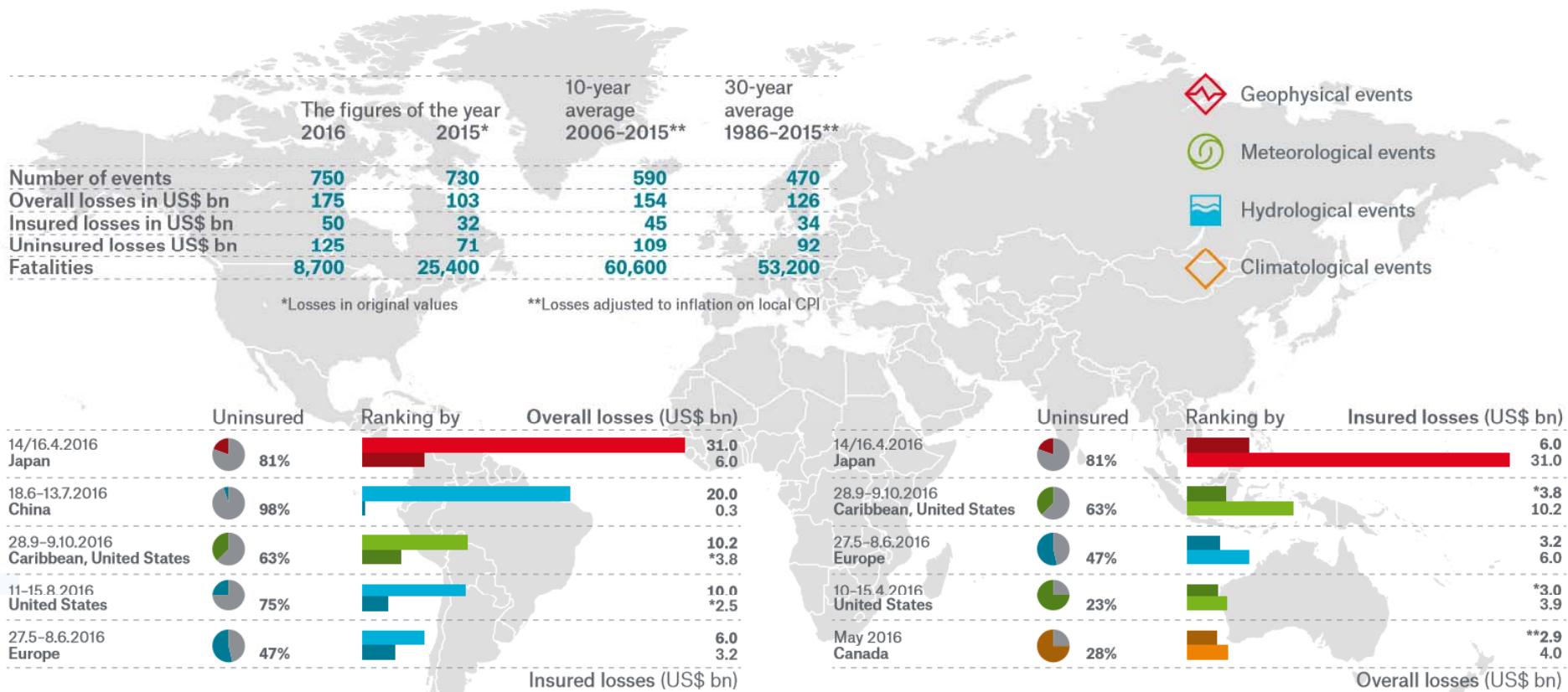
Political instability and corruption have been a factor. Without effective government for decades, Haiti currently ranks 163rd out of the 188 countries on the UN Human Development Index. It spends little on storm defences.

CHINA FLOODING JUNE-JULY 2016 [HEAVY RAINS IN THE YANGTZE BASIN]



Following the severe floods of 1998, China launched an extensive flood protection programme. Over the following ten years alone, the government invested more than 620 billion yuan (US\$ 87bn). As a result, the impact of the annual floods has diminished, even though values have risen sharply. The primary focus of these efforts was on river flooding. However, the measures adopted were not enough to cope with the consequences of the torrential local rainfall.

Natural catastrophes in 2016



*Source: Property Claim Services (PCS)

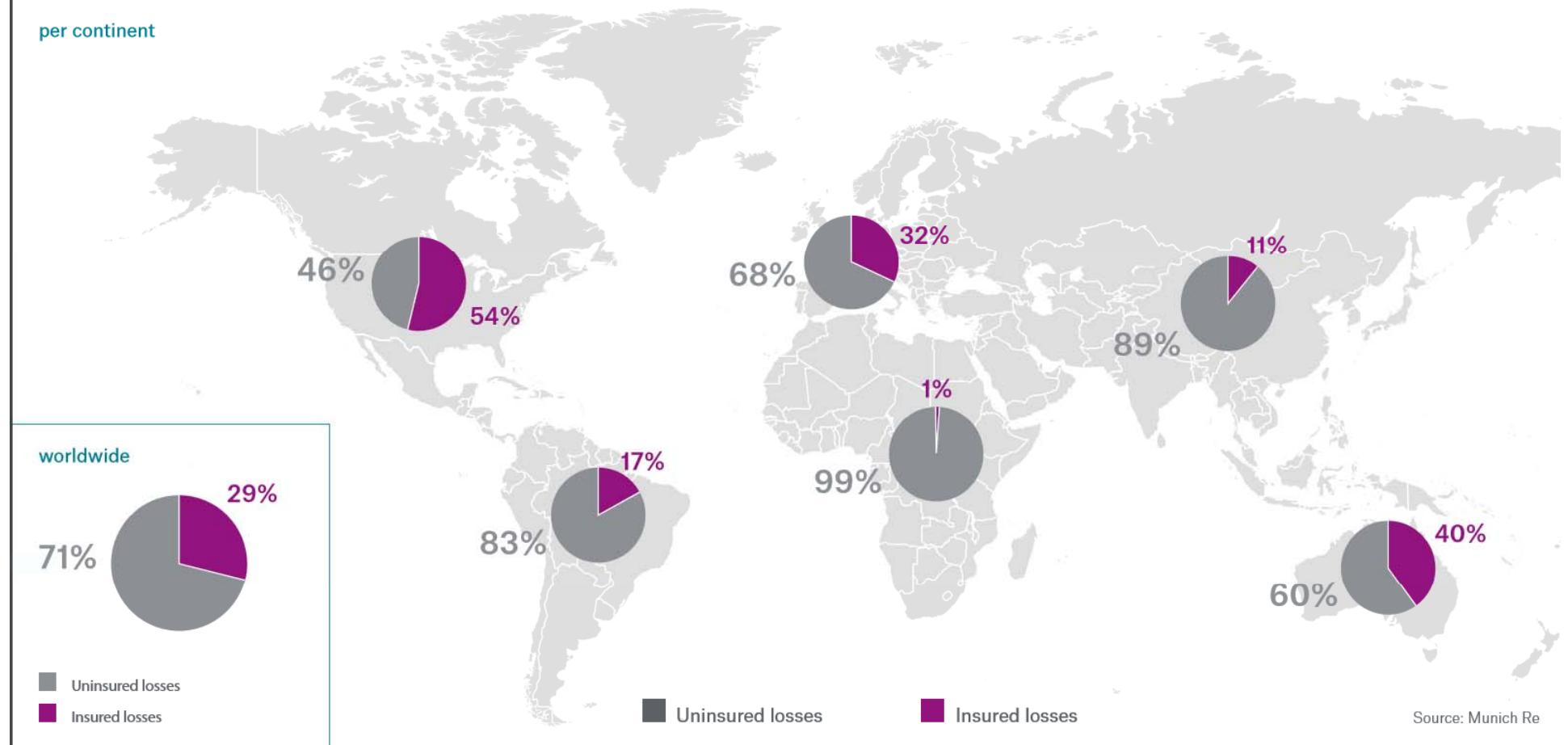
**Source: Catastrophe Indices and Quantification Inc. (CatIQ Inc) www.catiq.com

Source: Munich Re

Loss events 2016

Insured/uninsured losses as a percentage of overall losses

per continent



FORT McMURRAY FIRES May 2016



Wildfires spark biggest-ever loss for Canada's insurance industry

Wildfires in Canada were another cause of large insurance losses in 2016. The cause of the wildfires is still under investigation, and could be the result of human activity.³ Due to dry conditions and strong winds, once triggered, fires spread rapidly through the forests of Alberta. The town of Fort McMurray was evacuated, and many homes there were completely destroyed. Economic losses were USD 3.9 billion. The area is the heart of Canada's oil sands production with a high concentration of insured economic assets. As such, the insured losses were around USD 2.8 billion. This is one of the costliest wildfire events in insurance industry history, and it is the biggest loss the Canadian insurance sector has ever experienced.





2015

Press release

El Niño curbs losses from natural catastrophes in 2015

Losses from natural catastrophes in 2015 were again lower than in the previous year. The natural climate phenomenon El Niño reduced hurricane activity in the North Atlantic, while it brought major floods and heatwaves to many developing and emerging countries. The deadliest catastrophe, and also the costliest in terms of overall losses, was the Nepal earthquake in April, where some 9,000 people lost their lives and overall losses totalled US\$ 4.8bn.

"In terms of financial losses, we were somewhat fortunate in 2015: Strong tropical cyclones frequently only hit sparsely populated areas or did not make landfall at all. In the North Atlantic, El Niño helped to curtail the development of heavy storms.

Measures to reduce loss susceptibility have also had a positive effect", explained Peter Höppe, Head of Munich Re's Geo Risks Research Unit. However, the comparatively low losses are no reason to become complacent: "Scientists believe that in 2016 the strong El Niño phase might be followed by its twin sister, La Niña. Both versions of the climate oscillation ENSO (El Niño/Southern Oscillation) in the Pacific influence weather extremes throughout the world. A La Niña phase would promote the development of hurricanes in the North Atlantic, for example."

The year at a glance

- 2015 saw the lowest losses of any year since 2009. Overall losses totalled US\$ 90bn (previous year US\$ 110bn), of which roughly US\$ 27bn (US\$ 31bn) was insured.
- The loss amounts were also below the long-term inflation-adjusted average for the period 1985–2014 (overall losses US\$ 130bn, insured losses US\$ 34bn).
- The natural catastrophes of the past year claimed 23,000 lives, substantially more than the previous year's figure of 7,700. However, the number of victims was still some way below the annual average for the last 30 years (54,000).
- For the first time, more than a thousand loss events were recorded in a single year. However, this is primarily due to improved communication of such events. In particularly benign years, a lot of minor events are recorded.

The year's most devastating natural catastrophe was the earthquake in Nepal, which occurred on 25 April northwest of the capital Kathmandu and reached a magnitude of 7.8. Nepal and the neighbouring states of India, China and Bangladesh are all highly exposed to earthquakes, as this is where the Indian and Eurasian continental plates meet. The Indian plate moves about 4–5 cm north each year and pushes up the world's highest mountain range, the Himalayas, by about a centimetre each year. This is what



And that was also what happened just before midday on 25 April near the town of Gorkha. The tectonic plates were displaced by up to four metres at a depth of 10–25 km. Countless buildings, including many historically important sites, were destroyed. Around 9,000 people were killed and 500,000 were made homeless. Landslides occurred in the mountains to the north, which buried entire villages in the valleys. It is believed that many more would have died if the earthquake had not struck at Saturday lunchtime. Some 6,000 school buildings throughout the country were either badly damaged or destroyed. Thankfully, there are no lessons on a Saturday.



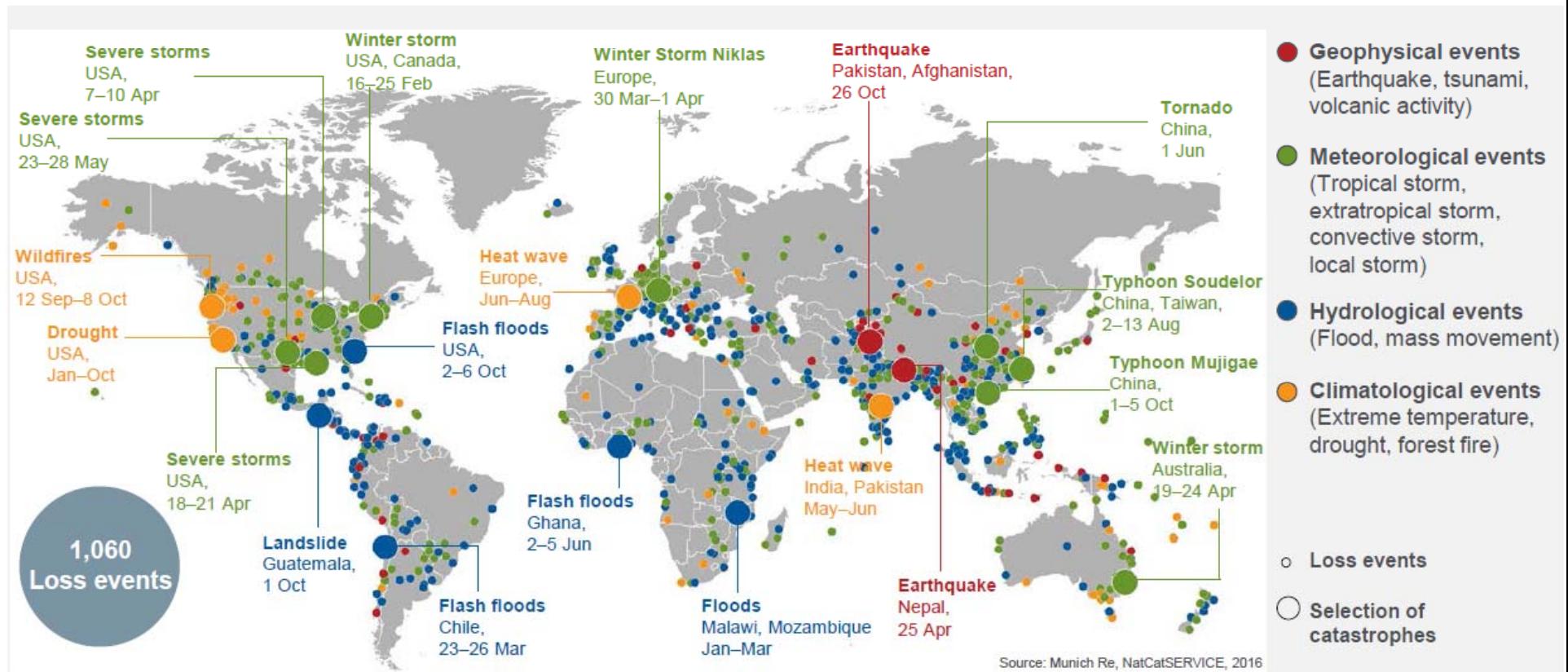
NEPAL EARTHQUAKE [M7.8; APRIL, 25, 2015] – 9,000 deaths

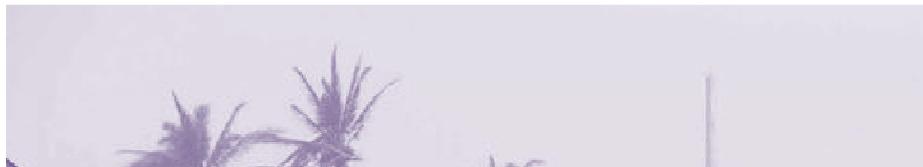


DEPTH – 13 km [PLATE BOUNDARY IN INDIA-EURASIA CONTINENTAL COLLISIONAL ZONE]

Natural loss events worldwide 2015

Geographical overview





7 January 2015 | Reinsurance

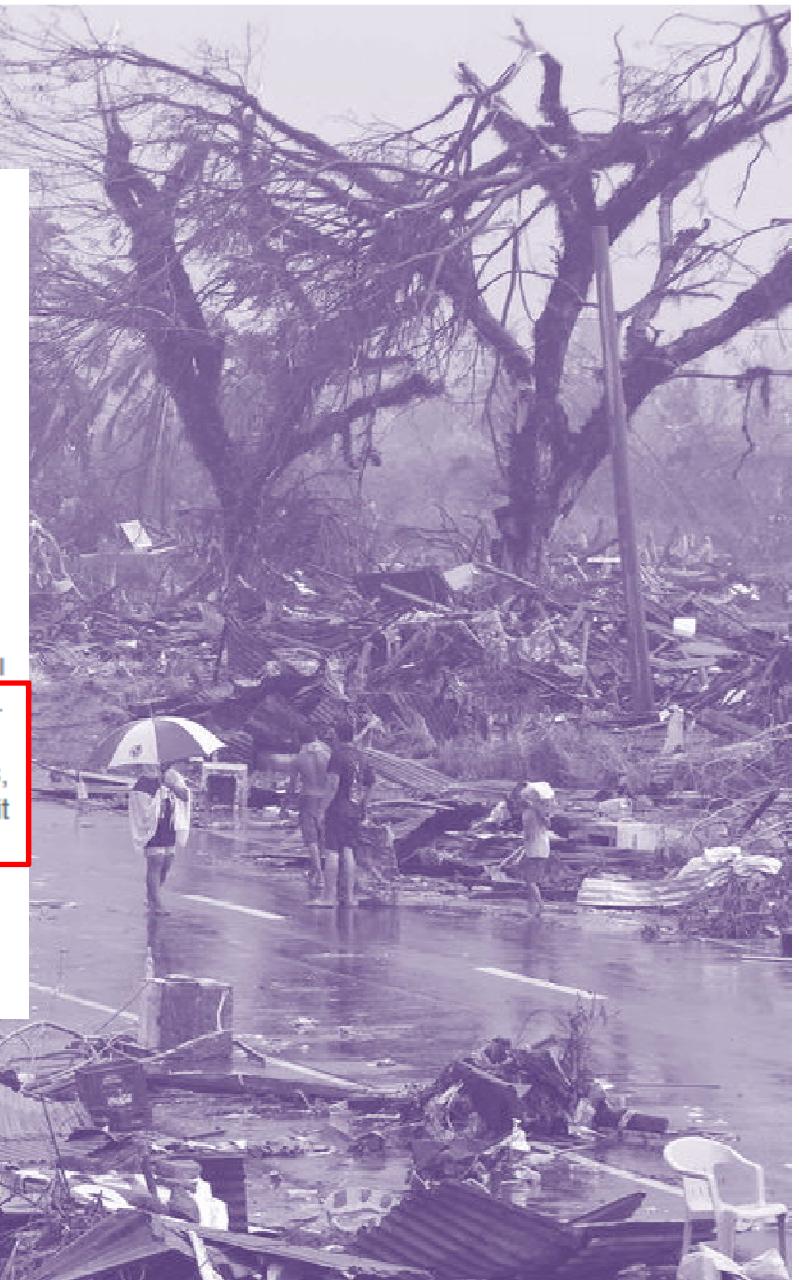
Press release

Review of natural catastrophes in 2014: Lower losses from weather extremes and earthquakes

The absence of very severe catastrophes and a quiet hurricane season in the North Atlantic meant that losses from natural catastrophes in 2014 were much lower. At US\$ 7bn, the most expensive event in terms of overall loss was Cyclone Hudhud in India. Around 7,700 people lost their lives in natural catastrophes.

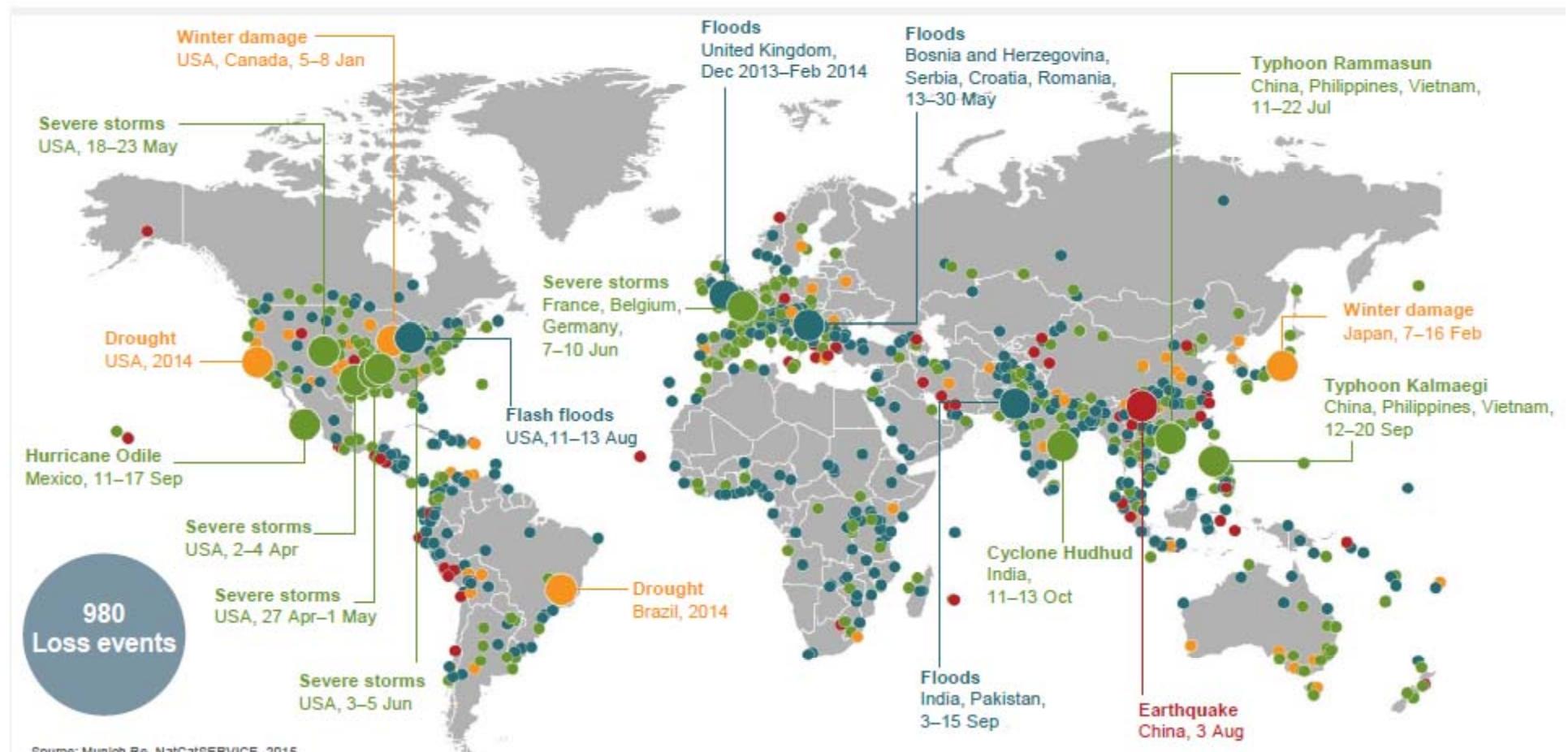
"Though tragic in each individual case, the fact that fewer people were killed in natural catastrophes last year is good news. And this development is not a mere coincidence. In many places, early warning systems functioned better, and the authorities consistently brought people to safety in the face of approaching weather catastrophes, for example before Cyclone Hudhud struck India's east coast and Typhoon Hagupit hit the coast of the Philippines," said Munich Re Board member Torsten Jeworrek.

"However, the lower losses in 2014 should not give us a false sense of security, because the risk situation overall has not changed. There is no reason to expect a similarly moderate course in 2015. It is, however, impossible to predict what will happen in any individual year."



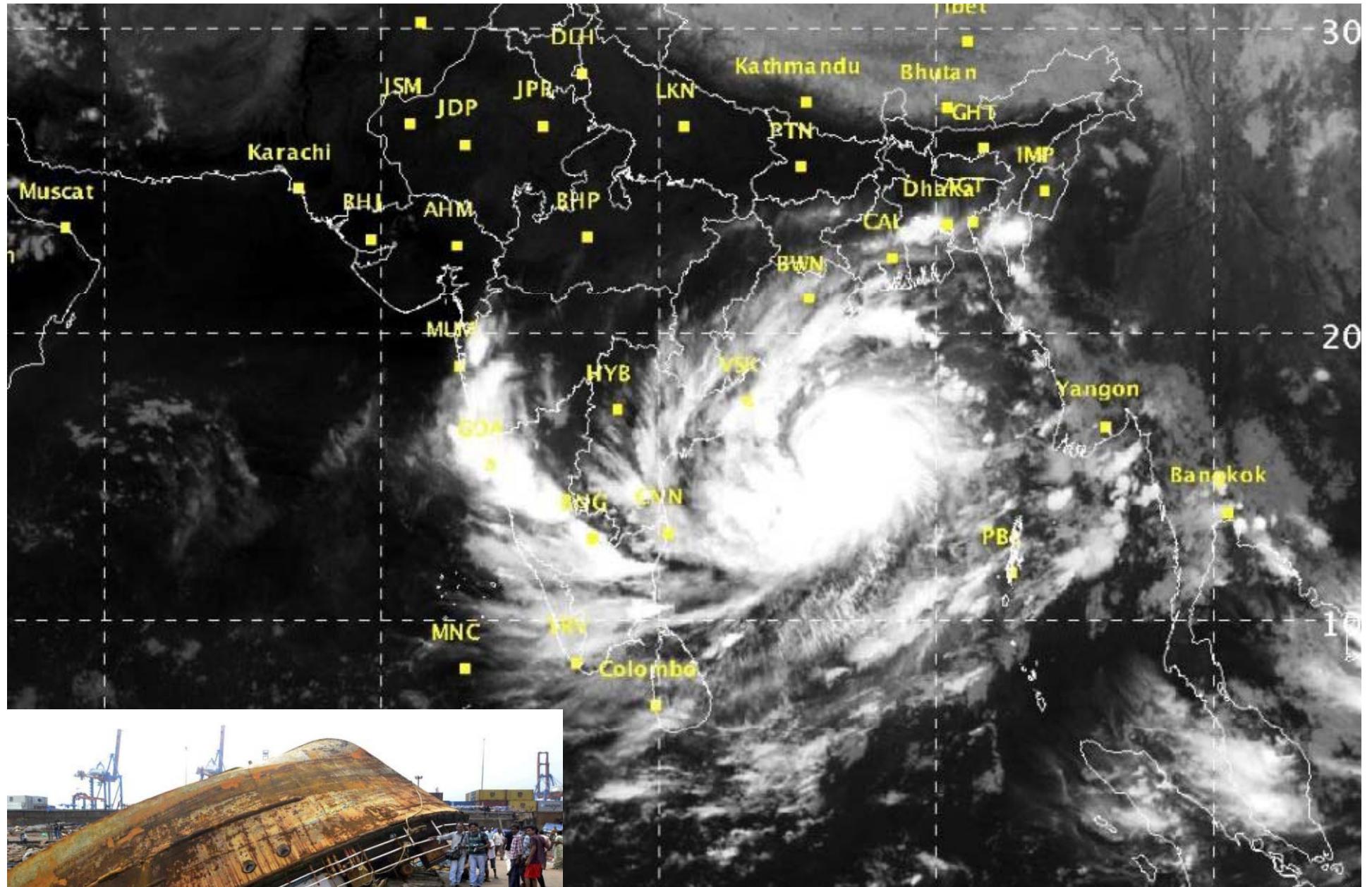
Loss events worldwide 2014

Geographical overview



- **Loss events**
- **Selection of catastrophes**
Overall losses \geq US\$ 1,500m

- **Geophysical events**
(Earthquake, tsunami, volcanic activity)
- **Meteorological events**
(Tropical storm, extratropical storm, convective storm, local storm)
- **Hydrological events**
(Flood, mass movement)
- **Climatological events**
(Extreme temperature, drought, wildfire)

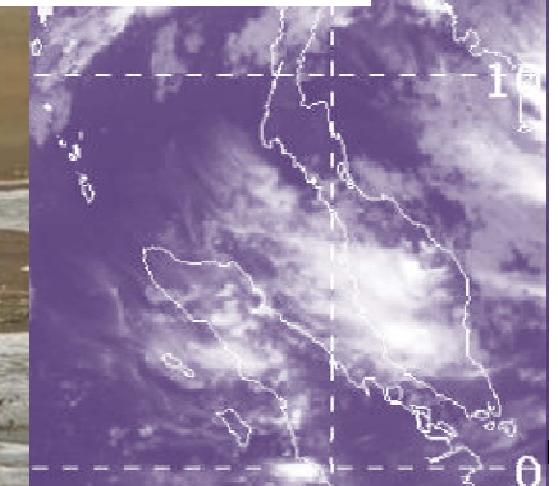


CYCLONE HUHUD, BAY OF BENGAL, OCTOBER 2014



CYCLONE HUDHUD – WARNING AND MITIGATION

The costliest natural catastrophe of the year, Cyclone Hudhud, also illustrated the practical effect of measures by the authorities to limit damage. Hudhud reached its maximum strength on 10 October over the Gulf of Bengal, and with wind speeds of over 190 km/h, was a Category 4 storm (of a maximum 5). On 12 October, it made landfall near the Indian port of Visakhapatnam, an important economic centre with a population of two million in the Andhra Pradesh region. In some places, more than 120 litres of rain per square metre fell within 24 hours. Thanks to warnings from the Indian weather service, the authorities evacuated around half a million people and brought them to secure accommodation. This kept the number of fatalities for a catastrophe of this strength at a low level (84). Of the overall losses of approximately US\$ 7bn, roughly US\$ 530m was insured – a comparatively small proportion, but insurance density in India is showing pleasing constant growth.



Ranking by overall losses

Date	Country/Region	Event	Fatalities	Overall losses US\$ m	Insured losses US\$ m
11-13.10.2014	India	Cyclone Hudhud	84	7,000	530
7-16.2.2014	Japan	Winter damage	37	5,900	3,100
3-15.9.2014	India, Pakistan	Floods	685	5,100	330
3.8.2014	China	Earthquake	617	5,000	-
2014	Brazil	Drought	-	5,000	-

Ranking by insured losses

Date	Country/Region	Event	Fatalities	Overall losses US\$ m	Insured losses US\$ m
7-16.2.2014	Japan	Winter damage	37	5,900	3,100
18-23.5.2014	United States	Severe storms	-	3,900	2,900*
7-10.6.2014**	France, Belgium, Germany	Severe storms	6	3,500	2,800
5-8.1.2014	United States, Canada	Winter damage	-	2,500	1,700*
3-5.6.2014	United States	Severe storms	-	1,600	1,300*

*Source: Munich Re NatCatSERVICE, Property Claim Services. **Time period for several severe storm events.

ERUPTION OF MOUNT ONTAKE,JAPAN [September 2014]



MOUNT ONTAKE, JAPAN [September 28, 2014]



Depew, NY – 19 November 2014





Floods in Bosnia, 2014 [the city of Brcko, May 18, 2014]



© SWNS.com

Flooding in United Kingdom {River Severn flooding, Worcester, January 2014]

ASIA-PACIFIC

Tsunami-hit nations mark 10th anniversary

Memorial services held in Indonesia, Thailand and other countries a decade after massive waves killed 220,000 people.

Last updated: 26 Dec 2014 22:12

January 2005



AFP/GETTY

January 2005



AFP/GETTY

December 2014



AFP/GETTY



2013

Munich Re Says 2013 Insured Disaster Losses Declined 52%

By Oliver Suess | Jan 7, 2014 4:29 AM ET | [0 Comments](#) [Email](#) [Print](#)

Munich Re, the world's biggest reinsurer, said claims from natural catastrophes including floods and hailstorms fell 52 percent last year amid a quieter hurricane season.

Insured losses declined to about \$31 billion, the Munich-based company said in a [statement](#) today. That compares with \$65 billion reported for 2012. Total losses were about \$125 billion last year, the reinsurer said, adding that both figures were below the average of the past decade.

While the 2013 [Atlantic hurricane season](#) was relatively mild, insurers faced claims from wind and hailstorms as well as flooding in Europe. German carriers [paid](#) about 7 billion euros (\$9.5 billion) for weather damages, according to the GDV industry association, though claims payments weren't sufficient to let reinsurers charge higher prices.

Swiss Re Ltd. (SREN), the second-largest reinsurer worldwide, said on Dec. 18 that natural and man-made catastrophes in 2013 caused \$130 billion in economic losses. Insured losses fell to \$44 billion from \$81 billion a year earlier, the Zurich-based reinsurer said.

Last year's June-through-November Atlantic storm season, which can result in insurer's and reinsurer's biggest losses, was one of the quietest in the last 20 years with the fewest hurricanes since 1982, reinsurance broker Willis Re said [last](#) month.





Swiss Re

Sigma preliminary estimates: natural catastrophes and man-made disasters in 2013 cost insurers worldwide USD 44 billion

18 DECEMBER 2013, ZURICH

- Total economic losses from disasters reached USD 130 billion in 2013 worldwide
- Insured global losses from natural catastrophes and man-made disasters totalled USD 44 billion, with flooding a major driver
- Around 25 000 lives were lost as a result of natural catastrophes and man-made disasters in 2013

According to preliminary *sigma* estimates, insured losses from natural catastrophes and man-made disasters in 2013 are estimated to be around USD 44 billion, down from USD 81 billion in 2012. Insured losses from natural catastrophes are at least USD 38 billion, down from USD 75 billion, while man-made disasters generated the remaining USD 6 billion of insured claims this year, little changed from 2012.

The overall economic losses from this year's catastrophic events reached USD 130 billion, compared with USD 196 billion in 2012. The total loss of life climbed to around 25 000 from 14 000 last year.

Press release

Overall picture of natural catastrophes in 2013 dominated by weather extremes in Europe and Supertyphoon Haiyan

Exceptionally high losses from weather-related catastrophes in Europe and Supertyphoon Haiyan dominated the overall picture of natural catastrophes in 2013. Floods and hailstorms caused double-digit billion-dollar losses in central Europe, and in the Philippines one of the strongest cyclones in history, Supertyphoon Haiyan, resulted in a human catastrophe with over 6,000 fatalities.

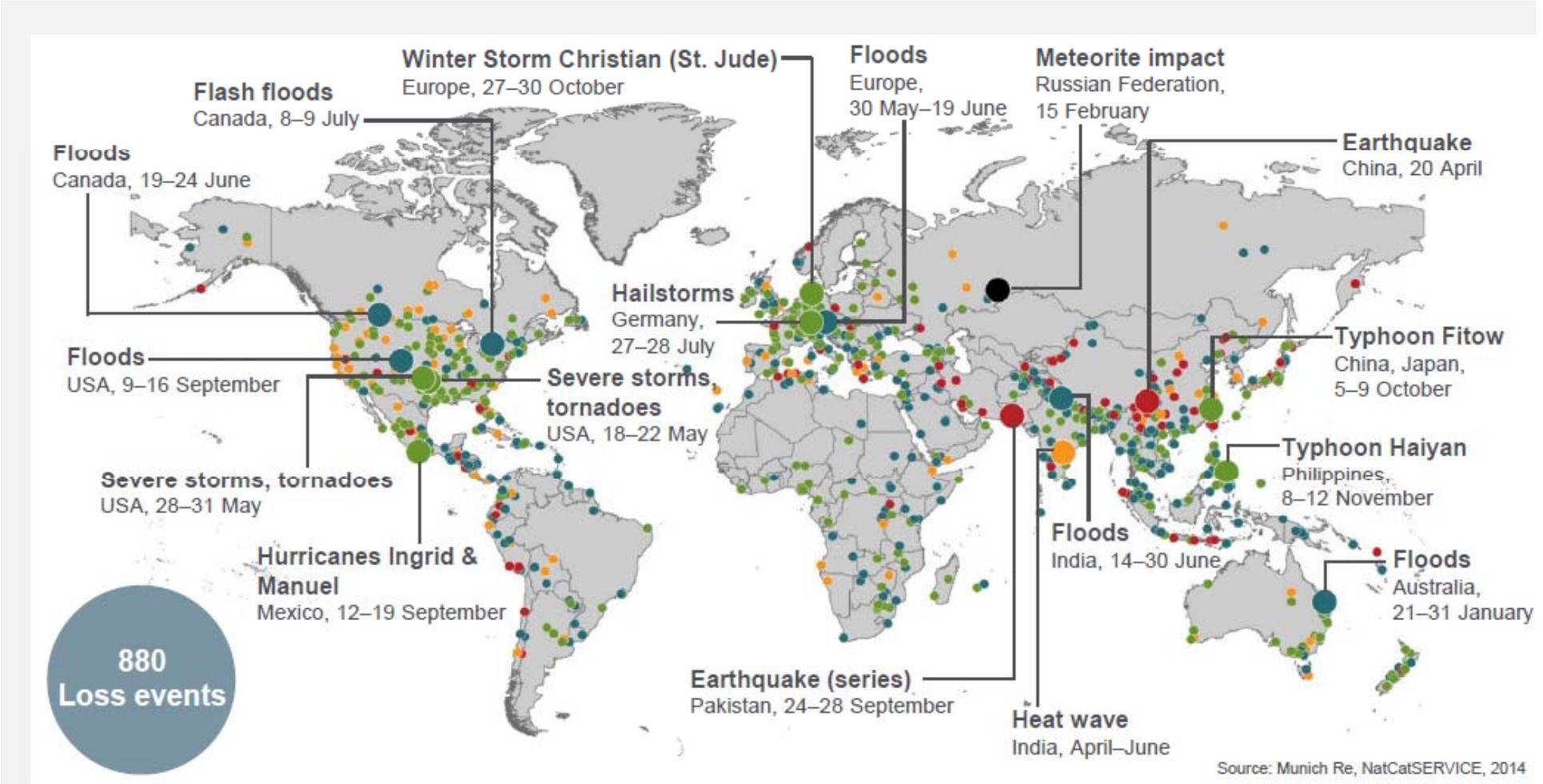
Globally, losses from natural catastrophes in 2013 were somewhat more moderate: the direct overall losses of around US\$ 125bn and insured losses of around US\$ 31bn remained below the average figures of the past ten years (US\$ 184bn and US\$ 56bn). Regrettably, in a total of 880 natural catastrophes (average of the past ten years: 790), more than 20,000 people were killed. This meant that the death toll was higher than in 2012, but significantly below the average of the past ten years (106,000).

"Several of the events of 2013 illustrated how well warnings and loss minimisation measures can restrict the impact of natural catastrophes. In the case of the most recent winter storms in Europe, for example, the losses remained comparatively low", said Torsten Jeworrek, Munich Re Board member responsible for global reinsurance business. "At the same time, events like those in the Philippines show the urgent need for more to be done in developing and emerging countries to protect people better. This includes stabler buildings and protection facilities, and insurance programmes – also with state backing – to provide those affected with financial assistance after a disaster."



Loss events worldwide 2013

Geographical overview



© 2014 Münchener Rückversicherungs-Gesellschaft, Geo Risks Research – As at January 2014



- | | |
|---|---|
| ● Geophysical events
(Earthquake, tsunami, volcanic eruption) | ● Hydrological events
(Flood, mass movement) |
| ● Meteorological events
(Tropical storm, extratropical storm, convective storm, local storm) | ● Climatological events
(Extreme temperature, drought, wildfire) |
| ● Extraterrestrial events
(Meteorite impact) | |

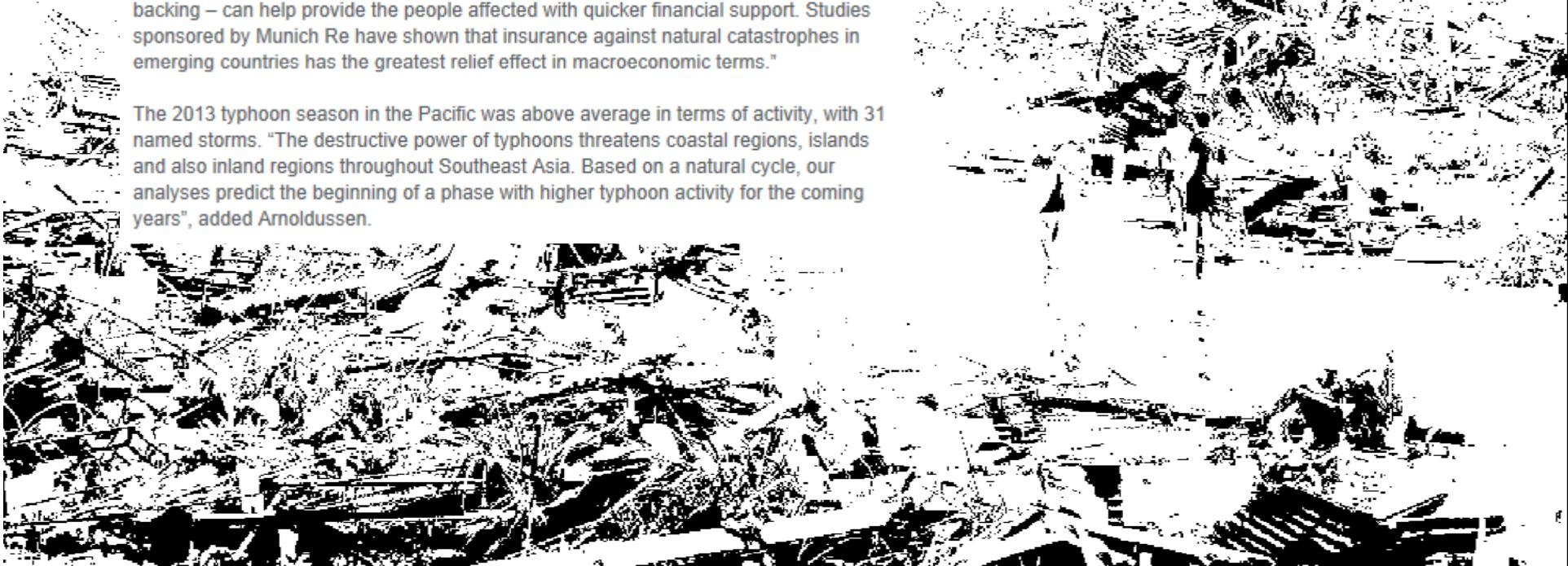
Haiyan probably the strongest tropical storm ever to make landfall

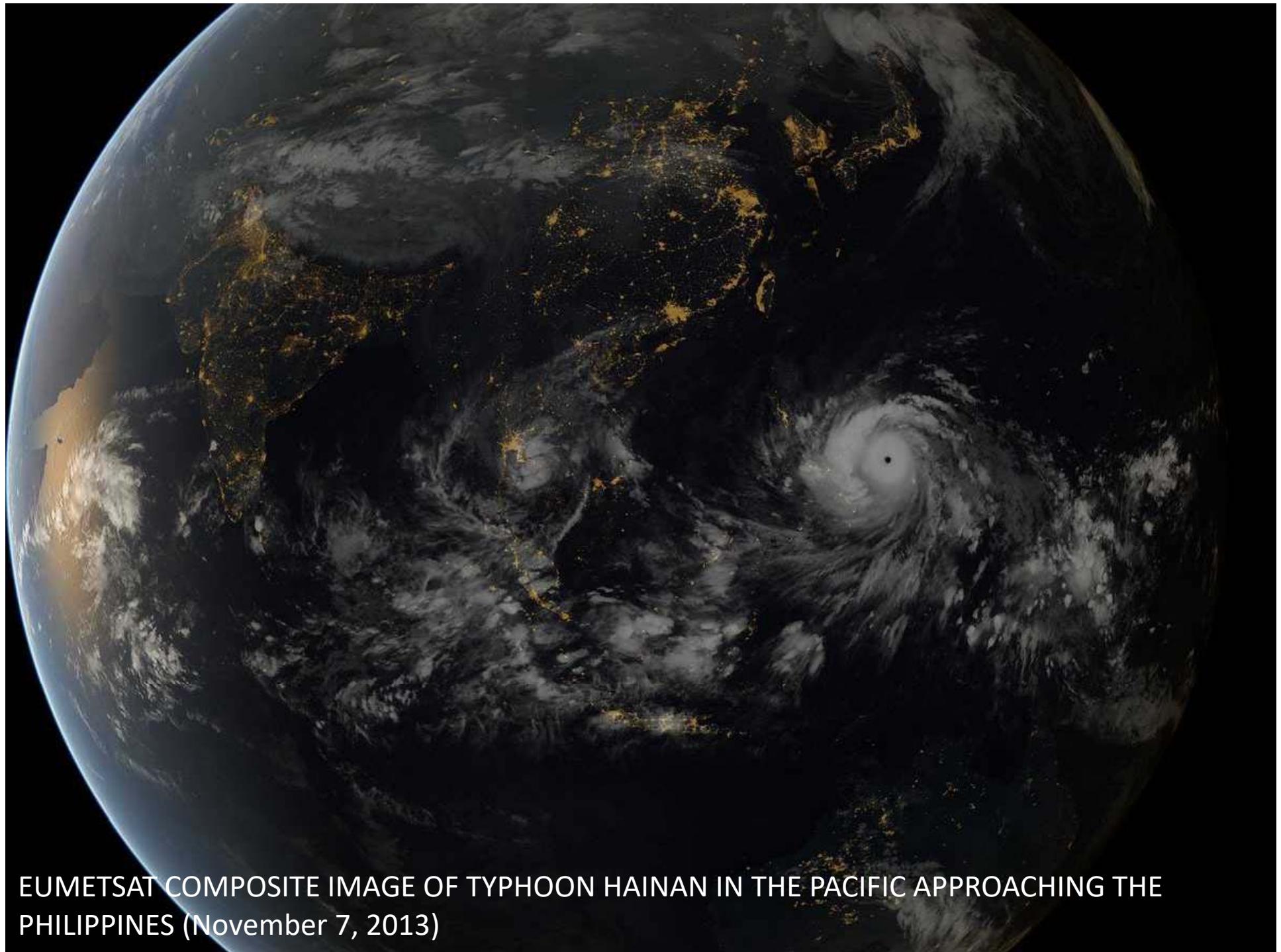
The most severe catastrophe in human terms was caused by Supertyphoon Haiyan, which tore across the southern Philippines on 7 November, with maximum wind speeds of well over 300 km/h. Shortly before that, the strongest gust was measured over the ocean at 379 km/h. The radius of the storm system amounted to around 600 km. And the eye of the tropical storm, just outside of which the wind speeds are highest, measured an exceptional 20–25 km in diameter. Haiyan was probably the strongest recorded cyclone ever to make landfall. As a result of the extreme wind force of over 300 km/h and the resultant flood wave of up to 6 m in height, many settlements like the coastal city of Tacloban were razed almost to the ground

Over 6,000 people were killed in the storm, and millions were left homeless. The harvest in this significant agricultural region, with extensive sugar cane cultivation, was largely destroyed. The overall loss totalled some US\$ 10bn, equivalent to around 5% of the Philippines' annual economic output. Owing to the very low insurance penetration, the insured loss will probably only be in the mid three-digit million range.

"Haiyan shows the importance of government measures in construction planning. The Philippines are the country most frequently affected by tropical cyclones", said Ludger Arnoldussen, whose responsibilities on Munich Re's Board of Management include the Asian markets. "At the same time, insurance programmes – possibly also with state backing – can help provide the people affected with quicker financial support. Studies sponsored by Munich Re have shown that insurance against natural catastrophes in emerging countries has the greatest relief effect in macroeconomic terms."

The 2013 typhoon season in the Pacific was above average in terms of activity, with 31 named storms. "The destructive power of typhoons threatens coastal regions, islands and also inland regions throughout Southeast Asia. Based on a natural cycle, our analyses predict the beginning of a phase with higher typhoon activity for the coming years", added Arnoldussen.





EUMETSAT COMPOSITE IMAGE OF TYPHOON HAINAN IN THE PACIFIC APPROACHING THE PHILIPPINES (November 7, 2013)

TYPHOON HAIYAN STRUCK PHILIPPINES ON NOVEMBER 8, 2013 : DAMAGE IN TACLOBAN CITY



TYPHOON HAIYAN (YOLANDA) 2013 : 7,254 Dead and Missing, 550,928 houses totally destroyed (as of January 8, 2015)

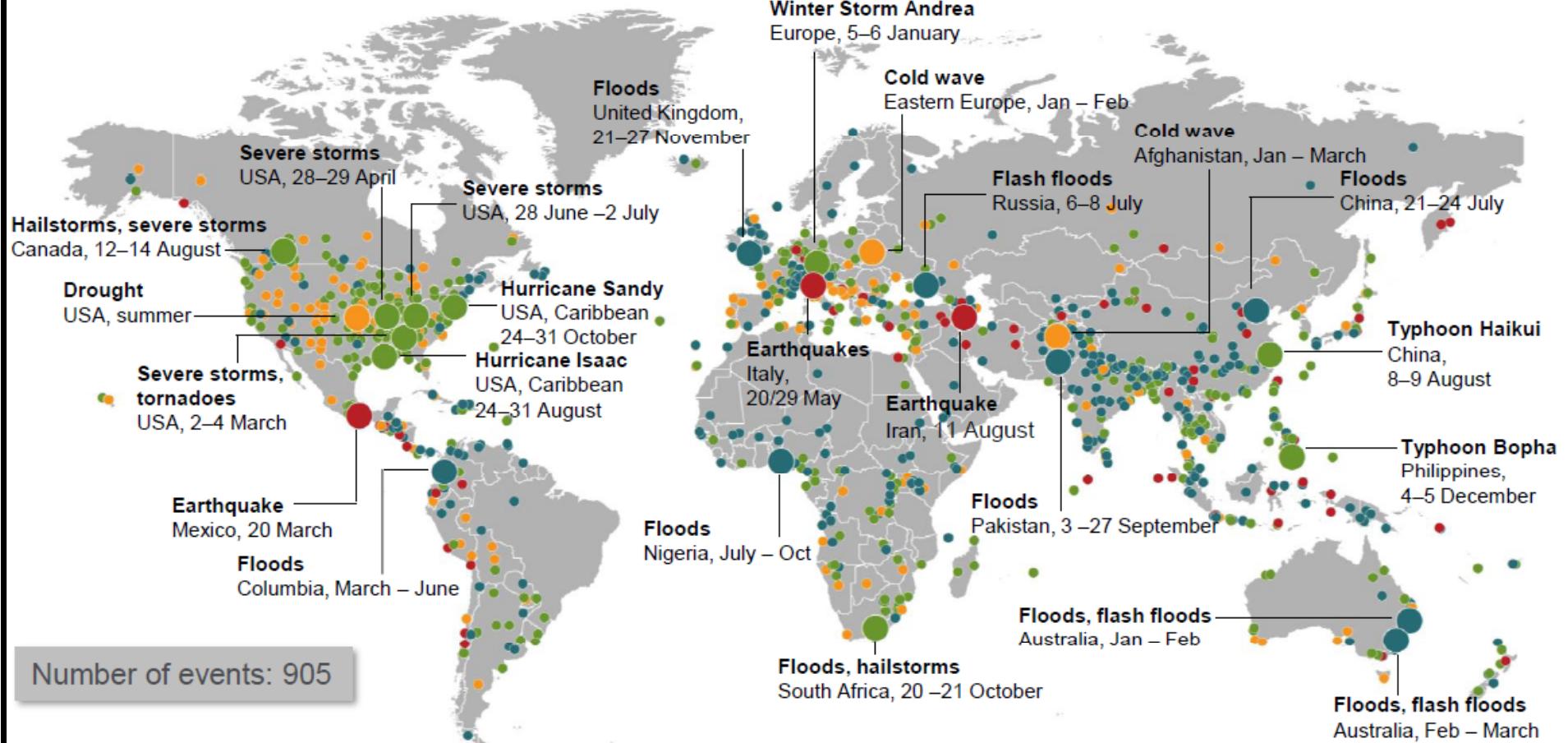




2012

Natural Catastrophes 2012

World map



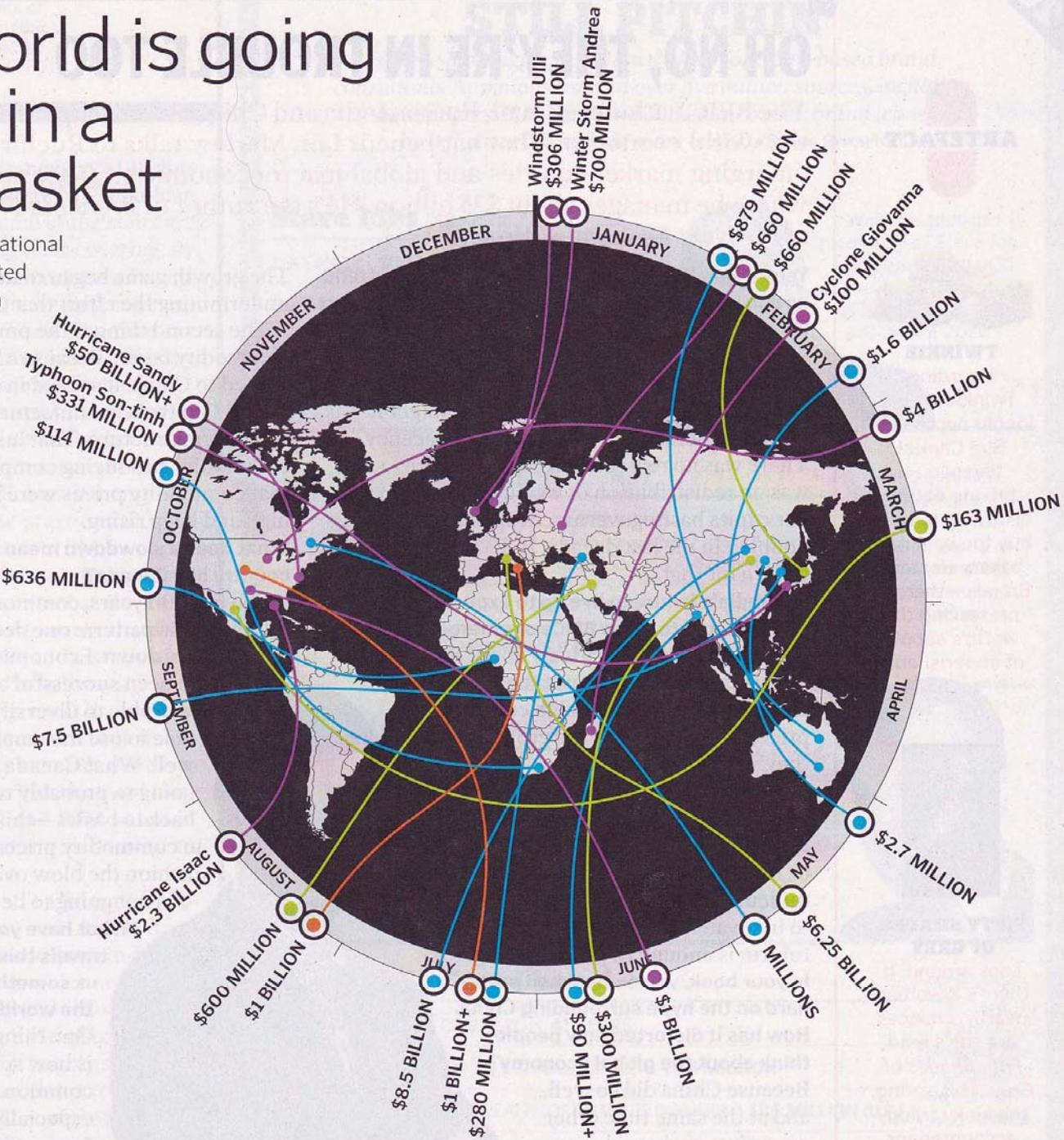
The world is going
to hell in a
handbasket

In October, the International Monetary Fund reported that destruction from natural disasters has increased from an estimated \$20 billion on average per year during the 1990s to about \$100 billion per year between 2000 and 2010. In the first half of this year, the U.S. accounted for 85% of all losses—and that was before Hurricane Sandy devastated the Eastern Seaboard.

Typhoons
\$366 M

Hurricanes
\$636 M

Tropical Storms
\$7.5 B



Press release

Natural catastrophe statistics for 2012 dominated by weather extremes in the USA



The USA accounted for a higher proportion of global natural catastrophe losses than usual in 2012, due to a series of severe weather-related catastrophes. Last year, natural catastrophes caused US\$ 160bn in overall losses and US\$ 65bn in insured losses worldwide. Some 67% of overall losses and 90% of insured losses were attributable to the USA – the respective averages are 32% and 57%. The year's highest insured loss was caused by Hurricane Sandy, with an estimated amount of around US\$ 25bn.

Munich Re Board member Torsten Jeworrek: "The heavy losses caused by weather-related natural catastrophes in the USA showed that greater loss-prevention efforts are needed. It would certainly be possible to protect conurbations like New York better from the effects of storm surges. Such action would make economic sense and insurers could also reflect the reduced exposure in their pricing."

Overall, losses were significantly lower in 2012 than in the previous year, when record figures were posted due to the earthquakes in Japan and New Zealand and severe floods in Thailand. In 2011, overall losses came to US\$ 400bn and insured losses to US\$ 119bn – also a record amount. A long-term comparison shows that 2012 losses were above the ten-year average of US\$ 50bn for insured losses and slightly below the average of US\$ 165bn for overall losses.

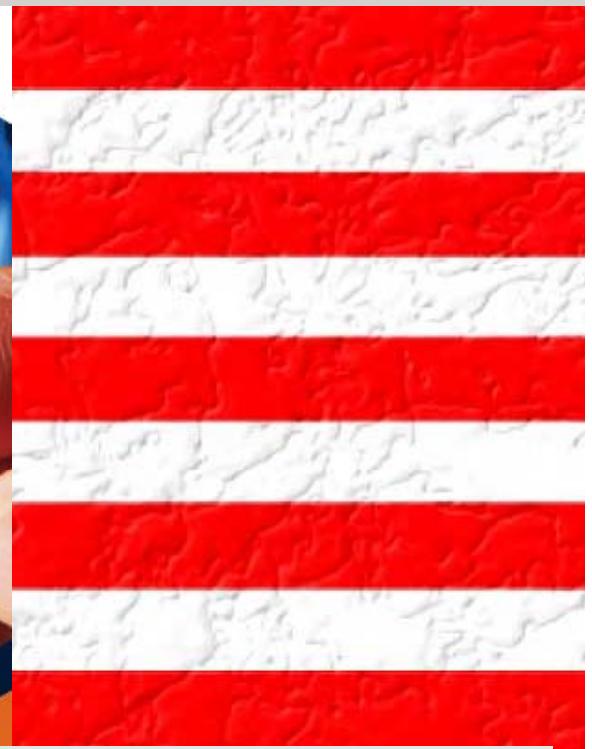
Some 9,500 people lost their lives in natural catastrophes last year compared with the ten-year average of 106,000. The relatively small number of fatalities was due to the fact that, in 2012, few severe natural catastrophes occurred in emerging and developing countries, where natural catastrophes tend to have far more devastating consequences in terms of human lives.



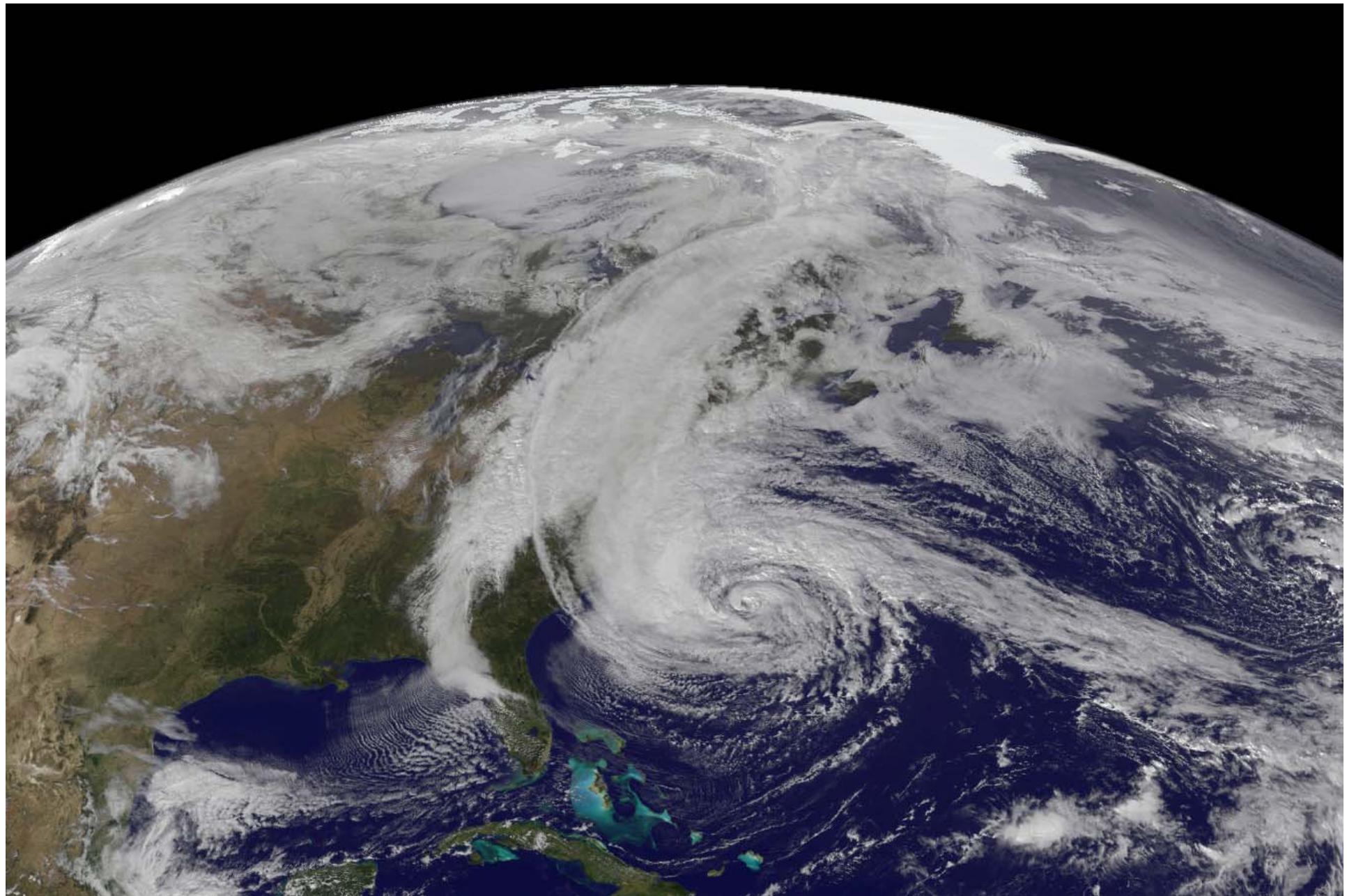
CoreLogic® 2012 Natural Hazard Risk Summary and Analysis



Each year brings a unique set of hazards with which we must contend. Although tornadoes and earthquakes were not as frequent or severe in 2012, history and probability have demonstrated that current inactivity is not a reliable indicator of future inactivity. The ability to accurately identify the potential for each hazard is a key component in preparing for and mitigating the loss associated with these natural disasters.



After record-breaking destruction in 2011, natural disasters continued to cause extensive damage in the U.S. in 2012. Beginning with several major tornadoes in January, homeowners, city officials, emergency responders, insurers and many others faced severe hazard risk through the end of summer and into fall. Even as tornado activity eased in May, catastrophic wildfires, freshwater flooding and hurricane-driven storm surge hit homeowners across the U.S. and, in some instances, contributed to record amounts of damage and destruction.



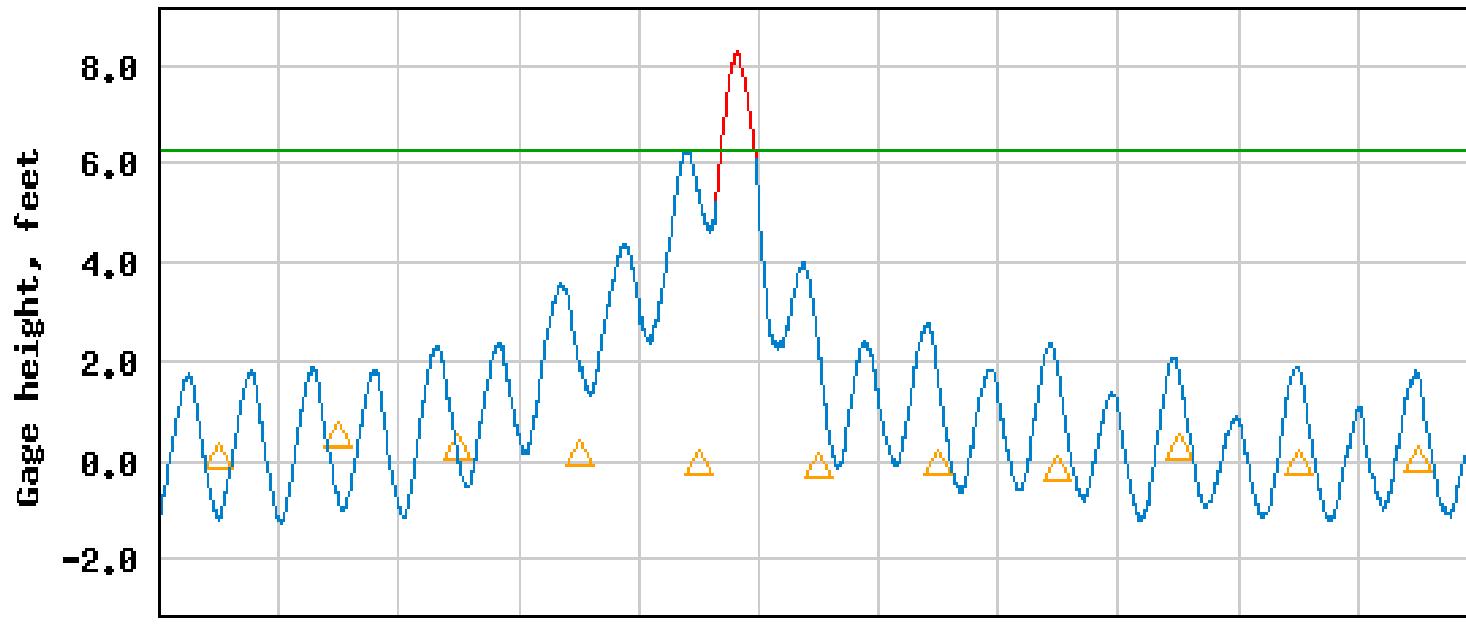
Hurricane Sandy, October 28, 2012



Storm surge flooding - Tuckerton, NJ (October 30, 2012)



USGS 01409335 Little Egg Inlet near Tuckerton NJ



Oct	Oct	Oct	Oct	Nov	Nov
25	27	29	31	02	04
2012	2012	2012	2012	2012	2012

----- Provisional Data Subject to Revision -----

- Orange triangle: Median daily statistic (9 years)
- Blue line: Gage height
- Red line: Estimated gage height
- Green line: Gage cannot accurately measure above this tide level



Seaside Heights, NJ: effects of storm surge flooding, Superstorm Sandy (October 30, 2012)



© Polaris / eyevine

Beachfront homes at Rockaway, Queens, New York destroyed/damaged by Sandy storm surge



Munich, 04 January 2012
Press release

Review of natural catastrophes in 2011: Earthquakes result in record loss year



A sequence of devastating earthquakes and a large number of weather-related catastrophes made 2011 the costliest year ever in terms of natural catastrophe losses. At about US\$ 380bn, global economic losses were nearly two-thirds higher than in 2005, the previous record year with losses of US\$ 220bn. The earthquakes in Japan in March and New Zealand in February alone caused almost two-thirds of these losses. Insured losses of US\$ 105bn also exceeded the 2005 record (US\$ 101bn).

Torsten Jeworrek, Munich Re Board member responsible for global reinsurance business: "Thankfully, a sequence of severe natural catastrophes like last year's is a very rare occurrence. We had to contend with events with return periods of once every 1,000 years or even higher at the locations concerned. But we are prepared for such extreme situations. It is the insurance industry's task to cover extreme losses as well, to help society cope with such events and to learn from them in order to protect mankind better from these natural perils."

An aerial photograph capturing the scale of destruction in a coastal town. The landscape is a vast expanse of dark, twisted metal and debris. In the center-left, a large cargo ship is partially submerged and tilted, its hull and superstructure mangled. The surrounding area is filled with the skeletal remains of houses, their roofs and walls reduced to rubble. In the background, a massive column of dark smoke rises into the sky, billowing from a distant industrial or residential area. The overall scene conveys a sense of a major catastrophe, likely an earthquake and tsunami, followed by fire and further structural collapse.

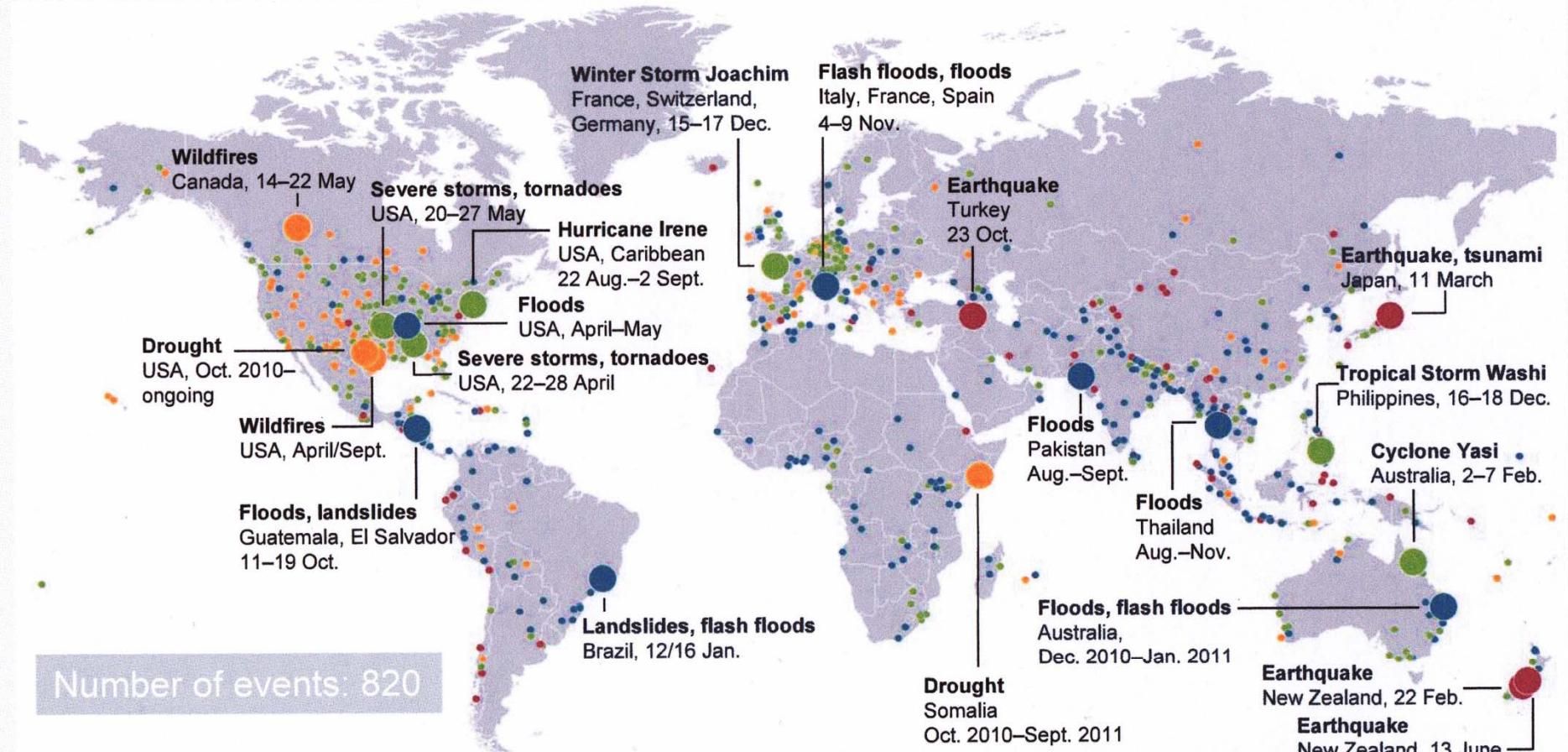
2011

Kesennuma City, Miyagi Prefecture, March 11, 2011



Natural Catastrophes 2011

World map



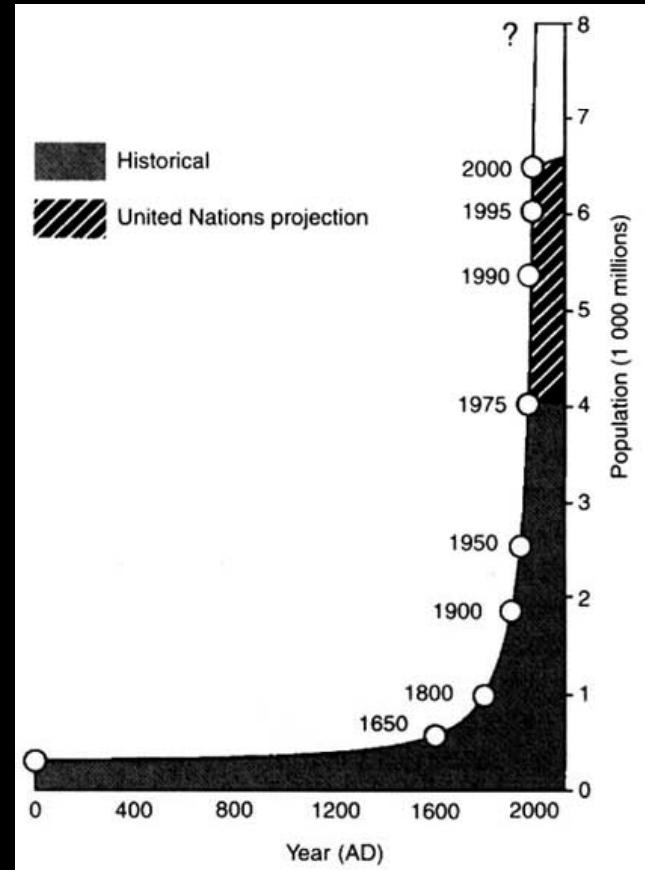
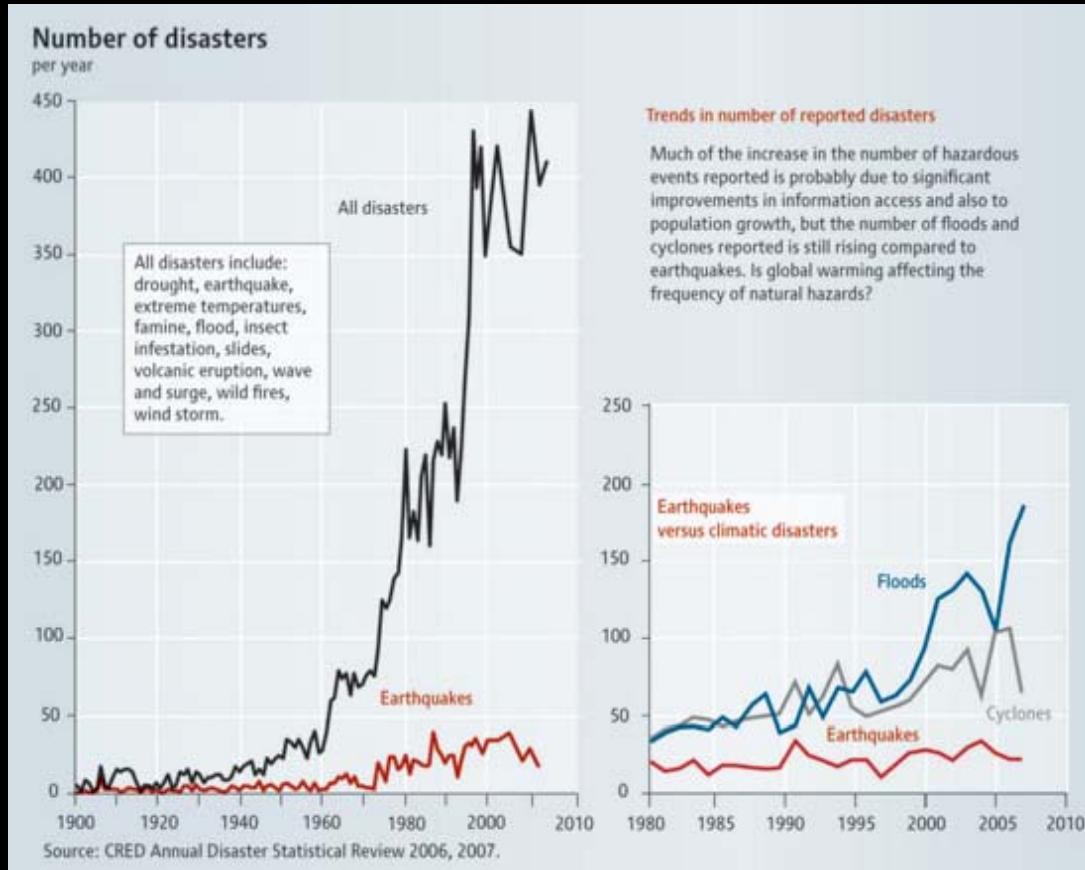
- Natural catastrophes

- Selection of significant loss events

- Geophysical events (earthquake, tsunami, volcanic activity)
- Meteorological events (storm)

- Hydrological events (flood, mass movement)
- Climatological events (extreme temperature, drought, wildfire)

INCREASE IN NATURAL DISASTERS VERY EVIDENT FROM DATABASES



5 KEY QUESTIONS INCLUDE;

1. How are disasters defined? What threshold is used?
2. What is role of increasing global and regional population (increasing exposure) ?
3. What is role of climate change in changing magnitude and frequency of atmospheric and hydrologic hazards (increasing hazard ?) ?
4. What is role of increasing value of damaged assets (increase in insurable losses) ? The issue of loss monetization ?
5. What is role of increased reporting ?



Are Natural Hazards and Disaster Losses in the U.S. Increasing?

PAGES 381, 388–389

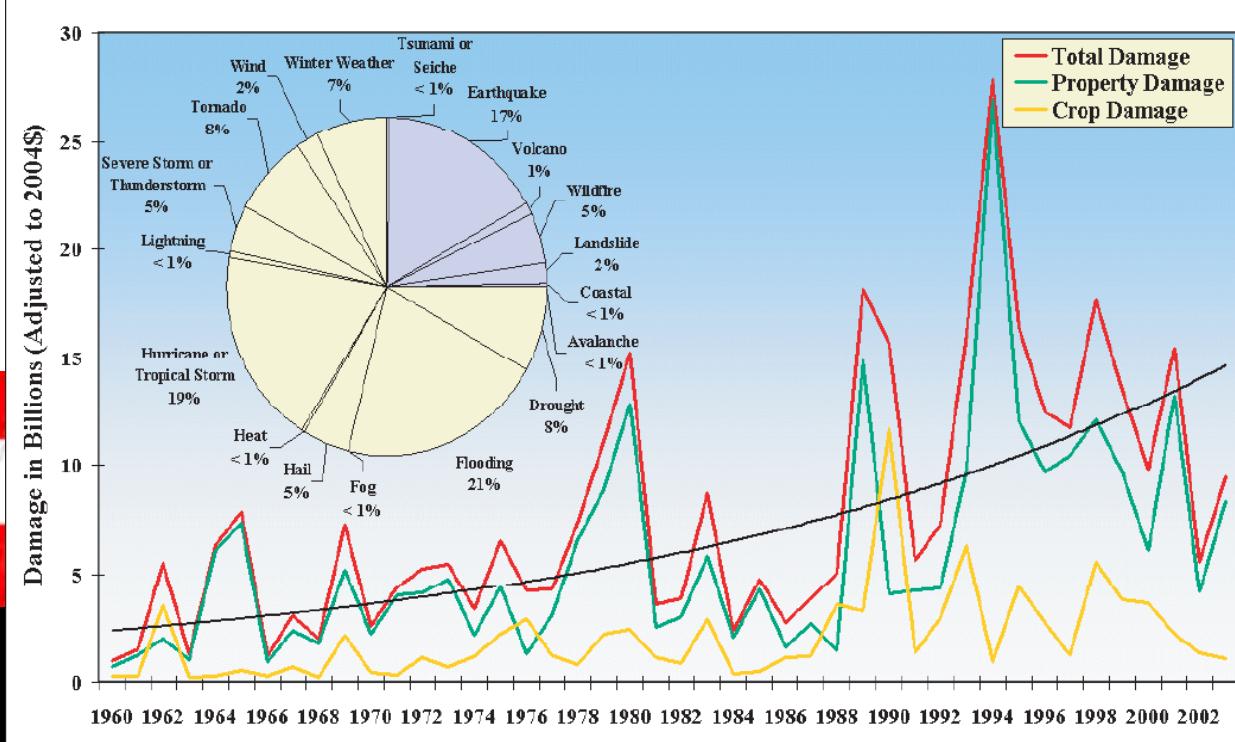
More than 35 major Presidential disaster declarations, including those for Hurricanes Katrina and Rita, already have been declared across the United States in 2005. This is a harbinger of another costly year for natural disasters.

While losses from the 2004 hurricane season are still being tallied, estimates suggest that each Florida hurricane last year was responsible for more than \$5 billion in damages (<http://www.ncdc.gov/oa/reports/billionz.html>). This year (2005) may prove to be the costliest ever. To see whether the years 2004–

these storm records do not represent all natural hazards. Another concern is how losses are defined and measured. With concerted effort, such a national loss inventory can be created

colleagues at the Hazards Research Lab at the University of South Carolina. The database, presently covering 1960–2003 (updates are made every six months), was collated from a variety of governmental sources including the U.S. Geological Survey (USGS) and the NCDC.

Events were selected for the database if they caused more than \$50,000 in property and/or crop losses. The events then were classified into 18 different hazard categories, and were



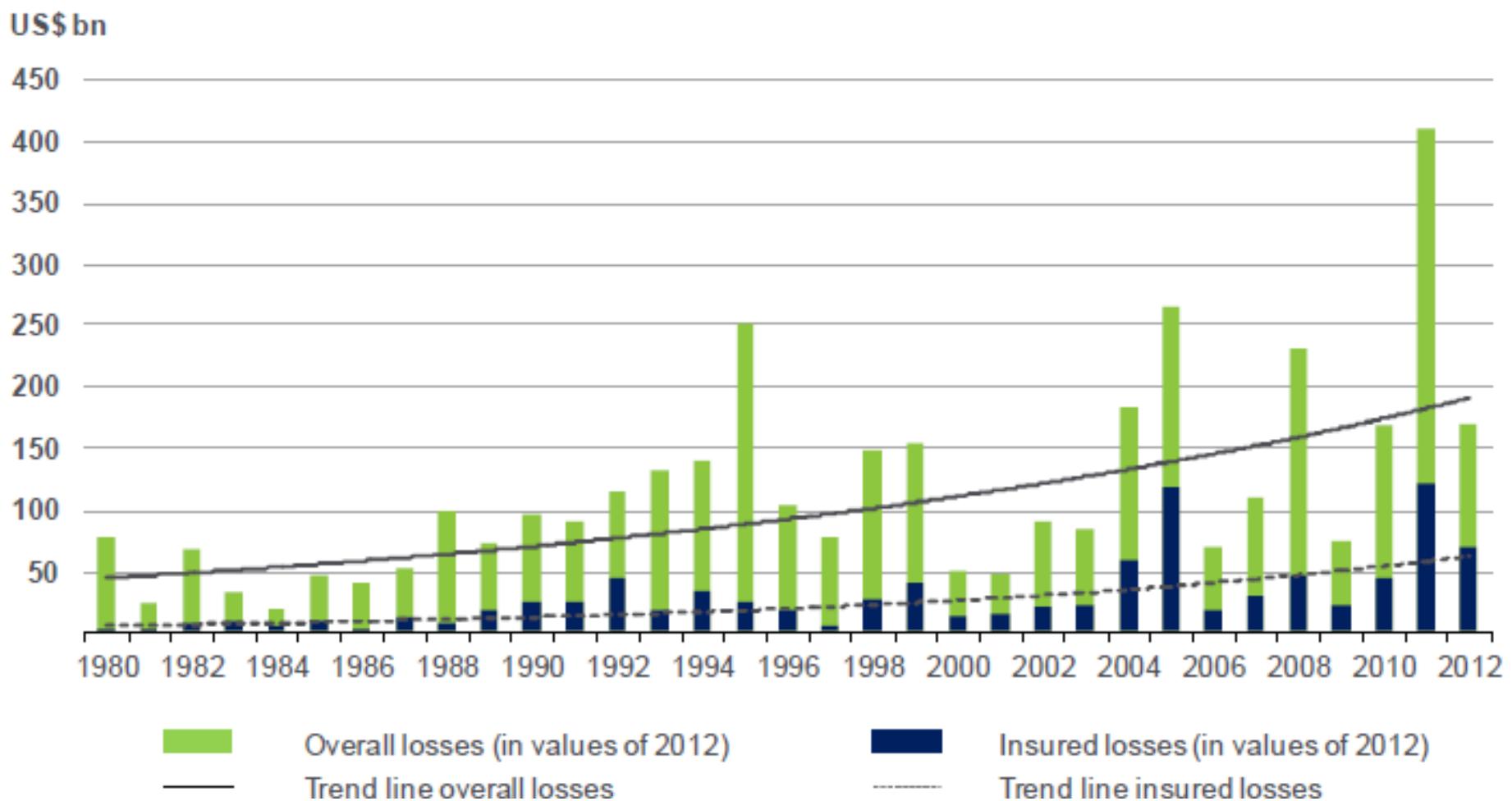
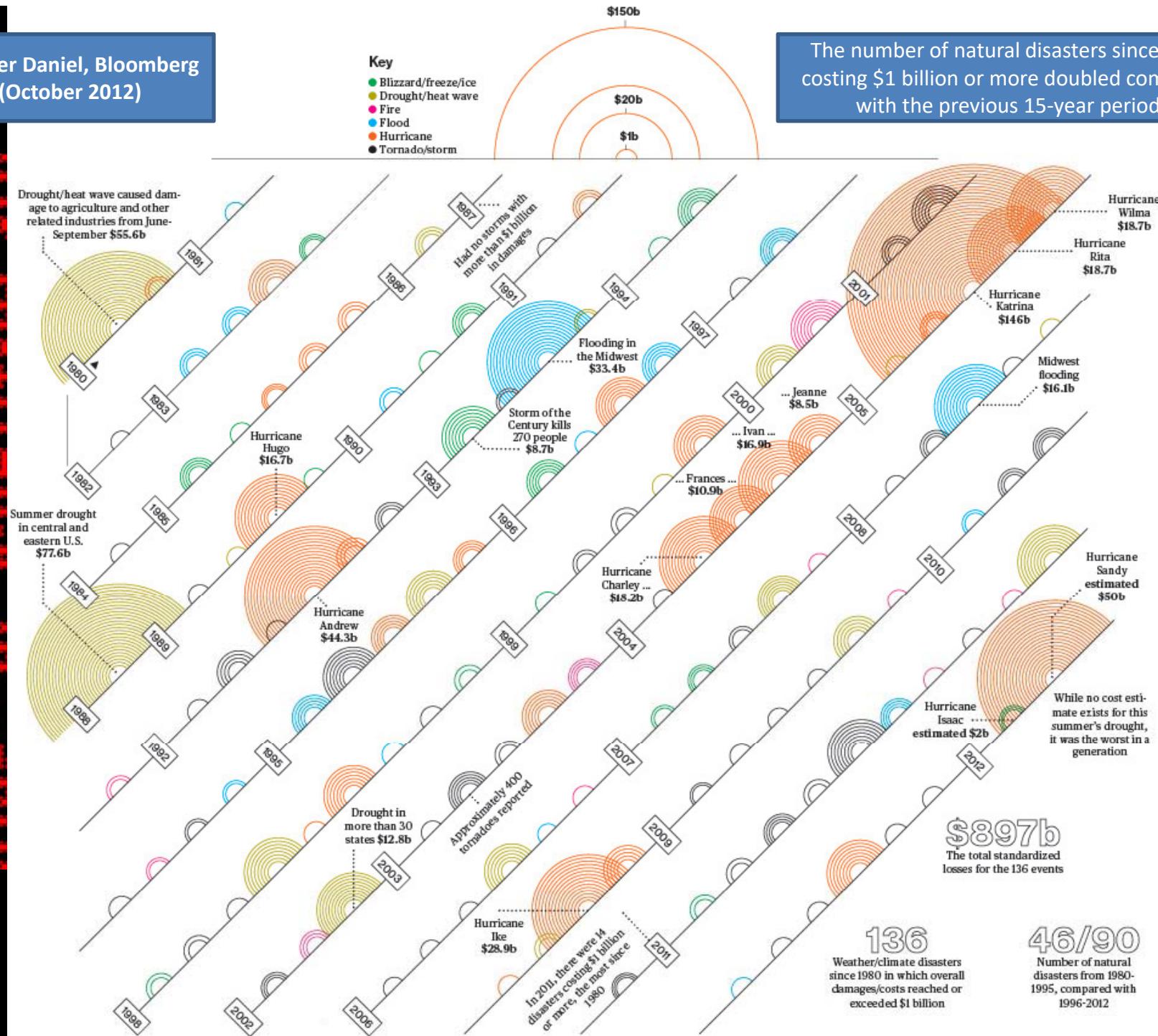


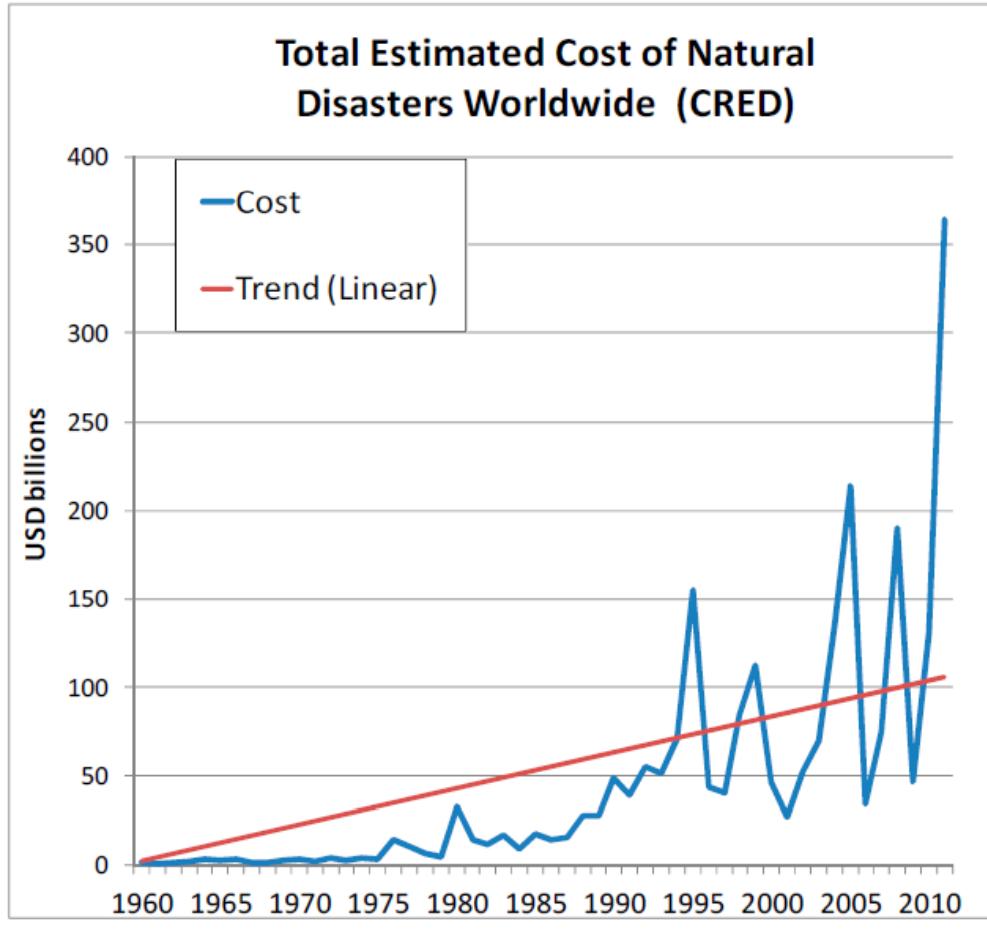
Fig. 1 Natural catastrophes worldwide 1980-2012: In the past 30 years, there has been a significant increase in direct overall losses and insured losses; Source: Munich Re NatCatSERVICE



Jennifer Daniel, Bloomberg
(October 2012)

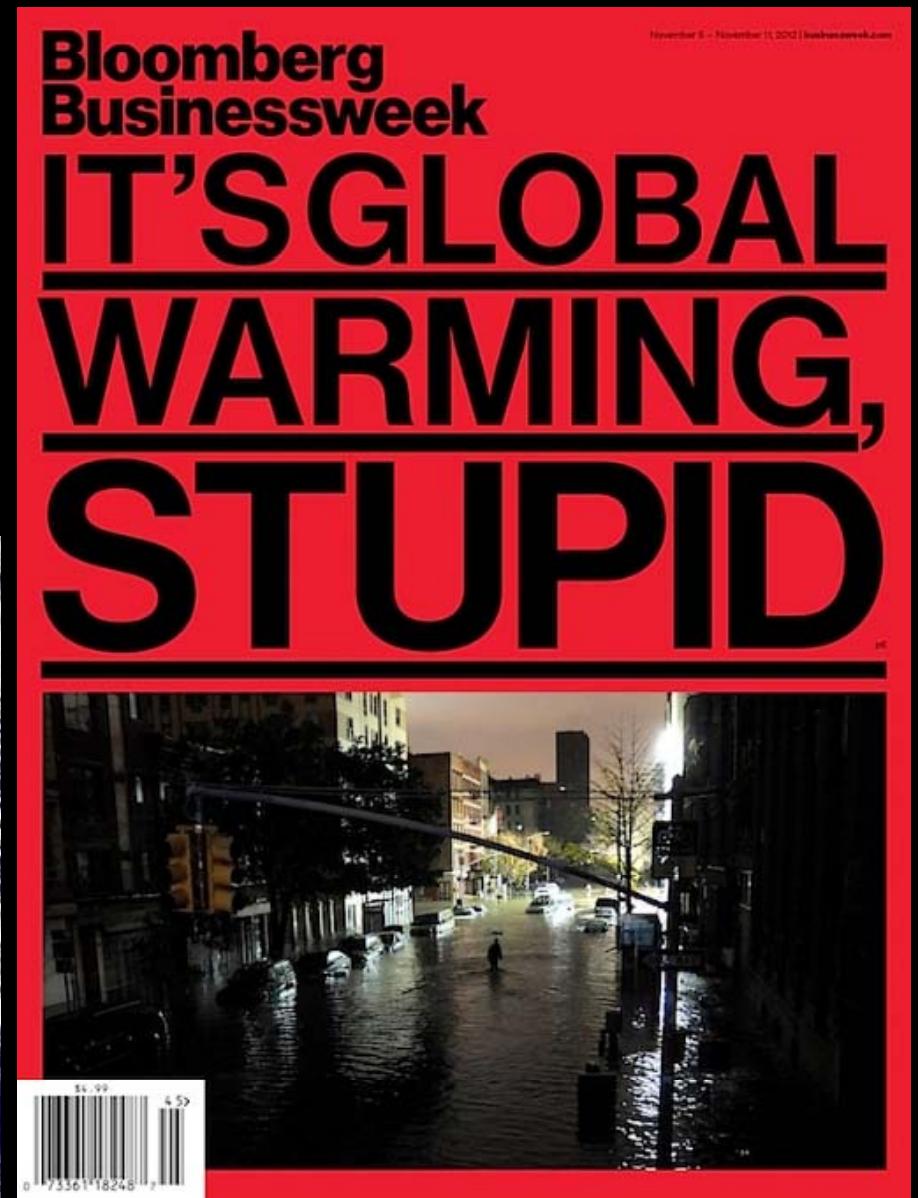
The number of natural disasters since 1996 costing \$1 billion or more doubled compared with the previous 15-year period.





	Haiti	Japan	Kenya	NZ	Pakistan	Samoa	St. Lucia
Disaster	Earthquake	Earthquake Tsunami	Drought	Earthquake	Floods	Tsunami	Hurricane
Cost US\$ bn	\$8 bn	\$213 bn	\$0.8 bn	\$24 bn	\$10 bn	\$0.08 bn	\$0.43 bn
% GDP	120%	3.6%	1.9%	10%	5%	15%	43%
No. affected	4.3 mn	0.4 mn	4.3 mn	0.3 mn	18 mn	5400	3,000
% pop	43.0%	0.3%	10.6%	6.9%	10.0%	3.0%	1.7%

RELATIONSHIP BETWEEN CLIMATE CHANGE AND EXTREME HAZARDS (DISASTERS?)



Global warming at a standstill, new Met Office figures show

The Met Office has downgraded its forecast for global warming to suggest that by 2017 temperatures will have remained about the same for two decades.



It is thought that factors such as ocean current patterns may be behind the slowdown Photo: REUTERS

By **John-Paul Ford Rojas**
11:59AM GMT 08 Jan 2013

Print this article



HAVE DISASTER LOSSES INCREASED DUE TO ANTHROPOGENIC CLIMATE CHANGE?

BY LAURENS M. BOUWER



TABLE I. Normalization studies of disaster loss records.

Hazard	Location	Period	Normalization	Normalized loss	Reference
Bushfire	Australia	1925–2009	Dwellings	No trend	Crompton et al. (2010)
Earthquake	United States	1900–2005	Wealth, population	No trend	Vranes and Pielke (2009)
Flood	United States	1926–2000	Wealth, population	No trend	Downton et al. (2005)
Flood	China	1950–2001	GDP	Increase since 1987	Fengqing et al. (2005)
Flood	Europe	1970–2006	Wealth, population	No trend	Barredo (2009)
Flood	Korea	1971–2005	Population	Increase since 1971	Chang et al. (2009)
Flood and landslide	Switzerland	1972–2007	None	No trend	Hilker et al. (2009)
Hail	United States	1951–2006	Property, insurance market values	Increase since 1992	Changnon (2009a)
Windstorm	United States	1952–2006	Property, insurance market values	Increase since 1952	Changnon (2009b)
Windstorm	Europe	1970–2008	Wealth, population	No trend	Barredo (2010)
Thunderstorm	United States	1949–98	Insurance coverage, population	Increase since 1974	Changnon (2001)
Tornado	United States	1890–1999	Wealth	No trend	Brooks and Doswell (2001)
Tornado	United States	1900–2000	None	No trend	Boruff et al. (2003)



Far Rockaway, New York (in the wake of Superstorm Sandy, October 2012)



TŌHOKU EARTHQUAKE AND TSUNAMI 東北地方太平洋沖地震

MARCH 2011



A magnitude 9.0 undersea megathrust earthquake struck off the coast of Japan, 154 kilometers from the Fukushima Daiichi Nuclear Power Plant. The plant was automatically shut down following the earthquake and backup generators started the cooling process. 41 minutes later, powerful tsunami waves reached the plant at heights of up to 14 meters. A seawall was designed to protect the plant from a worst-case tsunami of 6 meters. The waves inundated the Fukushima facility, disabling the backup generators. What is your view of the risk within a resilient risk management framework?

[READ MORE>>](#)

= 2 METERS



SECOND EDITION

WITH A NEW SECTION: "ON ROBUSTNESS & FRAGILITY"

NEW YORK TIMES BESTSELLER
THE
BLACK SWAN

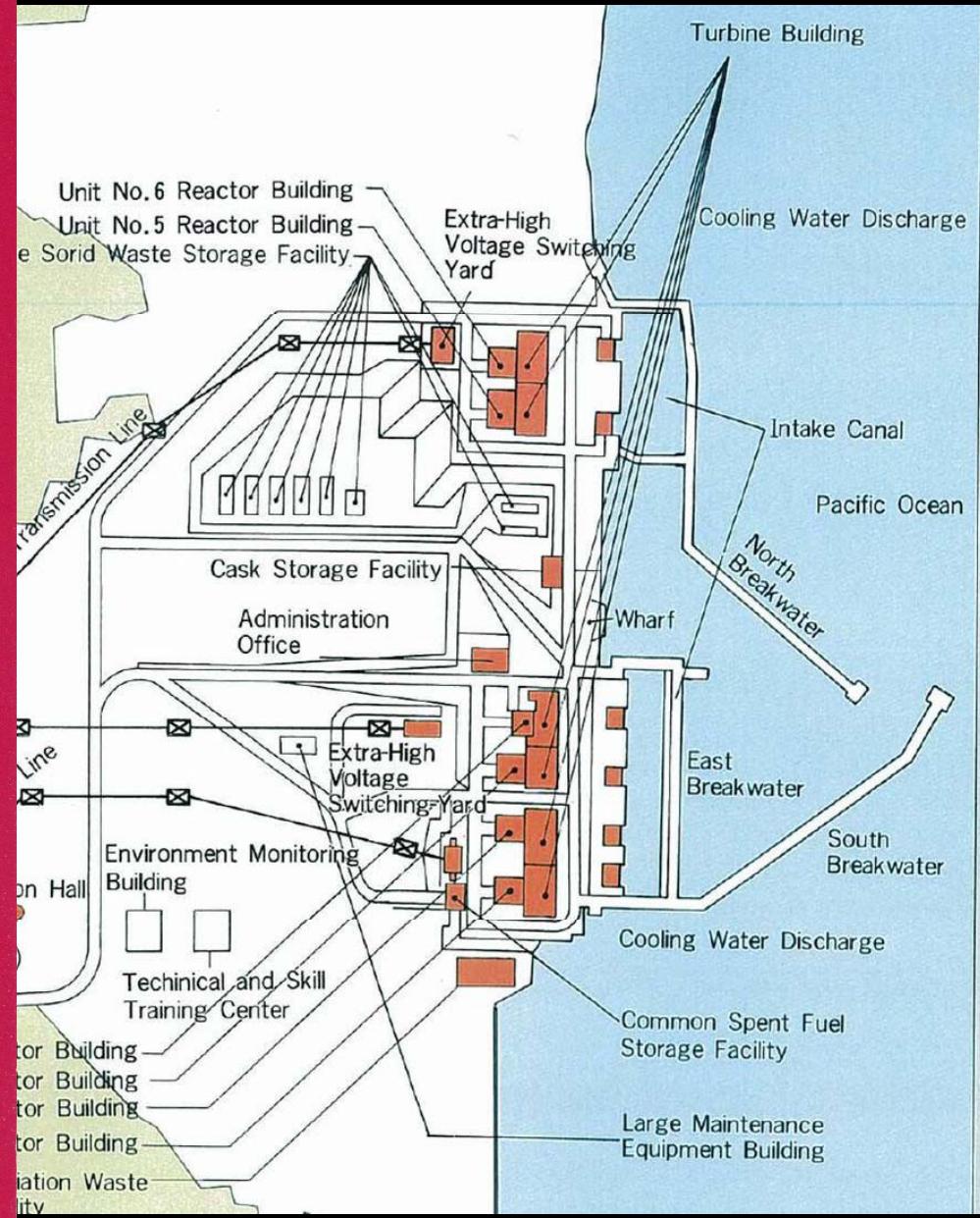


The Impact of the
HIGHLY IMPROBABLE

"The most prophetic voice of all."

—GQ

Nassim Nicholas Taleb



NATURAL HAZARDS OF CONCERN IN EARTH 270 (v. 2018)



HAZARD GROUP	HAZARD TYPE
GEOHAZARDS	EARTHQUAKES TSUNAMI VOLCANOES LANDSLIDES SURFACE COLLAPSE
ATMOSPHERIC HAZARDS	HURRICANES (TROPICAL CYCLONES, TYPHOONS) TORNADOES DROUGHT HEAT WAVE WILDFIRE
HYDROLOGIC HAZARDS	GLACIER HAZARDS FLOODS (RIVER AND COASTAL)
ULTIMATE HAZARDS	ASTEROID IMPACTS (ARMAGEDDON) SOLAR FLARES (SPACE WEATHER)

MANY HAZARDS DEVELOP MULTIPLE THREATS (e.g. Earthquake-triggered landslides; Earthquake-triggered tsunami; Floods caused by Hurricane heavy rainfall; Storm surges caused by Hurricanes). SOME HAZARDS ARE HYBRID HAZARDS (e.g., tsunamis, landslides, flooding)