# REALIDADE INEGÁVEL: ALTERAÇÕES CLIMÁTICAS

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# Greenland, 2019

Huge chunks of ice break off the Jakobshavn glacier in Western Greenland.
PHOTOGRAPH BY JAMES BALOG, NAT GEO IMAGE COLLECTION

**Greenland is currently the biggest contributor to global sea level rise.**

Nearly 70% of Earth's population lives within 100 miles of a coast, and vast amounts of infrastructure— airports, ports, cities, roads, Internet cables—sits in zones that could flood within decades.

# Sea Level Rise

**The total elevation of the global mean sea level over the altimetry era (since January 1993) has reached 90 mm.** (Data source: European Space Agency Climate Change Initiative sea-level data until December 2015, extended by data from the Copernicus Marine Service as of January 2016 and near-real-time Jason-3 as of April 2019)

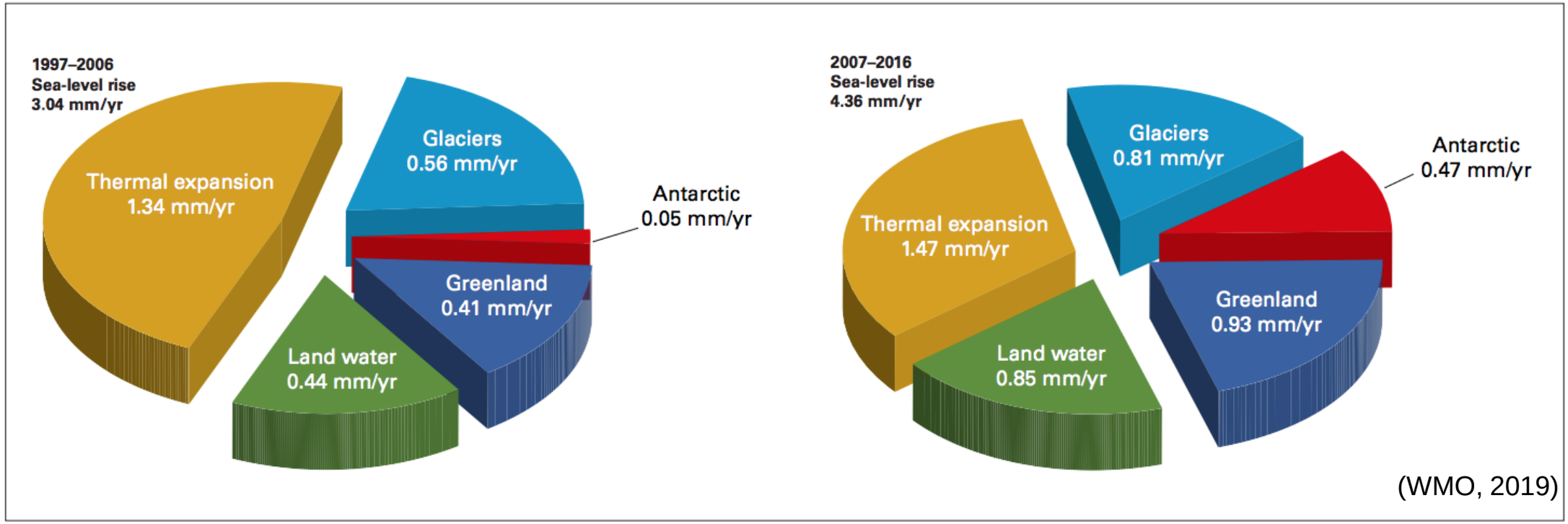


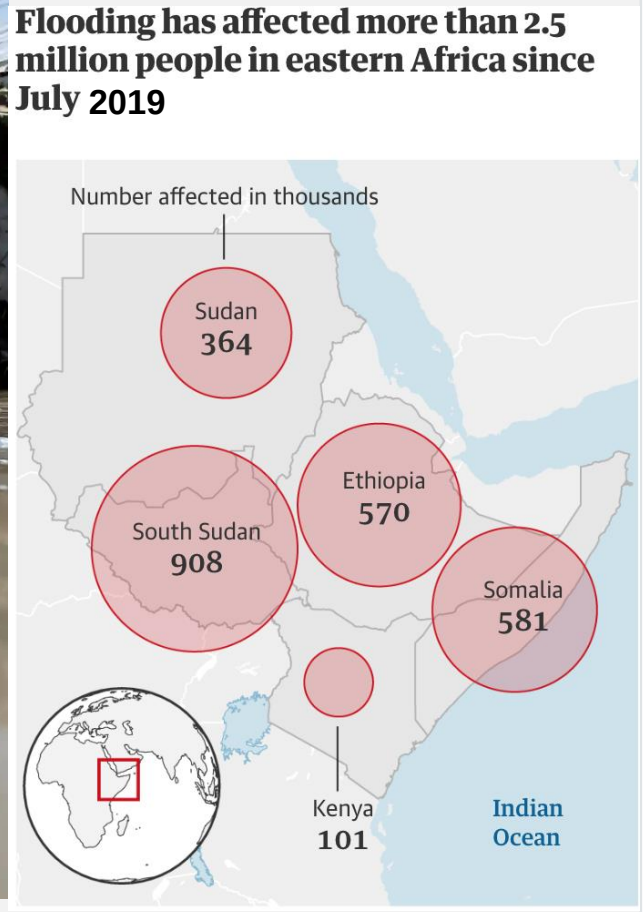

Figure 6. Contributions by different components to the rate of global mean sea-level rise during the periods 1997–2006 (left) and 2007–2016 (right).

Data source: European Space Agency Sea Level Budget Closure Project (v2 version). The observed rates of global mean sea-level rise are shown in the upper left corners. The difference between the sum of the various contributions and the observed values indicates errors in some of the components or contributions from components missing in the sea level budget computation.

# Washington, DC. July 8, 2019

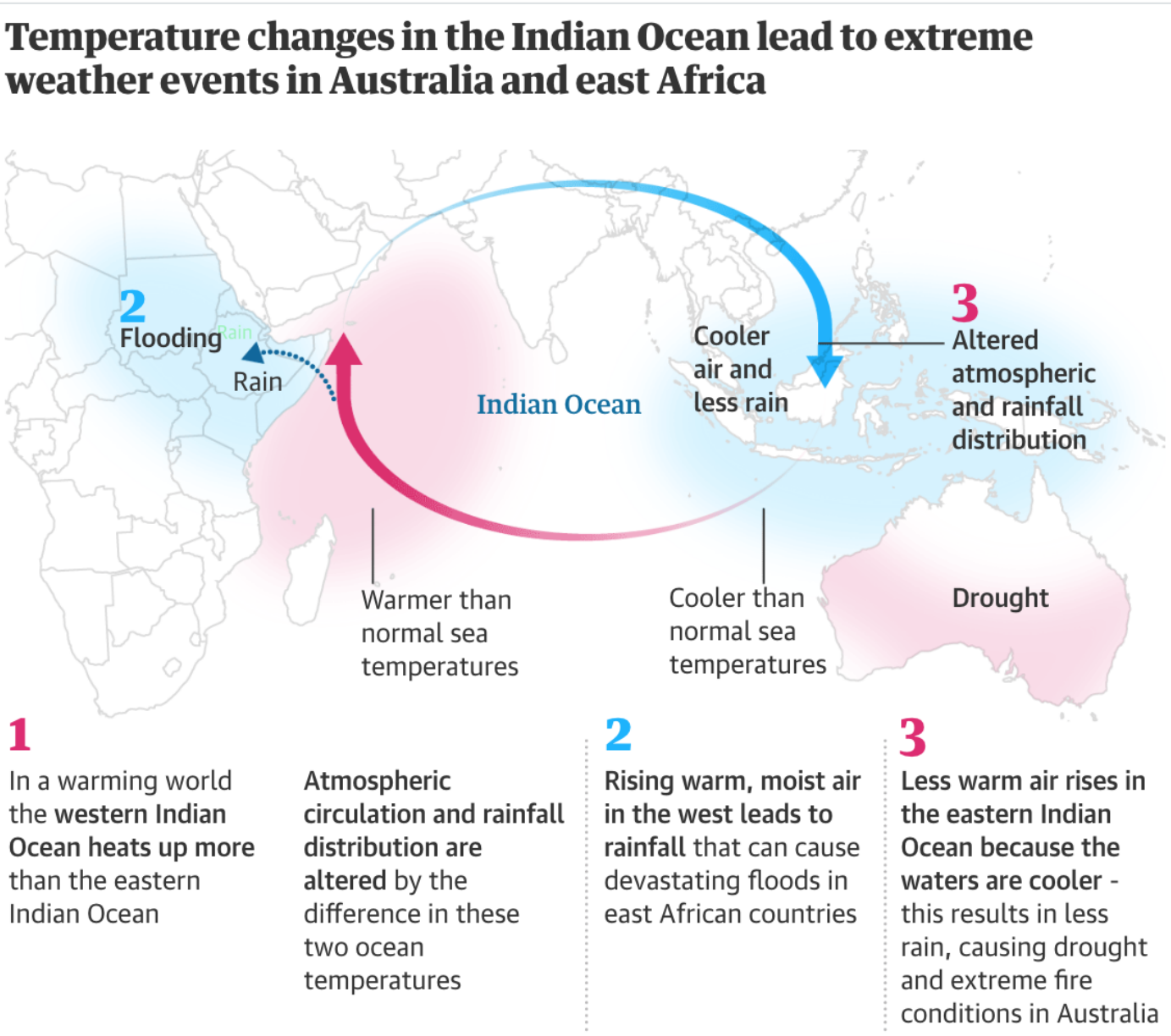
Severe flooding after 10 cm of rain fell within an hour —making it one of the area's **top 10 wettest July days** ever recorded.

# Somalia, November 2019




Communities already hit by war and drought face floods disaster as **370,000 displaced in camps**

# Indian Ocean dipole




"… research suggesting that **Indian Ocean dipole events have become more common with the warming in the last 50 years**, with climate models suggesting a **tendency for such events to become more frequent and becoming stronger**," Caroline Ummenhofer, scientist at Woods Hole Oceanographic Institution in Massachusetts (2019).

# Australia, November 2019

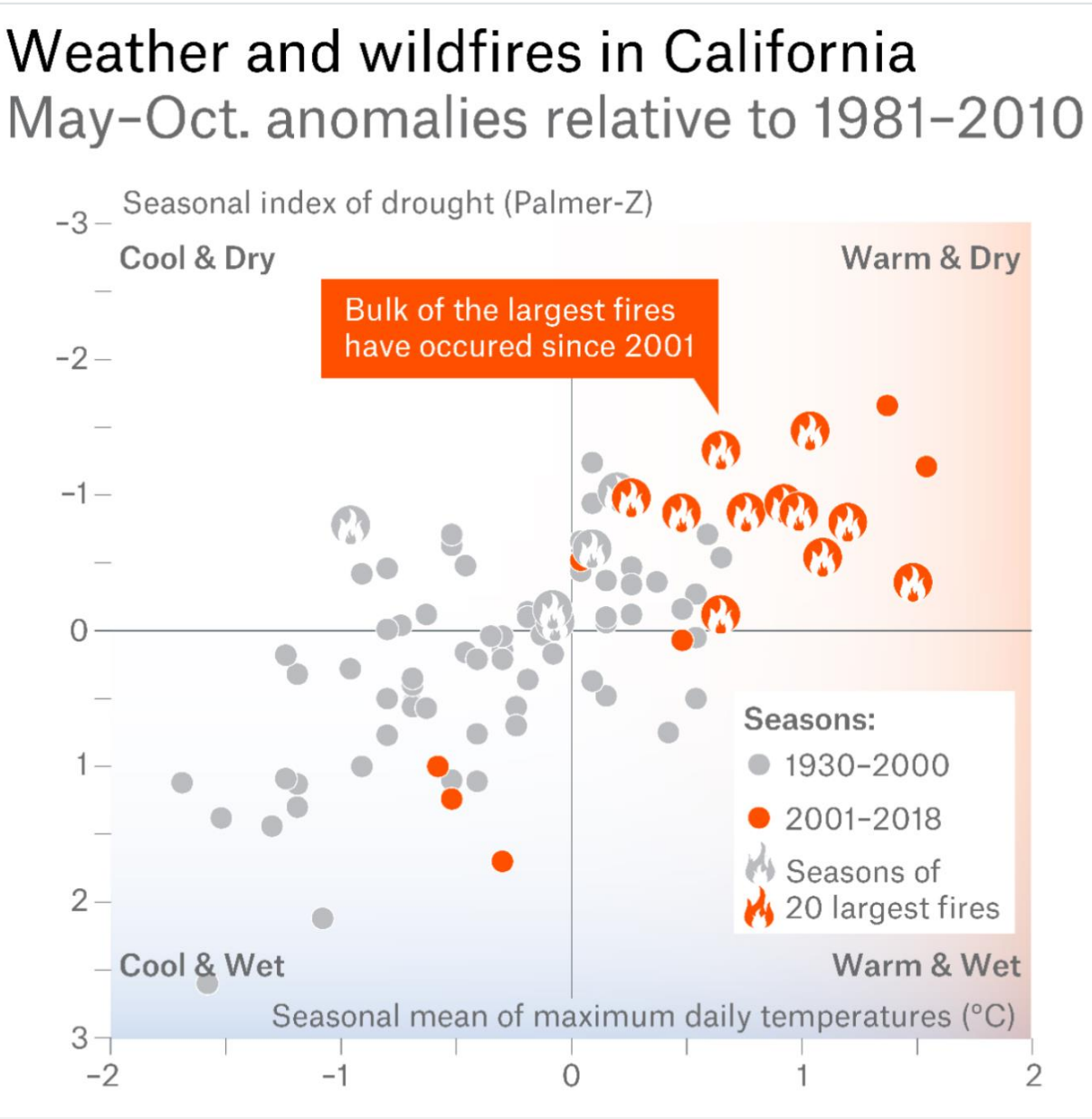
▲ Firefighters tackle the Gospers Mountain fire outside Sydney. Parts of eastern Australia have had record low rainfall in 2019, contributing to an unusually ferocious early bushfire season. Photograph: Dean Lewins/EPA

**Early bushfire season** across several states. At one point firefighters were battling **a fire front about 6,000km long**.

Driven by the amount of **dry fuel** available, which is **linked to the record-breaking drought**.

**Rainfall between Jan and Aug 2019 was the lowest on record** in some areas, with **record low soil moisture**. As temperatures and wind speeds increased but humidity remained low, conditions were primed for small fires to become major conflagrations.

# Wildfires




**16.5 US$ bn losses/one event**:
The "Camp Fire" in California was the costliest natural disaster in 2018 and the most destructive forest fire of all time - Insurers paid out US$ 12.5bn

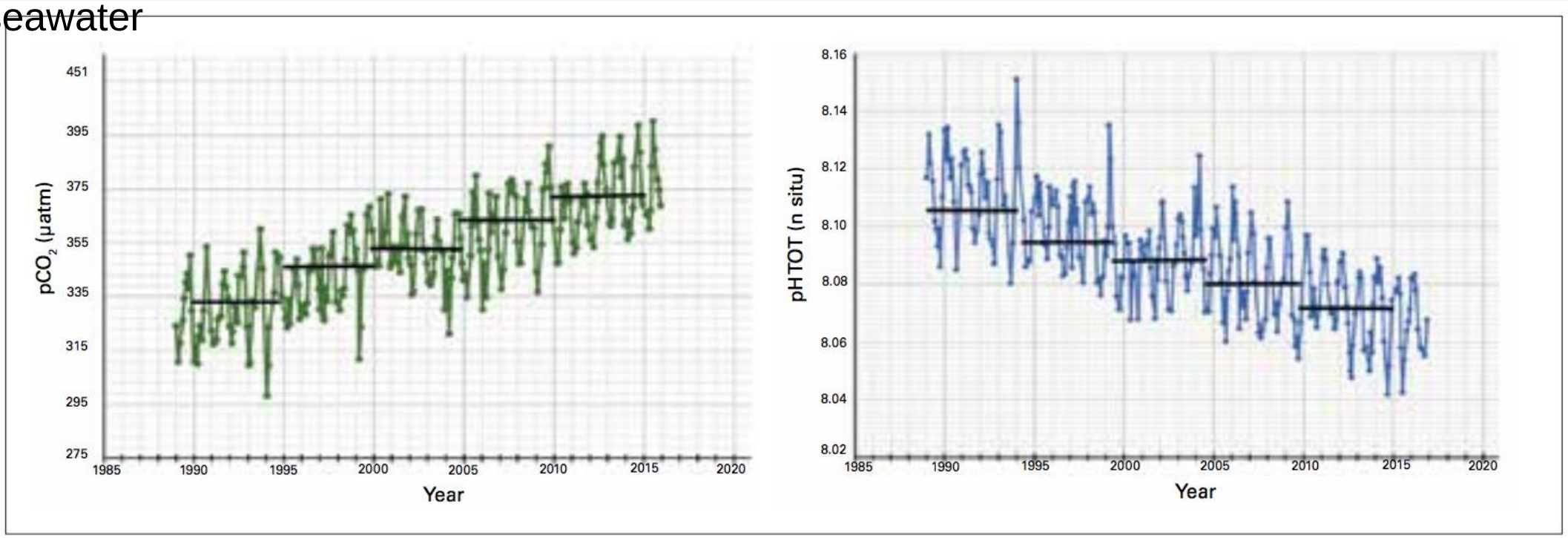
Data: National Centers for Environmental Information / NOAA / California Department of Forestry and Fire Protection.
Graphic: Munich Re

# Coral bleaching

**About 1/5 of the world's coral reefs have already been lost or severely damaged.** Another 35% could be lost within 10-40 years - twice the pace of rainforest decline. Great Barrier Reef suffers 89% collapse in new coral, after the climate change-induced mass bleaching of 2016 and 2017.

# Ocean acidification

clear trend of decreasing average pH, caused by increased concentrations of $CO_2$ in seawater




(WMO, 2019)

**The ocean absorbs around 30% of the annual emissions of anthropogenic $CO_2$ to the atmosphere.** Absorbed $CO_2$ reacts with seawater and changes the acidity of the ocean.
The decrease in seawater pH is linked to shifts in other carbonate chemistry parameters, such as the saturation state of aragonite, the main form of calcium carbonate used for the formation of shells and skeletal material.
**Overall increase of 26% in acidity of oceans since the beginning of the industrial revolution**.

# Extreme weather events 2015-2019

*Flood*

**June–July 2016, China – flood**
At least 310 deaths and US$ 14 billion in economic losses were attributed to the floods across the season

**August 2017, India (north-east); Bangladesh; Nepal – flood**
At least 1 200 deaths were reported across the three countries, and 40 million people were affected in some way, with the spread of waterborne disease a significant factor

**August 2017, Sierra Leone – landslide**
Major destruction and an estimated 1 102 death

**June–July 2018, Japan – flood**
At least 245 deaths were reported, along with 6 767 houses destroyed.

**August 2018, India (Kerala) – flood**
1.4 million people were displaced and 5.4 million affected in some way. At least 223 deaths were reported, with economic losses estimated at US$ 4.3 billion

(WMO, 2019)

# Extreme weather events 2015-2019

*Heatwave*

**May and June 2015, India; Pakistan – heatwave**
2 248 deaths were reported due to the heat in India, and 1 229 in Pakistan

**Summer 2015/16, South Africa – heatwave**
There were numerous heatwaves in South Africa during the 2015/16 summer. Pretoria broke its previous record high temperature on three separate occasions

**Summer 2015 and 2018, Europe – heatwaves**
In France 3 275 and 1 500 excess deaths were attributed to the heat in 2015 and 2018, respectively

**Summer 2018–19, Australia – heatwave**
Hottest summer on record for Australia. There were also significant heatwaves in the 2016/17 and 2017/18 summers, especially in New South Wales

**June–July 2019, Europe – heatwave**
Two major long and extended heatwaves recorded in Europe in June–July 2019 with national records broken in many countries. In southern France a national record for any month of 46.0 °C was observed. The heat dome spread northwards through Scandinavia and towards Greenland where it accelerated the already above-average rate of ice melt

(WMO, 2019)

# Extreme weather events 2015-2019

*Drought*

**2015/16, Northwest South America; Central America; Caribbean – drought**
Drought associated with the 2015/16 El Niño affected many parts of northern South America, Central America and the Caribbean. Rainfall averaged across the Amazon basin in Brazil in 2016 was the lowest on record

**2015–2018, Africa – drought**
Severely depleted water supply storages occurred in Cape Province of South Africa, leading to Cape Town to potentially run out of water during 2018. This followed severe drought in many parts of southern Africa in 2015 and 2016, following poor rainy seasons in 2014–2015 and 2015–2016. In east Africa in 2016–2017, 6.7 million people in Somalia were experiencing food insecurity at the drought's peak, decreasing to 5.4 million by the end of 2017 as conditions eased

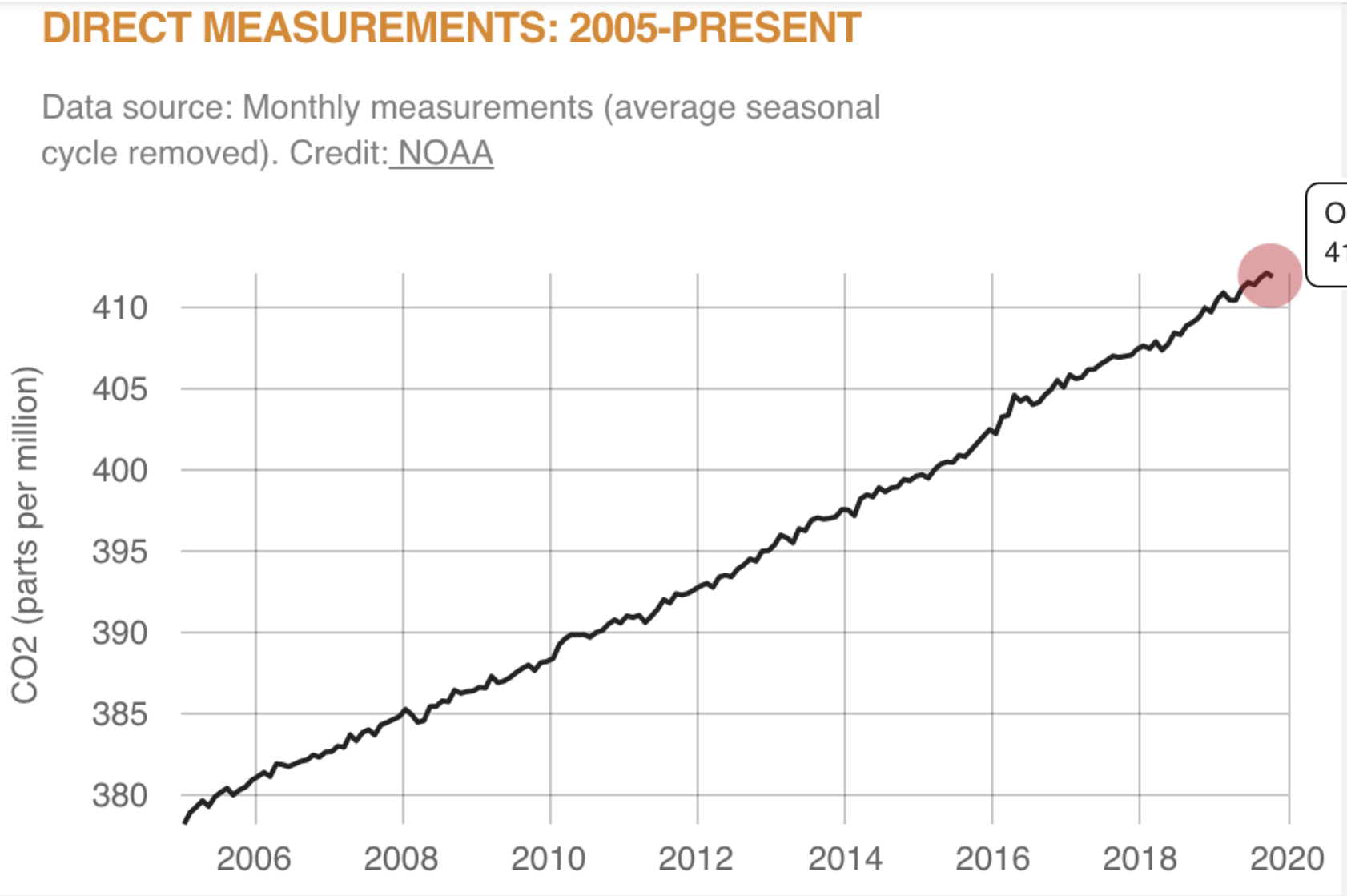
**2017–2019, Australia (mostly eastern) – drought**
There were significant agricultural losses, as well as large-scale fish deaths after the Darling River ceased to flow

**October 2017 – March 2018, northern Argentina; Uruguay – drought**
There were heavy losses to summer crops with agricultural losses estimated at US$ 5.9 billion

**2018, Europe (northern and central) – drought**
There were heavy agricultural losses across numerous countries, and low flows in the Rhine severely disrupted river transport, causing significant economic losses

(WMO, 2019)

# $CO_2$ in the atmosphere




Growth rate of concentration of carbon dioxide in atmosphere:

1960-1970: less than **1 ppm/y**,

Currently: **2.43** ± 0.26 **ppm/y** (mean ± 2 std dev)

Industrial Revolution, 19th century: 280 ppm.

# Global Average Temperature

**Table 1.** Concentrations of $CO_2$ (ppm), $CH_4$ (parts per billion, ppb) and $N_2O$ (ppb), their growth rates ($CO_2$ in ppm/year, $CH_4$ and $N_2O$ in ppb/year) averaged over 2015–2017 and 2011–2015, the relative change in growth rates between 2011–2015 and 2015–2017, and the percentage of 2015–2017 concentration to pre-industrial concentration (before 1750). *Source: WMO Global Atmosphere Watch*

| | *Concentration* | | | *Growth rate* | | |
|---|---|---|---|---|---|---|
| | *2015-2017* | *2011-2015* | *2015-2017 % to pre-industrial* | *2015-2017* | *2011-2015* | *% change* |
| $CO_2$ | 403 | 395.5 | 145 | 2.6 | 2.2 | +18% |
| $CH_4$ | 1851.7 | 1826.4 | 256 | 8.7 | 7.2 | +21% |
| $N_2O$ | 329.1 | 326.2 | 122 | 0.87 | 0.73 | +19% |

(WMO, 2019)

## GLOBAL TEMPERATURE CONTINUES TO RISE: 2015–2019 IS THE WARMEST FIVE-YEAR PERIOD

- The **average global temperature**: **1.1 ± 0.1 °C above pre-industrial** (1850–1900) level, is therefore likely to be the warmest of any equivalent period on record. It is **0.20 ± 0.08 °C warmer than the average for 2011–2015**
- The global mean **land-surface temperature: 1.7 °C above pre-industrial** and 0.3 °C warmer than 2011– 2015.
- The global mean **sea-surface temperature: 0.8°C above pre-industrial** and 0.13 °C warmer than 2011–2015.

# Paris Agreement

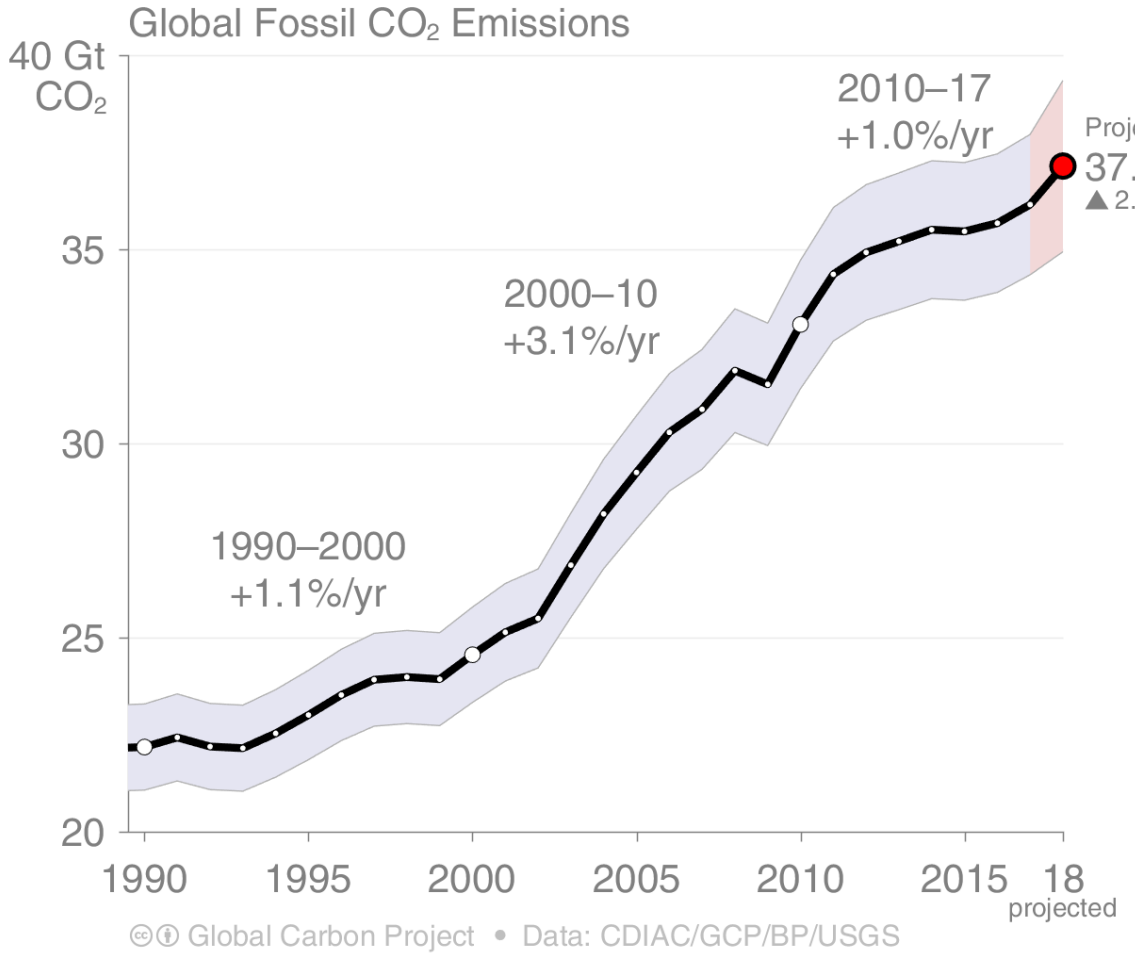

GOAL: avoid serious changes in the climate systems, **limit the increase of global temperature well bellow 2° C**

TARGET: achieve the balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of 21st century (Artº 4.1) – **CARBON NEUTRALITY**

# Global Fossil $CO_2$ Emissions

Global fossil $CO_2$ emissions: 36.2 ± 2 $GtCO_2$ in 2017, 63% over 1990

Projection for 2018: 37.1 ± 2 $GtCO_2$, 2.7% higher than 2017 (range 1.8% to 3.7%)

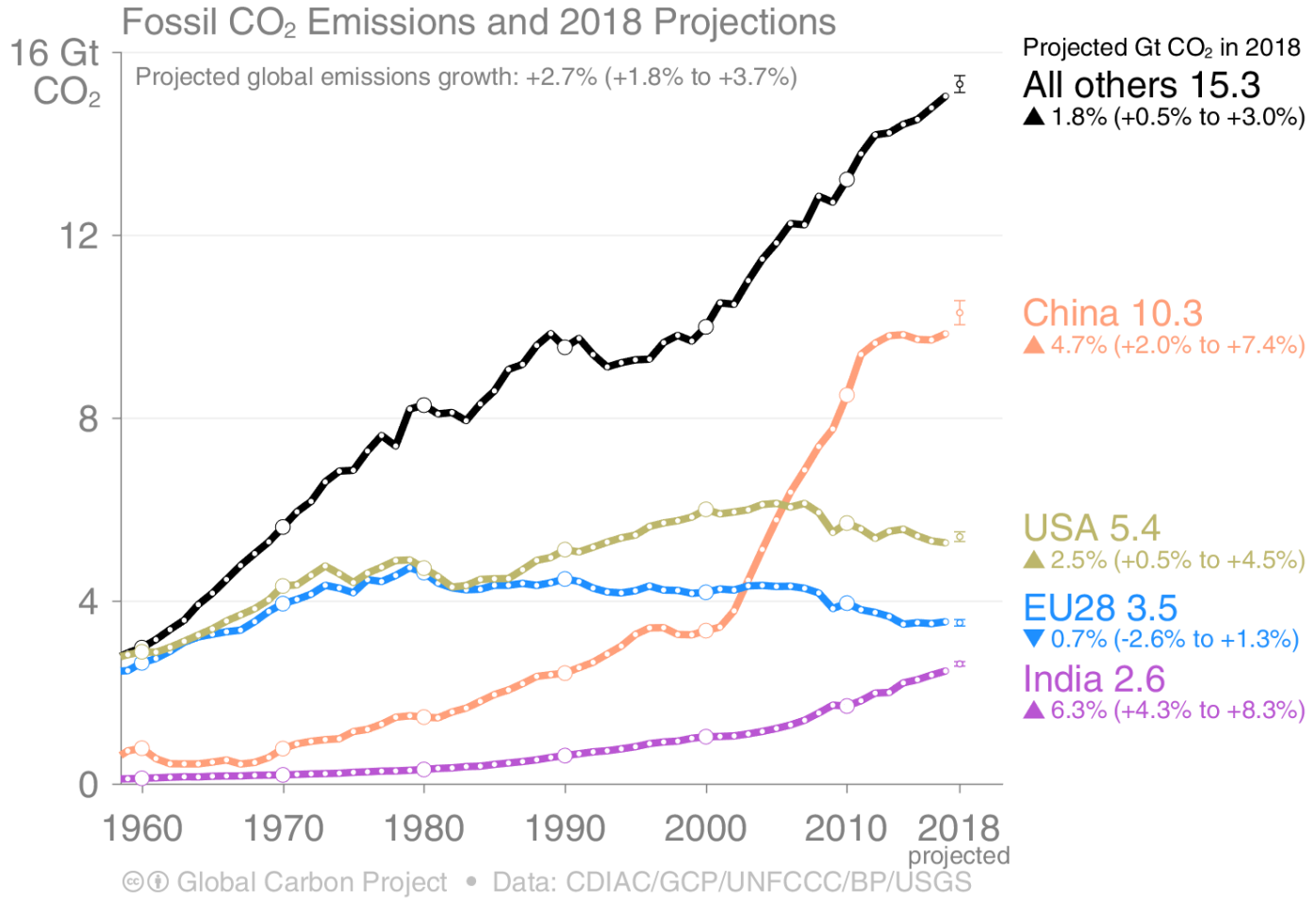



Uncertainty is ±5% for one standard deviation (IPCC "likely" range)

Estimates for 2015, 2016 and 2017 are preliminary; 2018 is a projection based on partial data.
Source: CDIAC; Le Quéré et al 2018; Global Carbon Budget 2018

# Emissions Projections for 2018

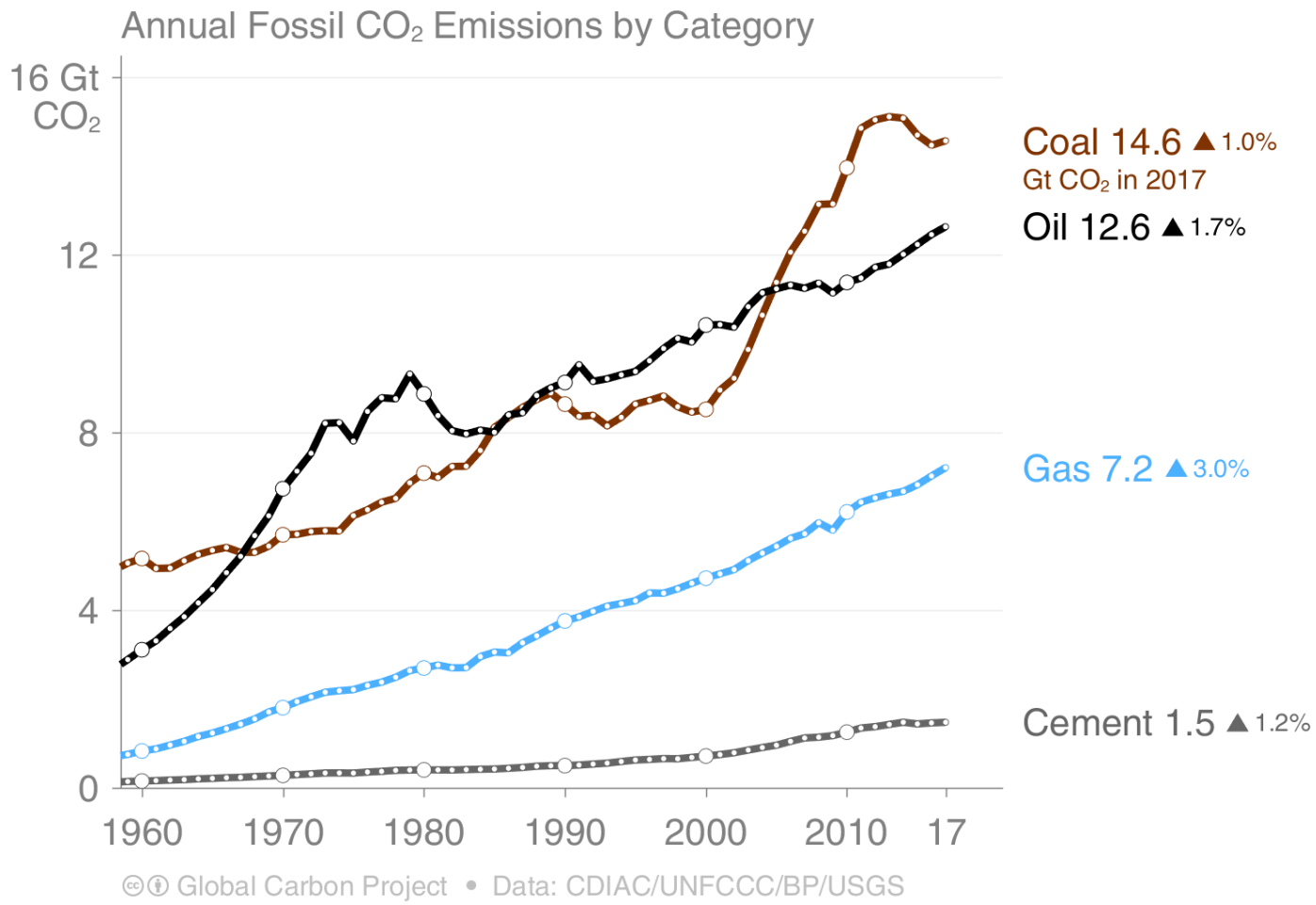
Global fossil $CO_2$ emissions are projected to rise by 2.7% in 2018 [range: +1.8% to +3.7%]
The global growth is driven by the underlying changes at the country level.




Source: CDIAC; Jackson et al 2018; Le Quéré et al 2018; Global Carbon Budget 2018

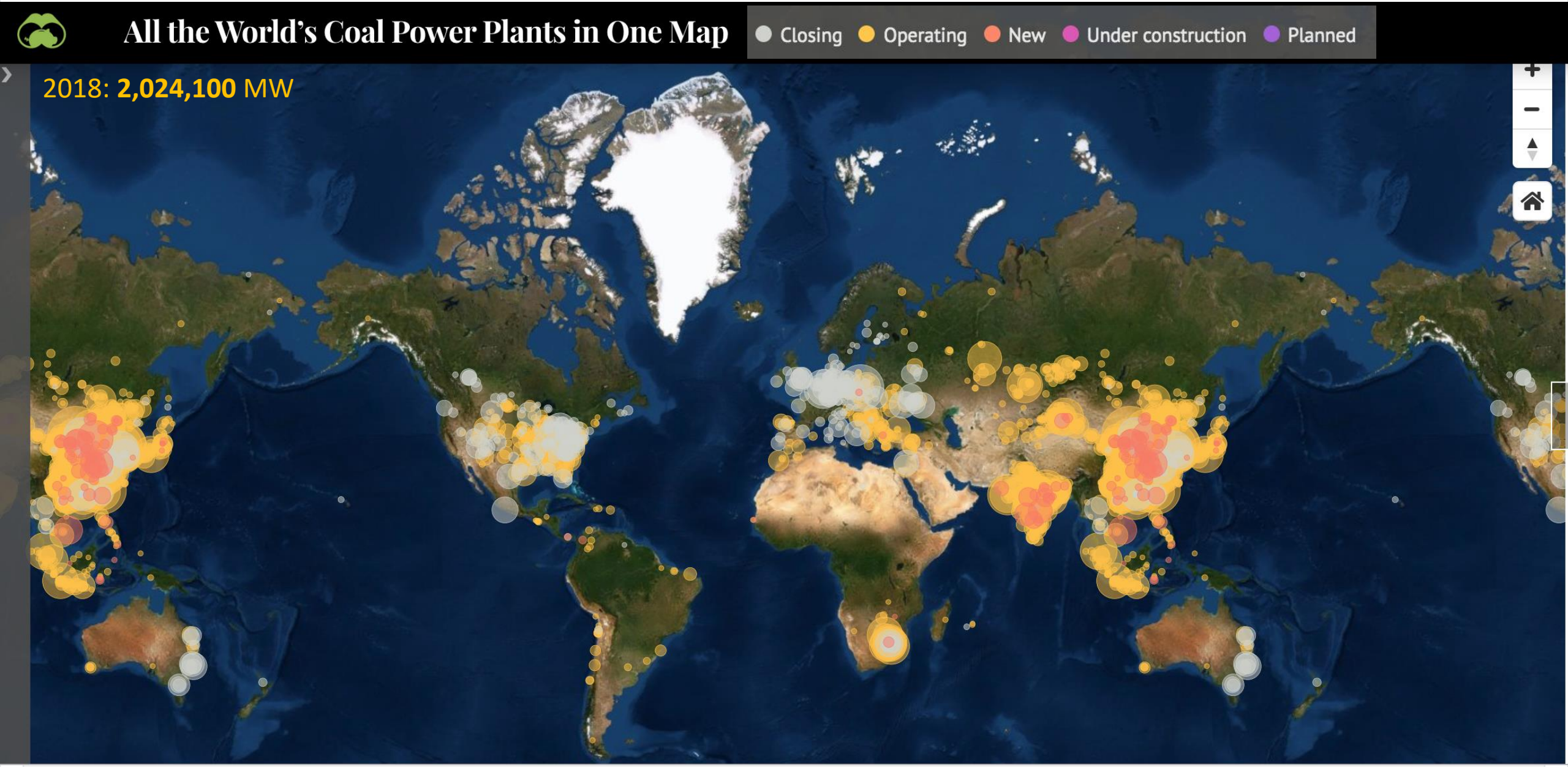
# Fossil $CO_2$ Emissions by source

Share of global fossil $CO_2$ emissions in 2017:
coal (40%), oil (35%), gas (20%), cement (4%), flaring (1%, not shown)



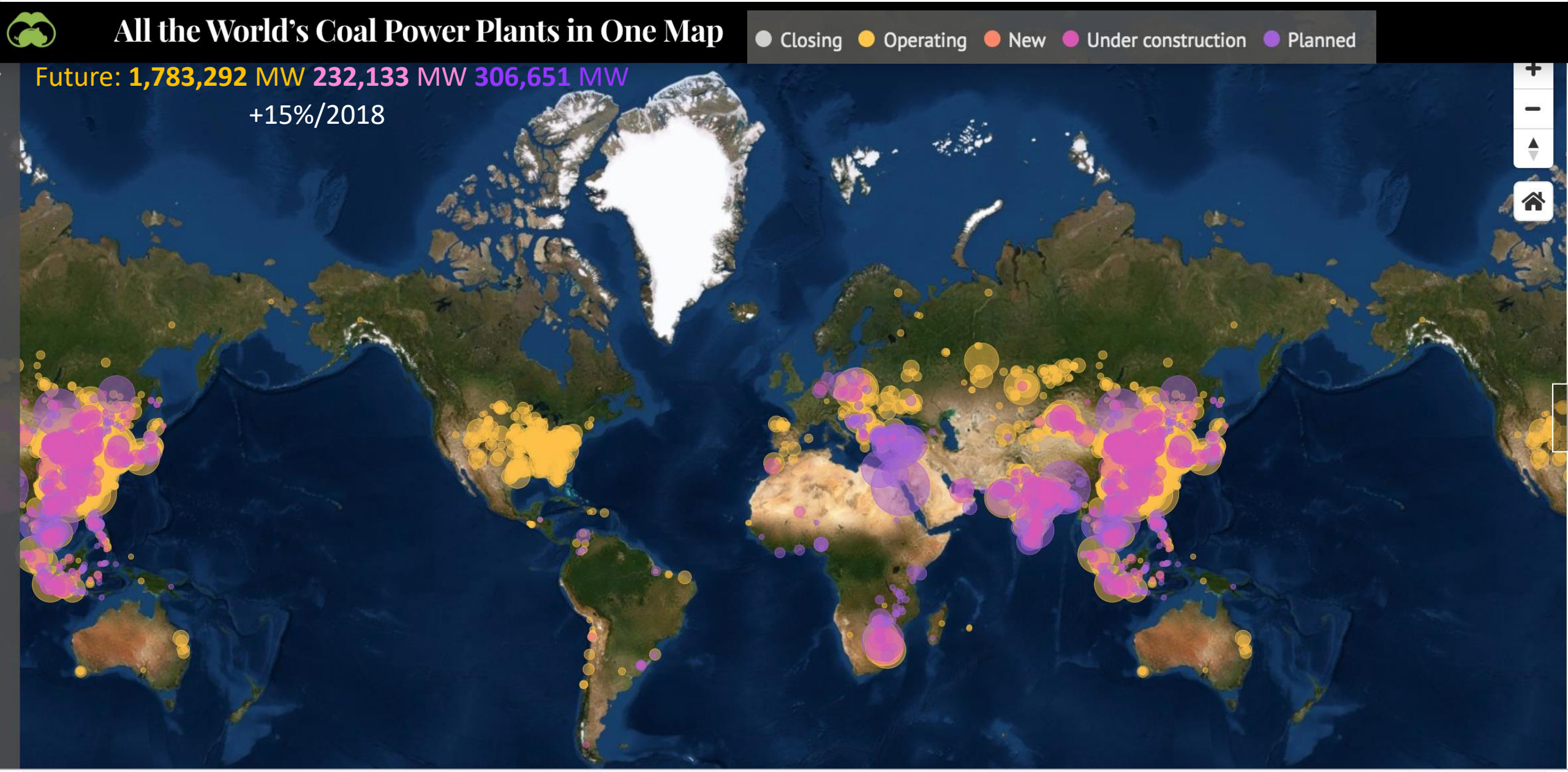

Source: CDIAC; Le Quéré et al 2018; Global Carbon Budget 2018

# Coal



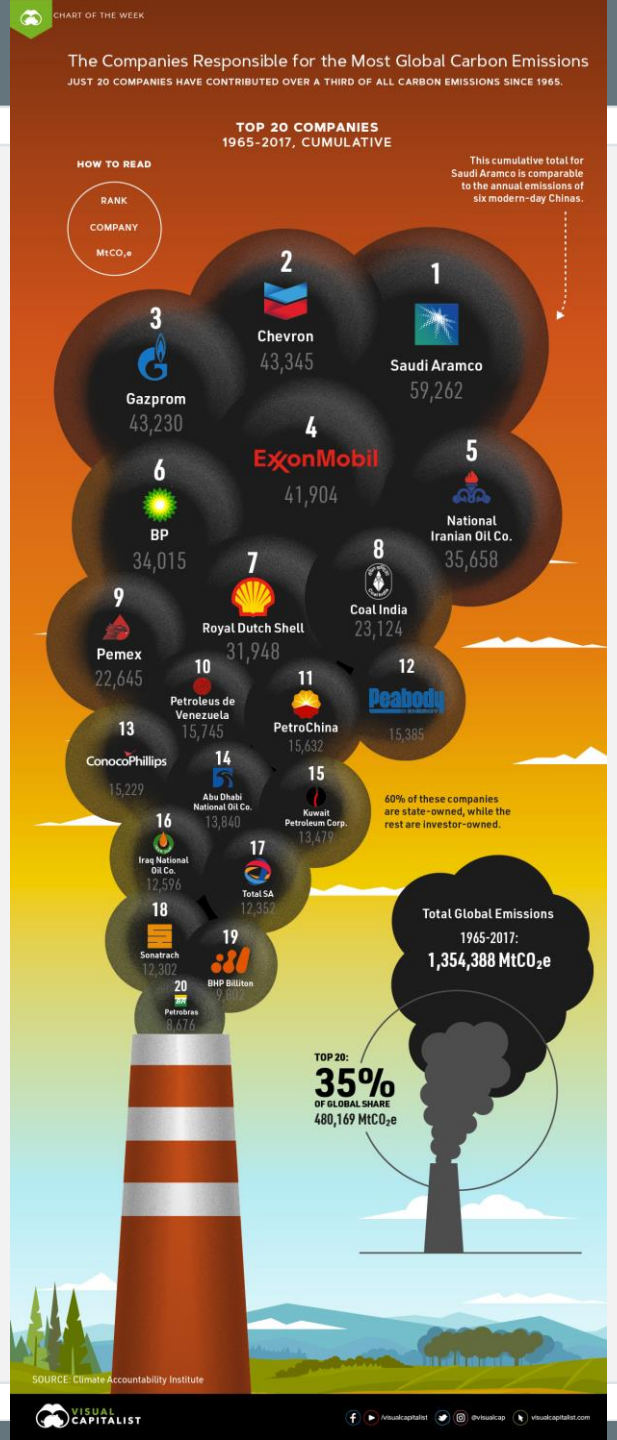

Source: visualcapitalist.com

# Coal




Source: visualcapitalist.com

Since 1965, it's estimated over **1.35 million metric tons** ($MtCO_2e$) of greenhouse gases have been released into the atmosphere—and over a third can be traced back to just 20 companies.




**Global Fossil Fuel Subsidies Remain Large** (IMF, May 2019)

2015: $4.7 trillion (6.3% of global GDP)
2017: $5.2 trillion (6.5% of GDP).

The largest subsidizers in 2015:

- China ($1.4 trillion)
- United States ($649 billion)
- Russia ($551 billion)
- European Union ($289 billion)
- India ($209 billion)

Efficient fossil fuel pricing in 2015 would have lowered global carbon emissions by 28% and fossil fuel air pollution deaths by 46%, and increased government revenue by 3.8% of GDP

# What future?

The Economist Intelligence Unit

THE COST OF INACTION: RECOGNISING THE VALUE AT RISK FROM CLIMATE CHANGE (2015)

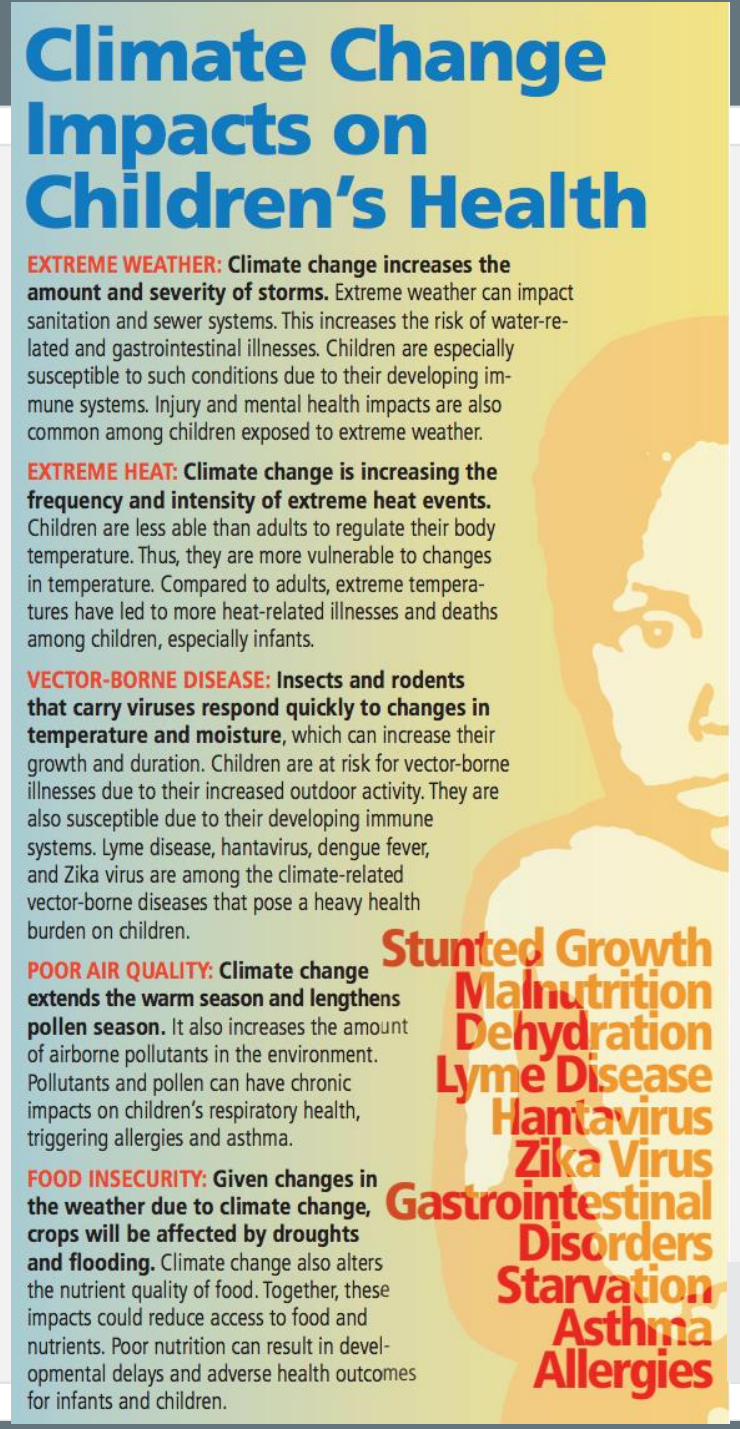
Table 1 - Value at risk

| VaR due to climate change | Mean (average) | 5°C | 6°C |
|---|---|---|---|
| Present value from the perspective of a private investor | US$4.2trn | US$7.2trn | US$13.8trn |
| Present value from the perspective of a government | US$13.9trn | US$18.4trn | US$43.0trn |

Table 2 - Percentage reduction in risk should warming be kept within 2°C

| VaR due to climate change | Mean (average) | 5°C | 6°C |
|---|---|---|---|
| The perspective of a private investor | 50% | 63% | 76% |
| The perspective of a government | 57% | 71% | 85% |

# What future?




It was early August, and Logan attended his junior high school basketball practice. The intensity of the drills was matched only by the temperature of over 100°F (37,8ºC) inside the unairconditioned gym.

As practice progressed, Logan became dizzy and eventually collapsed. He suffered heat stroke and developed life-threatening complications. After a week in the hospital, Logan returned home.

Heat stroke is becoming more common among young athletes. **Heat illness is now the top cause of death and disability in high school athletes (USA).**

Jonesboro, Arkansas

(Logan's story: http://ksi.uconn.edu/personal-stories/logan-johnsons-story/)

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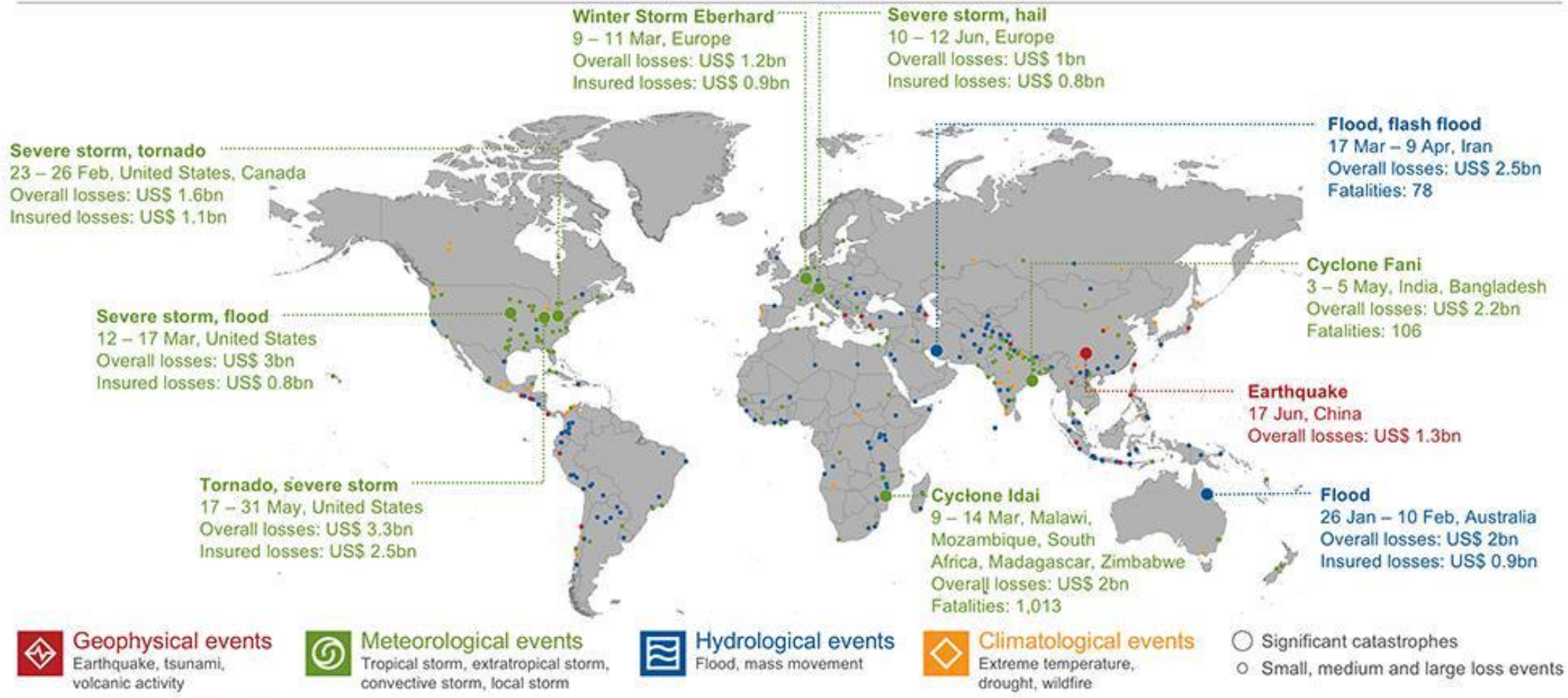
NatCatSERVICE

# Relevant loss events worldwide January – June 2019

## Geographical overview

Munich RE




Source: Munich Re, NatCatSERVICE, 2019