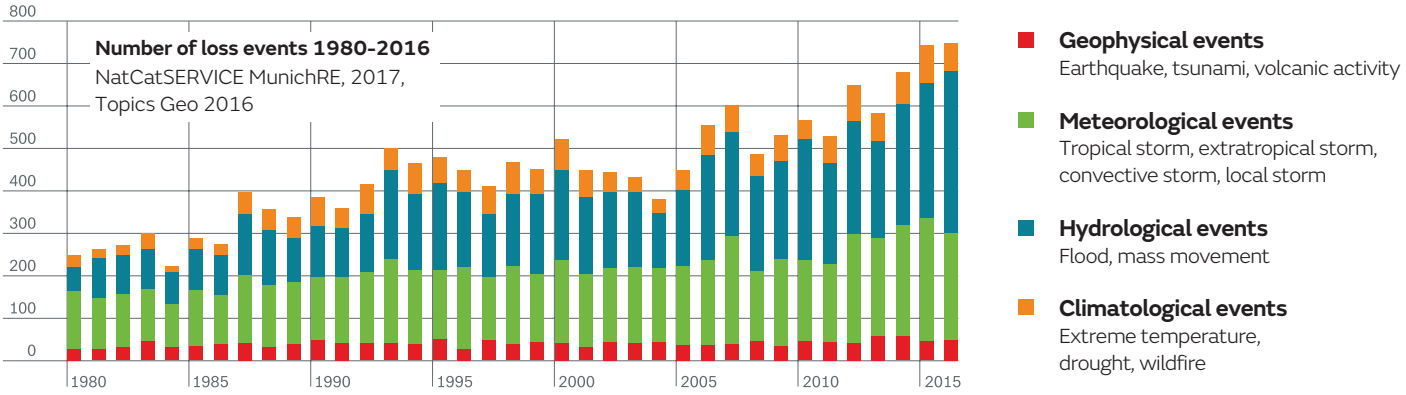
Met Office

Observed changes in extremes

Huge cost of weather and climate extremes

Extreme weather and climate events can inflict huge human and financial costs on society. In 2016, overall worldwide losses from meteorological, hydrological or climatological disasters amounted to US$ 127bn, with 2016 being the fifth-costliest year for insured losses since 1980[1]. In the USA alone, there have already been 15 events with damages of at least US$ 1bn in 2017*, resulting in the deaths of 282 people. Loss estimates for hurricanes Maria, Irma and Harvey range from US$ 15bn to US$ 55bn each[2].

Are extremes becoming more frequent?



The number of extreme events which cause loss in any given year is affected by both changing human factors, such as growing population and increasing infrastructure, as well as natural variability of the climate.

In addition, there is evidence that the frequency of some types of extremes have changed – particularly warm temperature extremes and heavy rainfall events. There has also been a decrease in cold extremes. There is some evidence of a human contribution to changes in tropical and extratropical storm activity. It is more likely than not that further changes will occur in the future in response to human influences.

What is the cause of changes in extremes?

The Intergovernmental Panel on Climate Change Fifth Assessment Report (2014) says changes in many extreme weather and climate events have been observed since about 1950. There is evidence of a human contribution to changes in temperature extremes, heavy rainfall events, and an increase in extreme high sea levels in a number of regions.

Attribution science is adding to this evidence all the time. This rapidly developing area of science looks to understand whether human influence on the climate contributed to extreme events by making them more likely or more severe.

Scientists have published more than 150 such studies looking at weather events around the world.

EXTREME HEAT

Almost all studies on extreme heat events indicate human influence.

DROUGHT

About half the studies on drought show significant human influence.

EXTREME RAINFALL

A smaller but increasing number of studies on extreme rainfall detect a human signal.

TROPICAL STORMS AND HURRICANES

The picture here is complex. There is strong evidence that increasing sea temperatures increase the intensity of tropical storms. Rising sea levels also increase the risk of coastal flooding. However, there may be an overall decrease in the global total number of tropical cyclones.

*as of October 2017 [1]NatCatSERVICE MunichRE, 2017, Topics Geo 2016 – Natural catastrophes 2016 – Analyses, assessments, positions
[2]NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2017). https://www.ncdc.noaa.gov/billions

Case studies

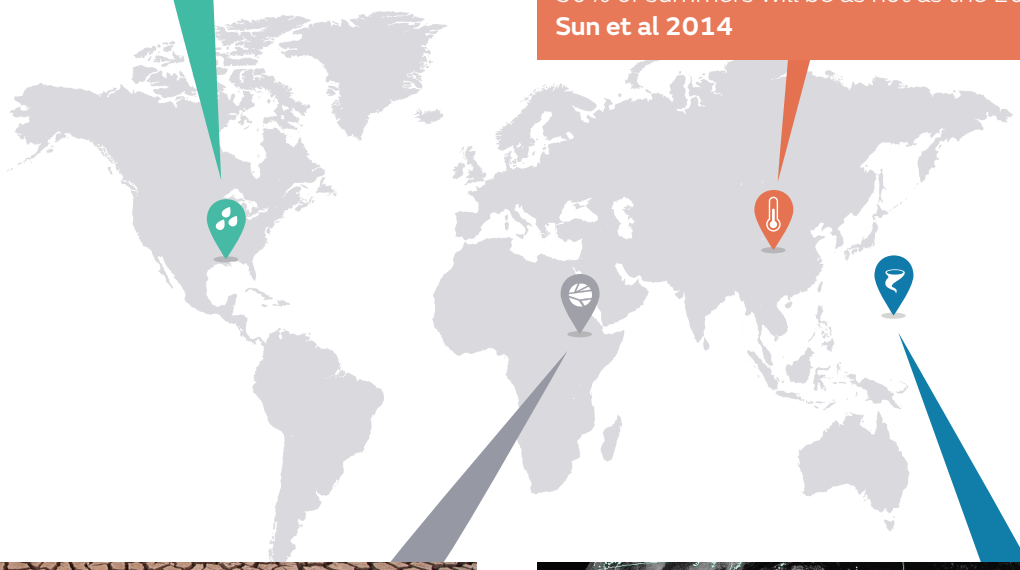
Climate change is altering the risk of some extreme events. Although a human influence can't be detected in all events, below are four examples of events with a clear human-induced change.

2016 Flooding in Louisiana, USA

A storm system over the US Gulf Coast region resulted in a three-day period of intense rainfall. An attribution study suggests the probability of an event, as in south Louisiana 2016, has increased by at least 40% due to human influence. What was an event with a return period of 100 years in the 20th century should now be expected to occur, on average, once every 70 years or less. This trend is expected to continue over the 21st century. **Van der Wiel et al 2017**

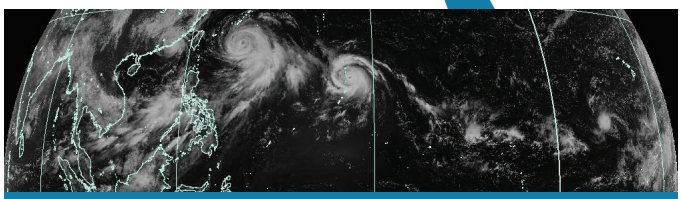
2013 Summer heatwave, China

Summer 2013 was the hottest on record in Eastern China. Economic losses associated with the accompanying drought have been estimated at ¥59 bn (£6.9 bn). Research indicates the increasing frequency of extreme summer heat in Eastern China is primarily attributable to human greenhouse gas emissions. Heat of this magnitude is estimated to be about a 1-in-30-year event averaged over the 1955–2013 period, but this became about a 1-in-5 year event in the context of 2013 alone. By 2024 it is projected that at least 50% of summers will be as hot as the 2013 summer. **Sun et al 2014**



2014 Drought, East-Africa

Human caused warming contributed to the 2014 East African drought by increasing temperatures and increasing the temperature difference between western and central Pacific sea surface temperature, reducing rainfall, evapotranspirationand soil moisture. **Funk et al 2015**



2015 Cyclone activity, Western North Pacific

2015 saw extremely high levels of tropical cyclone activity in the Western North Pacific. This was found to be mainly caused by sea surface warming in the eastern and central Pacific, with human influence largely increasing the odds of this event. **Zhang et al 2016**

Funk, C., Shukla, S., Hoell, A. and Livneh, B., 2015. Assessing the contributions of East African and west Pacific warming to the 2014 boreal spring East African drought. Bulletin of the American Meteorological Society, 96(12), pp.S77-S82.

van der Wiel, K., Kapnick, S.B., van Oldenborgh, G.J., Whan, K., Philip, S., Vecchi, G.A., Singh, R.K., Arrighi, J. and Cullen, H., 2017. Rapid attribution of the August 2016 flood-inducing extreme precipitation in south Louisiana to climate change. Hydrology and Earth System Sciences, 21(2), p.897.

Sun, Y., Zhang, X., Zwiers, F.W., Song, L., Wan, H., Hu, T., Yin, H. and Ren, G., 2014. Rapid increase in the risk of extreme summer heat in Eastern China. Nature Climate Change, 4(12), p.1082.

Zhang, W., Vecchi, G.A., Murakami, H., Delworth, T.L., Paffendorf, K., Jia, L., Villarini, G., Gudgel, R., Zeng, F. and Yang, X., 2016. Influences of natural variability and anthropogenic forcing on the extreme 2015 accumulated cyclone energy in the Western North Pacific. Bulletin of the American Meteorological Society, 97(12), pp.S131-S135.