Record-breaking heavy rainfall events increased under global warming

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Heavy rainfall events setting ever new records have been increasing strikingly in the past thirty years. While before 1980, multi-decadal fluctuations in extreme rainfall events are explained by natural variability, a team of scientists of the Potsdam Institute for Climate Impact Research detected a clear upward trend in the past few decades towards more unprecedented daily rainfall events.

They find the worldwide increase to be consistent with rising global temperatures which are caused by greenhouse-gas emissions from burning fossil fuels. Short-term torrential rains can lead to high-impact floodings.

Extreme rainfall in Pakistan 2010 caused devastating flooding which killed hundreds and lead to a cholera outbreak. Other examples of record-breaking precipitation events in the period studied include rainstorms in Texas in the US, 2010, which caused dozens of flash-floods. And no less than three so-called 'once-in-a-century' flooding events in Germany all happened in just a couple of years, starting 1997. "In all of these places, the amount of rain pouring down in one day broke local records - and while each of these individual events has been caused by a number of different factors, we find a clear overall upward trend for these unprecedented hazards", says lead-author Jascha Lehmann.

The average increase is 12 percent globally - but 56 percent in South East Asia

An advanced statistical analysis of rainfall data from the years 1901 to 2010 derived from thousands of weather stations around the globe shows that over 1980-2010 there were 12 percent more of these events than expected in a stationary climate, a scenario without global warming. "Due to the upward trend, the worldwide increase of record-breaking daily rainfall events in the very last year of the studied period reaches even 26 percent", Lehmann adds.

The record-breaking anomaly has distinct patterns across Earth's continents with generally wet regions seeing an over-proportional increase and drier regions less so. In South East Asian countries the observed increase in record-breaking rainfall events is as high as 56 percent, in Europe 31 percent, in the central US 24 percent. In contrast, some regions experienced a significant decrease of record-breaking daily rainfall events. In the Mediterranean, the reduction is 27 percent, and in the Western US 21 percent. Both regions are at risk of severe droughts.

The link to climate change: warmer air can hold more water

While a statistical analysis of course cannot provide direct physical cause-effect relations, the scientists compared their findings to existing knowledge about how much more water can be stored in the atmosphere when temperatures rise, as given by the well-known Clausius-Clapeyron equation. This additional moisture can be released during short-term heavy rainfall events. The scientists show that the observed increase in unprecedented heavy rainfall events generally fits with this thermodynamically expected increase under global warming.

"One out of ten record-breaking rainfall events observed globally in the past thirty years can only be explained if the long-term warming is taken into account," says co-author Dim Coumou. "For the last year studied,

2010, it is even one event out of four, as the trend is upward".

Up to now, studies could add up to only medium confidence on how human induced greenhouse gases have contributed to changes in heavy precipitation events at the global and regional scale. The new analysis now helps to fill this research gap. Building on previous work on extreme precipitation, it is the first to study worldwide observational data of record-breaking daily rainfall events in this context.

"The recent upward trend is worrying"

The scientists took into account that the quality of historic weather data differs from one place to another. For instance, rainfall measurements from the Sahara desert are scarce which inhibits making any conclusions for this particular region. Other regions like Europe or the US are well covered with rainfall measurements stretching back over a century which enables the authors to draw conclusions with high levels of confidence

"The pronounced recent increase in record-breaking rainfall events is of course worrying," Coumou concludes. "Yet since it is consistent with human-caused global warming, it can also be curbed if greenhouse gas emissions from fossil fuels are substantially reduced."

More information: Lehmann, J., Coumou, D., Frieler, K. (2015): Increased record-breaking precipitation events under global warming. *Climatic Change* DOI: 10.1007/s10584-015-1434-y

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