More intense and more frequent floods and droughts in the future

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Severe floods, like the ones that pummelled Ruhr in Schwerte, North Rhine-Westphalia, in mid-July, are likely to become more frequent and more intense in the future. Credit: dpa

Extreme climate events like the ones experienced by many regions

around the world this summer are threatening to become more frequent and more devastating in the future. This applies to flooding as well as heatwaves and droughts, which in turn can lead to devastating forest fires. This is the conclusion reached by more than 200 scientists from 66 countries, including several researchers from the Max Planck Society, in the sixth assessment report of the Intergovernmental Panel of Climate Change (IPCC) on the scientific basis of climate change. The report focuses on the regional effects of global warming. According to the report, the Mediterranean region, among others, is likely to be particularly hard hit.

Forest fires are expected to become frequent in the northern Mediterranean. This is because droughts and heatwaves will become increasingly likely there in the future, as in many other areas of the world. Heatwaves, which until the end of the 19th century occurred only once every 50 years, are now almost five times more frequent. With an average warming of 1.5 degrees Celsius, they are likely to occur nearly nine times as often, and with a two-degree temperature rise, about 14 times as often. And they will also be two and 2.7 degrees hotter, respectively, on average than before 1900. Compared to that time, droughts are probably already 1.7 times more frequent today due to climate change, and with a warming of two degrees Celsius, their number will probably increase by 2.4 times. Droughts will also become drier.

The fact that heatwaves and droughts can be attributed to climate change is mainly due to advances in attribution research. It determines how much the probability of such extreme events increases with a certain rise in the average global temperature. According to this, heavy rainfall can be expected to increase in some regions of Europe in the future because the warmer air can absorb more moisture. For the same reason, the average amount of precipitation in higher latitudes will actually increase.

Irreversible for centuries: Ice loss in the Arctic and sea level rise

The statements on the regional increase of extreme events are a new focus of Working Group I in its part of the IPCC's Sixth Assessment Report. In it, scientists evaluated 14,000 studies on the scientific basis of climate change; scientists from the Max Planck Institutes for Meteorology in Hamburg and for Biogeochemistry in Jena were also involved. With the report, the working group is making available for the first time an interactive tool that can be used to determine the effects of climate change for individual regions.

Some consequences of climate change are reversible, but by no means all. For example, Greenland's glaciers will almost certainly continue to shrink this century, and the Arctic's summer ice will also continue to recede. This trend will be irreversible for decades, if not centuries. "We used to say we could still prevent the Arctic from becoming ice-free. Now, for the first time, we have a case where it is likely too late for that, and all we can do is limit the frequency of ice-free summers. To me, this is a sign of how far climate change has progressed," says Dirk Notz, a scientist at the Max Planck Institute for Meteorology and professor at the University of Hamburg, who contributed to the report as lead author of the chapter on ocean, cryosphere and sea level. The case for sea level rise is similar. Both a dramatic decline in Antarctic ice and a rise in sea level of two meters by the year 2100 and five meters by the year 2150 are still considered rather unlikely. However, both developments cannot be ruled out if CO_2 continues to be released unchecked and if the polar ice masses prove to be more unstable than previously thought and if as yet not clearly identified tipping points come into play.

The Atlantic Meridional Overturning Circulation, or Amoc, which includes the Gulf Stream, is unlikely to collapse abruptly before 2100.

However, it will most likely weaken. If it does come to a complete halt, however, it would very likely have serious effects on the climate in Europe, for example, where there would be less precipitation, and on the monsoons in Africa, Asia and the southern hemisphere.

CO_2 emissions must fall to net zero by 2050 to meet 1.5-degree target

In addition, the sub-report contains the clearest evidence yet that global warming of 1.1 degrees Celsius to date is due to human greenhouse gas emissions. But this also means that a reduction in CO_2 emissions can prevent warming above two degrees Celsius and perhaps even above 1.5 degrees Celsius, as envisaged by the Paris climate agreement. However, CO_2 emissions must be cut quickly and sharply. "The only chance we have of meeting one target or the other is if we quickly bring down emissions. That has to happen practically within this decade," says Jochem Marotzke, director at the Max Planck Institute for Meteorology and co-directing author of the chapter on the future of global climate. "We need, in order to reach the limit of 1.5 degrees of warming, to have reduced CO_2 emissions to net zero by mid-century." To have any chance of limiting warming to two degrees, CO_2 emissions would have to fall to net zero by about 2070. Net zero in this context means that while CO_2 can still be released, it must be removed from the atmosphere elsewhere, for example by reforestation.

However, an uncertainty remains with the 1.5-degree target: even if we succeed in halting the rise in CO_2 concentrations in the atmosphere over the next 30 years, he said, it is possible that the Earth will warm by more than 1.5 degrees Celsius on average globally. "However, we may stay slightly above that for a while, and then the temperature will go down again," says Jochem Marotzke.

Every 10th of a degree counts

Limiting greenhouse gas concentrations in the atmosphere is becoming increasingly difficult in this context: so far, the oceans and vegetation on land have absorbed a large proportion of the CO_2 released by humanity. But these carbon sinks, as they are called in technical jargon, are binding the greenhouse gas less and less efficiently over the course of the century. In other words, they absorb a smaller and smaller portion of the man-made CO_2.

The fact that our natural allies in the fight against climate change are losing strength is another reason to reduce greenhouse gas emissions quickly and significantly. And these efforts will be worthwhile even if the 1.5-degree target can no longer be achieved. Because the report of Working Group I in the Intergovernmental Panel on Climate Change also shows that every tenth of a degree by which warming is limited counts. Dirk Notz says: "We are not passively at the mercy of climate change, we are controlling it. We still have the choice in which scenario we will end up."

Provided by Max Planck Society

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