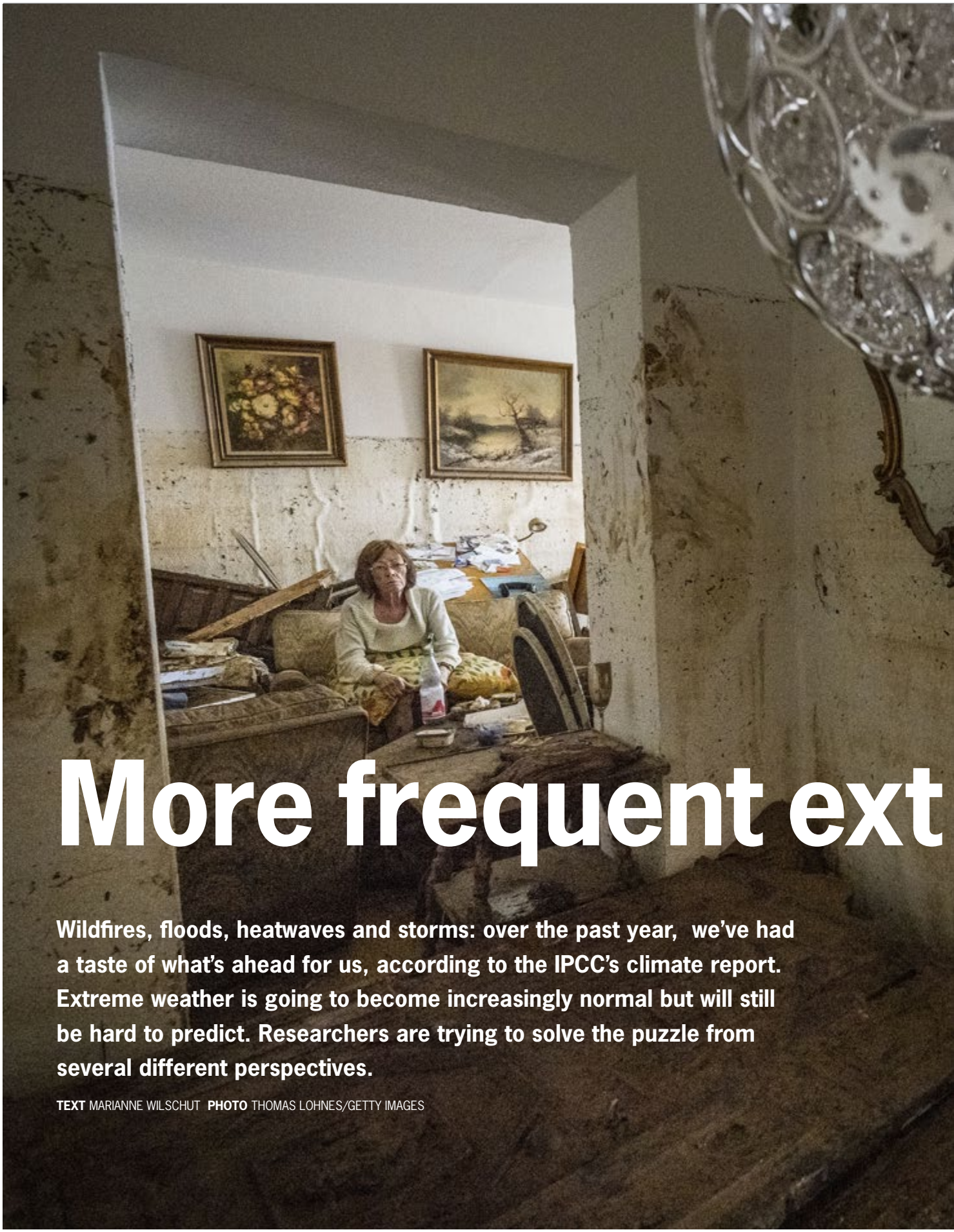


More frequent ext

Wildfires, floods, heatwaves and storms: over the past year, we've had a taste of what's ahead for us, according to the IPCC's climate report. Extreme weather is going to become increasingly normal but will still be hard to predict. Researchers are trying to solve the puzzle from several different perspectives.

TEXT MARIANNE WILSCHUT **PHOTO** THOMAS LOHNES/GETTY IMAGES

reme weather

It was like a science fiction film. Armed with planes, drones, meteorological towers, scintillometers, soil sensors, weather balloons with radio sondes and much more measuring equipment, more than 60 scientists invaded the Ebro basin in Catalonia, Spain, last summer. They were from prominent European and America institutes such as NASA, ESA, the Met Office, Meteo France and Wageningen University & Research, and they came to collect data that could help improve weather modelling, in the context of the LIASE project.

Improving weather models can improve the accuracy of predictions about how human activity affects extreme weather, explains Oscar Hartogensis, the project leader on behalf of the Wageningen Meteorology and Air Quality chair group. 'Current weather models have difficulty getting a handle on dry areas that are irrigated on a large scale, like this part of Catalonia, or California, northern Mexico and parts of Iran.'

A large-scale irrigation system was built in the Ebro basin in the 20th century, for cultivating apples, pears and crops like maize and alfalfa. 'In summer, that makes for a big contrast with the surrounding area that is not irrigated. The temperature difference can be five degrees. That causes wind circulations between the dry and the wet areas, which increase evaporation. These air currents also provide wildfires with extra oxygen, while the high levels of evaporation can cause extreme precipitation locally.' Hartogensis experienced this for himself in the Ebro basin. 'Towards the end of the LIASE field research, we witnessed a serious hailstorm. Hailstones the size of golf balls made short shrift of a vineyard on the edge of the area.'

VIBRATING AIR

To study the impact of evaporation on the local weather, the researchers looked at all the processes influencing the evaporation process, such as the transpiration of moisture from the stomata of the crops, the impact of clouds and sunlight on evaporation, and the impact of that in turn on air circulation patterns. 'We hope thus to get a better idea of the interaction between the atmosphere and the surface.'

Studies like this one in Catalonia are all pieces of the puzzle that scientists are putting together in the hope of being able to predict extreme weather more accurately. In August, the IPCC, the UN's climate panel, warned the world in a new report that without drastic measures to limit global warming to 1.5 degrees, we will face greater extremes of weather such as heavy rainfall, severe cyclones, more frequent and intense heatwaves, and extreme drought. An analysis by Munich Re, one of the world's biggest reinsurers, shows that the number of weather-related disasters has increased significantly since 1980. The biggest increases were in the number of floods, heatwaves and periods of extreme drought. The main regions affected by these events are North America, Asia and Australia/ Oceania.

> 'The Earth's climate is not changing in the same way everywhere'

It is highly likely that these extremes will become more normal, and yet it remains difficult to predict these weather phenomena. 'Weather systems just are complex and the climate on Earth is not changing in the same way everywhere,' says Hartogensis. 'In countries that have a rainy season, such as Bangladesh, it is clear that the monsoon has started behaving differently, and rainy seasons are either becoming wetter or less wet. Which variant occurs is hard to predict. In north-western Europe, the seasons are largely governed by large-scale weather complexes. Those circulation patterns get disturbed more often nowadays. The jet stream – the strong wind blowing high in the atmosphere – gets blocked, and as a consequence we get longer periods of heavier rain or longer periods of hot, dry weather. We could see that during recent summers.'

LIVING WITH FIRE

Because of those longer periods of drought and higher temperatures, countries in north-western Europe and even the northernmost parts of Scandinavia, Russia, Canada and Alaska, will be affected by wildfires more often. 'Due to climate change, the Netherlands must not just learn to live with water, but also with fire,' says the Wageningen wildfire expert Cathelijne Stoof. In 2020 alone, there were 724 wildfires in the Netherlands – 177 more than the previous year. Unlike the battle with water, awareness of wildfires and preparation for dealing with them are in their infancy in the Netherlands. 'The Dutch fire brigade is more specialized in dealing with fires in buildings, whereas the dynamics of wildfires are quite different. We are seeing too that the changing climate is making wildfires so intense that they can change the weather in their turn. Thunderclouds can build up because of the tremendous heat, for example. Due to the electric storms and the wind from such weather complexes, the fire can spread faster in different directions. This makes it less safe to fight the fire. In 2017, 64 people died in Portugal because of this, in some cases because people in their cars got trapped by the fire when trying to escape.'

PHOTO SHUTTERSTOCK

PHOTO WUR

PHOTO IRTA

In the Ebro basin in Catalonia, Spain, scientists from European and American institutes are collecting data to help improve weather models of dry areas that are irrigated on a large scale.

Stoof does research on wildfires in countries including Portugal and Spain, and founded Pyrolife, a programme in which 15 European PhD researchers are being trained as interdisciplinary experts on wildfire research. She proposes that when fire breaks out, a meteorologist should analyse all the weather data from a distance, so that the fire brigade can be warned in time of changes in wind direction or humidity. She also feels that more money should be invested in fire prevention worldwide. 'We need a more inclusive approach to fire. The firefighting world is incredibly masculine with big fire engines and helicopters that turn out with a lot of fanfare, but firefighting alone isn't going to cut it anymore. You can achieve more with an integral, preventive approach in collaboration with nature managers, decisionmakers, the recreation sector, education and local communities. Fires happen not just because of extreme weather, but also because of inappropriate landscape management. By removing undergrowth in strategic parts of the forest and creating open strips, you can keep fires controllable. And what we call mosaic landscapes, which have varied vegetation, are less prone to wildfires. If more attention had been paid to fireproof landscape management in California, the fires there wouldn't have got so out of control.'

ECONOMIC IMPACT

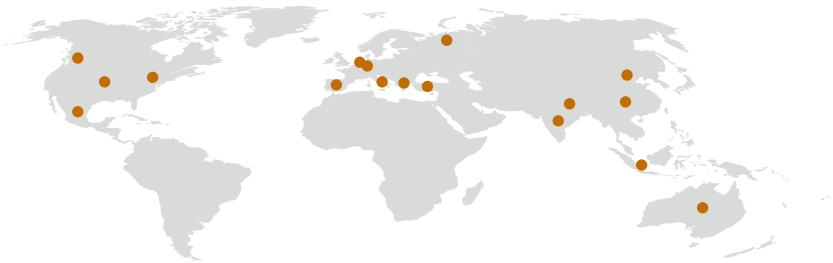
As well as wildfires, the Netherlands is also facing more frequent and serious flooding, dry weather, and storms. The potential effects of all this are visualized on Klimaateffectatlas.nl. On this website, you can see per region and even down to street level what the chances will be in 2050 of flooded streets, wildfires, tropical nights, and long droughts. Such extreme weather events can have a big social and economic impact. As an example, the physical damage alone caused by the flooding in South Limburg last July is estimated to come to between 350 and 600 million euros. And the tornado that tore through the town of Leersum a month before that did 37 million euros' worth of damage.

Both the economic and the social damage done by extreme weather is currently being mapped through another platform that will go online at the end of 2023: the Climate Impact Monitor. 'Extreme weather doesn't just damage buildings, roads and vehicles,' explains the instigator of this project, Rutger Dankers of Wageningen Environmental Research. 'It also has consequences for health, agriculture and nature. A heatwave causes additional illness and deaths, but heat, combined with long droughts, also affects water quality, and it can increase energy costs because air conditioning gets switched on and cooling installations have to work harder.'

Unlike meteorological data on precipitation and temperature, data on the impact of >

EXTREME WEATHER IN 2021

Weather extremes are increasing due to climate change. We are seeing more heat records, extreme rainfall and storms, and these lead to droughts, wildfires and flooding. 2021 gave us a foretaste of what is in store for the world in the coming decades. A sample of the extreme weather events worldwide.



January Eastern, central and northern **Spain** were hit by exceptionally heavy snowfall and severe cold. Life in the capital, Madrid, was totally disrupted.

PHOTO LERMA / SHUTTERSTOCK.COM

February Almost 10 million residents of **Texas** and northern **Mexico** were without electricity due to Blizzard Uri, which brought temperatures of minus 13 degrees Celsius.

PHOTO MAROUANESITTI / SHUTTERSTOCK.COM

March The air in the Chinese capital of **Beijing** was turned orange by a heavy sandstorm coming from the Gobi desert, which is expanding due to climate change.

PHOTO VINCENT369 / SHUTTERSTOCK.COM

April Tropical cyclone Seroja left a trail of death and destruction from landslides and flooding in its wake in Indonesia and western **Australia.**

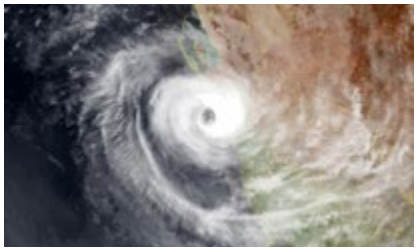


PHOTO NASA

May North-western **Russia** experienced tropical temperatures: about 20 degrees higher than normal. The temperature in Narjan-Mar, within the Arctic Circle, went up to 31.9°C.

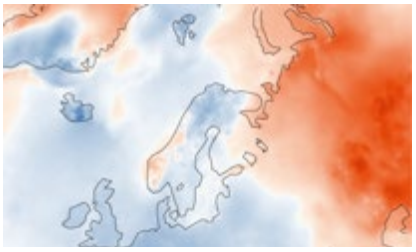


PHOTO C3S/ECMWF

June The northwest of the **United States** and the Canadian province of **British Columbia** faced a historic heatwave. The Canadian town of Lytton reached 49.6 °C and was devastated by a wildfire.

PHOTO ANP

July Heavy rain caused flooding in **Germany, Belgium** and South Limburg, in **the Netherlands**. There were 184 deaths in Germany and 41 in Belgium.

PHOTO ANP/AP

August Record temperatures in **Greece, Turkey** and **Italy,** rising to 50°C locally, caused enormous wildfires.

PHOTO ANP

October Heavy monsoon rains caused floods and landslides in **India** and **Nepal;** more than 100 people died due to extreme weather.

PHOTO ANP/AFP

> ‘The amount of damage caused by natural disasters is increasing’

extreme weather are not yet registered centrally. Dankers is working on collecting these data together with partners such as the Dutch Union of Insurers, RIONED, STOWA, the Climate Adaptation foundation, several provinces, and the Royal Dutch Meteorological Institute KNMI. Dunkers: ‘In other countries, such as Russia, the impact of extreme weather has been documented for some time, with a view to prevention. Once we have a better overview of the impact of extreme weather and the regions where it occurs frequently, we can be better prepared for it. Cities can be designed to cope better with heavier rainfall, or they can plant more vegetation to provide more cooling during heatwaves. And the KNMI can finetune its warnings by specifying the impact the weather could have per region.’
In comparison with 1953, when a catastrophic flood caused 1836 deaths, we are much better prepared for natural disasters now, says Dunkers. ‘You can see that all around the world. The number of deaths from natural disasters is decreasing, but the structural damage is increasing. There are more people, more houses and more roads, so the chances of damage are higher.’ Last year alone, according to Munich Re, 210 billion dollars’ worth of damage was caused worldwide by natural disasters, including volcanic eruptions and earthquakes.

TIPPING POINTS

In the latest climate report, the IPCC warns of tipping points in relation to extreme weather. These are events that mean the climate has changed so much that there is no way back. The icebergs, the Gulf Stream in the Atlantic, the permafrost in tundra regions, the frozen methane in the seabed, and the Amazon rainforest are all examples of elements in the climate system that could reach a tipping point where they set off a domino effect, says Marten Scheffer, professor of Aquatic Ecology and Water Quality Management, and an expert on transitions. Scheffer: ‘The Amazon Forest, for instance, plays a key role in the formation of clouds and rain. If the Amazon region changes into a savannah due to felling, increasing fires and forest dieback, that could have a big effect on the regional climate. And the loss of such a big reservoir would raise CO_2 levels worldwide.’

GULF STREAM WEAKENING

Another event hanging over our heads like a sword of Damocles is the possible stopping of the warm Gulf Stream that brings warm water from the Gulf of Mexico to the northern Atlantic Ocean and is known as the climate’s conveyor belt. ‘If the polar ice melts, large amounts of fresh meltwater will get mixed with salt seawater, which then won’t easily sink to the bottom, where the current in the direction of the tropics starts. Then the Gulf Stream could lose momentum, which could lead to colder weather in the north, and warmer weather in the south. It is not certain whether that is going to happen, but there are signs that the Gulf Stream is weakening.’
In the Wageningen SparcS Centre, which Scheffer set up, the mechanisms underlying major system changes are analysed. ‘Because even if tipping points in systems like the climate are hard to predict, there are similarities between them and other tipping points in society. There are warning signs, just as there are with people suffering from depression. Some of those warning signs are of a universal nature, because there’s a reduction in resilience as a tipping point approaches.’ You can see that kind of reduction in subtle changes in the pattern of fluctuations. ‘Those ups and downs are a giveaway about the capacity to recover from small, natural disturbances. Surprisingly enough, we find the same signal in many different complex systems as a tipping point approaches. At a deep level, then, there are significant similarities between things as different as brains, ecosystems and the climate system.’

SOCIAL CHALLENGE

As far as extreme weather is concerned, the biggest impact in the coming decades is going to come from the increasing occurrence of heatwaves and long droughts, says Scheffer. ‘A recent study by SparcS shows that for thousands of years, we humans have flourished best in a climate with an average annual temperature of around 13 degrees. We call that the human niche. With global warming, that niche is going to shift. In the next 50 years, one to three billion people will be living in regions that are too hot, and that will inevitably lead to migration. Migration is a potential source of conflict. So migration that is a form of adaptation to climate change is primarily going to pose a societal challenge.’
There is good news too, though, says Scheffer. ‘Every degree less of global warming prevents about a billion people from resorting to migration. And that can be achieved by calling a radical halt to the extraction of fossil fuels from the ground, and by adapting our diet. You can’t just leave that to consumers. As with combatting a pandemic, it will only succeed if governments shoulder their responsibilities.’ ■

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WCDI
Wageningen Centre for Development Innovation runs online courses about Climate & Environment, which are relevant to this topic.
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