Intergovernmental Panel on Climate Change:

Sixth Assessment Report, 2021

https://www.ipcc.ch/report/ar6/wg1/#FullReport, 1300 pages

The Intergovernmental Panel on Climate Change (IPCC) is the world's leading authority on climate change, and its role is to provide objective scientific information relevant to understanding human-induced climate change, its natural, political, and economic impacts and risks, and possible response options as well. The first chapter of its Sixth Assessment Report, Climate Change 2021: The Physical Science Basis, was published earlier this month after eight years in the making. Given that it analysed the work of hundreds of experts and peer-review studies, it is the most comprehensive assessment of climate science to date, and it is considered to represent the world's full knowledge to date of the physical basis of climate change. By using new climate model simulations and methods combining multiple lines of evidence lead to an improved understanding of how the Earth's climate is changing because of human activity.

According to this report, "it is unequivocal that human influence has warmed the atmosphere, ocean, and land". Concentrations in the atmosphere have continued to increase in 2019, carbon dioxide (CO_2) reached 410 ppm, methane (CH_4) 1866ppb, and nitrous oxide (NO_2) 410 ppm respectively. Looking at these data, the researchers could say with high to very high confidence that in 2019, atmospheric CO_2 concentrations were higher than at any time in at least 2 million years, and concentrations of CH_4 and N_2O were higher than at any time in at least 800,000 years.

As a result, since 1850, each of the last four decades has been successively warmer than any decade that preceded it with the global surface temperature being an estimated 1.09 °C higher in the period 2011– 2020. Though this is the average figure, some parts of the world are heating a lot faster than others: the Arctic for example is heating up at a rate that is more than twice as fast as the global average. Compared to the period 1992–1999, due to this warming, the rate of ice sheet loss increased by a factor of four by 2019. Under all emissions scenarios considered global surface temperature will continue to increase until at least the mid-century. Based on multiple lines of evidence, the very likely range of equilibrium climate sensitivity (ECS) -the global temperature rise following a doubling of CO_2 concentration (520 ppm) in the atmosphere compared to pre-industrial levels of 260 ppm - is between 2°C and 5°C. Given that the current level of atmospheric CO_2 stands at 410 ppm, we are expected to reach 520 ppm in the next 50-100 years. This means that not only the goal of limiting global warming to 1.5°C will fail, but 2°C will be exceeded and in the worst-case scenario, we could be on the path of reaching 5°C of warming by the end of the 21st century. It goes without saying, this is only the case unless deep reductions in CO_2 and other greenhouse gas emissions occur in the coming decades. In the scenario of very low future GHG emissions, global surface temperature could decline back to below 1.5°C by 2100, with only a temporary overshoot of 0.1°C above 1.5°C global warmings.

Many changes in the climate system become larger in direct relation to the rising global temperatures and even at 1.5°C of global warming, there will be an increasing occurrence of some extreme events unprecedented in the observational record. The researchers found that human-induced climate change is already affecting many weather and climate extremes, such as heatwaves; heavy precipitation; droughts; and tropical cyclones, in every region across the globe. According to the report, some recent hot extremes (for example, the prolonged heatwave in northeastern Siberia during the first half of 2020) observed over the past decade would have been extremely unlikely to occur without human influence on the climate system. Therefore, it can be said that human-induced climate change is the main driver of hot extremes becoming more frequent and more intense and cold extremes (including cold waves) becoming less frequent and less severe since the 1950s. Due to these new extremes, the Arctic is likely to be practically sea ice-free in September at least once before 2050 with more frequent occurrences for higher warming levels.

Many of these changes due to past and possible future greenhouse gas emissions "are irreversible for centuries to millennia, especially changes in the ocean, ice sheets and global sea level." Regarding the world's oceans, these include changes in the global ocean temperatures, deep ocean acidification, and deoxygenation. Mountain and polar glaciers are also committed to continuing melting for at least decades, if not centuries to come. In the longer term, the sea level is expected to rise and remain elevated for thousands of years due to continuing deep ocean warming and ice sheet melt. Under a very high GHG emissions scenario, we would be approaching a 2 m rise by 2100 and 5 m by 2150. However, even if global warming is limited to 1.5°C, sea levels could still rise by about 2 to 3 m over the next 2000 years.

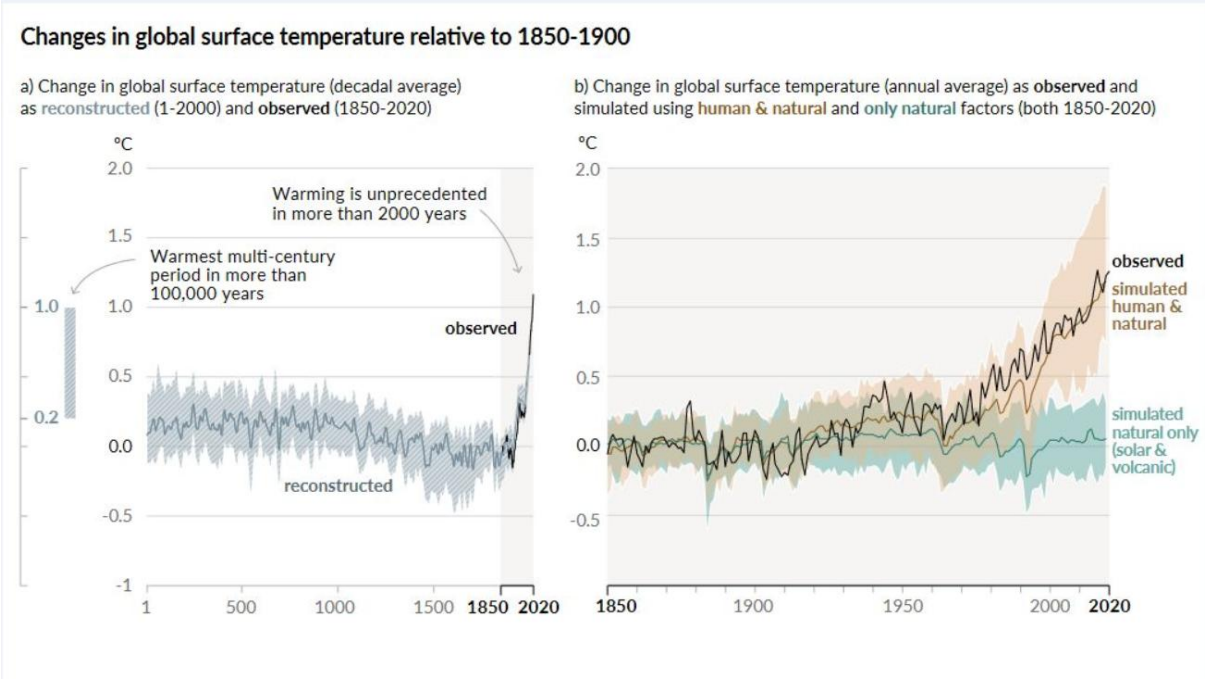
Every degree of warming matters. For example, extreme heat thresholds relevant to health and agriculture are projected to be exceeded more frequently at higher global warming levels. Droughts at multiple locations, including crop-producing areas, are also likely to become more recurrent at 2°C and above compared to 1.5°C global warming. On the global scale, extreme daily precipitation events are also projected to intensify by about 7% for each 1°C of global warming, resulting in intensified and more frequent flooding in most regions in Africa and Asia, North America, and Europe as well.

To prevent such climate breakdown, only rapid and drastic reductions in greenhouse gases can help us. These stark findings must force new and urgent policy measures to shift the global economy to a low-carbon footing. Reaching net-zero anthropogenic CO2 emissions is a requirement to stabilize human-induced global temperature increase at any level. In addition, scientists also emphasise the importance of delivering "strong, rapid and sustained reductions" in the human-caused methane emissions, that largely come from agriculture and the production of fossil fuels, to stand a fighting chance against climate change.

Ahead of Cop26, António Guterres, the UN Secretary-general warned the participating 197 countries: "This report is a *code red* for humanity. The alarm bells are deafening, and the evidence is irrefutable: greenhouse gas emissions from fossil fuel burning and deforestation are choking our planet and putting billions of people at immediate risk". Dr. Friederike Otto, one of the report's authors, also urged the world to take note of the fact that "we are not

doomed" yet and every action we take to reduce greenhouse gas emissions will make a difference.

The report will be followed next year by two further installments: one focusing on the impacts of the climate crisis and another detailing the potential solutions. Until then, let's hope that in November the nations come to Cop26 prepared with fresh plans of how to significantly reduce GHG emissions.



Climate change is already affecting every inhabited region across the globe with human influence contributing to many observed changes in weather and climate extremes

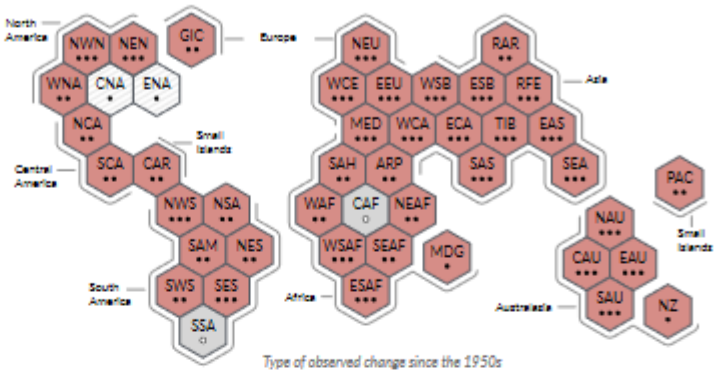
a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's regions

Type of observed change in hot extremes

- Increase (41)
- Decrease (0)
- Low agreement in the type of change (2)
- Limited data and/or literature (2)

Confidence in human contribution to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Type of observed change since the 1950s

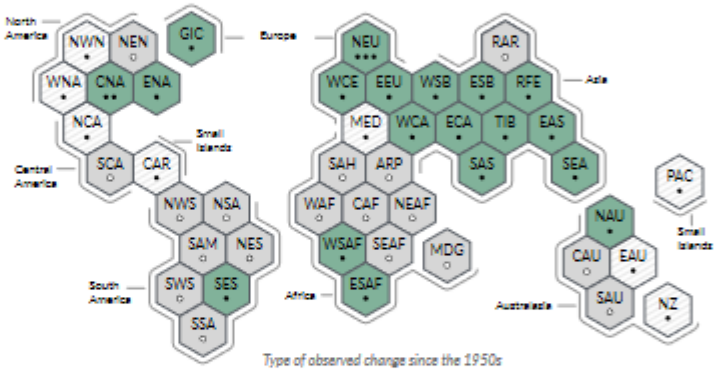
b) Synthesis of assessment of observed change in **heavy precipitation** and confidence in human contribution to the observed changes in the world's regions

Type of observed change in heavy precipitation

- Increase (19)
- Decrease (0)
- Low agreement in the type of change (8)
- Limited data and/or literature (18)

Confidence in human contribution to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Type of observed change since the 1950s

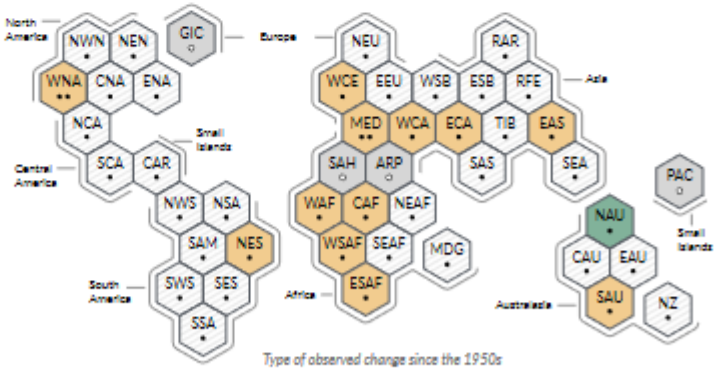
c) Synthesis of assessment of observed change in **agricultural and ecological drought** and confidence in human contribution to the observed changes in the world's regions

Type of observed change in agricultural and ecological drought

- Increase (12)
- Decrease (1)
- Low agreement in the type of change (28)
- Limited data and/or literature (4)

Confidence in human contribution to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Type of observed change since the 1950s

Each hexagon corresponds to one of the IPCC AR6 WGI reference regions

NWN *North-Western North America*

IPCC AR6 WGI reference regions: **North America:** ***NWN*** *(North-Western North America),* ***NEN*** *(North-Eastern North America),* ***WNA*** *(Western North America),* ***CNA*** *(Central North America),* ***ENA*** *(Eastern North America),* **Central America:** ***NCA*** *(Northern Central America),* ***SCA*** *(Southern Central America),* ***CAR*** *(Caribbean),* **South America:** ***NWS*** *(North-Western South America),* ***NSA*** *(Northern South America),* ***NES*** *(North-Eastern South America),* ***SAM*** *(South American Monsoon),* ***SWS*** *(South-Western South America),* ***SES*** *(South-Eastern South America),* ***SSA*** *(Southern South America),* **Europe:** ***GIC*** *(Greenland/Iceland),* ***NEU*** *(Northern Europe),* ***WCE*** *(Western and Central Europe),* ***EEU*** *(Eastern Europe),* ***MED*** *(Mediterranean),* **Africa:** ***MED*** *(Mediterranean),* ***SAH*** *(Sahara),* ***WAF*** *(Western Africa),* ***CAF*** *(Central Africa),* ***NEAF*** *(North Eastern Africa),* ***SEAF*** *(South Eastern Africa),* ***WSAF*** *(West Southern Africa),* ***ESAF*** *(East Southern Africa),* ***MDG*** *(Madagascar),* **Asia:** ***RAR*** *(Russian Arctic),* ***WSB*** *(West Siberia),* ***ESB*** *(East Siberia),* ***RFE*** *(Russian Far East),* ***WCA*** *(West Central Asia),* ***ECA*** *(East Central Asia),* ***TIB*** *(Tibetan Plateau),* ***EAS*** *(East Asia),* ***ARP*** *(Arabian Peninsula),* ***SAS*** *(South Asia),* ***SEA*** *(South East Asia),* **Australasia:** ***NAU*** *(Northern Australia),* ***CAU*** *(Central Australia),* ***EAU*** *(Eastern Australia),* ***SAU*** *(Southern Australia),* ***NZ*** *(New Zealand),* **Small Islands:** ***CAR*** *(Caribbean),* ***PAC*** *(Pacific Small Islands)*